# Effect of Nutrition Education Intervention about Iodine Deficiency Disorders and Iodized Salt Intake on Mothers performance

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## Abstract

**Background:** Iodine deficiency is the world's single greatest cause of preventable mental retardation in developing countries. **The aim** of this study was to evaluate the effect of nutrition education intervention about iodine deficiency disorders and iodized salt intake on mothers performance. A quasi-experimental design was used in this study. The study was conducted at six maternal and child health centers in Zagazig City (Shaybah Al-Nakariah, Shabanat, Bahnbay, Al-Nakhas, Shambara Al-Maimuna, and Al-Aslouji). **Sampling**: Sample composed of 125 mothers were selected randomly from maternal and child health centers. **Three** tools were used to collect the necessary data for achieving the study objective: An interviewing questionnaire to assess socio-demographic characteristics, knowledge about iodized salt and iodine deficiency disorders' scale, attitude, and practices related to iodine. **Results**: all the mothers' had got satisfactory knowledge, positive attitude and adequate practice (100%, 100%, & 99.2%) post intervention versus pre intervention( 6.4%, 20%, & 30.4%) respectively with highly statistically significant differences which continued 3 months later. Moreover, in a multivariate analysis, statistically significant independent positive predictors of the mothers' practice scores related to iodine salt and iodine deficiency disorders were their intervention, education, income, knowledge score, and attitude score. **Conclusion:** This study revealed that the educational intervention was highly statistically significant positive effect on the studied mothers' performance (knowledge, practice & attitudes). Therefore, it is **recommended** that educational nursing intervention about iodine deficiency disorders and iodized salt intake should be provided periodically and continually to all mothers attending MCH Centers by qualified health professionals.

**Key words:** Nutrition, Education, Intervention, Iodine, Salt Intake, Mothers, Iodine Deficiency Disorders, Knowledge, Practice, Attitudes.

## Introduction

Iodine Deficiency Disorder (IDD) is a significant public health problem in 130 countries affecting 740 million people, and an estimate done revealed that one third of the world's population is currently exposed to its risk. Globally, iodine deficiency (ID) is one of the fourth major nutritional deficiency disorders and is the single most common cause of preventable mental retardation and brain damage. About 2.2 billion people i.e., 38% of the world's population live in iodine-deficient areas. Although, iodine supplementation has virtually eliminated endemic goiter in the United States, the most well-known effects of IDD are visible goiter and cretinism, a condition characterized by severe brain damage occurring in very early life **(Biban & Lichiardopol, 2017).**

Iodine deficiency causes a spectrum of diseases called iodine deficiency disorders (IDD), which affect all stages of life from early pregnancy to the adult. IDDs are associated with many thyroid related diseases including mental and physical retardation (cretinism), spontaneous abortions, stillbirths, congenital abnormalities, birth defects, delayed growth and puberty, hypothyroidism, goiter, and infertility. Furthermore, the social and economic impact of IDD is significant, with iodine deficiency resulting in lower intelligence quotient, productivity and student achievement (**Eastman & Zimmermann, 2018).**

Iodine is one of the essential elements that enable the thyroid gland to produce thyroid hormones, which is vital for growth and development of the brain and central nervous system. Adequate iodine intake is important among mothers of child-bearing age, and pregnant mother who had adequate iodine

intake prior to conception, showed better status of thyroid hormones during pregnancy. A study in Italy showed that mothers who regularly consumed iodized salt for two years before conception, had better thyroid hormones status, higher urinary iodine concentrations (115 µg/L vs. 63 µg/L), and less thyroid dysfunctions (6.4% vs. 36.8%), compared to those who started consuming iodized salt from the beginning of their pregnancy **(Heidari et al., 2019).**

The community health nurses play has an influential role in imparting knowledge on the importance of iodine in fetal brain development in mothers. They work in various settings such as rural and urban community settings, maternal and child health centers and many other areas; they can utilize these opportunities to spread awareness **(Abraham, 2020)**. The nurses take an active role in ensuring that the mother and the fetus have a balanced diet during pregnancy. Nurses are in charge of giving nutrition education and counseling to mothers in order to improve their nutritional status. The nurses' main focus is on promoting a healthy diet by increasing the variety and amount of food consumed, ensuring adequate weight gain through sufficient and balanced protein and energy intake, and encouraging the use of micronutrient supplements, food supplements, or fortified foods on a consistent and ongoing basis **(Brantsæter et al., 2014).**

**Significance of the study:**

In Egypt, endemic goiter and low urinary iodine concentration have been reported in several regions, where thyroid palpation was the standard method for determining thyroid size. However, since progress is made towards elimination of iodine deficiency disorders, Ultrasonography measurement of thyroid volume is preferable to inspection and palpation for determination of goiter prevalence **(Abd El Naser et al., 2013).** Similarly**,** a study in England in 2013 showed that children born to mothers with urine iodine level of 50-150 µg/L had low IQ and cognitive function. Indeed, there is some evidence indicating that mild ID is common during pregnancy, which may result in reduced production of thyroid hormones, and consequently impaired fetal neurodevelopment. According to the World Health Organization (WHO) criteria, primary school children are at great risk, and an interventional program for prevention is crucial among them **(Bath et al., 2013).** In this study**,** mothers of reproductive age group were selected as a target group, because mothers and children are highly vulnerable to IDD. In addition, mothers are mainly responsible for household meal preparation using iodized salt (**Asfaw et al., 2020**).

**The aim of this study**

Was to evaluate the effect of nutrition education intervention about iodine deficiency disorders and iodized salt intake on mothers performance.

**<u>This was accomplished through the specific objectives:</u>**

1. Assess mothers' performance prior nutrition education intervention about iodine deficiency disorders and iodized salt intake.
2. Plan, & implement, nutrition education intervention about iodine deficiency disorders and iodized salt intake on mothers performance.
3. Evaluate effect of nutrition education intervention on mothers performance post intervention.

1.1. **Hypothesis:**

- Mother’s knowledge, practices’ and attitudes’ scores toward iodine deficiency disorders and iodized salt intake will be improved after nutrition education intervention.

