



युवतियों की थायरॉइड स्क्रीनिंग

सतत नाभिकीय चिकित्सा-आधारित कार्यक्रम का सार्वजनिक स्वास्थ्य प्रभाव

Thyroid Screening Among Young Women

Public Health Impact of a Sustained Nuclear Medicine-Led Program

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Thyroid disorders represent a major endocrine health concern in India, with hypothyroidism and subclinical hypothyroidism occurring more frequently than in many Western countries, emphasizing the need for early detection and preventive screening strategies among vulnerable populations such as young women. This study aimed to evaluate the feasibility and impact of thyroid screening camps conducted as part of a Nuclear Medicine outreach initiative for young adult females. Screening camps were organized at educational institutions and community centres involving participants aged 18–25 years. After informed consent, demographic details, clinical history, and symptoms suggestive of thyroid dysfunction were documented. Blood samples were collected for biochemical investigations including thyroid-

stimulating hormone (TSH), thyroxine (T4), anti-thyroid peroxidase antibodies (anti-TPO), vitamin D, vitamin B12, and other relevant parameters where applicable. Participants also received counseling regarding thyroid health, nutrition, lifestyle factors, and the importance of early diagnosis. Individuals with abnormal findings were referred for further medical evaluation and management. The initiative improved awareness regarding thyroid disorders and enabled identification of previously undetected thyroid dysfunction and associated biochemical abnormalities. Community-based thyroid screening programs may serve as an effective strategy for awareness generation, early diagnosis, referral, and future epidemiological and translational research activities.

Introduction

Thyroid disorders are among the most common endocrine diseases worldwide and represent a major public health concern in India. Epidemiological studies have reported a comparatively higher prevalence of hypothyroidism and subclinical hypothyroidism in the Indian population than in many Western countries. In India, the prevalence of hypothyroidism and subclinical hypothyroidism has been estimated to be approximately 10.95% and 8.02%, respectively, while lower prevalence rates have generally been reported in the United States and Europe [1,2]. Hyperthyroidism and subclinical hyperthyroidism, although less common, also contribute significantly to endocrine morbidity. The increasing burden of thyroid dysfunction in India highlights the need for greater awareness, early diagnosis, and community-based screening initiatives, particularly among vulnerable populations such as young women [1].

Young women between 18 and 25 years of age represent a particularly vulnerable group because this period is associated with important hormonal, metabolic, and reproductive transitions. In addition, nutritional deficiencies and limited healthcare accessibility continue to contribute to thyroid dysfunction in several rural and semi-urban regions of Maharashtra despite nationwide iodization programs. Many thyroid abnormalities during early adulthood remain undiagnosed because symptoms such as fatigue, weight fluctuations, menstrual irregularities, anxiety, hair loss, and poor concentration are often nonspecific and attributed to lifestyle-related stress [3].

The consequences of undetected thyroid dysfunction extend beyond individual health. Hypothyroidism and autoimmune thyroid disease may adversely affect fertility, pregnancy outcomes, fetal neurodevelopment, and long-term metabolic health. Early identification and timely intervention are therefore important not only for improving quality of life but also for safeguarding future maternal and child health [4].

Recognizing this public health need, the "Thyroid Disorders and Immunoassay Development" (TDID) Section at Radiation Medicine Centre (RMC) has initiated thyroid screening and awareness camps targeting young women in educational institutions and underserved communities. These outreach activities integrate the scientific strengths of nuclear medicine with preventive healthcare strategies, thereby transforming laboratory expertise into direct societal benefit [Fig.1].



Fig.1: Blood collection team during the "Thyroid Screening Camp".

Thyroid Disorders Among Young Women: A Growing Public Health Concern

Thyroid disorders disproportionately affect women, with studies from India reporting a significantly higher prevalence among females compared to males. Hypothyroidism, subclinical hypothyroidism, autoimmune thyroiditis, and iodine deficiency-related goiter are increasingly being detected in adolescents and young adults. Several Indian campus-based studies have reported thyroid dysfunction rates ranging from 7% to 13% among apparently healthy young women, indicating that a substantial proportion of cases remain clinically silent [5].

