# Iron in Drinking Water and its Impact on Human Health –A Study in Selected Units of Jalalabad Cantonment

Rahman I[1], Wahab MA[2], Akter M[3], Mahanta TR[4]

## ABSTRACT

**Background**: Prevalence of diseases due to appearance of excessive amount of iron in drinking water is increasing day by day. Often people are unaware about the harmful effects of excess iron that may be present in drinking water. Sometimes they overlook minor symptoms. Adequate study was not conducted before to rule out actual scenario. The aim of this study is to represent the detrimental effect of excessive iron in drinking water as well as to create awareness to get rid of it.

**Methods**: A cross-sectional study was carried out in 17 units of 17 Infantry Division, Jalalabad Cantonment, Sylhet covering the period of January 2019 to May 2019. Total 52 participants were selected purposively who had been suffering from various kinds of abdominal symptoms; their source of drinking water was marked. Water was collected from 5 different sources to see iron level. Again they were monitored after establishing Reverse Osmosis water filter. Iron level at drinking water was also tested each time at laboratory by Atomic Absorption spectrometry method. Informed written consent was taken from the patients. A semi-structured questionnaire was developed and data were collected by face to face interview. Analysis was done by using Statistical Package for the Social Sciences (SPSS version 25).

**Results**: Among 52 respondents, maximum i.e. 25(48.07%) developed moderate to severe constipation followed by 16(30.76%) developed dyspepsia and while others i.e.11(21.15%) had both the symptoms. Symptoms were most severe among the persons who used to drink water having highest concentration of Iron (1.9 mg/L). After establishment of Reverse Osmosis water purifier the iron concentration in water reduced significantly and only 4(8%) had constipation and 6(12%) had dyspepsia.

**Conclusion**:   Iron is a natural constituent of drinking water. But considering the harmful impact of excessive iron present in drinking water to human health, regular monitoring should be ensured to identify the risk group.

**Keywords**: Iron, Constipation, Dyspepsia

## INTRODUCTION

Iron is an important constituent of many compound molecules of the Earth. Iron is the fourth most abundant element making up 5.6% of earth's crust.[1] Iron is an essential mineral required for various bodily functions, such as transporting oxygen, takes part in oxyhemoglobin mechanism, supporting metabolism, and maintaining healthy skin and hair.[2] However, its overload causes severe health problems in human beings such as liver cancer, diabetes, cirrhosis of liver, heart

1. Col Irtika Rahman, MPhil, MPH 2. Col Md Abdul Wahab, MD 3. Lt Col Monowara Akter, MPhil 4. Maj Timir Ranjan Mahanta.

diseases and infertility etc.[3] Elemental iron is rarely found in nature. Iron may remain in two forms e.g. Fe2+ and Fe3+. They may readily combine with oxygen and sulfur containing compounds to form oxides, hydroxides, carbonates, and sulfides. Iron is most commonly found in nature in the form of its oxides. Melting point of iron is 1535°C and specific gravity 7.86 at 25°C.

Like other complex molecule Iron remain in drinking water at various concentration that can be detected in many ways including laboratory tests. A concentration of 40 µg/litre can be detected by taste in distilled water. In well-water, iron concentrations below 0.3 mg/litre were characterized as unnoticeable, whereas levels of 0.3–3 mg/litre were found acceptable.[4] In drinking-water supplies, iron (Fe2+) salts are unstable and are precipitated as insoluble iron(Fe3+) hydroxide, which settles out as a rust-coloured silt. Anaerobic ground water may contain iron(Fe2+) at concentrations of up to several milligrams per litre without discoloration or turbidity in the water when directly pumped from a well, although turbidity and colour may develop in piped systems at iron levels above 0.05–0.1 mg/litre. At concentrations above 0.3 mg/litre staining of laundry and plumbing occur.

Besides, Iron also augments unwanted bacterial overgrowth throughout its supply line which increases health hazard by both due to its increased concentration and increased amount of ingested bacteria.

