PACIFIC JOURNAL OF MEDICAL SCIENCES

{Formerly: Medical Sciences Bulletin}

ISSN: 2072 – 1625

Pac. J. Med. Sci. (PJMS)

www.pacjmedsci.com. Email: pacjmedsci@gmail.com.

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ABSTRACT:
Thyroid Function Tests are used for assessing the thyroid status of an individual. In the Solomon Islands blood samples for thyroid function tests are collected and sent to the Royal Brisbane Hospital Laboratory in Australia on a weekly basis. The major objective of this study was to use the thyroid function tests results obtained over the period 2008 to 2012 to retrospectively assess the prevalence of thyroid dysfunction in the Solomon Islands. This study used convenience sampling that included all the 2070 requests for thyroid function tests from 2008 to 2012 recorded in the registry books in the Clinical Biochemistry Department in the National Medical Laboratory Pathology Division in the National Referral Hospital in Honiara Solomon Islands.
The data collected were analyzed using Microsoft excel for Windows 8 and the Statistical Packages for Social Sciences version 20 for Windows. Ethical clearance and permission were obtained from the appropriate authorities. A total of 1485 (71.7%) recorded results were used for data analysis. Thyroid disorders were prevalent in 51.5% of the patients in 2008, 43.9% of the patients in 2009, 54.8% of the patients in 2010, 52.6% of the patients in 2011 and 51.8% of the patients in 2012. The prevailing thyroid disorder in each of the five years was primary hyperthyroidism, 36.4% in 2008, 25.8% in 2009, 31.5% in 2010, 28.7% in 2011 and 28.2% in 2012. The number of thyroid function tests requests for females was about twice that of males in all the various years. Prevalence of primary and subclinical hyperthyroidism was significantly higher among the female patients compared to the male patients in all the various years.

Keywords: Thyroid function tests, Solomon Islands, hyperthyroidism,
Submitted: May 2014; Accepted: July 2014

INTRODUCTION:

The Thyroid glands synthesize and release the thyroid hormones, Thyroxine (T4) and Triiodothyronine (T3). This process is regulated by Thyroid Stimulating Hormone (TSH) produced in the anterior lobe of the pituitary gland, which is regulated by Thyrotropin Releasing Hormone (TRH) produced in the Hypothalamus [1 – 3]. The regulation occurs via the Hypothalamic-Pituitary-Thyroid axis (HPT axis) [1 – 3]. The thyroid gland releases mainly T4, which is de-iodinated to T3 in target tissues containing the Deiodinase with Seleno-Cysteine [3]. The thyroid hormones are transported in blood mainly bound to Thyroxine-Binding Globulin (TBG). The actions of thyroid hormones are carried out by the very limited unbound fractions (FT4 and FT3) in blood plasma [1 – 3]. FT3 is the biologically active form of the thyroid hormones, because it binds to receptors and triggers end-organ effects [1 – 3]. The level of TSH in blood is inversely related to the levels of FT4 and FT3 in blood, a process regulated via the negative feedback control of the HPT axis, which is essential for maintenance of normal thyroid function [1 – 3]. Thyroid Function Tests (TFT) is the recommended biochemical tests for assessing the thyroid status of an individual [1 – 5]. The TFT involve assessing the serum or plasma levels of TSH, FT4 and FT3. The request for TFT can be for serum or plasma TSH alone, a combination of TSH and FT4, or for TFT [1 – 5]. In most circumstances the clinicians select the type of TFT that is most appropriate to diagnose or exclude thyroid dysfunction [2, 5]. The assay of serum TSH level is considered as the most sensitive, specific and reliable first step for assessing the thyroid status in both overt and subclinical thyroid dysfunction [2, 4 – 6]. However, the TSH test alone is not absolute in diagnostic accuracy, which can be enhanced by careful selection of the combination of TFT [4, 5]. Thus, for reliable diagnoses to be made the complete TFT should be requested at least once for an individual with thyroid dysfunction, or a strong clinical suspicion of thyroid dysfunction [4, 5].

According to Dayan [4] six different combinations or panels of TFT results can occur in clinical practice. The six panels are [4]: Low TSH, Raised FT4 or FT3: indicative of Primary Hyperthyroidism; Low TSH, Normal FT4 or FT3: indicative of subclinical Hyperthyroidism; Raised TSH, Low FT4 or FT3: indicative of Primary Hypothyroidism; Raised TSH, Normal FT4 or FT3: indicative of Subclinical Hypothyroidism; Low or Normal TSH, Low FT4 or FT3: indicative of non-thyroidal illness (Euthyroid sick syndrome); Normal or Raised TSH, Raised FT4 or FT3: indicates discordant result.

