

## Supplement

### Undiagnosed diabetes by socioeconomic status and health care consumption in the Tromsø Study 1994-2016

#### Table of contents

Methods .....	2
<i>The Tromsø Study surveys (Tromsø 4 - Tromsø 7)</i> .....	2
<i>Tromsø Study questionnaire questions</i> .....	2
<b>Supplementary Figures</b> .....	5
<b><i>Figure 1. Flow chart included participants from the Tromsø Study surveys. The Tromsø Study 1994-2016.</i></b> .....	5
<b><i>Figure 2. Age standardized diabetes prevalence by sex and survey. The Tromsø Study 1994-2016.</i></b> .....	6
<b><i>Figure 3. Prevalence of known and undiagnosed diabetes by age in Tromsø 4 (1994-1995), Tromsø 5 (2001), Tromsø 6 (2007-2008) and Tromsø 7 (2015-2016).</i></b> .....	7
<b><i>Figure 4. Age standardized diabetes prevalence by body mass index in Tromsø 4 (1994-1995), Tromsø 5 (2001), Tromsø 6 (2007-2008) and Tromsø 7 (2015-2016).</i></b> .....	8
<b>Supplementary Tables</b> .....	9
<b><i>Table 1. Mean HbA1c by sex, age and other characteristics in each survey. The Tromsø Study 1994-2016.</i></b> .....	9
<b><i>Table 2. Associations of household income with undiagnosed diabetes. The Tromsø Study 1994-2016.</i></b> .....	10
<b><i>Table 3. Percentage of participants who visited a general practitioner during the last 12 months prior to screening visit among people with undiagnosed diabetes and no diabetes.</i></b> .....	11
<b><i>Table 4. Cross-tabulation by diabetes status for participants in Tromsø 6 and Tromsø 7.</i></b> .....	12

## Methods

### *The Tromsø Study surveys (Tromsø 4 - Tromsø 7)*

All residents born 1969 or earlier were invited to the fourth survey in 1994-1995. Altogether 26,992 (76%) out of an eligible population of 35,420 subjects participated completed a questionnaire and attended. All participants aged 55 to 74 years, plus 5–10% samples of other age groups who attended the main survey, were invited to a second examination. HbA<sub>1c</sub> was measured in 7,184 individuals. Tromsø 5 was carried out in 2001, a total of 10,353 individuals were invited, and 8,130 aged 30 - 89 years attended (78.5%). Among those participants 6,158 HbA<sub>1c</sub> measurements were performed. The sixth health survey, Tromsø 6 was conducted in 2007–2008, 19,762 individuals aged 30 to 87 years were invited and 12,984 attended (65.7%). HbA<sub>1c</sub> was measured in 12,768 participants (98% of the total). Tromsø 7 was performed in 2015-16, 32,591 people from 40 years and onwards were invited and 21,083 (65% of the invited) participated. 20,813 HbA<sub>1c</sub> measurements were included in the data collection.

### *Tromsø Study questionnaire questions*

Tromsø 4: (1994-95) 27158 participants

Diabetes:

- Do you have diabetes? If diabetes, age first time?

Educational level:

- What is the highest levels of education you have completed?

- 1 : 7-10 years primary/secondary school, modern secondary school
- 2 : Technical school, middle school, vocational school, 1-2 years senior high school
- 3 : High school diploma (3-4 years)
- 4 : College/university, less than 4 years

5 : College/university, 4 or more years

Use of health care system:

- How many visits have you made during the past year due to your own health or illness to a general practitioner / Emergency GP?

Tromsø 5 (2001) 8130 participants

Diabetes:

- Do you have, or have you had diabetes? If diabetes, age first time?

Educational level:

- How many years of education have you had?

Health care system:

- How many visits have you made during the last 12 months to a general practitioner?

Tromsø 6 (2007-08) 12984 participants

Diabetes:

- Do you have, or have you had diabetes? If diabetes, age first time?

Educational level

- What is the highest levels of education you have completed?

- 1 : Primary/secondary school, modern secondary school
- 2 : Technical school, vocational school, 1-2 years senior high school
- 3 : High school diploma
- 4 : College/university less than 4 years
- 5 : College/university 4 years or more

Health care system:

- Have you during the last 12 months visited a general practitioner?  
- If you have visited a general practitioner the last 12 months, how many visits have you made?

Household income:

- What was the households total taxable income last year? Include income from work, social benefits and similar

- 1 : Less than 125000 NOK
- 2 : 125000-200000 NOK
- 3 : 201000-300000 NOK
- 4 : 301000-400000 NOK
- 5 : 401000-550000 NOK
- 6 : 551000-700000 NOK
- 7 : 701000-850000 NOK
- 8 : More than 850000 NOK

Tromsø 7 (2015-16) 21083 participants

Diabetes:

- Do you have, or have you had diabetes? If diabetes, age first time?