The vulnerability of young women arises from multiple interacting factors. Nutritional deficiencies such as inadequate iodine, iron, selenium, vitamin D, and vitamin B12 intake may impair thyroid hormone synthesis and metabolism. Hormonal fluctuations associated with puberty, menstrual cycles, and reproductive maturation further influence thyroid physiology. In rural settings, poor awareness regarding thyroid symptoms, delayed healthcare access, and financial constraints contribute to underdiagnosis [6].

Subclinical hypothyroidism deserves particular attention because affected individuals may appear healthy despite biochemical abnormalities. If left untreated, these conditions can gradually progress to overt hypothyroidism and contribute to obesity, dyslipidemia, menstrual disturbances, infertility, polycystic ovarian syndrome (PCOS), depression, and cardiovascular complications. Importantly, thyroid dysfunction during pregnancy is associated with miscarriage, preterm delivery, low birth weight, and impaired cognitive development in children [7].

These concerns highlight the urgent need for early screening programs specifically designed for young women before the onset of pregnancy and major reproductive complications.

Nuclear Medicine and the Role of Radioimmunoassay in Thyroid Diagnostics

Nuclear medicine has played a transformative role in thyroid disease diagnosis and management for several decades. Among its most significant contributions is the development of highly sensitive immunoassay techniques such as Radioimmunoassay (RIA) and Immunoradiometric Assay (IRMA), which enable precise quantification of thyroid hormones and related biomarkers [Fig.2].

The RIA Services of TDID Section at RMC routinely performs RIA and IRMA-based investigations for thyroid hormones, autoimmune markers and tumor marker including, thyroxine (T4), thyroid-stimulating hormone (TSH), free thyroxine (FT4), anti-thyroid peroxidase antibodies (anti-TPO) and thyroglobulin (Tg) [8, 9, 10, 11]. These assays are particularly valuable for detecting early and subclinical thyroid dysfunction, where hormone changes may be subtle and difficult to identify through conventional screening approaches.

RIA-based methodologies offer several advantages in resource-limited settings:

- *High analytical sensitivity and specificity*
- *Reliable detection of low hormone concentrations*

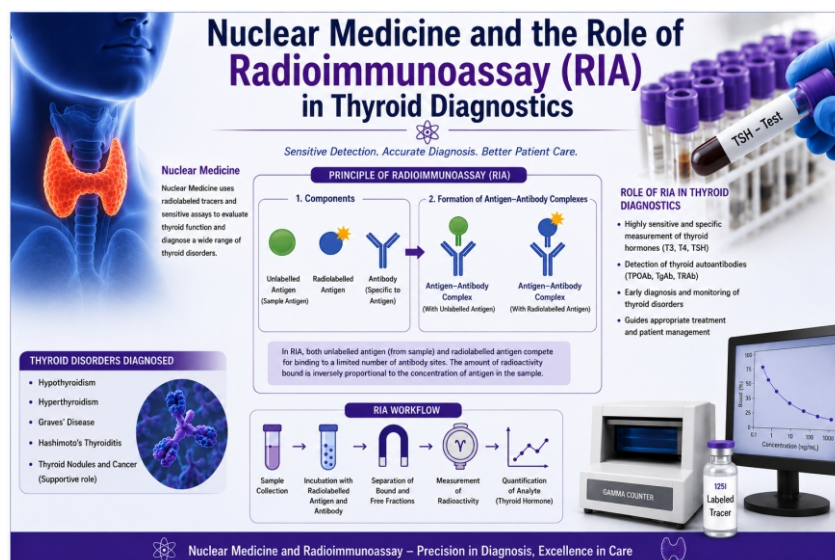


Fig.2: Role of radioimmunoassay in thyroid diagnostics.

- Cost-effective large-scale population screening
- Standardized performance for epidemiological studies
- Suitability for autoimmune thyroid disease assessment

The department has also contributed to indigenous kit development, reducing dependency on imported diagnostic systems while promoting self-reliance in nuclear medicine technology [10, 11]. Research activities within the laboratory include studies on thyroid autoimmunity, iodine metabolism, biomarker development, thyroid cancer monitoring, and genetic factors influencing thyroid disorders [12].

Collaborations with Academic Institutions

Through collaborations with academic institutions such as Department of Foods and Nutrition, The Maharaja Sayajirao University of Baroda, India [13, 14]; Department of Food Science and Nutrition, SNDT University, Mumbai [12], Guru Nanak College of Arts, Science & Commerce (Autonomous) and Guru Nanak Institute of Management Studies, Mumbai [Fig.3]; the department has extended its expertise beyond laboratory diagnostics into public health outreach and awareness generation. To date, we have successfully collected approximately 300 samples through



Fig.3a: College student volunteers providing blood samples during the "Thyroid Screening Camp"

these screening camps, with a target enrolment of nearly 1000 participants.

