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RESEARCH ARTICLE

Quality of life in participants with primary hypothyroidism on treatment at Chris Hani Baragwanath Academic Hospital

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Background: Many participants living with hypothyroidism treated with levothyroxine continue to experience challenges with their physical, social, cognitive, and psychological functions. These symptoms may lead to poor quality of life (QoL).
Objectives: This study aimed to determine the health-related QoL in participants living with hypothyroidism on levothyroxine therapy and to describe the association between QoL in participants living with hypothyroidism on levothyroxine therapy and various demographic and treatment parameters.
Methods: The disease-specific ThyPRO instrument was used to measure the QoL in treated hypothyroid participants at Chris Hani Baragwanath Academic Hospital (CHBAH). The study recruited 127 participants with primary hypothyroidism on levothyroxine therapy for more than six months, who attended the clinic from 1 January 2021 until 30 September 2021. ThyPRO contains 84 items, summarised in 13 scales.
Results: Of the 127 participants, the average Overall QoL was 31.4%. The highest ThyPRO scores were recorded for vitality (49.9%), difficulty in coping with the mood (38.5%), tiredness (37.5%), nervousness, and tension (33.3%). No negative impact on mean ThyPRO scores was recorded for sex life among all the respondents. Indian and White descent participants had poorer ThyPRO scores of 44.4% and 39.3%, respectively, as compared with Black participants at 30.7% and mixed origin at 26.0%. Smokers had a poorer ThyPRO score of 40.1% compared with 30.3% among non-smokers. Participants who were on treatment for less than one year had poorer ThyPRO scores of 61.0% as compared with 29.4% of those who received treatment for longer (between one year and four years) and 31.1% for more than five years.
Conclusion: Participants who received treatment for an extended period had a better QoL. It is recommend to use ThyPRO to assess the health-related QoL in treated hypothyroid patients for future clinical research and good clinical practice.

Keywords: levothyroxine therapy, primary hypothyroidism, quality of life, ThyPRO

Introduction

Hypothyroidism is a common chronic endocrine condition characterised by abnormal functioning of the thyroid gland and failure to produce adequate thyroid hormones to satisfy the needs of all tissues.[1] The worldwide population records a prevalence of up to 5% of hypothyroidism, and approximately 5% of the world population is still undiagnosed with this condition.[2]

Primary hypothyroidism occurs when the thyroid gland cannot secrete sufficient thyroid hormones. It may be categorised biochemically as overt when the thyroid-stimulating hormone (TSH) is higher than the normal reference range in combination with the low level of free thyroxine (FT4), or subclinical hypothyroidism (SCH) when there is a high level of TSH with a normal serum level of FT4.[3–5] In the USA, the National Health and Nutrition Examination Survey (NHANES III) study reported a prevalence of 4.6% for both overt and subclinical hypothyroidism. However, a clinical trial in the USA reported a prevalence of 0.4% of overt and 9% of SCH.[5,6] SCH prevalence ranges from 8% to 18% of adults over 65 years.[7]

There is limited data on the prevalence of hypothyroidism in Africa. This is possibly due to the lack of studies, surveillance programmes, and laboratory diagnostic tests in Africa.[8] A study in Cape Town reported a prevalence of 1.7% of hypothyroidism among the White and Mixed origin population but not the African population.[8] Many hypothyroid patients still experience problems related to their physical (cold intolerance, weight gain, tiredness, puffy face, hoarseness of the voice, and constipation), social, cognitive (poor memory and difficulty in concentration), and psychological (depression) functions.[9–11] These symptoms are reported despite patients being optimally managed with levothyroxine therapy, even when the TSH level has normalised.[10]

Hypothyroidism symptoms could affect these patients' QoL.[9–11] This could be due to the serum level T3, which is not normalised because of the lack of conversion of T4 to T3. The low T3 could explain why hypothyroid patients have poor QoL. The poor QoL could also be due to the inconsistency of the treatment, even when the thyroid level is euthyroid.[10] A Danish study postulated that sexual dysfunction and depression were related to SCH.[12] A Colorado study showed that abnormal TSH was found in 40% of participants due to poor adherence or treatment inconsistency.[13]

