

# Knowledge, Attitude, Practices (KAP) of Metabolic Disorders in South Indian Population

P. Aravinda Swami<sup>1\*</sup>, R. T. Saravana Kumar<sup>2</sup> and Manohar Babu Sitty<sup>3</sup>

<sup>1</sup>Department of Clinical Pharmacy and Pharmacy Management, SIMS College of Pharmacy, Guntur - 522001, Andhra Pradesh, India; swami8055@gmail.com

<sup>2</sup>Department of Clinical Pharmacy and Pharmacy Management, Annamalai University, Annamalinagar – 608002, Tamil Nadu, India; srisaravanakumarrt@gmail.com

<sup>3</sup>Department of Pharmacy, SIMS College of Pharmacy, Guntur - 522001, Andhra Pradesh, India; manoharsitty@yahoo.co.in

## Abstract

The main objective of the present study was to perform the knowledge, attitude and perception of metabolic disorders (Hypothyroidism and Type II DM) in South Indian population. A prospective observational study was conducted in the city of Vijayawada, South India to assess the KAP of the individuals towards the common conditions of Hypothyroidism and Type II DM using standard questionnaire and procedure. A total of 980 houses were screened in a span of 1 year, resulting in 187 people living with thyroid disorders and 735 with Diabetes Mellitus. After passing through the selection criteria, we are left with 130 of Hypothyroid (H) and 456 of T2DM alone patients. Out of whom 55 were lost during follow-up. Statistical analysis was performed using SPSS 16 version by using Chi-square test. Knowledge and perception of the individuals regarding the T2DM was found to be good compared to the Hypothyroidism. However, practicing them in their daily life is often found missing due to the rapid urbanization and less awareness created by counseling.

**Keywords:** Attitude, Diabetes Mellitus, Hypothyroidism, Knowledge, Practice

## 1. Introduction

The deep hidden connection between Diabetes Mellitus and thyroid malfunction was examined in 1927, by Coller and Huggins. A few investigations have confirmed a complex interlacing biochemical, hereditary and hormonal impairments reflecting this pathophysiological association<sup>1-3</sup>. A meta-analysis reported that 11% of Diabetes Mellitus patients presented thyroid dysfunction over a period and reported an association between thyroid dysfunction and Diabetes Mellitus<sup>4</sup>. Most of the researchers reported autoimmunity as the significant pathological cause of this association<sup>5-7</sup>. With this strong link between diabetes and thyroid diseases, the American

Diabetes Association (ADA) advised the people with diabetes must be periodically checked for asymptomatic thyroid dysfunctions<sup>8,9</sup>.

Unmanaged pre-diabetes (both Type 1 and Type 2) may induce a “low serum T3 state” characterized by low serum total and free T3 levels, increase in reverse T3 (rT3) but near normal serum T4 and TSH concentrations<sup>10</sup>. Thyroid hormones precisely control insulin release. In Hypothyroidism, as a result of decrease in thyroid hormone, having direct impact on insulin release by bringing about diminished glucose-prompted insulin discharge by pancreatic beta cells. Conversely, the reaction of beta cells to glucose or catecholamine is elevated in hyperthyroidism because of higher beta cell mass and

\*Author for correspondence

Thyrotoxicosis causes rise in insulin elimination<sup>11,12</sup>. In all ethnic groups, reductions in physical activity, gender and increasing age are the risks of diabetes. Higher consumption of refined carbohydrates, saturated fats and trans-fats are also some of the risk factors for the development of diabetes in all populations, while low glycemic index foods and foods high in dietary fiber have been shown to decrease the risk. In general, a typical South Asian meal has a higher caloric intake and a higher percentage of carbohydrate than European meal<sup>13</sup>.

Health education is considered as a basic part to improve information and thought behavior; there are certain evidences that individuals affected by diabetes often lack information and conduct on nature of illness completely. This may have impact and influence on the disease prognosis and associated complications<sup>14</sup>. The relation between thyroid dysfunction and T2DM has been a less explored arena which may behold answers to various facts of metabolic syndrome. The management of these conditions largely depends on the affected person's ability to pursue self-care in daily living. Proper management and education require patients to be aware of the nature of the disease, its risk factors, treatment and complications. Thus, there exists an immense responsibility and concern in creating awareness and bring importance among individuals prompts better control of the disease and associated complications.

A Knowledge, Attitude, Practices (KAP) survey is a quantitative method that provides access to qualitative and quantitative information. The questionnaire for the present study was prepared from thorough literature review, tailored according to the socio-demographics of the South Indian population. Thus redeveloped questionnaire was reviewed and authenticated by the Endocrinologists of the Government General Hospital and the Ethical committee of the Southern Institute of Medical Sciences.

