



Thyroxine Replacement Therapy during Ramadan Fasting: Physicians' and Patients' Perceptions and Practices

Salem A. Beshyah^{1,2,3} Aly B. Khalil⁴ Anas S. Beshyah⁵ Mahmoud M. Benbarka⁵ Ibrahim H. Sherif⁵

¹ Department of Medicine, Yas Clinic Khalifa City, Khalifa City, Abu Dhabi, United Arab Emirates

² Department of Medicine, College of Medicine and Health Sciences, Khalifa University, Abu Dhabi, United Arab Emirates

³ Department of Medicine, Dubai Medical College for Girls, Dubai, United Arab Emirates

⁴ Imperial College London Diabetes Center, Abu Dhabi, United Arab Emirates

⁵ Department of Medicine, Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates

⁶ Department of Medicine, Sindan Clinic, Tripoli, Libya

Address for correspondence Salem A. Beshyah, PhD, FRCP, Department of Medicine, Yas Clinic Khalifa City, Khalifa City, Abu Dhabi, SW11, United Arab Emirates (e-mail: beshyah@yahoo.com).

J Diabetes Endocrine Practice 2023;6:17–24.

Abstract

Objective Thyroxine (T4) therapy is taken on an empty stomach and no food is taken for a short period. During Ramadan fasting (RF), Muslim patients may face difficulties taking levothyroxine as recommended.

Materials and Methods We performed a mixed methods study of an online survey of 218 physicians to explore their perceptions and practices. Also, we interviewed a sample of 172 hypothyroid patients to establish their practices and source of information. Their median age was 46 (17–90) years; they had hypothyroidism for a median of 5 years and took a median thyroxine dose of 100 µg daily. Furthermore, we attempted to explore the effects of RF on available thyroid function tests.

Results Consultants were 58.4%, and the most represented specialty was endocrinology, 46.1%. Regarding the impact of RF on T4 therapy, 52.3% thought the RF was not clinically relevant in most patients on T4 replacement. However, 27.5% thought RF affects T4 replacement therapy in a clinically relevant manner. About 77.1% of respondents reported giving advice routinely to all patients on T4 replacement during RF. One hundred sixty-four respondents were split between recommending taking the medications with *Iftar*, *Suhour*, or other times. Most respondents (73.9%) do not repeat measurements of thyroid hormone levels after Ramadan unless needed during their scheduled clinic visit. On the other hand, 50.3% of the patients confirmed that their physician advised them to take their thyroxine during Ramadan, whereas 40.4% could not recall receiving any advice. About 59.9% of the patients took thyroxine with *Iftar*, 23.8% with *Suhour*, and 16.3% at different times. In those patients where thyroid

Keywords

- ▶ hypothyroidism
- ▶ thyroxine replacement therapy
- ▶ Ramadan fasting
- ▶ Patients' perceptions
- ▶ Physicians' practices

article published online
March 3, 2023

DOI <https://doi.org/10.1055/s-0043-176327>.
ISSN 2772-7653.

© 2023. Gulf Association of Endocrinology and Diabetes (GAED). All rights reserved.

This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

function tests were available before and after RF, serum thyroid-stimulating hormone and serum-free T4 did not show a specific pattern in the group as a whole and with subgroups.

Conclusion There is variation in the advice that hypothyroid patients receive on taking thyroxine during Ramadan and in their practices. Further studies are needed to determine the best timing for thyroxine replacement.

Introduction

Primary hypothyroidism is a common endocrine disorder.¹ Several studies have demonstrated that optimal and more consistent levothyroxine (LT4) absorption occurs under fasting conditions.² Nonfasting administration of LT4 has been criticized for being associated with higher and more variable serum thyroid-stimulating hormone (TSH) concentrations.³ Subjective improvement was observed with a change in the timing and frequency of LT4 administration.⁴ On the other hand, lower serum TSH concentrations were demonstrated when levothyroxine was taken at bedtime,⁵ and other workers proved that the evening dose of LT4 had an equal lowering effect on TSH as compared to the morning dose.⁶

