Situation of Iron Deficiency and Its Management Prioritizing Dietary Intervention in Nepal

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Review Article

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Abstract

Background

Control of iron deficiency disorders is prioritized in the nutrition policies of Nepal. The situation is still threatening the public health in both rural and urban areas.

Objective

There are limited reviews on the iron deficiency situation in Nepal. This study was undertaken to find out the extent of iron deficiency anemia and intake of dietary iron among the general population in Nepal.

Materials and methods

Published research articles, books, bulletins, and online materials regarding iron deficiency were studied in both national and international scenarios.

Results

Nearly 46 percent of children (6–59 months) and 35 percent of women (15–49 years) were still suffering from anemia though the trend has been decreasing for the last 15 years. Mostly, young children (6–23 months) and pregnant women were the victims due to their high iron requirements and lower intake of dietary iron. The most common risk factors related to iron deficiency anemia (IDA) found in different studies were low intake of dietary iron, vitamin A deficiency, hookworm infection, malaria, heavy menstrual blood loss, and multiparity. Iron deficiency situation in the Nepalese population is triggered by Illiteracy, lack of awareness, negligence, poor economy, food insecurity, lack of food diversity, changes in dietary behavior, cultural behaviors, poor health and sanitation, and patriarchal structure of the society.

Conclusion

The main risk factor of IDA is low intake of dietary iron. There is a need of multiple approaches to address IDA with more focus on dietary iron to reduce anemia.

Key words

Iron Deficiency Anemia, Iron Requirement, Nutrition, Women and Children, Nepal

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Background

Iron deficiency is one of the most widespread and common nutritional deficiencies in Nepal leading to anemia[1-3]. It presents a major threat particularly to children and pregnant women. According to the report of the WHO, approximately 60 percent of the pregnant women in developing countries were anemic, and iron deficiency anemia (IDA) was associated with about 20 percent of premature births, low birth weights, and maternal deaths[4]. Though its severity is higher in developing countries, it is still a public health problem in developed countries like the United States[5]. This is also a major public health problem in the Gulf countries where 20-67 percent of the preschool children and 23-54 percent of the pregnant women are suffering from IDA[6]. The situation in Nepal is also not good. A recent widespread study in Nepal revealed that nearly half (46.2%) of children aged 6–59 months, two thirds (69%) of young children aged 6–23 months, 35 percent of women aged 15–49 years, and 47.6 percent of pregnant women were found to be anemic[1]. It is a major problem for development, performance, and productivity of the people. Iron deficiency accompanied by protein-energy malnutrition to a great extent affects infant and maternal health. Besides, iron deficiency during pregnancy increases the risk of maternal mortality, premature birth, and low birth weight along with several complications[7]. It was revealed in the study that the low birth weight was tripled and preterm delivery was more than double with IDA, but both cases were not increased with anemia from other causes[7]. A study in the plains of Nepal also revealed that 88 percent of cases of anemia among pregnant women were linked with iron deficiency[2]. This study has aimed at assisting public health professionals, policy makers, and plant breeders to make new strategies for fighting against the iron deficiency problem by reviewing the situation of nearly 20 years of iron deficiency in Nepal.

Materials and methods

This review paper was prepared with an extensive study of published articles that were available in the Web of Science database, open access materials on the Internet using Google, books, institutional bulletins, and online material from reliable sources. A systematic analysis was performed from/of more than 25 materials published from 1987 to 2012, both nationally and internationally. However, the iron deficiency problem mostly from 1995 to 2009 was highlighted in this review. This study has explored the magnitude of the constraints and factors that may contribute to the prevalence of anemia in Nepal in relation to the global and regional scenario. Possible dietary approach to address iron deficiency situation has been proposed in addition to the existing ones.

Data abstraction and analysis

Before preparing this review, it was attempted to collect as many published materials as possible regarding iron deficiency in Nepal. Women of childbearing age, pregnant women, and children were the group in focus for this review. Micronutrients, iron, iron deficiency, women, children, pregnant women, iron deficiency anemia, Nepal, etc. were the key words used for searching related materials in the web, library, and in institutions. The major findings in each research have been highlighted and the nutritional approach of addressing the iron deficiency problem has been discussed throughout this review paper.

