Volume 4, Issue 3, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

IODINE STATUS IN ASSOCIATION WITH DIETARY INTAKE AMONG SCHOOL GOING CHILDREN (6-12 YEARS) OF DIFFERENT ETHNICITY

Arshad Ali[1], Muhammad Shahid Zafar[2,3], Ajmal Khan[1], Ayman Iqbal[4], Ukasha Munir[4], Niamatullah[*1]

[1]Department of Human Nutrition, Faculty of Nutritional Sciences, The University of Agriculture, Peshawar – 25130, Pakistan

Agricultural Products Processing Research Institute, Chinese Academy of Tropical Agricultural Sciences, Zhanjiang, Guangdong 524001, China

[3]College of Food Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, 430070, China

[4]Institute of Food Science and Nutrition University of Sargodha, 40100, Punjab, Pakistan

DOI: https://doi.org/10.5281/zenodo.18884475

Keywords
Urinary Iodine Excretion, Ethnic Group, School Going Children

Article History
Received: 06 January 2026
Accepted: 19 February 2026
Published: 06 March 2026

Corresponding Author: *
Niamatullah

Abstract
Iodine deficiency is a major public health issue in underdeveloped nations, including Pakistan. A cross sectional research was conducted in Buner district of Khyber Pukhtunkhwa (KPK) to measure the status of iodine of school going children in three diverse ethnic groups. 150 children between the ages of 6 and 12 were preferred randomly for this study. Comprising 50 children from each ethnic group i.e., Sikh, Hindu and Muslims with the inclusion criteria that they should be free from any chronic disease and not using any iodine supplements. Data on socio demographic, anthropometric and dietary intake was recorded from the children on the pre-designed questionnaire. The iodine status was determined by measuring urinary iodine excretion (UIE). Salt iodine content was measured by using rapid test kit. Palpation method was used for goiter status assessment. Study results showed that UIE of Hindu children was significantly (p<0.05) lower than Muslim and Sikh group. Iodine content in salt of Hindu group was lower than both groups where the highest iodine content in salt was assessed in Muslim group. The goiter status was non-significantly (p>0.05) different in all three groups. The iodine content in salt and dietary iodine was significantly (p < 0.05) correlated with Urinary iodine excretion of Muslim group and was non-significantly (p>0.05) positively correlated with Sikh and Hindu groups. This study concluded that ethnicity is also an associated factor in iodine level of the people through influencing the dietary intake of iodine rich food, iodize salt consumption. Therefore, should be considered in the planning for eradication of iodine insufficiency disorders.

INTRODUCTION
Iodine—a trace element of which only ~5 g meets a 70-year need—is essential for synthesising thyroid hormones (T3, T4) that drive pre- and post-natal brain development and overall metabolism (Omar & Desouky, 2015; Saira et al., 2014; Sethi & Kapil, 2004).

A healthy adult holds 15–20 mg iodine, 70–80 % of it in the thyroid "factory" that daily traps ~60 µg to replace renal losses and sustain T3/T4 secretion (Lazarus, 2015; Zimmermann, 2009).

ISSN: (e) 3007-1607 (p) 3007-1593

Inadequate iodine causes goitre, cretinism, cognitive deficits, growth retardation, neonatal hypothyroidism and higher fetal/neonatal mortality; fetal-infant neuro-development is especially vulnerable, yielding lifelong neurological and psychiatric sequelae when supply is poor during gestation and early life.

Those in severely iodine deficient areas have an intelligence quotient that is on average 12 point lower than children in iodine abundant areas (Pearce et al., 2013). Iodine status can be easily and affordably determined by testing the iodine levels in the urine. Urine is a sensitive measure of current iodine consumption and can reveal recent changes in iodine status since the majority of iodine consumed by the body is excreted in it. This indication, however does not give specific information concerning thyroid function. Although individual urine iodine content might fluctuate regularly, or even within the same day, these fluctuation tend to balance out among groups, making it is a good pointer of a population iodine position. Urinary excretion of iodine is useless for diagnosing and treating people. Because urinary iodine level, are not normally distributed. The median is the recommended measure of central tendency for data, and percentiles are more often employed to explain date distribution than standard deviation (WHO, 2013) The World Health Organization recommends a daily iodine intake of 90 µg for preschool children (0 to 59 months) and 120 µg for schoolchildren (6 to 12 years). Men and non-pregnant, non-lactating women should consume 150 µg/d More specifically, pregnant women should consume 250 µg /d, which is almost 10% more than the RDA (Zimmermann, 2009). According to the WHO, approximately 2 billion people, as well as one third of school-aged-children, are deficient in iodine. The United States of America has the lowest rate of iodine deficiency rate in the world, at 10.6%, while 90 per cent of homes use iodinated salt, the top rate in the globe. The later years of twentieth century, Europe had the uppermost prevalence of iodine deficiency (52.4%), with house iodized salt intake of 50.2 per cent, far below the required amounts. Many European countries still have ineffective IDD control efforts (Jahangir et al., 2015). Pakistan has an endemic iodine shortage, which leads to a high frequency of goiter. In 1994, a strategy to minimize incidence of iodine insufficiency disease were implemented. In Pakistan, iodizing salt is also important as per the 2009 Iodine deficiency disorder control bill, which is only partially implemented. However, it is execution is unregulated, and the success of the programmed is not regularly monitored as a result of these factors, goiters affect 20-50 percent of Pakistani schoolchildren in some places. IDD rates are greatest in Pakistan KPK region in North West Pakistan (Saifullah et al., 2018). Despite being classified as a severe iodine deficient country in 2004, Pakistan's NNS report goiter prevalence of 10.4% in mothers in 2001. 11.8% in rural and 5.8% in urban. After ten years, NNS reported in 2011 that goiter prevalence had decreased by 1.8 percent in urban areas and 3.4 percent in rural areas, indicating positive progress(Subhan et al., 2014). Urinary iodine concentration in vulnerable groups is an important indicator for the evaluation of the Universal Salt Iodization (USI) project. When it comes to vulnerable groups, median urine iodine concentrations (median UIC) vary from region to region and study. With 25% of studies demonstrating median UICs below 100 g/L and 35% demonstrating above 300 g/L, indicating low and excessive iodine intake, respectively, in pregnant women and school children, the median UIC varies from below 100 g/L to over 400 g/L. This development demonstrates the lack of a regulatory framework and monitoring system. Iodine intake that are insufficient or high have negative health impacts, according to the literature. Iodine consumption from natural foods is low since very few items are naturally iodine-rich. It is essential to increase the intake by using iodized salt. Unchecked iodine supplementation can result in high iodine ingestion through Discretionary salt consumption. To evaluate dietary intakes of iodine on a regular basis in children is crucial. In tuition centers and schools Children pass a lot of time. When they are not at

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

home, they often consume the meal of their choice. Consumption of Foods with greater levels of Tran's fat, added salt, and sweets is common in children. on a discretionary basis because they are addictive, widely promoted, easily accessible, tasty, affordable, and under peer pressure. Chips are common one among these food varieties. are the most popular and are often consumed with salt. Reliant on whether iodized salt is used in preparation or not, the iodine consumption from these meals may be high or low. (Mario et al., 2020). Iodine insufficiency is caused by either a lack of iodine in one diet or a difficulty with absorption in the body. Seafood, seaweeds and the most major dietary sources of iodine are iodized salt. although items of animal's origins, such as meat and milk, can also be a substantial source of iodine provided animals fed on iodine sufficient soils. Although insufficient nutritional intake is the primary reason, additional food known as goitrogens, such as cabbage, kale, cassava, millet and taro root, have been proposed to interfere with thyroid hormone production and use. In addition, the source of water, coexisting nutritional deficits, poor socioeconomic position, low maternal education and poor hygiene also effect status of iodine (Hassen et al., 2019). In a multicultural, ethnicity is a significant predicator of behaviour and may provide vital information regarding unique causes of iodine insufficiency and relevant technique for dealing with iodine deficiency. Iodine deficiency disease refers to the negative health consequences linked with a dietary iodine deficit. Even little iodine shortage during pregnancy might cause modest IQ and hearing impairments. The various ethnic group would have varied eating patterns cooking pattern and hence have varying iodine levels (Riley et al., 2005). Despite this, there is very little considerable research that examines iodine status in school going children of different ethnic groups. Accordingly, this study is being carried out to look at the iodine status of school-age children from various ethnic backgrounds. Our expectation was that school going children of different ethnic groups' would have different dietary intake and different salt consumption in addition they would therefore also vary in iodine status.