During Ramadan, Muslims worldwide abstain from food and fluid intake from dawn to sunset for 29 to 30 days. The two main meals are taken just before dawn (*Suhour*) and after sunset (*Iftar*). This prolonged fasting causes several minor metabolic and hormonal changes in the body, which rarely cause any problems for a healthy individual.⁷ However, problems may arise in certain chronic diseases, and thus, patients are advised to consult their physicians before planning to fast.⁸

During Ramadan fasting (RF), patients may find taking LT4 on an empty stomach challenging since the first evening meal is commonly associated with family gatherings and other social activities. Several recommendations were sug-

gested for the supposedly best way of taking LT4 concerning food ingestion. Most of these are based on a direct translation from practices outside Ramadan.^{9–13}

Therefore, we aimed to examine physicians' perceptions regarding the clinical relevance of fasting to LT4 replacement therapy and their practices in advising patients and monitoring them after Ramadan. Second, we wished to ascertain patients' perceptions regarding thyroxine replacement therapy during RF, the source of their knowledge, and related practices.

Materials and Methods

Design

This is a mixed methods study, including physicians' survey and patients' structured interview. Both parts of the study occurred between January and August 2017 at the Center for Diabetes and Endocrinology Clinic, Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates.

Physicians' Survey

We studied the physicians' views and practices through an electronic survey using a commercial provider (Survey Monkey, Palo Alto, California, United States). We included a convenience sample of physicians from an email database. The survey (→ **Table 1**) had seven questions with closed-end multiple choices. The domains were (1) professional profile

Table 1 The questionnaire used in the survey of physicians' views and practices on Thyroxine replacement therapy during Ramadan

Q1. Please confirm your eligibility and consent. ^a [3 options: I am willing to participate in the survey/I do not wish to participate in this survey]
Q2. Please indicate your specialty (5 options: endocrinology/internal medicine with interest and practice in endocrinology/Internal medicine/primary care (GP or family physician)/other (please specify)
Q3. Please indicate your current career stage/professional grade (4 options: consultant/specialist/resident/others)
Q4. What is your view on the impact of Ramadan fasting thyroxine replacement therapy? [Options: agree; I think Ramadan fasting affects thyroxine replacement therapy significantly in a clinically relevant manner/disagree; I think Ramadan effect is a minor issue and is not clinically relevant in most patients on thyroxine replacement therapy/Neutral. I am aware of the issue but do not feel strongly in favor or against the choices above/No answer; I do not know, or I am not sure]
Q5. Do you advise patients on how they should take their thyroxine therapy precisely during Ramadan? [Options: No, I give no specific advice routinely; Yes, I advise all my patients routinely]
Q6. If you have answered YES in the preceding question, How do you advise patients to take their Thyroxine therapy during Ramadan? [3 options: I advise patients to take Thyroxine at <i>Iftar</i> time and delay the <i>Iftar</i> for 30–60 minutes/I advise patients to take thyroxine at <i>Suhour</i> and delay the <i>Suhour</i> by 30–60 minutes/I advise patients at any other times they wish but ensure no food before for 2 hours and 1 hour after (e.g., <i>After Taraweeh</i> or <i>Before Bed Time</i>)]
Q7. Do you monitor thyroid function tests specifically after Ramadan in patients on thyroxine Replacement therapy? [2 Options: No, unless needed for routine scheduled monitoring visit/Yes, I do it routinely after Ramadan]

^aConsent is electronically mandated before access to the rest of the questions using a logic built into the survey software.