Result

Causes

Though the primary cause of anemia is iron deficiency, it often occurs due to a decreased number of red blood cells or lower amount of hemoglobin or decreased oxygen-binding ability of hemoglobin molecule. These consequences were often attributed to ineffective hematopoisis, hemorrhage, hemolysis, lower iron intake than needed (Table 1), poor absorption of the iron in the intestines, vitamin A deficiency, hook worm, and malarial infection[2,8-13]. There is a need of studying the etiology of anemia among children 6-23 months and other strata for Nepal through a micronutrient status survey so as to know to which extent anemia is attributed to iron and other concomitant causes like malaria, infections, inflammation, and other micronutrient deficiencies, etc.

Table 1: Nutritional requirements for iron dietary reference intakes[9]

Life Stage	Age group	Males (mg/day)	Females (mg/day)
Infants	7-12 months	11	11
Children	1-3 years	7	7
Children	4-8 years	10	10
Children	9-13 years	8	8
Adolescents	14-18 years	11	15
Adults	19-30 years	8	18
Adults	31-50 years	8	18
Adults	>50 years	8	8
Pregnancy	All ages	-	27
Lactation	14-18 years	-	10
Lactation	>19 years	-	9

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A study pointed out that cultural behavior was one of the causes of IDA in women of South Asian origin[14]. It revealed that these women have a tendency to avoid food from animal sources like meat, egg, and fish at the time of heavy menstrual blood loss, making them vulnerable to IDA[14]. Cultural behavior was also responsible for nutritional deficiency in Nepal. The culture of eating at the last in the family put women in risk of getting qualitatively and quantitatively less food. Furthermore, poverty and unequal intra-household food distribution system increase the risk of iron deficiency among women in Nepal. Living in patriarchal families, men usually have outdoor foods like meat, fish, etc. and are unaware of family needs. According to a dietary assessment, men's iron intake was found to be higher than that of women, which is attributed to their larger portion of daily food at home and frequent consumption of foods of animal origin at the local market[15]. Even in the Kathmandu Valley, the capital of Nepal, where people are thought to be informed and educated, the mean daily iron intake is 7.5 mg in men and 6.3 mg in women, which was less than the daily requirement (Table 1)[8]. The iron deficiency problem in rural areas of Nepal was also similar to that of urban areas. A recent study in a village of Nepal has revealed that 54 percent of the women took less than the average recommended dose of iron[16]. Another community-based study in Eastern Nepal revealed that the prevalence of IDA among the adolescent population was nearly 66 percent of which 70 percent were from urban areas[17].

Gundruk, a traditionally preserved vegetable from broad leaf mustard is rich in iron content[18]. This is a cheap source of iron for poor families for whom meat becomes a food for festivals. Unfortunately, children are reluctant to eat *gundruk* in their meals, which makes the poor families vulnerable to iron deficiency problems. There is a need for technological innovations to present iron-rich foods in appropriate forms of use targeting pregnant women and children. Furthermore, the incorporation of meat (which is the main source of heme iron) in the diet of marginalized and ultra poor families is not so common due to its high price. So, women and children of those communities become more vulnerable to nutritional deficiency as in the United States where most of the iron-deficient women were those from minority, low income, and multiparous groups[5]. There is a limited availability of black gram, which is another source of dietary iron. Lentil is taking over the place of black gram because the former one is easily available at the market at a cheaper price than black gram.

Hookworms, malaria, vitamin A and D deficiencies contribute to anemia and iron deficiency in pregnant women in the Terai areas of Nepal[2,3]. The prevalence of anemia was linearly associated with the intensity of hookworm infection[2]. Certain foods, e.g. tea, wheat bran, and legumes, contain chemical compounds like phosphate, phytate, casein, tannin, and polyphenols, which are reported as inhibitors of iron absorption[10,11]. Drinking tea is a common practice in Nepalese society which minimizes the bioavailability of iron if taken together with other foods. The bioavailability of non-heme iron is reported to be poor as it is highly affected by above inhibitors that are present in plant sources.