Educational level

- What is the highest levels of education you have completed?

- 1 : Primary/partly secondary education. (Up to 10 years of schooling)
- 2 : Upper secondary education: (a minimum of 3 years)
- 3 : Tertiary education, short: College/university less than 4 years
- 4 : Tertiary education, long: College/university 4 years or more

Health care system:

- Have you during the last 12 months visited a general practitioner?  
- If you have visited a general practitioner the last 12 months, how many visits have you made?

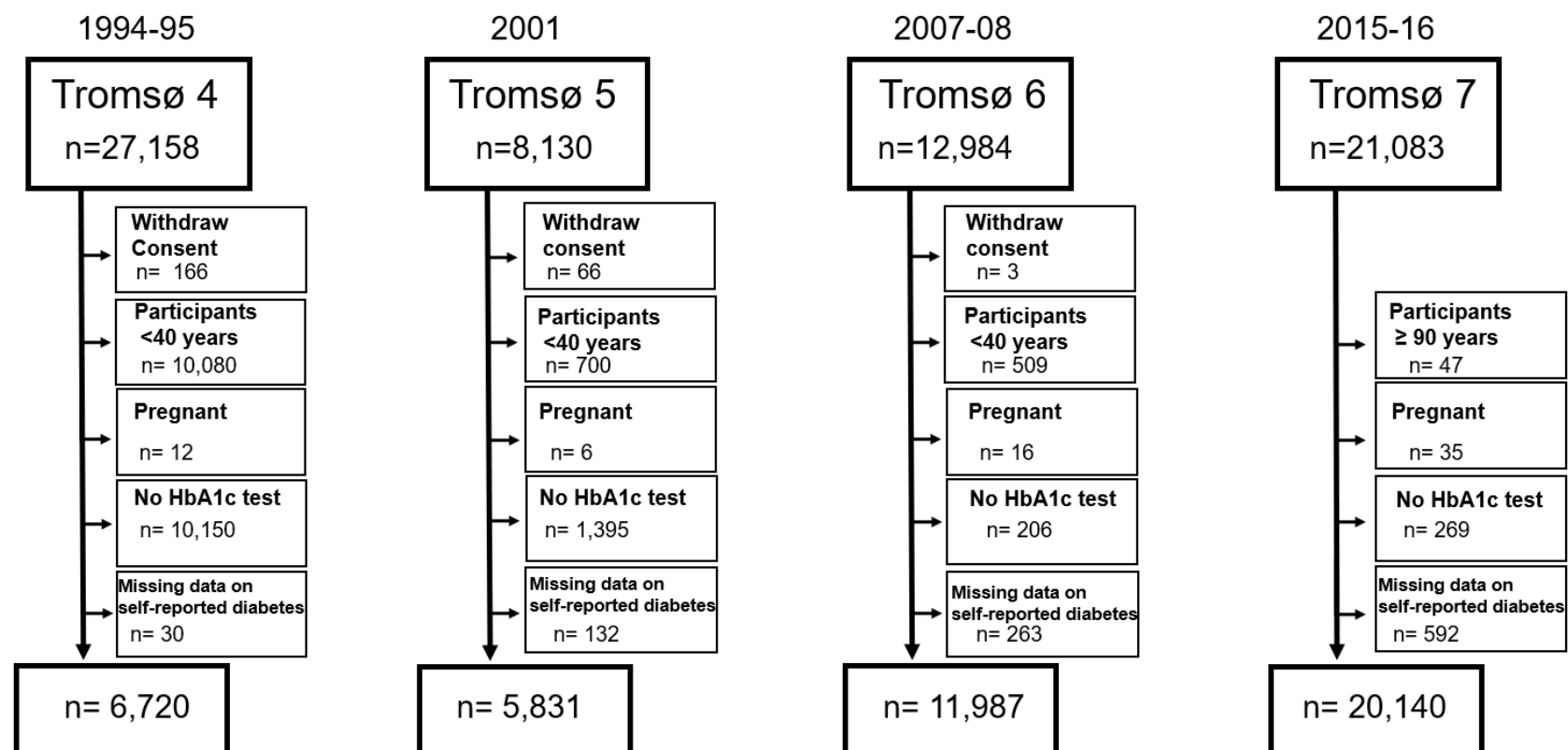
Household income:

- What was the households total taxable income last year? Include income from work, social benefits and similar

- 1 : Less than 150000 NOK
- 2 : 150000-250000 NOK
- 3 : 251000-350000 NOK
- 4 : 351000-450000 NOK
- 5 : 451000-550000 NOK
- 6 : 551000-750000 NOK
- 7 : 751000-1000000 NOK
- 8 : More than 1000000 NOK