In KAP surveys, the knowledge part is typically used only to assess the extent of community knowledge about public health aspects related to national and international public health programs. While the term, attitude is usually used to refer to a person's general feelings about an issue, object or person. Furthermore, attitudes are interlinked with the person's knowledge, beliefs, emotions and values and they are either positive or negative. A third and integral part of KAP surveys is the investigation of health-related practices. Questions typically concern the

use of different treatment and prevention options and are hypothetical<sup>15</sup>.

## 2. Methods

This study aims at evaluating the KAP of the South Indian population about Hypothyroidism and Diabetes Mellitus and their interplay in a view to increase the quality of life and to ascertain the role of Hypothyroidism in T2DM patients and vice-versa. The present study was approved by the ethical committee at Southern Institute of Medical Sciences: IHEC/SIMS/2018/021

This investigation was conducted during the period January 2018 to January 2019 in Vijayawada city. It is a cross-sectional study which was performed on a random sub-population regardless of sex and age on adult population (>30 years), children are not considered based on the lesser incidence and the duration of disease to appreciate long-term effects. A systematic review of households was done to find and select the study subjects with Hypothyroidism and Diabetes Mellitus. We have emphasized the importance of them participating in this survey and explained the Questionnaires and procedure. Participation in the present study was entirely voluntary; no name was recorded on the questionnaires or any forms used; and the data was kept confidential all over the study.

Each participant was now given a data collection form (translated in their local language) comprising the general characteristics, knowledge, Attitude and practice questionnaires of Hypothyroidism and Diabetes Mellitus previously authenticated by the Health Care Professional (HCP) in the respective fields. Required support and assistance was provided in understanding the forms and questionnaires. Filled questionnaires and forms were investigated for fulfillment and precision before entry and evaluation; we also randomly asked a few questions from the forms they filled, and to check whether the filled information was genuine and real. Then the data was coded, analysis was performed by SPSS version 16 by adopting Chi-square test.

## 3. Results

A sum of 980 houses was screened, resulting in 187 people living with thyroid disorders and 735 with Diabetes Mellitus. After passing through the selection

**Table 1.** General characteristics and anthropometric data of H and T2DM groups

Characteristics	T2DM (N = 468)	H (N = 117)
Age, years; mean (SD)	54.43(11.94)	37.87(10.05)
Gender; n (%)		
Male	290(62)	32(27.3)
Female	178(38)	85(72.6)
Level of Education; n (%)		
Higher	148(31.8)	42(35.8)
Middle	172(36.7)	39(33.3)
Lower	98(21.1)	23(19.6)
Uneducated	50(10.4)	13(11.1)
Health behavior; n (%)		
Smoking	213(45.5)	1934(16.2)
Alcohol	247(52.7)	12(10.2)
Life Style; n (%)		
Sedentary(>8 hr In-activity)	164(35)	82(70)
Sedentary(4-8 hr In-activity)	159(33.8)	30(25.7)
Non-Sedentary(<4 hr In-activity)	145(31.1)	5(4.3)
Weight, kg; mean (SD)		
BMI Categories; Kg/m <sup>2</sup> , n (%)		
Obese (equal or >30 kg/m <sup>2</sup> )	221(47.5)	41(35)
Overweight (25.0-29.9 kg/m <sup>2</sup> )	146(30.9)	38(32.4)
Normal (18.5-24.9 kg/m <sup>2</sup> )	76(16.1)	29(24.7)
Under weight (<18.5 kg/m <sup>2</sup> )	25(5.5)	9(7.6)

Table 1 Continued

Family history; n (%)		
Present	329(70.2)	21(17.9)
Absent	139(29.8)	96(82.1)
K/C/O disease; n (%)	414(88.5)	102(87.2)
Newly diagnosed; n (%)	54(11.5)	15(12.8)
Duration of having the condition, years; n (%)		
<1	100(24.1)	43(37.1)
1-5	163(39.4)	38(32.8)
6-10	89(21.5)	26(22)
>10	62(15)	10(8.1)

criteria, we are left with 130 of Hypothyroid (H) and 456 of T2DM alone patients. Out of whom some were lost; discontinued (29), not available (14), wrong diagnosis (6) and for other reasons (6). By assessing the symptoms and probability of risk, we have highly encouraged a sample of 89 to go for immediate testing for thyroid and DM, out of whom 54 were diagnosed with T2DM and 15 with Hypothyroidism. As a result, we are left with (102+15) of Hypothyroid and (414+54) of T2DM participants, on whom the survey is built.

