P. Sharma et al. (2021) Int. J. Appl. Sci. Biotechnol. Vol 9(3): 169-175.
DOI: 10.3126/ijasbt.v9i3.39863

ISSN (Online): 2091-2609
DOI Prefix: 10.3126/ijasbt

International Journal of Applied Sciences and Biotechnology (IJASBT)

Research Article

Prevalence of Thyroid Disorder in Residents of Western Region of Nepal

Preeti Sharma[1]*, Namarata Thapa Magar[1], Mahesh BK[2]

[1]Gandaki Medical College &Teaching Hospital, Pokhara, Nepal
[2]Hebei North University, Hebei, China

Article Information

Received: 25 June 2021
Revised version received: 10 September 2021
Accepted: 14 September 2021
Published: 29 September 2021

Cite this article as:
P. Sharma et al. (2021) Int. J. Appl. Sci. Biotechnol. Vol 9(3): 169-175. DOI: 10.3126/ijasbt.v9i3.39863

***Corresponding author**
Preeti Sharma,
Gandaki Medical College &Teaching Hospital, Pokhara, Nepal.
Email: preeetisharma@rocketmail.com

Peer reviewed under authority of IJASBT

Abstract

Thyroid disorder, such as goiter, hypothyroidism, and hyperthyroidism, are leading health problems in Nepal. Owing to geographical and environmental factors, iodine deficiency is prime cause of thyroid disorder. The objective of study to estimate the prevalence of thyroid disorder in residents of western region of Nepal (Pokhara valley). **Materials & Methods:** The study design was hospital based retrospective study. The data of T3, T4, TSH was collected from subject visiting Department of Biochemistry at Gandaki Medical College Teaching Hospital and Research Centre, Nepal. The samples was collected, serum was separated and thyroid hormones was assayed by Enzyme linked Immunosorbent assay kit from RFLC (India). **Result:** The total study population was 2248 cases of which 580 (male) and 1668 (female) were enrolled in the study. The prevalence of thyroid disorder was 22.42 % in western region. Subject with hypothyroidism was 12.41% (279) & subject with hyperthyroidism were 10.41% (234) respectively. Female subject of age (15-44) years had a hypothyroidism, i.e. 52.83% (112). About 73.15% (109 out of 149 subjects) were female cases suffered from subclinical hypothyroidism. The thyroid disorder found most prevalent in reproductive age group in female residents in our study. **Conclusion:** Hypothyroidism is prevalent in all age group of female residents of western region of Nepal.Our study conclude that hypothyroidism and subclinical hypothyroidism found more prevalent in reproductive age group in residents of western region of Nepal.

Keywords: Thyroid disorder; Hypothyroidism; Subclinical hypothyroidism; Iodine Deficiency; Residents

Introduction

Thyroid disorder such as goiter, hypothyroidism, hyperthyroidism, is a major health problem found in Nepal (Baral *et al*.,2000). Nepal, a landlocked country, where most of the area covered by Himalayan and hilly region and abundant of population reside, lies in area of severe ambient iodine deficiency region (Vanderpump, 2005; Shrestha *et al*., 2007). The prevalence rate of thyroid dysfunction from previous studies was found to be around 30%. Mentioned that 0.2% of death in Nepal are caused by endocrine disorder of which iodine deficiency disorder was the major cause (Ganie and Zargar, 2007). Nepalese find that the prevalence of iodine deficiency is high, so they are at high risk of thyroid dysfunction (Gelal *et al*., 2009). About 1/3th of a world population reside in area of iodine deficiency it is mention that iodine deficiency is common cause for thyroid disorder, worldwide. (Peter, 2009)

Two major types of thyroid disorder are hypothyroidism & hyperthyroidism. Hypothyroidism results from reduced secretion of both thyroxin & tri-iodothyronine. Biochemically, decrease in T3 & T4 concentration leads to increase secretion thyroid stimulating hormone from the

pituitary gland & amplify increase in serum TSH. Hypothyroidism result from inadequate production of thyroid hormone, classified as overt /subclinical based on degree of the clinical severity & extent of abnormalities in thyroid hormone levels. Subclinical hypothyroidism is a condition (asymptomatic) which is usually asymptomatic, in which free T3 & T4 levels are within reference range & TSH level are above reference range. Overt hypothyroidism refers to high level of TSH & low level of circulating T3 &T4 (Peter, 2009). Hypothyroidism, clinically, a common condition, with prevalence rate of 2% in adult women and the prevalence rate of 0.2% in adult men (Asmelash *et al*., 2019).

