CLINICAL STUDY

Changes in the prevalence of hypothyroidism: the HUNT Study in Norway

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Abstract

Objective: Untreated hypothyroidism is common in iodine-replete areas. Frequent thyroid function testing and use of levothyroxine treatment for subclinical hypothyroidism suggest that the prevalence may have decreased. Therefore, in this study, we examined changes in the prevalence of hypothyroidism in a Norwegian county from 1995–1997 to 2006–2008.

Design: Population surveys of 33 917 individuals in 1995–1997 and 49 180 individuals in 2006–2008 were carried out.

Methods: We compared the prevalence of untreated overt, untreated subclinical, and treated hypothyroidism between 1995–1997 and 2006–2008.

Results: The prevalence of untreated overt hypothyroidism among women decreased by 84% from 1995–1997 (0.75%) to 2006–2008 (0.12%) (prevalence ratio (PR) 0.16; 95% CI 0.10–0.26). The corresponding decrease among men was 43% from 0.21 to 0.12% (PR 0.57; 95% CI 0.28–1.16). The prevalence of untreated subclinical hypothyroidism decreased by 64% from 3.0 to 1.1% in women (PR 0.36; 95% CI 0.31–0.42) and decreased by 54% from 2.1 to 1.0% in men (PR 0.46; 95% CI 0.38–0.56). Conversely, the prevalence of treated hypothyroidism among women increased by 60% from 5.0 to 8.0% (PR 1.60; 95% CI 1.50–1.71), and the corresponding prevalence in men doubled from 1.0 to 2.0% (PR 1.96; 95% CI 1.59–2.41). The prevalence of any form of hypothyroidism remained essentially similar at 9% in women and 3% in men.

Conclusions: The prevalence of untreated hypothyroidism in this Norwegian county decreased strongly from 1995–1997 to 2006–2008. The findings suggest that the prevalence of untreated hypothyroidism in populations with easy access to thyroid function testing and levothyroxine treatment may now be low.

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Introduction

From large population studies carried out in the 1970s to 1990s, we have learnt that untreated hypothyroidism is common in iodine-replete areas. In these studies, ~0.2–0.5% of the participants had biochemically overt hypothyroidism and 4–10% had subclinical hypothyroidism (1, 2, 3, 4, 5, 6). Subsequent observational evidence has suggested that subclinical hypothyroidism may be associated with an increased risk of coronary heart disease, adverse pregnancy outcomes, and progression to clinical hypothyroidism (1, 7). The knowledge of the high prevalence and potential hazards of hypothyroidism, as well as increased availability of thyroid function tests, may have led to more frequent thyroid function testing and liberal treatment of subclinical hypothyroidism. However, it is not known to which extent the prevalence of untreated hypothyroidism may have changed. In this

population-based study, we, therefore, examined changes in the prevalence of hypothyroidism in a Norwegian county during an 11-year period ranging from 1995–1997 to 2006–2008.

Subjects and methods

Study population

The HUNT Study is a series of three surveys carried out in the Nord-Trøndelag county in Norway (8, 9). In each of the surveys, all the residents who were aged 20 years or above were invited to participate, and the study included comprehensive questionnaires, clinical examination, and blood sampling. The second (HUNT 2) and third (HUNT 3) surveys included thyroid function measurements.

In HUNT 2 (1995–1997), 93 898 people were invited, and 65 215 (69%) participated (8, 9). Serum thyrotropin (TSH) concentrations were measured in subsamples of the population, including all women aged 40 years or above, a 50% random sample of men aged 40 years or above, and 5% random samples of women and men aged below 40 years. In total, TSH concentrations were measured in 33 948 participants from these samples. Among these participants, we excluded 31 who did not reply to the questionnaire items on thyroid diseases (2), leaving 33 917 participants (23 274 women and 10 643 men) for analysis.

In HUNT 3 (2006–2008), 93 860 people were invited, and 50 807 (54%) participated (9). Serum TSH measurement was planned for all the subjects, and TSH concentrations were measured in 49 180 participants (26 822 women and 22 358 men) who were included in the present analysis.