Among the 117 Hypothyroid (H) and 468 T2DM participants, males were 32 (27.3%), 290(62%) and females were 85 (72.6%), 178 (38%) in Hypothyroid and T2DM groups respectively. The mean age for H and T2DM groups was around 54 and 38 years, respectively. Most of the participants in group H were having higher education (35.8%) compared to the medium level of education (36.7%) in the T2DM group. The smoking and alcohol consumption were found around 50% of participants compared to 13 in T2DM and H groups, respectively. Considering the lifestyle and BMI, most of the population were leading a sedentary lifestyle and are

obese in both groups. A positive correlation was found among 70 and 18% of the participants, for the presence of similar diagnosis between their parents among the groups T2DM and H, respectively. In looking at the duration of having the disease, majority of participants in T2DM had it since 5 years (39.4%) compared to less than a year (37.1%) in group H (Table 1).

In view of Hypothyroidism, around 18% of the participants answered 'I didn't have any idea; what the thyroid gland is and its capacities, while 82% have picked explicit answers that are factual with respect to the thyroid on various degrees of knowledge. Among these, around 15% related thyroid problems to disturbances in menstruation, unsuccessful labor and birth of the dead fetus, while 23.1% related to mental components as, Bipolar disorder, confusion, inability to concentrate, rapid changes in mood and tension, 27.6% to neck and joint agony and weight gain, and 34.7% obstruction and/or loose bowels, voice changes and neck swelling.

Regarding Hypothyroidism, 35.4% are aware of iodized salt had a role in the treatment of Hypothyroidism. Most of the participants (42.3%) answered 'I don't

**Table 2.** Attitude and practice about Hypothyroidism in South Indian population

Criteria	N = 117	Percentage	*P value
What is the thyroid gland			
I don't know	22	18.4	< 0.05
Gland lies in the front of the neck	34	29.3	
Important gland for metabolism and all body functions	30	26.1	
Important endocrine gland	15	13.1	
Important endocrine gland lies in front of the trachea	16	13.1	
Function of the thyroid gland			
Regulation of body temperature, blood pressure, growth and metabolism	28	23.8	< 0.05
Regulation of growth	25	21.3	
Regulation of body temperature	17	14.5	
Regulation of body temperature and blood pressure	21	18.3	
Regulation of using of body energy	5	4.2	
I don't know	21	17.9	
Symptoms of Hypothyroidism			
Neck pain, joint pain, joint weakness, excessive weight gain.	32	27.6	< 0.05
Swelling of the neck, voice changes, constipation and/or diarrhea for long periods	41	34.7	
Bipolar disorder, confusion, inability to concentrate, rapid changes in mood, hyper panic attacks	27	23.1	
Disturbance in women's menstrual cycle, recurrent miscarriage, birth of dead fetus	17	14.6	
Using of regular medications for Hypothyroidism			
Yes	81	68.9	< 0.05
No	21+15	31.1	
Are you doing regular thyroid gland investigations			
Yes	74	63.4	< 0.05
No	28+15	36.6	
Have you been told about the importance of doing regular investigations by HCP			
Yes	86	73.1	< 0.05
No	31	26.9	
Reasons for not doing regular thyroid investigations			
Have no idea	13	11.1	< 0.05
Have no money	6	5.1	
Fear of investigations	10	8.5	
No need	7	5.9	
Lack of time	15	12.8	

\*p-value calculated using Chi-square ( $\chi^2$ ) test,  $p \leq 0.05$  consider as statistically significant

know' for the question; whether herbal remedy can cure Hypothyroidism. The majority (36.1%) answered 'No' to stopping of taking medication when reports are normal. The majority (60%) answered 'yes' for; whether to stop the treatment in pregnancy and 'I don't know' (42.4%) for women with thyroid insufficiency can conceive normally. A percentage of 62.6 thought that cabbage, cauliflower and soy products have to be avoided in case of Hypothyroidism. Overall most participants had good knowledge of no information on some aspects of the disease. (Tables 2 and 3). In terms, of practice around 30% of the participants

are not taking the medications regularly, only 73.1% had been informed about the importance of regular medical check-up and only 63.4% were doing their regular check-ups. Lack of time and have no idea of the importance of the check-ups has made around 25% of the participants not doing regular investigations.