Design and Implementation of Thyroid Screening Camps

The thyroid screening initiative was conceptualized as a community-oriented preventive healthcare program aimed at identifying hidden thyroid dysfunction among young women. The outreach strategy combines biochemical screening, health education, nutritional awareness, and epidemiological research within a single integrated framework.

Target Population

The thyroid screening camp primarily focusses on asymptomatic young women without a prior diagnosis of thyroid disease or other major systemic disorders, aged 18–25 years, studying in colleges and universities, as well as young women residing in rural Maharashtra. This age group was selected because thyroid disorders during early adulthood often remain asymptomatic yet significantly influence future reproductive and metabolic health.

Screening Protocol

The core screening investigation includes serum TSH estimation using sensitive RIA-based assays. Individuals with abnormal TSH values, particularly those exceeding the predefined cutoff levels (>5.2 IU/mL), are advised further evaluation using:

- Free thyroxine (Ft4)
- Total T4
- Anti-TPO antibodies

To provide a more holistic health assessment, additional biochemical investigations may include:

- Vitamins: Vitamin B12, Vitamin B9 (Folate), Vitamin D
- Fertility hormones: Estradiol, FSH, LH, Progesterone, Prolactin
- Biochemical tests: Blood Glucose (HbA1C), Complete

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Blood Count (CBC), Kidney Function Tests (KFT), Lipid Profile, Liver Function Tests (LFT), Serum Calcium.

This integrated approach helps identify metabolic and nutritional factors commonly associated with thyroid dysfunction.

Awareness and Educational Activities

Each camp incorporates educational sessions conducted by senior scientists, clinicians, and technical experts from RMC. These sessions typically include:

- Basic thyroid gland physiology
- Common symptoms of thyroid disorders
- Importance of iodine nutrition
- Lifestyle and dietary guidance
- Reproductive implications of thyroid dysfunction
- Role of nuclear medicine in diagnosis and monitoring

Such educational interventions help dispel myths associated with thyroid disorders and encourage timely medical consultation.

Ethical and Research Components

All screening activities are conducted in accordance with Institutional Ethics Committee guidelines following appropriate informed consent procedures. Participants identified with abnormal clinical or biochemical findings are referred for further medical evaluation and management. Blood samples collected during the screening camps may also be preserved for future research studies investigating genetic polymorphisms and molecular biomarkers associated with thyroid disorders. These may include analysis of deiodinase gene variants, particularly DIO2 Thr92Ala polymorphisms, which are involved in the peripheral conversion of thyroxine (T4) to the biologically active hormone triiodothyronine (T3). Alterations in DIO2 Thr92Ala activity have been implicated in thyroid hormone homeostasis, susceptibility to

hypothyroidism, metabolic dysfunction, impaired response to levothyroxine therapy, and inter-individual variability in thyroid hormone metabolism [15].

Societal Impact of Nuclear Medicine Outreach

The thyroid screening initiative demonstrates how nuclear medicine can directly contribute to preventive healthcare and community welfare. Traditionally perceived as a highly specialized hospital-based discipline, nuclear medicine is increasingly expanding its role into public health, awareness generation, and early disease detection.

Early Diagnosis and Prevention

One of the most significant impacts of the program is the identification of asymptomatic and subclinical thyroid disorders before the development of major complications. Early diagnosis allows timely initiation of treatment and lifestyle modifications, thereby preventing long-term endocrine and reproductive consequences.

Empowerment Through Awareness

The educational component of the camps empowers young women to recognize symptoms, seek medical advice, and understand the importance of nutritional health. Increased awareness also helps reduce stigma and misconceptions surrounding hormonal disorders and reproductive health issues.

Strengthening Public Health Data

The screening initiative provides valuable epidemiological data on thyroid disorders, nutritional deficiencies, and autoimmune markers among young Indian women aged 18–25 years. Such data are important for understanding regional disease patterns, identifying vulnerable populations, and estimating the burden of undiagnosed thyroid dysfunction in the community. The findings may support the development of targeted screening strategies, improve healthcare resource allocation, guide preventive health programs, and contribute to evidence-based public health policies aimed at improving long-term endocrine and reproductive health outcomes.

