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Review Article

Systematic Review on Association between Iodine Level during Pregnancy and Its Outcomes

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ABSTRACT

Pregnant women are at the higher risk of developing iodine deficiency during the pregnancy period that affects normal functioning of thyroid hormones consequently normal growth and development of foetus as well as pregnant women health gets affected. The foremost changes in thyroid function associated with pregnancy are due to an increase in hormone necessities that begin in the first trimester of gestation. This rise can only be met by a proportional upsurge in hormone production, somewhat which depends directly upon the concentration of iodine. This systematic review focused on published articles, studied the association between moderate to severe iodine deficiency in pregnant women and children. Overall results showed that moderate-to-severe iodine deficiency increases rates of impulsive abortion, reduces birth weight, and increases infant mortality during pregnancy. Offspring of iodine deficient mothers are at high risk for cognitive disability, with cretinism being the most severe manifestation. Throughout childhood moderate-to-severe iodine deficiency reduces somatic growth.

Keywords- Iodine, Pregnancy, Thyroid, Mortality.

INTRODUCTION

Regardless of significant growth in the last 25 years, in the world today, one of the most common micronutrient deficiencies is iodine deficiency. Iodine deficiency outcomes in a varied range of adverse effects all over the lifetime. [1]

Iodine is a necessary micronutrient for the proper functioning of thyroid hormones, thyroxine (T_4) and triiodothyronine (T_3), that is crucial for metabolism, normal growth, and development during pregnancy, infancy and throughout life. [2] In 1990, the UN World Summit for Children established a goal that was the global elimination of iodine deficiency. [3] The clear definition for iodine deficiency defined by the WHO in terms of population median urinary iodine concentration (UIC), ≤ 50mg/l. [4] Further iodine deficiency is classified according to the median urinary iodine concentration (UIC) as mild (UIC 50-99 mg/l), moderate (UIC 20-49 mg/l) or severe (UIC 20 mg/l). [5] In the past, iodine deficiency was supposed to cause only goitre and cretinism. However, over the last quarter of the century, the range of diseases increases which includes goitre, cretinism, hypothyroidism, brain damage, abortion, still birth, mental retardation, psychomotor defects hearing and speech impairment. [6] Thyroid hormone is predominantly critical for neurodevelopment of fetal and infant. Brain development is reliant on adequate thyroid hormone, while severe iodine

deficiency during pregnancy may cause, hypothyroidism in pregnant women and fetal subsequently serious cognitive and neurologic deficits has been observed in children. [7] In addition, to the overt manifestations of severe iodine deficiency, seemingly pregnant women & healthy children breathing in severely iodine-deficient regions may suffer from endemic hypothyroidism. [8]

Burden of Iodine Deficiency -

According to WHO it is estimated that worldwide approximately 37% (285 million) of school-age children and two billion individuals nearly have insufficient iodine intake. In India district level surveys conducted in 2006 showed that out of 324 districts, the Iodine Deficiency Disorder (IDD)in 263 districts was a major public health problem, including total goitre prevalence rate of more than 10% in the population. [9] Recently about 350 million people who are consuming salt with inadequate iodine content are at risk of IDD. In India a larger number of populations is suffered from IDD, and the major cause is the soil of the subcontinent, which is deficient in iodine therefore, the food derived from it is also deficient in Iodine. In India every year nine million pregnant women and eight million new born are at a risk of IDD. These estimations are based on the household-level coverage of adequately iodized salt as reported in Coverage Evaluation Survey (CES) 2009 and extrapolated to total population estimates from Census 2011. [10,11]

In India 2013, about 200 million people were at higher risk of IDDs and another 71 million were suffering from goitre and other disorders.IDD was a public health problem in 47 countries [12] out of the 130 countries which was reported data for IDD in 2006 (comprising 91.1% of the total global population).