In viewing T2DM participant's knowledge and attitude about diabetes, a maximum percentage (95) have given good and appropriate answers regarding nature, risk factors and symptoms of the disease. However, a percentage of 22 have said 'I don't know'

**Table 3.** Knowledge about Hypothyroidism in South Indian population

KNOWLEDGE	YES N (%)	NO N (%)	I DON'T KNOW N (%)	*P Value
Do iodized salt have a role in treatment of Hypothyroidism	41 (35.4)	35 (29.8)	41 (34.8)	< 0.05
Herbal remedy can cure thyroid disorders	37 (31.3)	31 (26.4)	49 (42.3)	< 0.05
Can you stop treatment of Hypothyroidism when the investigations were normal?	35 (29.5)	42 (36.1)	40 (34.4)	< 0.05
Can you stop treatment of Hypothyroidism in pregnancy because it harms the fetus?	70 (59.8)	21 (18.2)	26 (22)	< 0.05
Can women with thyroid insufficiency conceive normally?	33 (28.2)	34 (29.4)	50 (42.4)	< 0.05
Are cabbage, cauliflower and soy products should be avoided in case of Hypothyroidism	73 (62.6)	17 (14.2)	27 (23.2)	< 0.05
Is Hypothyroidism a genetic disease?	29 (25)	55 (46.7)	33 (28.3)	< 0.05
Is Hypothyroidism infectious disease	21 (17.8)	57 (48.5)	40 (33.7)	< 0.05
Is radioactive iodine one of the therapeutic options?	66 (56.4)	20(16.8)	31 (26.8)	< 0.05

\*p-value calculated using Chi-square ( $\chi^2$ ) test,  $p \leq 0.05$  consider as statistically significant

for the nature of the disease. When asked about the preventive and treatment measures, a very good portion of the participants were having the highest awareness. In the practice section, around 17% of the participants are not taking the medications regularly, 86.5% had been informed about the importance of regular medical

check-up and 30.5% were doing their regular check-ups. The reason for not attending regular check-ups was found to be having no idea or awareness mainly (10%) followed by others. Overall, the KAP of T2DM participant's was very good compared to the H group. (Tables 4, 5). The complications associated with T2DM are found in around

**Table 4.** Participants suffering from other co-morbid conditions and chronic diseases

Items of questionnaire		Frequency	%	*P Value
T2DM complications	Damage to retina and vision loss	51	10.9	<0.05
	Retinal damage and vision loss, numbness and sensation loss	55	11.7	<0.05
	Retinal damage and vision loss, sensation loss and numbness, weakened immunity, increased occurrence of infections.	53	11.3	<0.05
	Retinal damage and vision loss, chronic renal failure, sensation loss and numbness	46	9.8	<0.05
	Retinal damage and vision loss, chronic renal failure, sensation loss and numbness and weakened immunity, increased occurrence of infections.	21	4.5	<0.05
T2DM with chronic diseases	Heart disease. Hypercholesterolemia and Thyroid disease	38	8.1	<0.05
	Heart disease, hypercholesterolemia and asthma	38	8.1	<0.05
	Hypertension and Thyroid	48	10.2	<0.05
	Heart disease, hypertension and Thyroid disease	26	5.5	<0.05
	Hypertension and hypercholesterolemia	58	12.3	<0.05
	Asthma	17	3.6	<0.05
	Peptic ulcer	20	4.2	<0.05

\*p-value calculated using Chi-square ( $\chi^2$ ) test,  $p \leq 0.05$  consider as statistically significant

**Table 5.** Knowledge, attitude and practice of T2DM participants in South India

Items of Questionnaire		Frequency (n = 468)	%	*P value
Participant's idea about nature of T2DM	Decline in body sensitivity to insulin	56	12	<0.05
	Partial or total insulin secretion	159	34	<0.05
	Excess sweet eating	150	32	<0.05
	Don't know	103	22	<0.05
Risk factors of T2DM (Participant's knowledge)	Hypertension	106	12.8	<0.05
	Previous Gestational diabetes	89	22.6	<0.05
	Aging	115	19.1	<0.05
	Lack of exercise and Obesity	64	24.6	<0.05
	Genetics	60	13.7	<0.05
	Thyroid/Lifestyle/Others	34	7.2	<0.05
Symptoms of T2DM	Thirst, regular peeing, decreased healing of wounds	89	19	<0.05
	Thirst, regular peeing, decreased healing of wounds and obscure vision	90	19.2	<0.05
	Thirst, regular peeing, obscure vision and decrease in weight despite increment in hunger	131	27.9	<0.05
	Thirst, regular peeing, decrease in weight despite increment in hunger and foot abscess	148	31.6	<0.05
	No symptoms	10	2.1	<0.05



