Effect of environmental iodine deficiency (EID) on foetal growth in Nigeria


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**Background & objectives**: There is scarcity of information on impact of iodine deficiency on growth and development of newborns, both pre-term and term babies. The present study was carried out to see the impact of iodine deficiency (ID) on the intrauterine foetal growth and development in terms of birth weight (BW) in an African population living in an iodine deficient zone.

**Methods**: The maternal and cord serum thyroid parameters at term delivery (38-40 wk of gestation) were measured and correlated with the birth weights of the corresponding newborns, and the results compared between those assessed in an ID zone (Jengere region of Bassa district, Plateau State, Nigeria) and with that of non ID (Control) zone, Jos, the State capital.

**Results**: The level of maternal and neonatal thyroid function were significantly reduced in the group with low birth weights (<2.5 kg) as compared to the level seen in normal birth weights category in both control (Jos) and ID (Jengere) regions. Both in non ID and ID regions the maternal serum thyroxine (T4), thyroxine binding globulin (TBG) and free thyroxine index (FT4I) were positively correlated ($P<0.005$) with BW of term babies while thyroid stimulating hormone (TSH) ($P<0.005$) and thyroxine binding capacity (TBK) ($P<0.05$) showed negative correlation. Maternal T3 and T3/T4 ratio did not show any correlation with BW in Jos, while in the ID region of Bassa the BW showed a positive correlation ($P<0.005$) with the maternal serum T3 and T3/T4 ratio. Cord serum analysis of the term babies revealed that the BW was positively correlated with its T4, triiodothyronine (T3), TBG, FT4I and T4/TBG ratio (Jos only) ($P<0.005$) in both ID region of Bassa and non ID control zone of Jos. Cord serum TSH and TBK showed negative correlation ($P<0.005$) with BW. Thyrotrophin releasing hormone (TRH) stimulation test revealed that mothers with small for date (SFD) babies at term were more hypothyroid compared to the level of thyroid function seen in the women delivering normal babies.

**Interpretation & conclusion**: Maternal thyroid hormone plays a significant role in the intrauterine foetal growth and development, and the smaller babies and their corresponding mothers, in an ID affected area are functionally sub-thyroid in greater proportion due to prevailing long standing environmental iodine deficiency (EID). Maternal T3 is an important factor in the defence of foetus in ID regions.

**Key words** Iodine deficiency - foetal growth - maternal-cord serum thyroid parameters
Birth weight (BW) is a convenient and conventional indicator of foetal growth and development in a newborn, and is widely used as a potential marker in the assessment and study of retarded foetal growth in utero. Intrauterine growth retardation (IUGR) may permanently influence the endocrine system during the process of foetal development\(^1\). Most of the previous studies carried out on thyroid function and BW were largely focused on the pre-term (birth <38 wk of gestation), low birth weight pre-term (< 2500 g), very low birth weight (VLBW) (< 1500 g) and very pre-term (<30 wk of gestation) infants\(^2\)\(^-\)\(^4\). In these groups of newborns, the functional changes in thyroid particularly in the form of low serum thyroxine (T4), free thyroxine (FT4), triiodothyronine (T3) and thyroxine binding globulin (TBG) with normal or raised TSH levels (transient hypothyroxinaemia) have been reported especially during 1st wk of birth\(^3\)\(^-\)\(^6\). In pre-term infants low cord serum T4 level was found to correlate with gestational age or BW\(^2\). A high serum reverse triiodothyronine (rT3) due to defective hepatic deiodinase system has also been reported in this group of babies\(^4\). The hypothalamus-pituitary-thyroid axis of these preterm infants was found to be in a disturbed modulating functional state compared to the term babies\(^2\)\(^,\)^7. Maternal injection of glucocorticoids or foetal treatment with exogenous T4 or T3 have been reported to be helpful in stabilizing the deranged thyroid function and pituitary-thyroid axis back to the normal level\(^7\). The severity of the respiratory distress syndrome (RDS) as clinical indicator of immature baby was found to be associated with low T3 in umbilical cord\(^8\)\(^-\)\(^9\). There is lack of information with respect to the thyroid function in mothers and their corresponding small for date (SFD) babies [born at term (>38 wk but <42 wk of gestation to eliminate the post matured or excessive size babies) with BW <2500 g] especially in the black African population, except that thyroid stimulating hormone (TSH) level was found to be higher in children born small for gestational age (SGA) in white Europeans (Italians)\(^1\).