Thyroid function in HUNT 2

If TSH concentrations were above 4.0 mU/l, serum free thyroxine and TPO antibody concentrations were measured. The measurements were carried out at the Hormone Laboratory, Aker University Hospital (Oslo, Norway), using DELFIA hTSH Ultra (total analytical variation <5%) and DELFIA FT4 (total analytical variation <7%) from Wallac Oy (Turku, Finland) and a luminoimmunoassay for TPO antibodies from B.R.A.H.M.S. Diagnostica GmbH (Berlin, Germany). The reference ranges were 8–20 pmol/l for free thyroxine and <200 U/ml for TPO antibodies. For TSH, the laboratory's reference range was 0.2–4.5 mU/l, but subsequent analyses indicated that 0.5–3.5 mU/l may be a more appropriate reference range for this population (2). In this study, we used a TSH concentration of 4.5 mU/l as a cut-off to indicate hypothyroidism, as has been done in the recent studies carried out by the Thyroid Studies Collaboration (7, 10).

The questionnaire included items on current or previous thyroid diseases, including the use of levothyroxine or thionamides. The prevalence of hypothyroidism in HUNT 2 has been reported previously (2), but we re-estimated the prevalence in the present study, using similar definitions of hypothyroidism for HUNT 2 and HUNT 3.

Thyroid function in HUNT 3

If TSH concentrations were above 3.0 mU/l, serum free thyroxine and TPO antibody concentrations were measured. TSH (total analytical variation <5% and reference range 0.20–4.5 mU/l), free thyroxine (total analytical variation <5% and reference range 9.0–19.0 pmol/l), and TPO antibody (reference range ≤5.6 U/ml) concentrations were measured at Levanger Hospital, Nord-Trøndelag Hospital Trust, using chemiluminescent microparticle immunoassays on an

Architect ci8200 obtained from Abbott, with reagents obtained from Architect iSystem (Abbott Ireland, Longford, Ireland; and Abbott Laboratories). The methods used for TSH measurement in HUNT 2 and HUNT 3 were compared using blood samples obtained from 94 individuals. For TSH concentrations below 5 mU/l, the results did not systematically differ between the methods. For TSH concentrations above 5 mU/l, the values were, on average, 3.7% lower when using the Architect method (HUNT 3) than when using the DELFIA method (HUNT 2).

We used the unique 11-digit identity number of every Norwegian citizen to link the data to the Norwegian Prescription Database (www.norpd.no), which includes information on virtually all prescriptions dispensed to non-institutionalized inhabitants in Norway since January 2004. From this database, we obtained individual information on dates on which levothyroxine and thionamides had been dispensed.

Classification of hypothyroidism

In each survey, we classified hypothyroid participants as having treated, untreated overt, or untreated subclinical hypothyroidism. Treated hypothyroidism was defined as the use of levothyroxine without the use of thionamides, as indicated by self-report (for HUNT 2) or information from the prescription database (for HUNT 3). For HUNT 3, short-term levothyroxine use a long time before the examination (indicated by no dispensing during the last 6 months and less than three dispensings in total) did not qualify as treated hypothyroidism. For people who did not use levothyroxine or thionamides, we defined untreated overt hypothyroidism as having TSH concentrations above 4.5 mU/l combined with free thyroxine concentrations below the laboratory's reference range and untreated subclinical hypothyroidism as having TSH concentrations above 4.5 mU/l combined with free thyroxine concentrations at the lower reference limit or higher.

Statistical analyses

For each type of hypothyroidism, we estimated the prevalence in HUNT 2 and HUNT 3 and the prevalence ratio (PR, with 95% CI) between the surveys using a log-binomial regression model. We analyzed women and men separately and adjusted for age (<40, 40–49, 50–59, 60–69, 70–79, or ≥80 years). We also estimated the prevalence of hypothyroidism in each survey by age group. Furthermore, we studied the change in the prevalence of subtypes of untreated subclinical hypothyroidism defined by TSH concentration (4.6–6.9, 7.0–9.9, or 10.0 mU/l or higher) or TPO antibody status (positive or negative antibody status, using the upper reference limit as the cut-off level). In additional analyses, we examined whether the PRs changed after adjustment for BMI, smoking habits,

and alcohol consumption. In the regression model, we used a clustered sandwich estimator of variance to account for repeated measurements among those who participated in both surveys. In HUNT 2, participants aged below 40 years were weighted due to differences in sampling probability.