TFT results can be classified as concordant or discordant [4]. Concordant is indicated when the TSH, FT4 or FT3 results indicate the same

findings or they agree as in Euthyroid, Hyperthyroid or Hypothyroid. Discordant is indicated when the TSH, FT4 or FT3 results are contradictory, because they do not indicate the same findings [4].

In most developed countries TFT are routinely used for screening, diagnosis and monitoring treatment of patients with suspected or overt thyroid dysfunction [2, 5, 7]. In some resource limited countries TFT are used in very limited clinical settings, mainly for the diagnosis of patients with suspected thyroid dysfunction. The blood samples are collected from the patients, the serum or plasma samples obtained are then sent to laboratories outside the country for the assay of TFT. In these resources limited countries it is important to regularly assess the TFT results in order to determine the prevalence and trend of thyroid dysfunction among the population.

The Solomon Islands is one of the resource limited countries in which TFT are done outside the country. Blood samples are collected and serum samples are prepared and sent to the Royal Brisbane Hospital Laboratory in Australia on weekly basis. Although this process has been in place for several years, there are no published data on the prevalence of thyroid dysfunction among the population in the Solomon Islands.

Results obtained in a recent study on the status of iodine nutrition among school-age children in Honiara, Solomon Islands indicated successful implementation of the universal salt iodization (USI) strategy [8]. The report further indicated that iodine deficiency was not a public health problem among schoolchildren, age 6 – 12yrs, in Honiara, Solomon Islands. The reported median urinary iodine concentration (UIC) for all the children was 328.0ug/L and the Inter-quartile range was 210.4 – 437.0ug/L. In addition, a total of 257 (55.6%) children had UIC over 300.0ug/L, which indicates risk of developing adverse health consequences. The authors also reported that 170 (36.8%) children had UIC in the 300.0 to 500.0ug/L range and 87 (18.8%) had UIC greater than 500.0ug/L, which indicates Iodine Induced Hyperthyroidism (IIH). The data reported in this study strongly indicates the need to assess the thyroid status of the population.

The major objective of the present study was to use the TFT results obtained over the period 2008 to 2012 to retrospectively assess the prevalence of thyroid dysfunction in the Solomon Islands.

SUBJECTS AND METHODS:

The Solomon Islands have six main islands and nine provinces. Seven of these nine provinces have one public hospital each. There are three private hospitals, one in the Western province, one each in Malaita and Choiseul provinces [9 – 11]. The major general hospital that also serves as the National Referral Hospital (NRH) for all the nine provinces is located in Guadalcanal, which is the biggest province in the Solomon Islands [9 – 11].

Honiara the capital city and main administrative centre in the Solomon Islands is also located in Guadalcanal.

The specific site for this retrospective hospital based study was the Clinical Biochemistry Department (CBD) in the National Medical Laboratory Pathology Division (NMLPD) in the NRH, Honiara, Solomon Islands. All samples for TFT from the public and private hospitals in Solomon Islands are sent to the CBD in the NMLPD NRH for registration and shipment to the Royal Brisbane Hospital Laboratory (RBHL) in Australia on a weekly basis. The TFT results are sent back to the CBD NMLPD NRH, where the results are recorded before they are released to the appropriate clinicians in the various hospitals.

This study used convenience sampling that included all the TFT recorded in the registry books in the CBD in NMLPD NRH from 2008 to 2012. The information collected from the registry books included, laboratory identification number (ID) and name of each patient, age, gender, tests requested, date the sample was received, date the sample was sent to RBHL in Australia, date the results were received from RBHL and the TFT results obtained. In the books the age for most of the patients was registered as adult. The laboratory ID and names were use to identify patients with more than one tests per year. The recorded reference ranges were those used in the RBHL; they are TSH: 0.3 to 4.5mU/L, FT4: 7.0 to 17.0pmol/L and FT3: 3.5 to 6.0pmol/L.

The data collected were analyzed using Microsoft excel for Windows 8 and the Statistical Packages for Social Sciences (SPSS) version 20 for Windows.