Impact of environmental iodine deficiency (EID) on the SFD babies is not well known. Iodine deficiency disorders (IDD), a major global health hazard, reportedly affects nearly 1/5th of the world population; notably in the form of visible goitre, physical and mental growth retardation, cretinism, low IQ among children and various forms of reproductive failures in women including high rate of neonatal hypothyroidism\(^10\)\(^,\)^11. The present study was undertaken to assess the impact of prevailing iodine deficiency (ID) on the thyroid function of mothers and their babies born at term, and its relationship with the birth weights as a measure of intrauterine foetal growth in an African population where the reported incidence of IDD is remarkably high\(^12\)\(^-\)\(^16\).

### Material & Methods

The Plateau State of Nigeria, West Africa is an iodine deficient zone with varying level of depleted water and soil iodide ranging from place to place, associated with increased dietary goitrogens [thiocyanates (SCN) and hardness of water (well and ponds)], high goitre prevalence (GP) and reduced urinary iodide excretions (UIE) among the school children and adult inhabitants\(^13\)\(^-\)\(^16\). Bassa district in which Jengere is a major rural township, is maximally affected with EID [GP- school children 25% and adult 42%, UIE 9.04 ± 5.71 μg/dl, drinking water iodide (DWI) 0.0084 ppm, high goitrogens in local staple diets e.g., cassava (SCN), sweet potatoes, millets and acha (a fine locally produced grain-digitaria exilis) rich in glycosylflavones, a potent goitrogen] and was selected as a test - zone for ID in the present investigation\(^12\)\(^-\)\(^14\). While Jos, the State capital, is relatively iodine sufficient zone (GP- school children 0.4% and adult 3.8%, UIE 15.34± 7.5 μg/dl, DWI 0.041 ppm, less intake of goitrogens and uniform consumption of chemically treated tap water of less hardness in nature)\(^13\)\(^-\)\(^15\) was used as a control zone in the current study. In this preliminary study (covering the period 1987-1998) after obtaining the necessary informed consent and ethical clearance from the University authorities, 46 pregnant woman (age range 15-44 yr) at Jos and 26 women (age range 16-36 yr) from Jengere region of Bassa district (which is about 50 km away from Jos) were assessed
at term delivery (38-40 wk of gestation) and maternal and corresponding cord blood specimen were collected as paired samples. Eligible women willing to participate were consecutively selected. Women with pre-term (<38 wk of gestation) deliveries were excluded. BW of all the newborns delivered at term (38-40 wk of gestation) with APGAR score 8-10 (vigorous, pink and crying) in both the groups were recorded on a single pan balance with the help of attending mid-wife/nurse on duty. Some common features frequently observed among the African women associated with low BW babies such as anaemia, malaria, hypertension, veneral disease, malnutrition, asthma, placental insufficiency, sickle cell disease, pre-eclampsia, alcohol and smoking habits and intake of drugs, e.g., methyl DOPA, antiepileptics, phenobar, etc., were ruled out while selecting the subjects for the present investigation 17,18. This was done through detailed history recording and clinical examinations carried out in the antenatal clinic (ANC) (at the Jos University Teaching Hospital, Jos), routine laboratory tests done in ANC and through preventive medications such as Daraprim (weekly as antimalarial) and folate/iron for mild anaemia, etc. Women with moderate to severe anaemia and those with malnutrition were excluded by the measurement of haematocrit (packed cell volume and Hb) and serum total protein and albumin [by biuret and bromocresol green (BCG) dye binding methods respectively] 19,20. Random urine samples of the pregnant women at delivery (23 from Jos and 14 from Jengere) were analyzed for iodide concentration by conventional ceric ion-arsenious ion method 21. All the subjects assessed were selected without any population, nutritional or socio-economic bias and they all belonged to similar socio-economic mixed-income group. The nutritional status of both the groups were similar with regular dietary habit and intake of cassava, yam, millet, maize, rice, acha (a fine grain), beans, and (occasionally fowl, guinea fowl, dry fish), palm/groundnut oil, vegetables and sometime beef. None of the women investigated were hypertensive, smokers or alcohol consumers. One woman in Jos and 8 in Jengere were goitrous (grade 2-3) with soft and diffuse enlarged thyroids. Antithyroid antibody (ATAB) studies for both the thyroidal anti microsomal and anti thyroglobulin fractions (conducted previously on the same population) 22 were found to be negative in almost all the samples (only 3 out of a total of 280 samples analyzed showed positive result for antimicrosomal antibody), ruling out the possibilities of Hashimoto’s disease and other forms of thyroidities. The unhaemolysed sera separated through centrifugation (5000 g) were subjected to the determination of various thyroid parameters using ‘ELISA’ technique 23. The test kits used in these determinations were manufactured by Boehringer Mannheim Immunodagnostica, Mannheim, Germany based on ELISA. For serum T4, T3, thyroid stimulating hormone (TSH), thyroxine binding globulin (TBG) and thyroxine binding capacity (TBK) commercial kits (Boehringer: 100 tests/one kit) were used 23. Serum free thyroxine index (FT4I) was calculated by dividing the serum values of T4 with those of TBK (FT4I=T4/TBK). Serum T4/TBG ratio was multiplied by 10 as per the SI Unit. The quality control sample ‘Precinorm’ (Boehringer) was used to ensure the reliability of the results. The inter- and intra-batch precision was recorded as co-efficient of variation (CV) and was less than 8 per cent in each batch of analysis.