Risk factors and people at risk

The common risk factors of iron deficiency were heavy menstruation, blood losses from the body due to colon cancer, hookworm infection, pregnancy/repeated pregnancy and low dietary intake of iron[19]. The recent survey in Nepal reported that only one in four children had received iron-rich food in the last 24 hours before the survey[1]. The iron requirement is high during pregnancy and rapid growth stages due to heavy iron utilization in metabolic activities. Hence infants, children, adolescent, women of childbearing age, pregnant and lactating women are most vulnerable to IDA[20]. Dietary iron in vegetarians consists solely of the non-heme type (grains and vegetables), which is poorly absorbable and is considered a major factor in the etiology of IDA[12]. We should keep in mind that only 15 percent of the iron in foods is absorbed in healthy persons; however, this proportion increases as the body's need for iron increases[20]. Moreover, human iron absorption is less than 30 and 5 percent respectively of what is actually the content in meat and plant sources[20].

Management of iron deficiency in Nepal

Iron supplementation in the form of tablets has become the major strategy for both curative and preventive approaches to iron deficiency in pregnant women in Nepal (Table 2). The daily dose for iron supplementation for pregnant women is 60 mg with 400 µg of folic acid from the beginning of the second trimester of the pregnancy until 45 days postpartum[21]. However, if the duration of supplementation during the time of pregnancy is short, it can also be continued during postpartum for a period of 6 months. Alternatively, the daily intake dose is increased to 120 mg/day. Such interventions in Nepal have resulted in a significant reduction of the risk of obstetric complications[22]. The government of Nepal provides the biannual deworming tablets (Albendazol) to the children of 1–5years (Table 3) as a strategy of reducing iron deficiency anemia among pre-school children[23]. Through the School Health and Nutrition Program, the primary school children also receive bi-annual de-worming medication[24].

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Table 2: Guidelines for therapeutic supplementation of iron and folate to treat severe anemia[21]

Age group	Dose	Duration
< 2 years	25 mg iron + 100-400 µg folic acid daily	3 months
2–12 years	60 mg iron + 400 µg folic acid daily	3 months
Adolescents and adults, including pregnant women	120 mg iron + 400 µg folic acid daily	3 months

Since home fortification of foods with iron has been successful in treating anemia in some countries[25], the Ministry of Health and Population (MoHP) has also started home fortification programs in Nepal with multiple micronutrient powders (MNPs) under the World Health Organization's guidelines[26]. This does not ask for a change in food habits as the powders are sprinkled on the food that the children usually eat. This has also helped a timely initiation of complementary food. This program has targeted children completing 6 months. Although there are global evidence of the impact of anemia reduction through MNPs, the impact has not yet been evaluated in Nepal. Simultaneously, the second anemia control plan 2012–2016 is being formulated by MoHP addressing anemia among all strata, particularly the most vulnerable ones like children of 6-23 months young, children of 6-59 months, adolescents, pregnant women.

Table 3: Guidelines for Albendazol therapy to treat intestinal worms in Nepal[23]

Target	Dose	Time
Children (1- < 2 years)	½ tablet of Albendazol (200 mg)	Twice a year (integrated with vitamin A program)
Children (2–5 years)	1 tablet of Albendazol (400 mg)	Twice a year (integrated with vitamin A program)
Pregnant women (after first trimester)	1 tablet of Albendazol (400 mg)	Once (after completion of first trimester)

In our daily life, it is a good idea to integrate such preventative approaches like reduction of hookworm infection, iron fortification, intake of iron rich foods together with vitamin A-rich foods, increased consumption of iron-rich foods during pregnancy and childbearing age, frequent exposure to sun light to ensure the vitamin D content in the body, etc.

The dietary approach to managing iron deficiency

Beside iron tablet supplementation, iron fortification is one of the rapid interventions to improve the iron status of the population. The National Nutrition Policy and Strategy 2004 has also clearly mentioned its regular fortification of commonly used wheat flour with iron and its effective implementation. This has now been made mandatory in Nepal, hence all flour mills must fortify the wheat flour with iron and folic acid. Since rice is our staple food, genetically engineered rice enriched with phytase and cysteine-peptide, which increase iron bioavailability and absorption, respectively, has a great potential for improving the iron status substantially in Nepal[27]. The Ministry of Health and Population also has the infant and young child feeding program linked to the micronutrient powder sprinkling program to improve nutritional status and iron bioavailability among children under 6–23 months of age.

