**Impact of Iron Status on Thyroid Function: A Community Based Cross Sectional Study in Eastern Nepal**

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**ABSTRACT**

**Background**: Iron deficiency is the most common nutritional deficiency in the world. The relation between thyroid hormones and iron status is bidirectional. The aim of this study was to assess iron nutrition status and evaluate its relationship with thyroid hormone profile among children of Eastern Nepal. **Methods**: A community based cross-sectional study was conducted in eastern Nepal. A total of 200 school children aged 6-12 years were recruited after taking informed consent from their guardians. Blood samples were collected and assayed for free thyroid hormones (fT3 and fT4), thyroid stimulating hormone (TSH), serum iron, total iron binding capacity (TIBC) concentration and percentage transferrin saturation was calculated. **Results**: The mean serum iron and TIBC was 74.04 µg/dl and 389.38 µg/dl respectively. The median transferring saturation was 19.21%. The overall prevalence of iron deficiency (Transferrin saturation < 16%) was 34% (n=68). The mean concentration of fT3 and fT4 was 2.87 pg/ml and 1.21 ng/dl respectively, while the median TSH concentration was 3.03 mIU/L. Median TSH concentration in iron deficient group (3.11 µg/dl) and iron sufficient group (2.91 µg/dl) was not significantly different. Among iron deficient children 5.9% had subclinical hypothyroidism (n=4). Iron status indicators were not significantly correlated with thyroid profile parameters in the study population. **Conclusions**: The prevalence of iron deficiency is high and iron deficiency does not significantly alter the thyroid hormone profile in the study region.

**Keywords**: iron deficiency; thyroid hormones; school children; subclinical hypothyroidism.

**INTRODUCTION**

Iron is a critical element in the function of all cells. Iron deficiency is the most common nutritional deficiency in the world and remains a major public health problem particularly in developing countries. It adversely affects growth, development and alters the physiology of thyroid.1

The relation between thyroid hormones and iron status is bidirectional. Thyroid hormones increase iron absorption and incorporation into erythrocytes, whereas iron deficiency impairs thyroid hormone secretion and metabolism.2 Severe iron deficiency could interfere with thyroid hormone synthesis and decrease the thyroperoxidase activity.3 It may also reduce circulating levels of T4-5’ deiodinase, resulting in diminished conversion of T4 to T3.4

There are mixed evidences from various part of world relating iron status and thyroid profile. The aim of the present study was to assess iron nutrition status and evaluate its relationship with thyroid hormone profile among school children of eastern Nepal

**METHODS**

A cross sectional study was conducted in Udayapur District situated in Eastern part of Nepal from August 2014 to July 2016. Udayapur district has diverse geographical and socioeconomic variations. Primary school children (6 years to 12 years) were enrolled in this study from three schools. Two schools were selected from terai (plain) belt whereas one school was from the hilly region. We randomly selected 200 healthy school going children after excluding those children taking drugs that interfere with thyroid function and those having chronic illness. Sample size was calculated on the basis of latest prevalence of iron deficiency in Nepal (prevalence of iron deficiency = 36%, 95% confidence interval, 80% power).5 Informed written consent was obtained from the guardians of respective participating children. 3 ml of venous
Though the median transferrin saturation was within
the range for thyroid hormones were fT3 (1.2–4.2 pg/
dl), fT4 (0.8–2.2 ng/dl) and TSH (0.39–6.16 mIU/L)
according to kit manufacturer. Participants were
classified as euthyroid, subclinical and overt hypo
and hyperthyroid based on the thyroid hormone
function status. Serum iron and TIBC was measured by
colorimetric method using commercial kit
manufactured by Human GmbH, Germany. We used
percentage transferrin saturation as an indicator of
iron deficiency. Children with saturation <16% were
considered iron deficient. Measurements of serum
fT3, fT4 and TSH was carried out using ELISA
commercial Kit from Diametra. Normal reference
range for thyroid hormones were fT3 (1.2–6.16 mIU/L)
and TSH (0.39–6.16 mIU/L) respectively. The mean±SD of serum fT3 and fT4
were (2.87±0.52 pg/ml, 1.21±0.26 ng/dl and 3.03
(2.26, 4.34) mIU/L respectively. The mean±SD of serum iron, TIBC and
hilly region while 59% (n=118) were from terai
(plain) region. The mean age of the participating
children was 10.13±1.66 years. The overall
mean±SD/median (IQR) of serum iron, TIBC and
percentage transferrin saturation was 74.04±20.14
µg/dl, 389.38 ± 23.7 µg/dl and 19.21 (14.40, 22.79)
respectively. The mean±SD of serum iron, TIBC and
median (IQR) of serum TSH concentrations was
2.87±0.52 pg/ml, 1.21±0.26 ng/dl and 3.03 (2.26,
4.34) mIU/L respectively.