Table 2 Structured interview instrument for the study/audit of patients' practices taking thyroxine during Ramadan fasting^a

A. Patients' characteristics
1. Serial number and 2. Record number (deleted before analysis)
3. Sex: [male, female]
4. Age [free text, years]
5. What is the duration of known hypothyroidism? [free text years]
6. Last change of dose. [free text years]
7. What is your daily thyroxine dose? [free text, µg]
B. Questions on thyroxine therapy during Ramadan fasting
8. Source of advice (Who advised you about taking your thyroxine during Ramadan fasting?) [4 Options: doctor, pharmacist, else, none]
9. What is the time of intake of thyroxine: [<i>Iftar</i> , <i>Suhour</i> , other time]
10. What is the time allowed after thyroxine intake [free text minutes]
11. What is the time allowed before thyroxine. [free text (minutes)].
B. Assessment of the impact of Ramadan fasting on thyroid function tests (Subject to availability) ^a
12. Serum TSH [before; after]
13. Serum thyroxine (T4) [before and after]

Abbreviation: TSH, thyroid-stimulating hormone.

^aWithin 12 weeks before or after Ramadan, retrieved from the patient's medical records during consultations.

and (2) impact of RF on LT4 replacement therapy, (3) advice to patients on how they should take their thyroxine therapy during Ramadan?, and (4) monitoring of thyroid functions after Ramadan. The physician identification and conduct of the study are similar to the previously published studies exploring the management patterns of common endocrine disorders in the Middle East and North Africa.^{14–16}

Patients' Survey

We invited a convenience sample of patients, including consecutive patients receiving LT4 replacement therapy who attended a single endocrine clinic for any clinical encounter during RF and within 12 weeks after that. We enquired about the pattern of LT4 intake during RF and the source of their advice (►Table 2). In addition, available thyroid function tests (TFT) measurements were examined before and after RF when available for up to 12 weeks.

Data Analysis

Descriptive analysis was used to summarize data of the physicians and patients separately. Continuous variables were presented as median (range) or mean (standard deviation), and categorical variables were presented as frequencies (number [percentage]). The percentages were calculated for each separately to adjust for any missing answers. Physicians' advice and patients' practices regarding the timing of intake of levothyroxine during Ramadan were compared using the chi-squared test.

Results

Physicians' Survey

Of the 218 participating respondents, 54.8% were consultants (attending physicians, and the most represented spe-

cialty was endocrinology 46.1%) (►Table 3). Regarding the impact of RF on LT4 therapy, 52.3% of respondents thought the RF effect was not clinically relevant in most patients on LT4 replacement. Whereas just over a quarter of respondents (27.5%) thought RF affects LT4 replacement therapy in a clinically relevant manner. The remainder were undecided (►Table 3).

One-hundred sixty-eight respondents (77.1%) reported giving advice routinely to all patients on LT4 replacement during Ramadan. One-hundred sixty-four of these were split between recommending taking the medications with *Iftar* (18.3%), with *Suhour* (29.3%), or at other times with specific advice on keeping the food-thyroxine-food gaps (►Table 3). Most respondents (73.9%) do not repeat measurements of thyroid hormone levels after Ramadan unless needed during their scheduled clinic visit. In contrast, a smaller proportion (26.2%) indicated that they check TFT routinely after Ramadan.

Patients' Survey

A total of 172 consecutive patients were interviewed. They were 125 females and 47 males. The median age was 46 (17–90) years and had had hypothyroidism for a median duration of 5 years. Their median LT4 daily dose was 100 µg that was stable for 6 months (►Table 4). Over half (50.3%) confirmed their physician's advice on taking their thyroxine during Ramadan, whereas 40.4% could not recall receiving any advice (►Table 4). About 59.9% of the patients took thyroxine with their *Iftar*, 23.8% with their *Suhour*, and 16.3% at other times.

►Table 5 presents the LT4 to food-time gap and the serum TSH and serum T4 (whenever available) in the group as a whole and in the subgroups depending on when they took their LT4. For the *Iftar* subgroup, the food-LT4 gap was