Levothyroxine (LT4) is the recommended treatment for hypothyroidism worldwide.[1,14–16] Thyroxine hormone should be initiated depending on the residual thyroid function, bodyweight, and TSH range to be achieved with treatment.[14] Other factors such as age, sex, pregnancy, gastrointestinal

function, and the use of other medication may require a change in the treatment dosage. American guidelines state that the treatment should be optimised by the replacement of thyroid hormones until hypothyroidism symptoms and signs are resolved, TSH is normalised in these participants and to avoid overtreatment, particularly in old participants.[15] The National Institute for Health and Care Excellence (NICE) guidelines have suggested levothyroxine as the treatment of choice in hypothyroid patients; it does not recommend triiodothyronine (T3) as a monotherapy or dual therapy with levothyroxine because there is not enough evidence of its benefit. Treatment should be adjusted as per the optimal well-being or symptom-free status of the patient.[17] The Society of Endocrinology Metabolism and Diabetes of South Africa (SEMDSA) suggests monitoring TSH levels every 4–8 weeks until the blood level is within the expected laboratory reference range and adjusting therapy according to each patient's results.[1]

The thyroid-related QoL instrument, Thyroid specific Patient Reported Outcome (ThyPRO), is a validated instrument used to evaluate people with benign thyroid diseases. It assesses how participants describe their happiness, feelings, problems, and the impact of illness and therapy on their everyday lives through a validated questionnaire. This tool helps assess the participant's physical, social, and mental well-being.[18]

The objectives of this study are to investigate disease-specific Health-Related Quality of Life (HRQOL) in patients with primary hypothyroidism who are biochemically euthyroid on levothyroxine treatment using a ThyPRO questionnaire. Second, to determine the association between QoL and various parameters such as sociodemographics (age, sex, ethnicity), body mass index (BMI), level of education, smoking status, biochemical tests (TSH/FT4/thyroid peroxidase antibody [TPOAb]) and duration and dose of treatment, in treated participants living with hypothyroidism.

Methods

Ethical considerations

Permission for the study was received from the Head of the Endocrinology Division at CHBAH, and ethics approval was granted from Wits Human Research Ethics Committee M200820. The author of the ThyPRO questionnaire granted written permission for its use.

Study population

This prospective study used the ThyPRO instrument to measure the QoL in 127 participants living with primary hypothyroidism attending the outpatient endocrine clinic at Chris Hani Baragwanath Academic Hospital (CHBAH) in South Africa. Participants consented to participate in the study and they completed the ThyPRO questionnaire and an additional questionnaire on sociodemographics and co-morbidities. The BMI was calculated using Quetelet's formula.[19]

Data were collected from January 1, 2021 until September 30, 2021. For this study, participants were 18 years old or older and on treatment for primary hypothyroidism for more than 6 months. The TSH levels of the participants were within the normal reference range as per the National Health Laboratory Service (NHLS) guidelines. The TSH results at baseline were collected within one month of completing the questionnaire. All the participants were euthyroid with normal TSH and FT4. Patients who were pregnant or were on treatment for less than six months or were diagnosed with underlying secondary or tertiary hypothyroidism were excluded from the study.

The ThyPRO questionnaire is summarised in 13 scales as outlined in Table 1 and it comprises 85 items (questions) to assess several aspects of QoL among the participants. This is based on tiredness, cognitive, anxiety, depression, emotional susceptibility, impaired social life, and a one-item scale on the overall impact of thyroid disease on QoL.[20] The participants need about 15 to 20 minutes to answer The ThyPRO questions on what they have been feeling during the past 4 weeks. Each item (question) is rated using a five-point Likert scale from 0 to 4 with no symptoms/no problem (score of 0), for little problem/symptoms (score of 1), for some symptoms (score of 2), for quite a few symptoms (score of 3), to severe symptoms/problems (score of 4).[18] The 13 scales are averaged and their items linearly transformed to have their respective score on the scale of 0 to 100. The total score of each scale is calculated according to the formula = 100*(raw sum score of all items on the scale/total number of items on that scale * 4). For example, the psychological well-being scale has 7 items: 6a, 6b, 6c, 6d, 6e, 6f, 6g. Assuming the participant answers were respectively "Quite a bit", "A little", "Quite a bit", "Very much", "Very much", "Not at all", "Some", then the scale score will be $100*(3+1+3+4+4+0+2)/(4*7) = 100*17/28 = 60.7$. The 13th scale is an average value of the 12 other scales. A high score suggests worse health status and a low score suggests good health status.[13] The overall ThyPRO score represents the mean of all 12 ThyPRO parameter scores for each participant (symptoms, tiredness, vitality, memory and concentration, nervousness and tension, psychological well-being, difficulty coping, relationships with other people, daily activities, sex life, appearance, and negative impact on quality of life). Thyroid results were retrieved from NHLS records or the participants' files. These tests included TSH, FT4, and TPOAb.