In India, 91 percent of households had access to iodized salt, among these 71 percent consumed adequately iodized salt as per the Coverage Evaluation Survey 2009 while, other 9 percent used unionized salt. State level IDD surveys were conducted in seven States (Kerala, Tamil Nadu, Orissa, Rajasthan, Bihar, Goa and Jharkhand) from 2000 to 2006 by International Council for Control of Iodine Deficiency Disorders (ICCIDD) in partnership with State medical colleges, Micronutrient Initiative (MI) and UNICEF. [13] The household-based surveys on the consumption of iodized salt were done as per the recommended guidelines of WHO/UNICEF/ICCIDD and used 30 cluster into 40 children sampling methodology and the study population included children age group of 6-12 years. [14] Three indicators were studied *including* total goiter rate (TGR), urinary iodine (UI) concentration and iodine content of salt. The household level consumption of adequately iodized salt (≥15 ppm) ranged from 18.2 per cent in Tamil Nadu to 91.9 percent in Goa. The median urinary iodine excretion ranged from 76 µg/l in Goa to 173.2 µg/l in Jharkhand. TGR ranged from 0.9 per cent in Jharkhand to 17.5 per cent in Goa. [14] Wide difference was also seen across different States/Union Territories; with Chhattisgarh (31.6%), Karnataka (35.5%) and Jharkhand (41.4%) being the low coverage States and Manipur (98.3%), Meghalaya (98%) and Nagaland (97.1%) being high coverage States. [10]

Iodine Requirement and its Role During Pregnancy-

Pregnancy is associated with profound changes in thyroid function and eventually requirement for iodine. [15] Since iodine is an essential micronutrient for the synthesis of thyroid hormones including Tri-iodothyronine (T3) and Thyroxine (T4), these hormones further play vital role in normal growth and development of the brain and central nervous system of fetal. [16] Inadequate iodine intake leads to insufficient thyroid hormone production resulting in iodine deficiency disorders (IDD), abortion, still birth, mental retardation, deaf-mutism, squint, dwarfism, goitre, neuromotor defects etc are the major results. Thus, IDD directly affects human development and thus major burden on

health system of a nation. [17] Iodine deficiency is the major preventable cause of irreversible mental retardation in the world with nearly 2 billion people with IDD. [18] Mainly two reasons are responsible for iodine lacking pregnant women to remain euthyroid. Firstly, at the end of the first trimester, there is increase in maternal fT_4, in response to which hCG depresses the concentration of maternal TSH. The second reason was that the maternal thyroid gland responds to a state of comparative iodine deficiency by invoking the identical responses in the thyroid gland as would arise in the non-pregnant state, such as increased iodine trapping, synthesis of T_3 over T_4, hyperplasia, and ultimately goitre. Thus, the pregnant woman will seem to be euthyroid as both TSH and T_3 concentration decreases within the normal reference range. In such states, localised hypothyroxinemia occurring in precise parts of the developing fetal brain is supposed to be responsible for the neuro developmental damage due to iodine deficiency. [16]

Throughout the first two trimesters of pregnancy the foetus is totally dependent on the maternal thyroid hormone source as the foetal thyroid does not develop until 13-15 weeks of gestation. A lack of iodine in the diet may result in the mother becoming iodine deficient, and subsequently the foetus. Daily recommended iodine intake during pregnancy from 200-250 microgram/day. While the iodine intake for different age group is presented in Table.1. Dietary sources of iodine include seaweed, iodized salt, dairy products and fish.

Table 1.Daily Recommendation of Iodine intake (µg/day) by WHO-

S.No.	Age Group/ Population Group	Daily Dose
1.	Infants (0-59 months)	90µg
2.	Children (6-12 yrs.)	120 µg
3.	Adults (>12 yrs.)	150 µg
4.	Pregnant women	190-250 µg
5.	Lactating women	250 µg

Procedures to Assess Iodine Sufficiency

There are several methods used in the screening of population iodine sufficiency. Median urinary iodine concentrations (as a biomarker for dietary iodine intake) [19] imitate iodine intake. Thresholds for median urinary iodine sufficiency have been recognized for populations, given important day-to-day variation of iodine intake. [20] As in Table 2, population iodine sufficiency is defined by median urinary iodine concentration that is 100 µg/L or more in nonpregnant women and children younger than 2 years and 150 µg/L or more in pregnant women. [21]

Table 2 -Population iodine sufficiency based on median urinary iodine concentrations

	Pregnancy	Lactation	Children younger than 2 yrs
Insufficient	<150µg/l	<100µg/l	<100µg/l
Adequate	≥150µg/l	≥100µg/l	≥100µg/l

