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Thyroid Status of School Going Children in Northern Part of Bangladesh

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THYROID STATUS OF SCHOOL GOING CHILDREN IN NORTHERN PART OF BANGLADESH

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DECLARATION

I, hereby declare that the research work submitted as a dissertation entitled **"THYROID STATUS OF SCHOOL GOING CHILDREN IN NORTHERN PART OF BANGLADESH "** submitted to the Institute of Biological Sciences, University of Rajshahi, Rajshahi, Bangladesh for the degree of Doctor for Philosophy is the result of the original research work carried out by me under the supervision of Dr. Parvez Hassan, Ph.D., Associate Professor, Institute of Biological Sciences, University of Rajshahi and Professor Naiyyum Chowdhury, Co-ordinator, Dept. of Biotechnology, BRAC University, Mohakhali, Dhaka- Bangladesh (Ex-Chairman, Bangladesh Atomic Energy Commission (BAEC) and the Department of Microbiology, University of Dhaka, Dhaka-1000, Bangladesh).

I, further, declare that this dissertation or part thereof has not been the basis for the award of any degree, diploma or associate ship of any other similar title.

29.06.09

(A. K. M. Mostafa Zaman)

Signature of the Candidate

CERTIFICATE

We do there by certify that A K M Mostafa Zaman is the sole author of the dissertation entitled **"THYROID STATUS OF SCHOOL GOING CHILDREN IN NORTHERN PART OF BANGLADESH".** This dissertation or part there of has not been previously submitted for the award of any degree, diploma or associate ship of any other similar title.

We are forwarding this dissertation to be examined for the degree of Doctor of Philosophy to the Institute of Biological Sciences, University of Rajshahi, Rajshahi, Bangladesh. **A K M Mostafa Zaman** has fulfilled all the requirements according to the rules of the University for Submission of a dissertation for the Ph.D. degree.

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DEDICATED

TO

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- The author

ABSTRACT

Iodine plays a decisive role and regulates thyroid function in metabolism for the process of early growth and development of most organs, especially of the brain. Lack of iodine in the diet can cause a spectrum of conditions, known as iodine deficiency disorders (IDD) a problem of alarming magnitude in Bangladesh. One fifth of the total population has goiter, a disorder caused by iodine deficiency. Forty-three percent have either clinical or sub clinical evidence of IDD and mental retardation due to IDD is estimated to affect 0.4 percent of the population. Northern part (study area, Dinajpur district) of Bangladesh is a hyper endemic zone of IDD (Khaliullah *et al.*, 1996, HKI 2002, Yusuf *et al.*, 2008).

The present study was a school-based, cross-sectional one conducted over a period of four years from July 2004 to June 2008. A total of 1060 school children between the ages of 6 – 15 yrs (median was 10.44 ±2.49 SD) from 30 different educational institutes / schools in Dinajpur district situated in the Northern part of Bangladesh (a hyper endemic iodine deficient zone) were examined for the presence of goiter by palpation method and their blood and urine samples were subjected to biochemical analysis to find out the thyroid hormone (T_3, T_4, TSH) and urinary iodine levels (UIE). Measurement of weight and height were made as per recommendation of WHO/UNICEF/ICCIDD (2001). The nutritional status of school children was evaluated according to height and weight z-scores and the prevalence of underweight, stunting and wasting were to be calculated according WHO recommended cut-off points

Data was collected through two structured questionnaire containing all the variables of interest and also included information on knowledge of iodine nutrition among mothers (n=312) of study children regarding their socio-demographic variables.

The total goitre rate (TGR) of school going children of the study area was 7.8 % (Grade 1+2 = 7.1% + 0.7%). Goitre prevalence increased with the advancement of age irrespective of sex and the goitre prevalence rate in higher age children was 2/3 times higher as compared to the lower age children (6-8 yrs). The lower the age, better was the iodine nutritional status and goitre prevalence was lower age in group 1 (6-8 yrs) and 2 (8.1 10 yrs) 3.8% and 4.3% and simultaneously higher the age (age group 3 (10.1- 12 yrs) and 4 (12.1-15 yrs) goiter prevalence was higher 10.6% (9.5% + 1.1%) and 11.4% (10.1% + 1.1%).

The present study showed that the goiter prevalence was more in girls 8.6% than in boys (7.3%). The ratio of iodized salt intake of age groups 1,2,3 and 4 was 82.6%, 74.3%, 69.3% and 63.0%, respectively and totally 71.7%; relatively same as national coverage (national IDD survey 2004-

05, 70.0%). Regular consumption of iodized salt among boys was (62.8%) and was < girls (84.5%).

Goitre was found to be more prevalent among Tribals (10.5%) than Hindus (7.8%) and Muslims (7.4%). Consumption of iodized salt were more by Hindus compared to Tribals and Muslims (86.5%>74.0%>67.5%). The goitre prevalence rate increased gradually with the lowering of socioeconomic status and TGR of different socioeconomic level rich, upper middle class, lower middle class, poor and vulnerable was (2.2%), (2.3%), (6.0%), (9.0%) and (19.1%), respectively. The differences in goitre prevalence among different socio-economic statuses was statistically highly significant ($p=0.000 < 0.05$).

The median concentrations of T_3, T_4 and TSH of the present study population was slightly upper than the lower level of reference range. The median UIE of study children was 159.23 ± 67.02 μg/L (near about national median UIE estimations in school study children i.e. 163.0 μg/L). In the boys median UIE (171.24 ± 67.17 μg/L) was higher than that of girls (149.33 ± 62.45 μg/L). The total prevalence of iodine deficiency in our study children was 23.7%; for boys it was 20.9 % and girls was 26.7% On the basis of age group, the ratio of UIE level (<100 μg/L), age group 1(9.58%) and 2 (14.5%) fall in mild categories, group 3 (30.94%) in moderate and group 4 (51.1%) fall in severe grade of iodine deficiency.

The total prevalence of underweight (WAZ), stunting (HAZ) and wasting (WHZ) (<median -2Sd) for boys was 26.8% , 16.5% ., 13.1.%, for girls was 23.6% , 22.2% 9.5% and severe grade of underweight, stunting and wasting (<median -3SD) for boys was 6.6%, 5.2%, and 2.5% for girls was 5.1%, 5.8% and 1.1% . The total prevalence of under nutrition for boys under weight was 33.4%, stunting 21.7% and wasting 15.6% while for girls was 28.7%, 28.0% and 10.6%.

The iodine nutritional status impact among mothers is threatening. Only 11.6% mothers having adequate knowledge of iodine and rest 88.4% have known only two words (Iodine and Goitre). 68.7 % of the rural women complain against high price and the rest quality of iodized salt. The majority of the people in the study area were not aware of the order banning the use of non-iodized salt and the benefits of iodized salt.

The study results showed mild TGR (7.8%), moderate iodine deficiency with poor community knowledge of iodine nutrition indicating that the population of the study area Dinajpur, Bangladesh is going through a transition phase from iodine-deficient to iodine-sufficient. Insufficient awareness-raising activities and knowledge is the main cause of persisting IDD in 21^{st} century in the study region (Dinajpur District, Northern Part of Bangladesh).

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INTRODUCTION

1. INTRODUCTION

1.1. Iodine deficiency disorders (IDD) - a public health problem.

Iodine deficiency is a major public health problem throughout the world, particularly among pregnant women and young children. It is a threat to the social and economic development of any country. The most devastating outcomes of iodine deficiency are increased prenatal mortality and mental retardation. Iodine deficiency is the greatest cause of preventable brain damage in childhood which is the primary motivation behind the current world-wide drive to eliminate it (WHO - Iodine status worldwide, 2005).

The present study area is Dinajpur, the northern part of Bangladesh which is A hyper endemic Iodine deficient zone particularly badly affected by a high prevalence of IDD and goitre (Yusuf *et al.* 1994, Khalilullah *et al.* 1996). Protein energy malnutrition (PEM), under weight, stunting and wasting a also higher in this region. Helen Keller International Bangladesh, 2002, Bangladesh Demographic and Health Survey, 1999-2000).)

1.2. Iodine

Iodine is a non-metallic trace element and an essential micronutrient which is required by humans for the synthesis of thyroid hormones. The main factor responsible for iodine deficiency is a low dietary supply of iodine. Most of the Earth's iodine is found in oceans, and iodine content in the soil varies from region to region. Iodine deficiency occurs in populations living in areas where the soil has a low iodine content as a result of past glaciations or the repeated leaching effects of snow, water and heavy rainfall. Crops grown in this soil, therefore, do not provide adequate amounts of iodine when consumed (Iodine status worldwide, WHO 2005).

1.3. Iodine and the brain.

Thyroid hormones, and therefore iodine, are essential for normal development of the brain (Stanbury 1994, Boyages 1994). If a fetus or newborn is not exposed to enough thyroid hormone, it may have permanent mental retardation, even if it survives. The most damaging consequences of iodine deficiency are on fetal and infant development.

Maternal iodine deficiency causes miscarriages, other pregnancy complications and infertility. Low birth weights and decreased child survival also result from iodine deficiency. Cretinism is a very severe degree of iodine deficiency and includes brain damage (Bleichrodt and Born 1994, Delange 2001). It includes permanent dense mental retardation and varying degrees of additional developmental defects such as deafmutism, short stature, spasticity and other neuromuscular abnormalities. The physiologic effects of the thyroid hormones are summarized in Table 1 (a).

Table 1 (a): Physiologic effects of Thyroid Hormones

Target tissue	Effect	Mechanism
Nervous system	Developmental	Promote normal brain development
Bone	Developmental	Promote normal growth and skeletal development
Heart	Chronotropic	Increase number and affinity of ß-adrenergic receptors
	Inotropic	Enhance responses to circulating catecholamines. Increase proportion of Ü myosin heavy chain (with ATPase activity)
Adipose tissue	Catabolic ·	Increase protein breakdown
Muscle	Catabolic	Increase protein breakdown
Gut	Catabolic	Increase rate of carbohydrate Absorption
Lipoprotein	Metabolic	Stimulate formation of LDL receptors
Other	Calorigenic ·	Stimulate oxygen consumption by metabolically active tissues exceptions are tests, uterus, lymph nodes, spleen, anterior pituitary)· Increase metabolic rate

(Mc Phee *et al.*.2000).

1.4. Health consequences of Iodine

Iodine is present in the body in minute amounts, mainly in the thyroid gland. Its main role is in the synthesis of thyroid hormones. When iodine requirements are not met, thyroid hormone synthesis is impaired, resulting in hypothyroidism and a series of functional and developmental abnormalities grouped under the heading of "Iodine Deficiency Disorders (IDD)" as shown in Table 1. Goitre is the most visible manifestation of IDD. Endemic goitre results from increased thyroid stimulation by thyroid stimulating hormone (TSH) to maximize the utilization of available iodine and thus represents maladaptation to iodine deficiency (Delange *et al.* 1998, Dumont *et al.* 1995.).

The most visible consequence of iodine deficiency is goiter. This word means "an enlarged thyroid." The process begins as an adaptation in which the thyroid is more active in its attempts to make enough thyroid hormone for the body's needs, despite the limited supply of raw material (iodine), much as a muscle gets bigger when it has to do more work. If this adaptation is successful and the iodine deficiency is not too severe, the person may escape with only an enlarged thyroid and no other apparent damage from the iodine deficiency (Delange, 1994).

Table 1(b). WHO and ICCIDD Goitre gradation system.

Grade	Description
Grade 0	Thyroid gland not palpable
Grade I	Thyroid gland is palpable, but not visible with normal or head in extended position
Grade 2	Thyroid easily visible with head in normal position
Grade 3	Goitre visible from a distance

Source: (WHO, UNICEF, ICCIDD - 1993)

(Mother and daughter of tribal in study area)

However, the most damaging disorders induced by iodine deficiency are irreversible mental retardation and cretinism (Heztel 1983, Stanbury 1994, Delange 2001). If iodine deficiency occurs during the most critical period of brain development (from the fetal stage up to the third month after birth), the resulting thyroid failure will lead to irreversible alterations in brain function. In severely endemic areas, cretinism may affect up to 5–15% of the population. A meta-analysis of 19 studies conducted in severely iodine deficient areas showed that iodine deficiency is responsible for a mean IQ loss of 13.5 points in the population (Bleichrodt and Born 1994, Delange 2001). While cretinism is the most extreme manifestation, of considerably greater significance are the more subtle degrees of mental impairment leading to poor school performance, reduced intellectual ability and impaired work capacity (Stanbury and Pinchera, 1994).

Table 1(c). The spectrum of iodine deficiency disorders of life span shows in table.

Fetus	Abortions Stillbirths Congenital anomalies Increased prenatal mortality Increased infant mortality Neurological cretinism — mental deficiency Deaf—mutism Spastic diplegia Squint Myxoedematous cretinism - dwarfism mental deficiency, Psychomotor defects and fetal hypothyroidism
Neonate	Neonatal hypothyroidism Neonatal goiter
Child	Goitre
Adolescent	Juvenile hypothyroidism Impaired mental function Retarded physical development
Adult	Goiter with its complications Hypothyroidism Impaired mental function

Source: (Heztel, 1983; ACC/SCN-1987; Stanbury 1998, Laurberg 2006, WHO: global database on iodine deficiency - 2005).

1.5. Iodine Deficiency World-wide

Iodine deficiency is considered to be the most common preventable cause of mental disorders in the world today, having manifestations at different stages of human life. A large proportion of people with severe iodine deficiency are women of reproductive age, who are at a higher risk of pregnancy-related problems, including abortion, stillbirth, low-birth weight infants, brain damage or cretinism in infants even before birth and lower chance of survival.

Iodine deficiency can cause goitre and brain damage in neonates whereas manifestations in children include goitre, loss of energy, impaired school performance and retarded physical development. In adults, iodine deficiency can lead to goitre and related complications, loss of energy and impaired mental function.

According to a 1990 WHO report, some 26 million people suffer from brain damage associated with iodine deficiency disorder, which includes six million cretins (WHO - Iodine status worldwide, 2005). All these have resulted in a growing awareness of the problem all over the world.

1.5.1. Iodine deficiency and goitre in Bangladesh

Results of surveys conducted since the 1960s have shown that high levels of iodine deficiency are prevalent in Bangladesh. The Nutrition Survey of East Pakistan 1962-1964 reported a goitre rate of 28.9% in former East Pakistan, now Bangladesh (US Department of Education, Health and Welfare, Nutrition survey of East Pakistan, March 1962 – January 1964.). The 1981-1982 National Goitre Prevalence Survey reported levels of iodine deficiency disorder nationwide, with a goitre rate of 10.5% (Mannan *et al.* 2001).

This result was, however, criticized because the health officers and workers who were assigned to identify goitre cases were not adequately trained. The National Iodine Deficiency Disorder Survey 1993 revealed a goitre rate of 47.1% (Yusuf *et. al* 1994). Another survey, using the 'EPI-30 cluster'-sampling methodology, found a prevalence of cretinism of 0.5%; 69% of subjects had low urinary concentrations of iodine (urinary iodine excretion [UIE] <10 μg/dl). Women and children were more affected than men, in terms of prevalence of both goitre and UIE. The presence of widespread severe iodine deficiency in all ecological zones indicates that the country as a whole is an iodine-deficient region (Yusuf *et al.,* 1996).

1.5.2. Salt iodization in Bangladesh

To combat iodine deficiency disorder, the Government of Bangladesh, in 1989, passed the Iodine Deficiency Disease Prevention Act. The Act proclaimed universal iodization of edible salt for human and animal consumption and included prevention, enforcement and education efforts. Under this act, the Bangladesh Council of Scientific and Industrial Research (BCSIR) and other institutions would be responsible for monitoring the quality of iodized salt manufactured and sold from that time onwards. Most salt-crushing units (which produce pure white sea salt from impure colored products of salt croppers) have been provided with iodization equipment and UNICEF supplied the iodizing agent-potassium iodate - free of charge. Despite this law and this assistance, much of the salt used by the people are not iodized (IPH. BSCIC, UNICEF, ICCIDD, 1996.).

A survey in 1995 showed that only 30% of iodized salt manufactured in Bangladesh contained an acceptable level of iodine (Khorasani, 1999). Surprisingly, 10% of commercial brands contained no iodine at all. Only 30% of producers were using the recommended level of iodine, 10% were using mixtures of fortifying agents and 10% were not using any iodine at all.

Another survey conducted with UNICEF support in 1997 showed that the situation had not improved (Yusuf *et. al.* 1996). This survey found that only 57% of salt factories with iodization facilities were in regular production, 7% produced iodized salts only irregularly and 36% were closed. Of 379 samples collected from 138 factories, only 5% contained adequate amounts of iodine, 46% contained too little, 1% contained no iodine at all and 49% contained too much. Some contained significantly more than it should, i.e. up to 20 times the recommended amount of iodine. Of 1,104 samples collected from retail outlets, 7% contained no iodine and only one contained the recommended amount whereas 44% contained too little and 56% contained large excess of iodine.

Another cross-sectional study conducted in a coastal area in southern Bangladesh, during 1997-1998, comprising of 21,190 households revealed that only 1.9% of the households used iodized salt in daily cooking. (Rasheed *et al.* 2001). In the Baseline

Survey of the National Nutrition Programme in 2004, 39.5% of households were consuming table salt containing an inadequate concentration of iodine (<15 ppm) (Ahmed *et al.* 2005).

The barriers limiting the use of iodized salt include the wide availability of coarse salt, lack of knowledge about the link between iodized salt and iodine deficiency disorders and the high cost of iodized salt. These situation shows that the salt-iodization program in Bangladesh is not making headway. The reasons may include: lack of quality-control measures in production units, lack of skill among production personnel and failure on the part of the government regulatory agencies (Khorasani *et al.* 1995).

1.6. NUTRITION

Proper nutrition is an absolute necessity for children. Children who are well-fed are generally healthy and much more likely to lead successful lives. Healthy women lead more fulfilling lives; healthy children learn more in school and out. Good nutrition benefits families, their communities and the world as a whole.

Malnutrition is devastating and it plays a part in more than half of all child deaths worldwide and also perpetuates poverty. Malnutrition blunts the intellect and saps the productivity of everyone it touches. The 1992 Convention on the Rights of the Child recognizes the right of all children to survival, to develop to the fullest, to protection from harmful influences: abuse and exploitation; and to participate fully in family, cultural, and social life. Governments have a moral and legal responsibility to protect these rights, and provide children with a secure and healthy foundation on which to grow. Children's nutrition and well being are the foundation of a healthy, productive society (UNICEF/WHO, 1994; UNICEF/WHO, 2005).

1.6.1. General Facts and Statistics of Child nutrition.

- Almost 1/3 of all children in the developing world have stunted height due to malnourishment.
- 143 million children are underweight for their age.
- 175 million children have stunted height due to malnourishment.
- More than 60% of all children do not exclusively breastfeed for the vital first 6 months.

• Iodine deficiency is the main cause of preventable mental retardation and brain damage.

• 40 to 50 percent of children under five in developing countries are iron deficient.

•At least 100 million children under five suffer from vitamin A deficiency (Iodine status worldwide, WHO, 2005.).

1.7. Global Malnutrition

Malnutrition is not merely a result of too little food, but is a combination of factors: insufficient protein, energy and micronutrients, frequent infections or disease, poor care and feeding practices, inadequate health services and unsafe water and sanitation.

The four most important forms of malnutrition worldwide (protein-energy malnutrition, iron deficiency and anemia's (IDA), vitamin A deficiency (VAD) and iodine deficiency disorders (IDD) are examined below in terms of their global and regional prevalences, the age and gender groups most affected, their clinical and public health consequences and especially the recent progress in country and regional quantitation and control. Zinc deficiency, with its accompanying diminished host resistance and increased susceptibility to infections, is also reviewed. WHO estimates that malnutrition (underweight) was associated with over half of all child deaths in developing countries in 1995.

The prevalence of stunting in developing countries was expected to decline from 36% in 1995 to 32.5% in 2000; the numbers of children affected (excluding China) are expected to decrease from 196.59 millions to 181.92 millions. Stunting affects 48% of children in South Central Asia, 48% in Eastern Africa, 38% in South Eastern Asia, and 13-24% in Latin America. IDA affects about 43% of women and 34% of men in developing countries and usually is most serious in pregnant women and children, though non-pregnant women, the elderly, and men in hookworm-endemic areas also comprise groups at risk. Clinical VAD affects at least 2.80 million preschool children in over 60 countries and sub-clinical VAD is considered a problem for at least 251 millions; school-age children and pregnant women are also affected.

Globally about 740 million people are affected by goitre and over two billions are considered at risk of IDD. However, mandatory salt iodization in the last decade in many regions has decreased dramatically the percentage of the population at risk. Two recent major advances in understanding the global importance of malnutrition are (1) the data of 53 countries that links protein-energy malnutrition (assessed by underweight) directly to increased child mortality rates and (2) the outcome in 6 of 8 large vitamin A supplementation trials showing decreases of 20-50% in child mortality (WHO:global database on iodine deficiency -2005).

1.8. Indicators for assessment and monitoring

Several indicators are used to assess the iodine status of a population: thyroid size by palpation and /or by Ultrasonography, urinary iodine (UI) and the blood constituents, TSH or thyrotropin, and thyroglobulin. Until the 1990s total goitre prevalence (TGP) was recommended as the main indicator to assess IDD prevalence. However, TGP is of limited utility in assessing the impact of salt iodization. In endemic areas, TGP may not return to normal for months or years after correction of iodine deficiency. During this period, TGP is a poor indicator because it reflects a population's history of iodine nutrition but not its present iodine status. TGP is still useful to assess the severity of IDD at baseline and has a role in evaluating the long term impact of control programmes.

As UI is a more sensitive indicator to recent changes in iodine intake, it is now recommended over TGP (WHO, UNICEF, ICCIDD 2001). Most countries have started to implement IDD control programs and a growing number of countries are consequently monitoring iodine status using UI. TSH levels in neonates are particularly sensitive to iodine deficiency however difficulties in interpretation remain and the cost of implementing a TSH screening program is high. The value of thyroglobulin as an indicator of global IDD status has yet to be fully explored.

While IDD affects the entire population, a school-based sampling method is recommended for UI and TGP as the most efficient and practical approach to monitor IDD as this group is usually easily accessible and can be used as a proxy for the general population (Laurberg *et al.*, 2000). School-age refers to children aged 6–12 years, here after referred to as school-age children unless otherwise noted. Iodine deficiency is considered to be a public health problem in populations of school-age children where the median UI is below 100 μg/l (Table 1(d)) or goitre prevalence is above 5% (WHO, UNICEF, ICCIDD, 2001).

Table 1 (d). Epidemiological criteria for assessing iodine nutrition based on median UI concentrations in school-age children.

Median UI μg/dl	Iodine Intake	Iodine Nutrition
< 20	Insufficient	Severe iodine deficiency
20–49	Insufficient	Moderate iodine deficiency
50–99	Insufficient	Mild iodine deficiency
100-199	Adequate	Optimal_iodine nutrition
200-299	More than adequate	Risk of iodine induced hyperthyroidism within 5–10 years following introduction of iodized salt in susceptible group
≥ 300	Excessive	Risk of adverse health consequences (iodine induced hyperthyroidism, auto-immune thyroid disease.)

Source: (WHO, UNICEF, ICCIDD, 2001).

Bangladesh is one of the most densely populated countries in the world with a population more than 140 millions. Protein-energy malnutrition (PEM) is a very serious public health problem in developing countries and more than half of the total death of the under five children are related, directly or indirectly to malnutrition .

Bangladesh made substantial progress in reducing malnutrition between 1990 and 2000, with the proportion of underweight children falling from 66.6 per cent to 51.1 per cent, and the level of child is stunting falling from 65.5 per cent to 48.8 per cent. If this current rate of improvement continues, the percentage of underweight and stunted children will be halved by 2015. Nevertheless, the prevalence of child stunting and underweight in 2000 are still 'very high' according World Health Organization (WHO) criteria. Chronic energy deficiency in non-pregnant women declined from 52 per cent in 1996-97 to 45 per cent in 1999-2000, but is still very high. Low birth weight is estimated to affect 30-50 percent of infants (Mitra and associates 2004, HKI 2006)

Since 1997, the prevalence of night blindness, an early indicator of vitamin A deficiency, has been maintained below the 1 per cent threshold that indicates a public health problem. This success has largely been due to the vitamin A supplementation program, which increased in coverage from 41 per cent in 1993 to over 85 per cent in the second half of the decade by linking the distribution of vitamin A capsules with the Coverage of iodized salt increased from 19 per cent in 1993 to 70 per cent in 1999, and correspondingly, the prevalence of iodine deficiency fell from 69 percent to 43 percent (BBS-2003).

The nutritional status of adolescent girls and women is a key factor in the persistence of malnutrition in Bangladesh. Children are much more likely to be of low birth weight and to remain malnourished throughout their lives if their mothers were malnourished during adolescence and prior to and during pregnancy. Malnourished children are physically weak, they lack resistance to disease, they do less well at school, they are less productive as adults and they remain vulnerable for the rest of their lives.

In Bangladesh, malnutrition is caused by multiple factors. The immediate causes are diseases and inadequate intake of food. The underlying causes of malnutrition include the inability of households to grow and purchase sufficient food for their needs; poor maternal and child-care practices, including inadequate breastfeeding and complementary feeding for infants and young children and inadequate provision of food for adolescent girls and pregnant and lactating women.

These are compounded by delays in recognizing the signs of malnutrition or disease and in seeking care for children and women, inadequate access to quality health services, including family planning, immunization and medical services and poor access to sanitary facilities and potable water (UNICEF: The state of Worlds children 2004).

1.9 Control of IDD

The recommended strategy for IDD control is based on correcting the deficiency by increasing iodine intake through supplementation or food fortification. Four main components are required to implement the strategy: correction of iodine deficiency, surveillance including monitoring and evaluation, intersectorial collaboration and advocacy and communication to mobilize public health authorities and educate the public (Iodine status worldwide, WHO, 2005.).

1.9.1. Correcting iodine deficiency

1.9.1.1. Iodine supplementation

The first iodine supplements were in the form of an oral solution of iodine such as Lugol, which was given daily. After the Second World War, considerable progress was made in reducing IDD with iodized oil – initially using the intra-muscular form and in the 1990s, using the oral form. For example, iodized oil was used with success in Papua New Guinea and thereafter in China, several countries in Africa and Latin America and in other severely endemic areas (Iodine status worldwide, WHO, 2005).

The oral form of iodized oil has several advantages over the intramuscular form: it does not require special storage conditions or trained health personnel for the injection and it can be given once a year. Compared to iodized salt, however, it is more expensive and coverage can be limited since it requires direct contact with each person. With the introduction of iodized salt on a large scale, iodized oil is now only recommended for populations living in severely endemic areas with no access to iodized salt (WHO, Iodine status worldwide, 2005).

1.9.1.2. Food fortification with iodine.

Over the past century, many food vehicles have been fortified with iodine: bread, milk, water and salt. Salt is the most commonly used vehicle. It was first introduced in the 1920s in the United States (Marine, Kimball, 1920) and in Switzerland (Burgi, Supersaxo, Selz 1990). However, this strategy was not widely replicated until the

1990s when the World Health Assembly adopted universal salt iodization (USI) (the iodization of salt for both human and livestock consumption) as the method of choice to eliminate IDD. In 2002, at the Special Session on Children of the United Nations (UN) General Assembly, the goal to eliminate IDD by the year 2005 was set (UNICEF- The state of the World's children 2004).

USI was chosen as the best strategy based on the following facts: (i) salt is one of the few commodities consumed by everyone; (ii) salt consumption is fairly stable throughout the year; (iii) salt production is usually in the hands of few producers; (iv) salt iodization technology is easy to implement and available at a reasonable cost (0.4 to 0.5 US cents/kg, or 2 to 9 US cents per person/year); (v) the addition of iodine to salt does not affect its color, taste or odour; (vi) the quality of iodized salt can be monitored at the production, retail and household levels; and (vii) salt iodization programs are easy to implement.

In order to meet the iodine requirements of a population it is recommended to add 20 to 40 parts per million (ppm) of iodine to salt (assuming an average salt intake of 10 g per capita/day). There are two forms of iodine fortifcants, potassium iodate and potassium iodide. Because iodate is more stable under extreme climatic conditions it is preferred to iodide, especially in hot and humid climates (WHO/UNICEF/ICCIDD, 1996). For historical reasons, North America and some European countries use potassium iodide while most tropical countries use potassium iodate.

1.9.1.3 . Safety in approaches to control iodine deficiency

Iodine fortification and supplementation are safe if the amount of iodine administered is within the recommended range. For more than 50 years iodine has been added to salt and bread without noticeable toxic effects (Bflrgi, Schaffner, Seiler 2001). However, a rapid increase in iodine intake can increase the risk of iodine toxicity in individuals who have previously had chronic iodine deficiency. In this report "total goitre prevalence" is used instead of "total goitre rate" (TGR) to be in agreement with the terminology that is universally used in epidemiology (Bleichrodt and Born, 1994).

Iodine-induced hyperthyroidism (IIH) is the most common complication of iodine prophylaxis and it has been reported in almost all iodine supplementation programs in their early phases). For programs using iodized salt, there is less information. IIH occurs in the early phase of the iodine intervention and primarily affects the elderly who have longstanding thyroid nodules. However, it is transient and its incidence reverts to normal after one to ten years. Monitoring of salt quality and iodine status of populations and training of health staff in identification and treatment of IIH are the most effective means for preventing IIH and its health consequences (Boyages, 1994).

1.10. Monitoring and evaluating the IDD control programs.

1.10.1, Monitoring iodine levels of salt.

Governments usually set the level at which salt should be iodized. Monitoring aims to ensure that the salt industry complies with the regulations set by the government and that the iodine levels are re-adjusted if necessary. Iodine levels are monitored (at a minimum) at the factory and household levels and if possible at the retail level. If iodized salt is imported it is monitored at the point of entry into the country. The monitoring process at the factory level is the salt producer's or importer's responsibility and is regularly supervised by the relevant public authorities. In most cases the Ministry of Health carries out the monitoring at the household level. Iodine content in salt is best measured by titration. Field test kits have been developed. They only give qualitative results, indicating if iodine is present or not. Because of this, they are of limited use; moreover their reliability has recently been questioned. However, they are can still be useful for training educating and for advocacy purposes for the public and staff (WHO/ UNICEF/ICCIDD - 1993, 2001).

1.10.2. Monitoring of iodine status.

When salt is adequately iodized, it is likely that a population's iodine status will improve and the thyroid function of that population will normalize. Monitoring the population's iodine status is nevertheless necessary since dietary habits may change in some segments of the population or the iodine level of salt may not be sufficient to meet the requirements of some groups, in particular pregnant women (WHO/UNICEF 1994, 2005, Zimmermann *et al.* 2005).