**2. Subjects and Methods**

**Study design:**

A quasi-experimental design, with pre-post assessment was used.

**Study setting**:

The researchers randomly selected six (MCH) centers for the study. These centers were maternal and child health centers in Shaybah Al-Nakariah, Shabanat, Bahnbay, Al-Nakhas, Shambara Al-Maimuna, and Al-Aslouji MCH Centers.

**Subjects:**

Simple random sample was used in this study. A total of convenience sample of 125 mothers was recruited to participate in this study. Their inclusion criteria were: mother attending the MCH center for any cause as, pre, post natal care, family planning, nutrition, laboratory analyses, child immunizations, dental care, first-aid and pharmaceuticals services.

**Sample size:**

***Knowledge***: The sample size is estimated to detect the difference between the rate of satisfactory knowledge before ($p_1$=30%) and after ($p_2$=80%) the intervention **(Ansari and Khan 2016)** with a 95% level of confidence ($\alpha$ error = 5%), and a study power of 90% (β error=10%). Using the Open-Epi program for sample size of a difference between two proportions, the estimated sample size was 23 subjects.

***Practice***: The sample size is estimated to detect the difference between the rate of inadequate practice (use of non-iodized salt) before ($p_1$=25%) and after ($p_2$=8.1%) the intervention **(Ansari and Khan, 2016),** with a 95% level of confidence ($\alpha$ error = 5%), and a study power of 90% (β error=10%). Using the Open-Epi program for sample size of a difference between two proportions, the estimated sample size was 110 subjects. Therefore, the larger sample size will be used. After adjustment for a dropout rate of about 10%, the sample size was 125.

**Tools of data collection:**

**Tool (I):**. Face-to-face interview questionnaire It consisted of two parts namely;

- **Part (A):** Socio-demographic characteristics among mothers attending the Maternal and Child Health Centers as age, residence, education, job, family size, crowding index, income and sources of information.
- **Part (B):** Mother's knowledge questionnaire, to assess mother's knowledge toward ID and iodized salt intake. It included 10 questions as; benefits, required daily amount, sources, causes of deficiency, symptoms of deficiency, importance of iodized salt, sea salt iodine content, IDD in children, proper storage of iodized salt, and Iodized salt taste. It was developed by the researchers and guided by **Ansari and Khan (2016).** According to the literature, the correct responses were pre-determined and scored as follows a correct response was scored 1 and the incorrect zero. For each area of knowledge, the scores of the items were summed-up and the total divided by the number of the items, giving a mean score for the part. These scores were converted into a percent score, and means and standard deviations and medians were computed. Knowledge was considered satisfactory if the percent score was 50% or more, and unsatisfactory if less than 50%.

**Tool (II):** Mothers' attitudes Likert scale was used to assess their attitudes toward IDD and iodized salt intake. It was developed by the researchers and guided by **Ansari and Khan (2016)** as; role of media, role of healthcare providers, routine testing of sold iodized salt, role of Non-governmental organizations (NGOs), iodine deficiency is a worldwide problem; iodine deficiency is a problem in Egypt, ID and goiter, and iodine deficiency and child mental retardation**.** The responses "agree", "uncertain", and "disagree" were respectively scored 3, 2, and 1. The scoring was reversed for negative statements. The scores of the items were summed-up and the total divided by the number of the items, giving a mean score. These scores were converted into a percent score, and means and standard deviations and medians were computed. The attitude was considered positive if the percent score was 60% or more, and negative if less than 60%.

**Tool (III):** Mother's practice questionnaire related to IDD and iodized salt intake, guided by **Heidari et al. (2019).** It included seven self-reported questions categorized as: Salt purchasing and consumption habits of iodized salt, the use of iodized salt in cooking, keeping iodized salt in proper container, & properly storing, taking of iodized salt from container, add in proper time while cooking, and testing iodized salt efficiency.Their answers are scored as

following; done correctly were scored "1" and the items not done were scored. The scores of the items were summed-up and the total divided by the number of the items, giving a mean score. These scores were converted into a percent score, and means and standard deviations and medians were computed. The practice was considered adequate if the percent score was 60% or more, and inadequate if less than 60%.

**Fieldwork:**

The researchers were carried out the study in the following manner:

**Administrative and ethical considerations:**

After explaining the study's purpose, an official letter issued from the Faculty of Nursing was submitted to the competent authority of Zagazig MCH centers to obtain their approval for data collection. All ethical issues were taken into consideration during all phases of the study. After describing the study's goal, each mothers gave an informed oral consent for participation in the study. Before the commencement of the study, mothers were performed about their ability to withdraw from the study at any moment without giving any reason. During the data collecting procedure, privacy and confidentiality were respected.

**Tools development:**

The researchers made changes to the tools after reviewing recent literature.

**Tools Validity:**

A jury of three experts in Community Health Nursing from the Faculty of Nursing and Faculty of Medicine at Zagazig University assessed all of the study's tools for content validity, and proposed improvements were made.

**Tools Reliability:**

Cronbach's Alpha was used to conduct the reliability test, and the tools appeared to be reliable, where, Knowledge scale about iodine deficiency disorders and iodized salt intake was (r =0.75), attitude (r = 0.946), and practices related to iodine (r = 0.84), which indicated high internal consistency.

**Pilot study**:

Before conducting the main study, a pilot study was carried out on 15 mothers attending MCH centers who were later excluded from the main study sample. The purpose of the pilot study was to test questions about any ambiguity and feasibility of the tools. It also helped the researchers to estimate the time required to fill in the forms.

**Data collection process:**

The overall data collection process took about six months (beginning of June 2020 to end of November, 2020).

**Program:**

The educational intervention for mothers attended to the maternal and child health centers was implemented in the following stages:

**I. Assessment phase (Pre-intervention phase):**

Once permission was granted to proceed with the study, the researchers visited the study settings selected (maternal and child health centers of Zagazig City) and explained the aim of the study to the participated mothrs. The researchers usually started by introducing themselves to mothers, explaining the study's aim and nature briefly, and reassured them that information obtained will be treated is strictly confidential and would not be used for any purposes other than research.