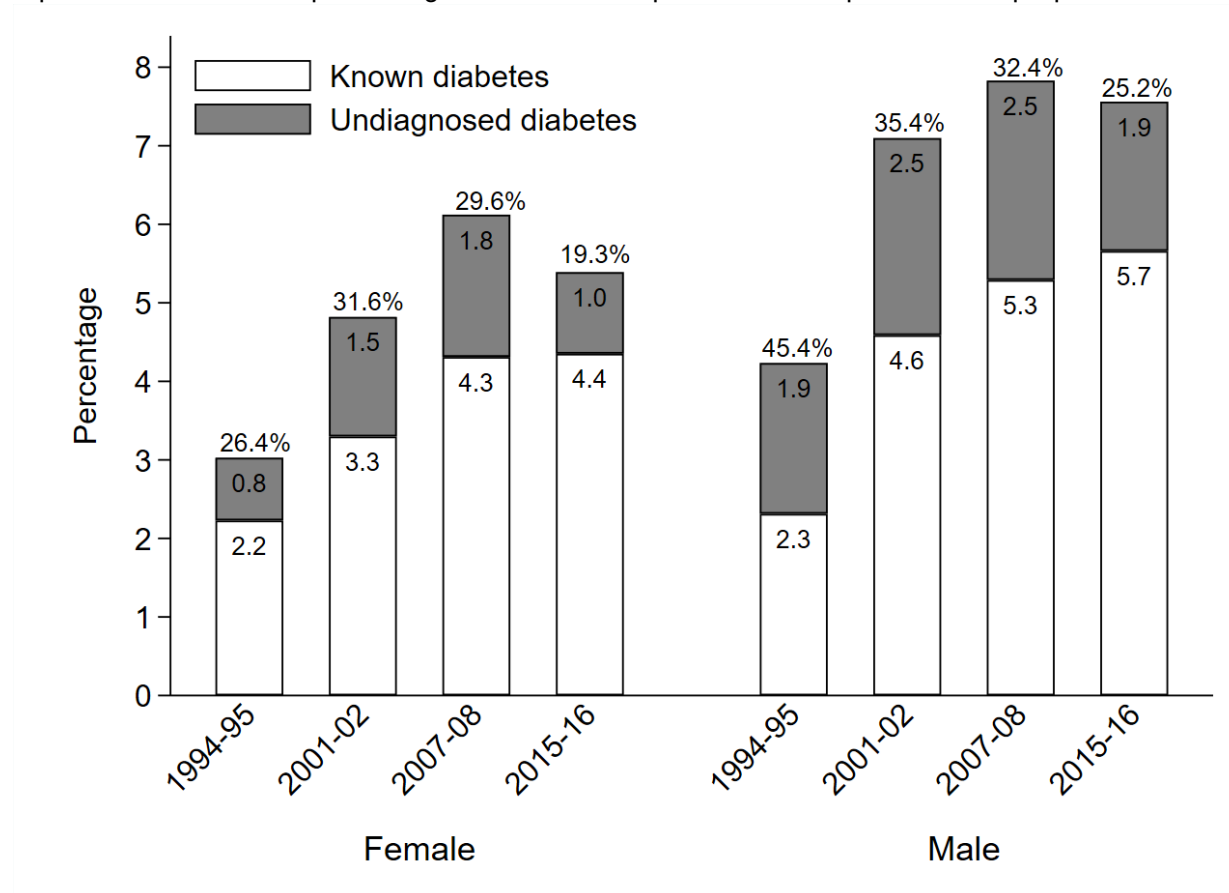
## Supplementary Figures

Figure 1. Flow chart included participants from the Tromsø Study surveys. The Tromsø Study 1994-2016