1.11. Increasing awareness of public health authorities and the general public.

WHO has played a pioneering role in mobilizing the international community and public health authorities by providing strategic guidance and technical support. In 1990, the World Health Assembly adopted a resolution urging Member States to take the appropriate measures to eliminate IDD. This goal was reaffirmed in a series of subsequent international forums including: the 1990 World Summit for Children (New York), the Joint WHO/Food and Agricultural Organization of the United Nations (FAO) and the International Conference on Nutrition in 1992 (Rome) and the Special Session on Children of the UN General Assembly in 2002 (New York).

This commitment catalyzed the involvement of a large number of additional actors. The United Nations Children's Fund (UNICEF) was one of the first organizations to assist countries in establishing salt iodization programs and still now plays a leading role in this regard (The state of the world's children, 2004).

The International Council for the Control of Iodine Deficiency Disorders (ICCIDD) played an instrumental role in providing technical support. Other important actors were the bilateral co-operation agencies, non-governmental organizations (NGOs) such as the Micronutrient Initiative, the salt industry, and donor foundations such as Kiwanis International and the Bill and Melinda Gates Foundation (WHO: Iodine status worldwide, 2005).

1.12. Reinforcing the collaboration between sectors.

Network for sustainable elimination of iodine deficiency effective IDD control demands collaboration and clearly the salt industry has a major role to play by iodizing salt and ensuring its delivery to regions worldwide. To facilitate the participation and co-ordination of the salt industry as well as other sectors in IDD control, the Global Network for Sustained Elimination of Iodine Deficiency was established in 2002. In most countries where iodine deficiency is a public health problem, a national multi-sectorial IDD body has been established, usually chaired by the Ministry of Health. Its main roles are to design and supervise the implementation of an IDD control plan and to coordinate the activities of the various sectors and partners involved. It acts in concert with the national and international partners involved in IDD control (UNICEF 2005, WHO global database on iodine deficiency-2005).

(Further information on this network can be obtained on the Internet: http://www.sph.emory.edu/iodinenetwork/.)

1.13. International resource laboratory network for IDD control program.

Where iodine deficiency is a public health problem, laboratory facilities to measure the indicators required to monitor the program are often insufficient or lacking altogether. To overcome this problem, the International Resource Laboratories for Iodine (IRLI) Network has been created, under the coordination of the Centers for Disease Control and Prevention (CDC), WHO, UNICEF, the Micronutrient Initiative and ICCIDD. The main role of this network is to provide technical support to national laboratories which may need assistance through regional or sub regional resource laboratories in monitoring their IDD control programs. In every WHO region at least one resource laboratory has been identified (WHO: Iodine status worldwide, 2005).

1.14. Sustaining IDD control programs

In order to achieve the global goal set for 2005, IDD control programs and monitoring need to be constantly sustained due to the fact that IDD simply re-appears if salt iodization is interrupted. This may happen when the responsible public health authorities are demobilized or if the salt industry fails to effectively monitor iodine content. In order to assess the sustainability of control programs and track their progress towards the IDD elimination goal, criteria have been established by WHO (Table 1(e).

Table 1(e). Criteria for monitoring progress towards sustainable IDD elimination Indicators Goals.

Indicators	Goals
Salt Iodization coverage □ Proportion of households consuming adequately iodized salt (Adequately iodized salt refers to at least 15 ppm at household level)	> 90%
Urinary iodine □ Proportion of population with urinary iodine levels below 100 μg/l □ Proportion of population with urinary iodine levels below 50 μg/l	<50% <20%
Programmatic indicators At least 8 1. National body responsible to the government for IDD elimination. It should be multidisciplinary, involving the relevant fields of the 10 of nutrition, medicine, education, the salt industry, the media, and consumers, with a chairman appointed by the Minister of Health; 2. Evidence of political commitment to USI and elimination of IDD; 3. Appointment of a responsible executive officer for the IDD elimination program; 4. Legislation or regulation of USI; 5. Commitment to regular progress in IDD elimination, with access to laboratories able to provide accurate data on salt and urinary iodine; 6. A program of public education and social mobilization on the importance of IDD and the consumption of iodized salt; 7. Regular data on iodized salt at the factory, retail and household levels; 8. Regular laboratory data on urinary iodine in school-age children, with appropriate sampling for higher-risk areas; 9. Co-operation from the salt industry in maintenance of quality control; and 10. A database for recording results or regular monitoring procedures particularly for salt iodine, urinary iodine and, if available, neonatal thyroid stimulating hormone (TSH), with mandatory public reporting.	At least 8 of the 10.

Source: WHO, UNICEF, ICCIDD - 1996.

1.15. The Recommended Dietary Allowance (RDA)

The RDA for iodine was reevaluated by the Food and Nutrition Board (FNB) of the Institute of Medicine in 2001. The recommended amounts were calculated using several methods, including the measurement of iodine accumulation in the thyroid glands of individuals with normal thyroid function. These recommendations are in agreement with those of the International Council for the Control of Iodine Deficiency Disorders, the World Health Organization and UNICEF and are given in Table 1(f).

Table 1 (f). The Recommended Dietary Allowance (RDA) of iodine.

Recommended Daily	Iodine intake µg/day
Adults	150 easily meet household salt)
Pregnant	220 µg
Lactating	290 µg
Infants 0-6 months Infants 6-12 months	110 µg 130 µg
Children 1-8 yrs Children 9-16 yrs	90 µg 120 µg

(Source: Food and Nutrition Board USA, WHO, UNICEF, ICCIDD-2001)

CHAPTER-2

HYPOTHESIS AND OBJECTIVES

2. HYPOTHESIS, AIMS AND OBJECTIVES

2.1. RESEARCH HYPOTHESIS:

Iodine deficiency disorder (IDD) is a serious threat to the health and well being of people residing in goiter endemic areas.

2.2. RATIONALE:

Bangladesh is one of the countries most affected by iodine deficiency disorders (IDD) in the world. Iodine deficiency disorders are one of the major public health problems in Bangladesh. The presence of widespread severe iodine deficiency in all ecological zones indicates that the country as a whole is an iodine-deficient region (Yusuf *et al.* 1994). The first National IDD Survey in 1993 revealed that a very high prevalence of total goiter (47.1%), visible goiter (8.8%), cretinism (0.5%), and biochemical iodine deficiency (68.9%) as indicated by a low urinary iodine excretion (<100 ìg/L) existed in Bangladesh (Yusuf *et al.* 1994).

Due to universal salt iodization program, the goiter prevalence decreased from 47% in 1993 to 18% in 1999 and biochemical iodine deficiency among population decreased from 69% in 1993 to 43% in 1999 as the coverage of households consuming iodized salt increased from 14% in 1995 to 70% in 2003. Despite this encouraging result, IDD remain a significant public health problem in the country. The adverse effects include mental and physical congenital defects in newborns, low learning capacity, impaired growth, and poor health and low productivity among the general population.

A very recent survey was conducted between September 2004 and March 2005 by Yusuf *et al.* (2008) to monitor the current status of iodine deficiency disorders in children aged 6-12 years and women aged 15-44 years in Bangladesh as measured by goiter prevalence and urinary iodine excretion. In children, the total goiter rate (TGR) was 6.2%, compared to 49.9% in 1993. Prevalence of iodine deficiency (Urinary Iodine Excretion <100 ìg/L) was 33.8% in children compared to 71.0% in 1993. The findings of the survey revealed that Bangladesh has achieved a commendable progress in reducing goiter rates and iodine deficiency among children and women ever since the universal salt iodization program was instituted 10 years ago. However, physiological iodine deficiency still persists among more than one-third of children and women. Bangladesh thus has still a long way to go with the universal salt iodization program to eliminate iodine deficiency.

The Northern districts of Bangladesh i.e. Districts of Rajshahi Divisions are particularly badly affected by a high prevalence of IDD. The same parts of the country were found to be severely affected by iodine deficiency (measured as high goiter prevalent) 15 years ago (Yusuf *et al.* 1994). Dinajpur district situated in the northern part of Bangladesh, far from the sea level and is a hyper endemic iodine deficient zone as per National IDD survey report (1999). Dinajpur is often referred as the most backward regions of the country due to unequal distribution of resources.

The present study area is Dinajpur, the northern part of Bangladesh which is hyper endemic Iodine deficient zone particularly badly affected by a high prevalence of IDD and goiter (Yusuf *et al.* 1994, Khalilullah *et al.* 1996 and HKI, Bangladesh, 2002.).

The Government of Bangladesh is officially committed to IDD elimination through national, as well as international, commitments. In an attempt to eliminate IDD as a public health problem, National and International IDD control programs has been in operation in Dinajpur as well as all the Districts of Bangladesh.

Successful implementation of the IDD control programs requires continuous monitoring and evaluation through recommended methods and indicators. Thus the present study has been undertaken with the objectives to assess the prevalence of goiter, status of urinary iodine excretion (UIE) level and also find out the relationship of goiter prevalence with the salt intake and urinary iodine excretion. The study was a school-based, cross-sectional one was conducted during the period of July, 2004 to June, among 1060 school children, aged 6–15 years in Dinajpur district situated in the northern part of Bangladesh, which is a hyper endemic iodine deficient zone as per National IDD survey report (1999).

2.3. OBJECTIVES OF THE PRESENT STUDY.

The present research was conducted with the following objectives:

a) General objectives:

1. To determine the goiter prevalence among school children's from different Socio-economic setting.
2. To find out the percentage of edible salt intake and the prevalence of goiter
3. To find out age wise distribution of iodized salt intake among the study population.
4 To determine sex -wise distribution of iodized salt intake.
5. To determine the rate of iodized salt intake based on religion.
6. To determine the goiter prevalence rates among religious groups in the study population.
7. To find out the barriers (price, quality, both) of USI (universal salt iodization) from the user's vision on the basis of education and living area (urban and rural).

b) Specific objectives:

i) To determine the current age and sex-wise goiter prevalence *i.e.* measurement of Iodine deficiency disorder (IDD) among school children in endemic goitrous areas of Dinajpur district of Bangladesh.

ii) To access the current iodine status and determine the prevalence of iodine deficiency among the school children of the study area on the basis of sex and different age groups by means of the urinary iodine excretion (UIE).

iii) To estimate the serum level of thyroid hormones (T3, T_4 and TSH) of the study children.

iv) To evaluate the nutritional status of school children of study area according to height and weight z-scores. The prevalence of underweight, stunting and wasting are to be calculated according WHO recommended cut-off points.

v) To find out the Iodine nutritional knowledge of mother's of school children based on their educational levels, profession and area of residence (urban and rural).

CHAPTER-3

REVIEW OF LITERATURES

3. LITERATURE REVIEW

There are several studies related to this field some of which are reviewed below.

3.1. Nutrition in Bangladesh

Bangladesh has one of the highest rates of child and maternal malnutrition in the world as per health experts. According to the State of the World's Children Report (SOWC, 2008) issued by the UNICEF, eight million or 48% of all children under-five are underweight. Millions of children and women suffer from one or more forms of malnutrition, including low birth weight, stunting, underweight, Vitamin A deficiency, iodine deficiency disorders and anaemia (IRIN, 2008).

Malnutrition passes from one generation to the next because malnourished mothers give birth to malnourished infants. If they are girls, these children often become malnourished mothers themselves and the vicious cycle continues. Malnutrition contributes to about half of all child deaths, often by weakening immunity. Survivors are left vulnerable to illness, stunted or intellectually impaired. Newborn deaths make up nearly half of all under-five deaths (57%) and (71%) of infant mortality. One neonate dies in Bangladesh every three to four minutes; 120,000 neonates die every year, according to UNICEF.

However, Bangladesh is on track to achieve several Millennium Development Goals (MDGs) including reducing by 2015 the under-five mortality rate to 50 per 1,000 live births from 65, the UNICEF report claims. Matching achievements of only five other countries, Bangladesh has halved the child mortality rate since 1990. "Bangladesh has made good progress in the past decade towards achieving MDG-1, the eradication of extreme poverty and hunger," the UNICEF report said. Between 1996 and 2005, the prevalence of underweight children fell from 56% to 45%, while stunting fell from 55% to 40%. "If we can keep the price of essentials within the reach of the common people, we will be able to achieve the MDG goals of child survival and maternal health," said AKM Zafarullah, secretary of the Ministry of Health. Abdul Faiz, director-general of health services, is confident that Bangladesh will achieve the MDG-5 of reducing maternal mortality to 147 per 100,000 live births by 2015 from the present official rate of 320 per 100,000.

According to Christine Jaulmes, chief of communication and information of UNICEF Bangladesh, achieving the MDG would mean about 30 million children and two million mothers would be saved by 2015. "But, as urban slums, the Chittagong Hill Tracts, coastal regions and other ecologically vulnerable areas are falling behind, their distinct problems need to be addressed carefully," Faiz added, Natural disasters compound malnutrition, which is often considered a "silent emergency", even in normal times, stated UNICEF. Every five to 10 years there is a major disaster that causes widespread damage, wiping out crops, houses, safe water sources, livelihoods and wreaking havoc on nutrition. "Although the situation is improving in some sectors, the overall situation is quite serious and therefore not acceptable," said Mohammad Mohsin Ali, a UNICEF nutrition specialist. "The protein energy deficiency (PED) which is expressed through underweight, stunting and retarded physical growth of children is still unacceptably high," he added. "Iodine and vitamin-A supplementation are showing very positive outcomes, but iron deficiency anaemia among children and women is very high. Nearly 85% children less than one year of age and almost 50% of pregnant women suffer from iron deficiency anaemia. This needs to be addressed. "A national strategy for anaemia prevention and control has also been put in place. Both strategies aim at preventing and controlling the issues of malnutrition of children and mothers."

According to the Multiple Indicator Cluster Survey (MICS, 2006) more than 89 percent of children aged nine to 59 months have been given Vitamin-A supplements, saving more than 30,000 children each year. Eighty-four percent of all edible salt in

Bangladesh is now iodized, helping reduce the toll of iodine deficiency disorders. The prevalence of goitre in school-children has fallen from 50 to 6 percent in the past decade because of salt iodisation. Community Nutrition Promoters (CNPs) work in 24,000 community nutrition centers throughout the country providing information, advice and counseling to improve the nutritional status of children, adolescent girls and women. Seventy-five percent of all under-fives were fully immunized against all preventable childhood diseases in 2007, up from 64 percent in 2005. Immunizations have helped to prevent infectious diseases that cause malnutrition (UNICEF, State of the World's Children report-2008)

3.2. Child and Maternal Nutrition in Bangladesh.

The prevalence of malnutrition in Bangladesh is amongst the highest in the world. Millions of children and women suffer from one or more forms of malnutrition, including: low birth weight (LBW), stunting, underweight, vitamin A deficiency, iodine deficiency disorders and anaemia. Malnutrition passes from one generation to the next because malnourished mothers give birth to infants who struggle to thrive or grow well. If they are girls, these children often become malnourished mothers themselves. Malnutrition contributes to about one half of all child deaths, often by weakening immunity. Survivors of malnutrition are left vulnerable to illness, stunted and intellectually impaired (UNICEF, State of the World's Children - 2007).

The Government of Bangladesh (GOB) is committed to fulfilling children's rights to nutrition through its ratification of the Convention on the Rights of the Child and the Millennium Development Goals, many of which are closely linked with nutrition. With the assistance o development partners, the GOB has made substantial investments in nutrition, including the National Nutrition Program (NNP) which provides comprehensive nutrition services to children and women at a community level. As a result, the country has made significant progress in eliminating some forms of malnutrition, including vitamin A deficiency and iodine deficiency. Current nutritional status of Bangladesh has been shown in Table 3 (a).

Bangladesh has made good progress in the past decade towards achieving Millennium Development Goal 1, the eradication of extreme poverty and hunger. Between 1996 and 2005, the prevalence of underweight children fell from 56 to 45 per cent, and stunting fell from 55 to 40 per cent.

Table 3(a). Current nutritional status of Bangladesh .

Basic data (in %)	
Chronic energy deficiency	32
Low birth weight months) 42	36
Child malnutrition (0-59 months)	
Stunting	40
Underweight	45
Wasting	13
Night blindness in children (18-59 months)	< 1
Iodine deficiency in children (6-12 years)	34
Anaemia (6-59 months)	
Exclusive breastfeeding (< 6 months)	42

Source: UNICEF, State of the World's Children (2007).

3.2.1. Issues

Despite many achievements in the past decade, major improvements are still needed in order for all children to be free from malnutrition. The prevalence of LBW, underweight, stunting and anaemia in preschool children is "very high" or "serious" according to the World Health Organization's criteria. Gains in vitamin A deficiency and iodine deficiency will not be sustained if efforts are not continued.

Children and women become malnourished if they are unable to eat enough nutritious foods or if they become ill. While these two causes sound simple, they are the result of many factors at the household, community, national and international level which makes the elimination of malnutrition so challenging. Two major issues that must be considered at every level of intervention are equity and access. Childhood malnutrition is rooted in part in the discrimination against, and disempowerment of women. The unequal access to resources, particularly food and healthcare, and their inability to take household decisions make women less able to protect their own nutrition and health, and that of their children. Because these decisions frequently rest with the husband and other family members, these individuals must be specifically included in the target audience for advocacy and behavior change communication on nutrition (UNICEF, State of the World's Children report - 2008).

There are also inequities between socio-economic levels. The poorest children, women and households who need assistance most are often excluded from nutrition interventions, even if they are free, because they cannot afford the hidden costs associated with these services, such as taking time off work to access the services, Many of these poorest groups live in poorly serviced hard-to-reach areas in rural Bangladesh and in the urban slums. Natural disasters compound malnutrition, which is often considered a "silent emergency" even in normal times. Localized disasters, such as cyclones or floods, hit Bangladesh every year. And about every 5 to 10 years there is a disaster that causes widespread damage, wiping out crops, houses, safe water sources, livelihoods and wreaking havoc on nutrition (UNICEF, State of the World's Children report-2008).

3.2.2. Action

UNICEF's work focuses on high impact interventions to improve nutrition across the entire lifecycle from infancy through childhood, adolescence, and the child-bearing years. These interventions are implemented in close partnerships with Government, UN agencies (WHO and WFP), development partners (USAID, CIDA), Micronutrient Initiative and NGOs. Capitalizing on vitamin A's benefits UNICEF and the Government of Bangladesh (UNICEF, State of the World's Children report-2008).

3.2.3. Grains of salt to reduce iodine deficiency disorders.

A successful campaign to iodized salt is to reducing iodine deficiency in Bangladesh. Iodine deficiency causes intellectual impairment and lowers IQ by as much as 10 to 15 percentage points (Bleichrodt and Born, 1994). UNICEF works with both the Government and the private sector to support salt iodization in the areas of: policy development, technology development, business practices, capacity building, monitoring and evaluation, advocacy and behavior change communication. UNICEF has provided support for crucial amendments to the Salt Law that will make it mandatory for the livestock, food and beverage industries to use only iodized salt. UNICEF has also helped introduce new low-cost technologies to improve the quality of iodized salt. Changing behavior for improved nutrition since 2003, UNICEF has provided technical assistance in advocacy and behavior change communication to the government's National Nutrition Programme (NNP). UNICEF identified mechanisms to reach adolescent girls and boys, mothers, family members, community leaders and other stakeholders at the sub-national and national level with advocacy and communication interventions to support the alleviation of malnutrition.

Innovative approaches have been used, including street theatre, peer-to-peer education among adolescents, and "future search conferences" among community groups and decision makers. Special attention has been given to improving the interpersonal communication skills of the NNP community health workers. Responding to emergencies UNICEF has recently taken the lead, among all UN agencies, for coordinating the nutrition response during emergencies. After the devastating monsoon floods in 2004, UNICEF with the World Food Program and local NGOs delivered nutritious food supplements to 425,000 vulnerable children and women in the most severely affected areas (UNICEF, State of the World's Children report-2008).

3.2.4. Impact

Achievements that are directly linked to UNICEF's support include the following:

• 30,000 child lives are saved by vitamin A supplementation each year. The prevalence of night blindness, a symptom of vitamin A deficiency, has been kept below the level that indicates a public health problem.

• 84 per cent of all edible salt in Bangladesh is now iodized, helping reduce the toll of iodine deficiency disorders. The prevalence of goitre in school children decreased from 50 per cent to 6 per cent in the last decade as a direct result of salt iodization.

• A community-based model for preventing anaemia in adolescent girls and women has been piloted, and will be expanded to other areas in urban and rural Bangladesh.

• 15 million young children are treated with a dose of deworming medicine twice a year, significantly reducing intestinal worm infections, an important cause of anaemia.• Community Nutrition Promoters work in 24,000 community nutrition centres throughout one-quarter of the country providing information, advice and counselling to improve the nutritional status of children, adolescent girls and women. The nutrition of millions of children has benefited from improvements in health services, particularly the achievements in immunization, which has helped to prevent infectious diseases that cause malnutrition (UNICEF, State of the World's Children 2007).

3.3 Iodine deficiency disorders in Bangladesh, 2004-05.

A survey was conducted to monitor the current status of iodine deficiency disorders in children aged 6-12 years and women aged 15-44 years in Bangladesh as measured by goitre prevalence and urinary iodine excretion. Conducted between September 2004 and March 2005, the survey followed a stratified multistage cluster sampling design to provide nationally representative data, with self-weighted rural-urban desegregations. A total of 7233 children and 6408 women were examined for goitre and 4848 urine samples (2447 from children and 2401 from women) were analyzed for iodine. In addition, 5321 household salt samples were analyzed for iodine. In children, the total goitre rate (TGR) was 6.2%, compared to 49.9% in 1993 and the TGR among women was 11.7%, while in 1993 it was 55.6%. Prevalence of iodine deficiency (Urinary Iodine Excretion <100 µg/L) was 33.8% in children and 38.6% in women (compared to

71.0% and 70.2%, respectively in 1993). Again median UIE was higher in children (163 μg/L) than in women (140 μg/L). Boys had UIE of 175 μg/L as compared to 149 μg/L in girls. Iodine nutrition status in urban areas was considerably better than in rural areas. There was a clear inverse relationship between iodine deficiency and the coverage of households using adequately iodized salt (>=15 ppm). The findings of the survey revealed that Bangladesh has achieved a commendable progress in reducing goitre rates and iodine deficiency among children and women ever since the universal salt iodization program was instituted 10 years ago. However, physiological iodine deficiency still persists among more than one-third of children and women, which points to the need for all stakeholders to redouble their efforts in achieving universal salt iodization (Yusuf *et al.* 2008).

3.4. Current Status and Prospects for Sustainability of the world.

Countries and their population are assigned to specific categories if a substantial segment have, or are likely to have, deficient or excessive iodine nutrition, usually based on UI data (WHO, global database on iodine deficiency 2005).

Table 3(b). Global Iodine Nutrition.

	Population (in millions)	Countries
Deficient	3,034 (50%)	84 (53%)
Sufficient	2,839 (47%)	72 (45%)
Excess	210 (3%)	3 (2%)
Unknown	6 (<1%)	1 (<1%)

Countries and their population are assigned to specific categories if a substantial segment (not necessarily a majority) have, or are likely to have, deficient or excessive iodine nutrition, usually based on UI data (WHO, global database on iodine deficiency 2005).

The table 3 (b) suggests that about one-half of the world's population still lives in countries that have a substantial degree of iodine deficiency. Most countries do not have effective monitoring systems, and educational efforts have been insufficient. As stated earlier, monitoring and education are two of the crucial elements for sustainability, so the world needs to greatly accelerate its efforts. This becomes a race against time, both to meet the goal of 2005 as pledged by the United Nations General Assembly, and also to develop mechanisms for sustainability in countries while iodine nutrition still has the attention of governments and international agencies. Successes in some countries, e.g., Iran, China, Cameroon, Peru, show that sustainable optimal iodine nutrition is possible. The three greatest threats to sustainability are inadequate monitoring, changing personnel and priorities, and failure to embed IDD control (usually through iodized salt) into the country's way of life. These challenges can be met, as shown by these examples, but they demand accelerated efforts on the part of all, especially the countries themselves (WHO, global database on iodine deficiency 2005).

3.5. Micronutrients: Increasing Survival, Learning, and Economic Productivity:

This is a brief report about one USAID program with the power to improve the lives of millions of women and children. The things we take for granted - our vitamin pills, the iron in breakfast cereal, or fruits and vegetables available year round - are reasons that most families in the United States are as healthy as they are. The technologies that enable the United States to provide this kind of health protection to our citizens can be adapted and transferred to our developing country neighbors.

The benefits at the individual level are obvious. Millions of child lives are being saved and improved through programs that address micronutrient deficiencies. But there are benefits at the community, national, and global levels as well. Among the many interventions highlighted for IDD are: iodization of drinking water; iodized oil taken orally or through intramuscular injection; and salt iodization (Hall and Hotel 2005).

3.6. Recent Trends in Nutritional Status of Children in India.

An overall positive trend in nutritional outcome during the past few decades was observed. The gain was, however, modest and predominant in terms of reduction of more severe varieties of nutritional problems, such as classical kwashiorkor (0.4% to 0.1%) and extreme forms of Marasmus (1.3% to 0.1%). There was a distinct improvement in the prevalence of underweight (77.5% in 1975-1979 to 47% in 1998-1999) and stunting (78.6% to 45.5%) in the last twenty years, but there was virtually no change in the profile of wasting (18.1% to 15.5%)in this period. Data from relevant studies revealed a modest decline in the prevalence of low-birth-weights. There was an unambiguous evidence of appreciable decline in clinical vitamin A deficiency (Bitot's spots 0.21%) and iodine deficiency disorders in children aged less than 5years in the country. Most (74%) young children aged less than 3 years and adolescent females were anaemic, and in a considerable proportion of young children, the anaemia was of a moderate (46%) to severe (5%) degree (Sachdev and Shah, 2000).

These observations in children, despite a steep increase in population and continued social and economic inequity, are inspiring indications that at long last India may be at the turning point with respect to nutrition. Despite the apparent gain, current magnitude of deficiencies in virtually all nutritional public-health indicators is nowhere near the international standards. There is an urgent need to intensify efforts to improve the nutritional profile of children to optimize human resource development (Sachdev and Shah, 2000).

3.7. High Risk of Low-birth-weight Children and Nutritional Status of Mothers in India.

About 36% of the mothers had low BMI, whereas the mean BMI of women in India is 20.3. The low-birth-weight babies born to low-BMI mothers were 14% in urban and 27% in rural areas. Twenty-eight and 33% of the low-birth-weight babies were born to high-BMI mothers in urban and rural areas respectively. Of the low-BMI mothers, 35% in urban and 65% in rural areas had low-birth-weight babies. Although the country has established the integrated nutrition programs in most states and at block, village and anganwadi levels, there are still major obstacles which include poor outreach, less food intake, and distribution, resulting in adverse effect on the efforts to reduce malnutrition. More than one-fifth of the children had low birth-weight. Nutritional programs and policies should be focused on: (1) intervention from the early pregnancy period;(2) importance in rural areas; and (3) targeting younger women (Soundararajan and Palaniyandi, 2002).

3.8. Child Nutrition Survey of Bangladesh 2000.

The national prevalence of wasting (WHZ<-2.00), stunting (HAZ<-2.00), and under-weight (WAZ<-2.00) in the 6-71-month old children was 11.7%, 48.8%, and 51.1% respectively. There has been a statistically significant ($p<0.05$) fall in all three of these parameters of malnutrition since the last survey done in 1995-1996. Twelve percent of the boys and 11.4% of the girls were wasted ($p=0.56$), whereas 48.5% of the boys and 49.1% of the girls were stunted ($p=0.71$). The prevalence of underweight was 51.4% in the boys and 50.9% in the girls ($p=0.76$).There were statistically significant differences in the prevalence of malnutrition between the rural and urban populations. Wasting was 11.9% in the rural and 10.8% in the urban children. Stunting was found in 50.7% of the rural and 38.3% of the urban children. The prevalence of underweight was 52.8% in the rural and 42.2% in the urban areas. The data of the Bangladesh Bureau of Statistics indicate an improving trend in nutritional status. Height-for-age, which is a more stable indicator of nutritional status, shows an improved trend over the period. The Child Nutrition Survey of Bangladesh 2000 shows a decline in the prevalence of stunting from 51.4% in 1995-1996 to 48.8% in 2000 (Khurshid Talukder and Abdus Salam, 2003).

3.9. Community Nutrition Research in the South Asia

Results: In total, 495 papers were identified. Of these papers, 43% were on energy-protein deficiency, 40% on micronutrient deficiency, and 17% on diet and non-communicable diseases .Over the time period covered, there was no particular trend in category of nutritional problem addressed. There was a marked difference in type of research. While about one-third of the papers on micronutrient deficiencies included an intervention, the proportion was much lower or energy-protein deficiency (10%) and for diet and non-communicable diseases (5%).

The research performed has been relevant in as much as it has reflected the existing nutritional problems in the region. However, the research appears to show limitations in evaluating efficacy and effectiveness of interventions to prevent and control the nutritional problems, and, thus, the research may be difficult to use in policy decisions (Ekström and Dumont, 2000).

3.10. Nutrition Scenario in Bangladesh: Changes over the Decades

The prevalence of stunting (49%) and underweight (51%) among children aged less than 6 years had reduced in 2000 compared to those of the previous years (stunting and underweight: 51.4% and 57.4% in 1995-1996, 65.5% and 66.5% in 1989-1990, and 68.7% and 71.5% in 1985-1986 respectively). The prevalence of third-degree malnutrition had also decreased from 9.2% in 1985-1986 to 7.3% in 1989-1990 to 4.3% in 1995-1996 and 2.4% in 2000.Improvement has also been achieved over three decades with regard to the problem of night blindness among children (0.62% in 1999) due to vitamin A deficiency. At present, more than 2.7% of pregnant women, 2.4% of lactating, and 1.7% of non-pregnant/non-lactating women are night blind. The proportion of angular stomatitis was less in 1975-1976 compared to that in1981-1982 and 1995-1996.

Although the prevalence of anaemia among children aged up to 4years had reduced, it has increased among children above this age and among adolescents ,pregnant and lactating women. The proportion of the population suffering from iodine deficiency disorders increased from 10.52% in 1981-1982 to 69% in 1993 and decreased to 43% in 2000 (Mannan *et al.*, 2001). The consumption of cereals, pulses, non-leafy vegetables, milk, and milk products has decreased, while the intake of other foods, such as roots and tubers, leafy vegetables, and eggs has increased. Consumption of fruits, meat, fats, and oils remained almost unchanged. The intake of calorie, protein, fat, vitamin C, riboflavin, and niacin has decreased, while the intake of iron has increased over the decades. Although various programs have been implemented by different agencies for the last few years, it has not yet been possible to alleviate malnutrition remarkably. Appropriate actions should be taken immediately as per the guidelines of the international Food and Nutrition Policy and National Plan of Action for Nutrition to save the nation from the silent curse of malnutrition (Mannan *et al.*, 2001).