Data analysis

The independent t-test was used to compare the means of continuous variables during bivariate analyses involving categorical variables with two groups. Where categorical variables had more than two groups, one-way analysis of variance (ANOVA) was used to compare the means of normally distributed continuous variables. Linear regression was used to determine the association between overall ThyPRO score and independent variables at baseline (age, BMI, sex, and race). Independent variables were selected for multivariate analysis using a univariate p-value < 0.20. Sex and BMI were included a priori for multivariate analyses. Statistical significance for the final model utilised a multivariate p-value < 0.05. Statistical analyses were performed using SPSS software (IBM Corp, Armonk, NY, USA). The mean was used to characterise the central value of the symmetric distribution of the data, while the median and IQR were used to characterise the central value of the skewed distribution data.

Results

Participants' characteristics

A total of 127 participants were enrolled in the study, 96 (75.6%) were classified as Black, 17 (13.4%) were of Mixed origin, 9 (7.1%) were of Indian descent, and 5 (3.9%) were White. Ethnicity was self-reported. Most participants were females 113 (89.0%), with a mean age of 57.6 years. Approximately 11.0% were smokers and 75.6% had secondary education, of whom 11.0% had tertiary education. Most participants (69.3%) were

Table 1: Scales and items of ThyPRO

Symptoms		Tiredness	
1a	had the sensation of fullness in the neck?	2a	been tired?
1b	had a visible swelling in the front of your neck?	2b	been exhausted?
1c	felt pressure in your throat?	2c	had difficulty getting motivated to do
1d	had pain in the front of your throat?		anything at all?
1e	had pain in your neck that can be felt in your ears?	2d	felt worn out?
1f	had the sensation of a lump in your throat?		
1g	had the need to clear your throat frequently?	Vitality	
1h	felt discomfort swallowing?	3a	felt full of life?
1i	had difficulty swallowing?	3b	felt energetic?
1j	had the sensation of suffocating?	3c	been able to cope with the demands of your life?
1k	been hoarse?		
1l	had trembling hands?	Memory and concentration	
1m	had a tendency to sweat a lot?	4a	had difficulty in remembering?
1n	experienced palpitations (rapid heartbeat)?	4b	had slow or unclear thinking?
1o	experienced shortness of breath?	4c	had difficulty finding the right words?
1p	been sensitive to heat?	4d	been confused?
1q	been sensitive to cold?	4e	had difficulty learning something new?
1r	had an increased appetite?	4f	had difficulty concentrating?
1s	had loose stools?		
1t	had an upset stomach?	Relationship with other people	
1u	had moist or watery eyes?	8a	had difficulty being together with other people
1v	had bags under the eyes or swollen eyelids?		(for example, spouse, children, boy/girlfriend,
1w	had the sensation of dryness or grittiness in the eyes?		friends, or others)?
1x	had impaired vision?	8b	feel you were a burden to other people?
1y	felt pressure in (or behind) the eyes?	8c	have conflicts with other people?
1z	had trouble with vision?	8d	felt that people in your surroundings have lacked
1aa	had eye pain?		understanding of your thyroid disease?
1bb	been very sensitive to light?		
1cc	had swollen hands or feet?	Daily activities	
1dd	had dry skin?	9a	have difficulty managing your daily life?
1ee	had itchy skin?	9b	limit leisure activities or hobbies?
		9c	not be able to participate in life around you?
		9d	have difficulty getting around (for example,
			walking, running, bicycling, or driving a car)?
		9e	feel as if everything takes longer to do?
		9f	have difficulty managing your job (for example,
			finding it hard to cope or calling in sick)?
		To what extent your thyroid disease has affected	
Mood swings		you overall during the past weeks	
7a	had difficulty coping?	12	has your thyroid disease had a negative effect
7b	felt not like yourself?		on your quality of life?
7c	noticed you easily felt stressed?	Appearance (for example, by causing swelling of the neck, swollen face, hands,	
7d	had mood swings?	or feet, or changes in weight or to the eyes.)	
7e	felt irritable?	11a	has your thyroid disease affected your appearance
7f	felt frustrated?		(for example, swelling of the neck, eye changes,
7g	felt angry?		weight changes)?
7h	felt in control of your life?	11b	have you been unsatisfied with your appearance
7i	felt in balance?		because of your thyroid disease?
		11c	have you tried to camouflage or mask visible signs
Nervousness and tension			of your thyroid disease
5a	felt nervous?		(for example, by wearing a scarf or sunglasses)?
5b	felt afraid or anxious?	11d	have you been bothered by other people looking