The various factors such as age, gender, race, and geographic location play a huge role in the prevalence of thyroid diseases and the most common iodine intake The scope of thyroid diseases includes goiter, cretinism, hypothyroidism, brain damage, miscarriage, stillbirth, mental retardation, psychomotor deficits and hearing and speech .Iodine deficiency is the single most important cause of preventable brain damage and mental retardation in the world (Kochupillai, 2000; Hetzel *et al*., 2004; WHO/UNICEF/ICCIDD, 2008).

Hypothyroidism, a common disease, that women suffer from is eight times the reproductive age of men (Peter, 2009). According to the recommendations of the American Thyroid Association, adult should be screened for thyroid disease by measuring serum TSH concentration from age group of 35- years-old age group and then repeating it every 5 years globally (Ladenson *et al*., 2000). The research plan assesses the prevalence of various thyroid disorder based on the gender, age group, age and gender of residents in western region (Pokhara Valley) of Nepal. The purpose of this study was to evaluate prevalence rate of thyroid disorder among residents of Western Nepal (Pokhara Valley).

Material and Methods

The study design is based on a retrospective study of the hospital. The data of Free T3(Thyronine), FreeT4 (Thyroxine) and TSH (Thyroid Stimulating Hormone) was collected from the serum of the subjects who was the residents of Western region of age group (1-100) years visiting Biochemistry laboratory at Gandaki Medical College Teaching Hospital and Research Centre from 1st February 2013 to 28th February 2014. The total study population visiting biochemistry laboratory during a year was 2248 cases. Amongst them, 25.80% (580) cases were male population and 74.19% (1668) cases were female population visiting biochemistry laboratory at Gandaki Medical College Teaching Hospital and Research Centre Pokhara, Nepal. The Ethical review has been approved from institutional research ethical committee of Gandaki Medical College and Teaching Hospital and Research Centre.

Inclusion Criteria

a) All subject of age group from (1-100) year was enrolled in this study.
b) Subject visiting to Department of Biochemistry during a year was enrolled in this study.
c) The subject with thyroid disorder was only included in study.

Exclusion Criteria

a) The age groups below1 year, was excluded from the study.
b) Those cases which do not meet the T3, T4 & TSH criteria, were excluded from the study.
c) Duplication of person was excluded from study.
d) Pregnant females were excluded from the study.

Collection of Blood Sample

Venous blood sample (2-3) ml collect from anterior cubital vein in a petric dish vial, allowed it to coagulate and then separate the subsequent serum by centrifugation at 3000rpm for 10 min & stored at -20^{o}C until thyroid hormones is estimated. The thyroid hormone was assayed by Enzyme linked Immunosorbent assay kit from RFLC, India. The reference range used was for Free T3 (1.4-4.42 pg/ml), Free T4 (0.8- 2 pg/ml) & TSH (0.39-6.16I U/ml).

Thyroid function was considered normal (Euthyroidism) when subject had all three hormones within reference range. Hyperthyroidism refers to elevated T3, T4 & lower than normal TSH. Hypothyroidism refers to a decrease in T3, T4 & increase in TSH. Subclinical hypothyroidism (T3, T4 normal but elevated TSH level) (Peter, 2009; Helfend & Redfen, 1998). The classification is based on gender, age-wise distribution of cases, classification of cases based on serum TSH level, age-sex wise distribution of cases etc were parameters to be analysed in our study.

Statistical Analysis

Statistics is defined as the science of collection, organization and interpretation of data. It deals with all aspects of all this including the planning of the data collection in terms of the design of survey and experiment.

The data was entered into Microsoft excel 2010 & analyzed by statistical package for social science (SPSS version16). The data was presented as Mean ± SD. (mean and standard deviation).