3.11. The impact of iodine deficiency in the 21st century.

Iodine is an essential part of thyroid hormones, and many processes in the thyroid gland adapt to changes in iodine supply. Still, abnormalities in iodine intake are of major importance for the occurrence of thyroid diseases. Historically, the intake of iodine from food and beverage has been low in large parts of the world. Depending on the level of insufficiency, this has been associated with disturbed reproduction, developmental brain damage, and a high occurrence of goitre and thyroid function abnormalities in the populations involved. In recent decades national committees and international organizations (ICCIDD, WHO, UNICEF) have succeeded in improving iodine nutrition in many countries by iodine fortification of salt. In other countries, people have experienced a more haphazard increase in iodine intake caused by farmers' use of iodine rich cattle feed, or by food producers' addition of iodine containing chemicals to food (Laurberg, 2006).

The experience with this development is that focus on iodine intake in a population is necessary to avoid relapse of iodine deficiency, but focus is also necessary to avoid excessive iodine intake in the population or in subpopulations. Iodine has many effects on the thyroid gland, and both high and low iodine supply may lead to abnormalities .Iodine requirements are considerably higher during pregnancy and lactation, and the developing brain is particularly sensitive to abnormalities in thyroid function.

Therefore, special focus are needed on iodine intake and thyroid function in pregnant women. Iodine intake of a population should be monitored and, if necessary, adjusted by universal or focused intervention. Non-regulated and non-declared use of iodine containing substances in dairy farming, food industry and cosmetics is probably best avoided (Laurberg, 2006).

3.12. Iodine deficiency in school going children of Pondicherry.

The status of iodine deficiency in Pondicherry by finding out the urinary excretion of iodine and the prevalence of goiter among school children. 315 children between the age group of 9 - 13 yr from 30 schools in Pondicherry were examined for the presence of goiter and their urine samples were subjected to biochemical analysis to find out the urinary iodine levels (UIE). The percentage of children who had inadequate iodine intake and showed urinary iodine level of less than 100 mcg/ L was 44.4%. Amongst them, 14.3% had a greater degree of iodine deficiency with less than 50 mcg/L of iodine in urine. The prevalence of goiter was 15.24%. The prevalence of goiter is high. The iodine intake is quite low as exhibited by the UIE levels of < 100mcg/L in the children in Pondicherry, which might have had an unseen impact on the intelligence and school performance of these children (Sarkar *et al.*, 2007)

3.13. Mini Nutritional Assessment of rural elderly people in Bangladesh:the impact of demographic, socio-economic and health factors.

In stating the Millennium Development Goals, the United Nations aims to halve malnutrition around the world by 2015. Nutritional status of the elderly population in low-income countries is seldom focused upon. The present study aimed to evaluate the magnitude of malnutrition among an elderly population in rural Bangladesh.

Design and setting: Data collection for a multidimensional cross-sectional study of community-based elderly people aged 60 years and over was conducted in a rural area in Bangladesh. Of 850 randomly selected elderly individuals, 625 participated in home interviews. Complete nutritional information was available for 457 individuals (manage 69 ± 8 years, 55% female). Nutritional status was assessed using an adapted form of the

Mini Nutritional Assessment (MNA) including body mass index (BMI). Age, sex, education, household expenditure on food and self-reported health problems were investigated as potential predictors of nutritional status indicating chronic energy deficiency, was found in 50%of the population. MNA revealed a prevalence of 26% for protein–energy malnutrition and 62% for risk of malnutrition. Health problems rather than age had a negative impact on nutritional status. Level of education and food expenditure were directly associated with nutritional status. In order to reduce world hunger by half in the coming decade, it is important to recognize that a substantial proportion of the elderly population, particularly in low-income countries, is undernourished (Zarina Nahar Kabir *et al.,* 2005).

3.14. Thyroid hormone status in protein energy malnutrition in Indian children.

Thyroid hormonal status was measured in 80 malnourished children of protein energy malnutrition (PEM). Serum levels of tri-iodothyronine (T_3), thyroxine (T_4) and thyroid stimulating hormone (TSH) were measured by radioimmunoassay. The results were compared with 20 healthy, age and sex matched controls. Levels of T_3 and T_4 were significantly low in PEM cases whereas TSH levels were similar in PEM cases when compared to controls (Pankaj Aborl *et al.,* 2001).

3.15. Global IDD Day was celebrated on 21st October 2005, Delhi India.

National Launch of "Controlling Vitamin & Mineral Deficiencies in India; Meeting the Goal" organized by Micronutrient Initiative in New Delhi on 18 October 2005.Global IDD Day was celebrated on 21st October 2005 all over the separate advertisements which were carried in 153 Newspapers country. A total of 314 newspapers all over the country carried a published in all the regional languages including English & Hindi half page advertisement on IDD and Universal Salt Iodization by publications all over the country. Ministry of Health & Family welfare, Govt. of India (GOI). While Ministry of Health & family Welfare spent Rupees. 40,00,000/- The advertisement was published in all the 18 languages of the (Four Million) on this, the. Department of Women and Child Development (Pandav and Chandrakant, 2005)

3.16. In Tamil Nadu, consumers want their children to be healthy and intelligent.

FEDCOT is the Federation of Consumer Organizations in Tamil Nadu, India. In collaboration with UNICEF, it started a. campaign in 2004. Its objectives were to: • Create awareness about IDD

• Eradicate IDD from Tamil Nadu

• Encourage people in Tamil Nadu to demand iodized salt

• Educate salt retailers to sell only iodized salt for human consumption

FEDCOT launched their eradication of IDD program in 10 selected districts of Tamil Nadu from September 2004 to March 2005. The Salt Department, Government of India and the Government of Tamil Nadu simultaneously supported the Program. The program is planned to cover all the districts in Tamil Nadu in three phases.

FEDCOT's most potent weapon is "awareness creation", in consumers, traders and salt producers. Awareness creation is achieved through. Awareness campaigns in schools and self-help groups.

• 892 schools visited and 4,698 teachers motivated.

• Over 30,000 salt samples brought by students tested for iodine. •

• 1,453 Self-help groups covered and 29,796 women motivated.

• 40% increase in turnover in Tamil Nadu Salt Corporation's sale of iodized salt.

• Surveys and a motivational campaign gained wide media publicity.

In addition:

• 6 district workshops: with 78 salt manufacturers/traders, health workers, panchayat and municipal leaders participating.

• District level training program for consumer activists in 10 districts.

• Surveys conducted: 11,472 shops were visited by their activists and samples tested.

(Eric-Alain *et al.*, 2000)

3.17. The Effects of Dual Micronutrient Supplementation on Thyroid Function in School Children (An experimental study for east and central Africa).

From 2006 to 2007 an experimental study was conducted on 397 children, all with visible goiter grade of which 6.1% and 10.3% vitamin A and iron deficient respectively. A week after baseline data collection and de-worming, all children with visible goitre (n=332) but without iron and vitamin A deficiency were randomly grouped into four, A to D groups. Vitamin A deficient children (n=24) were randomly allocated to group A and group B while anaemic children (n=41) were distributed into group C and group D. Group A received 400mg oral iodized oil and group B received 200,000IU vitamin A plus 400mg oral iodized oil. Group C received 400mg oral iodized oil while group D received 100mg iron sulphate with folic acid and 400 mg oral iodized oil. Iron supplementation was continued two doses per day for six weeks. Vitamin A supplemented group received additional dose at six month. Post intervention data on iodine, vitamin A and iron status were collected at 6 and 11 month.

Children supplemented with iron + oral iodized oil capsule had significant goitre reduction than oral iodized oil supplemented group. The mean concentrations of thyroid hormone (T4) and Urinary iodine excretion (UIE) in iron + iodine supplemented group were significantly higher than the iodine alone supplemented group at 6 months after the intervention. Hemoglobin level at baseline in all study subjects and at 11 month after intervention in group D (iron + iodine supplemented group) significantly ($P<0.05$) correlated with T4 level. The significant goitre reduction in iron + iodine supplemented group than iodine alone supplemented group and significant correlation between level hemoglobin and T4 at baseline and at 11 month after intervention probably indicate that iron and iodine have a functional interaction in thyroid iodine metabolism. Supplementation of iodized oil with Iron is more effective in goitre reduction than iodine alone and this should be taken into consideration by iodine deficiency disorders (IDD) intervention programs (Abuye *et al.*, 2008)

3.18. Iodine Deficiency Disorders among School Children of Malda, West Bengal, India.

A community-based, cross-sectional study was conducted among 2,392 school children, aged 8-10 years, in Malda district of West Bengal, India, in January 2001 to assess their iodine status. The children were selected through a multistage 30 cluster-sampling technique to determine the status of iodine deficiency disorders (IDD) using recommended quantifiable indicators. The prevalence of goitre was assessed clinically using the standard palpation method by the teachers of Community Medicine, and a total goitre rate of 11.3%was found with no significant gender difference($p>0.05$). Urinary iodine excretion (UIE) levels of 341 study subjects, selected through systematic random sampling, were analyzed by the wet digestion method to determine biochemical iodine deficiency by the teachers of Biochemistry Department. The median UIE was 15 mcg/dL, and no child had UIE value less than 5 mcg/dL. Iodine content of 1,060 salt samples tested with spot-testing kit revealed 85.1%with adequate iodine content of ≥15 ppm. The finding of 11.3% of total goitre rate but with no evidence of current iodine deficiency (median UIE 15 mcg/dL) indicated that he Malda district is in the transition phase from iodine-deficient to iodine-sufficient (Akhil *et al.*, 2002).

3.19. Iodized Salt: Knowledge, Attitude and Practice of Mothers from Northern Bangladesh

The prevalence of iodine deficiency disorders in the form of palpable goitre among the study population was 12%. The study revealed that 93% of the mothers were housewife. Of the 93% mothers, 7% had not heard about iodized salt, 60% had heard about it from television and radio. Seventy-one percent of the respondents had knowledge about the symptoms of goitre. Only 28% were aware that goitre is a preventable disease, and 3% knew how to test iodine in salt. The majority of the households had open containers to store salt. About 56% of the households consumed iodized salt. The main cause of non-use of iodized salt was that it was not bought by their husbands as it was more costly than non-iodized salt, and it was not available in nearby shops and village markets (*hat*). : An integrated approach is essential to make iodized salt popular and acceptable to the general mass through behavior change communication (BCC). Greater awareness through BCC needs to be created among husbands and other members of households who actually buy salt (Alamgir Azad *et al.*, 1998).

3.20. Bangladesh - Health Nutrition and Population Sector Program

The Health Nutrition and Population Sector Program for Bangladesh will increase availability and utilization of user-centered, effective, efficient, equitable, affordable and accessible quality services, be it the Essential Services Package, improved hospital services, nutritional services or other selected services. The project has the following components: Component 1) will supports delivery of essential services (ESD). Such a package would focus on reduction of maternal mortality, through public information campaigns to raise awareness about the importance of antenatal care and maternity services to reduce problems during pregnancy, labor and the postnatal/neonatal period and obstetric complications. Component 2) will supports the development of policies and strategies for emerging challenges, and possibly implementation at a later stage, with a focus on: (a) Reduction of injuries and implementing improvements in emergency services; (b) Prevention and control of major Non-Communicable Diseases (NCD); (c) Urban health service development; (d) Improve the HNP response to disasters. Component 3) deals with Health, Nutrition and Population (HNP) reforms: (a) Public health sector management and stewardship capacity; (b) Health sector diversification; (c) Stimulating demand for HNP services (http://go.worldbank.org/LAHCOKN8S1).

3.21. Current global iodine status and progress over the last decade towards the elimination of iodine deficiency.

To estimate worldwide iodine nutrition and monitor country progress towards sustained elimination of iodine deficiency disorders. Cross-sectional data on urinary iodine (UI) and total goitre prevalence (TGP) in school-age children from 1993-2003 compiled in the WHO Global Database on Iodine Deficiency were analyzed. The median UI was used to classify countries according to the public health significance of their iodine nutrition status. Estimates of the global and regional populations with insufficient iodine intake were based on the proportion of each country's population with UI below 100 microg/l. TGP was computed for trend analysis over 10 years. UI data were available for 92.1% of the world's school-age children. Iodine deficiency is still a public health problem in 54 countries. A total of 36.5% (285 million) school-age children were estimated to have an insufficient iodine intake, ranging from 10.1% in the WHO Region of the Americas to 59.9% in the European Region. Extrapolating this prevalence to the general population generated an estimate of nearly two billion individuals with insufficient iodine intake. Iodine intake was more than adequate, or excessive, in 29 countries. Global TGP in the general population was 15.8%.: Forty-three countries have reached optimal iodine nutrition. Strengthened UI monitoring is required to ensure that salt iodization is having the desired impact, to identify at-risk populations and to ensure sustainable prevention and control of iodine deficiency. Efforts to eliminate iodine deficiency should be maintained (Anderson *et al.* 2005).

3.22. Effect of Salt Iodization on Prevalence of Iodine Deficiency Disorders among Children of District Swat, NWFP, Pakistan

Salt iodization has been one of the most cost-effective methods of controlling iodine deficiency. In Pakistan, Swat district has been declared as a model district where over 95% of edible salt is iodized. Assess the effect of salt iodization on the prevalence of iodine deficiency disorders among children of Swat district, NWFP, Pakistan. The results of clinical assessment of goitre of 8-11-year old children showed that only 4% of children had grade I goitre, and 17% were sub-clinically iodine-deficient. The results obtained were much lower than those of previous studies conducted on a similar age group of children, suggesting a positive impact of salt iodization on the prevalence of iodine deficiency disorders. Salt iodization has been effective in reducing iodine deficiency disorders in Swat district, Pakistan (Paracha *et al.*, 2003, Tasleem Akhtar and Zahoor Ullah, 2003).

3.23. Iodine Deficiency Disorders (IDD) can be prevented by consuming tiny amounts of iodine on a regular basis.

Iodine Deficiency Disorders (IDD) can be prevented by consuming tiny amounts of iodine on a regular basis. UNICEF is working with a range of partners in Bangladesh to promote iodization of salt, so that everyone receives enough of this micronutrient in their diet to avert IDD (UNICEF/WHO 2005).

Strategy

The overarching aim is to ensure that the activities are cost-effective and sustainable in the long term. This means:

- Maintaining through advocacy the Government's strong political commitment to the Control of Iodine Deficiency Disorders (CIDD) by Universal Salt Iodization (USI).
- collaboration with and participation of the private sector in sharing the costs of USI and in monitoring the quality of iodized salt
- Ensuring appropriate salt iodization at factory level and quality maintenance at wholesaler and retailer levels through monitoring, supervising and evaluating salt iodization at all levels, with particular emphasis on the performance of salt factories.
- Strengthening Behavioral Change Communication (BCC) to create more demand for iodized salt among consumers, retailers, wholesalers and producers.
- Intensive monitoring of the enforcement of the salt law.
- Developing collaborative partnerships with all relevant agencies (UNICEF/WHO-2005).

3. 24. Iodine nutrition in Africa

Africa has over 800 million people, about 15% of the world's population. Virtually all of its countries have had iodine deficiency in the past. ICCIDD has periodically summarized overall progress with frequent additional reports on individual countries or sub regions (Ekpechi 1987; Heztel 1983; Dunn 1996, and Stanbury 1998).

Table 3(c) . Classification of African Countries by Iodine Nutrition.

	deficient		Likely		likely		Status
Severe	moderate	mild	Deficient	Sufficient	sufficient	excess	uncertain
Gambia	Ethiopia	Mauritania	Angola	Algeria	Botswana	DR	Mali
SierraLeone	Guinea	Mozambique	Burkina Faso	Benin	Egypt	Congo	
	Senegal	Zambia	Burundi	Cameroon	Eritrea		
	Sudan		Cape Verde	Kenya	Gabon		
			CAR	Madagascar	Liberia		
			Chad	Nigeria	Libya		
			Comoros	Rwanda	Malawi		
			Congo (Braz)	Togo	Namibia		
			Cote d'Ivoire	Uganda	Sao Tome		
			Equat.Guinea	Zimbabw	S. Africa		
			Ghana		Swaziland		
			Guinea-		Tunisia		
			Bissau				
			Lesotho				
			Morocco				
			Niger				
			Somalia				
			Tanzania				

(WHO, global database on IDD -2005, IDD Newsletter 1997, 1999).

Table 2 (d). **Summary of African Iodine nutrition status**

	Countries of (50)		**Population**	
	Number	Percent	Million	Percent
Defficiency				
Severe	2	4	6.8	0.8
Moderate	4	8	120.3	14.7
Mild	3	6	32.0	3.9
Likely	17	34	170.1	20.7
Total	23	50	329.8	40.1
Sufficiency				
Known	11	21	274.4	33.5
Likely	11	23	151.9	18.5
Excess	1	2	53.6	6.5
Total	23	46	479.9	58.5
Uncertain	1	2	11.0	1.4
Total	50	(100%)	820.7	(100%)

(WHO, global database on IDD-2005, IDD Newsletter 1997 and 1999).

Table 3(c), a classification of countries by iodine nutrition, and Table 3(d), an overall summary.

Table 3 (e). Historical trends of iodine nutrition in African countries

	Deficient	Sufficient	Excess	Unknown
1987	32 (97%)	1 (3%)	0	15
1996	32 (78%)	9 (22%)	0	9
1999	14 (52%)	12 (45%)	1 (4%)	23
2002	26 (53%)	22 (45%)	1 (2%)	1

(WHO global database on IDD -2005, IDD Newsletter 1997 and 1999).

Overall status – Tables 3 (c) and Table 3 (d) two place each country in a category ranging from severe iodine deficiency to excess. Significant, are the large numbers of countries in the "likely deficient" categories (17 countries, 120 million people) and "likely sufficient" (12 countries, 151 million people) as well as one without enough information to categorize. Thus, over half the countries lack enough information to allow a proper conclusion about their iodine nutritional status.

ICCIDD has summarized Africa's iodine nutrition before Table 3 (e.). In 1987 few countries had data on urinary iodine, and conclusions were based on goiter prevalence by palpation. Many countries had virtually no information about iodine nutrition. Technology had improved somewhat by 1996, and urinary iodine measurement was coming into greater use. The summary in 1999 did not provide information on a number of countries, so its totals are smaller.

Despite these limitations, the data of Table 3(e) show several trends. First, the number of countries that are sufficient, or likely sufficient, has increased steadily. Secondly, we have more and better information than before, although data are still incomplete. Even the countries that remain deficient show evidence of lesser degrees of deficiency over time. Examination of individual countries show some with striking improvement, such as Algeria, Benin, Cameroon, DR Congo, Kenya, Madagascar, Malawi, Nigeria, Rwanda, and Togo. In a few, the iodine deficiency has probably worsened, such as Sierra Leone and Ethiopia. Africa has made great progress towards the elimination of iodine deficiency. The improvement can be attributed almost entirely to the increased utilization of iodized salt. Achievement of iodine sufficiency in some of the large countries that import all their salt has been striking – e.g., Congo, Cameroon, Nigeria, Zimbabwe. These successes have saved millions of children from the ravages of iodine deficiency. The successful countries should now focus their efforts on sustainability, recognizing the historical truth that countries letting their guard down will have a recurrence of iodine deficiency and its attendant consequences, as has happened in other parts of the world. We must also recognize that these initial triumphs were fairly straightforward, and bringing iodine sufficiency to the rest of the continent is a task of increasing complexity (WHO, global database on IDD-2005, IDD Newsletter 1997 and 1999).

Africa has made great strides towards iodine sufficiency in the past 15 years. Approximately 23 of the 50 countries considered here, representing 59% of its population, appear to be iodine sufficient. The major push for iodized salt, currently used by about 62% of households, is chiefly responsible for this improvement. By comparison, a 1987 summary concluded that virtually every African country had some iodine deficiency (WHO, global database on IDD-2005, IDD Newsletter 1997 and 1999).

3.25. Joint Statement by the World Health Organization and the United Nations Children's Fund Reaching Optimal Iodine Nutrition in Pregnant and Lactating Women and Young Children.

In 1994, a special session of the WHO and UNICEF Joint Committee on Health Policy recommended Universal Salt Iodization (USI) as a safe, cost-effective and sustainable strategy to ensure suffcient intake of iodine by all individuals (UNICEF/WHO,1994). It also suggested that temporary iodine supplementation be considered in areas of severe iodine def-ciency where USI cannot be rapidly implemented. Based on new evidence and lessons learned within the last decade, it appears that the most susceptible groups - pregnant and lactating women, and children less than two years of age - might not be ad-equately covered by iodized salt where USI is not fully implemented.

This situation may jeopardize the optimal brain development of the fetus and young child. In order to address this issue, WHO convened a technical consulta-tion on the prevention and control of iodine defciency in pregnant and lactating women and in children less than two years of age. The con-sultation, held on 24-26 January 2005 in Geneva, Switzerland, made recommendations to ensure optimum iodine nutrition among these groups (WHO, global database IDD-2005).

As a follow-up to the meeting, and in order to provide programmatic guidance to implement these recommendations within the country programme planning process, WHO and UNICEF held a joint meeting on 15-16 November 2005 at UNICEF Headquarters, New York, USA. This statement presents the conclusions of the joint WHO/UNICEF meeting.

The primary strategy for sustainable elimination of iodine defciency remains USI. In some countries, however, implementation of salt io-dization programmes may not be feasible in all areas, thus resulting in insuffcient access to iodized salt for some groups within the popula-tion. In these cases, besides strengthening the USI programmes, additional complementary strategies should be considered by the coun-try to ensure optimal iodine nutrition for these susceptible groups. As the first step, countries need to assess and categorize the level of implementation of salt iodization programmes and, based on this analysis, should revisit the strategy for the control of Iodine Defciency Disorders (IDD), as necessary. Guidance for the categorization and planning process is presented in this statement. (UNICEF/WHO- a joint meeting. 15-16 November 2005).

Universal salt iodization (USI) means the iodization of salt for consump-tion by both humans and animals.

-Guidelines for decision making on when and how to plan for additional iodine intake in pregnant and lactating women and children 7-24 months of age.

The consultation agreed on two main approaches for administering iodine supplements - either on a daily basis or on an annual basis using an iodized oil preparation - and an endorsement of the WHO- recommended dosages (WHO) as described in table 3 (f).

Table 3 (f). WHO-recommended dosages of daily and annual iodine supplementation

Population Group	Daily dose of iodine supplement (μg/d)	Single annual dose of iodized oil supplement (mg/y)
Pregnant women	250	400
Lactating women	250	400
Women of reproductive age (15-49 y)	150	400
Children < 2 y [a, b]	90	200

(WHO/UNICEF/ICCIDD-2005)

a. For children 0-6 months of age, iodine supplementation should be given through breast milk. This implies that the child is exclusively breastfed and that the lactating mother received iodine supplementation as indicated above.

b.These fgures for iodine supplements are given in situations where complementary food fortifed with iodine is not available, in which case iodine supplementation is required for children of 7-24 months of age.

3.26. Prevalence of Iodine Deficiency and Perception and Practice of Urban Pregnant Women Regarding Iodized Salt

The knowledge and practice of pregnant women in Dhaka city regarding iodized salt and iodine deficiency disorders (IDD), and estimate the prevalence of iodine deficiency. Methodology: A cross-sectional study was conducted among 504 pregnant women who attended the Maternal and Child Health Training Institute and the Dhaka Medical College Hospital for antenatal check-up during January-May 2001. Data-collection tools included a pre tested structured questionnaire, clinical examination of goitre, and biochemical estimation of urinary iodine. Urine samples were analyzed in the IDD Laboratory at the Institute of Nutrition and Food Science, University of Dhaka, Bangladesh. Results: Seventy-seven percent of the respondents did not have adequate knowledge on iodine, 80% were not aware of the consequences of iodine deficiency during pregnancy. Most (89%) respondents did not know the benefits of iodized salt. Ninety-nine percent consumed 'iodized'-labeled packet salt, and 94% stored salt in bottles with caps. The prevalence of goitre (grade 1+ grade 2) was 29%, indicating the prevalence of moderate goitre (WHO/UNICEF/ICCIDD criteria). Only one respondent (0.2%) had visible (irreversible) and the rest had palpable (reversible) goitre. Over one-fourth (29%) of the respondents had biochemical iodine deficiency (urinary iodine level <100 μg/L); of them, only 4% were severely deficient. Although most respondents used iodized salt, their perception about iodine and its iodine deficiency assessed by urinary iodine estimation was not alarming among the study population (Santhia *et al.,* 2002)

3.27. Effect of Psychosocial Stimulation on Development of Malnourished Children in Community Nutrition Centers of the Bangladesh Integrated Nutrition Project.

The study has done during November 1999-February2002 in Monohardi upazila of Narsingdi district in Bangladesh. Twenty CNCs were randomly assigned to psychosocial intervention or control. In the intervened CNCs, malnourished children (weight-for-age <-2 z-score) and their mothers (n=93) participated in a year-long intervention program of group meetings and home-visits by paraprofessionals when child-development activities were demonstrated twice a week. They were compared with malnourished children (n=101) attending the 10 control CNCs. The food supplementation included packets containing150 or 300 kcal given to moderately- or severely-malnourished children respectively. It was offered 6 days a week for 90-120 days and was repeated in some children who did not improve. Before and after the study, the growth and development of children were assessed. Results of multiple regressions indicated that the intervention significantly improved the scores of the children on the mental development index (B=-5.02, SE=2.2, p=0.023) and the psychomotor development index (B=-4.4, SE=2.2, p=0.051) compared to the control group. The nutritional status of the children in both the groups remained the same after one year.

Although mental development of the malnourished children significantly improved with the intervention, their nutritional status did not improve. Results of previous studies suggest that had their growth improved, their mental function would have improved more. To achieve full rehabilitation, there is an urgent need to review the nutritional treatment of undernourished children in these communities and to integrate psychosocial stimulation into the treatment (Hamadani *et al.*, 2002).

3.28. Socio-demographic and Health Characteristics of Bangladeshi malnourished Children Aged Less Than 2 Years Requiring Food Supplementation.

The proportion of female children among non-graduated group was found significantly higher than that of male children. (5.7% vs 3.6%). The proportion of the non-graduated among children of illiterate mothers was 7.3% which was significantly higher than the proportion among the children of educated mothers (2.6%). Number of live-births in the family, economic status and morbidity were found to be associated with the graduation after supplementation. Illiterate and low-income families need to be paid much attention to attain the adequate growth among malnourished children through food supplementation (Islam *et al.*, 2002).

3. 29. Iodine deficiency disorders among primary-school children in Kafr El Sheikh, Egypt.

The prevalence of iodine deficiency in primary-school children in Kafr El-Sheikh governorate was assessed. A total of 2250 primary-school children aged 8-10 years were selected by a two-stage cluster sampling technique. The results revealed that the prevalence rate of goitre was 27.1% and it was significantly higher in females (29.2%) than males (25.1%). The median urinary iodine level was 6.7 μg/dl and 3.9 μg/dl for grade 1 and grade 2 goitre respectively. It was concluded that iodine deficiency is a public health problem of moderate severity in primary-school children in Kafr El-Sheikh governorate. This necessitates an intervention programme through salt iodization (Nawal *et al.,* 1997.)

3.30. Assessment of the prevalence of iodine deficiency disorders among primary school children in Cairo

This study was done to assess the prevalence of iodine deficiency (ID) among primary schoolchildren in Cairo. A stratified random sampling technique covering the five geographic zones of Cairo was used. Data revealed that the goitre rate was 13.5%; being 10.8% among males and 16.2% among females. Prevalence among females was higher than that of males in all categories. Based on the data found by this study, it can be concluded that ID constitutes a mild public health problem among Cairo primary schoolchildren, and a salt iodization programme is highly recommended (Nawal *et al.,* 1997).

3.31. The barriers of USI in Bangladesh.

Bangladesh Universal Salt Iodination Act came into effect in 1989 It included the provision that the Bangladesh Council of Scientific and Industrial Research (BCSIR) and other institutions should be responsible for monitoring the quality of the iodized salt manufactured and sold from that time onwards. However, to our knowledge no reliable testing system has been systematically used as part of this compulsory monitoring procedure, and the BCSIR has not been officially involved. This is not surprising since quality control regulations are seldom strictly enforced in Bangladesh even in the case of drugs and other medical supplies.

For more than two decades the Government has been working with UNICEF to eradicate iodine deficiency disorders. After the Act of 1989 came into force the salt iodization program was taken up energetically. Most of the salt crushing units (which produce pure White Sea salt from the impure coloured products of the salt croppers) have been provided with iodization equipment, and UNICEF supplies the iodizing agent, potassium iodate, free of charge. Despite these efforts the product is not good and the iodization program is making no measurable impact. In 1995 we published the results of the first national study on the quality of iodized salt produced within the country. These showed that only 30% of the iodized salt manufactured in Bangladesh contained an acceptable level of iodine. Surprisingly, 10% of the commercial brands contained no iodine at all. Other findings suggested that most manufacturers may be fortifying salt with an iodine solution made with ethyl alcohol, rectified spirit or denatured alcohol. Only 30% were using the recommended iodate, 10% were using mixtures of fortifying agents, and 10% were not using any iodine at all (Khorasani and Rahman, 1995).

The 1997 survey conducted with UNICEF support showed that the situation had not improved. In particular, it indicated the following: (Khorasani, 1997)

- only 57% of the salt factories with iodization facilities were in regular production,7 produced iodized salt only irregularly, and 36% were closed;± of the 379 samples collected from138 factories, only 5% contained adequate amounts of iodine, 46% contained too little, 1% contained none at all, 49%contained too much; and, alarmingly,17% of the factories were producing iodized salt containing more than20 times the recommended amount of iodine;
- of the 1104 samples collected from retail outlets, 7%contained no iodine, only one contained the recommended amount;44% contained too little and 56% contained a very large excess.

These data show that the salt iodization program in Bangladesh is not making headway. As far as we have been able to as certain, the main reasons for this sad state of affairs are the following: lack of quality control measures in the production units, lack of skill in the production personnel, and failure on the part of the government agencies concerned to take appropriate measures to ensure the legally required quality of iodized salt.