Iodine Metabolism During Pregnancy-

Iodine from sources such as iodized salt or sea foods, dietary iodide, is entirely absorbed (>90%) in the stomach and duodenum. Iodide of dietary source then blends rapidly with iodide derived from the peripheral catabolism of iodothyronines and together they create the extra thyroid pool of plasma inorganic iodide (PII) that happens in a dynamic equilibrium with two organs, the thyroid gland and the kidneys. [22] The healthy adult holds up to 20 mg of iodine, and of it which 70-80% are stores in the thyroid. [23] Of the 80mg hormonal iodide produced daily by thyroid hormone catabolism, 15mg iodide is lost in the faeces, parting 65mg to be reallocated between the thyroid gland and irretrievable urinary losses. In these situations, the metabolic balance remains in equilibrium and the body is able to uphold a plenteous store of iodine in the thyroid ranging from 10 to 20 mg. However, in chronic ID the iodine content of the thyroid may drop to <20mg. [22] In iodine adequate area, the adult thyroid traps 60-80µg of iodine/ day to balance losses & maintain thyroid hormone synthesis.

The iodine necessity is increased ≥50% during pregnancy due to: firstly, maternal thyroid hormone increase, making to maintain maternal euthyroidism and

transfer thyroid hormone to the fetus early in the first trimester, before the fetal thyroid is effective; second principally in later gestation iodine is transfer to the fetus; and thirdly renal iodine clearance increases. [24]

Role of Thyroid Hormones During Pregnancy and its outcomes-

Iodine is mandatory for the production of thyroid hormones. Normal thyroid function during pregnancy is significant for the mother and developing foetus. During pregnancy four foremost changes arise in maternal thyroid physiology: (i) enlargement of the thyroid, (ii) modifications in handling of iodine, (iii) both the thyroid hormone binding proteins and thyroid hormones increases and, (iv) placental thyroid stimulators formation. [25]

Thyroid hormones (THs) are very imperative for growth and development of brain for the foetus and neonate. The initial stage of thyroid hormone dependent neurodevelopment depends on an ample supply of maternal T_4, and starts in the second half of the first trimester. This stage comprises neuronal proliferation and the onset of neuronal migration in the cerebral cortex, hippocampus and medial ganglionic eminence, with the end processes starting in the first trimester and continuing into the early second trimester. [26]

About the start of the second trimester the fetal thyroid begins to produce hormones, however, the complete development of the pituitary-portal vascular system in the fetus does not occur until ~18–20 weeks gestation. [16] The subsequent phase of thyroid hormone neurodevelopment comprises neurogenesis, neuron migration, axonal growth, dendritic branching and synaptogenesis, glial cell differentiation and migration, and the onset of myelination. [27]

The thyroid gland dysfunctions like hypothyroidism and thyrotoxicosis can affect the mother health as well as the child before and after delivery that can result in fatal disease; in humans, this comprises a high prevalence of mental retardation. Evident maternal thyroid failure through pregnancy's first half, has been allied with numerous pregnancy complications together with preeclampsia, premature labor, fetal death and low birth weight and intellectual impairment in the offspring. [7]

MATERIALS AND METHODS

A review process definite- the study designs, main outcome, participants (pregnant women of all the three trimesters, infants, neonates, children up to 14 yrs.) as well as data extraction.

Study Search

An electronic literature search was directed to classify papers on iodine and mental development outcomes in children, effect of iodine during pregnancy, deficiency of iodine during pregnancy, effect of iodine on the child of pregnant published from 2009 to June2017 on PubMed The search terms used were; iodine, iodine deficiency, child development; role of iodine during pregnancy, cognition; congenital hypothyroidism; diseases of iodine deficiency; dietary supplements; goitre, endemic; hypothyroidism; intelligence; iodine; The references in the identified studies were manually searched for additional studies.

Inclusion & Exclusion criteria-

Inclusion criteria for this systematic review included: (1) exposure to different iodine levels before and during pregnancy, or soon after birth, (2) inspection of iodine exposure and mental development outcome of children aged 0 to 14 years, and (3) cross sectional studies and cohort studies were taken inattention. (4) iodine deficiency, determined from the median urinary iodine concentration were considered in this systematic review.