Result

In this study, total 2248 subjects were enrolled from 1st February 2013 to 28th February 2014. Among this subject, 25.8% (580) represent male & 74.2% (1668) represent female (Table 1). Similarly, subject with high TSH was 12.41% (279) & subject with low TSH were 10.41% (234) (Table 2 & Fig. 1). Age wise distribution of all the case in various group shown in Table 2 & represent majority of population belong to age group (15-44) years about 51.47% (1157). Serum hormone level in each group are shown in

Table 3 &4. Female subject of age (15-44) years had a higher TSH, i.e., 52.83% (112) shown in table 5. In addition, Table 2 & 3 show that (279 out of 2248 subjects), 12.41% suffered from hypothyroidism. Similarly, table 3 & 4, shows that 53.40% of 149 of the 279cases have subclinical hypothyroidism. Similarly, in Table 5, the age - sex wise distribution of subclincal hypothyroidism subject represents that 43% (17) of shows male & 54.13% (59) were female between age group 15-44year.About 73.15% (109 out of 149 subjects) were female cases suffered from subclincal hypothyroidism.

Table1: Classification based on Gender

Sex	**Number**	**%**	**Mean age ± SD**
Male	580	25.8%	46.81 ± **19.239**
Female	1668	74.2%	43.29 ± **15.953**
Total n=2248			44.20 ± **16.928**

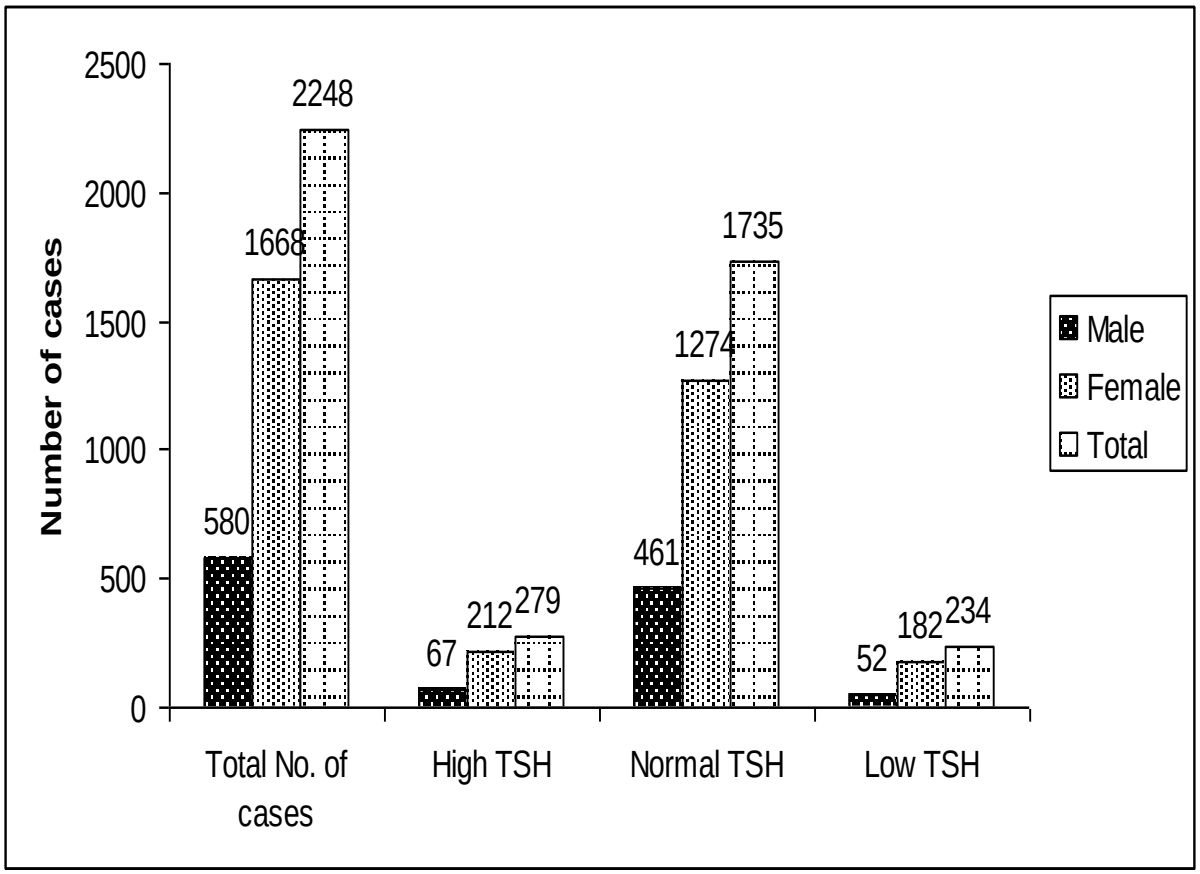

Fig. 1: No of cases in each (High TSH, Normal TSH, Low TSH).