**II. Planning phase:**

Based on a literature review, characteristics of the sample and the results obtained from the assessment phase, the researchers prepared the intervention sessions' content. As well, they designed an illustrated learning booklet, and its content was proved and then distributed to mothers attending the maternal and child health centers to be used as a guide for self-learning. The researchers established the sessions stressed the awareness on iodine deficiency disorders, the importance of proper storage and consumption of iodized salt. The educational intervention for the studied subjects was performed according to the following steps:

**a. Setting the program objectives**

- **General objective:** To increase knowledge as well as positive attitude and practice of mothers attending the MCH centers on IDD and iodized salt intake to prevent mental and physical retardation (cretinism), spontaneous abortions, stillbirths, congenital abnormalities, birth defects, delayed growth and puberty, hypothyroidism, goiter, and infertility.
- **Specific objectives: after implementation the current** study, the mothers attending the maternal and child health centers should be able to:
  - Enumerate the benefits and importance of iodized salt
  - Describe the required daily amount of iodized salt intake
  - Discuss the sources of iodized salt intake.
  - List the causes of deficiency.
  - Enumerate the symptoms of deficiency
  - Discuss the iodine deficiency in children
  - Explain the safe proper storage of iodized salt
  - Motivate the mothers positive attitudes regarding iodine salt intake.
  - Discuss the purchase iodized salt, use iodized salt in cooking, and consumption of iodized salt

**b. Preparation of the content**

The researchers prepared the nutritional educational intervention's material needed to meet all of the stated goals, based on studies of recent relevant researches, pre-assessment results, and mothers' characteristics.

**III. Implementation phase:**

All mothers were subjected to the health education intervention. The message was delivered using a question-and-answer approach to ensure the participation of all MCH centers. Sessions focused on improving mothers' knowledge, practice and attitudes of iodine deficiency disorders and iodized salt utilization. Additionally, safe, proper storage, and consumption of iodized salt practices and proper practice of iodized salt in cooking for the prevention of iodine deficiency disorders, A PowerPoint presentation supported this, followed by a group discussion about the contents. In addition, the researchers helped mothers gain KPA from feedback. Also, brochures with attractive images and simple, clear text were distributed in a booklet as a guidance to be referred to after the intervention. The intervention was implemented in three theoretical sessions and one practical session in each MCH Center. The total theoretical sessions was 18 sessions and six practical sessions.

**IV. Evaluation phase:**

This stage was done twice; after one month (July, 2020) and three months later (November, 2021) of the health education intervention using the same tools. The program efficiency improvement of mothers KAP of iodine deficiency disorders and iodized salt utilization was estimated by comparison of the variances between pre-, post-, and follow up tests and mean total scores.

**Statistical Design**

Data entry and statistical analysis were done using the statistical package for social science (SPSS) 20.0 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations and medians for quantitative variables. Cronbach alpha coefficient was calculated to assess the reliability of the developed tools through their internal consistency. Quantitative continuous data were compared using paired t-test for dependent groups. The non-parametric Mann-Whitney or Kruskal-Wallis tests were used for independent group comparisons. Qualitative categorical variables were compared using Chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables was less than 5, Fisher exact test was used instead. Spearman rank correlation was used for assessment of the inter-relationships among quantitative variables and ranked ones. In order to identify the independent predictors of knowledge, attitude, and practice scores, multiple linear regression analysis was used and analysis of variance for the full regression models was done. Statistical significance was considered at p-value $<0.05$, which highly

statistical significance was considered at P-value <0.001.

## Result

Table (1) shows socio-demographic characteristics of mothers, the mean age of the mothers is 30.6±7.6 ranged between 18-54 years. In addition, 50.4% of subjects were from rural areas. Moreover, 44.8% of them have secondary education, 72.0% are housewives, also, and 69.6% of mothers are having family size 2-4 children. As well, for 56.0% of mothers had crowding index <2, and 70.4% of them had sufficient income.

Table (2) describes awareness of iodized salt and sources of information among mothers, 33.6% of them were having awareness of iodized salt, and the highest source of information regarding iodized salt was internet followed by radio/TV.

Table (3) explains that there were highly statistically significant differences in benefits of iodine, required daily amount, sources, causes of deficiency, symptoms of deficiency, importance of iodized salt, sea salt iodine content, iodine deficiency in children, proper storage of iodized salt, and iodized salt taste at p-value <0.001. The total score of their satisfactory knowledge increased from 6.4% in pre-sessions' implementation to 100% in post and follow-up intervention.

Table (4) shows that there were highly statistically significant differences in all domains of attitudes regarding iodine among mothers throughout study phases at p-value <0.001. The total level of positive attitudes increased from 20.0% in pre-sessions implementation to 99.2% in post and follow-up interventions.

Table (5) portrays that there were highly statistically significant differences in practices related to iodine among mothers throughout study phases. All practice items p<0.001 except purchasing iodine salt. Additionally, the total adequate practice significantly improved from 30.4% in pre-intervention to 100.0 in post and follow- up interventions (P<0.001).

Table (6) describes that there were highly statistically significant differences in mothers' mean scores of knowledge, attitude, and practice at post-pre and FU-pre difference (P<0.001).

Table (7) illustrates that there were statistically significant differences in relations between mother's pre-intervention scores of knowledge and education, job, income and aware of iodized salt at P=0.05.

Table (8) presents that there were highly statistically relations between mother's pre-intervention mean scores of attitude and education, job, income and aware of iodized salt (P<0.001).

Table (9) explains that there were statistically relations between mothers pre-intervention mean scores of practice and education, job, income and aware of iodized salt.

Table (10) describes that mothers knowledge score pre-intervention had statistically significant correlation with attitude (.615), practice (.342), age (.179), education (.496), and income (.268). Significant differences correlation were detected between mothers' attitude scores pre-intervention (.414), education (.595), and income (.318), and significant correlation between practice score pre-intervention, education (.389), and income (.355). Meanwhile, mother's knowledge score post-intervention had statistically significant correlation with attitude (.741), practice (.638), education (.869) and income (.439), their attitude scores post-intervention with practice education and income. In the same way, follow up score among knowledge, attitude and practice (.866), (.750), (.654) respectively had statistically significant differences with practice, education, and income (.406), (272), (428) respectively.