(*Continued*)

Table 1: Continued.

Symptoms			Tiredness
5c	felt tense?		at you?
5d	been concerned about being seriously ill?	11e	has your thyroid disease influenced with
5e	felt uneasy?		clothes you wear?
5f	felt restless?	11f	has your thyroid disease made you feel too fat?
Psychological well-being			
6a	felt sad?		
6b	felt depressed?		
6c	felt discouraged?		
6d	cried easily?		
6e	felt unhappy?		
6f	felt happy?		
6g	had self-confidence?		

categorised as class 1 or higher for obesity. Most participants (67.7%) had more than one co-morbidity. The main co-morbidities recorded were hypertension, diabetes, human immunodeficiency virus (HIV), and chronic kidney disease (CKD).

Median (IQR) TSH values were 2.6 (1.0–4.5) mU/l with a normal range of 0.27–4.20 and median (IQR) FT4 was 16.6 (14.2–19.3) pmol/l with a normal range of 12.0–22.0 pmol/l. The median dose of LT4 was 100 µg. Among all the participants, 69.3% had been on treatment for more than 5 years, while 28.3% were on treatment for between 1 and 4 years and 2.4% had been on treatment between 6 months and 1 year (Table 2).

Table 3 shows the ThyPRO scores among the 127 participants. Each participant answered all the questions on all the ThyPRO parameters. The scores from zero to four were considered in the analysis. ThyPRO scores were high for vitality at 49.9%, difficulty in coping with the mood at 38.5%, tiredness at 37.5%, nervousness and tension at 33.3%. No negative impact on mean ThyPRO scores was recorded for sex life among the respondents. Low ThyPRO scores for relationships with other people were 18.8%, symptoms 18.5%, and both appearance and daily activities 16.7%. The average overall QoL of all the participants was 31.4%.

Table 4 presents the univariate ANOVA analysis of the association between the overall ThyPRO score and demographic characteristics at baseline. The univariate ANOVA results that were significantly associated with the overall ThyPRO score included smoking status (p-value = 0.031), ethnicities (0.025), duration of treatment (0.004), and the existence of co-morbidities (0.037). Indian descent participants had the highest ThyPRO score of 44.4% followed by White 39.3%, Black 30.7%, and Mixed origin 26.0%. Being a smoker was associated with higher ThyPRO score of 40.1% compared with non-smokers' scores of 30.3%. Duration of treatment for less than one year had a high score of 61.0% compared with 29.4% between one and four years, and 31.1% for more than five years of treatment. Participants with other conditions had a high score of 35.8%, more than two co-morbidities had a score of 34.2%, with one comorbidity at 31.7% compared with no comorbidities at 22.2%. The association between the overall ThyPRO score and BMI category (p-value = 0.743), sex (p-value = 0.995), education (p-value = 0.983), and dose treatment (p-value = 0.702), were not significant.

Figure 1 shows the comparison of ThyPRO scores with the age groups of the study population using a Box and Whisker plot. The mean score for the overall ThyPRO score did not differ across age groups (p-value = 0.625). The medians of the age groups did not differ.

Table 5 indicates the baseline predictors of QoL among participants treated for hypothyroidism. The baseline predictors of QoL are TSH, FT4, TPOAb, LT4 dose, age, BMI, smoking status, ethnicity, education, duration of treatment, and co-morbidity. Ethnicity, smoker, duration of treatment, and co-morbidity were statistically significant. The co-morbidities and treatment duration were statistically significant in multivariate analysis. Participants having one co-morbidity vs none increased their ThyPRO score by 9.5 units, while those having ≥ 2 conditions increased the score by 12.0 units, and participants with "other" co-morbidity increased by 13.6 units. Participants on treatment for longer than a year were less likely to have lower ThyPRO scores, suggesting improvement in QoL with longer treatment duration. Smoking status was statistically significant in the unadjusted model; being a smoker was associated with higher ThyPRO scores (i.e. poor health status). Smoking increased the ThyPRO score by 9.9 units compared with not smoking. Similarly, White patients and those of Indian descent were likely to document higher ThyPRO scores compared with Black patients.