1.1 OBJECTIVES:

To compare the iodine status of Muslim, Sikh and Hindus school going children of district Buner

To know the dietary intake of school going children of Muslim, Sikh and Hindu children

To correlate the dietary Iodine intake of the Muslim, Sikh and Hindus school going children to the Urinary iodine excretion

I. REVIEW OF LITERATURE

Ahmad et al., (2021) evaluated the iodine and selenium levels in Pakistan's Gilgit-Baltistan region. They identified the elemental composition of salt (n = 76), drinkable water (n = 82), urine sample (n = 451), and crops cultivated locally (n = 281). They evaluated dietary intakes of salt, selenium, and iodine. The result concluded that the in crops, the median amounts of Iodine and selenium concentrations were respectively 11.5 (IQR 6.01, 23.2) and 8.81 (IQR 4.03, 27.6) g/kg and 0.24 (IQR 0.12, 0.72) and 0.27 (IQR 0.11, 0.46) g/L. The iodine concentration median of iodized salt was 4.16mg/kg (IQ 2.99, 10.8). The population's median UIE were below WHO criteria (78 g/L precise gravity modified 83 g/L). The amount of iodine in iodized salt was lower than the WHO's recommended level. Everyday selenium intakes estimated from urine selenium concentration majority (46–90%) had urine selenium concentration below the estimated average requirement. of respondents. Low amounts of selenium and iodine were found in all crops. The WHO's recommended level of iodine was not met by the minimum amount of iodine in iodized salt. The estimated population consumed more salt on average per day than the WHO recommended level iodine EAR (95 g/day) is estimated to be 49 per cent from locally accessible food and drinking water and selenium was (45 µg/day). They concluded that Residents of Gilgit Baltistan are at risk of iodine insufficiency disorders. Iodine insufficiency in the environment

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

and in the nutrition despite utilizing iodized salt. Iodine and selenium environmental standards that are important to human health are required. Sohaib et al. (2020) assessed 264 Islamabad-area schoolchildren (9–12 y) for urinary iodine excretion (UIE) and thyroid volume. Mean UIE fell below WHO thresholds; 50th and 97th-percentile thyroid volumes exceeded reference limits. Dietary iodine and household-salt iodine were both sub-standard, confirming iodine deficiency in the capital comparable to other northern Pakistani regions. Adhikari et al., (2020) conducted a research to examine the iodine Urinary Excretion and to relate urinary excretion of iodine with salt usage and other socio demographic variables of the primary school-aged household in Suryodaya municipality in Ilam district, Nepal In two schools chosen at random through a lottery procedure as the study region, study was carried out using community- based cross-sectional approch. To collect urine and salt samples for the study's measurements of the salt's iodine content and urine's iodine content, 202 schoolchildren between the ages of 6 and 12 were enrolled. Salt iodine concentrations were determined using a quick test kit (RTK) and UIC was assessed using an ammonium persulfate digestion technique. Depending on the type of data, frequency, mean SD, and median (IQR) were used to express the results. In accordance with the findings, the study's population's median urinary iodine excretion was 152.14 g/L, and 30.7% of children had urine iodine levels below the recommended WHO standard. According to rapid test kit measurement, 93.1% of salt was available that was appropriately iodized. The quantity of urine iodine excretion was statistically significantly correlated with the amount of iodine present in the ingested salt ($P< 0.05$). Wang et al., (2019) undertook this study to provide recommendations and supporting data for the next phase of iodine supplementation, as well as to review accomplishments during the last 20 years. The monitoring information of children in Shanghai from 1997, 1999, 2005, 2011, 2014, and 2017 was compiled and examined in this study. 30 townships were sampled using the - proportional-to-size probability sample method for each monitoring year. With the aid of a straightforward random selection method, one school was selected from each town. 40 children between the ages of 8 and 10 were randomly chosen from each school. Equal numbers of kids of each gender and age were enrolled. The findings indicate that between 1997 to 2017 the urinary iodine levels median were 227.5 g/L, 214.3 g/L, 198.1 g/L, 181.6 g/L, 171.4 g/L, and 183.0 g/L, respectively. The rates of goitre were 3.07, 0.40, 0.08, 0.86, and 1.90%, respectively. The median thyroid volume was, respectively, 2.9, 1.2, 2.4, 1.0, 1.8, and 2.8 mL. The median thyroid volume and goitre rate showed a linear correlation ($r = 0.95$, $P = 0.014$). Every monitoring showed a decrease in the amount of iodine in household salt ($p<0.05$). When comparing the median thyroid volume in 1999 and the MUI in 2017, there was a statistically significant difference between the various household SIC groups ($P\leq0.05$). There were no significant changes among the other studied years. They came to this conclusion that children in Shanghai have a sufficient iodine level. The health of people depends on the regular monitoring of iodine levels. Hailu et al., (2016) design a cross sectional research to know associated factors of deficiency of iodine among children of school going age. A total of 422 children were selected through random sampling technique. In this study 393 school going children were included. Urinary iodine excretion level Median was 78μg/l, and 29% of households who consumed an acceptable amount of iodized salt there were goitres in some children and suboptimal urine iodine levels in 43.5% of the children. The findings also showed that the older children 10-12 years and among the female participant had a significant incidence of iodine insufficiency. The low urinary iodine level is elevated in this area. Therefore, severe iodine deficiency is the primary public health concern today. Iodized salt intake in this region is likewise said to be low. Additionally, schoolchildren should be taken into consideration to overcome the iodine deficiency. Omar & Desouky (2015) screened 1 887 Taif school-children: goitre 7·4 %, 71 % had UIE <100 µg/L, and T3/T4 rose with iodine. Low soil/water/salt iodine at high altitude signals public-health risk; salt iodization must be monitored and enforced. The results indicated that iodine could present a potential public health risk to the Saudi Arabian schoolchildren living in high- altitude areas. In the locations concerned, the process of salt iodization should be monitored; appraised and iodized salt should be properly distributed.

II. MATERIALS AND METHODS

1.1 Study Location

This research was carried out in primary schools of two tehsil and four union councils of district Buner Khyber- pukhtoonkhwa. Muslim children were selected from two schools randomly such as one government and one private school, and for the Hindu and Sikh children those schools were selected in selected tehsil where they were studying in majority.

1.2 Study Subject and Sampling Procedures

A total of 150 school going children aged 6-12 years were selected on Probability sampling techniques for this study comprising 50 children from each ethnic group (Sikh, Hindu and Muslim). Permission was taken from the schools head before data collection. A pre- designed questionnaire was used for socio demographic information and anthropometric assessment. All the children from the selected schools has guided about the 24 hours dietary assessment a day in advance and to bring a little amount of their common household salts to test for iodine levels. A quick testing kit received from the department of human nutrition was used to determine the amount of iodine in salt. Anthropometric assessment and questionnaires was filled from the selected children and their urine samples were collected in sterilized bottles and were freeze for urinary iodine determination.

1.3 Inclusion and exclusion criteria

Primary school students who do not use iodine supplements and do not have any chronic diseases and 6 to 12 years of age were enrolled in this study. Children below 6 years of age and above 12 years of age and those did not give permission were excluded from the study.

1.4 Data Collection

Head of the schools office was visited for permission. The aim of the study and activities were discussed in details to ensure corporation in recruiting children. Questionnaire was used to collect demographic information. The dietary intake was evaluated by using 24 hours dietary recall questionnaire.

1.4.1 Anthropometric Measurements An anthropometric measurement was conducted following WHO standard procedures. Data was recorded in a pre- designed questionnaire.

Weight was recorded to 0.1 kg on a zeroed digital scale with children shoeless and pocket-empty; height was measured to 0.1 cm with a non-stretch tape against a flat wall after removal of shoes and hair ornaments. MUAC was taken to 0.1 cm at the mid-acromion–olecranon point with a plastic insertion tape, waist and hip circumferences were obtained to 0.1 cm at the midpoint between the lowest rib and iliac crest and at the maximum gluteal protrusion, respectively, and their ratio calculated (Mushtaq et al., 2011), while muscle mass, fat mass and body water percentages were generated from a digital bio-impedance analyser after entering age, weight and height.