Table 3 Results of the physicians' survey study

Question and answer options (number of responders)	Responses
Specialty (217)	
● Endocrinology	100 (46.1%)
● General medicine with an endocrine interest	41 (18.9%)
● Primary care	32 (14.8%)
● Other	26 (12.0%)
● General internal medicine	18 (8.3%)
Career stage (professional grade) (217)	
● Senior	119 (54.8%)
● Mid-grade	67 (30.9%)
● Junior	15 (6.9%)
● Other grades	16 (7.4%)
Impact of Ramadan fasting on thyroxine therapy? (218)	
● The Ramadan effect is not clinically relevant in most patients on thyroxine replacement	114 (52.3%)
● Ramadan fasting affects thyroxine replacement therapy in a clinically relevant manner	60 (27.5%)
● I am aware of the issue but do not feel strongly in favor or against either of the above choices	29 (13.3%)
● I do not know or am not sure	15 (6.7%)
Do you advise patients on how they should take their thyroxine therapy precisely during Ramadan? (218)	
● Yes, I advise all my patients routinely	168 (77.1%)
● No, I give no specific advice routinely	50 (22.9%)
How do you advise patients to take thyroxine therapy during Ramadan? (164)^{a*}	
● I advise patients to do it at any other times they wish but ensure no food before it for 2 hours and 1 hour after (e.g., after <i>Taraweeh</i> prayers or bedtime)	86 (52.4%)
● I advise patients to take thyroxine at <i>Suhour</i> and delay the <i>Suhour</i> by 30–60 minutes	48 (29.3%)
● I advise patients to take thyroxine at <i>Iftar</i> time and delay the <i>Iftar</i> for 30–60 minutes	30 (18.3%)
Do you monitor thyroid function tests specifically after Ramadan in patients on thyroxine replacement therapy? (218)	
● No, unless needed for a routine monitoring visit	161 (73.9%)
● Yes, I do it routinely after Ramadan	57 (26.2%)

^aIncluded those who answered yes to the preceding question.

120 minutes, and LT4 to food time was 90 minutes (► **Table 5**). In those patients where TFTs were available before and after RF (up to 12 weeks on either side), serum TSH and serum-free T4 did not show a specific pattern in the group as a whole and with subgroups other than outliers who admitted poor compliance (► **Table 5**).

Physicians' Advice versus Patients' Practices

There was statistically significant discordance between the advice most physicians gave and patients' practices in the timing of LT4 intake. More physicians advise patients to take LT4 at any time provided the "food-LT4-food gaps" are maintained. In contrast, most patients take their LT4 with *Iftar* (► **Tables 3** and **4**; ► **Fig. 1**).

Discussion

RF is associated with major changes in meal times that may affect LT4 absorption and TFT in patients with hypothyroidism. Since LT4 has a narrow therapeutic index and is usually administered on an empty stomach, RF poses a challenge for patients on LT4. The fasting patients would have to take their LT4 doses outside of daytime fasting hours. Recently, several studies explored the impact of fasting on thyroid replacement therapy, dose adjustment, and timing of the LT4 intake.^{16–24} However, how much of this information is translated into clinical practice and patients' day-to-day behavior has yet to be established. Therefore, exploring physicians' and patients' knowledge, attitudes, and practices

Table 4 Results of the study of patients' practices in taking thyroxine during Ramadan fasting^a

Characteristics/Variables	Responses ^a
Sex (male/female) (172)	47 (27.3%) / 125 (72.7%)
Age (years)	46.4/46.0 (17–90)
Duration of known hypothyroidism (years)	6.9/5.0 (0.33–22)
Time since last change of thyroxine dose (months) ^b	5.5/6.0 (0.5–6)
Current daily thyroxine dose (µg)	105/100 (25–350)
Source of advice on taking your thyroxine during Ramadan? (171)	
● Doctor	86 (50.3%)
● Pharmacist	4 (2.3%)
● Else	12 (7.0%)
● None	69 (40.4%)
The time of taking thyroxine (172)	
● With <i>Iftar</i>	103(59.9%)
● With <i>Suhour</i>	41 (23.8%)
● At other times	28 (16.3%)
Time allowed after thyroxine intake (minutes) ^c	31/20 (0–300)
What is the time allowed before thyroxine intake (minutes) ^c	144/120 (0–360)

^aResults are shown as frequencies (number (%)) for categorical variables; and as mean/median (range) for continuous variables.

^bDurations stated as longer than 6 months were entered as 6 months.