Table 6 displays the proportion of smokers in each ethnic group. There were more smokers among the White participants (60%), while the other ethnic groups had fewer smokers: 22.2% were of Indian descent, 17.6% were of mixed race, and 6.3% were Black.

Discussion

Our study evaluated the QoL in treated primary hypothyroid participants on levothyroxine therapy by using the disease-specific ThyPRO questionnaire. In addition, the study determines the association between QoL and various parameters. Black participants constituted the majority (75.6%) compared with other ethnicities, which is representative of the South African population. The demographic for this study is contrary to global epidemiology. The mean age was 57.6 years. Global epidemiology shows hypothyroidism is a disease in women and the elderly, as confirmed by our study with a predominance of women (89%).[8]

Table 2: Baseline characteristics of participants treated for hypothyroidism

Variable	*n* = 127
Age/years, mean (SD)	57.6 ± 15.0
Sex, *n* (%)	
Female	113 (89.0%)
Males	14 (11.0%)
BMI category (kg/m^2)	
< 25	21 (16.5%)
25–29	18 (14.2%)
30–34	36 (28.3%)
35–39	27 (21.3%)
> 40	25 (19.7%)
Smoker, *n* (%)	14 (11.0%)
Female smoker, *n* (%)	13 (10.2%)
Male smoker, *n* (%)	1 (0.8%)
Non-smoker, *n* (%)	113 (89.0%)
Female non-smoker, *n* (%)	100 (78.8%)
Male non-smoker, *n* (%)	13 (10.2%)
Ethnicity, *n* (%)	
Black	96 (75.6%)
Mixed origin	17 (13.4%)
Indian descent	9 (7.1%)
White	5 (3.9%)
Education, *n* (%)	
None	12 (9.4%)
Primary	19 (15.0%)
Secondary	82 (64.6%)
Tertiary	14 (11.0%)
Comorbidity, *n* (%)	
None	19 (15.0%)
1 chronic* condition	68 (53.5%)
≥ 2 chronic* conditions	18 (14.2%)
Other**	22 (17.3%)
TSH (mU/l), median (IQR)	2.6 (1.0–4.5)
FT_4 (pmol/l), median (IQR)	16.6 (14.2–19.3)
TPOAb, median (IQR)***	336.0 (36–1600)
Dose LT_4 (ug), median (IQR)	100 (75–150)
Duration on treatment, *n* (%)	
≥ 6 months – 1 year	3 (2.4%)
1–4 years	36 (28.3%)
≥ 5 years	88 (69.3%)

*Chronic condition refers to main diseases, namely hypertension, diabetes, chronic kidney disease, and human immunodeficiency virus. **Others refer to diseases except for the four main diseases above.
***TPOAb's baseline characteristics were computed with 83 valid data (*n*) and 44 missing data.

Table 3: ThyPRO scores among study participants (*n* = 127)

ThyPRO Parameter	Mean ± SD or median (IQR) (%)
Symptoms	18.5 (8.9–30.6)
Tiredness	37.5 (12.5–68.75)
Vitality	49.9 ± 31.2
Memory and concentration	25.0 (4.2–45.8)
Nervousness and tension	33.3 (16.7–54.2)
Psychological well-being	28.5 (17.9–32.1)
Difficulty coping or having mood swings	38.5 ± 21.5
Relationships with other people	18.8 (0.0–43.8)
Daily activities	16.7 (0.0–41.7)
Sex life	0.0 (0.0–50.0)
Appearance	16.7 (0.0–37.5)
Negative impact on quality of life	25.0 (0.0–75.0)
Overall	31.4 ± 16.1