To examine the treatment practices of subclinical hypothyroidism in this population, we estimated the prevalence of each type of hypothyroidism in HUNT 3 among the participants with untreated subclinical hypothyroidism in HUNT 2 who had also participated in HUNT 3.

For those who participated in both surveys, the detection of hypothyroidism in HUNT 2 could have influenced the prevalence observed in HUNT 3. To evaluate this possibility, we compared the prevalence of hypothyroidism in HUNT 3 between participants who had their thyroid function tested in HUNT 2 and those who had not. This analysis was carried out in participants aged 50 years or above in HUNT 3, corresponding to the 40-year age cut-off for thyroid function measurement in HUNT 2.

To evaluate whether the prevalence of treated hypothyroidism differed between the study participants and the general population, we compared the prevalence of levothyroxine use in 2005 (the year prior to HUNT 3 examinations) between the participants of HUNT 3, the total population of Nord-Trøndelag, and the total Norwegian population, using population-level data on the prescriptions of levothyroxine from the Norwegian Prescription Database. We estimated this prevalence by sex and age group (10-year categories).

In the results reported herein, we used the laboratory's lower reference limit for free thyroxine to differentiate between overt and subclinical hypothyroidism, but this limit was slightly higher in HUNT 3 (9.0 pmol/l) than in HUNT 2 (8.0 pmol/l). Therefore, we repeated the analyses using 8.0 pmol/l as the reference limit in both the surveys, but the use of this alternative reference limit did not substantially influence the results. All the statistical analyses were carried out using Stata version 12.1 for Windows (Stata Corporation, College Station, TX, USA).

The study was approved by the Regional Committee for Medical Research Ethics and by the Norwegian Data Inspectorate, and all the participants gave their informed consent.

Results

The characteristics of the participants are given in Table 1. The proportion of participants by age group is given in Table 2. A total of 13 085 women and 5708 men had their thyroid function tested in both the surveys: 10 189 women and 4935 men in 1995–1997 (HUNT 2) only, and 13 737 women and 16 650 men in 2006–2008 (HUNT 3) only.

The prevalence of untreated overt hypothyroidism among women decreased by 84% from 1995–1997 (0.75%) to 2006–2008 (0.12%) (PR 0.16; 95% CI 0.10–0.26). The corresponding decrease among men was 43% from 0.21 to 0.12% (PR 0.57; 95% CI 0.28–1.16). The prevalence of untreated subclinical hypothyroidism decreased by 64% from 3.0 to 1.1% in women (PR 0.36; 95% CI 0.31–0.42) and by 54% from 2.1 to 1.0% in men (PR 0.46; 95% CI 0.38–0.56). Conversely, the prevalence of treated hypothyroidism in women increased by 60% from 5.0 to 8.0% (PR 1.60; 95% CI 1.50–1.71), and the corresponding prevalence in men doubled from 1.0 to 2.0% (PR 1.96; 95% CI 1.59–2.41). The prevalence of any of these forms of hypothyroidism remained essentially similar at 9% in women and 3% in men (Table 3).

Changes in the prevalence of untreated and treated hypothyroidism were present across all the age groups, but the absolute changes were largest among women aged 60 years and above. For these women, the prevalence of untreated subclinical hypothyroidism decreased from ~4 to 1% between the surveys, whereas the prevalence of treated hypothyroidism increased from ~8 to 13% (Fig. 1).

The prevalence of untreated subclinical hypothyroidism decreased regardless of the concentrations of TSH or the presence of TPO antibodies, but the strongest decrease was observed for subclinical hypothyroidism with TSH concentrations of 7.0–9.9 mU/l (prevalence

Table 1 Characteristics of the study population.