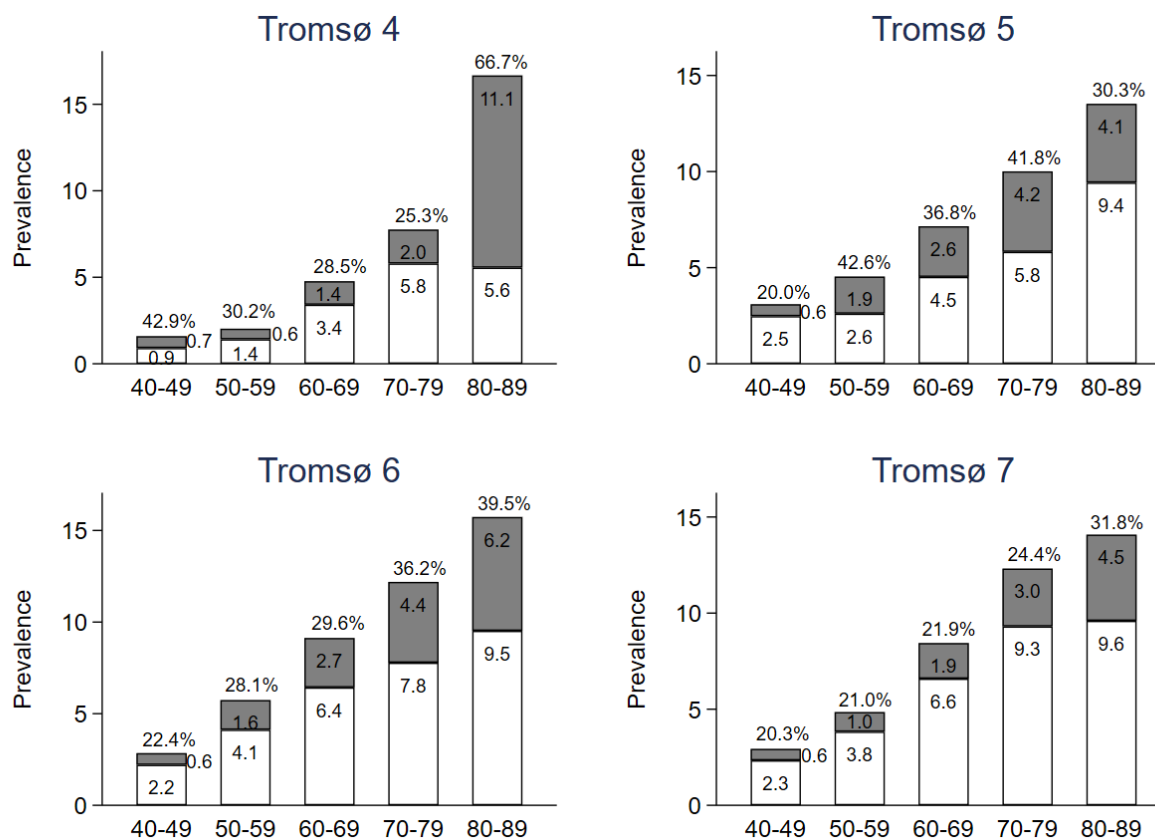
**Figure 2. Age standardized diabetes prevalence by sex and survey. The Tromsø Study 1994-2016**

Tromsø 4 (1994-1995), Tromsø 5 (2001), Tromsø 6 (2007-2008) and Tromsø 7 (2015-2016). In white, percentage of known diabetes and in grey percentage of undiagnosed diabetes, defined as HbA1c measurement  $\geq 6.5\%$  (48mmol/mol) and no self-reported diabetes. The percentage value on the top of the bars represents the proportion of undiagnosed diabetes to all diabetes.