Exclusion criteria- 1) Studies excluded were they examined adult, elderly or patient samples. 2) studies in which supplementation programme was carried out. 3) studies in which goitre prevalence were taken into consideration has been excluded.

Study Selection Process-Titles and/or abstracts of studies recognized through the

search were screened self-reliantly by two reviewers for eligibility against the inclusion and exclusion criteria. Data were also mined independently from papers by two or more reviewers. Data extraction tables were shaped to include the following information: (1) Author Name (2) year (3)QA (4)Ethnicity (5) study design (6) sample size (7) age of pregnant and children (8)urinary iodine concentration. There was high reliability across reviewers; through discussion discrepancies were fixed.

Figure 1 details the study assortment process and the number of papers recovered and excluded at each stage. Of the studies retrieved, and exclusions were made most commonly because the studies examined adult or elderly samples; assessed goitre prevalence, supplementation programmes carried during and after pregnancy. Review papers were also excluded. Some papers contained multiple studies (5-6). Therefore, forty-one articles were extracted providing forty- three studies for review. Respectively study seems in the data tables only once, regardless of whether the data were described in more than one paper.

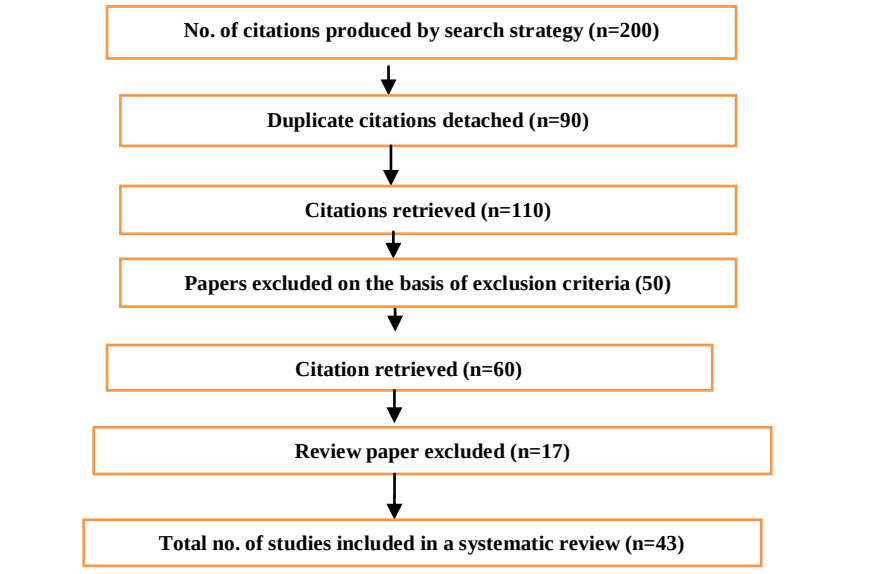

Fig 1.Flow diagram of the study selection process.

Quality Assessment-

Each study was evaluated for value using pre-defined assessment criteria by two of the authors autonomously. The inter-rater correlation for ratings was r 0·86 and discrepancies were deliberated as a panel with the third author to reach consensus. Therefore, we planned a fourteen-item tool which covered key elements of study aims and design, sample selection, urinary iodine concentration, controls, analysis and outcomes.

Quality assessment tool

Quality assessment sheet: Systematic Review on Association Between Iodine Level During Pregnancy and its Outcomes

Paper: Rater:

Score 0 if criterion not satisfied. Score 1 if criterion satisfied. Score:

No.	Criterion	Score
1.	Clear aims and objectives stated	
2.	Clear description of locale/environment, e.g. Place, laboratory/classroom	
3.	Clear description of sample, e.g. age (mean, SD, range), sex, number	
4.	Clear description of study design	
5.	Clear description of data collection	
6.	Provision of recruitment data and strategy	

7. Clear description of planning.
8. Appropriateness of planning.
9. Valid and reliable outcomes, e.g. appropriateness of cognitive test
10. Clear description of data analysis
11. Appropriateness of data analysis
12. Clear description of findings
13. Strengths of study and suggestions for future work
14. Limitations of study