1.4.2 Clinical assessments

For goiter assessment, the palpation technique suggested by WHO/UNICEF/IGN was followed. For all children, the presence of palpable goiter was graded as follows:

Grade 0: There is no palpable or visible goiter.

Grade I: The goiter could be detected but was not apparent only with neck in a neutral position.

Grade 2: Goiter that is palpable and visible.

Palpation examination was carried out for all children. Based on the established WHO criteria, the rate of goitre prevalence throughout the entire study area was assessed. (Organization, 2014).

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

1.4.3 Dietary intake assessment:

The dietary intake data of the respondents was evaluated by a face to face interview using a 24-hour dietary recall questionnaire. In this technique the respondent were asked to recall the previous 24 hours and the information about all food and beverages consumed in a given day was recorded. To estimate the amount of consumed food common measure such as (glass, cup and plate, etc.) (Appendix-III). and information from Pakistan Dietary Guidelines for Better Nutrition (PDBGH, 2018) was used.

The dietary intakes were then analyzed using the Nutri-Survey software for calculation of daily intake of energy and nutrients such as protein carbohydrates, fats, dietary fibres and micronutrient.

1.4.4 Salt Collection and Salt Iodine Analysis

Salt samples were collected from children for iodine content checking. Each student brought two spoons of salt from home in a clean plastic bag that was airtight. A fast field-tests kit was used to determine the iodine content of salt in each sample taken from children (MBI KITS). A stabilised starch-based solution is part of the kits. A drop of the solution was applied to a white salt tile, and the salt's iodine content was classified using a colour and expressed in parts per million (ppm) (sufficient 15 ppm).

1.5 Urinary analysis

The sample of urine was taken and handled in a sterile, iodine-free 40 mL plastic universal urine container; each child provided 15-20 mL of spot urine in screw-capped plastic bottles. A sample number was written on each bottle's label. The sample was kept in a cool box before being transported to the laboratory of the Human Nutrition and Dietetics Department at the Agriculture University of Peshawar, where it was kept at 30 °C till analysis. UIE, a well-recognized, affordable, and accessible biomarker, can be used to evaluate a population's iodine nutritional status (Ahmad, et al., 2021). For the determination of iodine Sandell- kalthoff reaction method was used. The techniques work on the oxidation-reduction principle involving solutions of ceric ammonium sulphate and arsenic acid, along with urine samples that have had ammonium per sulphate digested. Arsenic iron oxidises from As^{+3} to As^{+5} when iodine in urine interacts with ceric ammonium sulphate solution to change ceric ions into cerous ions.

Table 3.1: WHO cut-off values for iodine status

Median urinary iodine	Iodine intake	Iodine status (µg/L)
<20	Insufficient	Severe deficient
20–49	Insufficient	Moderate deficiency
50–99	Insufficient	Mild iodine deficiency
100-199	Sufficient	Adequate iodine nutrition
200–299	Above requirement	More than adequate iodine intake
≥300	Excessive	Risk of adverse health consequences

3.7 Statistical analysis

All the collected data regarding anthropomatry, clinical urinary and biochemical was checked error and cleaning was done. Analysis was done with statistical package for social science (SPSS). (Version 21). Chi square test was used for the significance in the frequencies of the different variables. Pearson correlation was used to find correlation among variables. One way ANOVA was applied for means comparison. The entire test applied were considered statistically significant at $p < 0.05$.

III. RESULTS AND DISCUSSION

One of the most essential components for the biological function of the human body is iodine, whose inadequate consumption results in iodine deficiency diseases (IDD), which have a negative impact on quality of life. Pakistan has implemented universal salt iodization in an effort to eradicate IDD, although the country still struggles with iodine inadequacy Khattak et al., 2017. This study was designed to evaluate the ethnicity impact on UIE. To measure the current iodine status of an individual, the most significant indicator is urinary iodine excretion because about 90% of the ingested iodine is excreted in urine and thus the excretion of iodine is used as a biochemical marker of iodine intake. A total of 150 school going children of aged 6 to 12 years were selected for this study. Ethnicity seeks its expression in diet, and for many individual's dietary practices reflect ethnic persuasion. Most religions have dietary norms or instructions. For some religions these precepts are very specific about what, how and when to eat or avoidance of certain foods. Sabate, 2004.

Table 4.1 Socio-demographic characteristics of the different ethnic groups

Variables	Characteristics	Mean +SD/ frequency			P- value
		Muslim	Sikh	Hindu	
Age (year)		10.43 ± 1.28	10.43 ± 1.52	9.53 ± 1.89	0.073
Gender	Male	50 (100%)	32 (64.00%)	35 (70.00%)	0.000
	Female	0 (%)	18 (36.00%)	15 (30.00%)	
Siblings		4.50 ±2.61	3.23 ±1.40	4.25 ± 1.53	0 .003
Family type	Nuclear	17 (34.00%)	20 (40.0%)	38 (76.00%)	0.000
	Joint	33 (66.00%)	30 (60.00%)	12 (24.00%)	

Table 4.1 shows the Socio-Demographics characteristics of the respondents of different ethnic groups' school going children. According to this table the mean age of the all three groups was non- significantly (p>0.05) different. Children With a mean age of 10 years were enrolled in the study. Zou et al., 2014 also reported 10 years age of their respondents who were selected for the IDD study in school going stage. This might be because of the reason that goitre measurement is a difficult indicator for iodine deficiency in school going stage, for which UIE is suitable method. Muktar et al., 2018 also selected school- age children for the assessment of iodine deficiency disorders and reported that this group is appropriate target group and due to their high vulnerability, accessibility of access, and suitability for a range of assessment tasks together. The siblings numbers was significantly (p<0.05) different among the three ethnic groups. More siblings are reported in Muslims as compare to other religions. Kramer et al., 2019 reported that Worldwide, Muslims live in the leading households, with the average Muslim individual exist in in a home of 6.4 people, followed by Hindus at 5.7. The define results are in line with our finding. The family type of the children was significantly (p<0.05) different as more children were belonging to joint family system in Muslim and Sikh community while less were from nuclear type. Hindu has a high number (76.0%) of nuclear and less (24.0%) were from joint system as shown in table 4.1. This might be because Muslim and Sikh have tradition of living jointly. In the current study the Hindu majority were from nuclear family Karmakar et al., 2019 conducted a study on knowledge, attitude, and practices (KAP) regarding iodized salt consumption and association on predominantly Hindu population they found that 67% (N=270) were from nuclear family. Another study by Lodhi et al., 2021 reported 65.5% Hindu residing in nuclear families. The findings of the aforementioned study are in line with our study.

Volume 4, Issue 3, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Table 4.2 Educational and occupational records of the parents of the different ethnic groups

Variables	Characteristics	Frequency / percent			P- value
		Muslim	Sikh	Hindu	
School type	Government	19(38.0%)	07 (14.0%)	21 (42.0%)	0.003
	Private	31 (62.0%)	43 (86.0%)	29 (58.0%)	
Father education	Primary	22 (44.0%)	25 (50.0%)	29 (58.0%)	0.295
	Matric	25(50.0%)	18 (36.0%)	18 (35.29%)	
	Bachelor	03 (6.0%)	07 (14.0%)	03(6.0%)	
Occupation	Employed	38 (76.0%)	37 (74.0%)	35 (70.0%)	0.388
	Unemployed	08 (16.0%)	06 (12.0%)	12 (24.0%)	
	Govt servants	04 (8.0%)	07 (14.0%)	03 (6.0%)	
Mother education	Primary	42 (84.0%)	42 (84.0%)	35 (70.0%)	0.142
	Matric	08 (16.0%)	05 (10.0%)	14 (28.0%)	
	Bachelor	0 (%)	03 (6.0%)	1 (2.0%)	
Occupation	None	50 (100%)	47 (94.0%)	49 (98.0%)	0.225
	Teacher	0 (%)	3 (6.0%)	1 (2.0%)	

Table 4.2 shows the educational records of the parents. According to table 4.2 high numbers of the respondents were from private school while less was from government school. No significant differences were found among parent's education of all ethnic groups. Most of the parents both fathers and mothers were primary level educated of all the studies respondents. Occupational data of mothers shows that all the mothers were house wife. Gokhale and Nuvvula, 2016 reported a study on the influences of socio economic and working status of parents on the incidence of dental caries in children and reported that most of parents were employees working on lower grade post. He further reported that 40.2% of the mothers were primary level educated. Sarah et al, 2016 reported that having basic, secondary, and tertiary education was significantly (P<0.05) correlated with good knowledge of iodized salt consumption.