Attempts to draw attention to this problem in order to solve it have so far failed. A promising alternative is being pursued in India, where a new scheme for large-scale monitoring of the quality of iodized salt has been started jointly by the International

Council for the Control of Iodine Deficiency Disorders and 60 national nongovernmental organizations to measure the iodine content in iodized salt by titration (WHO/UNICEF/ICCIDD, 2001.) A novel step involves providing schoolchildren in Delhi with detection kits to monitor the quality of iodized salt. By this means 5474 samples were analyzed, of which 5449 (99.5%) contained iodine. Of the 1712 samples tested in a laboratory, 1651 (96.4%) had adequate iodine content (>15 ppm), 53 (3.1%) had between 1 and15 ppm of iodine, and 8 (0.5%) had none. Acting independently and encouraged by India's example, I have developed facilities in my laboratory at the university for free testing of salt for iodine content, and invited the public to use them. I am also working with the youth welfare group ANANDO to set up monitoring units at its headquarters in Dhaka and at its regional centres in district towns, offering facilities for the free testing of iodized salt. We are suggesting to the Government and to nongovernmental organizations working in Bangladesh that they should replicate the Indian model and our own in the interests of public health (Khorasani, 1999).

3.32. Urinary iodine levels in three ecological zones of Bangladesh

Urinary iodine levels in children (5–11 years) and in adult males and females (15–44 years) of three ecological zones (hilly, flood-prone and plains) of Bangladesh were analyzed to determine the status of biochemical iodine deficiency in the country. Data indicated that a large majority of the population all over Bangladesh have biochemical iodine deficiency urinary iodine excretion (UIE) less than the accepted cut-off level of 10 μg/dl. Adults were deficient to comparable degrees, 31.3% severely iodine deficient. The flood-prone zone was less affected: 71.7% children had iodine deficiency and 25% were severely deficient. Adults of this zone were less affected than the children. Iodine deficiency was least severe in the plain zone: 59.8% children were biochemically iodine deficient and of them 23.4% had UIE less than 2.0 μg/dl. In the case of the adults of this zone, 60.8% were biochemically iodine deficient and 20.6% had severe iodine deficiency. The results indicate that Bangladesh as a whole is an iodine deficient region, with the hilly zone being the most severely affected. Children were slightly more affected than the adults, and females were more affected than the males (Yusuf *et al.*, 1994).

3.33. Horticulture-based food reduced Micronutrient deficiency

Horticulture-based food varieties, namely fruit, vegetables and nuts, are important for the daily diet as these contain micronutrients, fibre, vegetable proteins and bio-functional components. Consumption of fruits and vegetables is vital for a diversified and nutritious diet. Increasing dietary diversification is the most important factor in providing a wide range of micronutrients and this requires an adequate supply, access to and consumption of a variety of foods. However, food surveys show continuing low consumption of fruits and vegetables in many regions of the developing world (FAO 2002, World Bank. 2005).

Horticultural interventions combined with extensive nutrition education offer a long-term, food-based strategy to control and eliminate micronutrient malnutrition. Horticultural production, relatively easy for unskilled people, can play an important role in poverty alleviation programs and food security initiatives, providing work and income opportunities.

Fruits and vegetables can be produced on a small scale to meet a substantial part of dietary nutrient needs at the household and community level, health centers, refugee camps and related situations. Global demand for horticultural produce is expected to grow with population, rising standards of living and awareness of the health benefits of fruit and vegetables. Dietary patterns will also change with the expected increase in per capita consumption of fruits and vegetables. Developing countries may find new opportunities for trade in fruits and vegetables, offering a comparative advantage in the context of globalization.

The Food and Agriculture Organization of the United Nations (FAO) is implementing horticulture-based programs through field operations and normative activities. A variety of direct interventions are being implemented through field projects to improve nutrition levels and household food security in Latin America, the Caribbean, Africa, the Middle East and Asia.

The Integrated Horticulture and Nutrition Development Project (BGD/97/041), funded by the United Nations Development Program (UNDP) and the Government of Bangladesh (GOB), was implemented by the Ministry of Agriculture (MOA) with the Department of Agricultural Extension (DAE) as the Government Executing Agency. The project demonstrated and validated the use of food-based strategies to promote food and nutritional security (FAO- 2002, World Bank 2005).

3.34. Trends in child malnutrition, 1990 to 2005, Declining rates at national level mask inter-regional and socioeconomic differences.

The burden of malnutrition is much higher in South Asia compared to that of Africa and other parts of the world and Bangladesh is one of the worst-off countries in this regard. Established in the year 1990, with a goal to monitor trends and patterns in national nutrition situation, Nutritional Surveillance Project (NSP) of Helen Keller International (HKI) and Institute of Public Health Nutrition (IPHN), Govt. of Bangladesh has been collecting high-quality household-based data on nutrition, food security, health-care services and agro-economic conditions. Analyses of trends over the past 15 years (1990-2005) show a steady and remarkable decline in the under nutrition prevalence. However, these national trends conceal both interregional differences as well as differences among various income groups. Importantly, even if Bangladesh achieves the Millennium Development Goal (MDG) of reducing underweight by 50% compared to 1990 levels in 2015, rates will still remain above the threshold for 'very high prevalence' according to the World Health Organization(WHO). Improved strategic and programmatic planning and systematic monitoring and evaluation are critical to tackle persistent under nutrition (Helen Keller International, 2006).

3.35. Pakistanis attack IDD as "silent killer"

While "goitre is perhaps the only visible condition caused by iodine deficiency, others being lethargy, low level of physical energy and low intelligence"... researchers have demonstrated that school performance of children with proper iodine intake increases remarkably. Iodine is vital in supporting proper mental development of children. Its deficiency can cause irreversible mental retardation Iodine Deficiency Disorders can be prevented with just one teaspoonful of iodine, regularly consumed in tiny amounts at very little cost.

The executive coordinator of The Network for Consumer Protection, Dr. Talib Lashari, shared this information with participants attending an awareness session on Iodine Deficiency Disorders at the Islamabad Medical and Dental College (IMDC). The session was organized in connection with International Iodine Deficiency Disorders Day here on Thursday .Pakistan is amongst countries where iodine deficiency is a serious public health problem. A large number of Pakistanis are suffering from iodine deficiency, and millions of children are born unprotected of mental impairment every year because of iodine deficiency. The population of the hilly areas of NWFP, Azad Kashmir and the Northern Areas, as well as numerous pockets of population in Punjab, is highly iodine deficient. Lashari said, the current level of overall consumption of iodine salt in Pakistan is relatively low as compared to other regional countries. However, he appreciated that 53 districts have raised iodine usage to 70%.

Sheeba Afghani, communications officer from UNICEF, said that the Network, Ministry of Health, UNICEF and some other likeminded organizations have been striving to overcome this public health challenge and this has a positive impact. However, concerted efforts of civil society organizations, salt producers and policy-makers are required in partnership to overcome this challenge. The most viable option is having universal salt iodization (USI) of edible salt across the country. Since it is a public health concern, The Network and UNICEF will work in close collaboration to highlight the importance of iodized salt and to advocate at all levels to achieve this target.

Colonel (r) Dr. Ashraf Chaudhry, head of community medicine, IMDC, highlighted the importance of iodine in the general health of people. He informed that iodine is a mineral element that is required as a trace element in minute quantity by the human body. A spoonful of the substance is all that human beings need in their entire life span (The news in Pakistan, 2008).

3.36. Food consumption, energy and nutrient intake and nutritional status in rural Bangladesh: changes from 1981–1982 to 1995–96.

To determine and evaluate changes in nutritional status, food consumption, energy and nutrient intake in rural Bangladesh, using appropriate statistical analyses.: Repeated cross-sectional surveys. Two seasons in 1981–1982 and 1995–1996: Two villages with different production patterns.Anthropometric measurements of 1883 individuals, food consumption data of 404 households.: Repeated measurements of one-day food weighing and anthropometry in two seasons in 1981–1982 and 1995–1996. Mixed model analyses were used to evaluate and quantify temporal changes and their interactions with determinants.Prevalence of underweight children decreased from 82 to 70% (P=0.015), wasted children from 34% to 18% (P=0.009) and chronic energy deficient adults decreased from 78 to 64% (P<0.0001). Intake of fish and green leafy vegetables increased from (l.s. mean±s.e.) 23±3.0 to 40±1.8 g/person/day (P<0.001) and from 28±4.5 to 41±2.7 g/person/day (P=0.019), respectively. Rice intake remained unchanged: 463±12 g raw/person/day in 1981–1982 and 450±7.3 g raw/person/day in 1995–1996 (P=0.355). Calcium and iron intakes increased by 40% (P<0.0001) and 16% (P=0.0002), respectively, whereas vitamin A intake remained unchanged.: Nutritional status improved and intakes of nutrient dense food groups, fat, iron and calcium increased from 1981–1982 to 1995–1996 (Hels and Hasan, 2003).

3.37. Anthropometric Measurements in Rural School Children.

Anthropometric Measurements of 1012 rural school-going children, selected randomly, were performed. There were 776 males and 236 females in the age group of 5-15 years. The values of weight and height were recorded for every child in the study sample. Age and sex break-up was studied and compared with the ICMR (Indian Council of Medical Research) standard. The comparison made separately for boys and girls showed that the values for both sexes and in all age groups were less than the ICMR standard. The majority (83.6%) of the children belonged to the middle and low social class according to the modified Prasad's classification. An inference is, therefore, drawn that rural school children of middle and low socio-economic status are shorter and lighter as com pared with even their own counterparts on whom the ICMR values are based.

The state of health of school-going children in India is far from satisfactory despite the fact that school health programs along with other nutritional programs have been in operation for several decades. School-going children constitute a sizeable section of India's population, i.e. about 27%, which is easily accessible and also receptive.

An early and convenient method of assessing nutritional and socio-economic status of growing children is anthropometry. Physical growth, in terms of weight and height, is considered an important parameter reflecting the pattern of growth and development in a community. In the developing countries, the growing children by and large are deprived of good nutrition on account of their poor socio-economic status, ignorance and lack of health promotional facilities. This nutritional deprivation results in relative stunting of growth (Khan *et al.*, 1990).

3.38. Factors Causing Malnutrition among under Five Children in Bangladesh

The nutritional status of under five children is a sensitive indicator of a country's health status as well as economic condition. This study investigated differential impact of some demographic, socio-economic, environmental and health related factors on nutritional status among under five children in Bangladesh. The study used Bangladesh Demographic and Health Survey (Mitra and Associates) 1999-2000 (BDHS 1999-2000) data. Bivariate analysis and multivariate analysis (Cox's linear logistic regression model) were used to identify the determinants of under-five malnutrition. The analyses revealed that 45 percent of the children under age five were suffering from chronic malnutrition, 10.5 percent were acutely malnourished and 48percent had under-weight problem. The main contributing factors for under five malnutrition were found to be previous birth interval, size at birth, mother's body mass index at birth and parent's education (Rayhan *et al.,* 2006).

3.39. Assessment of IDD problem by estimation of urinary iodine among School children in Nepal.

Iodine deficiency disorder (IDD) is a major micronutrient deficiency problem in Nepal. Urinary iodine estimation has been the gold standard employed for the assessment of iodine status and of IDD. This study was conducted with objective to assess the urinary iodine among the school children of Kavre, Lalitpur and Parsa districts. Attempts were made to relate urinary iodine with salt use and other socio-demographic variables. Altogether 190 urine samples (74 samples from Kavre, 89 from Parsa and 27 from Lalitpur district) were collected from school children aged 5-13 years. The urinary iodine was analyzed by using urinary iodine assay kit (Bioclone Australia Pvt Limited). It was found that 3.2% children had urine iodine concentration below 20 microg/l. Similarly, the percentage of children with urine iodine concentration 21-50 microg/l, 51-99 microg/l, 100-299 microg/l and above 300 microg/l were 14.2%, 10.5%, 43.7% and 28.4% respectively. Iodine deficient population of school children was 39.2% of Kavre, 19.1% of Parsa and 25.9% of Lalitpur. Overall, it was found that 27.9% children had urine iodine level less than the normal WHO levels. The median urine iodine level was 139.0 microg/l of Kavre, 266.7 microg/l of Parsa and 244.4 microg/l of Lalitpur school children. Urinary iodine excretion (UIE) median value among male students was 211.9 microg/l, among female student was 190.2 microg/l and the difference was statistically insignificant ($P > 0.05$). There was no significant correlation between consumed salt iodine level and urine iodine excretion level ($P > 0.05$). Short-term iodine supplementation programs should be arranged for iodine deficient children in the study districts. This study shows that IDD continues to be prevalent in the country as a major public health problem, which requires strengthening effective intervention program and other preventive measures (Joshi *et al.*, 2006).

3.40. Iodine supplementation improves cognition in iodine-deficient school children in Albania: a randomized, controlled, double-blind study.

Iodine is required for the production of thyroid hormones, which are necessary for normal brain development and cognition. Although several randomized trials examined the effect of iodine supplementation on cognitive performance in schoolchildren, the results were equivocal.

We aimed to ascertain whether providing iodized oil to iodine-deficient children would affect their cognitive and motor performance. In a double-blind intervention trial, 10–12-y-old children (n = 310) in primary schools in rural southeastern Albania were randomly assigned to receive 400 mg I (as oral iodized oil) or placebo. We measured urinary iodine (UI), thyroid-stimulating hormone (TSH), and total thyroxin (TT_4) concentrations and thyroid gland volume (by ultrasound). The children were given a battery of 7 cognitive and motor tests, which included measures of information processing, working memory, visual problem solving, visual search, and fine motor skills. Thyroid ultrasound and the biochemical and psychological tests were repeated after 24 wk.

At baseline, the children's median UI concentration was 43 μg/L; 87% were goitrous, and nearly one-third had low concentrations of circulating TT_4. Treatment with iodine markedly improved iodine and thyroid status: at 24 wk, median UI in the treated group was 172 μg/L, mean TT_4 was ≈ 40% higher, and the prevalence of hypo-thyroxinemia was < 1%. In the placebo group after the intervention, these variables did not differ significantly from baseline. Compared with placebo, iodine treatment significantly improved performance on 4 of 7 tests: rapid target marking, symbol search, rapid object naming, and Raven's Colored Progressive Matrices ($P < 0.0001$). Information processing, fine motor skills and visual problem solving are improved by iodine repletion in moderately iodine-deficient schoolchildren (Zimmermann and Keven, 2006).

3.41. Iodine nutrition status in Maldives.

Iodine deficiency among the population of the Republic of Maldives. However, no overall biochemical iodine deficiency was observed since the median UIE of the children studied was found to be 115 mcg/l, indicating that the population of Republic of Maldives is possibly going through a transition phase from iodine deficient to iodine sufficient. Yet, there exist a large inequality for the various IDD parameters across the country showing an urgent need for more awareness on IDD and ensuring universal salt iodisation in the country so that the IDD can be eliminated (Umesh Kapil, 2002)

3.42. Impact of selective iron and/or iodine interventions on iron and iodine status of adolescents.

The impact of iron and iodized salt supplementation and iron with iodized salt supplementation for a period of six months was studied in relation to non-supplemented controls, on selected indicators of iron and iodine status among goitrous and non goitrous adolescents. A significant reduction in total goitre rate (TGR) and visible goitre rate (VGR) was observed in the group given iodised salt alone or with iron supplements. No change was observed in TGR in the group receiving iron supplements though VGR decreased. An increase in urinary iodine excretion (UIE) was observed among goitrous and non goitrous subjects receiving iodised salt alone or iron supplements alone. The goitrous control subjects in contrast showed a significant decrease in their UIE (-10.9 mcg/dL $p < 0.05$). Iodised salt supplementation caused an increase in T4 (thyroxine) in goitrous and non goitrous subjects and a decrease in TSH (thyroid stimulating hormone) in goitrous subjects. However, iron supplementation had an adverse effect on T_3 (triidothyronine) and T_4 in non goitrous subjects. Dual supplementation caused a significant decline in T_3 (among goitrous subjects) and T_4 concentrations (among non goitrous subjects). Haemoglobin (Hb) and serum ferritin (sf) concentrations improved with iodised salt among both the goitrous and non goitrous subjects, but for goitrous subjects, not with iron alone. This study suggests that if a subject is both iron and iodine deficient, iodine deficiency may be corrected in part by iron or iodine supplementation, although their co-administration may not be synergistic. The metabolic relationship between iron and iodine deficiency needs further investigation. However, goitre prevalence is clearly ameliorated with combined micronutrient supplementation to a greater extent than with iodised salt alone and not at all with iron alone (Nina and Meena, 1997).

3.43. Iodine deficiency in 2007: global progress since 2003

New UI data in school-age children were available for 41 countries, representing 45.4% of the world's school-age children. These data, along with previous country estimates for 89 countries, are the basis for the estimates and represent 91.1% of this population group. An estimated 31.5% of school-age children (266 million) have insufficient iodine intake. In the general population, 2 billion people have insufficient iodine intake. The number of countries where iodine deficiency is a public health problem is 47. Progress has been made: 12 countries have progressed to optimal iodine status, and the percentage of school-age children at risk of iodine deficiency has decreased by 5%. However, iodine intake is more than adequate, or even excessive, in 34 countries: an increase from 27 in 2003. There are insufficient data to estimate the global prevalence of iodine deficiency in pregnant women. Global progress in controlling iodine deficiency has been made since 2003, but efforts need to be accelerated in order to eliminate this debilitating health issue that affects almost one in three individuals globally. Surveillance systems need to be strengthened to monitor both low and excessive intakes of iodine (UNICEF, State of the World's Children 2007).

3.44. A multiple-micronutrient-fortified beverage affects hemoglobin, iron, and vitamin A status and growth in adolescent girls in rural Bangladesh

Adolescent girls have high nutrient needs and are susceptible to micronutrient deficiencies. The objective of this study was to test the effect of a multiple-micronutrient-fortified beverage on hemoglobin (Hb%) concentrations, micronutrient status, and growth among adolescent girls in rural Bangladesh. A total of 1125 girls (Hb a 70 g/L) enrolled in a randomized, double-blind, placebo-controlled trial and were allocated to either a fortified or non fortified beverage of similar taste and appearance. The beverage was provided at schools 6 d/wk for 12 mo. Concentrations of Hb and serum ferritin (sFt), retinol, zinc, and C-reactive protein were measured in venous blood samples at baseline, 6 mo, and 12 mo. In addition, weight, height, and mid-upper arm circumference (MUAC) measurements were taken. The fortified beverage increased the Hb and sFt and retinol concentrations at 6 mo ($P < 0.01$). Adolescent girls in the nonf ortified beverage group were more likely to suffer from anemia (Hb <120 g/L), iron deficiency (S.Ft <12 µg/L), and low serum retinol concentrations (serum retinol <0.70 µmol/L) (OR = 2.04, 5.38, and 5.47, respectively; $P< 0.01$). The fortified beverage group had greater increases in weight, MUAC, and BMI over 6 mo ($P < 0.01$). Consuming the beverage for an additional 6 mo did not further improve the Hb concentration, but the sFt level continued to increase ($P= 0.01$). The use of multiple-micronutrient-fortified beverage can contribute to the reduction of anemia and improvement of micronutrient status and growth in adolescent girls in rural Bangladesh (Ziauddin *et al.*, 2007).

3.45. Assessment of Iodine Deficiency Disorders in Purulia District, West Bengal, India

A cross-sectional, school-based study was conducted in July 2005 among 2,400 school children aged 8-10 years. The World Health Organization (WH) recommends the school children of this age-group for IDD survey. Sample size was based on assumed goitre prevalence of 50%, 95% confidence interval (CI), a design effect of 3, and relative precision of 10%. The multi-stage '30 cluster' sampling methodology and indicators for assessment of IDD, as recommended by the joint WHO/UNICEF/ICCIDD consultation, were used for the study. Goitre was assessed by the standard palpation technique, urinary iodine excretion was analyzed by the wet digestion method, and salt samples were tested by spot iodine testing kit. Investigators were trained to minimize observer-variation. The total goitre rate (TGR) was 25.9% (95% CI 24.1-27.1), with grade I and grade II (visible goitre) being 19.5% and 6.4% respectively. The goitre prevalence did not differ by sex, but a significant difference was observed in respect of age. The median urinary iodine excretion level was 9.25 mcg/dL (normal >10 mcg/dL), and 31.6% of the children had value less than 5 mcg/dL. Only 33.4% (801/2400) of the salt samples tested had adequate iodine content of >15 ppm, and 36.6% salt samples had no iodine. The high goitre prevalence (25.9%) and median urinary iodine (9.25 mcg/dL) below the optimum level (>10 mcg/dL) indicate existence of current iodine deficiency in Purulia district. The district is still in the iodine-deficient state. Moreover, the salt iodization level far below the recommended goal (>90%) highlights IDD as major public-health problems in the district. Intensified information, education and communication activities, along with sustained monitoring, are urgently required (Akhil *et al.*, 2006).

3.46. Bhutan has normal iodine nutrition (A Landmark Achievement).

Bhutan is first country in the South Asia Region to achieve the goal of sustainable elimination of IDD. The Royal Government of Bhutan has played an instrumental role in achievement this landmark. With its efforts, including a first ever implementation of an annual cyclic monitoring. System, the Bhutan model is a paradigm that should be replicated worldwide. Bhutan has been declared a "normal iodine nutrition country" and is the first country in south east Asia to achieve this status. Bhutan fulfilled all 10 indicators of the world health organization (WHO) for sustainable elimination of iodine deficiency disorders (IDD) according to a team of internal and external evaluators representing the network for sustainable elimination of IDD.

Political commitment, a national body responsible for the elimination of IDD, legislation on universal salt iodization, and an excellent monitoring system on salt quality are some of the indicators fulfilled.

In honour of its efforts the All India Institute of Medical Sciences (AIIMS) presented a plaque and citation to the R Government of Bhutan. His Excellency Mr Lyonpo Dago Tshering, Ambassador of Bhutan to India received the citation and plaque on behalf of his Government on the Day of Bhutan (17th December 2002) from the Director of AIIMS (Iodine status worldwide, WHO -2005).

3.47. Organization involved eradication of IDD by effective collaboration.

Members of the global community should communicate with each other, to improve efficiency and promote effective collaborations. Many international organizations are involved in the overall effort stands, identify countries that need more help, and track progress towards the stated goals of the UN on the virtual elimination of iodine deficiency. ICCIDD has one such database on its website, with individual listing for each country (www.iccidd.org). Both WHO and the Micronutrient Initiative are also developing databases to appear on their respective websites. UNICEF has collected data on iodized salt use, also available on the web. The ICCIDD website includes summaries of the global effort to promote optimal iodine nutrition. These include UN agencies, especially WHO, UNICEF, and the World Bank; bilateral donors, especially CIDA, AusAID, the Dutch Foreign Ministry, USAID; non-government organizations, like ICCIDD, the Micronutrient Initiative, Kiwanis International, and the Network for Sustained Elimination of Iodine Deficiency; and professional groups, such as salt producers, medical associations, and various others. Each of these organizations has its own mandates, areas of interest, and priorities. Communication among them is essential to avoid duplication and to apply resources in the most effective way. Several fora for communication exist, such as the UN Standing Committee on Nutrition and the Global Network. Linkages among organizational websites and publications such as the IDD

Newsletter also promote coordination. These efforts should be institutional in nature, because personnel and priorities change (Iodine status worldwide, WHO- 2005).

3.48. Iodine Deficiency Disorders: South East Asia Region

Iodine Deficiency Disorders (IDD) have been a major public health problem in all countries in the WHO-South East Asia Region (WHO-SEAR). It is estimated that a total of 599 million people from this region alone are affected by IDD, thereby constituting the highest number of population from a single region.

The proportion of households consuming adequately iodized salt varies between 1.7% in DPR Korea and 8% in Maldives to 75% in Thailand and 82% in Bhutan. While in the remaining countries it varies from 50% to65%. An external evaluation was co-ordinated by the Global Network for Sustainable elimination of iodine deficiency in 2002 which confirmed elimination of IDD in Bhutan. Efforts are in place to increase the availability of adequately iodized salt at the household level, and most importantly to sustain the coverage over 90% and to introduce a system of cyclic monitoring using IDD indicators.343 Reports from the Regions and the Countries (WHO – ICCIDD – CCM – AIIMS 2003, reports of ICCIDD Regional Coordinators-2003, Section VIII).

Table 3 (g). Classification of South East Asian Countries by Iodine Nutrition

	Deficient		likely		likely		Status
severe	moderate	mild	deficient	sufficient	sufficient	excess	uncertain
	India	Maldives	Bangladesh Mayanmar Nepal Srilanka	Bhutan			

Iodine Deficiency Disorders (IDD) is a public health problem in many countries of the World Health Organization and in the South East Asian Region (Dr John Dunn, 2003, WHO-SEAR)

Table 3 (h). Status of IDD Elimination Programs in WHO-SEAR Countries

No.	Country	Year	Goitre Prevalence	Current Intervention Strategy for IDD Elimination Programme iodized salt
1	Bangladesh	1999	17.8	iodized salt
2	Bhutan	1996	14.0%	iodized salt
3	DPR Korea	1996	14.0%	iodized salt
4	Indonesia	1993	14.0%	iodized salt , Iodized oil capsule
5	India	1996	2.3%-68.8%	iodized salt
6	Maldives	1995	24%	iodized salt Introduced
7	Mayanmara	1994	33%	iodized salt
8	Nepal	1999	40 %	iodized salt
9	Srilanka	2001	18.5%	iodized salt
10	Thailand	1998	14.0%	iodized salt/ water/iodized oil capsule

Source: (Dr John Dunn, 2003, WHO – ICCIDD – CCM – AIIMS-2003,)

The prevalence in India shows a wide range from 2.3% to 68% based on country-wide surveys, and from different States and Union Territories. Besides this, a high prevalence in this region is reported from Nepal where goitre prevalence is 40%. Bangladesh has successfully controlled the problem, bringing down the prevalence rate from 47% in 1993 to 17.8% in 1999. However, it still 21 remains a public health problem and continued efforts are required to completely eliminate it. Thailand and Bhutan have eliminated IDD as a public health problem. The prevalence of IDD is reduced from 8% in 1994 to 2.6% in 1988 in Thailand. In Bhutan, it has been reduced to 14% in 1996 from 60% in 1983. Thailand, Bangladesh and Bhutan have achieved near universal supply of iodized salt, but due to various reasons, they have not been able to achieve universal availability of iodized salt at the household level (Dr John Dunn, 2003, WHO – ICCIDD – CCM – AIIMS . 2003.)

3.49. WHO Country Cooperation Strategy 2008-2013, Bangladesh

Strategic Objectives for the Medium-term Strategic Plan 2008-2013 are as follows:

(1) To reduce the health, social and economic burden of communicable diseases.

(2) To combat HIV/AIDS, tuberculosis and malaria.

(3) Prevent and reduce disease, disability and premature deaths from chronic non-communicable conditions, mental disorders, violence and injuries.

(4) To reduce morbidity and mortality and improve health during the key stages of life, including pregnancy, childbirth, the neonatal period, and child hood and adolescence; and improve sexual and reproductive health and promote active and healthy ageing for all individuals.

(5) To reduce the health consequence of emergencies, disasters, crises and conflicts, and minimize their social and economic impact.

(6) To promote health and development, prevent and reduce risk factors for health conditions associated with the use of tobacco, alcohol, drugs and other psychoactive substances, unhealthy diets, physical inactivity and unsafe sex.

(7) To address the underlying social and economic determinants of health through policies and programmes that enhances health equity and integrates pro-poor, gender-responsive and human right-based approaches.

(8) To promote a healthier environment, intensify primary prevention and influence public policies in all sectors so as to address the root cause of environmental threats to health.

(9) To improve nutrition, food safety and food security, throughout the life-course, and in support of public health and sustainable development.

(10) To improve health services through better governance, financing, staffing and management informed by reliable and accessible evidence and research.

(11) To ensure improved access, quality and use of medical products and technologies.

(12) To provide leadership; strengthen governance and foster partnership and collaboration with countries, the United Nations system and other stakeholders in order to fulfill the mandate of WHO in advancing global health agenda as set out in the Eleventh General Programme of Work.

(13) To develop and sustain WHO as a flexible, learning organization, enabling it to carry out its mandate more efficiently and effectively (WHO Country Cooperation Strategy 2008-2013).

3.50. The Millennium Development Goals for Health and Nutrition in Bangladesh: Key Issues and Interventions-

Millennium Development Goals for Health and Nutrition in Bangladesh (UNDP report, 2005). Millennium Development Goals (MDG) for IDD Global elimination of brain damage due to iodine deficiency will make a significant contribution

> To eradicate extreme poverty and hunger

> Eliminating IDD through USI will ensure that children are able to learn better and therefore be more productive as adults.

> Eliminating IDD in children reduces the childcare burden for women

> **Reduce child mortality**

Iodine deficiency contributes to increased infant mortality

> **Improve maternal health**

Eliminating JDD in women of childbearing age is a priority.

3.51 Iodised salt for preventing iodine deficiency disorders in China.

Iodine deficiency is the main cause for potentially preventable mental retardation in childhood, as well as causing goitre and hypothyroidism in people of all ages. It is still prevalent in large parts of the world. To assess the effects of iodised salt in comparison with other forms of iodine supplementation or placebo in the prevention of iodine deficiency disorders. Study included prospective controlled studies of iodised salt versus other forms of iodine supplementation or placebo in people living in areas of iodine deficiency.

Studies reported mainly goitre rates and urinary iodine excretion as outcome measures. Study found six prospective controlled trials relating to our question. Four of these were described as randomised controlled trials, one was a prospective controlled trial that did not specify allocation to comparison groups, and one was a repeated cross-sectional study comparing different interventions.

Comparison interventions included non-iodised salt, iodised water, iodised oil, and salt iodisation with potassium iodide versus potassium iodate. Numbers of participants in the trials ranged from 35 to 334; over 20,000 people were included in the cross-sectional study. Three studies were in children only, two investigated both groups of children and adults and one investigated pregnant women. There was a tendency towards goitre reduction with iodised salt, although this was not significant in all studies. There was also an improved iodine status in most studies (except in small children in one of the studies), although urinary iodine excretion did not always reach the levels recommended by the WHO.

None of the studies observed any adverse effects of iodised salt. The results suggest that iodised salt is an effective means of improving iodine status. No conclusions can be made about improvements in other, more patient-oriented outcomes, such as physical and mental development in children and mortality. None of the studies specifically investigated development of iodine-induced hyperthyroidism, which can be easily overlooked if just assessed on the basis of symptoms. High quality controlled studies investigating relevant long term outcome measures are needed to address questions of dosage and best means of iodine supplementation in different population groups and settings (Wu *et al.*, 2002).

3.52. World Bank programs on Innovative Ideas to Improve Nutrition in Bangladesh.

The World Bank today has initiated the competitive Development Marketplace which is aimed at finding and funding innovative ideas that will change the lives of thousands of pregnant women, infants, and young children in Bangladesh and other South Asian countries. The Development Marketplace will also create a platform for engaging civil society and grassroots organizations who can contribute to improving nutrition among the poor in and can share their experiences with the broader development community.Titled "Family and Community Approaches to Improving Infant and Young Child Nutrition," the Development Marketplace is looking for entrepreneurial organizations across South Asia to submit proposals for local, small-scale projects which have the potential to be scaled up and replicated. This competition offers a unique opportunity to channel small grants directly to community organizations and NGOs who present innovative ways to address this devastating problem. The winners will be selected by an international jury of development and nutrition experts at the Development Marketplace event in August, 2009 in Dhaka, Bangladesh and will receive funding to implement their proposals.