RESULTS & DISCUSSION

Table.No.3- Summary table. Iodine Statusand Health Outcomes in Pregnant women-

Author	Year	QA	Ethnicity	Study design	Sample	Age	Iodine (urine)	95%CI	Findings
Keno .etal [28]	2017	13	Ethiopia	Cross sectional	40	-	70.5µg/l	48.1-83.8	80% of the pregnant women had insufficient iodine intake.
Torres. etal [30]	2017	14	Catalonia	Cross sectional	945	30.6	172µg/l	103.8-289.3	the total median UIC of women in the first trimester of pregnancy found in the study is revealing of adequate iodine nutritional status rendering to the criteria established by the WHO and ICCIDD, although 43.1% were found to have suboptimal levels.
Granfors.etal [31]	2015	12	Sweden	Cross sectional	459	-	98 µg/l	-	Results show insufficient iodine status in the pregnant population of Sweden.
Sarah etal [35]	2015	13	United Kingdom	Cohort Study	662	30.73	56.8 µg/l	-	Cluster of UK pregnant women was mildly-to-moderately iodine deficient in all trimesters, which is of major public health concern.
Fangang [32]	2013	13	China	Cross sectional	326	26.1	205 µg/l	-	the iodine nutrition of pregnant women had touched an adequate level.
Sabrina Maria SaueiaF.etal [33]	2013	14	Brazil	Cross sectional	191	25	137.7 µg/L,	132.9 – 155.9	Median UIC of the pregnant women considered was lower than the recommended value.
Stefanie V.etal [34]	2013	14	Belgium	Cross sectional	1299	28.5	124·1µg/l	118·3, 131·0	The median UIC during pregnancy designates iodine deficiency in Belgium and some women are at a higher risk of deficiency.
Yozen.etal [29]	2011	14	Japan	Cohort study	PW=683 POSTW=532	30.9 (PW) 31.0 (PO. W)	219µg/l 135µg/l	143.3-172.0	The occurrence of pregnant women with low UIC less than 100 µg/litre or high UIC greater than 500 µg/litre was 16.1 and 22.2%, respectively.
Pedrerol .etal [36]	2009	12	Spain	Cohort Study	557(I^{st}trimester) 251(III^{nd} trimester)	-	95 µg/l (I^{st}trimester) 104µg/l (III^{nd}trimester)	-	It was experiential, an association between thyroid function, iodine status, and prenatal growth. This study recommends a beneficial effect on birth weight at UIC below the present recommendations.
Rashid .etal [37]	2009	13	Banglade-sh	Cross sectional	263	25.8	133.4µg/l	-	Prevalence of iodine deficiencies was found to be 39.4% in pregnant women in Bangladesh.

A number of articles published between 2009 - 2017 in pregnant women of regions with moderate and higher deficiency are summarized in Table 1. The study by *Keno .etal* involved40 healthy pregnant women with no preceding history of thyroid disease, showing that the median UIC found in pregnant women was 70.5 µg/l. This value falls below the classification of median UIC and can be defined as insufficient iodine intake representing that about 50% of the pregnant women in the study area had UIC<70.5 µg/l. The mainstream of pregnant women (80%) in this study had an insufficient iodine intake. [28] Between November 2005 to January 2007, healthy pregnant and postpartum women without earlier history of thyroid disease, was studied by *Yozen. et al* and found that the median UIC in pregnant women was 219.0 µg/l, suggestively greater than that in postpartum women, which was 135.0 µg/l. The existence of pregnant women with low UIC less than 100 µg/litre or high UIC greater than 500 µg/litre was 16.1 and 22.2%, respectively. [29] The results from the *Torres. et al* study, performed in Catalonia, showed that the median UIC of women in the first trimester of pregnancy found in the study is revealing of adequate iodine nutritional status rendering to the criteria established by the WHO and

ICCIDD, although 43.1% were found to have suboptimal levels. [30] *Granfors et al.* across sectional study conducted in Sweden in 2015 showed that population of pregnant women are found to have insufficient iodine status. [31]