Our study showed that participants reported the highest ThyPRO scores for lack of vitality, difficulty coping or having poor mood, tiredness, nervousness, and tension, which displayed decreased QoL. Similar conclusions were drawn in a cross-sectional study where high scores dominated in tiredness, emotional susceptibility, and anxiety as compared with less physical symptoms.[13] The smallest affected QoL scales are for sex life, symptoms, appearance, and daily activities. Overall, treated hypothyroid participants have decreased QoL, and this may be due to the reduced amount of circulating T3 levels in the different tissues while being biochemically euthyroid.[10] Physiologically, the iodothyronine deiodinase enzyme plays a principal role in activating and deactivating thyroid hormone. Recent studies revealed a particular polymorphism of iodothyronine deiodinases in the hypothalamus. This polymorphism prevents the conversion of FT4 serum to T3.[21]

Our analysis of the association between the overall ThyPRO score and various parameters depicts that the ethnicities, smoking status, duration of treatment, and co-morbidities are statistically significant regarding the overall ThyPRO score, unlike BMI, sex, and education parameters. Indian descent and White participants had the highest ThyPRO score (decreased QoL), as compared with participants in other ethnic groups. A possible explanation could be that White participants were more likely to be smokers (60%), while Indian-descent smokers, as opposed to White, represent 22.2% of the Indian-descent participants. More investigations are required on the real causes of decreased QoL of those of Indian descent. Smoking was associated with higher ThyPRO scores compared with non-smoking.[9] There is some contradiction as to whether or not smoking cessation has a beneficial impact on mental health.[9,22]

Our study indicated that the treatment duration was negatively correlated with QoL. Participants on treatment for longer than a year were less likely to have decreased ThyPRO scores (good QoL), suggesting improvement in QoL with longer duration of treatment. A plausible explanation could be that compliance with LT4 improved with time. A Danish study reported that there is an improvement after six months of LT4, but some QoL scales were still affected including tiredness. Other studies did not find any association between QoL and the duration of hypothyroidism treatment.[9,10]

Participants who had more than two co-morbidities were more likely to have a high ThyPRO score, suggesting decreased QoL, which is expected. Another study reported significantly decreased QoL in hypothyroidism participants with hypertension as compared with non-hypertensive participants.[13] Our study shows that BMI, sex, age, education, and thyroid parameters did not significantly affect QoL. These findings did not correlate with other studies demonstrating a reduction of

Table 4: Association between overall ThyPRO score and demographic characteristics at baseline

Variables	Overall quality of life score	
	Mean ± SD	*p*-value
BMI category (kg/m^2)		
< 25	29.5 ± 16.7	0.743
25–29	27.4 ± 13.3	
30–34	32.1 ± 16.3	
35–39	33.6 ± 16.6	
> 40	32.3 ± 17.2	
Sex		
Female	31.4 ± 15.9	0.995
Male	31.3 ± 18.6	
Smoking status		
Non-smoker	30.3 ± 15.8	**0.031**
Smoker	40.1 ± 17.0	
Ethnicity		
Black	30.7 ± 16.0	**0.025**
Mixed origin	26.0 ± 12.2	
Indian descent	44.4 ± 16.7	
White	39.3 ± 19.5	
Education		
No education	30.8 ± 13.9	
Primary	31.6 ± 20.2	0.983
Secondary	31.1 ± 16.1	
Tertiary	32.9 ± 13.5	
Duration on treatment		
6 months – < 1 year	61.0 ± 22.2	**0.004**
1–4 years	29.4 ± 15.7	
≥ 5 years	31.1 ± 15.3	
Co-morbidity		
None	22.2 ± 10.7	**0.037**
1 chronic condition	31.7 ± 15.5	
≥2 chronic conditions	34.2 ± 12.9	
Others	35.8 ± 21.5	
Dose treatment		
< 100	29.7 ± 16.4	0.702
101–150	33.7 ± 15.0	
151–199	30.6 ± 18.7	
> = 200	30.2 ± 9.0	

P-values in bold are significantly associated with the overall ThyPro score.

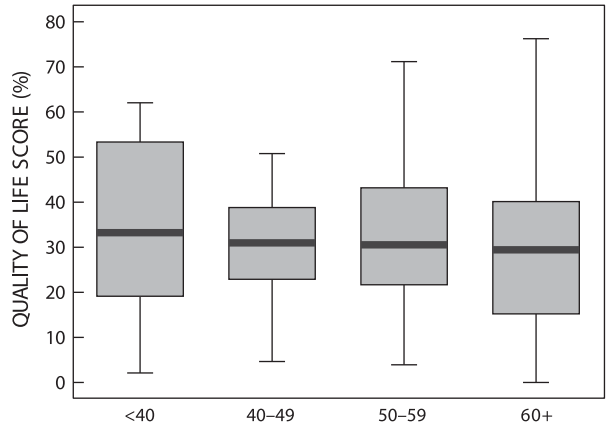

Figure 1: Box and whisker plots describing the distribution of ThyPRO scores by age group.