"The Development Marketplace is an exciting opportunity to find new solutions to malnutrition in this region. Malnutrition is a persisting problem in Bangladesh and one of the key contributors for child mortality. Malnutrition limits child growth potentials, affects school achievements and lowers lifetime earnings" said Tahseen Sayed, Acting Country Director for the World Bank Bangladesh. "We all look forward to welcoming these nutrition entrepreneurs from Bangladesh and around the region to Dhaka later this year and making awards to the most innovative proposals"."Recent evidence clearly shows that there are proven effective interventions to improve nutrition," said Andrea Vermehren, World Bank team leader for the Development Marketplace. "However, effectively implementing these interventions - and implementing them at scale is a major challenge. We believe this effort will help find new ways of providing innovative solutions to malnutrition."

South Asia suffers seriously from the problem of malnutrition, where child malnutrition rates are among the highest in the world. Both child underweight and stunting rates in the region are nearly double those in Africa. In Bangladesh more than 4 out of every 10 children are stunted and/or underweight. Progress in combating child underweight rates has slowed dramatically since the mid 1990s. In the last half of the last decade child underweight rates fell by 8 percentage points but in the first seven years of this decade the fall has been just 2 percentage points.Carel de Rooy Country Director, UNICEF, John Aylieff, Country Director WFP, Jean-Olivier Schmidt, GTZ, and Zeba Mahmud Director for MI expressed their support and enthusiasm for the partnership.

The South Asia Regional Development Marketplace is implemented in partnership with the Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), Micronutrient Initiative (MI), UNICEF, and the World Food Program. The competition is open to civil society groups, social entrepreneurs, youth organizations, private foundations, academia, and private sector corporations in Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka. The maximum award will be US$40,000 per proposal. Proposals will be accepted until March 31, 2009.The Development Marketplace global competition has awarded nearly US$46 million to small-scale projects over the last eight years. Using this funding as a launching pad, projects often go on to scale up or replicate elsewhere, winning prestigious awards within the sphere of social entrepreneurship (URL: http://www.worldbank.org/sar).

CHAPTER-4

MATERIALS AND METHODS

4.0. MATERIALS AND METHODS

The following methods were adopted to conduct the present study.

4.1. Study type- The present study is a prospective one.

4.2. Study place and period: This study was carried out in the Molecular Biology Laboratory of the Institute of Biological Sciences, University of Rajshahi, Rajshahi, Bangladesh during the period of July, 2004 to June, 2008 availing the laboratory facilities of the Department of Biochemistry, Dinajpur Medical College, Dinajpur, Bangladesh and as well as the Center For Nuclear Medicine and Ultrasound, Dinajpur, Bangladesh.

4.3. Study population: As per recommendation of WHO/UNICEF/ICCIDD (1994) the school children in the age group 6-15 yrs from both sexes were selected, because of their high vulnerability to goiter, easy accessibility and because they are representative of their age group in the community.

The study population consisted of students of class 1(One) to class X (Ten) aged 6-15 yrs. A total of 1060 students from 30 different Primary School, High School, Girls School, Missionary, Kinder Garden, English Medium School, Madrasha and Orphanage center of the study area were examined clinically. Most of the parents of children in the rural schools belonged to labor class while; those from the urban schools belonged to business class or were engaged in an employment and there was a marked variation in the socio economic status.

4.4. The Study Area:

The study area was Dinajpur district, situated in the Northern part of Bangladesh, which is far from the sea level and is a known hyper endemic iodine deficient zone as per National IDD survey report (1999).

4.5. The method of the Study

The protocol of the present study was submitted to the authority of the Institute of Biological Sciences, University of Rajshahi, Rajshahi, Bangladesh for approval. The ethics committee of the Institute approved the protocol.

The selected schools were first visited by the project team consisting of the researcher himself, physicians and medical technologists. The detailed objectives of the research project were discussed with the headmasters or Chief of the educational institutions and the other staff, in detail: accordingly they fixed dates for conducting screening camps according to their convenience

The camps were conducted for two consecutive days in each school in the months of March to September every year during the research period. During school hours, a team including, physicians, the researcher himself and medical technologists visited the school. The students of classes one to ten (age 6-15 yrs) who attended schools on those days were screened class-wise. They were called to the screening room in the order of entry of their names in the class attendance registers.

4.5.1. Methods of data collection and Data management:

All necessary information regarding individual students were collected during their enrollment, interviewing, and clinical examination (on the first day of the camp) using a structured questionnaire (research instrument) containing all the variables of interest like name of the student, age, sex, weight and height (measured during interview), religion address, father's name & occupation and monthly income (to access Socio-economic status), mother's name & occupation, number of children in the family, order of birth etc.

A part of the questionnaire included information on the results of thyroid size by palpation and grading of goitre, Urinary concentrations of iodine, Thyroid hormone T3, T4 and TSH (Triiodothyroninine, Thyroxine and Thyroid stimulating hormone) concentration in the blood, and nutritional status assessment and other findings and over all comments if, any which was filled up by the researcher himself in consultation with the visiting physician and medical technologist.

Students who were unable to furnish complete information about father's name, his occupation and monthly income or others were allowed to take their questionnaire home and get it filled by their parents and they were asked to bring it back to us on the next day (day 2 of the camp). For greater safety, we kept a carbon copy of the questionnaire in case it was lost.

At the same time, all students attending the camp, were also given another i.e. second specially designed questionnaire sheet to be filled up by their mothers regarding their knowledge of iodine nutrition on the basis of their education, profession, area of residence and their opinion about the barriers (price, quality, both) in the establishment of the goals of universal salt iodization (USI). Also information on food habit (Salt intake) was included. The students were requested to take their questionnaire home and get it filled by their mothers or parents and were asked to bring it back to us on the next day.

On the first day of the camp, each student was also was clinically examined in detail for iodine deficiency disorders and other nutritional deficiencies by a Physician and all in the team. In order to avoid inter-observer error and assure sensitivity, the thyroid examination was done by the project member who was an Epidemiologist (Post Graduate physician in Community Medicine) posted at Dinajpur Medical College, Dinajpur, Bangladesh having experience of more than 13 years.

On the second day of the camp, the main purpose was to collect the filled up questionnaires distributed among the students. Also unfinished clinical examination of students or height weight measurement, or urine and blood sample collection or any other work left on the previous day (Day 1 of camp) was performed on the second day of the camp.

4.5.1.1. Measurement of IDD: Measurement of IDD provides key information for deciding whether a program is required for IDD elimination and also demonstrates its effectiveness.

Methods for epidemiological measures of thyroid

The following methods were used for the measurement of thyroid under the present study:

i) Thyroid size by palpation of the thyroid

ii) Urinary excretion of iodine

iii) Thyroid hormone T3,T4 and TSH (Triiodothyroninine, Thyroxine and Thyroid stimulating hormone) concentration in blood

Clinical examination of the thyroid glands of 1060 school going children was performed through inspection and standard palpation method. With neck extended and tilting head backwards goiter was identified and classification of goitre grading was based on the criteria endorsed by WHO/UNICEF/ICCIDD (1994). Details of the methods of goitre grading have been discussed later in this chapter.

Urine and blood samples were taken from each 5^{th} and 16^{th} child after clinical examination of the thyroid gland was completed. A total of 220 urine samples and 70 blood samples were collected for the estimation UIE and T3, T4 and TSH, respectively. Details of the procedural methods used under the present study have been discussed later.

4.5.1.2. Anthropometric measurements:

In addition to the measurement of IDD under the present study, in order to evaluate the nutritional status of school children of the study area according to height and weight z-scores anthropometric measurements of their age, body height and weight were made. Instrumental error was avoided by using the same instrument in all the screening camps. The details of the anthropometric measurements methods have been described later in this chapter.

4.5.1.3. Data processing and analysis: The detailed proforma for data collection were filled during the examination and while interviewing the subjects. The findings of the study were tabulated according to the specific objectives. Data were organized into different groups of variables, processed and analyzed using computer software SPSS (Statistical Package for Social Sciences) Windows version 13.0. The test statistics used to analyze data were Chi-square (λ2). For any analytical tests the level of significance was set at 0.05 and p value , 0.05 was considered significant.

PROCEDURAL DETAILS:

4.6.1. Clinical assessment of goitre prevalence:

Clinical examination of the thyroid glands of 1060 school going children was performed through inspection and standard palpation method. Classification of goitre grading was based on the criteria endorsed by the joint WHO/UNICEF/ICCIDD (1994) as follows:

Grade 0: No palpable or visible goitre.

Grade I: A mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in the normal position. It moves upward in the neck as the subject swallows.

Grade II: A swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated.

The sum of grades 1 and 2 provides the Total Goitre Rate (TGR)

4.6.1.1. Estimation of Urinary Iodine Excretion

The measurement of urinary iodine has been recognized as the most common and most reliable biochemical test for assessing the iodine status of populations (May *et al.*, 1997).

To evaluate the state of iodine nutrition of study area on-the-spot urine samples were collected in wide mouthed screw capped plastic bottles. A total of 220 urine samples were collected for the estimation of UIE. A drop of toluene was added in each bottle to inhibit bacterial growth and to minimize odor. Urinary Iodine Excretion (UIE) levels were measured at the Institute of Nutrition and Food Science, Dhaka University, Dhaka-1000, Bangladesh by the wet digestion method adapted by Dunn *et al.* (1993) and the values were expressed as µg/ L.

Rapid urinary iodide test.

Assessment of iodine deficiency and monitoring of iodine supplementation programs demands rapid, simple and cost-effective methods for the determination of urinary iodide concentrations. We propose a rapid test based on the iodide-catalyzed oxidation of 3,3',5,5'-tetramethylbenzidine by peracetic acid/H2O2 to yield colored products. The color of the chemical reaction is compared with color categories of a pictogram corresponding to three ranges (<10, 10-30, and >>30 microg/100 mL) of iodide concentrations. The test is very easy to perform by MOL-300 (Auto Biochemistry analyzer), we determined the iodide concentrations of 220 random (untimed) urine samples from consecutive patients by both HPLC and the rapid test. The results obtained by both methods are in close agreement with respect to classification of the samples according to the above three ranges, with a maximum difference of <5% for each range. This rapid test is therefore very well suited to epidemiological surveys of iodine deficiency especially in developing countries.

4.6.1.2. Assessment of nutritional status by anthropometry:

Anthropometry is the measurement of the human. It is a quantitative method and is highly sensitive to nutritional status; especially among children. Therefore, in order to access the nutritional status of School children under the present study anthropometric measurements of their age, body height and weight were made as follows WHO (Zuguo Mei and Laurence, 2007, WHO 1995, 2006).

Age: The age of the examined students was recorded from the school register and was rounded off to the nearest whole number. Only those children who were listed in the register and were within the age group of 6 to 15 years were included.

Height: Height in centimeters (cm) was marked on a wall in the school with the help of a measuring tape. All children were measured against the wall. The children were asked to remove the footwear and stand with heels together and head positioned so that the line of vision was perpendicular to the body. A glass scale was brought down to the topmost point on the head. Height was recorded to the nearest 0.5 cm.

Weight: For measuring body weight a bathroom scale was used. It was calibrated against known weights regularly and zero error was checked for and removed if present every day. Clothes were not removed, as adequate privacy was not available. However, as the study periods for anthropometric data collection was in the month of May to September, the weather was warm; the students wore only light clothes. Weight was recorded to the nearest 500 grams.

4.6.1.3. Evaluation of the nutritional status of school children of study area according to height and weight z-scores.

The nutritional status of children under the present study was evaluated according to height and weight Z-scores. The prevalence of underweight, stunting and wasting was calculated according WHO recommended cut-off points. The total percentage of prevalence's of underweight (<median -2Sd of NCHS/WHO standards) for boys and girls was determined. The percent of severe grade (<median -3SD) of underweight, stunting and wasting was also determined (Zuguo Mei and Laurence, 2007, WHO 1995, 2006).

The anthropometric indicators recommended for adolescents are stunting (height for age > -2 Z scores) and under weight (Weight for age > -2 Z scores) has been found and wasting (weight for height > -2 Z scores). These were calculated separately for boys and girls for each age groups, as the WHO reference norms vary by age and sex.

4.6.1.4. Socio-economic statues of the study population

Categorization of socio-economic status has been done on the basis of their guardian's monthly income and profession. Depending upon their guardian's socio-economic conditions, the students were divided into 5 different groups. (Group 1= Rich (Monthly income Taka -20000+) ,Group 2= Upper Middle class (Monthly income Taka -15000+), Group 3= Lower middle class (Monthly income Taka -10000-15000) Group 4= Poor (Monthly income Taka:-3000 -5000) , Group 5= Orphaned (Dependent on others)

4.6.1.5. Collection of blood and sample processing:

With all aseptic precautions, 5.0 cc of venous blood was drawn from each child having goiter using disposable syringes by medical technologist. The samples were collected and kept in test-tube, test tube of blood preserved in ice box. Blood was kept for 30 min at room temperature for clotting and then centrifuged for 10 minutes. Supernatant serum was separated and stored at -20°C. Room temperature of the sample was attained prior to assay. Tests were carried out as early as possible after sample collection.

4.7.1. Thyroid hormone estimation (Biochemical variables)

Estimation of serum T_3 and T_4 were done by radioimmunoassay (RIA) and estimation of TSH was done by Immuno-radiometric assay (IRMA) in the *in vitro* laboratory of Centre for Nuclear Medicine and Ultrasound, Dinajpur, Bangladesh by trained persons.

The basic principle of RIA and IRMA is antigen antibody reaction. In RIA, antigen is labelled and specific antibody used. In IRMA, antibody was labelled (Heel , 1985).

4.7.2. Basic principles of the RIA method for the estimation of T_3 & T_4 hormone (Heel, 1985).

The RIA method depends on the competition between ^{125}I-labelled T_3 & T_4 containing in standards or in specimens to be assayed for a fixed or limited number of T_3 & T_4 antibody binding sites. After incubation, the amount of ^{125}I-labelled T_3 & T_4 bound to the antibodies inversely related to the amount of present in the sample. By measuring the proportion of ^{125}I-labelled T_3 & T_4 Bound in the presence of reference standards containing various known amounts of T_3 & T_4, the concentrations present in unknown samples can be interpolated.

4.7.3. Contents of the test kit:

Tracer: ^{125}I-labelled T_3, T_4

Standard: 6 vials of different concentrations.

For T_3: 0, 0.8, 1.5, 3.1, 6.2, and 12.3 nmol/L, For T_4: 0, 26, 52, 103, 206 and 309 nmol/L

T_3, T_4 antibody

Precipitant

4.7.4. Equipments:

1. Test tube with rack
2. Micropipette (50, 200 and 500 µl) with disposable tips
3. Vortex mixer
4. Centrifuge machine
5. Gamma counter

4.7.5. Assay protocol

Test tubes: Labelling and arrangement done in tube rack

Tube No.:

--> Total

--> Standard

--> Quality control (QC)

Rest --> Patients

(two tubes for each)

50 µl pipetted from standard, QC and patients serum in respective test tube.

200µl pipetted from tracer (^{125}I-labelled T_3/T_4) in all test tubes. Tube 1-2 separated.

200 µl antibody added to all test tubes except 1-2.

Vortexed for 10 seconds.

Kept in water bath at 37°C – 60 minutes for T_3 45 minutes for T_4.

Vortex mixing done and kept at room temperature for one hour.

Centrifuged at 3500 rpm for 20 minutes.

Decantation of all test tubes done except 1-2.

Counting was performed by RIA gamma counter.

The PC (personal computer) based RIA counter calculated the counts of each sample (unknown, standard and quality control) and also gave different quality control parameters. From the computer reading, values (expressed in µgl/L) of T_3 and T_4 were recorded.

4.8. Thyroid stimulating Hormone (TSH) assay by Immuno-radiometric assay (IRMA) (Heel, 1985).

4.8.1. Principle of the IRMA method for the estimation of TSH hormone.

This is two sites sandwich imunoradiometric assay for the measurement of TSH hormone in human serum. This involves the reaction of TSH present in serum with monoclonal & polyclonal antibody. This monoclonal antibody is labeled with ^{125}I as tracer (^{125}I -McAb) and the polyclonal antibody is coupled to magnetic iron oxide particles (PcAb(M)). The formed ^{125}I McAb_TSH-PcAb (M) complex sandwiches separated from unbound tracer by placing the assay tubes in the magnetic separator and decanting supernatant. The radioactivity of the tracer in the tubes is directly proportional to the concentration of TSH in the specimens.

4.8.2. Contents of TSH kit:

Tracer: ^{125}I-labelled McAb.

PcAb<M>: Polyclonal antibody coupled with magnetic iron oxide.

TSH standard:

Lyophilized:

Labelled

A, B, C, D, E, F, G

Concentration

0, 0.35, 1.0, 3.3, 10, 22, 75 mIU/L.

Concentrated wash buffer.

4.8.3. Equipments:

1. Test tube with rack
2. Micropipette (50, 200, 500μl and 1 ml) with disposable tips
3. Vortex mixer
4. Magnetic separator
5. Absorbent blotting paper
6. Gamma counter

4.8.4. Preparation for assay:

Standard: Reconstituted each vial with 1 ml of distilled water to get exact concentration.

Wash buffer (concentrated): Diluted with distilled water at ratio of 1:10.

Magnetic TSH-Ab suspension: resuspended by gentle mixing.

The kit and sample were allowed to reach temperature before use.

4.8. 5. Assay protocol:

Labelling of the test tubes and arrangement in the tube rack.

Tube No.:

--> Total

--> Standard

--> Quality control (QC)

Rest --> Patients (samples)

(two tubes for each)

Standard, QC, sample: 200 µl pipetted in respective test tubes.

Tracer (^{125}I-McAb): 50 µl pipetted in all test tubes.

Tube 1-2 was separated. Then vortex mixing was done.

Incubated in water bath at 37°C for one hour.

second antibody [PcAb<M>]: 500 µl pipetted in all test tubes except 1-2.

Again vortex mixing done.

Incubated at room temperature for one hour.

test tube rack was placed on a magnetic separator for 10 minutes -> decantation was done and rack was removed from separator.

One ml wash buffer was added in all test tubes except 1-2.

Again vortex mixing done.

Again, test tube rack was placed on a magnetic separator for 10 minutes -> decantation was done and rack was removed from separator.

Again, wash buffer was added.

Again, vortex mixing done.

Again, test tube rack was placed on a magnetic separator for 10 minutes -> decantation was done and rack was removed from separator.

Counting was performed by PC based RIA gamma counter. The computer of RIA counter calculated the counts of each sample (Unknown, standard and quality control) and also gave different quality control parameters. From the computer reading, values (mIU/L) of TSH were recorded.

CHAPTER-5

RESULTS

5. RESULTS

The present study is a prospective one carried out in Dinajpur district, situated in the northern part of Bangladesh, far from the sea level and is a hyper endemic iodine deficient zone as per report of the National Iodine Deficiency Disorders Survey of Bangladesh 1999 (Dhaka University/IPHN/BSCIC/UNICEF/ICCIDD, 2001).

Clinical examination of the thyroid glands of 1060 school going children was performed through inspection and palpation. Grading of goiter was done according to the criteria recommended by the joint WHO/UNICEF/ICCIDD (1992).

Data were collected using a specially designed structured questionnaire (research instrument) containing all the variables of interest like name of the student, age, sex, weight and height (measured during interview for nutritional status assessment), religion address, father's name, his occupation and monthly income (to access Socio-economic status), mother's name and her occupation, number of children in the family, order of birth, food habit (Salt), etc.

A second specially designed questionnaire sheet was also used that was to be filled up by the mothers of the school children regarding their knowledge of iodine nutrition on the basis of their education, profession, area of residence and their opinion about the barriers (price, quality, both) in the establishment of the goals of universal salt iodization (USI). Also information on food habit (Salt intake) was included. The students were requested to take their questionnaire home and get it filled by their mothers or parents and were asked to bring it back to us on the next day. Out of 500 questionnaire sheets 312 were returned to us.

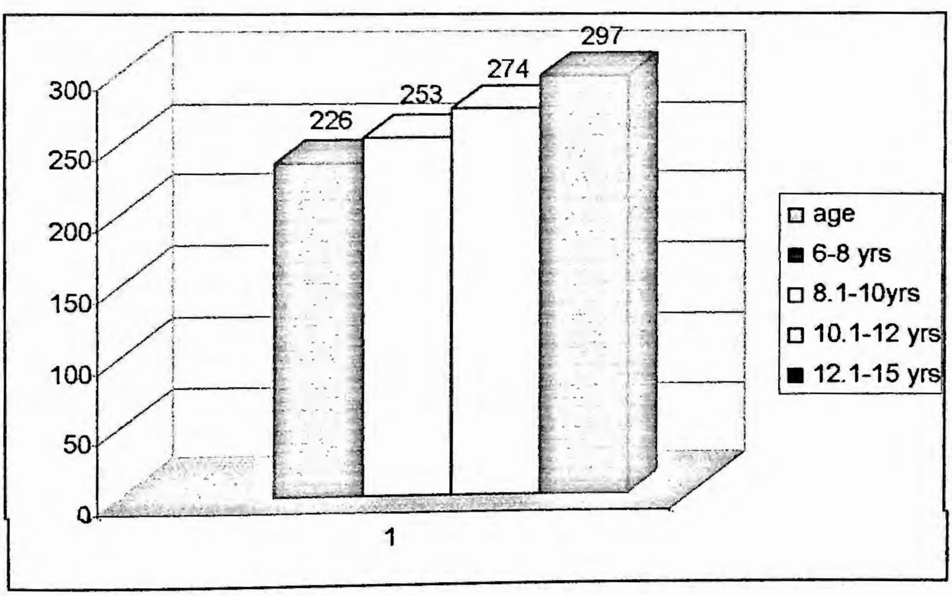
The present study also finds out the present iodine nutritional status of the school children of the study area by the estimation of urinary iodine excretion (UIE). Urine and blood samples were taken from each 5^{th} and 16^{th} child after clinical examination of the thyroid gland was completed. A total of 220 urine samples and 70 blood samples were collected for the estimation of UIE and T_3, T_4 and TSH, respectively.

Data were organized into different groups of variables. Appropriate descriptive and analytical statistics were done using the computer software SPSS Windows version 13.0. All the findings obtained in the present study have been organized into following sections.

5.1. Age-wise incidence of goiter.

Table 1 shows the age-wise pattern of the children screened and the incidence of goiter among them under the present study. As shown in the table, a total of 1060 children were included in the study. Ages of the study individuals ranged between 6-15 years the median age were 10.44 ± 2.49 (SD) *i.e.* they were students from Class I to Class X.

For study convenience, the participants of the present study were divided into four groups depending upon their age. Group 1 included students between the ages of 6 to 8.0 yrs, group 2 between the ages of 8.1 to 10.0 yrs, group 3 between ages of 10.1 to 12.0 yrs and group 4 included students between ages of 12.1 to 15yrs or above. The ratio of the respondents of group 1, 2, 3 and group 4 was 226 (22.2%), 253 (23.9 %), 274 (25.8%) and 307 (28.1%), respectively as shown in graph 1 below:



Graph 1. Different age groups of the study population.

As shown in Table 5 (a), the goiter prevalence for age group 1 and 2 was 3.8% and 4.3%, respectively and they all had goiters of grade 1 and none of them had grade 2 goiter. In age group 3, the total goiter rate was 10.6% (9.5 + 1.1%) among them 9.5% had grade-1 goiter and 1.1% had grade-2 goiter. The total goiter rate in case of age group 4 was calculated to be 11.4% (10.1 + 1.3%) and among them 10.1% had grade-1 goiter while 1.3% had goiter of grade-2. The differences in goiter prevalence among the different age groups of the present study population was found to be statistically significant, p=0.03 < 0.05.

Table 5(a). Relation of age on the incidence of goiter.

Age Group (yrs)	Goiter grade			Total (1+2) TGR
	Grade-0 (normal)	Grade-1	.Grade-2	
1 (6-8 yrs)	227 (96.2%)	9 (3.8%)	0.0	9 (3.8%)
2 (8.1-10 yrs)	242 (95.6%)	11 (4.3%}	0.0	11 (4.3%}
3 (10.1-12 yrs)	245 (89.4%)	26 (9.5%)	3 (1.1%)	29 (10.6%}
4 (12.1-15 yrs)	263 (88.5%)	30 (10.1)	4 (1.3%)	34 (11.4%}
All (n=1060)	977(92.2%)	76 (7.1)	7 (0.7%)	83 (7.8%)

λ^2=19.657, df=6, p=0.03 < 0.05. (Parentheses indicate percentage)

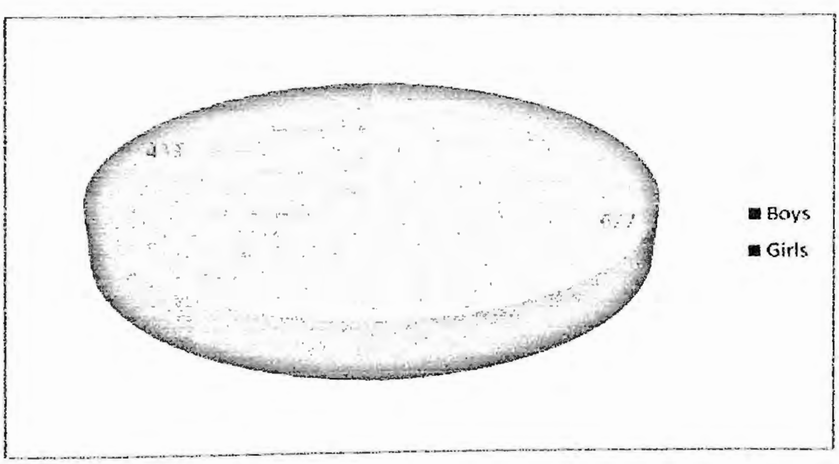
The calculated total TGR (goiter grade 1 + grade 2) of present study was 7.8% as shown in Table 5 (a), which is slightly higher than national (6.2% in 2004-2005) TGR in school children in the country (Yusuf *et al*, 2008). Higher TGR noticed in our study area may be due to the cause our study area Dinajpur district which is particularly considered a goiter – prone areas (Yusuf *et al* 1994, Khalilullah *et al.*, 1996). Goiter of grade 2 was not found in children in age group 1 (6-8 yrs) and group 2 (8.1-10 yrs) probably because these children were born after iodized salt became widely available in the market which explains the lower prevalence of goiter particularly grade 2 (Yusuf *et al.* 2008).

5.2. Sex-wise prevalence of goiter.

The sex-wise distribution of goiter among the study population has been shown in Table 5(b). Among total 1060 participants in the present study, 627 were boys (group1) *i.e.* representing 59.1% and 433 were girls (group 2) *i.e.* 40.9% of the total study population (Graph 2).

The total prevalence rate of goiter was found to be higher in girls (8.6%) than that of boys (7.3%). Statistically significant difference (λ^2=10.236, df=2, p=0.006 < 0.05) was found in the prevalence of goiter among the boys and girls.

Female predominance of thyroid diseases in the present study population is consistence with almost all other previous studies. Goiter of grade 2 was not detected in boys but was present in 1.7% girls as shown in Table 5(b). Higher incidence of goiter among girls observed in the present study may be due to physiological characteristics during puberty and quantitative dietary deficiency in females probably due to the brief stimulation of the thyroid gland which occurs during puberty and menstruation as observed by Bhagboti (1987). The higher prevalence of goiter in girls may be due to puberty related iodine metabolism in this age (Sahu *et al.* 2004).



Graph 2. Boys and girls of the study population

Table 5(b). Sex-wise incidence of goiter.

Sex	Goiter grade			
	Grade-0 (normal)	Grade-1	.Grade-2	Total (1+2) TGR
Boys (n=627)	581(92.7%)	46 (7.3%)	0.0	7.3%
Girls (n=433)	396 (91.4%)	30 (6.9%)	7 (1.7%)	8.6%
Combined (n=1060)	977 (92.2%)	76 (7.1%)	7 (0.7%)	7.8%

$\lambda^2=10.236$, df $=2$, $p=0.006 < 0.05$

5.3. Age-sex wise distribution of goiter among the boys and girls.

The results of cross tabulation of sex, age and goiter prevalence among boys and girls have been presented in Table 5(c) and Table 5(d), respectively. In both the tables the goiter prevalence is found to be lower among children belonging to the lower age group (Group 1, age 6-8 yrs) irrespective of sex. The goiter prevalence rate was observed to be increased gradually with the increases of ages of the study children. As shown in Table 5 (c) the goiter rate of grade 1 goiter among boys (group1) for the age groups 1, 2, 3 and 4 was 4.1%, 4.3%, 9.0% and 10.0%, respectively. Among girls (group.2) the rates were 3.5%, 4.4%, 10.3% and 10.4% for the age groups 1, 2, 3 and 4, respectively (Table 5(d).

Table 5(c). Age–sex wise distribution of goiter among the boys in the present study.

Age group	6-8 yrs	8.1-10 Yrs	10.1-12 Yrs	12.1-15 yrs
Grade-0 (normal)	116 (95.9%)	132 (95.7%)	152 (91.0%)	181 (90.0%)
Grade-I	5 (4.1%)	6 (4.3%)	15 (9.0%)	20 (10.0%)
Grade-II	0.0	0	0	0
Total : Grade-I + II	4.1%	4.3%	9.0%	10.0%

Table 5(d). Age-sex wise distribution of goiter among the girls in the present study.

Age group	6-8 yrs	8.1-10 Yrs	10.1-12 Yrs	12.1-15 yrs
Grade-0 (normal)	111 (96.5%)	110 (95.6%)	93 (86.9%)	82 (85.4%)
Grade-I	4 (3.5%)	5 (4.4%)	11(10.3%)	10 (10.4%)
Grade-II	0	0	3 (2.8%)	4 (4.2%)
Total: Grade-I + II	3.5%	4.4%	13.1%	14.6%

The data presented above in Table 5.(c) and 5.(d) showing age–sex wise distribution of goiter among the study boys and girls, respectively, clearly demonstrated that among the girls; grade 2 goiter was present in age groups 3 (2.8%) and group 4 (4.2%), whereas, grade 2 goiter was not detected among boys under the preset study. The differences between prevalence of grade 2 goiter among boys and girls was found to be statistically significant ($p=0.000 < 0.05$).