^cFor the whole group with no regard to the time of taking the thyroxine.

Table 5 Results of the thyroid function tests of patients taking thyroxine during RF with no change

Characteristics/Variables	All	<i>Iftar</i>	<i>Suhour</i>	Other
Thyroxine-food time gap (minutes)				
Before thyroxine	144/120 (0–360)	120/120 (120–120)	131/150 (0–240)	164/150 (30–360)
After thyroxine	31/20 (0–300)	20.2/20.0(0–120)	90/90(0–180)	73/30 (15–300)
Serum TSH (mIU/mL):				
Before RF	5.8/3.2 (1.04–148)	7.0/3.3(1.05–148)	4.8/3.9 (1.04–19.13)	3.6/2.4 (1.25–13.2)
After RF	5.3/3.0 (1.02–97)	6.3/2.9(1.02–97)	3.5/2.4 (1.12–20.3)	4.3/3.3 (1.02–10.9)
Serum T4 Before (pmol/L)				
Before RF	16.5/16.2 (3.52–32.9)	15.9/16.0 (3.5–26.1)	17.2/16.4 (10.0–32.9)	17.6/16.9 (8.8–24.8)
After RF	16.6/16.3 (2.7–38.0)	16.0/16.1 (4.5–38.0)	16.7/17.7 (2.7–25.8)	18.8/17.5 (12.7–26.7)

Abbreviations: RF, Ramadan fasting; TSH, thyroid-stimulating hormone.

is very timely. We chose the mixed methods study to evaluate physicians and patients and explore concordance or otherwise in their practices.

We made several observations. Over half of the physicians thought the RF effect was not clinically relevant in most patients on LT4 replacement. However, unexpectedly, over three-quarters reported routinely advising all patients on how to take their LT4 during RF. More than half recommended taking LT4 at any time with specific instructions about the medication-food time gap. In contrast, 59.9% of the patients

took LT4 with *Iftar*, although more than half (50.3%) confirmed receiving the physician's advice. The available serum TSH and serum-free T4 did not show a specific pattern in the group and subgroups. Furthermore, nearly (¾) 75% of physicians do not request TFTs after Ramadan unless they coincide with a scheduled clinic visit, supporting the notion that they do not consider it clinically relevant. There was a clear discordance between physicians' advice and patients' practices in LT4 timing.

Recent work addressed research questions (a) to the clinical and biochemical impact of RF on treated hypothyroid