Ethical clearance and permission for this study were obtained from the Ministry of Health and Medical Services (MHMS), Honiara, Solomon Island and the ethics and research grant committee in the School of Medicine and Health Science (SMHS) in the University of Papua New Guinea (UPNG).

RESULTS:

A total of 2070 TFT requests were recorded in the registry books in the CBD NMLPD NRH during the period 2008 to 2012. All the 2070 plasma samples were collected and sent to RBHL in Australia for analyses. According to the records, of the 2070 samples a total of 1485 (71.7%) were completed and results recorded. The results for 120 (5.8%) samples were received but not recorded, results for 403 (19.5%) samples were not returned and 62 (3.0%) samples were recorded as insufficient. Further analysis of the 2070 requests indicated that 296 (14.3%) were repeated cases or follow ups of patients and 1774 (85.7%) were new patients. All repeated and follow up results were excluded from further analysis of the data; furthermore, most of the repeated and follow up results were among those not recorded and those not returned. In the present study the mean age, age range and age groups of the patients in the various years were not

determined because "adult" was entered in the age column for over 75% of the patients in the various years.

Table 1 shows the distribution of the 2070 TFT requested and sent for analysis in the various years. From 2008 to 2011 a gradual increase was recorded in the number of TFT requested and sent for analysis. The lowest request (342) was made in 2008 and the highest (483) was made in 2011. In 2012 the number (378) of TFT requested and sent for analysis was 21.7% lower than the 2011 requests. The total number (%) of TFT completed and results received in the various years are also presented in Table 1. The combination of TFT requested and completed in the various years is presented in Table 2. Plasma [TSH] and [FT4] was the major combination of tests requested, which is standard procedure for TFT. The TFT combination that included plasma [FT3] was requested in fewer occasions in the various years, with the highest is 2011. Classification of the TFT results received in the various years is presented in Table 3. The percent distribution of the concordant results was higher in all the various years compared to the discordant results. The highest percentage (20.1%) of discordant results was obtained in 2010, followed by 19.3% in 2011, with the lowest (14.0%) in 2008. The unclassified results were mainly normal plasma [FT4] but with no corresponding results for plasma [TSH] or [FT3].

The concordant and discordant TFT results obtained in the various years are summarized in Table 4. Euthyroid status was the highest reported cases throughout the various years. Primary Hyperthyroidism was the most prevalent thyroid dysfunction results reported throughout the various years. This was followed by subclinical hyperthyroidism. Prevalence of primary hypothyroidism and subclinical hypothyroidism were each slightly above 5.0% in each of the various years. Non-thyroidal illness and other thyroid disorders were also slightly above 5.0% in each of the various years.

Table 1: Number of Thyroid Function Tests (TFT) requested and sent for analysis and TFT results received and recorded in the various years

TFT	2008	2009	2010	2011	2012
Requested	342	394	473	483	378
Results recorded	207 (60.5%)	248 (62.9%)	393 (83.1%)	379(78.5%)	258 (68.3%)

Table 2: Number of thyroid function tests combination completed and results received in various years

TFT requested	2008	2009	2010	2011	2012
Plasma [TSH]	207	248	393	379	258
Plasma [FT4]	207	248	393	379	258
Plasma [FT3]	60	93	182	262	156

Table 3: Classification of TFT results received in the various years

	2008 (n = 207)	**2009 (n = 248)**	**2010 (n = 393)**	**2011 (n = 379)**	**2012 (n = 258)**
Concordant	177 (85.5%)	205 (82.7%)	308 (78.4%)	300 (79.1%)	211 (81.8%)
Discordant	29 (14.0%)	39 (15.7%)	79 (20.1%)	73 (19.3%)	44 (17.0%)
Unclassified	1 (0.5%)	4 (1.6%)	6 (1.5%)	6 (1.6%)	3 (1.2%)

Table 4: Summary of concordant and discordant TFT results obtained in the various years