Student ‘t’ test was employed for detecting the level of significance between the groups (low birth weights <2.5 kg) and (normal birth weights) for each parametric data except UIE and TRH stimulation test (non parametric data) for which a ‘Mann Whitney U’ test was performed. The correlation study between the distribution of BW of neonates and that of the maternal as well as neonatal serum thyroid parameters for both the ID zone (Jengere, Bassa) and non ID zone (Jos) was carried out for comparison with the help of Compaq microcomputer using ANOVA (analysis of variance) diskette (CD-ROM FNL 3.0 Human Info NGO, Belgium) and (SAS, version 8.0 –SAS Institute Inc. Cary NC, 1999).

Thyrotrophin releasing hormone (TRH) stimulation test: Five women who delivered normal babies at term (38-40 wk of gestation) and another group of five women delivering SFD babies were assessed at 6 wk
postpartum period by this test. Fasting baseline blood samples were taken from each of them at the Chemical Pathology Laboratory of the Jos University Teaching Hospital and then 200 μg of TRH (each ampoule containing 0.5 mg/1ml, supplied by Japan International Cooperation Agency, Tokyo) was injected i.v. slowly while the subject was in lying posture. At 20 and 60 min post-injection (post-stimulation) interval, blood samples were again collected. Thus each subject provided 3 samples. Unhaemolysed sera separated by centrifugation were analyzed for quantitative detection of TSH and T4 levels using ELISA. This test however, proved difficult to be carried out on non-pregnant control subjects due to lack of co-operation and was thus abandoned. The non-pregnant control data were, however, recorded from the previous study conducted in caucasians for comparison with the present study.

**Results**

In the group with low birth weights (<2.5 kg) babies the maternal serum level of T4, T3, TBG and FT4 I were significantly reduced, while TSH and TBK exhibited a marked rise in comparison to the respective maternal values in the group with normal birth weights in Jos (control zone). A similar pattern of changes (with relatively more pronounced variation) was seen in the ‘low birth weights’ category of the ID region of Jengere (test zone) (Table I). The cord serum analysis in Jos shows that in the low birth weights group the serum level of T4, T3, TBG and FT4 I were all significantly reduced, while TSH and TBK showed a rise as compared to the group with normal birth weights. A similar picture was seen in the ID zone of Jengere region (Table I). The urinary iodide level in pregnant women from Jengere (mean 3.75 ± 1.8 μg/dl) was found to be significantly reduced (P<0.01) compared to the value seen in the pregnant group of Jos (mean 17.83 ± 2.6 μg/dl). The correlation studies carried out between the BW of the individual neonates and the corresponding maternal and cord serum thyroid parameters in Jos region indicated that the birth weights of term babies were positively correlated with the maternal serum T4 (r=0.87, P<0.005), FT4 I (r=0.97, P<0.001) and TBG (r=0.91, P<0.001). The level of serum TSH showed a marked negative correlation (r=-0.79, P<0.01) while TBK (r=-0.697, P<0.05) and T4/TBG ratio (r=-0.79, P<0.05) exhibited a weak but significant negative correlation with the BW. No correlation was observed between the maternal serum T3 and BW of the corresponding babies. Cord serum analysis showed that T4 (r=0.83, P<0.01), T3 (r=0.86, P<0.05), FT4 I (r=0.95, P<0.005) and T4/TBG ratio (r=0.82, P<0.05) were positively correlated with BW, while cord serum TSH (r=-0.86, P<0.01) and TBK (r=-0.87, P<0.005) exhibited negative correlation. Serum T3/T4 quotients in both the mothers and newborns were found to be unrelated to the BW of the term babies in Jos.