Concerning the mothers perception of the factors influencing their knowledge score to iodine salt, table 11 reveals that their intervention, age, education, and aware of iodized salts score were statistically significant independent positive predictors of this score. The model explains 0.95% of the variation in this score, whereas none of the other mothers' characteristics had a significant influence on it.

In a multivariate analysis, table (12) shows that statistically significant independent positive predictors of the mothers attitude

scores related to iodine salt were their intervention, education, and knowledge score. Conversely, their urban residence was a negative predictor. The model explains 0.90% of the variation in this score, whereas none of the other mothers characteristics had a significant influence on it.

Concerning the mothers perception of the factors influencing their practice score to iodine salt, table 13 describes that the intervention, education, income, knowledge score, and attitude score were statistically significant independent positive predictors of this score. The model explains 0.86% of the variation in this score, whereas none of the other mothers' characteristics had a significant influence on it.

**Table 1:** Frequency and Percentage of Socio-Demographic Characteristics of mothers under study (n=125)

| Socio-demographic characteristics | Frequency | Percent |
|---|---|---|
| **Age:** | | |
| **<30** | 65 | **52.0** |
| **30+** | 60 | **48.0** |
| **Range** | **18-54** | |
| **Mean±SD** | **30.6±7.6** | |
| **Median** | **29.0** | |
| **Residence:** | | |
| **Rural** | 63 | **50.4** |
| **Urban** | 62 | **49.6** |
| **Education:** | | |
| **Basic** | 18 | **14.4** |
| **Secondary** | 56 | **44.8** |
| **University** | 51 | **40.8** |
| **Job:** | | |
| **Working** | 35 | **28.0** |
| **Housewife** | 90 | **72.0** |
| **Family size:** | | |
| **2-4** | 87 | **69.6** |
| **5+** | 38 | **30.4** |
| **Range** | **2-7** | |
| **Mean±SD** | **4.0±1.0** | |
| **Median** | **4.0** | |
| **Crowding index:** | | |
| **<2** | 70 | **56.0** |
| **2+** | 55 | **44.0** |
| **Income:** | | |
| **Insufficient** | 37 | **29.6** |
| **Sufficient** | **88** | **70.4** |

**Table 2:** Awareness of Iodized Salt and Sources of Information among Mothers in the Study Sample (n=125)

| Sources of information | Frequency | Percent |
|---|---|---|
| **Aware of Iodized salt** | | |
| **No** | 83 | **66.4** |
| **Yes** | 42 | **33.6** |
| **Sources of information (n=42):@** | | |
| **Radio/TV** | 14 | **33.3** |
| **Friends/relatives** | 5 | **11.9** |
| **Internet** | 19 | **45.2** |
| **Health staff** | 6 | **14.3** |
| **Others** | **10** | **23.8** |

*(@) Not mutually exclusive*

**Table 3:** Statistical Differences of Knowledge about Iodine Salt and Iodine Deficiency Disorders among Mothers throughout Study Phases

| Knowledge of Iodine | Study phases | | | | | | $X^2$ (p-value) Pre-post | $X^2$ (p-value) Pre-FU |
|---|---|---|---|---|---|---|---|---|
| | Pre | | Post | | FU | | | |
| | No. | % | No. | % | No. | % | | |
| **Benefits** | 43 | 34.4 | 125 | 100.0 | 125 | 100.0 | 122.02 (<0.001*) | **122.02 (<0.001*)** |
| **Required daily amount** | 7 | 5.6 | 125 | 100.0 | 125 | 100.0 | 223.48 (<0.001*) | **223.48 (<0.001*)** |
| **Sources** | 39 | 31.2 | 125 | 100.0 | 125 | 100.0 | 131.10 (<0.001*) | **131.10 (<0.001*)** |
| **Causes of deficiency** | 5 | 4.0 | 122 | 97.6 | 122 | 97.6 | 219.08 (<0.001*) | **219.08 (<0.001*)** |
| **Symptoms of deficiency** | 43 | 34.4 | 125 | 100.0 | 125 | 100.0 | 122.02 (<0.001*) | **122.02 (<0.001*)** |
| **Importance of Iodized salt** | 38 | 30.4 | 125 | 100.0 | 125 | 100.0 | 133.44 (<0.001*) | **133.44 (<0.001*)** |
| **Sea salt iodine content** | 7 | 5.6 | 119 | 95.2 | 116 | 92.8 | 200.72 (<0.001*) | **190.14 (<0.001*)** |
| **Iodine deficiency in children** | 21 | 16.8 | 125 | 100.0 | 125 | 100.0 | 178.08 (<0.001*) | **178.08 (<0.001*)** |
| **Proper storage of iodized salt** | 13 | 10.4 | 121 | 96.8 | 120 | 96.0 | 187.60 (<0.001*) | **183.94 (<0.001*)** |
| **Iodized salt taste** | 11 | 8.8 | 123 | 98.4 | 123 | 98.4 | 201.75 (<0.001*) | **201.75 (<0.001*)** |
| **Total knowledge:** | | | | | | | | |
| **Satisfactory** | 8 | 6.4 | 125 | 100.0 | 125 | 100.0 | 219.92 | **219.92** |
| **Unsatisfactory** | **117** | **93.6** | **0** | **0.0** | **0** | **0.0** | **(<0.001*)** | **(<0.001*)** |