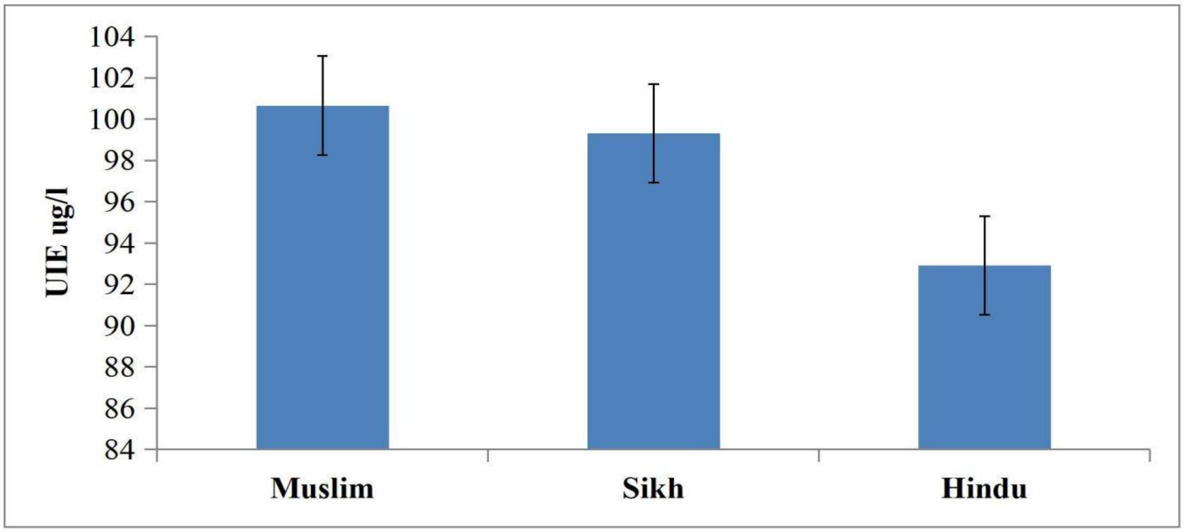

Figure 1: Urinary Iodine Excretion of Children from Three Ethnic Groups.

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

Figure 1 shows the mean differences of UIE among the different ethnic groups. According to the figure 1, the UIE was significantly different between the Muslim and Hindu and Sikh and Hindu groups, while this difference was non-significant between the Muslim and Sikh. All three ethnic groups' median urine iodine concentrations fall into the category of mild iodine insufficiency.

The lowest UIE was found in Hindu groups, where highest UIE was assessed in Muslim group. This might be because of rarely consumption of dairy product in the Hindu group. Another possible reason for this lower mean urinary iodine excretion in

Hindu group might be the low content of iodine in their salt (Figure 2).

Gyamfi et al., 2020 reported that according to WHO/ICCIDD criteria; mean UIE of 100–199 μg/L at the population level indicates adequate iodine intake and optimal nutrition whereas UIE above300 μg/L is reported as the excessive intake of iodine WHO 2013. The mean UIE of all respondents in the current study was 96 g/L, which is just below the optimal range. According to NNS 2011, the school children of Gilgit- Baltistan were mild iodine deficient another study Ahmad et al., 2021 reported that based on the UIE The population's mean urine iodine level was below WHO recommendations (uncorrected 78 g/L, specific gravity- corrected 83 g/L).. The results of the above mentioned study are in line with our findings. Severe (20 g/L), moderate (20–49 g/L), and mild (50–99 g/L) iodine deficiencies, adequate iodine level (100–199 g/L), risk of iodine-induced hyperthyroidism (200– 299 g/L), and risk of negative health effects (>300 g/L) are the four categories used to categorise iodine status. Andersson et al., 2012 Rana and Raghuvanshi, 2013 reported that iodine in salt is not enough for the eradication of IDD. Suitable intake of iodine from food is necessary as iodine is lost from food because of many cooking practices like boiling, shallow frying, deep frying and pressure cooking.

Table 4.3 Deficiency of Iodine in School Going Children of three different Ethnic groups

UIE categories	Frequency (%)			P-value
	Muslim	Sikh	Hindu	
> 100 adequate	28(56.0%)	27 (54.0%)	19 (38.0%)	.225
50-100 mild	22 (44.0%)	23 (46.0%)	31(62.0%)	

Table 4.3 show the Deficiency of iodine in school going children of three different ethnic groups. There UIE was non- significantly different in categories. As shown in table 4.3 overall 49.33% of children from the three groups were having normal urinary iodine Concentration while 50.66% of children were mild iodine deficient. From 50.66% Mild Iodine Deficient participant 62.0% were from Hindu children 46.0% were from Sikh and 44.0% were from Muslim group. The high prevalence of iodine deficiency in Hindu children might be because of the less consumption of iodized salt as shown in (figure 2) the mean salt iodine content was lower among all groups.

Table 4.4 Energy and macronutrient intake of the children's from three ethnic groups.

Variables	Mean ± SD			P- Value
	Muslim	Sikh	Hindu	
Energy (Kcal)	1172.38± 277.08	1225.46± 289.19	1153.52 ± 254.95	0.381
Fat (g)	44.03±24.46	49.92 ± 17.35	43.09 ± 22.59	0.229
Protein(g)	43.68±11.26	43.04 ±8.69	43.88 ± 12.16	0.919
Carbohydrates (g)	154.98 ± 28.69	154.13 ± 33.04	149.06± 26.13	0.612

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

Dietary fiber (g)	32.22 ±10.76	33.99 ± 12.44	33.34 ± 11.52	0.738

Kcal = kilocalories Gm. = Gram

Table 4.4 shows results on the Energy and macro-nutrient intake of the three different ethnic groups. All the ethnic groups show no differences in the intake of energy, fats, proteins, carbohydrates and dietary fibers. (P>0.05). Seid et., al conducted a study on nutrients consumption and associated factors among school going children they reported the mean energy intake of their respondent with SD was 1371.56 ± 172.47, mean Protein intake was 39.21 ± 6.51g and mean carbohydrates intake was 179.32 ± 50.56g. The results are in line with our study.

Table 4.5 Micronutrient Intake of the Different Ethnic Groups

24 hour recall	Mean / SD			P- Value
	Muslim	Sikh	Hindu	
Vitamin A (µg)	398.45± 634.19	429.49 ± 432.38	383.65 ± 547.37	0.475
Vitamin E (mg)	2.55 ±2.40[ab]	3.23 ± 3.83a	1.59 ± 2.65b	0.026
Vitamin B1 (mg)	1.13 ± 0.55a	0.90 ± 0.39b	1.12 ± 0.56a	0.043
Vitamin B2 (mg)	1.15 ± 0.92ab	0.93 ± 0.41b	1.28 ± 0.99a	0.098
Vitamin B6 (mg)	1.33 ± 0.42a	1.12 ± 0.45b	1.21 ± 0.45ab	0.072
Folic acid (µg)	292.9±181.45ab	278.42 ± 162.63b	369.74 ± 240.77a	0.046
Vitamin C (mg)	30.05 ± 33.10a	37.54 ± 40.36 a	24.53 ± 27.79a	0.158
Sodium (g)	1.92 ± 0.67a	1.67 ±0.55b	1.31 ± 0.65c	0.000
Potassium (g)	1.87± 0.63	1.92 ± 0.69	1.90 ± 0. 57	0.920
Calcium (mg)	288.21 ± 139.49b	327.69±144.61ab	355.10 ± 148.91a	0.066
Iron (mg)	14.12 ± 4.81ab	12.88 ± 4.13b	15.05 ± 5.78a	0.089
Zinc (mg)	11.58 ± 5.10a	9.13 ± 3.65b	11.55 ± 5.11a	0.011
Iodine (µg)	66.46 ± 24.11a	49.16 ± 31.39b	38.67 ± 33.64c	0.000

Mg = milligram, µg = microgram

Table 4.5 shows the mean micronutrient intake of the studied participant. A significant difference (p<0.05) was recorded for the Vitamin E, Vitamin B1, Folic acid, Sodium, zinc and iodine intake. The mean significant difference in iodine might be because of iodized salt consumption. (figure 2). Deka et al., 2015 analysed the food habits and nutritional inadequacies of teenagers. In the metropolitan areas of Uttar Pradesh's Jhansi district, a cross-sectional survey was undertaken among teenagers enrolled in schools and institution they reported the Mean calcium intake of the subjects was 454±398.62 (mg). The mean iron intake was 20±19.56 and mean Vitamin A intake was 760±551.12. Seid et al., 2018 examined nutrient intake and related variables in Dewa Cheffe District, north eastern Ethiopia, among school-age children (7-9 years). The mean calcium intake was 336.39 ± 90.56. The mean Iron intake was 15.76 ± 2.76. The mean vitamin c intake was 14.14 ± 8.25. The mean Riboflavin intake was 0.64 ± 0.4.