Table 5 Continued

T2DM treatment (Participant's knowledge)	Only medication	85	18.1	<0.05
	Only healthy diet	54	11.5	<0.05
	Healthy diet and medication	140	29.9	<0.05
	Healthy diet, exercise and medication	189	40.5	<0.05
T2DM preventive measures	Stop alcohol and smoking	85	18.1	<0.05
	Keep normal BP	73	15.6	<0.05
	Weight loss and modification of life style	186	39.8	<0.05
	Exercise regularly	110	23.5	<0.05
	Don't know	14	3	<0.05
Do you have regular check-up visits to your HCP?	Yes	325	69.5	<0.05
	No	89+54	30.5	<0.05
<b>Using of regular medications for T2DM</b>	Yes	390	83.4	<0.05
	No	24+54	16.6	<0.05
Have you been told about the importance of doing regular investigations by HCP	Yes	405	86.5	<0.05
	No	63	13.5	<0.05
Reasons for not doing regular T2DM investigations	Have no idea	34	7.2	<0.05
	Have no money	18	3.8	<0.05
	Fear of investigations	15	3.2	<0.05
	No need	18	3.8	<0.05
	Lack of time	14	3.0	<0.05

\*p-value calculated using Chi-square ( $\chi^2$ ) test,  $p \leq 0.05$  consider as statistically significant

48% of the participants, with majority complaining with or without Retinal damage, vision loss, chronic renal failure, sensation loss and numbness in extremities. Out of all the other co-morbidities, hypertension and hypercholesterolemia were the majors and associated thyroid condition was in a minor section.

## 4. Discussion

This community-based survey was conducted on the general population of Vijayawada city, to evaluate the knowledge, awareness and practice on thyroid disorders (mainly Hypothyroidism) and T2DM in a representative sample. Rapid urbanization and inclination to sedentary lifestyle are marking the necessity for assessing the conditions of precipitating metabolic syndrome among these residents. The results and outcomes of this study present unique information on trends in the South Indian population living with Hypothyroidism and Diabetes Mellitus.

KAP of an individual can influence their behavior and management about diseases and health care. Over a time period, a total number of 117 H participants were enrolled. Among which 32 (27.3%) were male and 85 (72.6%) were females; this was in accordance with the study conducted by Unnikrishnan A. G. et al. R. V. Jayakumar et al., A. R. M. Radaideh et al. and L. Hegedüs<sup>16-20</sup>. Majority of them were female and a significant percentage of them had a low level of knowledge compared with males. Population of both genders in the age group of >45 years of age had higher occurrence of H. Our outcomes were in concurrence with various other reports; where there was a propensity of having H with growing age across the genders Z. Meng et al., F. R. Tehrani et al.,<sup>21,22</sup>. Consequently, sex and age could speak to be the critical factors for H, inciting caution.

A percentage of 31.3 thought that herbal remedy could cure thyroid disorders, while Rai et al.,<sup>23</sup> found that 55.2% of females thought that thyroid disorders could be cured by using alternative medicine. Additionally, 62.6% thought that cabbage, cauliflower and soy products have to be avoided in case of Hypothyroidism, while in the study of Sethi et al.,<sup>24</sup> done on Hypothyroidism patient, 54.6% did not avoid eating cabbage, cauliflower and soya. The knowledge about obesity and weight gain

associated with Hypothyroidism was the same among the various study population. In a study by Singh et al.,<sup>25</sup> mentioned that 79.5% of patients attributed the weight gain to Hypothyroidism, while 78.6% of patients in our study agreed that Hypothyroidism causes weight gain. In looking at the practical aspects of hypothyroid patients, hardly 70% of the participants were using the medications regularly. Around 45 participants aren't doing the regular check-ups. There are varied reasons for the participants to go for a check-up, out of which the maximum had their symptoms aggravating being the reason. To our surprise, having no idea and lack of time are the reasons for around a quarter of the participants not able to do their regular check-ups. A low level of knowledge among participants was associated with lower concern and lesser precautions taken for thyroid disorders. Thus, these participants need to receive more inputs from the health-care system and physicians.

An aggregate of around 48% had T2DM in our examination. This was higher when correlated with the investigation of Khalid Alqurashi et al., which demonstrated that 30% of the considered population had DM<sup>26</sup>. This was near to Mansour M. Al-Nozha et al., works, which discovered 23.7% of the calculated population had DM<sup>27</sup>. Our recommendations are more critical than the studies from the Gulf area in Bahrain (25.7%) and Oman (16.1%)<sup>28,29</sup>. A proportion of 68.5 of them were having moderate to advanced education.