Table 2: Age- wise distribution of all the cases

Age group Years	**Total n=2248**	**Total Male n=580**	**Total Female n=1668**	**High TSH (Hypothyroidism) n=279**	**Normal TSH (Euthyroidism) n=1735**	**Low TSH Hyperthyroidism n=234**
0-14	27	12	15	2	23	2
15-44	1157	257	900	140	918	99
45-100	1064	311	753	137	794	133

Table 3: Serum Hormone Levels

Classification	**Serum Hormone Levels Mean ± SD**		
	T3	**T4**	**TSH**
Reference range	1.4-4.2	0.8-2.0	0.39-6.16
Total n= 2248	2.725 ± 1.338	1.246±0.613	3.557±5.599
High TSH n=279	1.658±0.591	0.820±0.786	14.997±9.40
Normal TSH n=1735	2.682±0.869	1.215±0.396	2.177±1.388
Low TSH n=234	4.317±2.70	1.982±0.974	0.152±0.102

Table 4: Hormone levels in various SH group

SH groups	**Serum Hormone Levels Mean ± SD**		
	T3	**T4**	**TSH**
Reference range	1.4-4.2	0.8-2.0	0.39-6.16
Total SH n= 149	1.989±0.509	0.987±0.182	9.674±4.780
SH Male n=40	2.036±0.494	1.005±0.205	8.458 ±2.630
SH Female n=109	1.971±0.516	0.981±0.174	10.120±5.297

Table 5: Age-sex wise distribution of cases in High TSH and SH groups

Age Group	**High TSH**		**SH**	
	Males n=67	**Females n=212**	**Males n=40**	**Females n=109**
0-14	0	2 (0.94%)	0	2 (1.83%)
15-44	28 (41.79%)	112 (52.83%)	17 (43%)	59 (54.13%)
45-100	39 (58.21%)	98 (46.23%)	23 (58%)	48 (44.04%)

Discussion

The objective of this study was to evaluate the prevalence of thyroid disorder among patients visiting the Department of Biochemistry, Gandaki Medical College Teaching Hospital and Research Centre, Pokhara. The prevalence rate of thyroid disorder in Pokhara valley was 22.42%.

A study showed that 30 % of the populations in eastern Nepal suffers from thyroid dysfunction (Baral *et al*.,2000). Similarly, study conducted revealed the prevalence of thyroid disease was 36% (Mahato *et al*., 2013) another study showed that thyroid function abnormalities was 15.8%, (Abraham *et al*., 2009) which shows a similar report to our study. Various studies conducted on the global prevalence of hypothyroidism. Various studies have presented with significant differences. The subclinical level of hypothyroidism 1% to 20% and the prevalence of hypothyroidism is 1-2% (Aminorroaya *et al*., 2009)

In our study, we found that 74.19% of subject were female cases. This fact indicates that females are more prone to thyroid dysfunction and similar findings were showed (Ladenson *et al*., 2000; Mahato *et al*., 2013). It was found that among the subjects undergoing thyroid function tests, female's thyroid disorder was five times that of men, indicating that goiter is a more common disease among female (Baral *et al*., 2000; Vanderpump *et al*., 2005; Bhutia *et al*., 2016).

This study showed that 12.41% of subjects had hypothyroidism & 10.41% subjects had hyperthyroidism. Similar results were found by the study conducted at eastern Nepal and G.B. Pant hospital. According to Whitley 1998, mentioned that prevalence of hypothyroidism (2-15%) usually higher in females than comparison with male among general population (Baral *et al*., 2000; Jha &Ahmed, 2013; Bhutia *et al*., 2016).

The prevalence of thyroid dysfunction may be due to geographic location and pattern of iodine deficiency therefore. (Mahato *et al*., 2013). Nepal is located on one of a disaster-striken areas of South East Asia due to iodine deficiency. In this area, due to repeated flooding & glaciation iodine gets leached out of upper crust of earth leading to environmental iodine deficiency (Vanderpump *et al*., 2005; Bhutia *et al*., 2016).