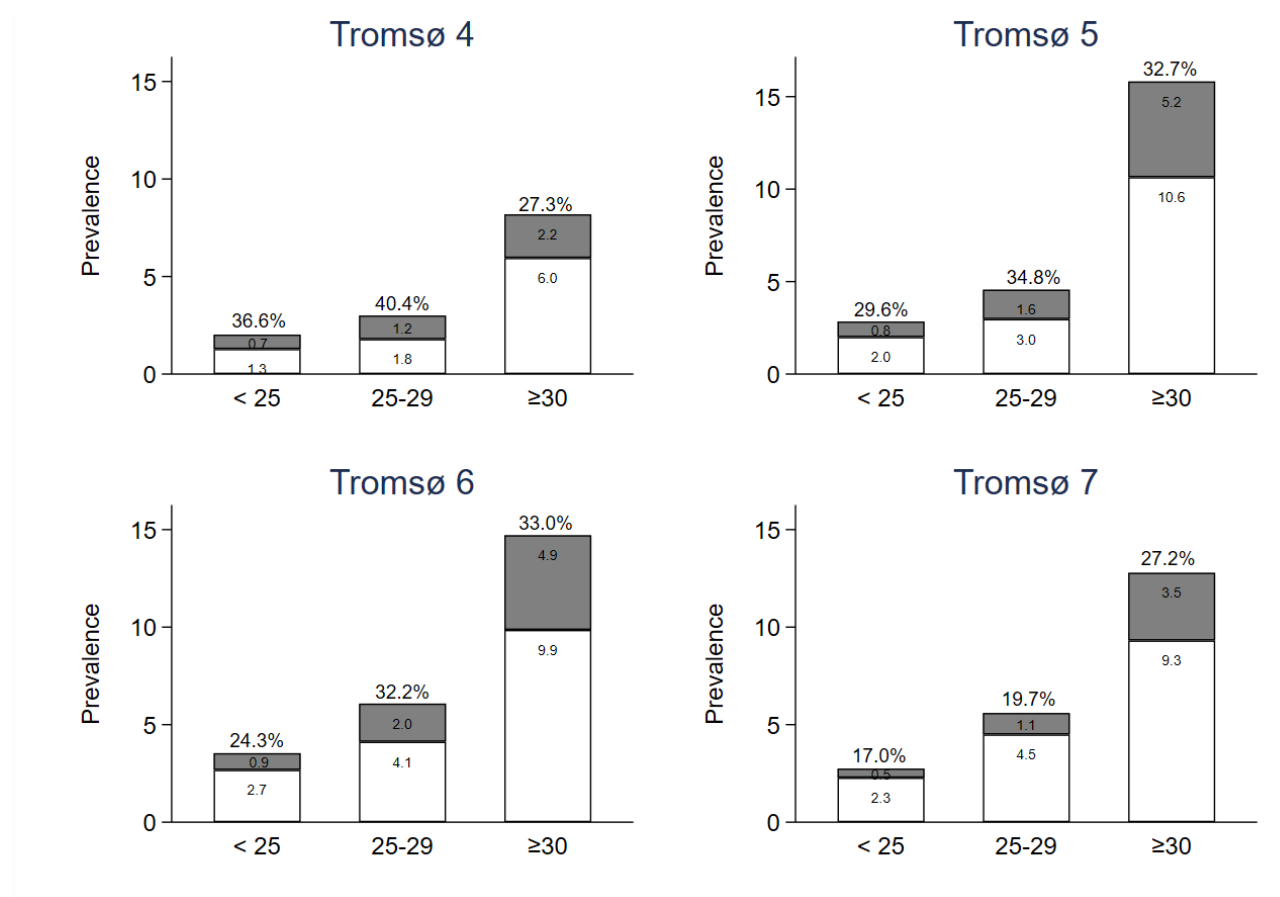
**Figure 3. Prevalence of known and undiagnosed diabetes by age in Tromsø 4 (1994-1995), Tromsø 5 (2001), Tromsø 6 (2007-2008) and Tromsø 7 (2015-2016).**

In white, percentage of known diabetes and in grey percentage of undiagnosed diabetes, defined by a HbA1c measurement  $\geq 6.5\%$  (48mmol/mol) and not self-reported diabetes. The percentage value on the top of the bars represents the proportion of undiagnosed diabetes to all diabetes.



**Figure 4. Age standardized diabetes prevalence by body mass index in Tromsø 4 (1994-1995), Tromsø 5 (2001), Tromsø 6 (2007-2008) and Tromsø 7 (2015-2016).**

In white, percentage of known diabetes and in grey percentage of undiagnosed diabetes, defined by a HbA1c measurement  $\geq 6.5\%$  and no self-reported diabetes. The percentage value on the top of the bars represents the proportion of undiagnosed diabetes to all diabetes.





## Supplementary Tables

Table 1. Mean HbA1c by sex, age and other characteristics in each survey. The Tromsø Study 1994-2016.