*Highly statistically significant at p<0.001*

**Table 4:** Statistical Differences of Attitudes Regarding Iodine salt and Iodine Deficiency Disorders among Mothers throughout Study Phases

| Attitudes | Study phases | | | | | | $X^2$ (p-value) Pre-post | $X^2$ (p-value) Pre-FU |
|---|---|---|---|---|---|---|---|---|
| | Pre | | Post | | FU | | | |
| | No. | % | No. | % | No. | % | | |
| **Role of media:** | | | | | | | | |
| **Agree** | 11 | 8.8 | 1 | 0.8 | 1 | 0.8 | | |
| **Uncertain** | 106 | 84.8 | 19 | 15.2 | 22 | 17.6 | 152.15 | **143.79** |
| **Disagree** | 8 | 6.4 | 105 | 84.0 | 102 | 81.6 | (<0.001*) | **(<0.001*)** |
| **Role of healthcare providers:** | | | | | | | | |
| **Agree** | 3 | 2.4 | 0 | 0.0 | 0 | 0.0 | | |
| **Uncertain** | 84 | 67.2 | 2 | 1.6 | 2 | 1.6 | 126.06 | **126.06** |
| **Disagree** | 38 | 30.4 | 123 | 98.4 | 123 | 98.4 | (<0.001*) | **(<0.001*)** |
| **Routine testing of sold iodized salt:** | | | | | | | | |
| **Agree** | 24 | 19.2 | 2 | 1.6 | 3 | 2.4 | | |
| **Uncertain** | 101 | 80.8 | 41 | 32.8 | 41 | 32.8 | 125.97 | **122.69** |
| **Disagree** | 0 | 0.0 | 82 | 65.6 | 81 | 64.8 | (<0.001*) | **(<0.001*)** |
| **Role of NGOs:** | | | | | | | | |
| **Agree** | 11 | 8.8 | 1 | 0.8 | 1 | 0.8 | | |
| **Uncertain** | 110 | 88.0 | 18 | 14.4 | 18 | 14.4 | 169.04 | **169.04** |
| **Disagree** | 4 | 3.2 | 106 | 84.8 | 106 | 84.8 | (<0.001*) | **(<0.001*)** |
| **Iodine deficiency is a worldwide problem:** | | | | | | | | |
| **Agree** | 20 | 16.0 | 0 | 0.0 | 1 | 0.8 | | |
| **Uncertain** | 105 | 84.0 | 24 | 19.2 | 22 | 17.6 | 171.86 | **173.43** |
| **Disagree** | 0 | 0.0 | 101 | 80.8 | 102 | 81.6 | (<0.001*) | **(<0.001*)** |
| **Iodine deficiency is a problem in Egypt:** | | | | | | | | |
| **Agree** | 5 | 4.0 | 0 | 0.0 | 0 | 0.0 | | |
| **Uncertain** | 112 | 89.6 | 5 | 4.0 | 5 | 4.0 | 200.85 | **200.85** |
| **Disagree** | 8 | 6.4 | 120 | 96.0 | 120 | 96.0 | (<0.001*) | **(<0.001*)** |
| **Iodine deficiency and goiter:** | | | | | | | | |
| **Agree** | 0 | 0.0 | 0 | 0.0 | 1 | 0.8 | | |
| **Uncertain** | 98 | 78.4 | 0 | 0.0 | 0 | 0.0 | 161.18 | **161.31** |
| **Disagree** | 27 | 21.6 | 125 | 100.0 | 124 | 99.2 | (<0.001*) | **(<0.001*)** |
| **Iodine deficiency and child mental retardation:** | | | | | | | | |
| **Uncertain** | 114 | 91.2 | 2 | 1.6 | 2 | 1.6 | 201.75 | **201.75** |
| **Disagree** | 11 | 8.8 | 123 | 98.4 | 123 | 98.4 | (<0.001*) | **(<0.001*)** |
| **Total attitude:** | | | | | | | | |
| **Positive** | 25 | 20.0 | 124 | 99.2 | 124 | 99.2 | 162.82 | **162.82** |
| **Negative** | **100** | **80.0** | **1** | **0.8** | **1** | **0.8** | **(<0.001*)** | **(<0.001*)** |

*Highly statistically significant at p<0.001*

**Table 5:** Practices Related to Iodine Salt and Iodine Deficiency Disorders among Mothers Throughout Study Phases

| Practices | Study phases | | | | | | $X^2$ (p-value) Pre-post | $X^2$ (p-value) Pre-FU |
|---|---|---|---|---|---|---|---|---|
| | Pre | | Post | | FU | | | |
| | No. | % | No. | % | No. | % | | |
| **Purchase iodized salt** | 122 | 97.6 | 125 | 100.0 | 125 | 100.0 | Fisher (0.25) | **Fisher (0.25)** |
| **Use iodized salt in cooking** | 123 | 98.4 | 125 | 100.0 | 125 | 100.0 | Fisher (0.50) | **Fisher (0.50)** |
| **Keep iodized salt in proper container** | 56 | 44.8 | 124 | 99.2 | 124 | 99.2 | 91.75 (<0.001*) | **91.75 (<0.001*)** |
| **Properly store iodized salt** | 70 | 56.0 | 122 | 97.6 | 122 | 97.6 | 60.70 (<0.001*) | **60.70 (<0.001*)** |
| **Proper intake of iodized salt from container** | 54 | 43.2 | 122 | 97.6 | 121 | 96.8 | 88.76 (<0.001*) | **85.50 (<0.001*)** |
| **Add iodized salt in proper time while cooking** | 15 | 12.0 | 119 | 95.2 | 117 | 93.6 | 173.96 (<0.001*) | **166.99 (<0.001*)** |
| **Testing iodized salt efficiency** | 36 | 28.8 | 125 | 100.0 | 125 | 100.0 | 138.20 (<0.001*) | **138.20 (<0.001*)** |
| **Total practice:** | | | | | | | | |
| **Adequate** | 38 | 30.4 | 125 | 100.0 | 125 | 100.0 | 133.44 | **133.44** |
| **Inadequate** | **87** | **69.6** | **0** | **0.0** | **0** | **0.0** | **(<0.001*)** | **(<0.001*)** |