In our study, 53.40% (279) of subjects had subclinical hypothyroidism, 46.59% of the subjects had overt hypothyroidism. Between them,73.15% (109), females had hypothyroidism and almost all populations had subclinical hypothyroidism lies in age group (15-44) years. This age group presented with high prevalence of thyroid diseases has high number of patients of thyroid disorder between age group (21-35) suffered from thyroid disorder and female were more vulnerable to thyroid disorder (Vanderpump *et al*., 2005; Jha & Ahmed, 2013; Bhutia *et al*., 2016).

In addition, subclinical hypothyroidism is more common than overt hypothyroidism, with a prevalence of 1.4–7.8% in the elderly and women. The highest proportion of subclinical hypothyroidism cases was found, especially in the female age group (20-59) years old. This indicates that subclinical hypothyroidism is more common in women, similar to our results, which indicate that (73.15%) of the female population suffers from subclinical hypothyroidism (Rohil *et al*., 2010). The prevalence of hypothyroidism ranges from 2% to 4%, mainly due to TAI. SCH is more common in female of childbearing age, up to 10%. Thyroid disease is more common in women than men and reaches peaks during the reproductive period which indicates a relationship between thyroid function and steroid production. Pathophysiological observations support the human hypothesis that changes in thyroid hormone production may damage the hypothalamus-pituitary ovaries and impair follicle formation (Poppe *et al*., 2020).

But our research on hypothyroidism and subclinical hypothyroidism is more common in the reproductive age group, and there are no patients with abnormal thyroid function in the reproductive age group. Some studies have shown that thyroid disease in the elderly is No gender differences were observed, which is contrary to our research (Bensenor *et al*., 2011).

Hypothyroidism increases with age and is most common in women and patients diagnosed with goiter (Wang *et al*., 1997). By Shaw *et al*. Throughout 2006, the incidence of hypothyroidism increased with age. We found the same trends in our in research. Hence, hypothyroidism mention as common thyroid disorder in a larger group of population. (Tunbridge *et al*.,1977).

Children below 15 years have existed with hypothyroidism which may be related with iodine deficiency disorder or Down's syndrome, which retards physical & mental growth & development (Das *et al*.,2007). In addition other studies have shown that the prevalence of goiters in female children is higher than in male (Gupta *et al*., 2016). Among the children under the age of 15 in our study, female have higher a proportion of hypothyroidism than male. Hence, hypothyroidism increase with age, which supports our study.

Recent studies have shown that compared with men, women have a higher incidence of hypothyroidism in the 21 to 30 age group (Bhutia *et al*., 2016). In other studies, thyroid disorder prevalence in women is higher at that of men. A study in dharan indicate thyroid disorder associated with diabetes, smoking, hypothyroidism, especially more prevalent in female gender (Khaitwada *et al*., 2015). So, thyroid disorder it with other risk factor found to higher in female gender, which again supports our study, female are more prone to thyroid disorder.

Research conducted in Ghana showed that compared with men, female subjects with T2DM had a three-fold in increase in thyroid autoimmune risk. This study a had a significantly higher representation of females. The frequency of thyroid autoimmunity in Ghanaian T2DM patients is significantly higher, and its existence is significantly related to thyroid dysfunction, females, hypercholesterolemia and hyperglycemia Therefore, it is necessary to screen patients with type 2 diabetes, especially women with hypothyroidism, which provides support for our research (Sarfo-Kantanka *et al*., 2017). Similarly, the various thyroid disorder are more common in females and the overall incidence would be increased along with aging for both genders especially for the females. In diabetic patients and prediabetic patients, the incidence of thyroid disease in women is significantly higher than that in men, which is consistent. This study shows that these factors related to thyroid disease have a greater impact on female residents (Du *et al*., 2019).

Conclusion

These hospital-based studies and results can be used as benchmarks for further research. Our research shows that in female patients in the western region, thyroid disorder is usually hypothyroidism and subclinical hypothyroidism is higher in residents of western region. Female cases were found to be more common in the age group (15-44), but the cause is unknown. In addition, the disease is predominantly found in female cases.

Limitation of Study

The study was hospital based; it doesn't represent the general population. The TSH test tool is used to screening for thyroid diseases, but a complete thyroid plate is required to accurately diagnose and evaluate thyroid disorder. Our research is based on thyroid function test, serum-free T3, T4 and TSH measurement. But including total T4, total T3 and thyroglobulin, anti-thyroxine peroxidase, anti-thyroglobulin, TSH receptor antibody and TSH immunoglobulin test can rule out thyroid disease. The cut-off values of thyroid hormone (T3, T4 &TSH) used was recommended by manufacturers because Nepal lacks its own reference interval for thyroid function test.