	Tromsø 4 1994-95		Tromsø 5 2001		Tromsø 6 2007-08		Tromsø 7 2015-16		Pooled data	
	Participants without known DM	Undiagnosed diabetes	Participants without known DM	Undiagnosed diabetes	Participants without known DM	Undiagnosed diabetes	Participants without known DM	Undiagnosed diabetes	Participants without known DM	Undiagnosed diabetes
<i>HbA1c (n)</i>	5.41 (6528)	7.62 (77)	5.42 (5558)	7.19 (172)	5.57 (11377)	7.16 (274)	5.59 (19157)	7.16 (290)	5.54 (42620)	7.21 (813)
<b>Sex</b>										
Female	5.42 (3694)	7.96 (37)	5.38 (3217)	7.11 (76)	5.54 (6040)	6.99 (124)	5.58 (10069)	7.01 (108)	5.52 (23020)	7.13 (345)
Male	5.41 (2834)	7.30 (40)	5.48 (2341)	7.26 (96)	5.61 (5337)	7.30 (150)	5.61 (9088)	7.24 (182)	5.57 (19600)	7.27 (468)
<b>Age groups</b>										
40-49	5.28 (435)	7.79 (3)	5.14 (315)	6.75 (2)	5.37 (3366)	7.54 (22)	5.44 (6091)	7.73 (37)	5.40 (10207)	7.64 (64)
50-59	5.35 (2578)	7.12 (16)	5.36 (1009)	7.18 (20)	5.54 (2254)	7.01 (38)	5.59 (5598)	7.21 (59)	5.51 (11439)	7.14 (133)
60-69	5.46 (2490)	8.11 (35)	5.42 (2282)	7.33 (63)	5.67 (3709)	7.32 (107)	5.69 (4615)	7.13 (91)	5.59 (13096)	7.36 (296)
70-79	5.51 (1008)	7.21 (21)	5.50 (1731)	7.08 (77)	5.75 (1611)	7.02 (77)	5.77 (2279)	6.99 (75)	5.65 (6629)	7.04 (250)
80-89	5.73 (17)	7.05 (2)	5.52 (221)	7.34 (10)	5.82 (437)	6.88 (30)	5.85 (574)	6.83 (28)	5.78 (1249)	6.93 (70)
<b>Education level</b>										
Primary	5.45 (3397)	7.75 (54)	5.46 (1674)	7.18 (65)	5.69 (3249)	7.21 (127)	5.71 (4143)	7.03 (121)	5.60 (12463)	7.23 (367)
Secondary	5.38 (1961)	7.10 (14)	5.41 (2569)	7.13 (69)	5.57 (3779)	7.13 (90)	5.61 (5230)	7.32 (80)	5.53 (13539)	7.19 (253)
Tertiary	5.35 (1132)	7.10 (8)	5.34 (1041)	7.27 (24)	5.48 (4210)	7.10 (51)	5.54 (9522)	7.18 (78)	5.50 (15905)	7.17 (161)
<b>Income</b>										
Low	-	-	-	-	5.67 (2025)	7.10 (79)	5.69 (3901)	7.09 (95)	5.69 (3901)	7.09 (95)
Medium	-	-	-	-	5.59 (2755)	7.16 (70)	5.62 (5345)	7.12 (94)	5.62 (5345)	7.12 (94)
High	-	-	-	-	5.44 (2754)	7.22 (26)	5.53 (9210)	7.34 (77)	5.53 (9210)	7.34 (77)
<b>BMI (kg/m<sup>2</sup>)</b>										
<25	5.37 (2798)	7.94 (18)	5.32 (1999)	7.07 (29)	5.48 (4086)	6.93 (39)	5.53 (6418)	6.90 (29)	5.46 (15301)	7.12 (115)
25-29	5.41 (2814)	6.80 (29)	5.43 (2489)	7.23 (71)	5.59 (5111)	7.29 (110)	5.59 (8374)	7.00 (98)	5.54 (18788)	7.14 (308)
≥30	5.57 (903)	8.21 (30)	5.57 (1037)	7.21 (71)	5.73 (2162)	7.13 (124)	5.71 (4319)	7.29 (160)	5.68 (8421)	7.29 (385)
<b>Consultation GP last year</b>										
Yes	5.40 (4292)	7.02 (11)	5.42 (4453)	7.11 (137)	5.58 (9224)	7.04 (236)	5.61 (15157)	7.10 (236)	5.55 (33126)	7.09 (654)
No	5.40 (1356)	7.22 (45)	5.40 (859)	7.66 (26)	5.53 (2055)	7.95 (33)	5.55 (3921)	7.38 (53)	5.51 (8191)	7.56 (123)

Data are mean (n). Education and household income are self-reported. Income is divided in lower third, mid third and upper third percentiles (<33, 33-66 and over 66).