*(*) Statistically significant at p<0.05*

**Table 6:** Comparison in Mothers Knowledge, Attitude, and Practice mean scores Throughout Study Phases

| Variables | Post-pre difference | | | Paired t-test | p-value |
|---|---|---|---|---|---|
| | Range | Mean±SD | Median | | |
| **Knowledge:** | | | | | |
| **Post-pre** | 3.0-14.0 | 10.8±2.9 | 12.00 | 41.64 | **<0.001*** |
| **FU-pre** | 3.0-14.0 | 10.7±3.0 | 11.00 | 40.44 | **<0.001*** |
| **Attitude:** | | | | | |
| **Post-pre** | 1.0-13.0 | 6.8±2.4 | 7.00 | 31.84 | **<0.001*** |
| **FU-pre** | 1.0-13.0 | 6.8±2.4 | 7.00 | 31.35 | **<0.001*** |
| **Practice:** | | | | | |
| **Post-pre** | 0.0-7.0 | 3.8±1.5 | 4.00 | 28.14 | **<0.001*** |
| **FU-pre** | **0.0-7.0** | **3.8±1.5** | **4.00** | **28.45** | **<0.001*** |

*(*) Statistically significant at p<0.05*

**Table 7:** Relation Between the studied Mothers Pre-Intervention mean Scores of Knowledge and Their Characteristics

| Variables | Knowledge score (max=14) | | Mann Whitney test | p-value |
|---|---|---|---|---|
| | Mean±SD | Median | | |
| **Age:** | | | | |
| **<30** | 1.4±5.1 | 0.00 | | |
| **30+** | 2.3±8.7 | 0.00 | 3.45 | **0.06** |
| **Residence:** | | | | |
| **Rural** | 1.8±7.7 | 0.00 | | |
| **Urban** | 1.8±6.5 | 0.00 | 0.04 | **0.84** |
| **Education:** | | | | |
| **Basic** | 0.0±0.0 | 0.00 | | |
| **Secondary** | 1.1±4.6 | 0.00 | H=30.73 | **<0.001*** |
| **University** | 3.3±8.3 | 4.00 | | |
| **Job:** | | | | |
| **Working** | 3.0±3.0 | 4.00 | | |
| **Housewife** | 1.4±2.4 | 0.00 | 9.84 | **0.002*** |
| **Family size:** | | | | |
| **2-4** | 1.7±2.6 | 0.00 | | |
| **5+** | 2.0±2.7 | 0.00 | 0.29 | **0.59** |
| **Crowding index:** | | | | |
| **<2** | 1.9±2.7 | 0.00 | | |
| **2+** | 1.7±2.6 | 0.00 | 0.28 | **0.60** |
| **Income:** | | | | |
| **Insufficient** | 0.8±2.0 | 0.00 | | |
| **Sufficient** | 2.3±2.8 | 0.00 | 8.01 | **0.005*** |
| **Aware of Iodized salt** | | | | |
| **No** | 0.1±0.5 | 0.00 | | |
| **Yes** | **5.2±1.7** | **5.00** | **111.41** | **<0.001*** |

*(*) Statistically significant at p<0.05* *(H) Kruskal Wallis test*

**Table 8:** Relation between the studied mothers pre-intervention mean Scores of Attitude and Their Characteristics

| Variables | Attitude score (max=24) | | Mann Whitney test | p-value |
|---|---|---|---|---|
| | Mean±SD | Median | | |
| **Age:** | | | | |
| **<30** | 16.1±2.1 | 16.00 | | |
| **30+** | 16.3±1.9 | 16.00 | 0.85 | **0.36** |
| **Residence:** | | | | |
| **Rural** | 16.2±2.1 | 16.00 | | |
| **Urban** | 16.1±1.9 | 16.00 | 0.19 | **0.66** |
| **Education:** | | | | |
| **Basic** | 13.4±1.8 | 13.00 | | |
| **Secondary** | 16.1±1.7 | 16.00 | H=47.71 | **<0.001*** |
| **University** | 17.3±1.3 | 17.00 | | |
| **Job:** | | | | |
| **Working** | 16.9±2.1 | 17.00 | | |
| **Housewife** | 15.9±1.9 | 16.00 | 9.16 | **0.002*** |
| **Family size:** | | | | |
| **2-4** | 16.1±1.9 | 16.00 | | |
| **5+** | 16.3±2.2 | 17.00 | 1.23 | **0.27** |
| **Crowding index:** | | | | |
| **<2** | 16.4±1.9 | 16.00 | | |
| **2+** | 15.9±2.1 | 16.00 | 1.30 | **0.25** |
| **Income:** | | | | |
| **Insufficient** | 15.2±2.3 | 16.00 | | |
| **Sufficient** | 16.6±1.7 | 16.00 | 11.50 | **0.001*** |
| **Aware of Iodized salt** | | | | |
| **No** | 15.4±1.8 | 16.00 | | |
| **Yes** | **17.7±1.4** | **17.00** | **45.51** | **<0.001*** |

*(*) Statistically significant at p<0.05* *(H) Kruskal Wallis test*

**Table 9:** Relations Between Mothers' Pre-Intervention mean Scores of Practice and Their Characteristics

| Items | Practice score (max=7) | | Mann Whitney test | p-value |
|---|---|---|---|---|
| | Mean±SD | Median | | |
| **Age:** | | | | |
| **<30** | 3.8±1.2 | 4.00 | | |
| **30+** | 3.8±1.5 | 4.00 | 0.02 | **0.88** |
| **Residence:** | | | | |
| **Rural** | 3.7±1.3 | 4.00 | | |
| **Urban** | 4.0±1.4 | 4.00 | 1.57 | **0.21** |
| **Education:** | | | | |
| **Basic** | 2.6±1.1 | 2.00 | | |
| **Secondary** | 3.8±1.3 | 4.00 | H=21.47 | **<0.001*** |
| **University** | 4.3±1.2 | 4.00 | | |
| **Job:** | | | | |
| **Working** | 4.2±1.4 | 4.00 | | |
| **Housewife** | 3.6±1.3 | 4.00 | 4.10 | **0.04*** |
| **Family size:** | | | | |
| **2-4** | 3.8±1.3 | 4.00 | | |
| **5+** | 3.8±1.5 | 4.00 | 0.06 | **0.81** |
| **Crowding index:** | | | | |
| **<2** | 3.9±1.4 | 4.00 | | |
| **2+** | 3.7±1.2 | 4.00 | 0.81 | **0.37** |
| **Income:** | | | | |
| **Insufficient** | 3.2±1.3 | 3.00 | | |
| **Sufficient** | 4.1±1.3 | 4.00 | 11.53 | **0.001*** |
| **Aware of Iodized salt** | | | | |
| **No** | 3.5±1.3 | 3.00 | | |
| **Yes** | **4.5±1.2** | **4.50** | **15.19** | **<0.001*** |