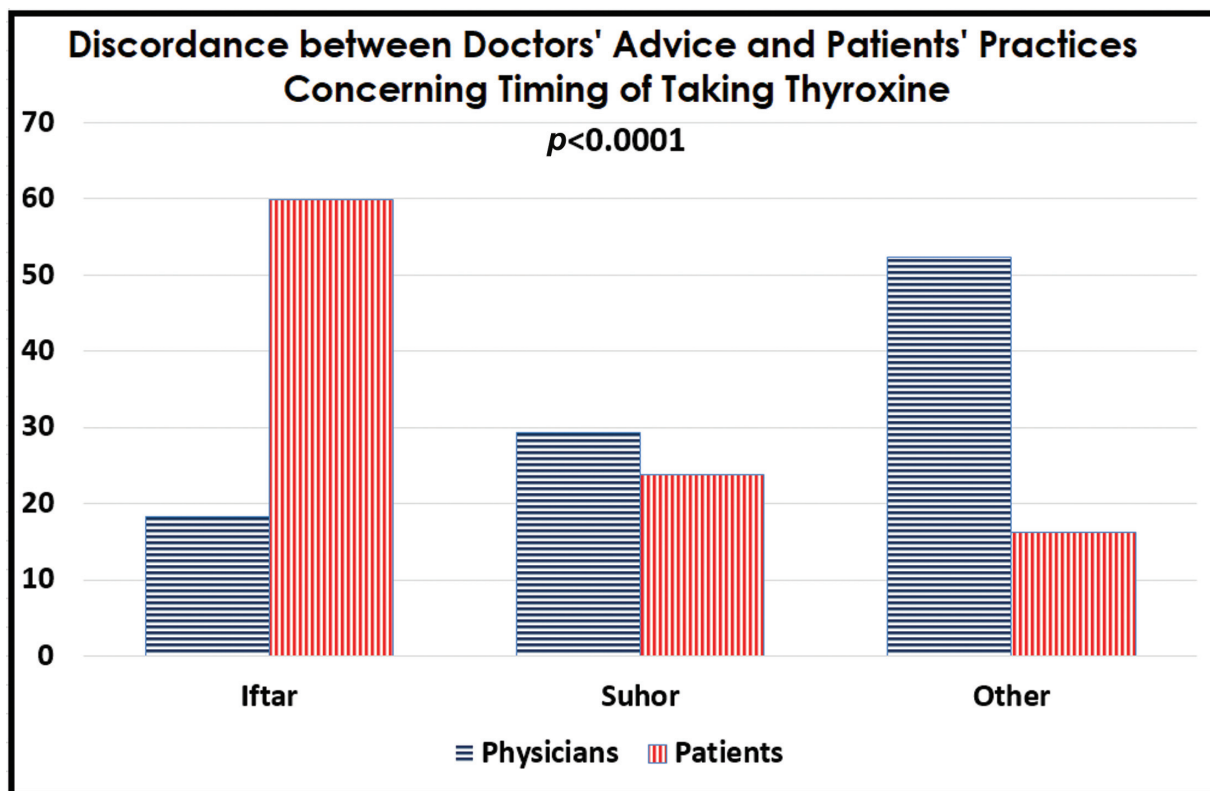


Fig. 1 The discordance between the doctors' advice and patients' practices concerning the timing of taking levothyroxine during Ramadan.

patients and (b) to specifically ascertain how best to optimize the dose or timing of LT4 during RF if needed. Elsherbiny studied the impact of fasting on thyrotropin and thyroid status during RF in 292 previously well-controlled hypothyroid patients (IFTAR study).²¹ RF resulted in a significant increase in post-Ramadan TSH, yet 80% of the patients remained euthyroid after Ramadan, suggesting that post-Ramadan TSH and euthyroidism are related to adherence and pre-Ramadan TSH. El-Kaissi et al retrospectively examined the adherence to levothyroxine, eating patterns, and levothyroxine administration concerning meal times during Ramadan in 112 fasting hypothyroid patients.¹⁹ Levothyroxine-treated hypothyroid patients showed a significant increase in plasma TSH post-Ramadan, amounting to 2.525 standard deviations, with older patients and males more likely to be affected. Moreover, Alkaf et al identified patients with higher TSH before RF at a greater risk of having more pronounced and clinically relevant changes.¹⁷ Indeed, only a smaller group whose thyroid disease appeared to be particularly affected by Ramadan's mealtime and lifestyle changes.

Furthermore, Or Koca et al investigated whether the dose of levothyroxine was changed during RF in 97 patients with a wide age range on a stable dose of LT4 for at least 6 months.²² They demonstrated a significant increase in serum TSH levels after Ramadan but no significant change in serum-free thyroxine (fT4) levels. They suggested making a small increase in LT4 dose before Ramadan in some hypothyroid patients wishing to fast.²²

Dellal et al evaluated the changes in thyroid functions during Ramadan and compared late evening and pre-Suhour use of

levothyroxine in hypothyroid patients.¹⁸ The increase in TSH was not significant after Ramadan. While there was an insignificant increase in median TSH, about one-third of patients had lower TSH, indicating the need to evaluate every patient individually and have close follow-up during Ramadan. Clinical studies with larger sample sizes were recommended to help determine the optimal time for levothyroxine use during Ramadan.

