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# Are general practitioners characteristics associated with the quality of type 2 diabetes care in general practice? Results from the Norwegian ROSA4 study from 2014

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## ABSTRACT

**Objective:** To explore the associations between general practitioners (GPs) characteristics such as gender, specialist status, country of birth and country of graduation and the quality of care for patients with type 2 diabetes (T2DM).

**Design:** Cross-sectional survey.

**Setting and subjects:** The 277 GPs provided care for 10082 patients with T2DM in Norway in 2014. The GPs characteristics were self-reported: 55% were male, 68% were specialists in General Practice, 82% born in Norway and 87% had graduated in Western Europe. Of patients, 81% were born in Norway and 8% in South Asia. Data regarding diabetes care were obtained from electronic medical records and manually verified.

**Main outcome measures:** Performance of recommended screening procedures, prescribed medication and level of HbA1c, blood pressure and LDL-cholesterol stratified according to GPs characteristics, adjusted for patient and GP characteristics.

**Result:** Female GPs, specialists, GPs born in Norway and GPs who graduated in Western Europe performed recommended procedures more frequently than their counterparts. Specialists achieved lower mean HbA1c (7.14% vs. 7.25%, $p < 0.01$), a larger proportion of their patients achieved good glycaemic control (HbA1c = 6.0%–7.0%) (49.1% vs. 44.4%, $p = 0.018$) and lower mean systolic blood pressure (133.0 mmHg vs. 134.7 mmHg, $p < 0.01$) compared with non-specialists. GPs who graduated in Western Europe achieved lower diastolic blood pressure than their counterparts (76.6 mmHg vs. 77.8 mmHg, $p < 0.01$).

**Conclusion:** Several quality indicators for type 2 diabetes care were better if the GPs were specialists in General Practice.

### KEY POINTS

- Research on associations between General Practitioners (GPs) characteristics and quality of care for patients with type 2 diabetes is limited.
- Specialists in General Practice performed recommended procedures more frequently, achieved better HbA1c and blood pressure levels than non-specialists.
- GPs who graduated in Western Europe performed screening procedures more frequently and achieved lower diastolic blood pressure compared with their counterparts.
- There were few significant differences in the quality of care between GP groups according to their gender and country of birth.

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## Introduction

Type 2 diabetes (T2DM) increases the risk of coronary heart disease (CHD) and often coexists with hypertension and dyslipidemia which add additional risk for cardiovascular complications and mortality [1,2]. When multiple risk factors such as life style factors, hyperglycaemia, hypertension and dyslipidemia are addressed simultaneously, vascular complications can be reduced [3,4].

The quality of T2DM care is affected by healthcare system factors such as health care organization, clinical guidelines, financial incentives [5–7], but also by health provider characteristics such as age, gender, speciality [7,8] and patient characteristics such as age, gender, socioeconomic position and ethnicity [7,9–12].

The Norwegian government offers state-funded health care service to all citizens. Norwegian guidelines for the diagnosis, treatment and follow up of diabetes patients have been published since the 1980's with the aim of improving the quality of care. General practitioners (GPs) with or without specialist training and approval as specialist in General Practice provide care for most patients with T2DM in majority of European counties including Norway [13,14]. Few studies have explored whether the quality of diabetes care is associated with the characteristics of GPs. In studies related to gender, female physicians, achieved better [15] or similar treatment targets for HbA1c, systolic blood pressure (SBP) and LDL-cholesterol compared with male physicians [16]. In studies comparing GP care with specialist care, GPs performed processes of care less often [17], but achieved lower mean HbA1c compared with specialists in endocrinology [18]. It is not known whether factors such as specialist training, formal specialist approval, GP's country of birth or GP's country of graduation are associated with the quality of diabetes care.

In Norway, approximately 57% of all GPs have a formal specialist approval achieved after completing the Specialist Education for General Practice [19]. Specialist approval requires re-certification every fifth year [20]. About 20% of GPs are born outside Norway [21]. Regardless of country of birth, there is an increasing proportion of GPs who have graduated abroad [19]. The qualifications of all GPs practicing in Norway are approved by the regulating authorities [20]. GPs who graduated in countries in the European Union (EU) or European economic areas (EEA) have to complete an internship, while GPs graduated outside EU/EEA have to meet additional requirements before they can apply for Norwegian authorization.

The primary aim of this study was to explore associations between the GP's gender, specialist status, country of birth and region of graduation and the quality of care for patients with T2DM as measured by the performance of processes of care, prescribed medication and intermediate outcomes (level of HbA1c, blood pressure and LDL-cholesterol). The secondary aim was to evaluate the associations between GPs characteristics and the intermediate outcomes according to patient gender and ethnicity.

## Material and methods

### Design, setting and participants

The present study is part of a cross-sectional survey, the ROSA4 study, assessing the quality of diabetes care in general practice in Norway in 2014. We selected 16 municipalities in five counties (Oslo, Akershus, Rogaland, Hordaland and Nordland). In total, 106 practices with 367 GPs were invited.