Swaminathan et al., (2020) cross- sectionally examine the diets of school- aged children by sex and weight status in india. The mean thiamine intake of male and female was 0.92mg and 0.89mg, mean Riboflavin intake was 0.89mg and 0.86mg, the mean Vitamin B6 intake was 1.32mg and 1.30mg, Mean folate intake was 191.0µg and 176µg and the mean iron intake was 14.7 and 13.1 respectively in male and female. The aforementioned studies are in line with our study.

Table 4.6.1 Correlation of dietary iodine with Urinary iodine excretion of the three ethnic groups

Variables	Pearson value, diet UIE
Muslim	0.334*
Sikh	0.075
Hindu	0.019

* Correlation is significant at the 0.05 level (2-tailed)

Table 4.6.1 shows the correlation of dietary iodine and UIE of the three ethnic groups. Table revealed that Muslim children shows significant relationship between their urinary iodine excretion and dietary iodine intake. Kim et al., 2019 reported that the dietary iodine intake was significantly correlated with the urinary excretion of iodine of healthy Koreans children. results shows that the dietary iodine is positively correlated with urinary iodine excretion of Sikh children. Moon et al. 1998 reported that dietary iodine intake was positively correlated with urinary iodine excretion. Rasmussen, et al. 1999 also reported the same results that in a mildly iodine deficient area, the iodine dietary intake was positively correlated with UIE.

Table 4.6.2 Correlation of salt iodine content with Urinary iodine excretion of the three ethnic groups

Variables	Pearson value Salt ,UIE
Muslim	0.366*
Sikh	0.165
Hindu	0.091

The Iodine level in salt was significantly (P0.05) correlated with urinary iodine excretion (P 0.05). of Muslim group. Iodine content of the salt consumed in Muslim household was significantly high along with significantly high urinary iodine level in the same group (Figure 1, 2). Significantly higher UIE of Muslim group might be because of their consumption of iodized salt. Shakya et al., 2015 reported a significant positive correlation between urinary iodine excretion and salt iodine content in school going children of eastern Nepal. The aforementioned studies results are in line with our findings. The salt iodine content was non- significantly ($P > 0.05$) positively correlated with UIE of Sikh and Hindu group. Iodine content of the salt consumed in Sikh household was non- significantly higher from Hindu children along with non-significantly ($P > 0.05$) higher UIE. Table 4.9 shows that 62% Hindu children were consuming iodized salt but still they have lower mean urinary iodine excretion, which might be because of their unhealthy cooking practices. Due to intensive heating iodine become volatile and lost from food. Goindi, et al. (1995) reported that some amount of iodine lost during various cooking processes. According to Wang, et al. (1999), the amount of iodine lost depends on the type of food consumed, as well as the water content of that food. The average amount of iodine lost during cooking ranges from 14% to 66%. According to Chavasit et al. 2002 high loss of iodine is caused by garlic, fresh chile, pepper, and green curry paste. Rana and Raghuvanshi 2013 reported up to 70% the cooking loss of iodine. As we know that our daily intake of the Iodine-

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

deficient foods don't satisfying iodine requirements, and iodized salt is the principal iodine source. We should therefore change our cooking methods to stop the loss of iodine during cooking.

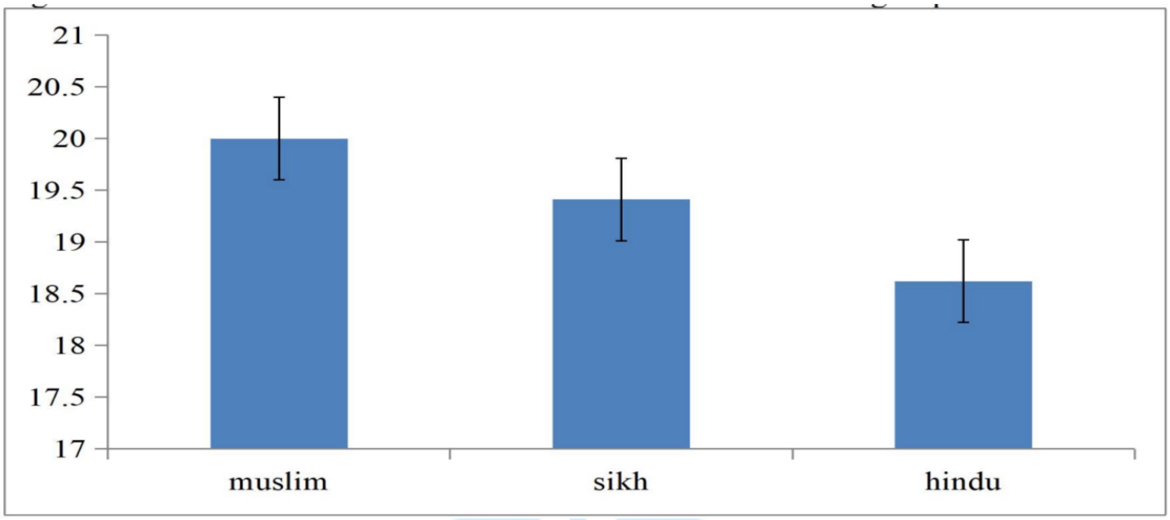

Figure 2: Iodine content in salt of the households of three ethnic groups

The iodine content of the salt, consuming by the three ethnic groups is shown in Figure 2. According to this figure, the iodine content in salt sample of the Hindu was significantly ($P<0.05$) lower then Muslim and Sikh community. This mean difference in salt might be because of the different brands of salt in the market. Dasgupta et al., 2008 observed that the amount of iodine in salt varied depending on the brand and even within a single container. Another reason for the lower content of iodine in salt samples of Hindu might be because of storage method. Storing of salt in open container effect the content of iodine Appiah, et al. 2020 reported in his study that majority (85.9%) of the women stores their salts in covered containers while the rest (14.1%) stores it in open containers. Anteneh, et al. 2017 publicized that close container had better amount of iodine content as compared to open container. Goris et al. 2018 reported that most households (65%) stored salt in uncovered container at home, and near the fire. These actions could cause a considerable iodine loss. According to aforementioned studies, the packing material, the transportation temperature; relative humidity etc. Can also affect the iodine content of salt. Moreover, during food preparation and cooking, some iodine is lost more than half of the women (57%) said they'd added salt to water for cooking, only to eliminate the salty water. An extra concern is insufficiently-iodized table salt, which may contain only minimum concentrations of iodine. Khattak, et al. 2017 publicised that iodine content of household salt was remarkably low (52% of salt sold had iodine content below the amount recommended at the household level), maybe due to non- approved packaging or a lack of knowledge about the volatile nature of iodine. According to a number of studies, household iodized salt contains insufficient amounts of iodine (in individual study, 54.5% of the salts had iodine content less than 15 ppm, and just 12.5% of all household salts had ideal iodine concentrations).