Table 5: Baseline predictors of QoL among participants treated for hypothyroidism

Variable	Unadjusted coefficient (95% CI)	*p*-value†
TSH (mU/l)	0.4 (−0.1–0.9)	0.139
FT_4 (pmol/l)	0.1 (−0.4–0.6)	0.682
TPOAb	0.0 (−0.0002–0.0002)	0.897
Dose LT_4 (ug)	−0.0 (−0.1–0.1)	0.508
Age (years)	−0.2 (−0.3–0.1)	0.090
BMI (kg/m^2)	0.2 (−0.2–0.5)	0.321
Sex		
Female	1.0	-
Male	0.0 (−9.1–9.1)	0.995
Smoking status		
Non-smoker	1.0	-
Smoker	9.9 (0.9–18.8)	0.031
Ethnicity		
Indian descent	1.0	-
Black	−13.7 (−24.6–2.9)	0.014
Mixed origin	−18.5 (−22.4–12.3)	0.005
White	−5.1 (−6.1–19.1)	0.565
Education		
None	1.0	-
Primary	0.8 (−11.1–12.7)	0.898
Secondary	0.4 (−9.6–10.3)	0.944
Tertiary	2.2 (−10.5–14.9)	0.736
Duration on treatment		
≥ 6 months–1 year	1.0	-
1–4 years	−31.5 (−50.0–−13.0)	0.001
≥ 5 years	−29.8 (−47.9–−11.7)	0.001
Co-morbidity		
None	1.0	-
One condition	9.5 (1.4–17.6)	0.022
≥ 2 conditions	12.0 (1.7–22.3)	0.022
Others	13.6 (3.8–23.4)	0.007

†Statistical significance set at < 0.05 for multivariate analysis.

QoL in participants with an increased BMI independent of levothyroxine therapy.[13] They cited that high BMI was a risk factor for causing other health problems such as hypertension, cardiovascular disease, diabetes mellitus, and malignancy.[1,10,13] Our results compared well with a previous study, showing no association between QoL and serum TSH and FT4.[13]

The limitations of this study are its small sample size of 127 participants, and selection bias could not be ruled out. The ThyPRO questionnaire is in English, which may not have been the first language of the majority of our participants, therefore language and literacy rates may have introduced some bias. A prospective study with QoL assessment before commencing therapy and comparing it at different time intervals might have been better.

Table 6: Number of smokers in each ethnic group

Ethnicity	Smoker	Total no. of participants	%
Black	6	96	6.3%
Mixed origin	3	17	17.6%
Indian descent	2	9	2.2%
White	3	5	60.0%

Conclusion

To our knowledge, this is the first QoL study done so far in an academic hospital in South Africa using the ThyPRO instrument. Our study demonstrated that QoL was affected in our participants regardless of adequate levothyroxine treatment and normal thyroid hormone results. Our findings have proved that lack of vitality, nervousness and tension, difficulty coping, or having poor mood and tiredness adversely affect participants' QoL. Ethnicities, smoking status, duration of treatment, and more than 2 other co-morbidities are correlated negatively with the overall ThyPRO score, while BMI, sex, and education did not significantly affect QoL. The participants with longer treatment duration had better QoL. Participants with no co-morbidities had better QoL than those with one or more than two and other co-morbidities. White and Indian patients were likely to document higher ThyPRO scores (decreased QoL) than Black participants. Participants who were smokers reported high ThyPRO scores (decreased QoL). There were no associations between QoL and thyroid blood results. We recommend the use of ThyPRO to assess the health-related QoL in treated participants living with hypothyroidism. This study may guide future clinical researchers and improve clinical practice to better understand participants' clinical problems and the impact of treatment on their QoL. Further research efforts should focus on assessing the impact of each of the individual conditions hypertension, diabetes, chronic kidney disease, and human immunodeficiency virus on the overall ThyPRO score, and highlight which condition would have a strong impact on ThyPRO score.

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