In Jengere region, the distribution of BW of the term newborns were positively correlated with the corresponding maternal serum T4 (r=0.92, P<0.005), T3 (r=0.96, P<0.005), TBG (r=0.93, P<0.005) and FT4 I (r=0.99, P<0.001) and negatively correlated with TSH (r=-0.91, P<0.005) and TBK (r=-0.89, P<0.005). Cord serum T4 (r=0.87, P<0.005), T3 (r=0.98, P<0.001), TBG (r=0.94, P<0.005) and FT4 I (r=0.98, P<0.005) were positively correlated with BW while TSH (r=-0.88, P<0.005) and TBK (r=-0.98, P<0.005) showed negative correlation. Serum T4/TBG and T3/T4 ratios in both maternal and cord serum samples did not show any significant correlation with BW of term babies in the ID region of Jengere, except for maternal serum T4/T3 ratio which showed positive correlation (r=0.84, P<0.005) (Fig. 2).

TRH stimulation test carried out at 6 wk post delivery in 5 African women with SFD babies and five with normal babies born at term and a comparison of the results with that reported in non-pregnant control in caucasians showed that baseline level of serum TSH in group with SFD babies was higher than that seen in the group with normal babies, while in non-pregnant control the reported value was comparatively much lower (mean 1.4 ± mU/l). Post-stimulation (with 200 μg of TRH i.v.) response of TSH was relatively enhanced in the group with SFD babies at 60’ compared to the relatively much lower response.
Table I. Comparison of maternal and cord serum thyroid parameters between the groups with ‘low birth weights’ and ‘normal birth weights’ in Jos and Jengere regions of the present investigation

<table>
<thead>
<tr>
<th>Groups/Parameters</th>
<th>n</th>
<th>T4 nmol/l (±SD)</th>
<th>T3 nmol/l (±SD)</th>
<th>TSH mU/l (±SD)</th>
<th>TBG nmol/l (±SD)</th>
<th>TBK (±SD)</th>
<th>FT4I (±SD)</th>
<th>T4/TBG (±SD)</th>
<th>T3/T4 (±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low birth weights &lt;2.5 kg</td>
<td>9</td>
<td>113.8±18.8* (52.6±16.5)*</td>
<td>1.95±.57* (0.87±.08)*</td>
<td>6.98 ±2.4*** (44.1±3.7)**</td>
<td>327.3 ±62.8** (384.3±17.2)*</td>
<td>1.21±0.1* (1.06±.12)*</td>
<td>194.1±25** (184.8±23.3)**</td>
<td>3.5±2.9 (.017±.003)</td>
<td></td>
</tr>
<tr>
<td>Normal birth weights 2.5-4.5 kg</td>
<td>37</td>
<td>128.7±13.8 (75.2±7.4)</td>
<td>2.4±41 (1.3±.25)</td>
<td>2.1±1.6 (20±6.6)</td>
<td>410±60 (451±73.9)</td>
<td>1.06±2 (0.93±.3)</td>
<td>120±23 (81±12.1)</td>
<td>3.16±25 (0.019±.003)</td>
<td></td>
</tr>
<tr>
<td>Urine I (µg/dl)</td>
<td>Jos (Pregnancy, delivery) (n=23)</td>
<td>17.83±2.6 mean 17.83±2.6 range (12.6-23)</td>
<td></td>
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<tr>
<td></td>
<td>Jengere (Bassa) (IDD test zone)</td>
<td>3.75±1.8 mean 3.75±1.8 range (0.15-7.35)++</td>
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</tr>
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</table>

| Urine I (µg/dl) | Jengere (Pregnancy, delivery) (n=14) | 60-126 mean 3.75±1.8 range (0.15-7.35)++ |