*(*) Statistically significant at p<0.05* *(H) Kruskal Wallis test*

**Table 10:** Correlations between Mothers Knowledge, Attitude, and Practice Scores and Their Characteristics Throughout Intervention phases

| Variables | Spearman's rank correlation coefficient | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pre (n=125) | | | Post (n=125) | | | FU (n=125) | | |
| | Knowledge | Attitude | Practice | Knowledge | Attitude | Practice | Knowledge | Attitude | Practice |
| **Knowledge** | 1.000 | | | 1.000 | | | 1.000 | | |
| **Attitude** | .615** | 1.000 | | .741** | 1.000 | | .711** | 1.000 | |
| **Practice** | .342** | .414** | 1.000 | .638** | .607** | 1.000 | .642** | .621** | **1.000** |
| **Characteristics:** | | | | | | | | | |
| **Age** | .179* | .085 | -.014 | .098 | .031 | -.071 | .114 | .073 | **-.029** |
| **Education** | .496** | .595** | .389** | .869** | .747** | .623** | .866** | .750** | **.654**** |
| **Family size** | .081 | .086 | -.078 | .060 | .103 | -.032 | .047 | .113 | **-.013** |
| **Crowding index** | -.047 | -.102 | -.081 | -.131 | -.072 | -.145 | -.106 | -.071 | **-.112** |
| **Income** | **.268**** | **.318**** | **.355**** | **.439**** | **.250**** | **.413**** | **.406**** | **.272**** | **.428**** |

*(*) Statistically significant at p<0.05* *(**) Statistically significant at p<0.01*

**Table 11:** Best Fitting Multiple Linear Regression Model for the Knowledge Score

| Items | Unstandardized Coefficients | | Standardized Coefficients | t-test | p-value | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | | | | Lower | Upper |
| **Constant** | -2.39 | 0.39 | | -6.195 | <0.001 | -3.15 | **-1.63** |
| **Intervention** | 10.74 | 0.13 | 0.93 | 81.426 | <0.001 | 10.48 | **11.00** |
| **Age** | 0.01 | 0.01 | 0.02 | 1.676 | 0.095 | 0.00 | **0.03** |
| **Education** | 0.97 | 0.08 | 0.16 | 12.493 | <0.001 | 0.82 | **1.12** |
| **Aware of iodized salt** | **2.14** | **0.15** | **0.19** | **14.123** | **<0.001** | **1.84** | **2.44** |

r-square=0.95 Model ANOVA: F=1828.24, p<0.001
Variables entered and excluded: job, residence, family size, crowding index, income

**Table 12:** Best Fitting Multiple Linear Regression Model for the Attitude Score

| Items | Unstandardized Coefficients | | Standardized Coefficients | t-test | p-value | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | | | | Lower | Upper |
| **Constant** | 13.12 | 0.29 | | 45.663 | <0.001 | 12.55 | **13.68** |
| **Intervention** | 4.50 | 0.43 | 0.59 | 10.486 | <0.001 | 3.66 | **5.35** |
| **Urban residence** | -0.25 | 0.12 | -0.03 | -2.092 | 0.037 | -0.48 | **-0.01** |
| **Education** | 0.96 | 0.08 | 0.24 | 11.268 | <0.001 | 0.79 | **1.12** |
| **Knowledge score** | **0.22** | **0.04** | **0.33** | **5.689** | **<0.001** | **0.14** | **0.29** |

r-square=0.90 Model ANOVA: F=877.97, p<0.001
Variables entered and excluded: age, job, family size, crowding index, income, awareness

**Table 13:** Best fitting multiple linear regression model for the practice score

| | Unstandardized Coefficients | | Standardized Coefficients | t-test | p-value | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | | | | Lower | Upper |
| **Constant** | .23 | .49 | | .468 | .640 | -.73 | **1.19** |
| **Intervention** | 2.35 | .33 | .54 | 7.060 | <0.001 | 1.69 | **3.00** |
| **Education** | .29 | .07 | .13 | 4.268 | <0.001 | .16 | **.42** |
| **Income** | .22 | .07 | .06 | 2.978 | .003 | .08 | **.37** |
| **Knowledge score** | .05 | .03 | .14 | 1.994 | .047 | .00 | **.11** |
| **Attitude score** | **.13** | **.04** | **.24** | **3.816** | **<0.001** | **.06** | **.20** |

r-square=0.86 Model ANOVA: F=467.82, p<0.001
Variables entered and excluded: age, job, residence, family size, crowding index, awareness

## Discussion

Iodine is a trace element (micronutrient) which plays a vital role in synthesis of thyroid hormones**.** Two billion people worldwide including 285 million children have Iodine Deficiency (ID). Iodine comprises 65% of thyroxin (T4) and 85% of triiodothyronine (T3) hormones. Thyroid hormones are crucial for growth and development of all body tissues throughout life. They are particularly essential for brain and neural system development during embryonic period. Therefore, it is critical to have adequate intake of iodine during pregnancy, to prevent irreversible consequences of ID **(Mahan et al., 2017).**

In the present study, the results revealed that for less than half of mother's their age was less than 30 with a mean age of 30.6±7.6 years. These findings are in agreement with those of the study of **Karmakar et al. (2019)**, in **Tripura, India**, which reported that majority of participants, belonged to 31-40 years, with a mean age of 38.6 (±13.8) years. As well, a previous carried out by **Sakhalkar and Sultana (2015),** to assess of knowledge, and practices regarding use of iodized salt among housewife of Osmanabad district, **India,** reported similar age range. Additionally, results of a resent similar study, carried out by **Sweazea et al. (2021),** in **Northwest Ethiopia,** detected that their respondents age was 33.36 ± 9.08 years.