## MATERIALS AND METHODS

This descriptive type of cross-sectional study was carried out in 17 units of 17 Infantry Division, Jalalabad Cantonment, Sylhet during January 2019 to May 2019. Appropriate approval was obtained from authorities of those units and ethical issues were duly addressed. A total of 52 participants were selected purposively for this study and all were male. A semi-structured questionnaire was developed and data were collected by face-to-face interview. Detail history was taken related to disorder of other systems of the body so that symptoms of other diseases don't hamper the desired study. Their symptoms related to excessive concentration of iron in drinking water were noted at first. Then their source of drinking water was identified. Water samples were collected from five (05) randomly selected water sources from 17 Infantry Division of Jalalabad Cantonment, Sylhet.

Then the selected participants were monitored regularly. They were instructed to continue the source of drinking water as before. This observation was carried out for five months. Among the participants, 25 were suffering from constipation, 16 were suffering from dyspepsia and 11 were suffering from both.

It was observed that, these symptoms vary among persons living in sainik line or living with family in quarters. Most family men used to drink water from both unit water source and their residence. Duration of drinking is also an important factor here which can modify symptoms.

Other symptoms include nausea and indigestion. But these symptoms were not present among the participants for long duration and continuously. Constipation and dyspepsia were observed to sustain for a long time.

The amount of Iron present in the drinking water was tested at laboratory of department of public health engineering by Atomic absorption spectrometry method. After getting the result the persons were taken under supervision. Their symptoms were once again reviewed.

Collected data was analyzed, checked & verified to exclude errors or omissions and

finally, analysis were done by Statistical Package for Social Sciences (SPSS) version 25.

## RESULTS

This study was conducted among 52 personnel working in different units of Sylhet cantonment during the period of January 2019 to May 2019.

**Table-I**: Concentration of Iron in different water samples (n=52)

| Source | Test Result(mg/L) | Std count (mg/L) |
|--------|-------------------|------------------|
| Sample-1 | 1.2 | |
| Sample-2 | 1.6 | |
| Sample-3 | 1.9 | 0.3-1 |
| Sample-4 | 2 | |
| Sample-5 | 0.6 | |

Table-I depicts that in collected water sample maximum iron concentration was found 1.9 mg/L and median concentration was 1.6mg/L
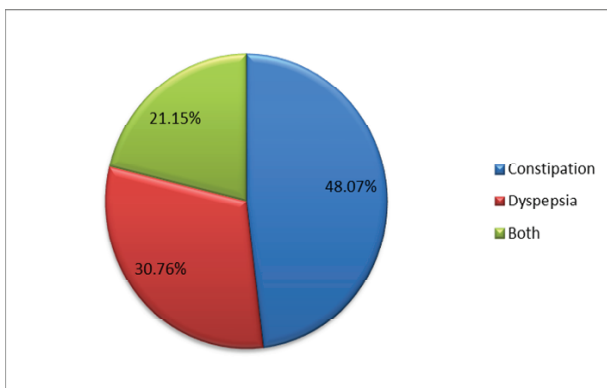


**Fig-1**: Distribution of the respondents by symptoms (n=52)

Fig-1 shows that maximum respondents 25(48.07%) developed constipation.

After getting result of iron test it was assumable/assumed that complains about abdominal discomfort are directly proportional to concentration of Iron. If we consider about constipation alone it proportionately increases with concentration of Iron (Fig-2).
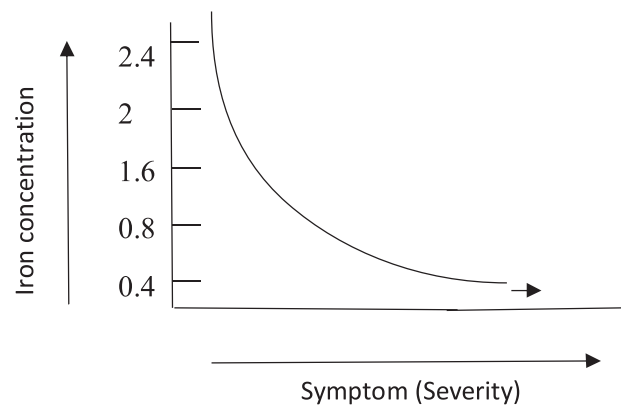


**Fig-2**: Severity of symptoms according to iron concentration

After the establishment of Reverse osmosis water the persons were again asked about their symptoms. It was found that symptoms improved with the decreasing concentration of iron in drinking water. One important thing to notify is that, the time taken for improvement was short. Within one month most of them were clinically symptom free with which they presented.