P values: *<.05; **<.01; ***<.005; <.001 compared to normal birth weight; ++<.01 compared to JOS group
Values in the parentheses indicate cord serum parameters; Values are mean ± SD
TBG, thyroxine binding globulin; TSH, thyrotropin; FT4I, free thyroxine index; TBK, thyroxine binding capacity; T4, thyroxine; T3, triiodothyronine
observed in the women with normal babies at 60'. In non pregnant control the reported post stimulation values were considerably lower at 20' (mean 13.5 mU/l) and at 60'(mean 9.8 mU/l). Similarly, the baseline value for serum T4 in the group with SFD babies was found to be much lower compared to a relatively higher level seen in the women carrying normal babies and that in non-pregnant control (104.1 nmol/l). The post-stimulation rise in T4 levels in SFD group was retarded and less pronounced at 20' but at 60' the rise observed was not significant, while the group with normal babies showed a comparatively higher response reading a mean of 117.3 nmol/l and 128.5 nmol/l at 20' and 60' respectively. The reported post-stimulation response in non pregnant control was considerably higher with values at 20' (139 nmol/l) and at 60' (146.2 nmol/l) (Table II).

**Discussion**

Studies on experimental animals (sheep, lamb, guinea pig and rat) have shown that thyroid hormones (T4 and T3) do not cross placenta. However, the maternal iodide can cross the placental barrier and helps build the thyroxine pool in the foetal circulation.

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Fig. 1. Scatter plots with regression line between the maternal and cord serum thyroxine (T4) and thyrotrophin or thyroid stimulating hormone (TSH) levels versus birth weight of the corresponding newborn babies delivered at term in the non iodine deficient (control) zone in Jos, Plateau State.
during pregnancy. Human studies indicated that thyroid hormones (especially T4) can cross placenta in appreciable quantities, whereas TSH cannot. TRH, a tripeptide can freely cross the placenta in both the direction and thus helps mediate (modulate) the maternal and foetal hypothalamus-pituitary-thyroid axis with corresponding changes in TSH in the maternal and foetal circulation.

In the present investigation a significant drop in the level of maternal and cord serum thyroid parameters observed in the low birth weights group in both Jos (control) and Jengere (ID) regions indicated that the thyroid hormones exert a positive impact on the process of intrauterine foetal growth and development.

The positive correlation observed between the maternal serum T4, TBG and FT4I and the BW of term babies in Jos and Jengere indicated that physical growth of foetus of term pregnancy among Africans was related to the maternal thyroid