The results showed that lowest prevalence of goiter was observed in children of low age group between both sexes. Among the higher age groups i.e. 3 and 4 in both sexes the goiter prevalence rate is two/three times higher than the lower age groups i.e. group 1 and 2. The reason for lower prevalence of goiter observed among children of low age group of both sexes in the present study may be due to the benefits of salt iodization programs. As these children were born long after salt iodization programs had begun in Bangladesh and probably they did not suffer from maternal iodine deficiency during their mother's pregnancy (Yusuf *et al*, 2008).

5.4. Age wise distribution of iodized salt intake of the respondents.

Table 5 (e) shows the percentages of age-wise salt intake among the participants of the present study. The percentages of regular use of iodized salt were 82.6%, 74.3%, 69.3% and 63.0% among the age groups 1, 2, 3 and 4, respectively.

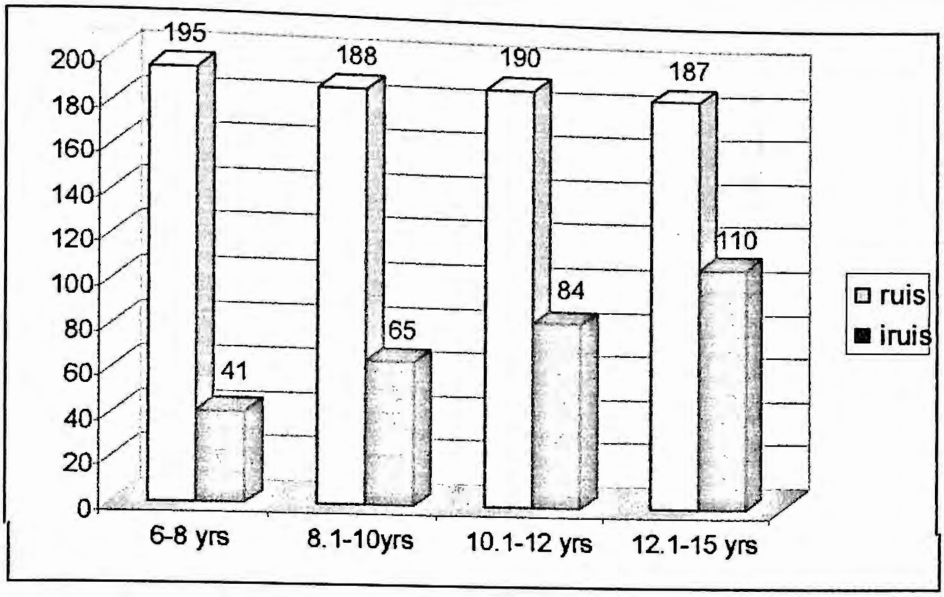
Table 5(e). Age wise distribution of iodized salt intake of the respondents.

Age group (yrs)	Salt intake	
	RUIS	IRUIS
1 (6-8 yrs)	195 (82.6%)	41 (17.4%)
2 (8.1-10 yrs)	188 (74.3%)	65 (25.7%)
3 (10.1-12 yrs)	190 (69.3%)	84 (30.7%)
4 (12.1-15 yrs)	187 (63.0%)	110 (37.0%)
Total n= 1060	760 (71.7%)	300 (28.3.3%)

RUIS: -Regularly using iodized salt, IRUIS: -Irregularly using iodized salt

The above data presented in Table 5(e) above clearly demonstrated that children of the lowest age group *i.e.* group 1 (6-8 yrs of age) consumed the highest percentage (82.6%) of iodized salts on regular basis and gives us hopeful signs for establishment in USI. Rest of the respondents used iodized salt irregularly. The average percentage of iodized salt intake among children in the present study was 71.7% which was almost similar to the national data reporting that about 70% population of Bangladesh use iodized salt (BBS 2006). The differences among RUIS and IRUIS users under the current study was found to be statistically significant $p=0.000 < 0.05$.

The age wise distribution of regular and irregular iodized salt intake among the participants of the present study has been shown in Graph 3 below.



Graph 3. Regular and irregular intake of iodized salt in different age groups.

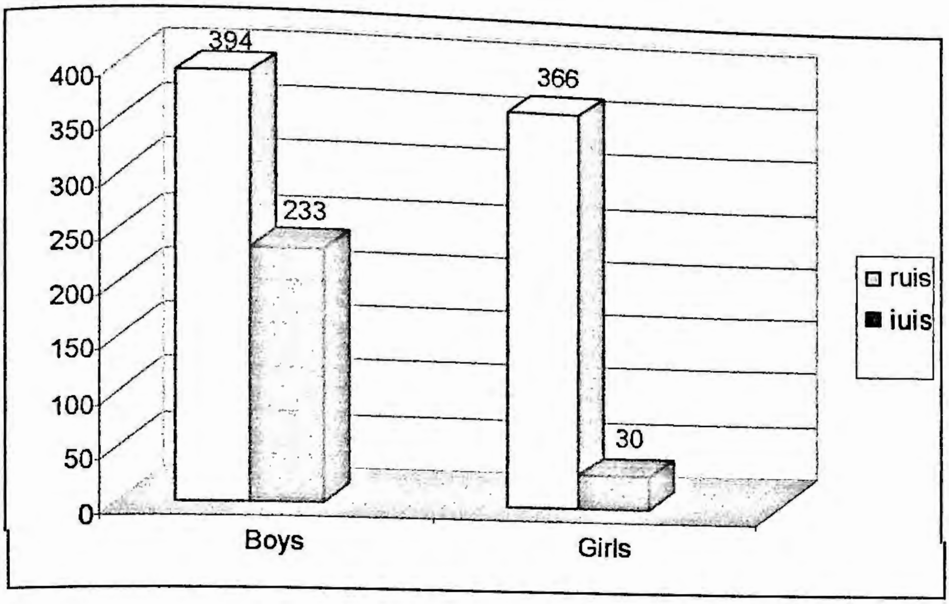
5.5. Sex wise distribution of iodized salt intake of the respondents.

On the basis of sex, the percentage of regular intake of iodized salt was 62.8% among boys (group1) while, it was 84.5% among girls (group2) as shown in Table 5(f). The results clearly indicated that the girls (group 2) are more conscious about the impact of iodine and IDD than the boys (group1). The increased awareness about iodine nutrition among the girls in the present study is a positive indication for future because healthy babies come from healthy mothers. Sex-wise distribution of iodized salt intake of the respondents in the present study has been represented in graph 4.

Table 5(f). Sex wise distribution of iodized salt intake of the respondents

Sex	Salt intake	
	RUIS	IRUIS
Boys (group 1)	394 (62.8%)	233 (37.2%).
Girls (group 2)	366 (84.5%)	67 (15.5%)
Total n =1060	760 (71.7%)	300 (28.3%)

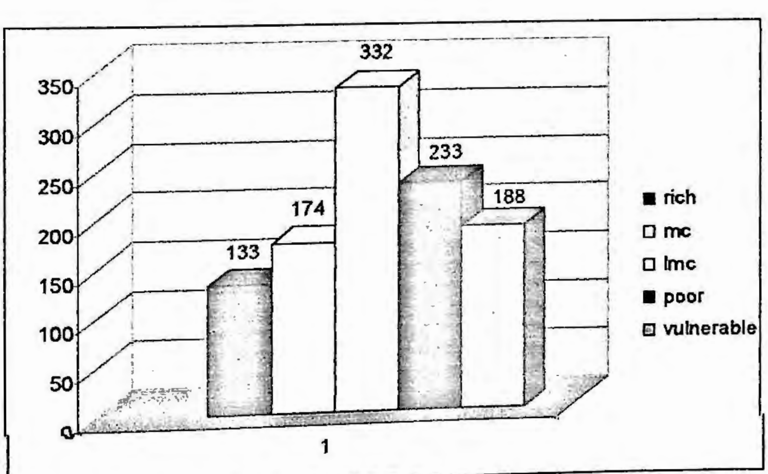
(RUIS: -Regularly using iodized salt, IRUIS: -Irregularly using iodized salt)



Graph 4. Sex wise distribution of iodized salt intake of the respondents

5.6. Goiter prevalence among school children from different socio-economic setting.

The socio-economic status of the participating students, under the present study, has been shown graphically in Graph 5. Assessment was done on the basis of their guardian's monthly income and profession. Depending upon their guardian's socio-economic conditions, the students were divided into 5 different groups. (Group 1= Rich (Monthly income Taka -20000+), Group 2= Upper Middle class (Monthly income Taka -15000+), Group 3= Lower middle class (Monthly income Taka -10000-15000) Group 4= Poor (Monthly income Taka:-3000 -5000), Group 5= Orphanage/vulnerable (Depending on others)



Graph 5. Participating students from different socio-economic setting.

Goiter prevalence among the participating students from different of Socio-economic statuses has been indicated in Table 5(g). The goiter prevalence rate ranged from 2.2%-19.1% among the different socio-economic settings. The data presented in Table 5 (g) clearly demonstrated that the prevalence rate of goiter increases gradually with the lowering of socioeconomic status. The highest goiter prevalence of 19.1% was noticed among the vulnerable group while the lowest goiter prevalence of 2.2 % was observed among rich group.

The differences in goiter prevalence among different socio-economic statuses was found to be *statistically highly significant* (p=0.000 < 0.05.). The results informed us that large programs on iodine are needed particularly among the vulnerable and poor to prevent Iodine deficiency disorders.

Table 5(g). Goiter prevalence on the basis of Socio-economic status of the students.

Socio-economic status	Goiter Grade			
	Grade-0 (normal)	Grade 1	Grade 2	Total (1+2) TGR
Rich	130 (97.7%	3 (2.2%)	0.0	3 (2.2%)
Middle class	170 (2.3%)	4(2.3%)	0.0	4 (2.3%)
Lower middle class	312 (94.0%0	16 (4.8%)	4 (1.2%)	20 (6.0%)
Poor	213 (91.4%)	17 (7.7%)	3 (1.28%)	20 (9.0%)
Vulnerable	152 (80.8%)	36 (19.1%)	0.0	36 (19.1%)
Total	977 (92.2%)	76 (7.1%)	(0.7%)	83 (7.8%)

P=0.000 < 0.05

5.7. Goiter prevalence rates among religious groups in the sample.

In the present study, a total of 1060 children were screened. Among them 744 (70.2%) were Muslims, 193 (18.2%) were Hindus and 123 (11.6%) were tribal (mostly Christians.) and were designated as group 1, 2 and 3, respectively. The incidence rate of goiter among Muslims, Hindus and Christians were 7.4%, 7.8% and 10.5%, respectively (Table 5.(h). The results clearly demonstrated that Christians (tribals) are significantly more prone to developing goiter ($p=0.003$) than the other two religions. i.e. Muslims and Hindus. Grade 2 goiter prevalence was also significantly higher (3.25%) than Muslims (0.13%) and Hindus (1.3%). We also found the presence of goiter among family members in the Tribal. Higher TGR in Tribals may be caused by long-term multi factorial geographical, environmental, nutritional and hereditary factors and poor community knowledge regarding iodine nutrition and further studies are required to unravel the causative factors (Jayakrishnan and Jeeja, 2002).

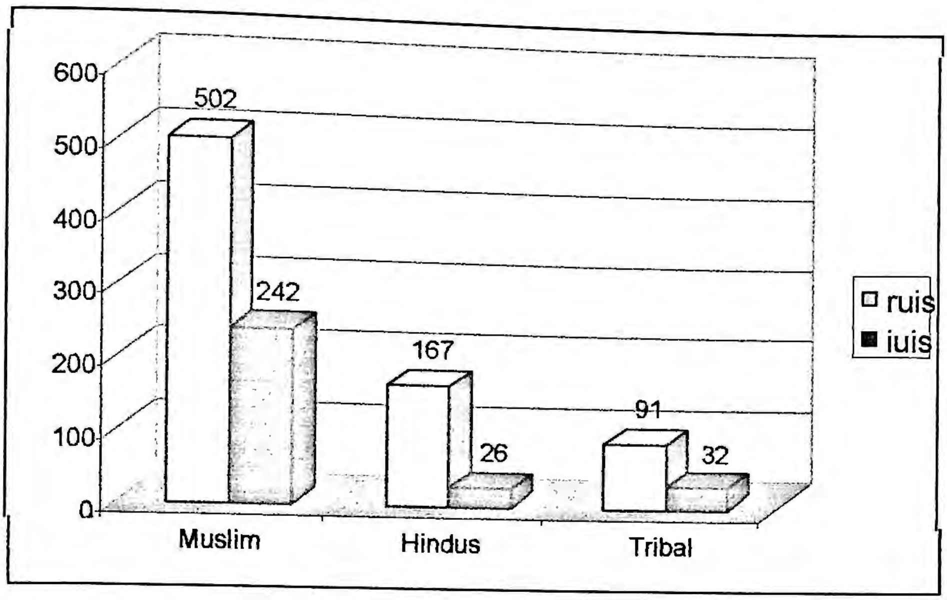
Table 5(h). Religion-wise incidence of goiter.

Religion	Goiter grade			Total (1+2)
	Grade-0 (normal)	Grade-1	Grade-2	TGR
Group 1 (Muslim)	689 (92.6%)	54 (7.2%)	1 (0.13%)	55 (7.4%)
Group 2 (Hindus)	178 (92.2%)	13 (6.7%)	2 (1.03%)	15 (7.8%)
Group3 (Christian)	110 (89.4%)	9 (7.3%)	4 (3.25%)	13 (10.5%)

$\lambda^2=16.218$, df=4, $p=0.003 < 0.05$.

5.8. Rate of iodized salt intake based on religion.

On the basis of religion, among the study population of the present study, the percentages of iodized salt in take on regular basis were 67.5% among Muslims, 86.5% among Hindus and 74.0% among Christians as shown in Table 5(i). The results presented in Table 5(i) shows clearly indicated that the consumption of iodized salt was highest among Hindus and this was found to be statistically highly significant ($p=0.000< 0.05$). Regular iodized salt intake on the basis of religion among the study population under the present study has been shown in graph 6 below.



Graph 6. Graphical representation of regular and irregular iodized salt intake among different religion.

Table 5(i). Rate of iodized salt intake on the basis of religion.

Religion	Salt intake	
	RUIS	IRUIS
Muslims	502 (67.5%)	242 (32.5%)
Hindus	167 (86.5%)	26 (13.5%)
Christians	91 (74.0%)	32 (26.0%)
All religions	760 (71.7%)	300 (28.3%)

($p=0.000< 0.05$). Significant

RUIS -Regularly using iodized salt, IRUIS -Irregularly using iodized salt

5.9. Percentage of edible salt intake and the prevalence of goiter.

The present study showed that among 1060 individuals, 760 persons i.e.71.7 % of the study population (belonging to *Group 1*) used iodized salt regularly while 300 persons i.e.28.3% (belonging to Group 2) used iodized salt irregularly. The total incidence rate (TGR) of goiter among group1 and group 2 was calculated to be 4.7% and 15.6%, respectively in Table 5(j).

Table 5(j). Percentage of edible salt intake and goiter prevalence.

Salt Users group	Goiter grade			Total TGR
	Grade-0 (normal)	Grade-1	Grade-2	
Group 1 (RUIS)	724 (95.3%)	31 (4.1%)	5 (0.65%)	36 (4.7%)
Group 2 (IRUIS)	253 (84.3%)	45 (15.0%)	2 (0.66%)	47 (15.6%)

P=0.000 < 0.05, Significant

RUIS -Regularly using iodized salt, IRUIS - Irregularly using iodized salt

The results clearly indicated that the prevalence of goiter was significantly higher (P=0.000 < 0.05) among members of group 2 (those irregularly using iodized salt) compared to than that of group 1 (Regularly using iodized salt). The present study, therefore, advocates the use of iodized salt on a regular basis particularly among the young children in order to minimize the prevalence of goiter.

5.10. Estimation of thyroid hormone of the study children.

The median concentrations of T_3, T_4 and TSH of the present study population was slightly higher the lower limit of normal range shown in Table 5(k). These results indicate marked improvement of iodine nutrition status of the population.

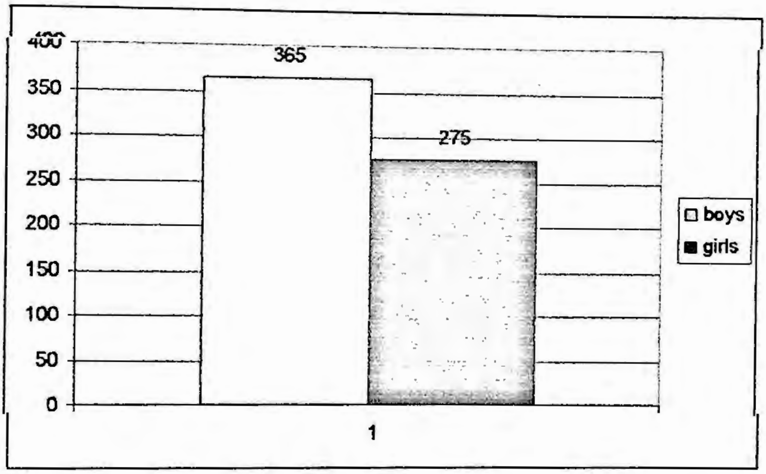
Table 5(k). Mean value of thyroid hormone (T_3, T_4 and TSH) of the study population.

Hormones	Number	Min.	Maxm.	Level (Mean ±SD)	Normal range
T_3	70	0.54	3.11	1.8419 ± 0.6733 mol/L.	1.30-3.40 nmol/L
T_4	70	44.0	186.0	119.428 ± 34.9374 nmol/L	54.0-174.0 nmol/L
TSH	70	0.50	5.30	2.8473 ±1.0958 mIU/L	0.40-4.80 mIU/L

5.11. Participating students in Anthropometric measurement.

The study comprised of 640 students between 6.0-15.0 years. Of the total participants boys (group1) were 365 (57%) and girls (group 2) were 275 (43%) as shown in graph 7. The mean weight and height of the study population was 27.10 ± 7.35 (SD) Kg ranged between (15 -57 Kg) and 129.8 ±13.94 (SD) cm ranged between (106 -170 cm), respectively.

The mean weight and height of the boys participating in the present study was 28.17± 7.35 (SD) Kg, ranged between (15 -57 Kg) and 132.60± +14.31(SD) cm, ranged between (115 -170 cm). The mean weight and height of the girls was 25.77± 6.25 (SD) Kg, ranged between (15 -56 Kg) and 126.93± 11.62 (SD) cm, ranged between (108 -168 cm). Boys were slightly taller and heavier than girls; however, both boys and girls were shorter and lighter as compared to the NCHS reference data for their ages and sex (WHO child growth standards -2006).

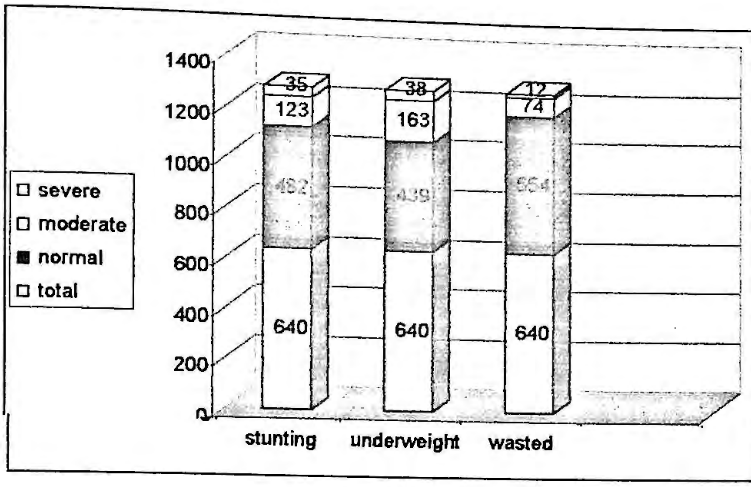


Graph 7. Study population for anthropometric measurements.

5.12. Anthropometric measurement (stunting, underweight and wasting) of study students.

The prevalence of stunting, underweight and wasting were calculated according WHO recommended cut-off points (WHO working group -1986, WHO 1995, 2006). The results of stunting, underweight and wasting under the present study, have been shown graphically in graph 8. The total prevalence of stunting of the study children was 158 (24.7%), *including moderate* (<median -2Sd), 123 (19.2%) and *severe* (<median -3SD) was 35 (5.5%). For underweight the total prevalence of 201 (31.4%) including moderate (<median -2Sd) 163 (25.5%) and severe (<median -3SD) 38 (5.9%). Rate of wasting was

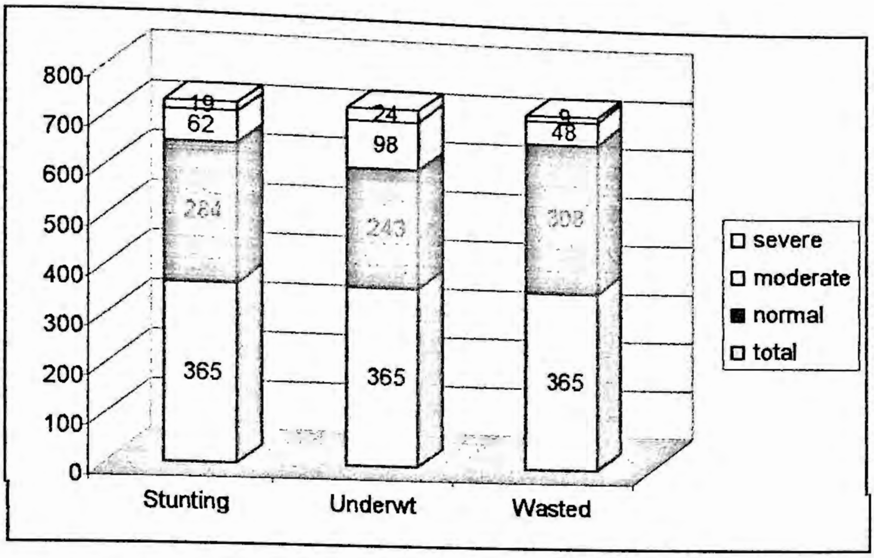
moderate (<median -2Sd), 74 (11.5%) and severe (<median -3SD) 12 (1.9%) and totally 86 (13.4%).



Graph 8. Representation of Stunting, underweight and wasting of the study children.

5.13. Nutritional indicators of Stunting, underweight and wasting among boys.

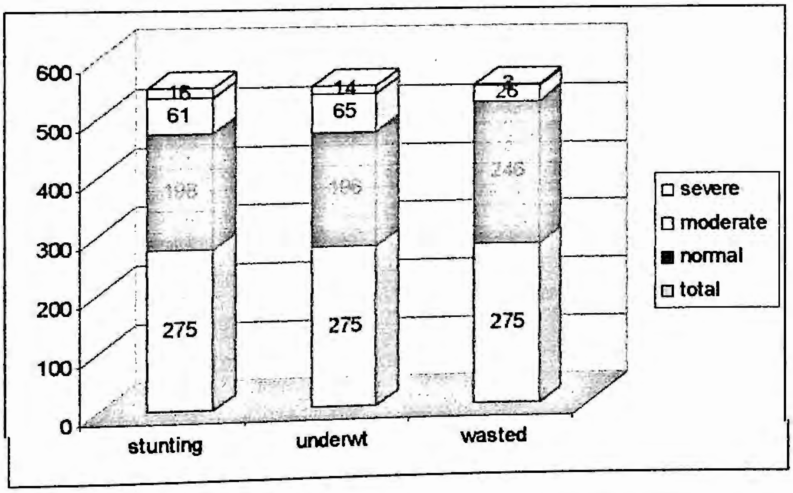
The prevalence of stunting, underweight and wasting were calculated according WHO recommended cut-off points (WHO working group 1986,WHO 1995, 2006) and the results have been shown graphically in graph 8 for the study boys. The total number of participating boys was 365. The number and percentages of severe grade of stunting, underweight, wasting (<median -3SD of NCHS/WHO standards) for boys in study students was 19 (5.2%), 24 (6.6%), 9 (2.5%) and moderate grades (<median -2Sd of NCHS/WHO standards) of stunting, underweight and wasting were 62 (17.0%), 98 (26.8%) and 48 (13.1%), respectively (graph 9).



Graph 9. Representation of nutritional indicator of stunting, underweight and wasting among boys of the study population.

5.14. Nutritional indicators of stunting, underweight and wasting among girls of the study population.

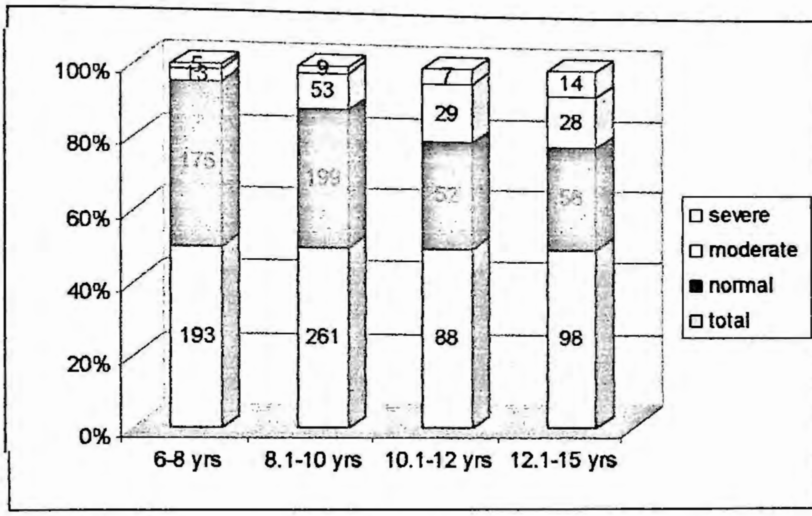
The prevalence of stunting, underweight and wasting were calculated according WHO standards and the results obtained in the present study have been represented graphically in graph 10. The number of participating girls was 275. The number and percentages of severe grade (<median -3SD) of stunting, underweight, wasting for girls was 16 (5.8%), 14 (5.1%), 3 (1.1%) and for moderate grades (<median -2Sd) of stunting, underweight and wasting were 61 (22.2%), 65 (23.6%) and 26 (9.5%), respectively.



Graph 10. Representation of nutritional indicator of stunting, underweight and wasting among girls of the study population.

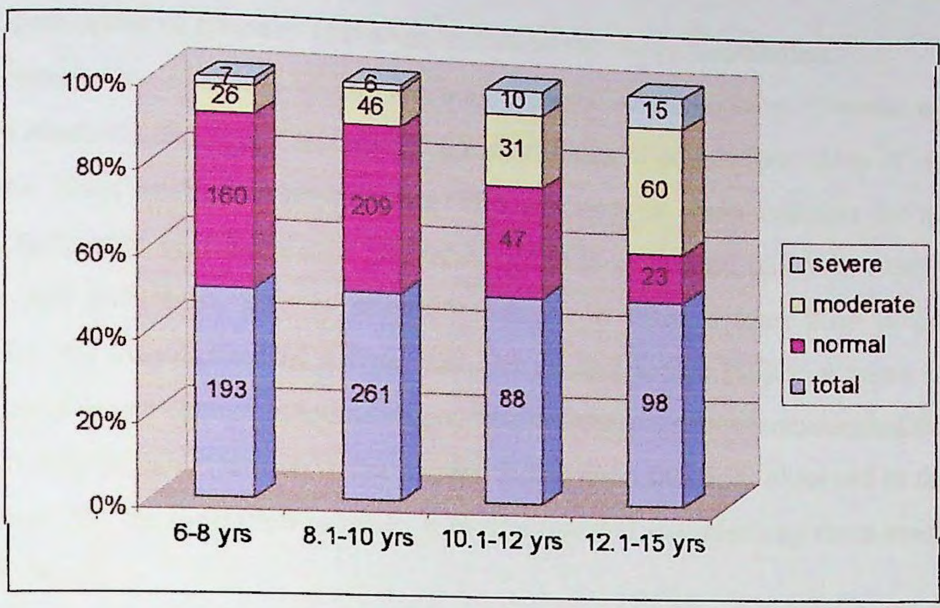
5.15. Stunting, underweight and wasting among children in different age groups.

Stunting: The prevalence of severe stunting (<median -3SD of NCHS/WHO standards) of the study children among the age groups 1, 2, 3, 4, were 5(2.6%), 9(3.5%), 7(7.9%), 14(14.3%) respectively and for moderate stunting were (<median -2SD of NCHS/WHO standards) 13(6.7%), 53 (20.3%), 29(33.0%), 28(28.6%), respectively as shown in graph 11.



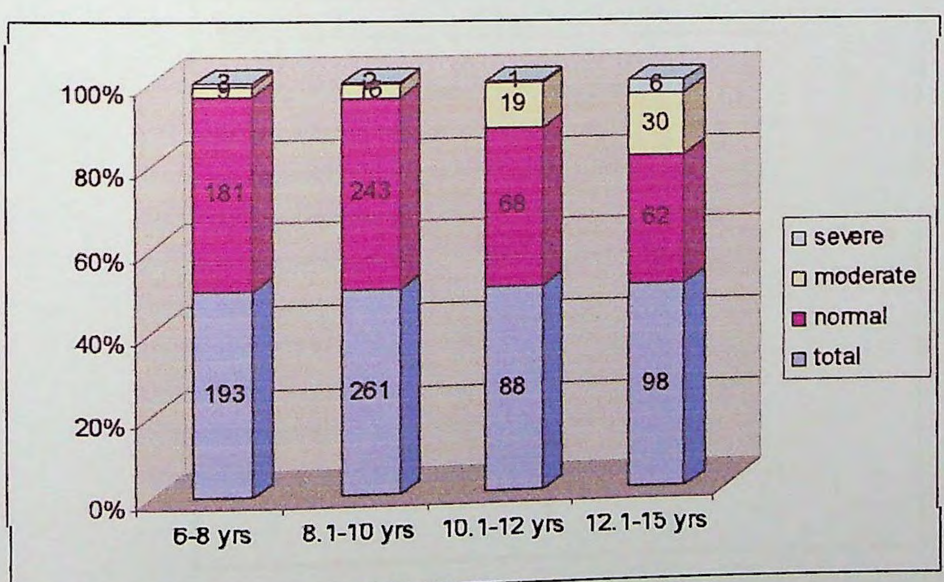
Graph 11. Stunting among children in different age groups of the study.

Underweight: The prevalence of severe underweight (<median -3SD of NCHS/WHO standards) of the study children in the age groups 1, 2, 3, 4, were 7 (3.6%), 6 (2.3%), 10(11.4%),15(15.3%) respectively and for moderate stunting were (<median -2SD of NCHS/WHO standards) 26(13.5%), 46 (17.6%), 31(35.2%) 60 (61.2%) respectively, as shown in graph 12.



Graph 12. Underweight among children in different age groups.

Wasting: The prevalence of severe wasting (<median -3SD of NCHS/WHO standards) of the study children in the age groups 1, 2, 3, 4, were 3(1.5%), 2(0.8%), 1(1.1%), 6(6.1%) respectively and for moderate stunting were (<median -2SD of NCHS/WHO standards) 9(5.5%), 16 (6.1%), 19(21.6%), 30(30.6%), respectively and the results have been represented graphically in graph 13.