Furthermore, it was noticed that as the literacy level builds up, the compliance with drug intake and exercising had escalated. About healthy lifestyle; around 40% did ordinary strolling and exercise, 50% being unpredictable and a minor segment were ignorant. The Indian Diabetic Risk Score (IDRS) rules were utilized to survey actual activity at work environment especially and discovered the greater part of them had a moderate to good activity in their way of life, 35% are having moderate to no physical activity<sup>30</sup>. Our investigation indicated that 82.1% of the members had adequate idea about diabetes. About 12% of them realized that T2DM was brought about by the reduction in tissue reaction to insulin, 34% realized that it was a reason for incomplete insulin discharge and 32% thought it was brought about by abundance sweet eating. In relation to risk factors associated with T2DM, 24.6% realized that absence of activity and being obese were

major issues for T2DM, 13.7% realized it was hereditary and just 12.8% realized that hypertension was a danger factor associated. In a Foma et al., study<sup>31</sup>, the outcomes demonstrated that of the 199 members, just 47% said they understood what DM was, which 53% in our observation.

Also, 67% realized that T2DM could bring about loss of sight, while 46.5% realized that T2DM could cause inadequate injury healing<sup>31</sup>. In this investigation, 40.5% said that a solid eating routine, exercise and complying to prescription were the best procedures to control T2DM. In the investigation by Foma et al.,<sup>31</sup> practically 50% of the examination members had no idea on how the condition could be declined while an insignificant number speculate that weight reduction (0.5%) and work out (5.6%) were fundamental measures in resisting the condition. Comparative perceptions have been accounted for from Oman<sup>32</sup> and Tanzania<sup>33</sup>. Though, our investigation results were totally unique as the larger parts were having a decent impression of T2DM. Members having complications of T2DM like Retinopathy and loss of vision are around 32%. Very scarce population had other co-morbidities associated with T2DM.

We have discovered that family background of thyroid infection, female sex and length of diabetes for over ten years are huge factors for various thyroid dysfunctions. Collecting data proof recommends that the event of subclinical Hypothyroidism is almost certain in T2DM patients contrasted with people and connected with expanded diabetic complications<sup>34</sup>. The thyroid volumes were found fundamentally higher in the two subjects with T2DM and T1DM than the typical population; T2DM patients were bound to develop thyroid nodules when compared with type 1 diabetic patients and the non-diabetes group<sup>35</sup>. The American Association of Clinical Endocrinologists and Thyroid Disease Clinical Practice Guidelines suggest early treatment of subclinical thyroid dysfunction and require continuous screening for thyroid variations in all diabetic patients<sup>36</sup>.

## 5. Limitations

There are a few limitations concerning this study. Firstly, the influence of age, gender and body weight on the ability of the thyroid gland was not assessed. Secondly, we cannot quantify the relation or create the cause and effect relation owing to no proper biological tests possibly done.

## 6. Conclusion and Recommendations

In conclusion, the occurrence of Hypothyroidism in patients with T2DM was high; showing a potential interaction between thyroid condition and DM. Hypothyroidism was discovered to be the most well-known thyroid sickness in the Indian population with MetS. The report from the current study will help in building up a connection among TD and T2DM in Indian patients more clearly. This information will likewise have prognostic significance for doctors in their routine clinical practice to grow better evaluation strategy for patients of TD with related MetS. This evaluation also suggests health policymakers to give more priority towards escalating health benefits and understanding on metabolic disorders and consistence in medication regimen. However, future large population studies are suggested.

## 7. References

1. Collier FA, Huggins CB. Effect of Hyperthyroidism upon Diabetes Mellitus: Striking improvement in Diabetes Mellitus from thyroidectomy. *Ann of Surg.* 1927; 86:877–84. PMID: 17865795 PMCID: PMC1399508. <https://doi.org/10.1097/00000658-192712000-00009>.
2. Brenta G, Danzi S, Klein I, Potential therapeutic applications of thyroid hormone analogs. *Nat Clin Pract Endocrinol Metab.* 2007; 3(9):632–40. <https://doi.org/10.1038/ncpendmet0590>.
3. Goglia F, Moreno M, Lanni A. Action of thyroid hormones at the cellular level: The mitochondrial target. *FEBS Lett.* 1999; 452(3):115–20. [https://doi.org/10.1016/S0014-5793\(99\)00642-0](https://doi.org/10.1016/S0014-5793(99)00642-0).
4. Kadiyala R, Peter R, Okosieme OE. Thyroid dysfunction in patients with diabetes: Clinical implications and screening strategies. *Int J Clin Pract.* 2010; 64(8):1130–9. PMID: 20642711. <https://doi.org/10.1111/j.1742-1241.2010.02376.x>.
5. Kordonouri O, Maguire AM, Knip M, Schober E, Lorini R, Holl RW, et al., Other complications and associated conditions with diabetes in children and adolescents. *Pediatr Diabetes.* 2009; 10(12):204–10. PMID: 19754631. <https://doi.org/10.1111/j.1399-5448.2009.00573.x>.
6. Holl RW, Bohm B, Loos U, Grabert M, Heinze E, Homoki J. Thyroid autoimmunity in children and adolescents with type 1 Diabetes Mellitus. Effect of age, gender and HLA type.