![Fig. 2. The scatter plots with regression line between the maternal and cord serum thyroxine (T4) and thyrotrophin or thyroid stimulating hormone (TSH) levels versus birth weight of the corresponding newborn babies delivered at term in the iodine deficient (test) zone in Jengere region of Bassa LGC, Plateau State.](image-url)
hormones. Serum T3 in Jos (control zone) did not show any correlation with BW, while in Jengere (ID zone) it exhibited significant positive correlation with BW, suggesting that the preferential synthesis of T3 and its increased requirements by the growing foetus in an iodine deficient area become an important compensatory protective mechanism in foetus. The observed positive correlation between maternal serum T3/T4 ratio and BW of term babies seen in Jengere, as opposed to Jos, further supported the above conclusion. The BW was found to be positively correlated with cord serum T4, T3, FT4I and T4/TBG ratio (in Jos only), but negatively correlated with cord serum TSH and TBK in both Jos and Jengere groups. During foetal development changes in body weight are accompanied by marked changes in body composition and the amount of water decreases as the body weight of the foetus increases. Increase seen in serum T4, T3 and TBG levels in the newborns with normal BW may partly be explained on the basis of above changes in body composition. The binding capacity of T4 molecules with TBG (measured as TBK) in the cord serum appears to decline progressively with increasing BW thereby reflecting a progressive rise in FT4I values with increasing BW of terms babies. This indicates the possibility that thyroxine in its physiological (unbound) active form is required for the critical development of the growing foetus until delivery. The inverse relationship between the cord serum TSH and BW and a positive relation between the cord serum T4 and BW of term babies in both Jos and Jengere regions with identical changes seen in the corresponding mothers in both the groups suggested that babies with low BW at term were probably in a varying state of hypothyroidism/hypothyroxinaemia compared to the babies with higher BW. In our earlier studies, 5 SFD (BW<2.5 kg at 40 wk of gestation) babies in Jos showed mean serum T4 level 52.6 ± 6.5 nmol/l and mean TSH 44.1 ± 3.7 mU/l and 9 SFD babies from Jengere showed mean serum T4 46.9 ± 5.4 nmol/l with corresponding TSH level 46.9 ± 1.2 mU/l. The low UIE found in the women with smaller babies supports the conclusions drawn from the above findings. This conclusion is further supported by the results obtained from the TRH stimulation tests. Compared to the women with normal babies, women with SFD babies showed higher and exaggerated response in TSH and sluggish response in T4 secretions following stimulation, suggesting that the mothers having SFD babies were probably in a sub-functional thyroid state or in a state of mild or compensated primary hypothyroidism. It is also interesting to note that in Jos group of mothers with normal babies the post-stimulation response was comparatively higher than the level of response reported in the non pregnant caucasian control.

Table II. Results of the TRH stimulation test carried out in the Nigeria women at 6 wk post-partum delivering normal babies and SFD babies at full-time gestation (40 wk)

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Fasting basal level</th>
<th>Post-stimulation (200 μg TRH i.v.)</th>
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<tbody>
<tr>
<td></td>
<td>TSH (mU/l)  T4 (nmol/l)</td>
<td>TSH (mU/l) T4 (nmol/l)</td>
</tr>
<tr>
<td>Women with normal babies (n=5)</td>
<td>4.0 ± 0.74  84.5 ± 6.6</td>
<td>19.4 ± 8.4  117.3 ± 5.4</td>
</tr>
<tr>
<td>19.0 ± 1.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women with SFD babies (n=5)</td>
<td>6.32 ± 2.0*  65.6 ± 9.3*</td>
<td>34.5 ± 10.5  90.7 ± 10.5**</td>
</tr>
<tr>
<td>24.6 ± 5.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (non-pregnant women) (n=24)</td>
<td>Mean 1.4  104.1</td>
<td>13.5  131</td>
</tr>
<tr>
<td>Range (0.5-2.7) (86-122) (05-20.5) (118-160) (4-15.6) (127.4-165)</td>
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</tr>
</tbody>
</table>

Result of Mann-Whitney U test; *P<0.05; **P<0.01 compared to women with normal babies
Values are mean ± SD; SFD, small for date.
suggesting in addition that generally the women population of Jos might be living in a state of relative iodine deficiency (proving one of our earlier observations in this regard that Jos may not be true iodine sufficient zone)\textsuperscript{15,38} or perhaps lack other factors yet unidentified, which affect the thyroid status adversely. In non-goitrous normal residents of the highly endemic sub-Himalayan region of northern India, most of the subjects assessed by TRH stimulation tests were similarly found to be functionally sub-thyroid\textsuperscript{19}. In similar neonatal studies the BW was found to be related with androgenic steroid DHEAS (dehydroepiandrosterone sulphate) while birth length (gestational age) was found to be determinant of TSH level in the newborns\textsuperscript{1}.

In conclusion, BW of term babies showed positive correlation with the maternal and foetal thyroxine (T4), and the requirements of the later (T4) increased appreciably in the growing foetus of the iodine deficient areas, preferably in the form of T3 (as an important protective compensatory mechanism) probably due to ID-induced increased activity of placental/peripheral deiodinase. BW of term neonates exhibited an inverse relationship with both maternal and foetal TSH levels, and mothers delivering SFD babies were in a relative state of sub-thyroid level, ranging from hypothyroinaemia to sub clinical (compensated) hypothyroidism.

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References


2. La Franchi S. Thyroid function in the preterm infant. \textit{Thyroid} 1999; 9 : 71-8.


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