	Euthyroid	Primary Hyperthyroidism	Primary Hypothyroidism	Subclinical Hyperthyroidism	Subclinical Hypothyroidism	Non-thyroidal illness
2008 (n = 206)	100 (48.5%)	75 (36.4%)	2 (1.0%)	17 (8.3%)	2 (1.0%)	10 (4.9%)
2009 (n = 244)	137 (56.1%)	63 (25.8%)	5 (2.1%)	17 (7.0%)	12 (4.9%)	10 (4.1%)
2010 (n = 387)	175 (45.2%)	122 (31.5%)	11 (2.8%)	46 (11.9%)	13 (3.4%)	20 (5.2%)
2011 (n = 373)	177 (47.4%)	107 (28.7%)	16 (4.3%)	35 (9.4%)	22 (5.9%)	16 (4.3%)
2012 (n = 255)	123 (48.2%)	72 (28.2%)	16 (6.3%)	25 (9.8%)	9 (3.5%)	10 (3.9%)

For further analysis the TFT results were separated according to gender. Table 5 shows the gender distribution of the TFT requested and sent for analysis in the various years. The total number of female patients was more than twice the number of male patients in all the years. Gender distribution of the TFT results received in the various years is presented in Table 6. Although more female TFT results were received the percent frequency of the results received for both male and female patients were similar. Thus, no significant differences were observed in the proportions of TFT results received for both males and females patients in the various years. No specific reasons can be given to explain the similarity in the proportionality of the results received. The TFT results received for both males and females in the various years were classified into concordant and discordant results. There were no significant differences in the percent distribution of the concordant results among the males in the various years and also among the females in the various years. However, the percent distribution of the concordant results of the females was significantly ($p < 0.05$) higher than those of the males in the various years. Similar findings were obtained for the discordant results among the males and among the females, and also between the males and females in the various years. These results are summarized in Table 7. Euthyroid status was high among the male and female patients throughout the various years.

Primary hyperthyroidism and subclinical hyperthyroidism were the prevailing thyroid disorders among the male and female patients. However, these disorders were significantly higher among the females compared to the males in the various years. The prevalence of Primary Hypothyroidism and subclinical hypothyroidism were each below 5.0% in the male and female patients in the various years. However, it was slightly higher among the female patients compared to the male patients in some of the years. Non-thyroidal illness and other results were more prevalent among the female patients in some of the years.

Table 5: Distribution according to gender of TFT requested and sent for analysis in various years

	2008 (n = 342)	**2009 (n = 394)**	**2010 (n = 473)**	**2011 (n = 483)**	**2012 (n = 378)**
Males	106 (31.0%)	124 (31.5%)	137 (29.0%)	142 (29.4%)	116 (30.7%)
Females	236 (69.0%)	270 (68.5%)	336 (71.0%)	341 (70.6%)	262 (69.3%)

Table 6: Gender distribution of TFT results for males and females received and recorded in various years

	TFT	2008	2009	2010	2011	2012
Males	Sent	N = 106	N = 124	N = 137	N = 142	N = 116
	Received recorded	64 (60.4%)	72 (58.1%)	117 (85.4%)	117 (82.4%)	72 (62.1%)
Females	Sent	N = 236	N = 270	N = 336	N = 341	N = 262
	Received recorded	143 (60.6%)	176 (65.2%)	276 (82.1%)	262 (76.8%)	186 (61.0%)

Table 7: Summary of concordant and discordant TFT results for males and females obtained in the various years

	Gender	Euthyroid	Primary Hyperthyroidism	Primary Hypothyroidism	Subclinical Hyperthyroidism	Subclinical Hypothyroidism	Non-thyroidal illness
2008 (n = 206)	Males	25 (12.1%)	25 (12.1%)	2 (1.0%)	2 (1.0%)	2 (1.0%)	5 (2.4%)
	Females	75 (36.4%)	50 (24.3%)	0	15 (7.3%)	0	5 (2.4%)
2009 (n = 244)	**Males**	39 (16.0%)	16 (6.6%)	2 (0.8%)	3 (1.2%)	8 (3.3%)	3 (1.2%)
	Females	98 (40.2%)	47 (19.3%)	3 (1.2%)	14 (5.7%)	4 (1.6%)	7 (2.9%)
2010 (n = 387)	**Males**	44 (11.4%)	41 (10.6%)	5 (1.3%)	13 (3.4%)	5 (1.3%)	5 (1.3%)
	Females	131 (33.8%)	81 (20.9%)	6 (1.6%)	33 (8.5%)	8 (2.1%)	15 (3.9%)
2011 (n = 373)	**Males**	52 (13.9%)	42 (11.3%)	4 (1.1%)	8 (2.1%)	8 (2.1%)	2 (0.5%)
	Females	125 (33.5%)	65 (17.4%)	12 (3.2%)	27 (7.2%)	14 (3.8%)	14 (3.8%)
2012 (n = 255)	**Males**	33 (12.9%)	22 (8.6%)	5 (2.0%)	2 (0.8%)	6 (2.4%)	4 (1.6%)
	Females	90 (35.3%)	50 (19.6%)	11 (4.3%)	23 (9.0%)	3 (1.2%)	6 (2.4%)