**Table 2. Associations of household income with undiagnosed diabetes. The Tromsø Study 1994-2016.**

	Prevalence of undiagnosed diabetes (%)				Undiagnosed as % of all diabetes			
	Low	Medium	High	p-value	Low	Medium	High	p-value
<b>Tromsø 6 2007-08</b>								
Crude	1 (Ref)	0.47 (0.35 - 0.62)	0.25 (0.17 - 0.39)	<0.01	1 (Ref)	0.87 (0.68 - 1.10)	0.74 (0.52 - 1.06)	0.06
Model 1	1 (Ref)	0.62 (0.46 - 0.84)	0.42 (0.27 - 0.66)	<0.01	1 (Ref)	0.95 (0.74 - 1.23)	0.85 (0.58 - 1.24)	0.41
Model 2	1 (Ref)	0.65 (0.48 - 0.88)	0.47 (0.30 - 0.73)	<0.01	1 (Ref)	0.95 (0.74 - 1.23)	0.85 (0.58 - 1.24)	0.41
Model 3	1 (Ref)	0.72 (0.53 - 0.99)	0.58 (0.36 - 0.94)	0.01	1 (Ref)	0.72 (0.53 - 0.99)	0.58 (0.36 - 0.94)	0.01
<b>Tromsø 7 2015-16</b>								
Crude	1 (Ref)	0.74 (0.56 - 0.98)	0.36 (0.27 - 0.49)	<0.01	1 (Ref)	1.09 (0.85 - 1.40)	0.98 (0.75 - 1.28)	0.91
Model 1	1 (Ref)	0.84 (0.63 - 1.13)	0.51 (0.37 - 0.72)	<0.01	1 (Ref)	1.11 (0.86 - 1.44)	1.02 (0.76 - 1.37)	0.84
Model 2	1 (Ref)	0.86 (0.64 - 1.15)	0.58 (0.42 - 0.81)	0.01	1 (Ref)	1.11 (0.86 - 1.44)	1.01 (0.75 - 1.36)	0.87
Model 3	1 (Ref)	0.96 (0.71 - 1.30)	0.73 (0.51 - 1.05)	0.09	1 (Ref)	1.22 (0.93 - 1.59)	1.14 (0.84 - 1.56)	0.37
<b>Pooled data</b>								
Crude (both sexes)	1 (Ref)	0.57 (0.47 - 0.70)	0.29 (0.23 - 0.36)	<0.01	1 (Ref)	0.92 (0.77 - 1.09)	0.79 (0.65 - 0.97)	0.03
Model 1 (both sexes)*	1 (Ref)	0.72 (0.58 - 0.89)	0.47 (0.36 - 0.62)	<0.01	1 (Ref)	1.01 (0.84 - 1.21)	0.95 (0.75 - 1.19)	0.71
Model 2 (both sexes)*	1 (Ref)	0.74 (0.60 - 0.91)	0.52 (0.39 - 0.68)	<0.01	1 (Ref)	1.01 (0.84 - 1.21)	0.95 (0.75 - 1.20)	0.72
Model 3 (both sexes)*	1 (Ref)	0.82 (0.66 - 1.03)	0.65 (0.48 - 0.87)	<0.01	1 (Ref)	1.11 (0.92 - 1.34)	1.11 (0.86 - 1.42)	0.34
Crude men	1 (Ref)	0.51 (0.39 - 0.66)	0.28 (0.21 - 0.38)	<0.01	1 (Ref)	0.85 (0.68 - 1.06)	0.75 (0.59 - 0.96)	0.02
Model 1 men †	1 (Ref)	0.67 (0.51 - 0.88)	0.51 (0.36 - 0.71)	<0.01	1 (Ref)	0.97 (0.77 - 1.22)	0.97 (0.74 - 1.28)	0.83
Model 2 men †	1 (Ref)	0.67 (0.52 - 0.88)	0.54 (0.39 - 0.76)	<0.01	1 (Ref)	0.97 (0.77 - 1.22)	0.97 (0.73 - 1.28)	0.80
Model 3 men †	1 (Ref)	0.70 (0.53 - 0.92)	0.57 (0.41 - 0.81)	<0.01	1 (Ref)	1.00 (0.79 - 1.26)	0.96 (0.73 - 1.27)	0.81
Crude women	1 (Ref)	0.59 (0.43 - 0.81)	0.21 (0.14 - 0.33)	<0.01	1 (Ref)	0.99 (0.75 - 1.31)	0.75 (0.50 - 1.11)	0.20
Model 1 women †	1 (Ref)	0.81 (0.59 - 1.13)	0.40 (0.24 - 0.66)	<0.01	1 (Ref)	1.09 (0.82 - 1.44)	0.91 (0.60 - 1.41)	0.90
Model 2 women †	1 (Ref)	0.86 (0.62 - 1.20)	0.47 (0.29 - 0.78)	0.01	1 (Ref)	1.09 (0.82 - 1.45)	0.93 (0.60 - 1.43)	0.95
Model 3 women †	1 (Ref)	1.01 (0.72 - 1.42)	0.65 (0.38 - 1.12)	0.18	1 (Ref)	1.21 (0.91 - 1.62)	1.20 (0.91 - 1.62)	0.25

Association measures are prevalence ratio (95% confidence intervals). The dependent variable is undiagnosed diabetes. Household income is divided in lower third, mid third and upper third based on percentiles <33, 33-66 and over 66. Model 1: adjustment for age and sex. Model 2: adjustment for age, sex and body mass index. Model 3: adjustment for age, sex, body mass index and education. Model 1\*: adjustment for age, sex and period of survey. Model 2\*: adjustment for age, sex, body mass index and period of survey. Model 3\*: adjustment for age, sex, body mass index, education and period of survey. † Model 1: adjustment for age and period of survey. † Model 2: adjustment for age, body mass index and period of survey. † Model 3: adjustment for age, body mass index, education and period of survey. Income gradient in undiagnosed diabetes did not significantly vary by sex (all p[interaction]>0.5).