- Horm Res. 1999; 52(3):113–8. PMID: 10725774. <https://doi.org/10.1159/000023446>.
7. Barker JM, Yu J, Yu L. Autoantibody subspecificity in type 1 diabetes: Risk for organ-specific autoimmunity clusters in distinct groups. *Diabetes Care*. 2005; 28(4):850–5. PMID: 15793184. <https://doi.org/10.2337/diacare.28.4.850>.
  8. American Diabetes Association. Standards of medical care in diabetes. *Diabetes Care*. 2013; 36(1):S11–66. PMID: 23264422 PMCID: PMC3537269. <https://doi.org/10.2337/dc13-S011>.
  9. Gray RS, Irvine WJ, Clarke BF. Screening for thyroid dysfunction in diabetics. *Br Med J*. 1979; 2(6202):1439. PMID: 519501 PMCID: PMC1597063. <https://doi.org/10.1136/bmj.2.6202.1439-a>.
  10. Donckier JE. Endocrine diseases and diabetes. Text Book of Diabetes Mellitus. J. C. Pickup and G. Williams, eds. UK: Blackwell Publishing Co.; 2003; 27:21–7. <https://doi.org/10.2337/diaclin.21.1.27>.
  11. Stanicka S, K. Vondra K, Pelikanova T, Vlcek P, Hill, Zamrazil V. Insulin sensitivity and counter-regulatory hormones in Hypothyroidism and during thyroid hormone replacement therapy, *Clin Chem Lab Med*. 2005; 43(7):715–20. PMID: 16207130. <https://doi.org/10.1515/CCLM.2005.121>.
  12. Mitrou P, Raptis SA, Dimitriadis G. Insulin action in hyperthyroidism: A focus on muscle and adipose tissue. *Endocr Rev*. 2010; 31(5):663–79. PMID: 20519325. <https://doi.org/10.1210/er.2009-0046>.
  13. Siegel K, Narayan KM, Kinra S. Finding a policy solution to India's diabetes epidemic. *Health Aff (Millwood)*. 2008; 27:1077–90. PMID: 18607043. <https://doi.org/10.1377/hlthaff.27.4.1077>.
  14. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of Diabetes Mellitus and its complications. Part 1: Diagnosis and classification of Diabetes Mellitus. Provisional report of a WHO consultation. *Diabet Med*. 1998; 15(7):539–53. [https://doi.org/10.1002/\(SICI\)1096-9136\(199807\)15:7<539::AID-DIA668>3.0.CO;2-S](https://doi.org/10.1002/(SICI)1096-9136(199807)15:7<539::AID-DIA668>3.0.CO;2-S).
  15. Annika L. How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi. *Anthropol Matters J*. 2009; 11(1):1–12.
  16. Unnikrishnan AG, Menon UV. Thyroid disorders in India: An epidemiological perspective. *Indian J Endocrinol Metab*. 2011; 15:78–81. PMID: 21966658 PMCID: PMC3169866. <https://doi.org/10.4103/2230-8210.83329>.
  17. Unnikrishnan AG, Kalra S, Sahay RK, Bantwal G, John M, Tewari N, et al., Prevalence of Hypothyroidism in adults: An epidemiological study in eight cities of India. *Indian J Endocrinol Metab*. 2013; 17:647–52. PMID: 23961480 PMCID: PMC3743364. <https://doi.org/10.4103/2230-8210.113755>.
  18. Jayakumar RV. Hypothyroidism and metabolic syndrome. *Thyroid Research and Practice*. 2013; 10(4):1–2.
  19. Radaideh ARN, Nusier MK, Amari FL, Bateiha AE, El-Khateeb MS, Naser AS, et al., Thyroid dysfunction in patients with type 2 Diabetes Mellitus in Jordan. *Saudi Medical Journal*. 2004; 25(8):1046–50.
  20. Hegedüs L. The Thyroid Nodule. *New Engl J Med*. 2004; 351(17):1764–71. PMID: 15496625. <https://doi.org/10.1056/NEJMcp031436>.
  21. Meng Z, Liu M, Zhang Q, Li K, Kun S, et al., Gender and age impacts on the association between thyroid function and metabolic syndrome in Chinese, *Medicine (Baltimore)*. 2015; 94(50):2193. PMID: 26683929 PMCID: PMC5058901. <https://doi.org/10.1097/MD.0000000000002193>.
  22. Tehrani FR, Tohidi M, Dovom MR. A population based study on the association of thyroid status with components of the metabolic syndrome. *Journal Diabetes Metab*. 2011; 02(8). <https://doi.org/10.4172/2155-6156.1000156>.
  23. Rai S, Sirohi S, Khatri AK, Dixit S, Saroshe S. Assessment of knowledge and awareness regarding thyroid disorders among women of a cosmopolitan city of Central India. *Ntl J Community Med*. 2016; 7(3):219–22.
  24. Sethi B, Khandelwal D, Vyas U. A cross-sectional survey to assess knowledge, attitude and practices in patients with Hypothyroidism in India. *Thyroid Res Pract*. 2018; 15:15–22. [https://doi.org/10.4103/trp.trp\\_25\\_17](https://doi.org/10.4103/trp.trp_25_17).
  25. Singh A, Sachan B, Malik NP, Sharma VK, Verma N, Singh CP. Knowledge, Awareness and Practices (KAP) among patients with thyroid swelling attending cytology clinic in a medical college. Meerut. *Scholars J Appl Med Sci*. 2013; 1:793–5.
  26. Alqurashi KA, Aljabri KS, Bokhari SA. Prevalence of diabetes mellitus in a Saudi community. *Ann Saudi Med*. 2011; 31(1):19–23. PMID: 21245594 PMCID: PMC3101719. <https://doi.org/10.4103/0256-4947.75773>.
  27. Al-Nozha MM, Al-Maatouq MA, Al-Mazrou YY, Al-Harthi SS, Arafah MR, Khalil MZ, et al., Diabetes Mellitus in Saudi Arabia. *Saudi Med J*. 2004; 25(11):1603–10.
  28. Hamadeh RR. Noncommunicable diseases among the Bahraini population: A review. *East Mediterr Health J*. 2000; 6:1091–7.
  29. Al-Lawati JA, Al Riyami AM, Mohammed AJ, Jousilahti P. Increasing prevalence of Diabetes Mellitus in Oman. *Diabet Med*. 2002; 19:954–7. PMID: 12421434. <https://doi.org/10.1046/j.1464-5491.2002.00818.x>.
  30. Minmini S, Suvetha K. Focus on primary prevention: A study on awareness of Diabetes Mellitus and its