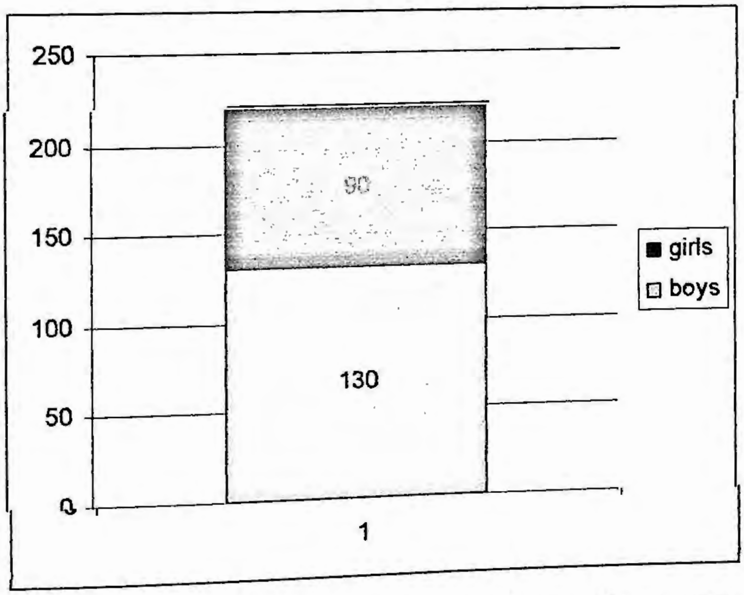


Graph 13. Wasting among children in different age groups.

5.16. Estimation of Urinary Iodine excretion in the study population.

The measurement of urinary iodine has been recognized as the most common and most reliable biochemical test for assessing the iodine status of populations (May *et al.* 1997). Until the 1990s total goiter prevalence (TGP) was used as .main indicator for assessing iodine deficiency in a population. However, TGP is of limited utility in assessing the impact salt iodization. This is primarily because it takes a long time to disappear following the introduction of iodized salt. As urinary iodine (UI) is a more sensitive indicator of recent change in iodine intake, this indicator is now recommended than TGP (WHO/UNICEF/ICCIDD-2001).The urinary iodine concentrations observed in this study confirmed that the iodization program was effective and was reaching most members of the community.

A total of 220 urine samples were analyzed and among them 130 were from boys and 90 from girls. The median urinary iodine excretion (UIE) of the children was estimated to be 159.23 µg/L, which is very close to our National median UIE reporting 163.0 µg/L among school children (Yusuf *et al.* 2008).In the boys median UIE was higher than girls. The median UIE for boys was 171.24 ± 67.17 µg/L (Std. deviation 67.17 and ranged between 17.0 µg/L -292 µg/L) and for girls was 149.33 ± 62.45 µg/L (Std. deviation 62.45 and ranged between 41 µg/L -281 µg/L). The total sample of boys and girls was 130 and 90, respectively (graph 14).



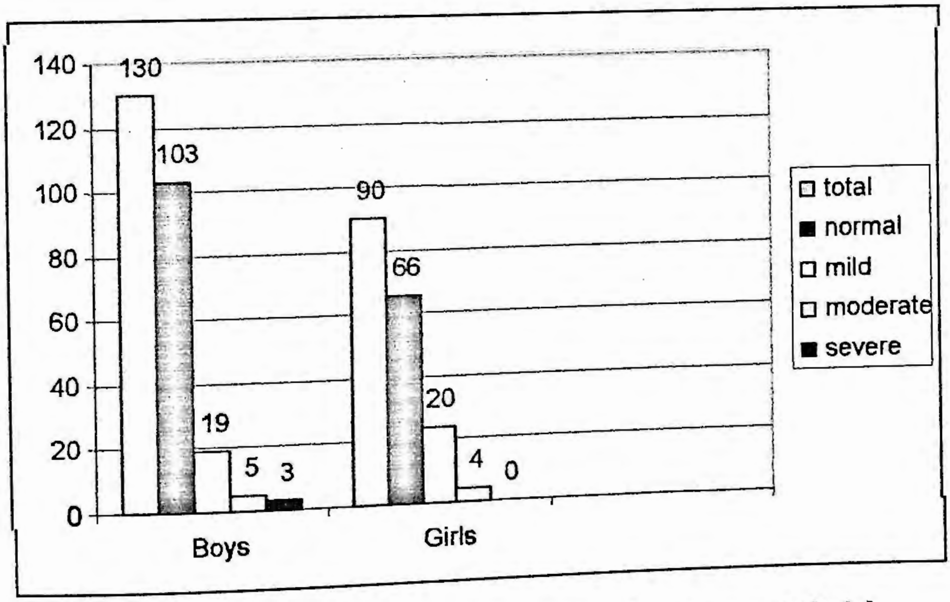
Graph 14. Representation of boys 130 (59.1%) and girls 90 (40.9%) participating in estimation of Urinary Iodine excretion.

The present study showed that 39 subjects (12 boys and 20 girls) i.e. 17.7% of the school children had mild degrees of iodine deficiency. 9 subjects (5 boys and 4 girls) i.e. 4.11% of the school children had moderate iodine deficiency while 3 subjects (all boys) had severe degree of iodine deficiency and the results have been presented in Table 5(l).

5.17. Present Iodine nutritional status of boys and girls.

As shown in Table 5(l), the total prevalence of iodine deficiency (UIE <100 µg/L) in boys was 27 (20.7 %) and in girls was 24 (26.6%). Among boys mild, moderate and severe iodine deficiency was 19 (14.6%), 5(3.8%) and 3(2.3%), respectively. Among girls mild, moderate and severe iodine deficiency was 20 (17.7%), 4(4.4%) and 0 (0.0%), respectively (Table 5(l) and graph 15). The results of the present study showed that the girls are not suffering from severe grades of iodine deficiency but among boys, 2.3% are still suffering from severe iodine deficiency in Table 5(l).

The total prevalence of iodine deficiency (UIE <100 µg/L) among boys and girls in the present study was calculated to be 23.2%. This was a progressive evidence of USI. as the total prevalence of iodine deficiency (23.2%) recorded in the present study is less than 33.8 % (UIE < 100 µg/ L) of that reported by Yusuf *et al.* (2008) in the National IDD survey 2004-05.



Graph 15. Present Iodine nutritional status of boys and girls.

Table 5(l). Prevalence of iodine deficiency among boys and girls.

Subjects	Urinary iodine concentration µg/ L					
	>100 Normal	<100 Mild	<50 Moderate	<20 Severe	Total no Mild, moderate and severe	Total <100 µg/ L
Boys	103 79.3%)	19 (14.6%)	5 (3.8%)	3 (2.3%)	29	20.7%
Girls	66 73.4%)	20 (22.2%)	4 (4.4%)	0 (0.0%)	24	26.6%
Total	169 76.8%)	39 (17.7%)	9 (4.1%)	3 (1.4%)	51	23.2%

5.18. Estimation of Urinary Iodine Excretion in different age group .

The status of iodine nutrition of study children in different age group was better than before and was best among members of the lower age groups i.e. 1 and 2. As per recommendation of the urinary levels of WHO/UNICEF/ICCIDD (2001) the iodine nutrition status of the age groups 1 (9.6%) and 2 (14.5%) fall under the mild iodine deficiency category, group 3 (31.0%) fall in moderate and group 4 (51.1%) fall in severe grades of iodine deficiency as shown in Table 5(m).

Table 5(m). Prevalence of iodine deficiency in children in different age groups.

Age group	Urinary iodine concentration µg/ L					Total <100 µg/ L
	>200 µg/ L Sufficient	>100 µg/ L Normal	<100 µg/ L Mild	<50 µg/ L Moderate	<20 µg/ L Severe	
1	42 (57.5%)	24 (32.9%)	7 (9.6%)	0.0	0.0	9.6%
2	28 (45.2%)	25 (40.3%)	9 (14.5%)	0.0	0.0	14.5%
3	4 (9.5%)	25 (59.5%)	7 (16.7%)	4 (9.5%)	2 (4.8%)	31.0%
4	1 (2.3%)	20 (46.5%)	16 (37.2%)	5 (11.6%)	1(2.3%)	51.1%

The results indicated that children of the lower age groups (1 and 2) of the present study had were suffering from mild iodine deficiency while children of the higher age groups (3 and 4) were suffering from mild, moderate and as well as severe iodine deficiency.

5.19. Estimation of Urinary Iodine Excretion among boys in different age groups

The results for estimation of Urinary Iodine Excretion (UIE) among boys in different age groups of the present study have been presented in Table 5(n). The results showed that the prevalence of iodine deficiency among the boys of age groups 1, 2, 3, and 4 was 14.6%, 8.5%, 35.0% and 60.0%, respectively. According to the WHO criteria group 1 and group to 2 boys fall in mild category of iodine deficiency, while group 3 boys fall under moderate and group 4 boys had severe grades of iodine deficiency.

Table 5(n). Prevalence of iodine deficiency among boys in different age groups.

Age groups	Urinary iodine concentration μg/ L					Total
	>200 μg/ L Sufficient	>100 μg/ L Normal	<100μg/ L Mild	<50μg/ L Moderate	<20 μg/ L Severe	< 100μg/ L
1	26 (54.2%)	15 (31.2%)	7 (14.6%)	0.0	0.0	14.6%
2	24(51.1%)	19 (40.4%)	4 (8.5%)	0.0	0.0	8.5%
3	1 (5.0%)	12 (60.1%)	3 (15.0%)	2 (10.0%)	2 (10. %)	35.0%
4	0.0	6 (40.0%)	5 (33.3%)	3 (20.0%)	1 (6.7%)	60.0%

5.20. Estimation of Urinary Iodine Excretion among girls in different age groups

The results for estimation of Urinary Iodine Excretion (UIE) among girls in different age groups of the present study have been presented in table 5.(o). The results showed that the prevalence of iodine deficiency among the girls of age groups 1, 2, 3, and 4 was 0.0%, 33.3%, 28.6% and 36.4%, respectively. According to the WHO criteria group 1 girls of our study population are out of dangerous effects of iodine deficiency and no girls had severe grades of iodine deficiency.

All data of this study pointed out that the members of the new generation i.e. group 1 child (6-8 yrs of age) and especially girls (6-8 yrs) carry better nutritional status than ever before. They overcoming the effects of iodine deficient zone and reaching towards iodine sufficient state.

Table 5(o). Prevalence of iodine deficiency in children in different age group for girls.

Age groups	Urinary iodine concentration µg/ L					Total
	>200 µg/ L Sufficient	>100 µg/ L Normal	<100µg/ L Mild	<50 µg/ L Moderate	<20 µg/ L Severe	< 100µg/ L
1	16 (64.0%)	9 (34.0%)	0.0	0.0	0.0	
2	4 (26.66%)	6 (40.0%)	5 (33.33%)	0.0	0.0	33.3%
3	3 (14.28%)	12(57.1%)	4 (19.04%)	2 (9.5%)		28.6%
4	1(3.57%)	14 (50.0%)	11 (39.3%)	2 (7.1%)		36.4%

5.21. Study of the knowledge among mothers of school children about iodine nutrition in different socio economic level (Education, profession, Living Area).

The study analyzed the basis of different variable socioeconomic structure (education, profession and area of residence) of female members of the household mostly as they are directly linked with nutritional activity of its members, especially children.

The study of knowledge about the impact of Iodine in human life among mothers was conducted by administering a pre-tested questionnaire to the households in the study area through the schoolchildren and requesting them to return the questionnaire the next day to the class teacher after getting them filled by their mother. Total 500 (five hundred) questionnaire sheets were distributed in equal 250 (two hundred fifty) sheets among rural and urban mothers. 62.4% of the mothers returned the proformas, 165 (66%) from urban and 147 (58.88%) from rural some of which had only incomplete answer. In IDD, the priority group was mothers having the children's of 6 to 15 years of age.

5.22. Iodine nutritional knowledge of mother's of school children based on their educational levels.

An important factor governing the health status of a population is its education level. The level of female education is particularly important since it is women members of the household who are; in general, more directly concerned with the health of its members, especially children. The results of the study of iodine nutritional knowledge among mothers of school children's based on their educational levels under the present study has been depicted in Table 5(p).

Table 5(p). The iodine nutritional knowledge of mothers of school children's based on their educational levels.

Education	Knowledge of Iodine nutrition	
	Only goiter	Others impact
<SSC	78 (100.0%)	0
>SSC	148(90.24%)	16 (9.75%)
Graduate	49(70.0%)	21 (30.0%)
Total	275 (88.14%)	37(11.85%)

The results indicated that the knowledge level of iodine nutrition is extremely low among the mothers of school children's. Only 11.8% female having idea and rest 88.14% knew only two wards (Iodine and Goiter) regarding iodine nutrition. 83.3% of the study women are using iodized salt for cooking purpose and as table salt. Maximum of them are using it not for preventing iodine deficiency but for other reasons such as clear, purity, non-caking quality projected by salt manufacturer, attractive packing and role of media for promoting their commercial interest. The results also suggested that the international emphasis on brain damage resulting from iodine deficiency has not been conveyed successfully to the consumer level in this country (Jooste *et al.*, 2005, Zargar *et al.* 1996, Mallik *et al.*, 1998, Mohapatra 2001, Bulliyya *et al.* 2006).

The result of our study highlights the necessity of female education. We found that the knowledge of Iodine nutrition among mothers having education level higher than SSC was 16% higher than mothers below SSC and graduate mother had 5% higher knowledge than mothers having education level over SSC, as shown in Table 5(p).

5.23. Iodine nutritional knowledge among mother's of school children based on their profession.

Three hundred twelve (312) mothers having at least one school going child were purposely selected for the present study. Among 312 participating mothers 247 (79.16%) were house wife and 65 (20.83%) were working woman involved in different kind of job outside household level.

As presented in Table 5(q) in the present study, we found that the knowledge of Iodine nutrition among working mothers was nearly 2.3 fold higher (9.3% and 21.5%) than mothers who were house wives and involved in household work only. The results indicated that the different types of mutual discussion or communication among working woman enhance their nutritional knowledge. The effect of enhancing nutritional knowledge was evident from the results of the present study. With an improvement in nutritional knowledge and dietary practices, anthropometric and biochemical profile of girls improved (Kamla-Raj 2005).

Table 5(q). Iodine nutritional knowledge among mothers of school children based upon their profession.

Profession	Knowledge about iodine nutrition	
	Only goiter	Other impacts
Working	51 (78.46%)	14 (21.53%)
House wife	224 (90.68%)	23(9.32%)

5.24. Iodine nutritional knowledge among rural and urban mothers

For the purpose of this study three hundred twelve (312) mothers of the selected schools children's were included. One hundred sixty five (165) i.e. 52.9% mothers from urban areas and one hundred forty seven 147 i.e. (47.1%) mothers from rural areas participated in the study. In the present study among 165 participating urban mothers 142 (86.05%) i.e. of majority mothers knew that deficiency of iodine nutrient causes goiter only and they were unaware of the other impacts of Iodine deficiency (Table 5 (r). Only 23 .i.e. (13.95%) mothers living in the urban areas were aware of other impacts of Iodine deficiency besides having the knowledge that iodine deficiency causes goiter.

Out of 147 participating mothers from rural areas 133 .i.e. (90.47%) mothers knew that deficiency of iodine nutrient simply causes goiter only and while only 14 (9.53%) rural mothers living in the urban areas were aware of other impacts of Iodine deficiency besides having the knowledge that iodine deficiency causes goiter.

Table 5(r). Knowledge of rural and urban mothers regarding iodine nutrition

Living area	Knowledge of iodine nutrition		
	Only goiter	Others impact	Total
Urban	142 (86.05%)	23 (13.95%)	165
Rural	133 (90.47%)	14 (9.53%)	147
Total (n=312)	275 (88.14%)	37	312

5.25. Problems of USI (universal salt iodization) from the user's vision on basis of Education and living area (urban and rural).

Naturally and genetically most women of our country are closely engaged with cooking and in the distribution of foods within the family members. Therefore, women are the main users, buyers or advisors in the buying of salt. So without their opinion establishment of USI is impossible and our study results are believed to provide information and help the programmers of USI strategy.

For the purpose of this study three hundred twelve (312) mothers of the selected schools children were included having different levels of education.

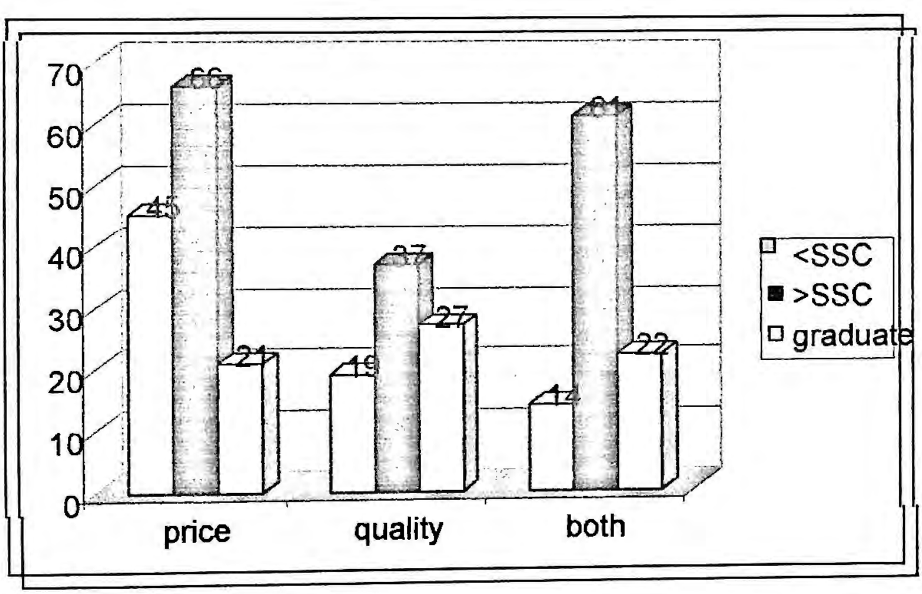
Among mothers who had an education level less than Secondary School Certificate (< SSC level) 57.7% mothers consider the higher price of iodized salt than the ordinary salt as a problem of USI, 24.3% mothers opinioned that it was the quality of salt while, 18% mothers thought that both the high price and salt quality was the problems of USI.

Among mothers having an education level higher than Higher Secondary Certificate (>HSC level) opinion regarding problems of USI were - High price of iodized salt (40.2%), the quality of salt (22.6%) and both the price and salt quality (37.2%). Mothers having graduation degrees opinioned that problem of USI were - high price of iodized salt (30.0%), the quality of salt (38.6%) and both the price and salt quality (31.4 %). Finally as problems of USI; the high price of iodized salt was mentioned by 43.3%, the quality of salt by 26.6% and both the reasons were mentioned by 31.1% of the total participants shown in Table 5(s).

Table 5(s). Education level of mothers of school children's and their opinion on problems of USI.

Education	Problem			Total
	Price of salt	Quality of salt	Both	
< SSC	45 (57.7%)	19 (24.3%)	14 (18.0%)	78 (100.0%)
>SSC	66 (40.2%)	37 (22.6%)	61 (37.2%)	164 (100.0%)
Graduate	21 (30.0%)	27 (38.6%)	22 (31.4%)	70 (100.0%)
Total	132 (42.3%)	83 (26.6%)	97 (31.1%)	312 (100.0%)

The education level of mothers of school children and their opinion on problems of USI under the present study has been graphically represented in graph 16 below:



Graph 16. Education level of mothers of school children and their opinion on problems of USI.

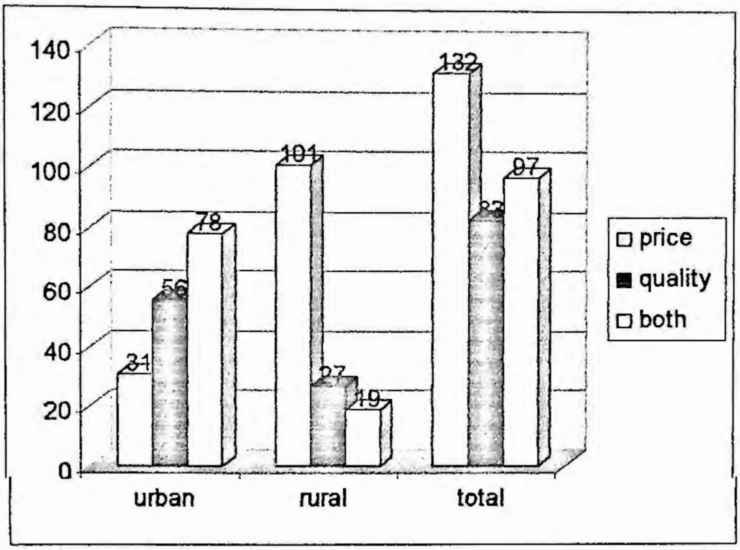
In our country more than 80% of the total populations live in rural areas. The opinion of rural as well as urban women community about iodized salt may help in implementing the program strategy of USI. In the present study, 18.8% women of the urban community opinioned that the high price of the iodized salt, which 2/3 times higher than the normal salt; is the main barrier of USI. 34% women mentioned that the problem was the quality of salt, while 47.2% women of the same community had their opinion that both the high price and salt quality were the barriers of Universal Salt Iodization as presented in Table 5 (t).

Among women living in rural areas, 68.7% held the opinion that the high price of iodized salt was the problem of USI. 18.4% women from rural community have mentioned that the problem was the quality of salt and 12.9% women opinioned that both high price and salt quality were the barriers of Universal Salt Iodization as presented in Table 5(t). The study shows the socio-economic differences between urban and rural. Finally as problems of USI; the high price of iodized salt was mentioned by 42.3%, the quality of salt by 26.6% and both the reasons were mentioned by 31.1% of the total participants as shown in Table 5(t).

Table 5(t). Problems of USI as per opinion of rural and urban mothers of school children.

Living area	Problem		
	Price of Salt	Quality of Salt	Both
Urban	31(18.8%)	56 (34.0%)	78(47.2%)
Rural	101(68.70%)	27(18.4%)	19(12.9%)
	132(42.30%)	83(26.6%)	97(31.1%)

The opinion of urban and rural mothers of school children on the problems of USI under the present study has been shown graphically in graph 17 below:



Graph 17. Opinion of urban and rural mothers of school children on problems of USI.

CHAPTER-6

DISCUSSION

6. DISCUSSION

Iodine deficiency disorder (IDD) continues to be an important public health problem in many countries and is the leading preventable cause of mental impairment worldwide (WHO/ UNICEF / ICCIDD, 1993). The consequences of iodine deficiency include severe mental retardation, goitre (a condition involving the enlargement of the thyroid gland and a disruption of normal thyroid production), hypothyroidism, abortion, stillbirths and low birth weight and mild forms of motor and cognitive deficits.

According to the latest estimates, about 2.5 billion people worldwide (38% of the world's population) have insufficient iodine intake, of which 313 million are in the South-eastern Asian region that includes Bangladesh (WHO, Iodine status world-wide 2005).Among the above population, nearly 60 million school-age children are suffering from different degrees of Iodine deficiency.

Iodine deficiency disorders (IDD) are one of the major public health problems in Bangladesh. The first National IDD Survey in 1993 revealed that a very high prevalence of total goitre (47.1%), visible goitre (8.8%), cretinism (0.5%), and biochemical iodine deficiency (68.9%) as indicated by a low urinary iodine excretion (<100 ìg/L) existed in Bangladesh (Yusuf *et al.* 1994).

A very recent survey was conducted between September 2004 and March 2005 by Yusuf *et al.* (2008) to monitor the current status of iodine deficiency disorders in children aged 6-12 years and women aged 15-44 years in Bangladesh as measured by goitre prevalence and urinary iodine excretion. In children, the total goitre rate (TGR) was 6.2%, compared to 49.9% in 1993. Prevalence of iodine deficiency (Urinary Iodine Excretion <100 ìg/L) was 33.8% in children compared to 71.0% in 1993.

The findings of the survey revealed that Bangladesh has achieved a commendable progress in reducing goitre rates and iodine deficiency among children and women ever since the universal salt iodization program was instituted 10 years ago. However, physiological iodine deficiency still persists among more than one-third of children and women.

Bangladesh thus has still a long way to go with the universal salt iodization programme to eliminate iodine deficiency. All stakeholders need to redouble their efforts in strengthening the on-going Control of Iodine Deficiency Disorders (CIDD) programme, with more vigilance in monitoring and supervision.

The Northern districts of Bangladesh i.e. Rajshahi Divisions are particularly badly affected by a high prevalence of IDD. The same parts of the country were found to be severely affected by iodine deficiency (measured as high goitre prevalent) 15 years ago (Yusuf *et al.* 1994). Dinajpur district situated in the northern part of Bangladesh, far from the sea level and is a hyper endemic iodine deficient zone as per National IDD survey report (1999). Dinajpur is often referred as the most backward regions of the country due to unequal distribution of resources. The Government of Bangladesh is officially committed to IDD elimination through national, as well as international, commitments. In an attempt to eliminate IDD as a public health problem, National and International IDD control programs has been in operation in Dinajpur as well as all the Districts of Bangladesh.

Successful implementation of the IDD control programs needs continuous monitoring and evaluation through recommended methods and indicators. Thus we undertook the present study to assess the prevalence of goiter, status of urinary iodine excretion (UIE) level and also find out the relationship of goitre prevalence with the salt intake and urinary iodine excretion. The study was, a school-based, cross-sectional one was conducted during the period of July, 2004 to June, among 1060 school children, aged 6–15 years in Dinajpur district situated in the northern part of Bangladesh, which is a hyper endemic iodine deficient zone as per National IDD survey report (1999).

As per the present study, the prevalence rate of goitre among of school going children (age 6-15 yrs.) of the study area Dinajpur, Bangladesh was 7.8 % (Grade 1 + 2 = 7.1% +0.7%). According to the Joint WHO, UNICEF and ICCIDD (1992) recommendation if more than 5 % of school children between 6 to 12 years of age suffer from goitre, the area should be classified as endemic to iodine deficiency.

Thus, our study area (Dinajpur) situated in the Northern part of Bangladesh is still endemic for iodine deficiency and the recorded prevalence rate of goitre of 7.8% indicated that the school children fall within the 'mild' category (5.0-19.9%) of Iodine deficiency as per Joint WHO / UNICEF/ ICCIDD recommendations (2001).

The results obtained for goitre prevalence rate, in the present study, can be compared with a recent study conducted by Akhil Bandhu Biswas *et al.* (2002) on Iodine deficiency disorders among school children of Malda, West Bengal, India were a total of 2,392 school children, aged 8-10 years were included and they found that the total goitre prevalence rate was 11.3% with no significant gender difference ($p>0.05$).

It is to be noted that in previous studies of IDD in school children carried out in Egypt by El-Sayed (1998), in Swaziland by Lwenje (1999) and Kalk *et al.* (1998) in South Africa and elsewhere reported higher goitre prevalence rates between 35 to 70% indicating a severe public health problem in each of the areas studied.

Even, in our neighboring Calcutta, India, Sinha (1999) after having implemented a universal iodized salt program for several years, a monitoring survey reported 23% of male school children and 32% of female school were moderately to severely iodine deficient.

The current prevalence rate of goitre of 7.8 % recorded among school going children of the area Dinajpur, Bangladesh and a recent study conducted by Akhil Bandhu Biswas *et al.* (2002) on Iodine deficiency disorders among school children of Malda, West Bengal reporting the total goitre prevalence rate of 11.3% clearly indicated that the goitre prevalence is gradually declining among school going children in Bangladesh as well as India are in a transition phase from iodine deficiency to iodine sufficiency due to the benefits of salt iodization programs and the increased awareness about the detrimental effects of iodine deficiency.

The results of goitre prevalence of the present study also demonstrated that there was a significant association between the age of school children and prevalence of goitre. The goitre prevalence is found to be lower among children belonging to the lower age group (Group 1, age 6-8 yrs) irrespective of sex. Prevalence rate was found to be increased gradually with the increases of ages of the children and among the higher age groups i.e. 3 and 4 in both sexes the goiter prevalence rate is two/three times higher than the lower age groups i.e. group 1 and 2. We also found that in children of age groups 1 and 2, goiter of grade 2 was not detected, but it was present among children of group 3 and 4 at low levels (1.1% and 1.3%).

The reason for lower prevalence of goiter observed among children of low age group of both sexes in the present study may be due to the benefits of salt iodization programs. As these children were born long after salt iodization programs had begun in Bangladesh and probably they did not suffer from maternal iodine deficiency during their mother's pregnancy (Yusuf *et al.* 2008).

For the same reasons the low incidence of goiter of grade 2 among the youngest age groups of children in the present study was because these children were born long after iodized salt was available in the market and the price became affordable to the general population. It appears that salt iodization has been effective in maintaining the prevalence of goiter specially type 2 at a very low level in children (Yusuf *et al.* 2008).

The results obtained above in the present study agree very well with the observations made by Rao *et al.* (2002) in their study on prevalence of goitre among school children in coastal Karnataka, India who have also reported that goitre rate increased with advancement of age and this was evident in boys as well as girls. Similar observations were also made by Sohal *et al* (1998), Kapil *et al.* (1997) and Chaurvedi *et al.* (1996).

The prevalence rate of 7.8% of goitre recorded in our study children falls within the 'mild' category (5.0-19.9%). Prevalence data from Bangladesh also illustrates the potential inconsistency in measurements of goiter by palpation. The increases in goiter prevalence rates reported for Bangladesh from 1981 (11.3%) to 1993 (47.1%) in 1999 17.2% and 2004-05 (6.2%) seems to be implausible (Yusuf *et al.* 2008).

In the present study, the goitre prevalence rate was higher in girls 8.6% (6.9% +1.7%) than in boys (7.3%). Female predominance of thyroid diseases noticed in the present study is consistence with almost all other previous studies conducted globally.

In a very recent study conducted by Rafiq *et al.* (2006) in their study on the prevalence of goitre in school children aged 6-12 years in district Budgam (Kashmir division) reported that goitre prevalence rate in girls was higher to an extent of 6.8% as compared to boys were it was 5.51%.

In another study conducted by Akhil Bandhu Biswas *et al.* (2002) on Iodine deficiency disorders among school children of Malda, West Bengal, India the prevalence rates of goitre in males and females, respectively, were 10.7% and 11.9%.

Ali Ahmad and coworkers (2005) in their study on Iodine status in children aged 8-11 year in Kabul, Afghanistan reported that the prevalence of goiter was higher in girls (15.2%) than in the boys (10.5%). Similarly, Nawal and coworkers (1995) while assessing the prevalence of iodine deficiency disorders among primary school children in Cairo, Egypt reported that the goitre rate was 16.2% among girls and 10.8% among boys.