	Women		Men	
	HUNT 2 (1995–1997) ^a <i>n</i> = 23 274	HUNT 3 (2006–2008) <i>n</i> = 26 822	HUNT 2 (1995–1997) ^a <i>n</i> = 10 643	HUNT 3 (2006–2008) <i>n</i> = 22 358
Age (years), median (IQR)	49 (36–64)	53 (40–64)	49 (37–64)	54 (42–64)
Serum TSH (mU/l), ^b median (IQR)	1.5 (1.1–2.2)	1.4 (1.0–1.9)	1.5 (1.1–2.1)	1.5 (1.1–2.0)
BMI (kg/m ²), mean (s.d.)	26.3 (4.5)	26.9 (4.8)	26.5 (3.5)	27.5 (3.8)
Current daily smokers (%)	28.9	21.3	29.0	17.8

IQR, interquartile range.
^aParticipants aged below 40 years were weighted due to differences in sampling probability.
^bIn people not using levothyroxine or thionamides.

Table 2 Proportion (%) of participants by age group in HUNT 2 (1995–1997) and HUNT 3 (2006–2008), by sex.

Age group (years)	Women		Men	
	HUNT 2 (1995–1997) ^a	HUNT 3 (2006–2008)	HUNT 2 (1995–1997) ^a	HUNT 3 (2006–2008)
20–39	31.3	23.7	29.8	20.3
40–49	20.8	19.7	21.3	19.8
50–59	16.7	21.7	18.1	23.6
60–69	13.6	18.6	14.8	20.4
70–79	12.7	11.2	12.2	11.7
≥80	5.0	5.1	3.8	4.3

^aParticipants aged below 40 years were weighted due to differences in sampling probability.

in 2006–2008: 0.1–0.2%) or TSH concentrations of 10.0 mU/l or above (prevalence in 2006–2008: 0.06%) (Table 4). Among women, the prevalence of mildly elevated TSH concentrations (4.6–6.9 mU/l) without TPO antibodies decreased by 60% (PR 0.40; 95% CI 0.30–0.52) from 0.90 to 0.36%. The corresponding decrease among men was 56% (PR 0.44; 95% CI 0.34–0.58) from 1.07 to 0.47%.

In additional analyses, we adjusted for BMI, smoking habits, and alcohol consumption to examine whether changes in these variables could explain the changes in the prevalence of hypothyroidism, but the PRs remained essentially unchanged after such an adjustment (data not shown).

To examine the treatment practices of subclinical hypothyroidism in this population, we studied the prevalence of treated and untreated hypothyroidism in HUNT 3 in 403 women and 114 men with untreated subclinical hypothyroidism in HUNT 2 who had also participated in HUNT 3. Among these participants, 66% of women and 44% of men were treated for hypothyroidism in HUNT 3, and such treatment was particularly common among those with a strong TSH concentration elevation or TPO antibodies in HUNT 2 (Table 5).

To evaluate whether the detection of hypothyroidism in HUNT 2 could have influenced the prevalence in HUNT 3, we compared the prevalence of treated and untreated hypothyroidism in HUNT 3 between participants who had their thyroid function tested in HUNT 2 and those who had not, but the prevalence did not differ substantially between the groups (Table 6).

To evaluate whether the prevalence of treated hypothyroidism differed between the study participants and the general population, we compared the prevalence of levothyroxine use in 2005 between the participants of HUNT 3 and the total adult population of Nord-Trøndelag, but the prevalence was essentially similar in both the groups (Fig. 2). The prevalence of levothyroxine use in the Nord-Trøndelag county also did not differ substantially from that in the total Norwegian population, but among women aged 60 years and above, the prevalence of levothyroxine use was ~1 percentage point higher in the Nord-Trøndelag county than in the total Norwegian population (Fig. 2).

Discussion

In this population study, we examined changes in the prevalence of hypothyroidism within a Norwegian county during an 11-year period ranging from 1995–1997 to 2006–2008. The prevalence of untreated hypothyroidism decreased strongly, and in 2006–2008, the prevalence of untreated overt hypothyroidism was only 0.1% and that of untreated subclinical hypothyroidism was 1%, with similar estimates for women and men. There was a corresponding increase in the prevalence of treated hypothyroidism, and thus, the prevalence of any form of hypothyroidism remained essentially similar at 9% in women and 3% in men.