In the current study, results indicated that majority of mothers had sufficient income. As well, a study conducted by **Sakhalkar and Sultana (2015),** in rural **Osmanabad**, reported that 71.5% of participants had income of 7001–15,000/- per month. As well as, the present stud revealed that the highest source of information regarding iodized salt was internet followed by Radio/TV. Local mass media could therefore be used as part of a national strategy to prevent iodine deficiency disorders. These previous findings were in agreement with those of **Karmakar et al. (2019)**, in **Tripura, India,** who mentioned that the majority of mothers got this information from internet (46.7%), family members and relatives (6%), health workers (5.9%), school teacher (2.2%).

The findings of the current study revealed that majority mothers' had unsatisfactory knowledge about Iodine regarding benefits, required daily amount, sources, causes of deficiency, symptoms of deficiency, importance of iodized salt, sea salt iodine content, IDD in children, proper storage of

iodized salt, and iodized salt taste before the implementation of the program. The lower knowledge levels pre-intervention may be attributed to the lack of role of media toward importance of iodine salt. Implementation of nutrition education programs as well as proper iodine interventions are highly recommended to overcome IDD in this age group. However, after the implementation of the program, there were significant improvements in all knowledge items' levels in the post test and follow-up. The findings of the present study revealed that highly statistically significant improvements in mothers total knowledge scores, about iodine salt were demonstrated after implementing the educational training program **(P<0.01**).

Interventions and programs can be formulated to enhance knowledge. So, the consumption of adequate iodized salt can be ensured to reduce ID problems. This finding was supported by **Lowe et al. (2015)** in **North-West Pakistan,** who mentioned that the knowledge attitude practice survey showed that the intervention was highly successful in increasing knowledge of the health benefits of iodised salt, with 100% of those interviewed stating that they were aware, compared with 26% at baseline. As well, these findings are consistent with those of a study carried out by **Habib et al. (2021)**, in selected coastal regions of **Bangladesh,** which revealed that after intervention 80.3% of family used iodized salt, and among those, only 57.6% of the households used adequate quantity of iodized salt**.** They had adequate knowledge about iodized salt**.**

Surprisingly it was found that the percentage of using iodized salt was higher among those who had moderate knowledge about iodine and iodized salt**.** Similarly**,** in a study conducted in **Sindh and Punjab**, participants reported that using iodized salt is better for physical growth and prevents goiter and other health problems**.** In the same way, after intervention, these findings are congruent with that the study of **Karmakar et al. (2019),** in **Tripura, India,** which indicated good knowledge, practice and attitude regarding use of iodized packed salt ($P > 0.05$). These previous findings were also in agreement with those of **Sweazea et al. (2021),** in **Northwest Ethiopia**, who in a very result study they detected good knowledge of IDD.

Concerning the mothers' practice related to iodine salt and IDD in the present study, the results revealed that nearly all mothers' purchase iodized salt and use it in cooking, also, less than half of them keep iodized salt in proper container and proper store it, as well, while intake of iodized salt from container, and minority of them add iodized salt in proper time while cooking. Surprising, only, less than one third of respondents reported to have adequate practice, which indicated that ID could be a significant problem in the future. Interestingly, after intervention all the mothers have adequate practice. The findings of the present study revealed that highly statistically significant improvements in mothers' total practices scores after implementing the educational training program (P<0.01).

These previous findings matched with those of **Karmakar et al. (2019),** who conducted a study at **Tripura, India**, they found that there was predominance of usage of iodized packed salt (98.9%) by the study population and only 1.1% used coarse salt (nonpacked). Majority of them stored salt in dry area (96.3%) and kept their salt in a covered container (95.6%); while, 8.9% reported sunlight exposure to salt. Majority stored salt for a period of 1 month, whereas 24.1% stored less than or equal to half month. However, of mothers 60.4% added salt at the middle of cooking, 37.4% at the beginning, and least 1.9% at the end.

Similar findings were found in studies elsewhere consciously even without knowing its benefits as those of **Kumar et al. (2013)** in **India**; **Lowe et al. (2015)**, in **North-West Pakistan; Sakhalkar and Sultana (2015)** in **rural Osmanabad; Banumathi (2016),** in **Tirunelveli District, Tamil Nadu; Roy et al. (2016),** in **India** and **Choudhury et al. (2016)** in **Ethiopia.**

Regarding the mothers' attitude towards iodine salt and iodine deficiency disorder in the present study, most of mothers had a positive attitude towards iodine before intervention. However, after intervention nearly all of mothers immediately post as well as follow up three months later had positive attitude. This

study result is in line with that of **Karmakar et al. (2019),** in **Tripura, India**, who found that the practice of using iodized salt was much lower among good-practiced scored people. There was a statistically significant correlation between knowledge and attitude with the educational status of the respondents ($p < 0.05$), while there was no correlation between the education of respondents with practice ($p > 0.05$). The respondents' age showed a strong correlation with knowledge, attitude, and practice ($p < 0.05$). The respondent's knowledge score strongly correlated with the attitude score but not correlated with the practice score ($P > 0.05$).

In the present study, a multivariate analysis showed that, the statistically significant independent positive predictors of the mothers' practice scores related to iodine were the intervention, education, income, knowledge score, and attitude score was a statistically significant independent positive predictor of this score. As well, the statistically significant independent positive predictors of the mother's attitudes' scores related to iodine salt were their intervention, education, and knowledge score. This might be related to that positive knowledge leads to adequate practice and positive attitude. Generally, this study reflected that the educational training program had significant positive effect on iodine salt mothers' performance. These findings matched with those of a similar study by **Karmakar et al. (2019),** who found that statistically significant independent positive predictors of the mothers' attitude scores related to practice and knowledge was their intervention.

## Conclusion:

Based on the present study results, findings showed that nutrition education intervention had highly statistically significant positive effect on the studied mothers' performance (knowledge, practice, & attitudes).

## Recommendations:

- Educational nursing intervention about iodine deficiency disorders and iodized salt intake should be provided periodically and continually to all mothers attending MCH centers.
- Universal salt iodination program is an effective measure to maintain the iodine status, with the recommended threshold for household level depending on typical use and availability of iodine from other dietary sources.
- Further study should be carried out on a larger scale for generalization of results.

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