Acknowledgement

Authors are grateful to Miss Supriya Sharma and Mr. Sunil Kumar Yadav for their assistance with the database. The authors express thankful to Department of Physiology and

Department of Biochemistry for their assistance during this research.

Financial Support

The Authors declares that there is no financial support.

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

Authors' Contribution

Ms Preeti Sharma, designed the research plan, collected the data. Then, she revised the manuscript as for intellectual content and finally, she approved the manuscript. Ms Namrata Thapa Magar has analysis the data and finally prepared for manuscript. Dr. Mahesh BK prepare the manuscript. Finally, final form of manuscript was approved by all authors.

References

Abraham R, Murugan VS, Pukazhvanthen P and Sen SK (2009) Thyroid disorders in women of Puducherry. *Indian J Clin Biochem* **24**: 52-59. DOI: 10.1007/s12291-009-0009-y

Aminorroaya A, Janghorbani M, Amini M, Hovsepian S, Tatbatbaei A and Fallah Z (2009) The prevalence of thyroid dysfunction in an iodine sufficient area in Iran. *Arch Iran Med* **12**(3): 267-270.

Asmelash D, Tesfa K and Biadgo B (2019) Thyroid Dysfunction and Cytological Patterns among Patients Requested for Thyroid Function Test in an Endemic Goiter Area of Gondar, North West Ethiopia. *International Journal of Endocrinology*. 2019, Article ID 9106767, 7 pages. DOI: 10.1155/2019/9106767

Baral N, Lamsal M and koner BC (2000) Thyroid dysfunction in eastern Nepal. *South Asian J. Trop Med Public Health* 33: 638- 641.

Bensenor IM, Goulart AC, Lotufo PA, Menezes PR and Scafua M (2011) Prevalence of thyroid disorder among older people result from Sao Paulo Ageing &health study. *Cad. Saúde Pública*, Rio de Janeiro, 27(1):155-161. DOI: 10.1590/S0102-311X2011000100016

Bhutia SC, Bhutia KL and Singh TA (2016) Thyroid dysfunction in central referral hospital, Sikkim. *Asian Journal of Biomedical and Pharmaceutical Sciences* 6(56): 17-19.

Das BKL, Baral N, Shyangwa P, Toora BD and Lamsal M (2007) Altered serum levels of thyroxine, triiodothyronine and thyroid stimulating hormone in patients with depression. *Kathmandu Univ Med* J **5**(3): 330–334.

Du W, Wang F, Zhao M, Zhang H, Zhang X, Zhao J, Gao L (2019) Prevalence of thyroid disorders and associated risk factors with various glycemic status in North China. *Biotechnology & Biotechnological Equipment* **33**(1): 1244-1250. DOI: 10.1080/13102818.2019.1656106

Ganie MA and Zargar AH (2007) Scenario of endocrinology in South Asia. *India Endocrinol Metabol* **11**: 1-2.

Gelal B, Aryal M, Das BKL, Bhatta B, Lamsal M and Baral N (2009) Assessment of iodine deficiency status among school children of Nepal by urinary iodine assay. *South Asian J trop med public health* **40**: 538-543.

Gupta VP, Patel PB, Kambo A, Paul J and Mohapatra SC (2016) Prevalence of Goitre among primary school children in the Mewat area of Haryana. *The Journal of Community Health Management April* **3**(2): 67-72. DOI: 10.5958/2394-2738.2016.00013.3

Helfand M and Redfern CC (1998) Clinical guideline, part 2. Screening for thyroid disease: an update American College of Physician. *Ann Intern Med* **129**: 144-158. DOI: 10.7326/0003-4819-129-2-199807150-00020

Hetzel BS, Delange F, Dunn JT, Ling J, Mannar Venkatesh, Pandav CS (2004) editors. Towards the global elimination of brain damage due to iodine deficiency -- a global program for human development with to a model applicable to a variety of health, social and environmental problems. International Council for the Control of Iodine Deficiency Disorders. New Delhi: Oxford University Press. Available from: http://www.iccidd.org/cm_data/hetzel-a-frontpage.pdf, accessed on April 1, 2016

Jailkhani R, Ramchandraya SA, Patil VS and Sameena (2015) A hospital-based study of prevalence of thyroid dysfunction in Srinagar. *Int J Med Sci Public Health* **4**(2): 151-154. DOI: 10.5455/ijmsph.2015.0310201433

Jha S and Ahmad N (2013). Prevalence of thyroid dysfunction in the patients visiting tertiary Heath care Hospital, Faridabad; Haryana, *International Journal of Scientific Research* **2**(10): 1-2.