Table 4.7Distribution of the ethnic groups on the basis of iodine content in their salt

Variables	Frequency (%)			P-value
	Muslim	Sikh	Hindu	
≤ 15ppm	5 (10.0%)	11(22.0%)	19 (38.0%)	.004
>15ppm	45(90.0%)	39(78.0%)	31 (62.0%)	

Table 4.7 shows the iodized salt consumption by ethnic group. The usage of iodized salt varied significantly (p 0.05) based on the individuals' ethnicity. In all, 74.0% of people consumed iodized salt, whereas 26.0% consumed iodized salt. Verma et.al 2001 reported in his study that 76% of the subjects consumed salt with adequate iodine content. The findings of the aforementioned study are in line with our study. Iodized salt consumption was higher in Muslim group. According to table 4.7 90.0% of Muslim were consuming iodized salt while 10.0% were consuming non iodized salt. 78.0% Sikh children were consuming iodized salt while 22.0% of Sikh children were consuming non iodized salt. Non iodized salt consumption in Hindu group was high among all groups. 38.0% of Hindu children were consuming non iodized salt and 62.0% were consuming iodized salt. According to Kuay et al. (2015), 40% of school-going children have normal urine iodine excretion between 100-199 g/l, whereas 28% have ranges below normal. They claimed that a minor iodine insufficiency was caused by the salt's having low iodine level. Results of the aforementioned study are in line with our study.

Table 4.8 Anthropometric Data of The Different Ethnic Groups

Variables	MEAN ±SD			P- Value
	Muslim	Sikh	Hindu	
Weight (kg)	26.92 ± 4.93[b]	30.74 ±6.23[a]	26.82 ± 5.98[b]	0.001
Height (cm)	131.60 ± 9.66[a]	135.15 ± 10.9[a]	126.05±11.07[b]	0.000
MUAC (cm)	17.05 ± 1.65[b]	19.58 ± 3.18[a]	16.73 ±1.64[b]	0.000
WC (cm)	55.07 ± 3.99[b]	62.07 ± 8.31[a]	54.35 ± 5.59[b]	0.000
HC (cm)	62.94 ± 4.75[b]	69.64 ± 9.16[a]	60.76 ± 6.60[b]	0.000
Wt.HR	0.86 ± .043[b]	0.88 ± 0.03[a]	0.88 ± 0.03[a]	0.029
% Body water[#]	62.15 ± 2.73	60.50 ± 4.82	61.67 ± 4.20	0.107
% Body fat[##]	15.40 ± 3.35[b]	17.33 ± 5.99[a]	13.42 ± 2.81[c]	0.000
%Body muscles[###]	79.78 ± 3.5[a]	77.95 ± 5.63[b]	80.02 ± 3.66[a]	0.036

Kg= Kilogram, Cm = Centimeter, , Wt.HR = waist to hip ratio. Normal ranges #=52-66%, ## =15-29, ###=62-80

Anthropometrics data of the three ethnic groups is given in table 4.8. A significant difference ($p<0.05$) was found for all the parameters of anthropometry except the body water between the different ethnic group. According to the results Weight, MUAC, WC, HC, Body fats of the Sikh children was significantly ($p<0.05$) higher from other two groups. Higgins et al., 2019 reported that Sikh have high level of BMI, raised waists to hip ratio and highest proportion with raised waist height ratio compared to Indian Muslim and

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Hindu. Koley and Sandhu, 2005 investigated that individual of same age will vary considerably in body size and shape, individual of same height will also differ greatly in body weight. Moreover, if two subjects having same height and same weight may be treated normal but their body composition may be different. The findings of current research study resemble to the work of Asif et al., 2018 who determine the appropriate MUAC cutoff point for identifying children with high BMI by examining MUAC's ability to correctly identify children with high body mass index (BMI). The Mean height with standard deviation (SD) of male and female school going children was 138.56±15.13 (cm) and 132.43±14.83 (cm). The Mean weight of the subjects was 31.66±9.85 (kg) and 29.25±9.79 (kg). The Mean Measurement of MUAC was 17.97±2.64 (cm) and 17.49±2.52 (cm) respectively. A study from Dey and Nath, 2017 reported the Mean weight with standard deviation (SD) of girls and boys was 27.84 ± 7.54 kg and 26.07 ± 7.92 kg respectively. The mean height (with SD) of the girls was 136.64 ± 11.68 cm, whereas that of boys was 134.08 ± 12.02 cm. A study from Parveen et al., 2022 reported the average WC (cm) and HC (cm) are 49.84 ± 5.15 and 54.84 ± 5.61 respectively of their respondents. The overall mean and SD of Body Fat Percent are 20.76 ± 5.78. The define results are in line with our study.

Table 4.9 Goiter Status of The Different Ethnic Groups

Variables	Category	Frequency / percent			P-value
		Muslim	Sikh	Hindu	
Goiter	Grade 0	43 (86.0%)	41 (82.0%)	46 (92.0%)	.256
	Grade 1	5 (10.0%)	5 (10.0%)	4 (8.0%)	
	Grade 2	2 (4.0%)	4 (8.0%)	0 (%)	

Table 4.9 shows the goiter status of the three ethnic groups. According to table 4.3 the goiter status of the three groups was non-significantly ($p>0.05$) different. Overall 86.6 % (130) had no goiter. Imdad et al., 2013 reported A study on the iodine status of adolescent girl of Lahore and reported no goiter data in 78.6% (n=660) and lower median urinary iodine concentration in some of the respondent. the findings of the mentioned study are in line with our results. The prevalence of goiter indicated the nonappearance of Iodine deficiency disorders. This difference may be because urinary iodine concentrations reflect the current situation of iodine in the body, while thyroid size shows the long term iodine status. Khattak et al., 2017 estimated in his study that 50% of the population is at the risk of IDD with critical consequences on the national economy. The goiter belt of northern areas of Pakistan is one of world's most severely endemic areas, where the women and children both have high rates of goitre. In Pakistan, it is estimated that 50 million individuals suffer from iodine deficiency, either clinically or sub clinically.

IV. SUMMARY

Iodine is a micronutrient that is necessary for everyone's health and wellbeing. It considered as basic and main component of thyroid hormone and normal activity of the body. Iodine plays a significant role in the early growth and development of most organs, particularly the brain. Early brain development happens in humans during prenatal and early postnatal life. Iodine consumption needs to be in the proper range for school-age children's neurodevelopment. The participants of study were 6 to 12 year old students in the district Buner Khyber Pakhtunkhwa of different ethnic groups. A total of 150 school going children were selected from three different ethnic groups. Data regarding anthropometry, socio-demographic was Collected through a pre-designed questionnaire. Urine samples were collected by visiting schools which was randomly selected. Pre-collected Urine samples were examined using the Sandell-Kolthofs reaction, whilst salt samples were analysed using a fast test kit for iodine detection. The mean ages of the respondent from all three groups were 10 years. Urinary iodine analysis shows a significant difference in mean UIE level of the three groups which shows higher UIE in Muslim children followed by Sikh and Hindu. The mean salt iodine level shows significant ($p<0.05$) difference among the groups and lowest content of iodine in salt was examined in Hindu group while the highest was assessed in Muslim children. Clinical examination of the thyroid gland revealed that 86.6% of the study respondents had no goiter. The 24 hours data dietary recall shows a significant difference of mean intake of iodine among the group. Muslim children have more iodine intake followed by Sikh and Hindus. Salt iodine content and dietary iodine intake were significantly correlated with Urinary iodine excretion of Muslim children and positively correlated with other two groups. The finding of this study revealed that The three ethnic groups examined in this study were all classified as having a mild iodine deficiency. Comparing the Hindu group to the Muslim and Sikh groups, it was discovered that they had significantly (p0.05) lower mean urine iodine concentrations. Differences in the use of iodized salt, the main source of iodine, are the most likely cause of the observed differences in the nutrient intakes of the ethnic groups. Dietary iodine consumption comes from foods that naturally contain iodine, processed or manufactured iodine-containing foods, and iodine-containing dietary supplements and pharmaceuticals. Findings also reveal that Hindu household salt had a mean iodine level that was lower than that of Muslim and Sikh populations.

V. CONCLUSION AND RECOMMENDATIONS

6.2 Conclusion

1. Study concluded that most of the respondents was mildly iodine deficient in all the three ethnic groups.
2. The mean iodine content in the respondent's salt was lower than the recommended level.
3. No symptom of goiter was shown by any ethnic group.
4. Iodized salt and dietary iodine is significantly correlated with UIE of Muslim children and positively correlated with Sikh and Hindu children.