However, since supplementation and fortification programs alone have proved not to be so effective in reducing the prevalence of iron deficiency anemia in developing countries, increase in dietary iron intake through iron-rich foods in a good composition and nutritional awareness and promotion seems to be more important to avoid its threat in public health[27]. Some people are not familiar with iron and its sources and some may know; however, it is missing from their diets due to different food habits, poor economy, or ignorance about its importance[28].

For the holistic improvement of human health it is very important to fulfill the iron requirements of the body by incorporation of a variety of iron-rich foods alternatively in the daily diet. The bioavailability of iron from animal sources (60% of iron in meat is heme iron) like meat is higher than from plant sources (non-heme iron) like cereals, fruits and vegetables[20]. The bioavailability of iron in black gram (15 mg/100 g) is higher than in other legumes which could serve as a good source of iron[29]. The production of black gram should be increased and people should have a balance use of black gram and lentil as dhal. Food diversification is extremely important to increase the bioavailability of iron. Supplementation, fortification, or increased intake of iron-rich foods, however, does not ensure the iron sufficiency in the body until and unless the vitamin A is provided to enable iron mobilization and transport. The most common cause of anemia in Nepal is inadequacy of dietary nutrients necessary for synthesis of hemoglobin, such as iron, folic acid, and vitamin B12. So, it is extremely important for children and pregnant women that they are not deficient in vitamin A, folic acid, vitamin B12, copper, magnesium, and zinc in addition to the control of parasitic infection.

Decreasing the inhibitors of iron absorption

Preceding the study, approval for the study was obtained

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from the institutional research ethical committee. The bioavailability of iron is not only dependent on the amount of iron intake and absorption capacity of the individual. Some chemical compounds in certain foods like phosphate, phytate, casein, tannin and polyphenols, etc. are powerful inhibitors of non-heme iron absorption[10,11,13,20]. For pregnant and iron-deficient people, it is suggested not to take too many foods like tea, coffee, and wheat bran, which may decrease the iron absorption in the body. Research has shown that coffee and tea may reduce iron absorption by 40 percent and 60 percent respectively[20]. However, individuals can avoid their inhibitory action by not taking such foods at the same time as their regular meals. Soaking legumes before cooking reduces phytic acid thereby reducing their inhibitory effect on iron absorption[20].

Increasing the enhancers of iron absorption

Some chemical compounds are found to increase the bioavailability and absorption of iron in the human body. For example, ascorbic acid, malic acid, citric acid, tartaric acid, cysteine, etc. increased non-heme iron absorption in the body[13]. It has been reported that these compounds increase the iron absorption often 2-4-fold. Similarly, non-heme iron absorption is also increased when meat or fish is consumed at the same time[20]. Rather it is better to include enhancers of iron absorption like fruit juice, green leafy vegetables, potatoes, some germinated foods, and foods which are rich in vitamin A precursors and vitamin C. A high intake of calcium-rich foods can increase the iron absorption because the calcium combines with phosphates and phytates, thereby reducing their inhibitory effect on iron absorption[20].

Increase iron intake

Nutrition/Health Education and Awareness

Nutrition/health education and awareness programs can be effective tools to fight against iron deficiency. The first and most important thing is that all people should know the importance of iron in our body. The second most important thing is they should be well acquainted with the iron rich foods (Table 4) and their bioavailability so that they can diversify their dietary sources and change their food habits[18,29-31]. Educating and motivating housewives through community health workers is extremely important since they play a key role in homestead food production, food selection, preparation and feeding of their families. Especially the vegetarians should be encouraged to have iron rich foods (Table 4) including those which enhance absorption and bioavailability of iron in the body. The traditional way of cooking in an iron pot (karahi) was also reported to enhance the iron content of food[30]. But due to modernization and easy availability of other cooking utensils this practice seems to be decreasing. Thus, such a good and easy practice should be preserved through nutritional education. Nutrition and health education in schools could bring significant changes in the whole family by changing their dietary behavior.