- complications among offsprings of diabetes patients. *Nat J Res Community Med.* 2016; 5(4):196–201.
31. Foma MA, Saidu YI, Omoleke SA, Jafali J. Awareness of Diabetes Mellitus among diabetic patients in the Gambia: A strong case for health education and promotion. *BMC Public Health.* 2013; 13:1124. PMID: 24304618 PMCID: PMC3913398. <https://doi.org/10.1186/1471-2458-13-1124>.
  32. Al Shafae M, Al-Shukaili S, Rizvi S, Al Farsi Y, Khan M, Ganguly S, et al., Knowledge and perceptions of diabetes in a semi-urban Omani population. *BMC Public Health.* 2008; 8(1):249. PMID: 18644163 PMCID: PMC2517595. <https://doi.org/10.1186/1471-2458-8-249>.
  33. Avi B, Colford J. Prevalence and treatment of diabetes in rural Tanzania. Stephenson R, Hennink M, ed. *Asia Pac Pop J.* Vol. 19. Berkeley: University of California at Berkeley; 2012; 2004:5–26.
  34. Han C, He X, Xia X, Li Y, Shi X, Shan Z, et al., Subclinical Hypothyroidism and type 2 diabetes: A systematic review and meta-analysis. *PLoS One.* 2015; 10(8):e0135233. PMID: 26270348 PMCID: PMC4535849. <https://doi.org/10.1371/journal.pone.0135233>.
  35. Junik R, Kozinski M, Debska-Kozinska K. Thyroid ultrasound in diabetic patients without overt thyroid disease, *Acta Radiologica.* 2006; 47(7):687–91. PMID: 16950706. <https://doi.org/10.1080/02841850600806308>.
  36. Wang C. The relationship between Type 2 Diabetes Mellitus and related thyroid diseases. *J Diabetes Res.* 2013; 2013:390534. PMID: 23671867 PMCID: PMC3647563. <https://doi.org/10.1155/2013/390534>