6.3 Recommendations

1. The fortification of iodine in salt should be assured by the food organization at industry level.
2. Government should make policies to educate the community about the importance of iodine in their daily food consumption and to advise them about the use of iodine-containing supplements among the many methods for temporarily improving children's iodine consumption is the use of appropriate.

3. ACKNOWLEDGEMENTS

First of all, I would like to thank Almighty ***Allah*** for enabling me to complete my research work. All the praises be for the ***Holy Prophet Muhammad*** ﷺ who is guidance and knowledge for humanity. I would like to thank my supervisor Dr. Niamatullah for being an ideal teacher and a mentor, offering advice and encouragement with a perfect blend of insight and humor. I'm proud of, and grateful for, my time working with him. I wish to express my sincere thanks to Dr. Zia Ud Din Chairman, Department of Human Nutrition, and Prof. Dr. Muhammad Ayub Dean, Faculty of Nutrition Sciences, The University of Agriculture Peshawar for their support and for providing me with all the necessary facilities for the research. A special thanks to Dr. Afia Zia, Dr. Muhammad Arif, Mr. Sami Ullah and Dr. Imran Khan for their precious time and suggestion during my research and Mr. Amin ur Rehman my elder brother who supported me at every moment of my life. Moreover, I am grateful to my beloved parents, family members and other relatives for their ever ending encouragement, sacrifice, moral

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

support, financial provision, blessing and their affectionate feeling to educate me. I can never forget their prayers and love. I should also thank to all my friends. They always encouraged me and were helpful during my studies and also I spent a good time with them while enjoying and sharing with them the happy and sad moments of life.

LITERATURE CITED

Adhikari, B. and Adhikari, P. 2020. Socio demographic characteristics and iodine status of the school going children of Suryodaya Municipality, Ilam. J. Food Sci. Technol. Nepal 12(12): 31-36 Ahmad, S., E. H. Bailey, M. Arshad, S. Ahmed, M. J. Watts, A. G. Stewart and S. D.Young 2021. Environmental and human iodine and selenium status: Lessons from Gilgit-Baltistan, North- East Pakistan. Environ. Geochem. Health: 43 (11): 4665-4686 Alsanosy, R.M.A., Gaffar, A.M., Khalafalla, H.E.E., Mahfouz, M.S., Zaid, A.N.S. and Bani, I.A., 2012. Current iodine nutrition status and progress toward elimination of iodine deficiency disorders in Jazan, Saudi Arabia. BMC. Public. Health. 12(1): 1-5 Andersson, M., Karumbunathan, V., & Zimmermann, M. B. 2012. Global iodine status in 2011 and trends over the past decade." J. Nutr. 142(4): 744-750.

Appiah, P. K., Yanbom, C. T., Ayanore,
M. A., & Bapula, A. 2020. Iodine content of salt use after years of universal iodization policy and knowledge on iodized salt among households in the Sissala East Municipality in Upper West Region of Ghana. J. Food Qual. 2020. 8- 16

Arif, M., J. A. Bangash and F. Khan 2006. iodine status of children (8-11 years) in district Peshawar, Pakistan. ARPN J. Agri. Bio. Sci. 6(8):1-6

Asif, M., Aslam, M. and Altaf, S., 2018. Mid-upper-arm circumference as a screening measure for identifying children with elevated body mass index: a study for Pakistan. Korean. J. Pediatr. 61(1): 6-11

Ategbo, E. A., Sankar, R., Schultink, W., van der Haar, F., & Pandav, C. S. 2008. An assessment of progress toward universal salt iodization in Rajasthan, India using iodine nutrition indicators in school-aged children and pregnant women from the same households. Asia Pac. J. Clin. Nutr.17(1): 56-62

Aweke, K. A., Adamu, B. T., Girmay, A. M., Yohannes, T., Alemnesh, Z., & Abuye, C. 2014. Iodine deficiency disorders (IDD) in burie and womberma districts, west gojjam, Ethiopia. African J. Food. Agric. Nutr. Dev. 14(4): 9167-9180

Balaji, K., Narayana, G., Sudheer, M., Hima Vani, K. V., & Padma, A. 2010. Assessment of iodine deficiency by analysing urinary iodine levels. Int. J. PharmTech. Res. 2(4): 2357-63

Bost, M., A. Martin and J. Orgiazzi 2014. Iodine deficiency: Epidemiology and nutritional prevention. Trace Elements Per Unit. 15(4): 3-7

Chavasit, V., Malaivongse, P., & Judprasong, K. 2002. Study on stability of iodine in iodated salt by use of different cooking model conditions." J. Food Compos. Anal. 15(3): 265-276.

Dasgupta, P. K., Liu, Y., & Dyke, J. V. 2008. Iodine nutrition: iodine content of iodized salt in the United States. Environ. Sci. Technol. 42(4): 1315-1323 Deka, M. K., Malhotra, A. K., Yadav, R., & Gupta, S. 2015. Dietary pattern and nutritional deficiencies among urban adolescents. J. Fam. Med. Prim. Care Rev. 4(3): 364-368

Dey, A.K. and Nath, A.B., 2017. Nutritional status of school going children (6-15 years) in a semi-urban area of Cachar District, Assam. J. Evol. Med. Dent. Sci. 6(54): 4057-4062

Diosady, L. L., Alberti, J. O., Mannar, M. V., & FitzGerald, S. (1998). Stability of iodine in iodized salt used for correction of iodine-deficiency disorders. II." Food. Nutr. Bull. 19(3): 240-250.

ISSN: (e) 3007-1607 (p) 3007-1593

Ershow, A. G., Goodman, G., Coates, P. M., & Swanson, C. A. 2016. Research needs for assessing iodine intake, iodine status, and the effects of maternal iodine supplementation. Am. J. Clin Nutr 104 (3): 941-949

Gokhale, N. and S. Nuvvula (2016). Influence of socioeconomic and working status of the parents on the incidence of their children's dental caries. J. Nat. Sci. Biol. Med. 7(2): 127-129

Goris, J. M., Temple, V. J., Zomerdijk, N., & Codling, K. 2018. Iodine status of children and knowledge, attitude, practice of iodised salt use in a remote community in Kerema district, Gulf province, Papua New Guinea. PLoS One (13): 11-22

Gyamfi, D., Wiafe, Y. A., Ofori Awuah, E., Adu, E. A., & Boadi, E. K. 2020.

Goitre prevalence and urinary iodine concentration in school-aged children in the Ashanti region of Ghana." Int. J. Endocrinol. (1): 8-16

Hailu, S., Wubshet, M., Woldie, H., & Tariku, A. 2016. Iodine deficiency and associated factors among school children: a cross-sectional study in Ethiopia. Arch. Public Health. 74(1): 1-7

Hassen, H. Y., Beyene, M., & Ali, J. H. 2019. Dietary pattern and its association with iodine deficiency among school children in southwest Ethiopia; A cross- sectional study. PloS one (8): 14-23 Higgins, V., Nazroo, J., & Brown, M. 2019. Pathways to ethnic differences in obesity: The role of migration, culture and socio-economic position in the UK. SSM. Pop. Health, (7) 94-100

Imdad, S., R. Muzaffar and M. S. Shoukat 2013. Evaluation of impact of dietary pattern on iodine and thyroid status of adolescent girls in Lahore. Biomedica. 29(3): 139-146

Jahangir, M., R. Khattak, M. Shahab, I. Tauseef and M. Khattak 2015. Prevalence of goiter and iodine nutritional status in school age children of district karak, khyber pukhtoonkhwa Pakistan. Acta. Endocrinol. 11(3):234- 239

Karmakar, N., Datta, A., Nag, K., Datta,

S. S., & Datta, S. (2019). Knowledge, attitude, and practice regarding household consumption of iodized salt among rural women of Tripura, India: A mixed-methods study. J. Educ. Health Promot. (8): 21-27

Khattak, R. M., Z. Saifullah, G. Khadija,

A. Fayyaz, S. Zaman, M. Gul, M. N. K. Khattak, B. Schauer, H. Völzke and T. Ittermann 2018. Regional influences on nutritional iodine status of pregnant women in Pakistan. Thyroid 28 (11): 1538-1546