Improvement was observed specially with the symptom of constipation and dyspepsia. The number of people suffering from constipation became 04 and for dyspepsia it became 06.
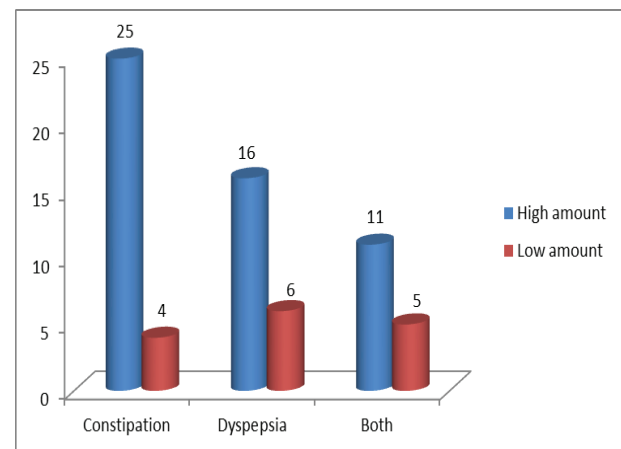


**Fig-3**: Distribution of the respondents before and after taking water with high and low concentration of iron respectively

## DISCUSSION

This is a descriptive type of cross sectional study considering Iron concentration of drinking water. Minerals are micronutrients that are required in a small amount for our body. Excess amount of this creates harmful effect to our body. Similarly Iron is a mineral that performs various roles in our body including formation of Hb. Iron may enter our body in both ferrous and ferric form.

In this study it was found that maximum iron concentration 1.9 mg/L and median concentration was 1.6mg/L which is more or less similar to the study conducted by Mar et al. in 2019[5] and Merrill et al. in 2011.[6] They found median concentration was 2.2 mg/L and 2.0 mg/L respectively. Another study conducted by Kumar et al. in 2017 showed maximum iron level in groundwater sample was 3820 parts per billion(ppb) and that in surface water sample was 6294 ppb whereas the permissible limit is 300 ppb.[7] Similarly the study conducted by Ghosh et al, showed the tube wells iron concentrations a wide range (0.02 to 6.2 mg/L) with a median iron concentration of 0.69 mg/L and inter quartile range 0.27 to 2.47 mg/L.

Merrill(2010) found iron concentration in a northeastern Bangladesh to be higher (median = 7.6 mg/L, inter quartile range = 1.6 to 17.6 mg/L) than this study.[8] Elevated level of iron (3.9 to 10.5 mg/L) was previously reported from a small village in Jashore district.[9]

In this study, though most of the participants were suffering from abdominal symptoms, further test and study are required to observe the involvement of other systems. Several other factors might be taken into consideration e.g. duration of drinking, number of drinking sources and frequency of changing of drinking source of water.

In the present study, it was found that most of the participants were suffering from constipation. Other abdominal discomfort was also present, for example dyspepsia, occasional loose motion and anorexia. The percentage of participants suffering from constipation was 49.1%. The concentration of water iron was not known to them. Then their Iron was tested after establishment of Reverse Osmosis water filter and found that the percentage of participants suffering from constipation has been reduced to 8%. But other symptoms did not reduce so much. For example, dyspepsia reduced to 19% while other symptoms remained almost same.

Several studies showed that excessive body iron may be an issue of concern because of a possible association with several chronic diseases, such as heart disease and diabetes.[10-14] A cross-sectional study in Bangladesh also suggested infants exposed to drinking water manganese concentrations higher than 0.4 mg/L had increased mortality risk during the first year of life when compared with unexposed infants.[15] A recent study conducted by Kullar et al also showed a positive association between manganese and iron concentrations in drinking water and reduced intellectual function of children ages 5.9–13.7 years in Canada.[16]