The reason for the higher incidence of goitre due to physiological characteristics during puberty and quantitative dietary deficiency in females is probably due to the brief stimulation of the thyroid gland which occurs during puberty and menstruation Bhagboti (1987) The higher prevalence of goiter in girls may be due to puberty related iodine metabolism in this age (Sahu *et al.* 2004)

Very interestingly, in the present study, none of the boys had type 2 goitre but (1.7%) girls of the study population had it. Many other sociological factors exist in this region and the boy child is given preference than the girl (Abrol *et al.* 2001)

According to the present study, goitre is found to be more prevalent among Christians (Tribal) 10.5% than among Hindus (7.8%) and Muslims (7.4%). Another finding of the study was that goiter of type-2 was especially highly (3.25%) prevalent in students of Christian than in Muslims (0.13%) and in Hindus (1.3%). We also found the presence of goiter among family members of Christian students.

The above results of the present study showed good agreement with the study of Jayakrishnan and Jeeja who worked on Iodine deficiency disorders in School Children in Kannur District, Kerala, India. The prevalence rate of goitre reported was 7.67% among Hindus, 5.6% among Muslims and 14.92% among Christians. According to the study Christians in the sample were more prone to developing goitre than the other two religions (Jayakrishnan and Jeeja, 2002). Higher TGR among tribal was reported to be due to multi factorial geographical, environmental, nutritional and other hereditary factors in that study.

Our study indicated that socioeconomic status has a great importance on all kinds of nutritional levels. In our study, the percentages of total goiter prevalence among different socioeconomic level were for Rich (2.2%), for Middle class (2.3%), for Lower middle class (6.0%), for Poor (9.0%) and for Vulnerable (19.1%) (Please see Table 5(g) in the results Chapter 5 of this thesis).

The results clearly demonstrated that the prevalence rate of goiter increased gradually with the lowering of socioeconomic status. The highest goiter prevalence of 19.1% was noticed among school children of the vulnerable group while the lowest goiter prevalence of 2.2 % was observed among rich group. The results informed us that large programs on iodine are still needed in our study area (Dinajpur) particularly among the vulnerable and poor as a high percentage (19.1%) of School Children belonging to these socioeconomic groups are still suffering from Iodine deficiency disorders. Similarly, in studies performed in other countries, the frequency of goitre and malnutrition was found to be higher in children with low socio-economic status (Joshi *et al.* 1993, Stone 1984 and Knudsen *et al.* (2003).

In another study conducted in South Africa, compared to respondents from high socio-economic households, respondents from low socio-economic households were considerably less informed about aspects of iodine nutrition covered in this study. The knowledge level of iodine nutrition was low among South Africans, particularly among the low socio-economic groups (Jooste *et al.* 2005).

Data on TGR prevalence on Bangladesh also illustrates the potential inconsistency in measurements of goiter by palpation The measurements of urinary iodine has been recognized as the most common and most reliable biochemical test for assessing the iodine status of populations (May *et al.* 1997). The urinary iodine concentrations observed in the present study confirmed that the iodization program was effective and was reaching most members of the community.

In Urinary iodine estimation under the present study, a total of 220 urine samples were analyzed. Among them 130 samples were from boys and 90 from girls. The total prevalence of iodine deficiency in our study children was 23.7%. Individually, total prevalence of iodine deficiency among boys was 20.9 % and for girls that was 26.7%

The median urinary iodine excretion (UIE) of the present study children was estimated to be 159.23 μg/L, which is very close to our National median UIE reporting 163.0 μg/L among school children. In the boys median UIE was higher than girls. The median UIE for boys was 171.24 ± 67.17 μg/L (Std. deviation 67.17 and ranged between 17.0 μg/L - 292 μg/L) and for girls was 149.33 ± 62.45 μg/L (Std. deviation 62.45 and ranged between 41 μg/L -281 μg/L).

The differences in prevalence of iodine deficiency among the boys and girls under the present study were found to be statistically insignificant. The study results showed that 76.3% of the School children live in iodine sufficient environment. Total prevalence of IDD were better in boys (20.9%) than girls (26.6%) but in iodine deficiency grading

2.5% of the school boys had severe grade of iodine deficiency in the age groups 3 and 4 but among girls none had severe iodine deficiency (Table 5 (l) results chapter 5 of this thesis).

Although, the overall results of the present study, indicated mild grades of deficiency of iodine nutrition among the study population, the results varied among different age groups and the age groups 1 (9.6%) and 2 (14.5%) fall in to mild categories, group 3 (31.0%) fall in moderate and group 4 (51.1%) fall in severe grade of iodine deficiency as per WHO criteria. The status of iodine nutrition of was found to best among school children of lower the age group (Group 1, age 6-8 yrs). (Table 5 (m) results chapter 5 of this thesis).

Again in boys the prevalence of IDD in age groups 1, 2, 3, and 4 was 14.6%, 8.5%, 35.0% and 60.0%, respectively. According to the WHO criteria, members of group 1 and 2 fall in mild, group 3 in moderate and group 4 in severe grades of iodine deficiency (Table 5 (n) results chapter 5 of this thesis}.

It is to be noted that the subjects of age group 3 and 4 for boys came from poor and vulnerable class and girls from lower middle class and poor. The reason for higher incidence of moderate to severe grade of iodine deficiency among these groups was due to lack of awareness about iodine nutrition with high cost of iodized salt (3-4 times higher than non iodized open salt.) and also these children were born long before the present availability and affordable price of iodized salt and they also probably suffered from maternal iodine deficiency during the their mother's pregnancy and or for other reasons.

The present study showed that the prevalence of iodine nutritional status among girls in age groups 1, 2, 3, and 4 was 0.0%, 33.3%, 28.6% and 36.4%, respectively. According WHO criteria, good news is for us is that currently girls of 1 of our study area (Dinajpur District, Bangladesh) are out of the dangers of iodine deficiency and no girls are suffering from severe grade of iodine deficiency.

The results of this study clearly indicated that the children of new generation especially girls (6-8 yrs) carry better iodine nutritional status than ever before. They are in a transition phase from iodine deficiency to iodine sufficiency and we hope if this trend continues, after the year 2015, we will join the IDD free world.

The results of estimation of serum thyroid hormones (T_3 and T_4) of the school children in the present study showed that the median concentrations of serum T_3 and T_4 was 1.8419 ± 0.6733 nmol/L and 119.428 ± 34.9374 nmol/L, respectively (Table 5 (k) in Results chapter 5 of this thesis). The results indicated that median concentrations of serum T_3 and T_4 of the study subjets was slightly higher than the lower levels indicating marked improvement of iodine nutrition status of the population. Improving trend of biochemical indicator of iodine deficiency related coverage of iodized salt (Impacts iodine in children). Recent cohort studies described that the changes in thyroid function has been alterd after USI in school-aged children in areas of endemic goiter (Zimmermann *et al.*, 2004).

The study population in our research was from urban as well as poor rural areas. Among the rural poor, protein calorie malnutrition is very common. In Bangladesh most of the populations are living in the rural areas and rural children frequently have at least some degrees of protein calorie malnutrition. Poverty is common in the Northern part of the Bangladesh and this region is also a hyper endemic iodine deficient zone. So, a low level of serum T_3 and T_4 in the study populations is most likely due to poverty and malnutrition in this region.

Protein calorie malnutrition often present in iodine deficient areas may contribute to thyroid abnormalities. Malnutrition causes various alterations in the thyroid structures and function (Gaitan *et al.* 1983). In chronic malnutrition, as in protein-caloric malnutrition, under nutrition, in anorexia nervosa are also associated with a decreased in serum T_3 and T_4 concentrations (Ingbar and Woeber, 1981).

The mean TSH level in our study population was 2.8473 ±1.0958 mIU/L. The normal range for serum TSH is 0.40-4.80 mIU/L. Therefore, the mean TSH level of 2.8473 ±1.0958 mIU/L recorded in our study is found to be relatively within the normal limits.

Iodine deficiency disorders were widely prevalent in Indian subcontinent before the successful salt iodization programs. There has been a remarkable decline in goitre prevalence and improvement of functional thyroid status and normalization of iodine nutrition status in the community.

Goiter endemicity of varying degrees still persists among school children even a decade after successful salt iodization in Bangladesh. Goiter can also develop from high intakes of goitrogens, naturally occurring substances in foods which decrease iodine availability or interfere with its tissue utilization. Dietary sources of goitrogens include cabbage, turnips, rapeseed oil (canola oil), peanuts, cassava, and soybeans. Goitrogens are inactivated by heating, roasting or cooking (Chandra *et al.*, 2004). Some other factors like high thiocyanate exposure or auto-immune thyroid disease could be responsible for such a phenomenon (Marwaha *et al.* 2003).

Another avenue of our study was the assessment of nutritional status of the study population. Weight and height, is considered an important parameter reflecting the pattern of growth and development in a community. In the developing countries, the growing children by and large are deprived of good nutrition on account of their poor socio-economic status, ignorance and lack of health promotional facilities (UNICEF).

The mean weight and height of the boys participating in the present study was 28.17± 7.35 Kg, and 132.60± +14.31cm. The mean weight and height of the girls was 25.77± 6.25 Kg and 126.93± 11.62 cm. Boys were found to be slightly taller and heavier than the girls; however, they found to be shorter and lighter as compared to the NCHS reference data for their ages and sex.

The results of anthropometric measurement for stunting, underweight and wasting among school children in the study area revealed that stunting was present in 158

(24.7%) children among them 123 had moderate and 35 severe stunting. Under weight was detected in 201 (31.4%) children and among them 163 has moderate and 38 severe. Wasting was noticed among 86 (13.4%) children among them 74 had moderate and 12 had severe wasting.

According to the present study, the number and percentages of severe grade of stunting, underweight, wasting calculated as per WHO recommendation in boys was 19 (5.2%), 24 (6.6%), 9 (2.5%), respectively and moderate grades of stunting, underweight and wasting was 62 (17.0%), 98 (26.8%) and 48 (13.1%), respectively (graph 9).

Again, according to the present study, the number and percentages of severe grade of stunting, underweight, wasting calculated as per WHO recommendation in girls was 16 (5.8%), 14 (5.1%), 3 (1.1%), respectively and for moderate grades of stunting, underweight and wasting were 61 (22.2%), 65 (23.6%) and 26 (9.5%), respectively.

The anthropometric measurements done in our study were done separately for boys and girls. The data showed that showed that the values obtained for both sexes and in all age groups were less than the NCHS/WHO standard. The majority (73%) of the children belonged to the middle and low socio-economic class. Like TGR and IDD, the nutritional status was also found to be better in children of the new generation (6- 8 year old children).

The nutritional status among school-going children in Bangladesh is far from satisfactory despite the fact that school health programs along with other nutritional programs have been in operation in the country for the past decades. School-going children constitute a sizeable section of Bangladesh's population, i.e. about one-third of total population, which is easily accessible and also receptive. The students included from lower socioeconomic level are growing with malnutrition, cannot utilize their full potentiality; have low resistibility to infection, are less reproductive and progressive although they are the representative of major children of the study region.

Objectives of the present study was also to find out the level of iodine nutritional knowledge of mother's of school children based on their educational levels (i.e., Graduates, > SSC> and <SSC), on their profession (working women versus housewife) and area of residence (urban versus rural).

Unfortunately, these three categories below SSC, house wife and rural residence ratio are much higher in this study area and probably also all over our country and in maximum countries of the third world. The study analyzed the basis of different variables socioeconomic structure (education, profession and area of residence) of female members of the household as they are mostly directly linked with nutritional activity of its members, especially children.

The results for study of iodine nutritional knowledge among mothers of school children's based on their educational levels under the present study clearly indicated the necessity for increasing education among the females of the study area.

The knowledge of iodine nutrition existing among the mothers of school children is extremely low and only 11.85% mothers had idea about the other impacts of iodine besides goitre and the rest 88.14% mothers simply knew two words (Iodine and Goitre) and had absolutely no idea about the others impacts of iodine deficiency. Against the background of the international emphasis on brain damage, a surprisingly small percentage of respondents were aware that mental impairment might result from iodine deficiency (WHO, UNICEF, ICCIDD - 2001).

The results also demonstrated that the level of iodine nutritional knowledge about the impacts of iodine other than goitre among mothers of school children was education dependent, and the highest awareness of 30% was recorded among mothers who were comparatively highly educated *i.e* had graduation degrees; followed by an awareness level of 9.75% among mothers having educational level higher than Secondary School Certificate (>SSC) and the among mothers having educational level <SSC the awareness

level was 0% and 100% of them knew that iodine deficiency cause only goitre and none of them knew about other impacts of iodine.

Similarly in studies from the Bargarh District (Mohapatra *et al.*, 2001), in Kashmir Valley of India and from the Andaman and Nicobar Islands (Mallik *et al.*, 1998) uniformly low levels of IDD awareness in the general public have been demonstrated which appears to be barriers in eliminating IDD in the regions.

The results of the present study clearly indicated that the international emphasis on brain damage resulting from iodine deficiency has not been conveyed successfully to the consumer level in our study area. The results also showed that although 83.3% of the study women are using iodized salt for cooking purposes and as table salt and majority of them are using it not for preventing iodine deficiency but for other reasons such as clarity, purity, non-caking quality projected by salt manufacturer, nice-packing and media for promoting their commercial interest.

Similarly, in a previous study entitled "To determine the level of knowledge regarding iodine nutrition and its relationship with socio-economic status in the South African population" only 15.4% of respondents correctly identified iodized salt as the primary dietary source of iodine, 16.2% knew the thyroid gland needs iodine for its functioning, and a mere 3.9% considered brain damage, and 0.8% considered cretinism, as the most important health consequence of iodine deficiency.

To close this IDD communication gap, which appears to inhibit the transfer of this message to the consumer level, both educational and public health communication strategies are required. In Turkey, the percentage of women using iodized salt increased significantly during a 3-month regional educational mass media campaign indicating that improved IDD knowledge may lead to a more widespread consumption of iodized salt (Gamze Çan *et al.* 2001).

Among the participating mothers in the present study majority (79.16%) were house wife and 20.83% were working woman involved in different kind of job outside household level. The knowledge of Iodine nutrition among working mothers was nearly 2.3 fold higher (9.3% and 21.5%) than mothers who were house. The reason behind the increased knowledge of Iodine nutrition among working mothers than house wives could be due to different types of mutual discussion or communication among working woman enhancing their nutritional knowledge.

The present study also tried to find out the problems in purchasing iodized salt available in the market. For natural and genetic reasons most women of our country are related to cooking and distributing of prepared food and they are the head of the food sector within family. Thus they are the main users, buyers or advisors in the buying of salt. So without their opinion establishment of USI is impossible and our study results are believed to provide information's and help the programmers of USI strategy.

According to the present study, among mothers of school children having education level < SSC, 57.7% mothers considered higher price of iodized salt than the ordinary salt as a problem of USI, 24.3% mothers opinioned that it was the quality of salt while, 18% mothers thought that both the high price and salt quality was the problems of USI.

Among mothers having an education level >HSC level (40.2%) opinioned high price of iodized salt, (22.6%) the quality of salt and (37.2%) said both the price and salt quality as the barriers of USI. Mothers having graduation degrees opinioned that problem of USI were - high price of iodized salt (30.0%), the quality of salt (38.6%) and both the price and salt quality (31.4 %).

Another variable to be considered in the present study was the area of residence. In our study, more than 80% of the total populations live in rural. The opinion of rural as well as urban women community about iodized salt may help in implementing the program strategy of USI. So participation and opinion of rural women community was considered for implementation in program strategy of USI.

68.7 % of women living in rural areas said the higher price of the iodized salt (3-4 times higher than normal salt) is the main barrier of USI, while 18.8% women of the urban community mentioned this as a problem. The study result highlights socio-economic differences between urban and rural. Finally as problems of USI; the high price of iodized salt was mentioned by 42.3%, the quality of salt by 26.6% and both the reasons were mentioned by 31.1% of the total participants.

Another alarming signal for us is that maximum school teachers of the study area have very limited knowledge about Iodine deficiency and goitre though maximum of them used iodized salt (Data, not shown). During the period of study, we have interacted with various kinds of people (Riksawala, farmer, day labour, businessman, driver, shopper, service holder and others). Nearly all strongly complained that the price and quality of iodized salt was the main barrier of USI and they also said us if iodine is more essential for all what is GOB doing for the poor. Lack of awareness in the community about iodine nutrition is the main factor for persistence of the IDD prevalence even after one and half decade after introduction of iodized salt in the Bangladesh.

Raising awareness about Iodine intake amongst school students, parents, teachers as well as in the community in general is accepted to be one of the important steps to achieve the IDD free world which is a must need for the survivors . The UNICEF / WHO has extended its support for expanding awareness generation activities among school-going children in Bangladesh (UNICEF, The state of the world's children 2004) but our study team found that it is very little according to demand.

There are many constraints, and iodized salt is not reaching all target communities (due to prices, in this study 68.7 % of the rural women complain price is too much for them) in particular the most disadvantaged. In some areas, there is a plethora of small-scale salt producers for whom iodization presents technical or practical difficulties. Although monitoring is essential for ensuring the long- term success of salt iodization program, monitoring systems for salt quality and urinary iodine are often inadequate, and the result is unacceptable variations in the quality of iodized salt. Other constraints include:

a). Insufficient availability of adequate and qualitative iodized salt, especially in rural areas

b). Low awareness about the need to use iodized salt (as the only means of protection against brain damage and subsequent loss of IQ points resulting in a decreased learning capability).

c). 3-4 times higher price of iodized salt, often leads household's to choice cheaper non-iodized salt in the market.

d). Poor enforcement of legislation against the production and sale of non-iodized salt (Dishonesty of business man).

e) The absence of any standard measuring, weighting facilities and lack in monitoring record keeping and quality assurance mechanism. Also motivated involvement of producers at the time of production, properly iodized salt will be difficult to achieve in Bangladesh.

CHAPTER-7

SUMMARY AND CONCLUSION

7. SUMMARY AND CONCLUSION

Iodine deficiency disorders (IDD) are major public health problems in Bangladesh. Dinajpur district situated in the northern part of Bangladesh is a hyper endemic iodine deficient zone as per National IDD survey report (1999). To eliminate IDD as a public health problem, National and International IDD control programs have been in operation in Dinajpur as well as in all the Districts of Bangladesh. Existing program to control IDD needs to be continuously monitored through recommended methods and indicators.

Thus the present study was undertaken to assess the prevalence of goiter, status of urinary iodine excretion (UIE) level and also find out the relationship of goitre prevalence with the salt intake and urinary iodine excretion. The study was, a school-based, cross-sectional one conducted during the period of July, 2004 to June, 2008 among 1060 school children, aged 6–15 years in Dinajpur district, Bangladesh- a hyper endemic iodine deficient zone.

The research instruments were two structured containing all the variables of interest. The first questionnaire contained variables like name of the student, age, sex, weight and height (measured during interview), religion address, father's name & occupation and monthly income (to access Socio-economic status), mother's name & occupation, no. of children in the family, order of birth etc. The second questionnaire sheet to be filled up by mothers of schools children included information about knowledge of iodine nutrition on the basis of their education, profession, area of residence and also their opinion about the barriers (price, quality, both) in the establishment of the goals of USI.

Goitre was assessed by standard palpation technique; urinary iodine excretion was analyzed by wet digestion method to determine the prevalence of iodine deficiency. Blood samples were obtained from all goitrous subjects for the determination biochemical variables like total serum T_3, total serum T_4 and total serum TSH. The nutritional status of school children was evaluated according to height and weight z-scores. The prevalence of underweight, stunting and wasting were to be calculated according WHO recommended cut-off points.

The total goitre rate (TGR) of the study population was 7.8%. Goitre prevalence was higher in girls (8.6%) than in the boys (7.3%) and this difference was statistically significant ($p=0.006 < 0.05$). Goiter prevalence varied among children of different age groups and the difference was statistically significant, $p=0.03 < 0.05$. Goitre prevalence increased with the advancement of age irrespective of sex and the goitre prevalence rate in higher age children was 2/3 times higher as compared to the lower age children (6-8 yrs). In girls, grade 2 goiter was present in age groups 3 (2.8%) and group 4 (4.2%), whereas, grade 2 goiter was not detected among boys and this difference was statistically significant ($p=0.000 < 0.05$).

Nearly 71.7% of the school children intake iodized salt and is almost similar to the national data (70%). The youngest children (6-8 yrs) consumed the highest percentage (82.6%) of iodized salts on regular basis. Regular intake of iodized salt was 62.8% among boys and 84.5% among girls. The girls, therefore, were more conscious about the impact of iodine and IDD than the boys. The incidence of goitre was significantly higher ($P=0.000 < 0.05$) among subjects irregularly in taking iodized salt as compared to those regularly in taking iodized salt..

The goitre prevalence rate increased gradually with the lowering of socioeconomic status (highest 19.1%, in vulnerable and lowest 2.2 % among rich group). The differences in goitre prevalence among different socio-economie statuses was statistically highly significant ($p=0.000 < 0.05$.).

The incidence rate of goitre among Muslims, Hindus and Christians students was 7.4%, 7.8% and 10.5%, respectively and the Christians (tribals) are significantly more prone to developing goiter ($p=0.003$) than Muslims and Hindus. Prevalence of Grade 2 goitre was also significantly higher (3.25%) in Christians than Muslims (0.13%) and Hindus (1.3%). The consumption of iodized salt was highest among the Hindus and lowest goitre prevalence (7.4%) was noticed among them and this was statistically highly significant ($p=0.000< 0.05$).

The median concentrations of T_3, T_4 and TSH of the present study population was slightly higher the lower limit of normal range indicating marked improvement of iodine nutrition status of the population.

The anthropometric measurements done in our study were done separately for boys and girls. The mean weight and height of the boys was 28.17± 7.35 Kg, and 132.60± +14.31cm while the mean weight and height of the girls was 25.77± 6.25 Kg and 126.93± 11.62 cm. Boys were found to be slightly taller and heavier than the girls; however, they found to be shorter and lighter as compared to the NCHS reference data for their ages and sex.

Stunting, underweight and wasting calculated according WHO recommended cut-off points of the school children showed that stunting was present in 158 (24.7%) children. Under weight was detected in 201 (31.4%) children and wasting was noticed among 86 (13.4%) children.

The median UIE was 159.23µg/L, which is very close to our National median UIE 163.0 µg/L among school children. Median UIE was higher (171.24 ± 67.17 µg/L) in boys than girls (149.33 ± 62.45 µg/L). The total prevalence of iodine deficiency (UIE <100 µg/L) among boys and girls was 23.2%, which is a progressive evidence of USI and is less than 33.8 % (UIE < 100 µg/ L) of that reported by Yusuf *et al* (2008) in the National IDD survey 2004-05.

The total prevalence of iodine deficiency (UIE <100 µg/L) was lower in boys (20.9%) than girls (26.7%) but in goitre grading 2.5% of the school boys had severe grade of iodine deficiency in the age groups 3 and 4 while the girls are not suffering from severe grades of iodine deficiency.

As per WHO criteria 39 subjects (12 boys and 20 girls) i.e. 17.7% of the school children had mild degrees of iodine deficiency. 9 subjects (5 boys and 4 girls) i.e. 4.11% of the school children had moderate iodine deficiency while 3 subjects (all boys) had severe degree of iodine deficiency girls are out of dangerous effects of iodine deficiency and no girls had severe grades of iodine deficiency.

All data of this study clearly pointed out that the members of the new generation i.e. children's of 6-8 yrs of age and especially girls carry better iodine nutritional status than before.

The knowledge about iodine nutrition is extremely poor among mothers of school children and only 11.8% had complete idea about iodine deficiency while the rest 88.14%; simply knew two words (Iodine and goitre). The study emphasizes on the necessity of increasing female education as mothers having education level > SSC had 16% higher knowledge of Iodine nutrition than mothers having education level < SSC and graduate mother had 5% higher knowledge than mothers having education level >SSC. Knowledge of Iodine nutrition among working mothers was nearly 2-3 fold higher (9.3% and 21.5%) than mothers who were house wives. Urban mothers were comparatively better informed about iodine deficiency than rural mothers. As problems of USI; the high price of iodized salt was viewed by 42.3% mothers, the quality of salt by 26.6% and both the reasons were mentioned by 31.1% of the total participating mothers of school children.

In conclusion, in the present study, a mild goiter rate of 7.8% was found, indicating a mild iodine deficiency among the child population of Dinajpur District, Bangladesh. However, no overall biochemical iodine deficiency was observed since the median UIE of the children studied was found to be 159.23µg/L, indicating that the population of the study area Dinajpur, Bangladesh is possibly going through a transition phase from iodine-deficient to iodine- sufficient.

CHAPTER-8

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8. REFERENCES

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The news in Pakistan, Islamabad (Friday, Oct 24 2008) Pakistanis attack IDD as "silent killer".

CHAPTER-9

APPENDIX

9. APPENDIX

Questionnaire-1

Field survey of IDD

1. ID: Name:-

2. Age :- yrs Sex:- M / F

3. Religion:

Muslim	Hindu	Tribal

4. Socio economic level (SEL), *Depends on guardians profession and income.*

Rich	UM Class	LM Class	Poor	Orphanage

5. Finding Goitre By Palpitation

Yes	No

If Yes Grade

0	1	2	3

6. .History of Family goitre

Yes	No

7 Weight in Kg

Kg

8. Height in cm,

cm

9.. Iodized Salt used :

Regular	Irregular

10. Others IDD abnormalities

Yes	No

Physicians Researcher

Questionnaire-2

Field survey of Iodine nutritional knowledge among mothers

ID No:-

1. Name:- age :- yrs

2. Educational qualification:

<SSC	>SSC	Graduate

3. Profession:

House wife	Working

4. Iodine deficiency causes ::

goitre	brain damage	retardation	others impact

5. Area of residence:

Urban	Rural

6.. Salt used :

Iodized	Non Iodized.

7. Problem of Iodized. Salt used

price	Quality	both

Researcher

VALUES OF UI (URINARY IODINE) OF THE STUDY CHILDREN

Sample No	UI concentration in µg/L
1	248
2	251
3	280
4	245
5	154
6	138
7	125
8	148
9	126
10	140
11	120
12	150
13	158
14	280
15	120
16	128
17	124
18	186
19	119
20	178
21	116
22	158
23	156
24	146
25	142
26	120
27	123
28	152
29	140
30	128
31	128
32	132
33	138
34	150
35	140
36	150
37	132
38	133
39	128
40	147
41	214
42	215
43	280
44	292
45	254
46	252

47	242
48	240
49	232
50	232
51	239
52	237
53	213
54	215
55	248
56	218
57	214
58	124
59	145
60	124
61	180
62	174
63	152
64	164
65	244
66	242
67	215
68	214
69	246
70	247
71	248
72	222
73	226
74	224
75	250
76	220
77	154
78	145
79	149
80	153
81	145
82	136
83	138
84	139
85	135
86	128
87	128
88	211
89	218
90	208
91	240
92	251
93	233
94	87
95	147
96	86

97	45
98	18
99	17
100	125
101	18
102	244
103	154
104	182
105	172
106	146
107	92
108	109
109	47
110	45
111	152
112	44
113	46
114	125
115	128
116	214
117	243
118	246
119	245
120	154
121	264
122	245
123	158
124	216
125	248
126	143
127	214
128	257
129	256
130	211
131	231
132	236
133	254
134	245
135	230
136	234
137	231
138	230
139	140
140	145
141	125
142	245
143	215
144	214
145	215
146	212

147	213
148	119
149	138
150	148
151	70
152	75
153	77
154	148
155	129
156	44
157	41
158	118
159	190
160	84
161	156
162	95
163	47
164	89
165	97
166	149
167	124
168	258
169	246
170	278
171	95
172	65
173	93
174	145
175	178
176	128
177	67
178	79
179	73
180	62
181	85
182	145
183	91
184	122
185	93
186	142
187	148
188	86
189	129
190	75
191	79
192	77
193	75
194	74
195	145
196	187

197	186
198	141
199	281
200	259
201	264
202	251
203	244
204	232
205	78
206	69
207	62
208	87
209	77
210	84
211	82
212	42
213	75
214	82
215	101
216	74
217	76
218	158
219	148
220	76

VALUES OF (T_3, T_4 AND TSH CONCENTRATION).

Serial No	Concentration of Hormone		
	T_3 (nmol/L)	T_4 (nmol/L)	TSH (mIU/L)
1	2.14	121.00	3.30
2	2.50	123.00	2.40
3	2.20	95.00	3.10
4	1.98	120.00	2.20
5	1.19	89.00	3.80
6	1.45	152.00	3.30
7	1.28	146.00	1.91
8	1.00	85.00	2.77
9	1.45	111.00	3.90
10	1.00	62.00	4.10
11	1.47	115.00	4.20
12	2.20	118.00	3.44
13	1.77	92.00	3.21
14	1.49	114.00	2.34
15	1.00	63.00	2.11
16	11.00	88.00	4.50
17	1.80	105.00	1.20
18	1.69	110.00	3.45
19	2.15	167.00	2.11
20	1.50	122.00	1.78
21	1.40	93.00	3.11
22	1.97	145.00	2.99

23	1.00	68.00	4.11
24	1.00	83.00	2.56
25	1.00	64.00	5.30
26	1.90	126.00	2.33
27	2.12	145.00	1.89
28	1.30	96.00	2.88
29	1.40	101.00	3.55
30	2.78	117.00	1.80
31	1.00	70.00	5.30
32	2.45	121.00	4.20
33	2.58	130.00	2.28
34	2.30	158.00	2.84
35	3.01	175.00	2.90
36	2.98	173.00	4.12
37	2.98	169.00	1.78
38	2.67	155.00	1.87
39	2.87	156.00	2.45
40	2.47	94.00	2.31
41	2.34	134.00	2.45
42	1.00	52.00	5.10
43	1.00	68.00	4.80
44	2.98	112.00	2.24
45	1.45	98.00	2.70
46	1.66	127.00	1.78
47	1.55	186.00	.50
48	1.00	44.00	3.20
49	1.00	111.00	4.20
50	1.35	57.00	2.56
51	1.79	98.00	5.11
52	1.00	156.00	2.33
53	1.70	108.00	3.80
54	2.22	156.00	2.88
55	1.97	145.00	1.05
56	2.67	111.00	.88
57	2.86	123.00	2.12
58	1.00	143.00	3.90
59	2.88	157.00	1.38
60	2.12	158.00	1.88
61	1.76	166.00	1.89
62	3.11	144.00	2.11
63	2.89	123.00	1.78
64	1.00	159.00	1.87
65	2.35	151.00	2.45
66	1.85	133.00	2.31
67	2.10	160.00	2.45
68	1.00	71.00	4.30
69	2.00	94.00	3.60
70	1.84	178.00	2.00

THE END