The population-based design with repeated surveys enabled us to study long-term changes in the prevalence of hypothyroidism, and the large sample size allowed precise estimates. Linkage with the Norwegian

Table 3 Prevalence of hypothyroidism in HUNT 2 and HUNT 3 and ratios of the prevalence in HUNT 3 to that in HUNT 2, adjusted for age.

Type of hypothyroidism	HUNT 2 ^a (1995—1997)		HUNT 3 ^b (2006—2008)		Prevalence ratio	95% CI
	Prevalence (%)	95% CI	Prevalence (%)	95% CI		
Women						
Untreated overt	0.75	0.51–1.00	0.12	0.08–0.17	0.16	0.10–0.26
Untreated subclinical	3.0	2.6–3.3	1.1	0.9–1.2	0.36	0.31–0.42
Treated	5.0	4.6–5.3	8.0	7.7–8.3	1.60	1.50–1.71
Any	8.7	8.2–9.3	9.2	8.9–9.6	1.06	1.00–1.12
Men						
Untreated overt	0.21	0.08–0.34	0.12	0.07–0.16	0.57	0.28–1.16
Untreated subclinical	2.1	1.8–2.5	1.0	0.9–1.1	0.46	0.38–0.56
Treated	1.0	0.8–1.2	2.0	1.8–2.2	1.96	1.59–2.41
Any	3.4	3.0–3.8	3.1	2.9–3.3	0.92	0.81–1.05

^a23 274 women and 10 643 men.

^b26 822 women and 22 358 men.

Figure 1 Prevalence (% with 95% CI) of untreated overt hypothyroidism (A), untreated subclinical hypothyroidism (B), treated hypothyroidism (C), and any form of hypothyroidism (D) in 1995-1997 and 2006-2008, by sex and age group.

Prescription Database ensured accurate information on the use of thyroid medications in HUNT 3. The use of medications in HUNT 2 was assessed by self-report, which may be less accurate, but it seems unlikely that this difference between the surveys may explain the changes in prevalence. Participants with thyroid dysfunction in HUNT 2 were recommended to contact their general practitioner for follow-up, and their subsequent treatment could have influenced the prevalence of hypothyroidism in HUNT 3. However, this is not likely to explain the changes in prevalence in our study, because the prevalence of treated and untreated hypothyroidism in HUNT 3 did not differ substantially between participants who had their thyroid function tested in HUNT 2 and those who had not. A similar prevalence of levothyroxine use among the participants of HUNT 3 as in the total population of Nord-Trøndelag also weakens the possibility that selection bias may have influenced the results. For TPO antibodies, no comparison was made between the measurement methods used in HUNT 2 and HUNT 3, and changes in the prevalence of subclinical hypothyroidism by TPO antibody status should, therefore, be interpreted with caution.

Few other studies have examined changes in the prevalence of untreated hypothyroidism, but similar to our study, a study among elderly patients in Birmingham, England, suggested that the prevalence of untreated subclinical hypothyroidism decreased from 6% in 1988-1989 to 3% around 2004 (11). More data are available on changes in thyroid hormone prescription. Thus, the annual number of thyroid hormone prescription items dispensed in England more than doubled from 1998 to 2007 (12), and in the Tayside region in Scotland, the prevalence of treated hypothyroidism increased by 63% from 1994 to 2001 (13). In Denmark, the incidence rate of treated hypothyroidism increased by ~80% from 1997 to 2008, which may be explained both by more extensive detection and treatment of hypothyroidism and by an increased incidence of hypothyroidism due to the introduction of iodized salt (14). However, the Norwegian population has long been considered to be iodine sufficient (15), and it seems unlikely that changes in iodine intake may explain the changes that we observed. Smoking (16, 17), alcohol consumption (18), and adiposity (19, 20, 21) are other factors that could influence the prevalence of hypothyroidism or prevalence of high TSH concentrations, but statistical adjustment for differences in smoking habits, alcohol consumption, and BMI between the surveys did not substantially influence the changes in prevalence in our study.