Promoting Indigenous Diagnostic Capability

The use of indigenous technologies (RIA/IRMA) developed within the department highlights the importance of self-reliance in medical diagnostics. Affordable, locally developed assays enable large-scale screening while reducing dependence on imported technologies, thereby aligning with national healthcare and scientific development goals.

Bridging Laboratory Science and Community Healthcare

The program exemplifies translational healthcare, where advanced laboratory technologies are directly utilized for societal benefit. By extending diagnostic expertise into educational institutions and rural communities, the department has successfully bridged the gap between scientific research and real-world healthcare needs.

Integrating Thyroid Screening with Broader Women's Health

An important strength of the initiative is its multidisciplinary and holistic approach. Thyroid dysfunction



Fig.3b: College student volunteers providing blood samples during the "Thyroid Screening Camp"

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Fig.3c: College student volunteers providing blood samples during the "Thyroid Screening Camp"

rarely exists in isolation and is often associated with nutritional, metabolic, and reproductive abnormalities. Therefore, the camps incorporate broader health assessments to provide comprehensive preventive care.

Nutritional Deficiencies and Thyroid Function

Deficiencies of iron, selenium, vitamin D, and vitamin B12 are increasingly recognized as contributors to thyroid dysfunction and autoimmune thyroiditis. Assessing these parameters alongside thyroid hormone levels allows better understanding of disease patterns and facilitates targeted nutritional counseling.

Reproductive and Metabolic Health

Thyroid disorders significantly affect menstrual regularity, ovulation, fertility, and pregnancy outcomes. By integrating reproductive hormone evaluation and metabolic profiling, the camps help identify young women at risk for PCOS, infertility, obesity, and metabolic syndrome.

Mental and Academic Well-being

Undiagnosed hypothyroidism may contribute to fatigue, impaired concentration, mood disturbances, and reduced academic performance among students. Early identification and treatment may therefore positively influence psychological well-being and educational productivity.

Operational Challenges and Future Opportunities

Despite its promising outcomes, large-scale thyroid screening in rural and semi-urban regions presents several logistical and social challenges:

- Limited healthcare infrastructure in remote areas
- Transportation and sample handling difficulties
- Inadequate public awareness regarding thyroid disorders
- Fear and stigma associated with hormonal diseases
- Financial and manpower constraints for repeated outreach programs

However, the department's infrastructure, including gamma counters, trained technical personnel, and

established immunoassay laboratories, enables efficient processing of large sample volumes. Mobile outreach models and collaborations with colleges, public health centers, and community organizations further strengthen implementation capacity.

Future Directions

The department aims to significantly expand the screening initiative over the coming years through:

- Collaboration with primary healthcare centers
- World Thyroid Day awareness campaigns
- Integration with women's health programs
- Development of regional thyroid health databases
- Genetic and molecular epidemiological studies

By 2027, the initiative aims to screen about 1000 young women while generating valuable data to guide future preventive strategies and policy recommendations.

Conclusion

The thyroid screening and awareness initiative undertaken by RMC represents an important example of how nuclear medicine can extend beyond hospital-based diagnostics into meaningful community healthcare outreach. Through the application of sensitive RIA and IRMA technologies, preventive screening strategies, and educational programs, the initiative addresses a significant yet often underrecognized health concern among young women.

The program has demonstrated the feasibility and effectiveness of conducting community-based endocrine health screening, facilitating the early identification of previously undiagnosed thyroid dysfunction and associated biochemical abnormalities while simultaneously improving awareness regarding thyroid health, nutrition, reproductive well-being, and preventive healthcare practices.

The encouraging participation observed during the screening camps reflects the growing acceptance and need for such outreach initiatives. Furthermore, the integration of indigenous diagnostic technologies with epidemiological and translational research provides valuable opportunities for future investigations involving molecular biomarkers and genetic susceptibility factors associated with thyroid disorders. By transforming scientific expertise into accessible healthcare services, the initiative contributes toward healthier future generations, improved maternal and child health, and greater public awareness of endocrine disorders. Overall, this outreach effort highlights the peaceful and humanitarian applications of nuclear science and its significant potential to improve public health and community well-being.

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