The data generated from the study was entered in
Microsoft excel 2013 and analysed using SPSS
version 21.0. Continuous variables was expressed as
mean±SD or median (IQR) according to the
distribution of the data. The categorical variables
was expressed as number (percentage). Independent
t test, one way ANOVA, Man whitney test and
kruskal Wallis test was applied according to the
distribution of the data. Pearson and Spearman’s rho
correlation was used to see the correlation between
iron status indicators and thyroid hormones. P-value
less than 0.05 was considered statistically

**RESULTS**

Out of the 200 participants, 41% (n=82) were from
hilly region while 59% (n=118) were from terai
(plain) region. The mean age of the participating
children was 10.13±1.66 years. The overall
mean±SD/median (IQR) of serum iron, TIBC and
percentage transferrin saturation was 74.04±20.14
µg/dl, 389.38 ± 23.7 µg/dl and 19.21 (14.40, 22.79)
respectively. The mean±SD of serum iron, TIBC and
median (IQR) of serum TSH concentrations was
2.87±0.52 pg/ml, 1.21±0.26 ng/dl and 3.03 (2.26,
4.34) mIU/L respectively.

Though the median transferrin saturation was within
reference range, 34% (n=68) of the children were
iron deficient as indicated by low transferrin
saturation. According to the geographical location, 28% (n=23) of the children from hilly region were
iron deficient whereas 38.1% (n=45) from terai
(plain) were iron deficient. The mean serum fT3 was higher in iron sufficient children than iron
deficient children. There was no significant
difference in mean serum fT3 and fT4 between iron
deficient and iron sufficient children. Iron deficient
children had higher median TSH than iron sufficient children but the difference was not
statistically significant as shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Biochemical parameters in study population according to geographical location and iron status.</th>
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<tbody>
<tr>
<td>Geographical location</td>
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<tr>
<td>Hilly (n=82)</td>
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<tr>
<td>Age (years)</td>
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<tr>
<td>Serum Iron (µg/dl)</td>
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<tr>
<td>TIBC (µg/dl)</td>
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<tr>
<td>Transferrin saturation (%)</td>
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<tr>
<td>fT3 (pg/ml)</td>
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<td>fT4 (ng/dl)</td>
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<td>TSH (mIU/L)</td>
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Data expressed as mean±SD and median (IQR). P value was calculated at 95% confidence interval.
Iron deficiency should account the different age groups, geographical location, and dietary patterns and more importantly the indices used to define iron deficiency.

In the present study we found thyroid dysfunction among 10% of the school children. Subclinical hypothyroidism was the most common thyroid dysfunction. Higher prevalence of thyroid dysfunction among school children was also reported by Khatriwada et al. and Chaudhari et al. We didn’t find significant difference between thyroid function parameters in iron deficient and sufficient children. Study done in various part of world in different age groups by Hashemipour et al., Aziza et al., and Yavuz et al. also found no significant difference between thyroid hormones with different iron status indicators. In contrast to our finding Martinez-Torres et al. reported 10% lower T3 levels in iron deficient subjects when compared to iron-replete subjects. Significant decreased T3 and T4 levels in iron deficient subjects was found by Beard et al. In our study no significant correlations was found between the iron status indicators and thyroid hormone level. Our finding was in accordance with study done by Wolde-Gebriel et al., Yavuz et al., and Hashemipour et al. in various parts of the world.

It is generally believed that iron deficiency adversely affects the physiology of thyroid and impairs thyroid hormone metabolism. Thyroid hormones increase iron absorption and incorporation into erythrocytes, whereas iron deficiency impairs thyroid hormone synthesis and metabolism. Though iron is required for the thyroid hormone synthesis and metabolism, it did not seem to effect the thyroid hormone metabolism to significant extent in the studied population. In most of the studies showing the significant difference in the thyroid function parameters and different iron status, comparative cross sectional or follow up studies were carried out taking iron deficient cases and iron sufficient controls. In those studies, iron status was assessed using more sensitive and accurate markers and done in populations of older age groups. There are multiple reasons for abnormal thyroid function. It is necessary to elucidate the roles of iodine deficiency, goitrogens, possible trace elements and vitamin A deficiencies. Thyroid antibodies was also not assessed in the population which might contribute to thyroid dysfunction seen in the studied population.

**CONCLUSIONS**

The prevalence of iron deficiency is high among children of eastern Nepal. Thyroid function
parameters didn’t significantly correlated with iron status indicators in the studied population. Only few cases of thyroid dysfunction were seen among iron deficient children but the exact causal effect association could not be ascertained as multiple factors may be associated with thyroid disorders.

**REFERENCES**


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**Conflict of Interest**: None