The decline in the prevalence of untreated hypothyroidism in our study population was counterbalanced by an increased prevalence of treated hypothyroidism. This suggests that more extensive detection of hypothyroidism and more liberal treatment of subclinical hypothyroidism may explain the reduced prevalence of untreated hypothyroidism. In support of this suggestion, we also

Table 4 Subtypes of untreated subclinical hypothyroidism defined by TSH concentration or TPO antibody status^a: prevalence in HUNT 2 and HUNT 3 and ratios of the prevalence in HUNT 3 to that in HUNT 2, adjusted for age.

	HUNT 2 ^b (1995–1997)		HUNT 3 ^c (2006–2008)		Prevalence ratio	95% CI
	Prevalence (%)	95% CI	Prevalence (%)	95% CI		
Women						
TSH 4.6–6.9 mU/l	1.95	1.68–2.23	0.89	0.78–1.00	0.46	0.38–0.54
TSH 7.0–9.9 mU/l	0.68	0.46–0.90	0.12	0.08–0.16	0.17	0.11–0.27
TSH ≥ 10.0 mU/l	0.33	0.21–0.45	0.06	0.03–0.09	0.18	0.10–0.32
TPO antibody negative	1.20	0.96–1.44	0.38	0.31–0.46	0.32	0.25–0.41
TPO antibody positive	1.71	1.42–1.99	0.68	0.58–0.78	0.40	0.33–0.49
Men						
TSH 4.6–6.9 mU/l	1.59	1.29–1.89	0.76	0.65–0.87	0.48	0.38–0.60
TSH 7.0–9.9 mU/l	0.37	0.22–0.52	0.18	0.12–0.23	0.49	0.30–0.79
TSH ≥ 10.0 mU/l	0.19	0.11–0.26	0.06	0.03–0.09	0.30	0.15–0.57
TPO antibody negative	1.27	1.02–1.51	0.53	0.43–0.62	0.42	0.33–0.53
TPO antibody positive	0.83	0.58–1.07	0.45	0.36–0.54	0.55	0.39–0.76

^aThe proportion of subclinically hypothyroid participants with available TPO antibody status was 98% in HUNT 2 and 99% in HUNT 3.

^b23 274 women and 10 643 men.

^c26 822 women and 22 358 men.

observed that a high proportion of subclinically hypothyroid individuals in HUNT 2 were subsequently treated with levothyroxine in HUNT 3. The latter observation should be interpreted with caution, however, because we do not know the participants' thyroid function at the initiation of levothyroxine treatment and information on thyroid function in HUNT 3 was available for only 49% of people with untreated subclinical hypothyroidism in HUNT 2.

Changes in the prevalence of hypothyroidism may differ between populations due to differences in the frequency of thyroid function testing, access to levothyroxine treatment, and clinical practice followed for the treatment of subclinical hypothyroidism. In Norway, there is easy access to primary health care,

thyroid function testing is performed liberally, and most of the costs for thyroid function testing and levothyroxine treatment are reimbursed. There are no national guidelines on screening or treatment for hypothyroidism, and the choice to treat subclinical hypothyroidism or not is made by the individual physicians, most often general practitioners. The strong decline in the prevalence of untreated overt hypothyroidism and subclinical hypothyroidism with TSH concentrations above 10 mU/l suggests that such hypothyroidism is now most often treated, as recommended (1, 22). For subclinical hypothyroidism with a mild TSH concentration elevation, there is no consensus on the benefit of treatment (1, 22, 23, 24), and mild TSH concentration elevation may frequently be due to causes other than

Table 5 Prevalence of types of hypothyroidism in HUNT 3 (2006–2008) among people with untreated subclinical hypothyroidism in HUNT 2 (1995–1997) who had also participated in HUNT 3,^a by type of subclinical hypothyroidism^b in HUNT 2, in women and men.