Khatiwada S, Rajendra KC, Sah SK, Khan SA, Chaudhari RK, Baral N, Lamsal M (2015) "Thyroid Dysfunction and Associated Risk Factors among Nepalese Diabetes Mellitus Patients", *International Journal of Endocrinology* 2015, Article ID 570198, 5 pages. DOI: 10.1155/2015/570198

Kochupillai N (2000) Clinical endocrinology in India. *Current Science* **79**: 1061-1067.

Ladenson PW, Singer PA, Ain KB, Bagchi N, Bigos ST, Levy EG, Smith SA and Daniels GH (2000) American Thyroid Association guidelines for detection of thyroid dysfunction. *Archives of internal medicine.* **160**(11): 1573-1575. DOI: 10.1001/archinte.160.11.1573

Mahato RV, Jha B, Singh KP, Yadav BK, Shah SK and Lamsal M (2015) Status of Thyroid disorders in Central Nepal:A Tertiary Care Hospital based study. *Int J App Sci Biotechnol* **3**(1): 199-122. DOI: 10.3126/ijasbt.v3i1.12218

Mahato RV, Nepal AK, Gelal B, Poudel B, Yadav BK, Lamsal M (2013) Spectrum of thyroid dysfunction in patient visiting kantipur Hospital, Kathmandu, *Nepal Mymensingh Med J* **22**(1): 164-169.

Peter PAS (2009) Epidemiology of thyroid dysfunction hypothyroidism & hyperthyroidism. *Thyroid International* **2**: 1-16.

Poppe K, Bisschop P, Fugazzola L, Minziori G, Unuane D, Weghofer A (2020) 2021 European Thyroid association Guideline on Thyroid Disorders prior to and during assisted Reproduction. *Eur Thyroid J* 9: 281-295. DOI: 10.1159/00051279

Rohil V, Mishra AK, Shrewastawa MK, Mehta KD, Lamsal M, Baral N &*et al* (2010) Subclincal hypothyroidism in eastern Nepal hospital-based study. *Kathmandu Univ Med. J* **8**: 265-268.

Sarfo-Kantanka O, Sarfo FS, Ansah EO, Yorke E, Akpalu J, Nkum BC and Eghan B (2017) Frequency and determinants of thyroid autoimmunity in Ghanaian type 2 diabetes patients: a case-control study Sarfo-Kantanka *et al. BMC Endocrine Disorders* **17**: 2. DOI: 10.1186/s12902-016-0152-4

Shaw CK, Thapalia A, Nanda S and Shaw P (2006) Thyroid dysfunction in Down Syndrome. *Kathmandu Univ Med J* **4**(2): 182–186.

Shrestha S, Das BK, Baral N and Chandra L (2007) Association of metabolic syndrome and its component with thyroid disease in females. *Int'l J Diabetes in Developing Countries* 27: 24-26. DOI: 10.4103/0973-3930.34754

Tunbridge WMG, Evered DC, Hall R, *et al* (1977) The spectrum of thyroid disease in a community: the Whickham survey. *Clin Endocrinol*. 7: 481–83. DOI: 10.1111/j.1365-2265.1977.tb01340.x

Vanderpump MPJ **(**2005**)** The Epidemiology of thyroid diseases**.** In: Braverman LE and Utiger RD (Ed) Werner and Ingbar's The Thyroid**:** A Fundamental and Clinical Text", 9/E. JB Lippincott-Raven, Philadelphia, pp 398-406.

Wang C, Crapo LM (1997) The epidemiology of thyroid disease &implication for screening. *Endocrinol meta Clin North Am* 26(1): 189-218. DOI: 10.1016/S0889-8529(05)70240-1

WHO/UNICEF/ICCIDD (2008) Assessment of Iodine Deficiency Disorders and monitoring their elimination: A Guide for programme managers. 3rd eds. Available: https://apps.who.int/nutrition/publications/micronutrients/iodine_deficiency/9789241595827/en/index.html