Khattak, R.M., Khattak, M.N.K., Ittermann, T. and Völzke, H., 2017. Factors affecting sustainable iodine deficiency elimination in Pakistan: A global perspective. J. Epidemiol. 27(6): 249-257 Kim, S., Kwon, Y. S., Kim, J. Y., Hong,

K. H., & Park, Y. K. 2019. Association between iodine nutrition status and thyroid disease-related hormone in Korean adults: Korean National Health and Nutrition Examination Survey VI (2013–2015)." Nutrients. 11(11): 27-57 Koley S, Sandhu JS. 2005. An Introduction to kinanthropometry. Volume I: 1st edn. Friends Publications New Delhi, India. Kuang Kuay, L., Ahmad, N. A., Beng Chin, T., Ying Ying, C., Mahjom, M., Awaluddin, S. M., ... & Aris, T. 2022. A 10-Year Impact Evaluation of the Universal Salt Iodization (USI) Intervention in Sarawak, Malaysia, 2008–2018. Nutrients, 14(8): 1585 Lazarus, J. H. 2015. The importance of iodine in public health. Environ. Geochem. Health. 37(4): 605-618 McDonnell, C. M., Harris, M., & Zacharin, M. R. 2003. Iodine deficiency and goitre in schoolchildren in Melbourne, 2001." Med. J. Aust. 178(4): 159-162

L. Mittal, M., Tandon, M. and Raghuvanshi, R.S., 2000. Brief report. Iodine status of children and use of iodized salt in Tarai region of North India. J. Trop. Pediatr. 46(5): 300-302 Muktar, M., Roba, K. T., Mengistie, B., & Gebremichael, B. 2018. Iodine deficiency and its associated factors among primary school children in Anchar district, eastern ethiopia. Pediatric Health Med. Ther. (9): 89.95 Mushtaq, M. U., Gull, S., Abdullah, H. M., Shahid, U., Shad, M. A., & Akram, J. (2011). Prevalence and socioeconomic correlates of overweight and obesity among Pakistani primary school children. BMC Public Health. 11(1): 1-10

M. Omar, M. S. And D. E.-S. Desouky 2015. Environmental, urinary iodine status and prevalence of goitre among schoolchildren in a high altitude area of Saudi Arabia. Pak. J. Med. Sci. 31(2): 414-418

N. Parveen, M., Khurram, H., Ahmad, S., & Shehzad, M. A. 2022. Modeling of Body Mass Index, Body Fat Percentage and Body Adiposity Index for Measuring Obesity and Its Risk in School-Going Children of District Multan. Pak. Pediatr. J. 46(2): 205-210

Pearce, E. N., M. Andersson and M. B. Zimmermann 2013. Global iodine nutrition: where do we stand in 2013?. Thyroid 23(5): 523-528

Pehrsson, P.R., Patterson, K.Y., Spungen, J.H., Wirtz, M.S., Andrews, K.W., Dwyer, J.T. and Swanson, C.A., 2016. Iodine in food-and dietary supplement– composition databases. Am. J. Clin Nutr. 104(3): 868-876

Rana, R. and R. S. Raghuvanshi 2013. Effect of different cooking methods on iodine losses. J. Food Sci. Technol. 50(6): 1212-1216.

Rasmussen, L. B., L. Ovesen, I. Bülow, T. Jørgensen, N. Knudsen, P. Laurberg and H. Perrild (2002). Dietary iodine intake and urinary iodine excretion in a Danish population. effect of geography, supplements and food choice. British J. Nutr. 87(1): 61-69

Rasmussen, L. B., Ovesen, L., & Christiansen, E. 1999 Day-to-day and within-day variation in urinary iodine excretion. Eur. J. Clin. Nutr. 53(5): 401- 407.

Riley, M. D., M. A. Hamrosi and E. M. Wallace 2005. Iodine status in pregnant women living in Melbourne differs by ethnic group. Asia Pac. J. Clin. Nutr. 14(1): 27-31

Sabate, J. (2004). Religion, diet and research. Br. J. Nutr. 92(2): 199-201 Saira, S., R. Khattak, A. Rehman, A. Khan and M. Khattak 2014. prevalence of goiter and iodine status in 6-12 years school children and pregnant women of district charsadda, Pakistan Acta. Endocrinol. 10(1): 1841-1844

Sarah, N. A., Prince, A. K., Yao, A. S., Geoffrey, A. A., Wisdom, T. K., & Margaret, K. (2016). Knowledge on iodized salt use and iodine content of salt among household in the Hohoe municipality, Volta region-Ghana. Cent. Afr. j. Public Health. 2(1): 1-10 Sarkar, S., Mohanty, B., & Basu, S. 2007. Iodine deficiency in school going children of Pondicherry. Indian J. Pediatr. 74(8): 731-734

Sarwar, S. 2014. Urinary iodine levels in residents of Azad Jammu and Kashmir. J. Rawalp. Med. Coll. 18(1): 142-144

Seid, E., Derseh, L., Derso, T., Assefa, M., Gonete, K. A., & Tariku, A. 2018. Nutrient consumption and associated factors among school age children in Dewa Chefe District, northeast Ethiopia: a cross-sectional study. BMC research notes, 11(1): 1-8

Sethi, V. And U. Kapil 2004. Iodine deficiency and development of brain. The Ind. J. Pediatrics, 71(4): 325-329 Shakya, P. R., Gelal, B., Das, B. K. L., Lamsal, M., Pokharel, P. K., Nepal, A. K., ... & Baral, N. 2015. Urinary iodine excretion and thyroid function status in school age children of hilly and plain regions of Eastern Nepal. BMC. Res. Notes. 8(1): 1-9

Sohaib, M., S. Naz, M. Rafi, M. M. Chaudhry, N. Irfan and M. Tufail 2020. Nutritional status of iodine in schoolchildren of Islamabad, Pakistan: a comparison with the WHO references. Pak. J. Nucl. Med. 10(1): 20-26

Stephanie, K., Conrad, H., Anna, S. & Haley, N. 2019. Religion and living arrangements around the world. P. R. Center. (9): 61-67

Subhan, F., M. Jahangir, S. Saira, R. M. Khattak, M. Shahab, M. Haq and M. N.

K. Khattak 2014. Prevalence of goiter and iodine status among 6-12 years school age children in district Kohat, Pakistan. South East Asia J. Public Health 4(2): 42-46

L. Swaminathan, Sumathi, Sumithra Selvam, Tinku Thomas, Krishnaswamy G. Jayachitra, and Anura V. Kurpad. 2020. Dietary intakes and their association with weight status in male and female school children in South India: A cross-sectional study. Res.square. (1): 11-24

M. Venance, M. S., Martin, H. D., & Kimiywe, J. 2020. Iodine Status and Discretionary Choices Consumption Among Primary School Children, Kinondoni Tanzania. Pediatric Health Med. Ther. 11: 359-365

Verma, M., & Raghuvanshi, R. S. 2001. Dietary iodine intake and prevalence of iodine deficiency disorders in adults. J. Nutr. Environ. Med. 11(3): 175-180 Wang, G. Y., Zhou, R. H., Wang, Z., Shi, L., & Sun, M. 1999. Effects of storage and cooking on the iodine content in iodized salt and study on monitoring iodine content in iodized salt." Biomed. Environ. Sci.: BES 12(1): 1-9.

Wang, Zhengyuan, Jiajie Zang, Zhehuan Shi, Zhenni Zhu, Jun Song, Shurong Zou, Wei Jin, Xiaodong Jia, Changyi Guo, and Shoujun Liu. 2019. Iodine status of 8 to

10 years old children within 20 years following compulsory salt iodization policy in Shanghai, China. Nutr. J. 18 (1): 1-8

WHO, (2013). Urinary iodine concentrations for determining iodine status deficiency in populations. Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization.

Zimmermann, M. B. 2009. Iodine deficiency. Endocr. Rev. 30(4): 376-408 Zou, Y., Lou, X., Ding, G., Mo, Z., Zhu, W., Mao, G., & Zhou, J. 2014. An

assessment of iodine nutritional status and thyroid hormone levels in children aged 8–10 years living in Zhejiang Province, China: a cross-sectional study. Eur. J. Pediatr. 173(7): 929-934