**Table 3. Percentage of participants who visited a general practitioner during the last 12 months prior to screening visit among people with undiagnosed diabetes and no diabetes.**

	Tromsø 4 1994-95		Tromsø 5 2001		Tromsø 6 2007-08		Tromsø 7 2015-16	
	No diabetes	Undiagnosed diabetes	No diabetes	Undiagnosed diabetes	No diabetes	Undiagnosed diabetes	No diabetes	Undiagnosed diabetes
All	4,247 (75.9%)	45 (80.4%)	4,316 (83.8%)	137 (84.1%)	8,988 (81.6%)	236 (87.7%)	14,823 (79.4%)	236 (81.7%)
Female	2,521 (80.4%)	22 (88.0%)	2,578 (86.4%)	62 (86.1%)	4,995 (85.4%)	111 (92.5%)	8,237 (83.7%)	95 (88.0%)
Male	1,726 (70.2%)	23 (74.2%)	1,738 (80.2%)	75 (82.4%)	3,993 (77.4%)	125 (83.9%)	6,586 (74.5%)	141 (77.9%)
p-value	<0.001	0.001	<0.001	0.52	<0.001	0.04	<0.001	0.04
<b>Age groups</b>								
40-49	278 (70.6%)	1 (50%)	236 (76.4%)	2 (100%)	2,494 (75.0%)	15 (68.2%)	4,469 (74.5%)	22 (59.5%)
50-59	1,740 (76.3%)	11 (78.6%)	780 (81.3%)	13 (65.0%)	1,736 (79.0%)	33 (89.2%)	4,261 (77.5%)	44 (74.6%)
60-69	1,582 (75.8%)	19 (82.6%)	1,768 (82.3%)	52 (83.9%)	2,993 (83.8%)	91 (86.7%)	3,712 (83.0%)	79 (87.8%)
70-79	634 (77.8%)	13 (81.3%)	1,368 (88.6%)	60 (87.0%)	1,393 (91.9%)	71 (93.4%)	1,900 (87.5%)	69 (92%)
80-89	13 (86.7%)	1 (100%)	164 (87.7%)	10 (100%)	372 (92.8%)	26 (89.7%)	481 (90.1%)	22 (78.6%)
p-value	0.04	0.44	<0.001	0.03	<0.001	0.02	<0.001	0.001
<b>Education level</b>								
Primary	2,177 (78.5%)	26 (78.8%)	1,320 (86.2%)	51 (82.3%)	2,652 (86.3%)	111 (89.5%)	3,340 (84.4%)	96 (80.0%)
Secondary	1,303 (75.1%)	11 (78.6%)	2,042 (84.2%)	58 (84.1%)	3,039 (82.8%)	78 (86.7%)	4,106 (80.5%)	67 (83.8%)
Tertiary	747 (71.1%)	7 (87.5%)	791 (78.9%)	19 (82.6%)	3,181 (76.9%)	44 (86.3%)	7,173 (76.5%)	64 (82.1%)
p-value	<0.001	0.65	<0.001	0.90	<0.001	0.49	<0.001	0.67
<b>Income</b>								
Low	-	-	-	-	3,331 (86.8%)	142 (91.0%)	3,196 (85.2%)	75 (79.0%)
Medium	-	-	-	-	2,934 (80.1%)	52 (80.0%)	4,246 (81.8%)	78 (83.9%)
High	-	-	-	-	2,016 (74.3%)	22 (84.6%)	6,822 (75.2%)	62 (80.5%)
p-value					<0.001	0.08	<0.001	0.75
<b>BMI</b>								
<25	1,791 (74.5%)	12 (85.7%)	1,554 (82.5%)	20 (80.0%)	3,176 (79.2%)	33 (84.6%)	4,884 (77.0%)	25 (86.2%)
25-29	1,830 (75.4%)	15 (71.4%)	1,942 (83.7%)	57 (86.4%)	4,064 (82.0%)	93 (85.3%)	6,457 (78.7%)	84 (85.7%)
≥30	619 (82.2%)	18 (85.2%)	798 (86.5%)	59 (83.1%)	1,734 (85.6%)	109 (90.8%)	3,442 (84.2%)	125 (78.1%)
p-value	<0.001	0.87	0.01	0.91	<0.001	0.19	<0.001	0.13

**Table 4. Cross-tabulation by diabetes status for participants in Tromsø 6 and Tromsø 7.**

Tromsø 7 survey	Tromsø 6 survey				<i>Total</i>
	No diabetes	Known diabetes	Undiagnosed diabetes	Did not participate	
No diabetes	7162	21	25	11547	18755
Known diabetes	159	281	81	462	983
Undiagnosed diabetes	122	3	22	143	290
Did not participate	3660	305	146	3437	7548
<i>Total</i>	11103	610	274	15589	27576