Type of hypothyroidism in HUNT 3	Type of untreated subclinical hypothyroidism in HUNT 2													
	Any		TSH 4.6–6.9 mU/l, TPOAb–		TSH 4.6–6.9 mU/l, TPOAb+		TSH 7.0–9.9 mU/l, TPOAb–		TSH 7.0–9.9 mU/l, TPOAb+		TSH ≥ 10.0 mU/l, TPOAb–		TSH ≥ 10.0 mU/l, TPOAb+	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Women														
	(n=403)		(n=114)		(n=157)		(n=25)		(n=59)		(n=7)		(n=36)	
Treated	265	66	40	35	113	72	16	64	55	93	3	43	35	97
Untreated overt	2	0.5	0	0	2	1	0	0	0	0	0	0	0	0
Untreated subclinical	38	9	13	11	19	12	1	4	2	3	2	29	0	0
No hypothyroidism	98	24	61	54	23	15	8	32	2	3	2	29	1	3
Men														
	(n=114)		(n=51)		(n=23)		(n=7)		(n=11)		(n=2)		(n=19)	
Treated	50	44	10	20	11	48	3	43	7	64	2	100	16	84
Untreated overt	3	3	0	0	1	4	0	0	1	9	0	0	1	5
Untreated subclinical	20	18	12	24	4	17	1	14	2	18	0	0	1	5
No hypothyroidism	41	36	29	57	7	30	3	43	1	9	0	0	1	5

^aOf 801 women and 260 men with untreated subclinical hypothyroidism in HUNT 2, 403 (50%) of women and 114 (44%) of men participated in HUNT 3.

^bDefined by TSH concentration and by negative (TPOAb–) or positive (TPOAb+) TPO antibody status, using a TPO antibody concentration of 200 U/ml as the cut-off. TPO antibody concentrations were measured in 398 (99%) of women and 113 (99%) of men with untreated subclinical hypothyroidism in HUNT 2 who had also participated in HUNT 3.

Table 6 Prevalence of hypothyroidism among participants aged ≥ 50 years of HUNT 3 who did or did not have their TSH concentrations measured in HUNT 2, adjusted for age.

Type of hypothyroidism	TSH concentrations not measured in HUNT 2 ^a		TSH concentrations measured in HUNT 2 ^b		Prevalence ratio ^c	95% CI
	Prevalence (%)	95% CI	Prevalence (%)	95% CI		
Women						
Untreated ^d	1.7	1.1–2.3	1.4	1.2–1.6	0.80	0.55–1.17
Treated	10.7	9.3–12.1	12.1	11.5–12.6	1.13	0.98–1.29
Any	12.4	11.0–13.9	13.4	12.9–14.0	1.08	0.95–1.23
Men						
Untreated ^d	1.5	1.3–1.8	1.3	1.0–1.5	0.82	0.61–1.10
Treated	2.8	2.5–3.2	3.4	2.9–3.8	1.19	0.98–1.44
Any	4.4	3.9–4.8	4.6	4.1–5.2	1.06	0.91–1.24

^a2382 women and 7910 men.^b12 805 women and 5504 men.^cPrevalence ratio of participants who had their TSH concentrations measured in HUNT 2 to those who had not.^dOvert or subclinical.

hypothyroidism, including obesity (19, 20), age-related physiological changes in pituitary–thyroid axis function (25, 26), or simply being in the upper tail of the physiological distribution of TSH concentrations. In a study carried out in the Mayo Clinic in 1995–1996,

levothyroxine was prescribed for only 20% of people with serum TSH concentrations of 5–10 mU/l without evidence of autoimmune thyroiditis (27). The declining prevalence of mild TSH concentration elevation without TPO antibodies that we observed may suggest that people with a mild TSH concentration elevation without evidence of autoimmune thyroiditis are increasingly being treated with levothyroxine.

In conclusion, the prevalence of untreated overt and subclinical hypothyroidism in the Nord-Trøndelag county in Norway was more than halved from 1995–1997 to 2006–2008, and the decline was counterbalanced by an increased prevalence of treated hypothyroidism. Increased thyroid function testing and more liberal treatment of subclinical hypothyroidism may explain these changes. The findings suggest that prevalence of untreated hypothyroidism in populations with easy access to thyroid function testing and levothyroxine treatment may now be low.

Declaration of interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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Figure 2 Prevalence (%) of levothyroxine use in 2005 among the participants of HUNT 3, the total population of Nord-Trøndelag, and the total population of Norway, by age group, in women (A) and men (B).

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