DISCUSSION:

The results obtained in the current study indicated that thyroid disorders were present in most of the patients for which TFT were requested and the results received and recorded. Thyroid disorders were prevalent in 51.5% of the patients in 2008, 43.9% of the patients in 2009, 54.8% of the patients in 2010,

52.6% of the patients in 2011 and 51.8% of the patients in 2012. These prevalence values obtained for each of the five years (2008 to 2012) were higher than the prevalence values reported for similar hospital based studies in Western part of Nepal (33.66%), Eastern part of Nepal (30.0%) and Kavre Nepal (25.0%) [12,13].

In our study the prevailing thyroid disorder in each of the five years was primary hyperthyroidism, 36.4% in 2008, 25.8% in 2009, 31.5% in 2010, 28.7% in 2011 and 28.25 in 2012. This was followed by subclinical hyperthyroidism. The total prevalence of primary and subclinical hyperthyroidism obtained in each of the five years (Table 4) were higher than the 24.8% reported among patients in Western part of Nepal, 9.0% in Kavre and 1.8% in Pondicherry India [12, 14], but lower than the 58.2% reported by Gomez et al. [15]. Some authors have reported high prevalence of hyperthyroidism among females compared to males in iodine-replete areas [16, 17]. The prevalence of primary and subclinical hyperthyroidism was higher among the female patients compared to the male patients. The high prevalence of primary and subclinical hyperthyroidism among female patients in our study was higher than the prevalence reported for both Western and Eastern parts of Nepal and for Kavre Nepal [12, 13].

Some possible reasons for the high prevalence of hyperthyroidism obtained in the present study include selection bias of a hospital-based study; it may also be due to continuous high consumption of iodized salt. A recent report indicated that iodine deficiency was not a public health problem among school children in Honiara Solomon Island, because of successful implementation of USI strategy, which included availability and use of adequately iodized salt [8]. It is however important to ensure effective monitoring of the USI strategy. One of the consequences in the failure of effective monitoring is the excessive intake of iodine. This may have a complex disruptive effect on thyroid metabolism, which may result in increased risk of thyroid cancer and either hypothyroidism or hyperthyroidism in susceptible individuals [19 – 21].

The prevalence of primary and subclinical hypothyroidism obtained in our present study in each of the five years (Table 4) was lower than the 8.9% prevalence reported for Western part of Nepal [12] and the 9.4% report by Usha et al in India [17], but within the 4.0% and 5.4% prevalence reported for similar studies in Pakistan [18].

The recent report [8] indicating high median UIC (328.0ug/L) among schoolchildren in Honiara, with 55.6% having UIC over 300ug/L and that 18.8% had UIC over 500.0ug/L strongly indicates the need to effectively monitor the implementation of the universal salt iodization (USI) strategy for the control of iodine deficiency in the Solomon Islands. This

report together with the results obtained in the present retrospective assessment of the Thyroid status of patients strongly supports the need for screening of women of childbearing age as a way of monitoring their iodine and thyroid status. Early detection of abnormalities can be corrected or treated so as to prevent the negative effects of thyroid dysfunction.

In conclusion, a search of the literature indicated that no previous study that evaluated the thyroid status of the population in Solomon Islands has been published. This retrospective study clearly indicates prevalence of both primary and subclinical hyperthyroidism in the Solomon Islands with high prevalence among female patients compared to male patients.

ACKNOWLEDGEMENT:

We thank and acknowledge the support of Dickson Manongi. We also acknowledge the support of Alfred Dofai head of the National Medical Laboratory Pathology department and the staff in the Clinical Biochemistry Department in the National Referral Hospital in Honiara, Solomon Islands for helping to compile the data for this project. Many thank and appreciation to Gloria Mace, Sandra, Elishama, Simeon, Samson Grant, Jenny Bautau and all the staff members in the Basic Medical Sciences, School of Medicine and Health Sciences, University of Papua New Guinea.

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