Table.No.4-Summary table. Iodine Status and Health Outcomes in Children-

Author	Year	QA	Ethnicity	Study design	Sample	Age	Iodine (urine)	95%CI	Findings
Keno .et al [28]	2017	14	Ethiopia	Cross sectional	73	-	88.6µg/l	66.9-113.5	72.6% of the school children had insufficient iodine intake.
Aakre.et al [38]	2017	14	Algeria	Cross sectional	298	2.5	451.6 µg/l	273.9–1003.3	A connotation between thyroid dysfunction and poorer developmental status amongst children with excessive iodine intake. The high iodine intake may have caused the thyroid dysfunction and hence the late developmental status.
Sarah C. Bath.et al [35]	2016	13	United Kingdom	Cross sectional	165	8-10 yr	144 µg/l	-	This pilot study proposes that iodine deficiency is improbable to be a problem in UK children aged 8–10 years. This could be a result of higher intake of milk, the major UK dietary iodine source, in this age group than in teenagers and adults.
Hong.et al [39]	2016	13	China	Cohort study	34,547 (1999) 38,932 (2011) 47,188 (2014)	9.07 (1999) 9.02 (2011) 9.01 (2014)	306.0 µg/l (1999) 238.6 µg/l (2011) 197.9 µg/l (2014)	-	the median urinary iodine concentration of children decreased significantly.
Doggui.et al [40]	2016	13	Tunisia	Cross sectional	1560	-	220 µg/L	199–241	Only 11.4% of the children had UIC <100 µg/L, but with great regional disparities (4.3% to 25.5%, $p <$ 0.01); though, more than a quarter of the subjects were at risk of adverse health significances due to iodine excess. Children from households of low socio-economic levels were more prone to insufficient UIC.
Coccaroet .al. [41]	2016	13	Italy	Cross sectional	234	13.5	133.9 µg/L	-	The data described recommend the existence of an adequate iodine intake in the population of Cassino despite the little percentage of iodized salt sold by local retailers.
Girma.et al [42]	2016	13	Ethiopia	Cross sectional	116	8.0	34.2 µg/L	-	Distribution of urinary iodine values according to the epidemiological criteria for assessing iodine nutrition presented that 18.9% had UIC indicating severe iodine deficiency (< 20 ug/L). Sixty three percent (63.2%) had values representative moderate iodine deficiency (20 - 49 µg/L) and 16% had UIC between 50 and 99 µg/L indicating mild iodine deficiency.
Jaiswal .et al [43]	2014	13	Bangalore	Cross sectional	187	5.4	220 µg/L	-	the existing cut-off for median UIC in children representing more-than-adequate intake, recommended by the WHO/UNICEF/International Council for the Control of Iodine Deficiency Disorders may, need to be reassessed.
Fangang [32]	2013	12	China	Cross sectional	627	-	271.4 µg/l	-	The iodine status in children is above the necessity, should reduce their iodine intake.
Hynes.et al [44]	2004	13	Tasmania	Cohort	170	5-14	75µg/L(1989-99) 76µg/L(2000-01)	-	Tasmanian primary school-aged children are another time mildly iodine-deficient by WHO criteria

The study conducted in China by *Fangang etal* found that the iodine level of pregnant women had reached an adequate level. The iodine status in pregnant women is above the necessity; there should be reduction of their iodine intake. [32] Two cross sectional studies done by *Sabrina et al* and *Stefanie. et al* in Brazil and Belgium

assessed iodine status among pregnant women by determining the median UIC values, and found to be lower than the recommended value. [33,34] *Sarah.et al.* considering pregnant women (n = 662) in United Kingdom, found that the MUIC was 56.8 µg/l, which showed that cluster of pregnant women was mildly to moderate iodine deficient in all trimesters, which was found to be major public health concern. [35] The reportage of cohort study conducted by *Pedrerol et al.* in Spain, July 2004- July 2006 considering 657 pregnant women found median UIC was 95 and 104 mg/l during the first and third trimesters respectively. [36] Women with the third trimester UICs between 100 and 149µg/l had minor risk of having an SGA (small for gestational age) newborn than women with UICs below 50µg/l. A cross-sectional study was conducted by *Rashid et al* in Bangladesh where 263 pregnant were participated in the study. Urine sample was collected from pregnant women, in a sterile container and was stored in the refrigerator at –20ºC, for urinary iodine assess. The median UIC of pregnant was found to be 133.4µg/l, so the occurrence of iodine deficiencies was found to be 39.4% in pregnant women in Bangladesh. [37]