El-Kaissi et al in their observational study found no relationship between the time of levothyroxine administration and the change in TSH level.¹⁹ The same group a year later reported a randomized prospective study where hypothyroid patients were randomized to take levothyroxine at one of three times during Ramadan at dusk 30 minutes before *Iftar* meal, 3 or more hours after *Iftar* meal, or at dawn 30 minutes before *Suhour* meal.²⁰ TFTs were performed 3 months before and 6 weeks after Ramadan. Data from patients with at least one blood test before or after Ramadan were analyzed. The result of the study suggested that instructing patients to take levothyroxine at the time of breaking the fast 30 minutes before the *Iftar* meal minimizes unfavorable changes in plasma TSH post-Ramadan.²⁰

Also, Zaboony et al explored the best time for L-thyroxine intake during Ramadan. Fifty patients took L-thyroxine treatment for primary hypothyroidism.²⁴ Patients were divided into three groups with different times of L-thyroxine intake: pre-*Iftar*, post-*Iftar*, and pre-*Suhour* with very precise instructions on the T4-food-T4 gaps. They found no significant differences in TSH control between the groups.²⁰

Al-Qahtani et al evaluated the impact of LT4 timing during Ramadan on TSH levels in post-thyroidectomy patients to

determine the best timing for LT4 intake and identify the predictors of any TSH changes.¹⁶ Patients had stable thyroid function for 6 months before the study period and fast more than or equal to 20 days of Ramadan. They found that fasting patients who took LT4 pre-*Iftar* did not experience significant changes in TSH, whereas those who took LT4 post-*Iftar* or pre-*Suhour* did.

The physicians' part of the study is limited with its sample size and online survey nature, although the questions were direct and few. However, its objective was to explore the physicians' perceptions and practices. The patients' part of the study is limited by its observational nature, the long duration of data collection. Furthermore, TSH may not be the best method for the assessment of thyroid status around RF.

Conclusion

This study combined an assessment of both doctors and patients. Not all physicians think that RF has a clinically meaningful impact, and not all doctors give specific advice consistently. Furthermore, there needs to be more clarity in the advice that hypothyroid patients receive on taking thyroxine during Ramadan and in their practices. Real-world data from the present study did not reveal a major impact on TFT values taken in routine clinic visits. Further studies are needed to establish the relevance of RF to thyroxine replacement to develop evidence-based recommendations. Until then, patients should be offered all possibilities so they can choose the most suitable timing individually. Since various studies have employed different methods, critical appraisal of all the available studies is timely.

Authors' Contributions

S.A.B. adapted the questionnaire and managed the online and patients survey. A.S.B. managed the data collection and analysis. All other authors reviewed the data and contributed to the data analysis and interpretation, drafting, and revising the manuscript and approving its final version.

Compliance with Ethical Principles

The physician survey was approved by the IRB of Sheikh Khalifa Medical City, and all physicians provided informed consent digitally before they could answer the survey questions. The patient section was conducted as a quality improvement exercise; patients provided informed verbal consent for their data to be included in the audit. All data were analyzed anonymously.

Funding and Sponsorship

None.

Conflict of Interest

None declared.

Acknowledgments

We thank all the colleagues who responded to the survey.