Improving the Household Food Security Level

A healthy diet is a key to a healthy lifestyle. A research done in the Baitadi District has revealed the significant link between the household food insecurity and the nutritional condition of women and/or children[32]. Compared to mothers from food secure households, research has reported that the mothers from food insecure households were 78 percent more likely to be anemic. Encouraging community people to increase the production of poultry, fish, and livestock products together with year-round vegetables and fruits increases the availability and accessibility of iron-rich foods. Women and children should have equal access to the foods both indoor and outdoor. Community people should be trained in preservation and processing of the food items for future use. For example, *gundruk*, is a rich source of iron (94.3 mg/100 g) which could be used as an alternative source of iron at the time when the fruits and vegetables are limited[18]. However, a technological modification of *gundruk* or an alternative dietary iron should be provided for children.

Homestead food production

Most of the people in the countryside have a subsistence type of farming system. Though they are poor, most of the families have a small kitchen garden or homestead where they can raise livestock or produce year round vegetables or fruits for self-consumption or selling at the local market. They should be encouraged to produce animal and vegetable products, increase the consumption and generate some income from selling their products so that they can buy other products from neighbors or local markets. Homestead food production can be a tool for increasing household food security. Families should be motivated to exchange their products to ensure that they take nutrient rich foods from a variety of foods.

Discussion

This is an updated review of the iron deficiency situation in Nepal focusing on children and women. Preschool children, women of childbearing age, and pregnant women should have been given due consideration during planning and making strategies against iron deficiency anemia. Low iron intake through diet during high iron requirements particularly below five years of age and pregnancy was one of the major risk factors of IDA. This study mainly focused

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on nutritional intervention to address this problem together with supplementation. From political situation of the last 15 years in Nepal, it was seen that people were sometimes prevented from getting basic medications including iron tablets in many places of Nepal due to frequent long strikes with no transportation. If a dietary approach is given a due priority together with supplementation during pregnancy, the situation of IDA seems to be manageable in Nepal. This study has realized to know the changes in the dietary pattern of Nepalese women during heavy menstrual blood loss. It is important to know whether Nepalese women have tendency to avoid foods of animal origin during menstruation period as reported in a study on women of South Asian origin[14]. To understand the changes in dietary behavior a comparative study of dietary recall before the menstruation and during the menstruation can be done. Similarly, a comparative study of dietary recall before the pregnancy and at different periods of pregnancy is needed. This helps to understand which food component is lacking or has been increased and whether that puts the iron status at risk or not. Due to high iron requirements and poor intake, children and women of childbearing age become more vulnerable to IDA, resulting into maternal and child mortality, premature birth, low birth weight and undernourishment.

Table 4: Some common iron-rich foods (compiled)[18,29,31]

Food	Iron content (mg/100g)
Spinach	3.5
Lentils	3.3
Beans (red kidney)	2.9
peas	1.5
Bread (wholewheat)	2.4
Fish (trout)	1.9
Egg (whole boiled)	1.1
Rice (white cooked)	1.5
Grapes	0.3
Apples	0.1
Bananas	0.2
Wine, dry, 12% ethanol	0.2
Rayo ko gundruk	94.3
Maseura	44
Mula ko sag ko gundruk	26.6
Beaten rice (*Chiura*)	20
Black gram	15

A regular intake of iron-rich foods throughout the year is extremely necessary for children and women, who require a high amount of iron for their body (Table 4)[18,29-31]. Varietal production of preserved broad leaf mustard and *gundruk*, value addition to *gundruk* may increase the tastiness and intake of these products amount children and women. There is no sufficient research on dietary diversification and iron level in underutilized crops in Nepal. Moreover, people should be motivated to consume other cereals (millets, buckwheat) containing high iron content as an alternative to white rice. A small modification before cooking, like soaking, malting, etc., might increase the bioavailability of iron in pulses, millet, buckwheat, etc. Dreyfuss *et al.*[2] reported that vitamin A deficiency also triggers iron deficiency in pregnant women in Nepal. Though several programs were implemented to promote intake of green vegetables, yellow-colored fruits in addition to the supplementation and fortification, iron deficiency situation is not satisfactory. Different food components interfere with iron bioavailability, a function of absorption and metabolism[10-13]. So, a dietary approach of managing IDA should be viewed by different angles but not just by increasing the consumption of iron-rich food. The dietary composition at a specific time point should be compatible so that a maximum of ingested iron becomes available to the body. Particularly for young children, dietary modifications alone may not be sufficient to prevent anemia as more than two thirds of them are anemic. Home fortification (through sprinkles) needs to be considered as an acute response to addressing the problem. But these modifications are not mutually exclusive; home fortification must be simultaneously complemented by other dietary measures, i.e. food fortification, supplementation, and other public health measures.