For adults, around 39% of the tubewells (n = 33) showed Hazard indexes (HI) values higher than 1, which indicate relatively high health threat. WHO Expert Committee on Food Additives shows the effects of toxic doses of iron include 3 depression, rapid and shallow respiration, coma, convulsions, respiratory failure, and cardiac arrest.[17]A study done by Linus Pauling Institute, 2001 showed, Iron supplements can cause gastrointestinal irritation, nausea, vomiting, diarrhea, or constipation in some people.[18] Cara Murray in 2017 showed Iron overload can lead to hemochromatosis, which can lead to liver, heart

and pancreatic damage, as well as diabetes. Early symptoms include fatigue, weight loss, and joint pain. Excessive iron is never recommended for digestion; it can lead to stomach problems, nausea, vomiting, and other issues. It was observed that family men used to drink water from more than one source. So, their symptoms were variable. As their number was only nine, so we can assume that this meagre number can hardly affect the overall study. Among them some were suffering from constipation and dyspepsia while others were symptom less. Even after establishment of reverse osmosis their symptoms did not reduce as they were consuming water from other sources. As this study was completed within five months so long term complications of excessive Iron in drinking water was not taken into consideration.

Water is the foremost constituent of the fluids of living beings and is decisive for all known forms of life. It is impossible for us to survive without pure drinking water.[20-21] Groundwater is an inevitable component of natural resources and plays an important role to serve as many purposes like drinking, irrigation, and other domestic usage.[22] Although trends on abstraction and use in each country are not available, globally groundwater is estimated to provide approximately 50% of current potable water supplies, 40% of the water demand of self-supplied industry and 20% of water use in irrigation.[23] Bangladesh has about 1.8 million hand tube-wells for supplying drinking water from underground sources to meet the need of 124 million people. But at present, groundwater of Bangladesh is being contaminated widely by leaching of harmful materials and chemicals from anthropogenic sources, such as unwise application of pesticides and fertilizers, unscientific disposal of waste materials, etc. Heavy metals, most harmful among these chemicals, which are present in trace amount,

but have significant effects on drinking water and causes harmful impacts on human health.[24]

In Bangladesh, iron is the fourth most abundant metal in the earth's crust, of which it accounts for about 5%. Elemental iron is rarely found in nature. It is most commonly found in nature in the form of its oxides.[25] When large amount of iron is present in water, it becomes toxic for health and the appearance changes as well which indicates that the water is unsuitable for drinking. Iron (as $Fe^{2+}$) concentrations of 40 µ g/litre can be detected by taste in distilled water. In a mineralized spring water with a total dissolved solid content of 500 mg/litre, the taste threshold value was 0.12 mg/litre. In well-water, iron concentrations below 0.3 mg/litre were characterized as unnoticeable, whereas levels of 0.3–3 mg/litre were found acceptable.[26] In drinking-water supplies, iron($Fe^{2+}$) salts are unstable and are precipitated as insoluble iron($Fe^{3+}$) hydroxide, which settles out as a rust-coloured silt. Anaerobic ground waters may contain Iron($Fe^{2+}$) at concentrations of up to several milligrams per litre without discoloration or turbidity in the water when directly pumped from a well, although turbidity and colour may develop in piped systems at iron levels above 0.05–0.1 mg/litre. Iron also promotes undesirable bacterial growth ("iron bacteria") within waterworks and distribution system, resulting in the deposition of a slimy coating on the piping. Excess amount of metal ion can harm human body elements because of its toxicity and causes nausea, vomiting, abdominal pain, dyspepsia, constipation, pneumonia, asthma and vision problems.[27] As millions of people of Bangladesh rely on groundwater sources for their daily domestic and other purposes, the assessment of groundwater quality is one of the most important tasks. The results of such investigations can minimize different health related problems and can ensure a healthy

life with safe drinking water sources. Considering these views, the study was conducted to investigate the iron contamination in drinking water and its effect on human body in Bangladesh.

## CONCLUSION

Iron is essential to our body and needed in a very small amount. While a low level of iron isn't harmful but excessive iron in drinking water is obviously detrimental to health. This is because iron often carries with its bacteria that feed off the iron to survive. These small organisms can be harmful when digested. Again, if iron levels are too high than normal, serious health effects can develop including iron overload which can lead to hemochromatosis that causes liver, heart and pancreatic damages well as well as diabetes. Containing excessive iron in drinking water is a slow poisoning which can be preventable.

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