In 2017, cross sectional study was done by *Keno et al and Aakre et al* to investigate the iodine status of school children of Aira district, west Ethiopia. The second study, was done to explored whether young children's developmental status is associated with thyroid dysfunction in an area of chronic excessive iodine exposure. The UIC was found to be 88.6µg/l and 451.6 µg/l in the both respective studies. Findings of the study carried by Keno showed that school children (72.6%) in this study had an inadequate iodine intake. Whereas in the study done by Aakre. et al showed an connotation between thyroid dysfunction and poorer developmental status amongst children with excessive iodine intake. [28,38] A experimental study was carried out by *Sarah. et al* in 2016, including boys and girls aged 8–10 years (n=165) where enlisted from schools in three areas of the UK (Omagh, Northern Ireland; Glasgow, Scotland, and Guildford, South-East England). Spot urine samples, for measurement of UIC, were collected in the winter months (November 2012 to March 2013) and in the summer, in Omagh only (September 2013). The MUIC was 161 µg/L in winter samples (*n* = 134) and 127 µg/L in summer (*n* = 31). For the group MUIC was 144 µg/L, samples from the two seasons. [35] *Hong. et al* carried an intervention cohort study by utilizing data from the 19992011and 2014 Chinese national iodine deficiency disorder (IDD) surveys, for the assessment of the effect of different levels of salt iodine content on thyroid volume (ThV) distribution. According to the respective study Chinese children, aged 8-10 yrs were selected in 1991,2011 & 2014 were 34547,38932 and 47188. Iodine content in urine sample & in household iodized salt was measured. The median urinary content was found to be 306.0 µg/l in 1999, 238.6 µg/l in 2011, 197.9 µg/l in 2014. In the study it was found that with decreased salt iodization levels, the median urinary iodine concentration and median ThV of children also reduced. [39] Findings from the three different cross sectional studies [40-42] carried in the year of 2016 designs which are summarized in Table 4. Among these 3 studies, *Doggui et al* found that more than a quarter of the subjects were at risk of adverse health significances due to iodine excess. Children from households of low socio-economic levels were more prone to insufficient UIC. [40] Coccaro *et al* recommend the existence of an adequate iodine intake in the population of Cassino despite the little percentage of iodized salt sold by local retailers [41] whereas study carried by *Girma. Et al* in Ethiopia found that about 18.9% had UIC indicating severe iodine deficiency (<20 ug/L). Sixty three percent (63.2%) had values representative moderate iodine deficiency (20 - 49 µg/L) and 16% had UIC between 50 and 99 µg/L

indicating mild iodine deficiency. [42] A cross sectional study was carried in Bangalore by *Jaiswal et al* in 2014 on women & children to relate the iodine status of pregnant women and their children who were utilizing same all meals in Bangalore. The result showed that urban population of southern India which has been selected ensures adequate iodine intake in pregnant women, iodine intake in their children is in the more-than-adequate range giving to current cut-off criteria. [43] *Fangang. et al* carried-out a cross-sectional study in six areas of China, the effective sample size was taken to be 627 school children. MUIC was found to be 271.4 μg/L, this shows that the iodine status in children is above the necessity. [32] The last study which was included in the summary table 4 was done by *Hynes e tal* in Tasmania were 170 children at baseline (1998/99) and at follow-up (2000/01) aged 5-14 yrs were recruited in the study. The median UIC was 75μg/L(1989-99) and 76μg/L(2000-01). It was found that school-aged children in Tasmania primary school mildly iodine-deficient by WHO criteria. [44]

CONCLUSION

Iodine deficiency throughout pregnancy has vital impacts for the mother and the foetus, mainly thyroid under-function and goitrogenesis. Moreover, iodine deficiency is related with alterations of the neurological, psychological and child's intellectual development through both gestation and the postnatal period. Therefore, iodine prophylaxis should be given methodically to women during pregnancy.

This systematic review has been explored the public knowledge regarding role of iodine during pregnancy and its effect on the foetal growth. Mostly people have insufficient knowledge regarding role and risk factor of iodine during pregnancy. In a country the cases of IDD are increasing day by day at an alarming rate. This review article is a suggestive measure to let the people know that still a lot has to be known about the role of iodine during pregnancy and in children. An approach is essential with operative and effectual coordination amongst all stakeholders of IDD control efforts to achieve and sustain the IDD control goal.

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