Though there are some controversies over genetically modified foods, it has been possible to increase the nutritional value of the food by genetic modification that may help fighting nutritional deficiency[27]. If we really want to address iron deficiency through a dietary approach, crop improvement programs should also go together. Iron biofortification is possible to increase the amount and bioavailability in food by crop improvement programs. Agricultural scientists in the Nepal Agricultural Research Council may work on breeding, selection, or improvement of some of the crops that are most used in Nepal to increase the iron content and iron bioavailability. Iron content and bioavailability can also be increased to some extent just by cooking food items in iron cookware[30].

A dietary survey in the Kathmandu valley revealed that the daily food intake in women was much lower than that of estimated requirements suggesting that there is enough room for the improvement of iron deficiency through

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increased consumption of iron-rich diets[8]. In a similar other study more than 50 percent of healthy women had less than the recommended level of iron in their diet[16]. A separate study in the Southern plains of Nepal revealed seasonal variation of micronutrient deficiency suggesting a seasonality in micronutrient-rich food availability[33]. A food plan can be launched incorporating *gundruk*, black gram, and other iron-rich food crops which might be helpful to supply the iron in the seasons when fruits and vegetables are scarce. But there should also be frequent intake of foods from animal sources which contain readily available iron.

This study did not include the iron deficiency situation of men and elderly population of Nepal. Though the need of iron in the elderly population is not that much higher compared to pregnant women, iron could be deficient in their body due to decreased digestion and absorption capacity with age. A study of these populations is also needed. This review might be helpful for the public health professionals and policy makers to address the problem through the dietary approach.

Nutritional relevance

Our study signifies that the lower intake of dietary iron is the primary cause of iron deficiency anemia in Nepal. Low intake of iron-rich dietary sources is associated to some extent with income level, availability, behavior, and ignorance. A difference in dietary behavior before and after the menstruation as well as before and after the pregnancy could exist among Nepalese women which make them in risk of iron deficiency.

What this study adds

This review is an important contribution to the study and management of iron deficiency anemia in Nepal. The study has focused on systematic use and consumption of the dietary sources of iron as an alternative to the supplementation in normal population. The ultimate and long term remedies of iron deficiency exist in our periphery. We shouldn't be dependent on international organizations for this micronutrient which is easily available in our own indigenous dietary sources. With good nutritional set up, we can easily address the daily iron requirement through dietary sources but it can be supplemented during pregnancy due to high requirement.

Future scope of study

This study forms the basis for the development of future programs and studies on iron deficiency in Nepal. This study has generated an idea that dietary recommendation could be helpful to identify the needs and sources of different nutrients including iron for Nepalese people. This study may assist the health professionals to study the nutritional relevance and etiology of anemia among the children of 6 to 23 months. Additionally, it also has indicated the need of comparative study of dietary changes before and after the menstruation as well as before and after the pregnancy in Nepalese condition to reveal their association with prevalence of anemia.

Conclusion

The dietary approach deserves a further study concerning iron deficiency situation in Nepal for its holistic management. People need to be educated and awared of the consequences of iron deficiency and change their dietary and cultural behavior to consume more iron-rich foods. Knowledge on changes in dietary behavior before and during menstruation as well as before and during pregnancy might generate some information that could be helpful for the formulation of new strategies. The government should focus on iron centered nutritional program for whole population in an integrative way and should prioritize iron intake through diet. It would be a good idea not only to increase the consumption of *gundruk* but also to add value to it so that children and women like to have it with their meal. In the long term, for the improvement of overall health of the population, food diversification is the most effective way to address the iron requirements of the body and also to overcome other nutritional problems. This review might be helpful for planning and formulating new strategies against iron deficiency problems in coming days.

Conflict of Interests

The authors do not have any conflict of interest arising from the study.

Authors' contributions

KA designed the study, performed systematic review, drafted the paper, and improved the manuscript. UK and AL made additional contribution in the draft and revised the manuscript. PD contributed by revising the manuscript and including recent intervention programs in Nepal with some updated and recent references on the manucript. All the authors approved the final manuscript.

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