References

- Biondi B, Cooper DS. Thyroid hormone therapy for hypothyroidism. *Endocrine* 2019;66(01):18–26
- Colucci P, Yue CS, Ducharme M, Benvenga S. A review of the pharmacokinetics of levothyroxine for the treatment of hypothyroidism. *Eur Endocrinol* 2013;9(01):40–47
- Bach-Huynh TG, Nayak B, Loh J, Soldin S, Jonklaas J. Timing of levothyroxine administration affects serum thyrotropin concentration. *J Clin Endocrinol Metab* 2009;94(10):3905–3912
- Bhutani S, Bhutani J, Balhara YP, Kalra S. Atypical thyroxine replacement in hypothyroidism: a clinical audit. *Thyroid Res Pract*. 2012;9:81–83
- Rajput R, Chatterjee S, Rajput M. Can levothyroxine be taken as evening dose? comparative evaluation of morning versus evening dose of levothyroxine in treatment of hypothyroidism. *J Thyroid Res* 2011;2011:505239. Doi: 10.4061/2011/505239
- Bolk N, Visser TJ, Nijman J, Jongste IJ, Tijssen JG, Berghout A. Effects of evening vs morning levothyroxine intake: a randomized double-blind crossover trial. *Arch Intern Med* 2010;170(22):1996–2003
- Roky R, Houti I, Moussamih S, Qotbi S, Aadil N. Physiological and chronobiological changes during Ramadan intermittent fasting. *Ann Nutr Metab* 2004;48(04):296–303
- Beshyah SA, Fathalla W, Saleh A, et al. Ramadan fasting and the medical patient: an overview for clinicians. *Ibnosina J Med Biomed Sci*. 2010;2(05):240–257
- Hadjzadeh M, Pakdel R, Hayatdavoudi P, Nematy M. Hypothyroidism and Ramadan fasting. *J Fasting Health* 2014;2:80–83
- Beshyah SA, Fiad TM, Saadi HF. Management of common endocrine conditions other than diabetes mellitus during Ramadan fasting. *Ibnosina J Med BS* 2012;4(04):137–146
- Karoli R, Fatima J, Chandra A, Mishra PP. Levothyroxine replacement and Ramadan fasting. *Indian J Endocrinol Metab* 2013;17(02):318–319
- Raza SA, Ishtiaq O, Unnikrishnan AG, et al. Thyroid diseases and Ramadan. *Indian J Endocrinol Metab* 2012;16(04):522–524
- Beshyah SA, Ali KF. Management of adrenal insufficiency: a survey of perceptions and practices of physicians from the Middle East and North Africa. *J Diabetes Endocr Pract* 2021;4:125–130
- Beshyah SA, Khalil AB. Clinical practice patterns in the management of thyroid nodules: the first survey from the Middle East and Africa. *J Diabetes Endocr Pract* 2021;4:167–174
- Beshyah SA, Almalki MH, Azzoug S, Barake M, Al Dahmani K, Chihaoui M. Diagnosis and management of Cushing's disease: a survey of endocrinologists from the Middle East and North Africa. *J Diabetes Endocr Pract* 2022;5:21–28
- Al-Qahtani KM, Aldeeri IA, Alshaibi AM, et al. Optimal timing of thyroid hormone replacement during Ramadan fasting: a randomized controlled trial in patients with prior total thyroidectomy. *Thyroid* 2022;32(09):1029–1036
- Alkaf B, Siddiqui M, Ali T, et al. Ramadan fasting and changes in thyroid function in hypothyroidism: identifying patients at risk. *Thyroid* 2022;32(04):368–375
- Dellal FD, Ogmen B, Ozdemir D, et al. Effect of Ramadan fasting on thyroid hormone levels in patients on levothyroxine treatment. *J Coll Physicians Surg Pak* 2020;30(10):1009–1014
- El-Kaissi S, AbdelWareth L, Dajani R, et al. Levothyroxine administration during Ramadan: a prospective randomized controlled trial. *Eur Thyroid J* 2021;10(06):455–460
- El-Kaissi S, Dajani R, Lee-St John TJ, et al. Impact of lifestyle changes during Ramadan on thyroid function tests in hypothyroid patients taking levothyroxine. *Endocr Pract* 2020;26(07):748–753

- 21 Elsherbiny TM. Impact of fasting on thyrotropin and thyroid status during Ramadan in 292 previously well controlled hypothyroid patients. IFTAR study. *Endocrine* 2023;79(03):484–490
- 22 Or Koca A, Dağdeviren M, Altay M. Should the dose of levothyroxine be changed in hypothyroidism patients fasting during Ramadan? *Turk J Med Sci* 2020;50(04):784–788
- 23 Sheikh A, Mawani M, Mahar SA. Impact of Ramadan fasting on thyroid status and quality of life in patients with primary hypothyroidism: a prospective cohort study from Karachi, Pakistan. *Endocr Pract* 2018;24(10):882–888
- 24 Zaboon IA, Alidrisi HA, Hussein IH, et al. Best time for levothyroxine intake in Ramadan (THYRAM): Basrah experience. *Int J Endocrinol Metab* 2020;18(02):e94325