### Data collection and variables

Data regarding the participating GPs and the care of their patients were collected from January 2015 to April 2016 by research nurses.

A questionnaire was used to gather self-reported GP characteristics (age, gender, specialist status, country of birth, country of graduation, year of Norwegian authorization and number of years working as GP in Norway).

Based on self-reported information GPs were grouped into 1) male or female, 2) specialists or non-specialists, 3) born in Norway or other countries, 4) graduated in Western Europe or other (Eastern Europe, Asia, Africa, America). The number of patients on the GPs lists was obtained from the Norwegian Health Economics Administration at the time of data collection. Based on characteristic of the area in which the practices were located, the practices were grouped as either urban or rural practices.

A software program was used to identify all patients ($\geq$18 years) with a diabetes diagnosis between 2012–2014 and capture pre-defined data including results of the blood tests, urine tests and prescriptions from electronic medical records (EMRs). The research nurse examined the EMRs to verify the diabetes diagnosis, electronically registered data and to collect relevant data not suitable for electronic capture such as complications. Variables used in the present study included: patient characteristics (age, gender, diabetes duration); processes of care

(documentation of HbA1c, blood pressure, LDL-cholesterol, creatinine/estimated glomerulofiltration rate (eGFR), albuminuria, body height, body weight, eye examination, foot examination, smoking habits, referral to ophthalmologists, endocrinologists and internists); pharmacological therapy (prescriptions of glucose lowering-, antihypertensive-, and lipid lowering- and antithrombotic agents); intermediate outcomes (HbA1c, blood pressure, LDL-cholesterol); macrovascular complications (CHD (angina, myocardial infarction, percutaneous coronary intervention/coronary artery bypass surgery), stroke (excluding transient ischemic attacks), percutaneous transluminal angioplasty/arterial surgery). For the majority of variables, most recently recorded value from period October 1st 2013 to December 31st 2014 was used, for smoking habits (January 1st 2010 to December 31st 2014), eye examination and referral to ophthalmologists (July 1st 2012 to December 31st 2014) and referral to endocrinologists or internists (January 1st 2013 to December 31st 2014). Treatment targets were based on key recommendations in the Norwegian 2009-guildelines: HbA1c ≤ 7.0%, BP ≤ 135/80 mmHg, LDL-cholesterol ≤ 1.8 mmol/L or 2.5 mmol/L for patients with or without known macrovascular complications respectively [22].

All Norwegian citizens are given a unique personal identification number (ID-number) at birth. Based on this number, we obtained information about country of birth and educational level from Statistics Norway. The patient's ethnicity was based on country of birth and is categorized as 1) Norwegians (born in Norway), 2) South Asians (born in Pakistan, Sri Lanka, India and Bangladesh) and 3) Other (born in other countries). The patient's education was grouped into 1) preprimary and primary education 2) secondary education and 3) tertiary education, in accordance with the International Standard Classification of Education [23].

### Statistical analyses

We performed analyses stratified by GPs characteristics and compared the processes of care, pharmacological therapy and intermediate outcomes between these GP groups. Descriptive statistics in the form of frequencies (proportions) and medians (percentiles) were used to describe the characteristics of the GPs and their patients. The independent-samples T-tests were used to compare mean differences of numerical variables between different GP groups while associations between GP and patient factors with GP groups were established from the Chi-square tests.

We fitted two-level and three-level regression models to account for the dependence of patients' data within GPs, who were in turn clustered/nested within GP practices. To that end, binary multilevel regression models were fitted to the data on proportions while linear multilevel regression models were fitted to intermediate continuous outcomes. All models were adjusted for patient's level characteristics (age, gender, ethnicity and education) while further adjustments using the GP-level characteristics (age, gender, specialist status, country of birth and region of graduation) were done in the three-level models. As there was strong correlation between GPs age and years as GP in Norway, we included only GPs age in our adjustments. As we tested a number of hypotheses, we used the Benjamin Hochberg procedure to control for multiple testing and the significance level was set at <0.05. The analyses were performed with SPSS Statistics 24 and StataSE 14.

## Results

Of the invited practices, 77 (73%) with 282 GPs (77%) participated. We received completed questionnaires from 277 (98%) GPs. In total, 55% of GPs were male, 68% were specialists, 82% were born in Norway and 87% graduated in a Western European country. Male GPs, specialists and GPs who had graduated in Western Europe were more likely to be older and to have had more years practising as a GP in Norway (Table 1).

Altogether, the GPs had 342 044 patients on their lists. In total, 11 428 patients with a diabetes diagnosis were identified. We excluded patients with other than T2DM (n = 1180) and those who were registered with the participating GPs but received care from another doctor (n = 166), leaving 10082 patients with T2DM to be included in the study. Of these, 81% were born in Norway, 8% were born in South Asia and 11% born in other countries. Interestingly, the ethnic composition and educational level of patients on the GPs' lists varied significantly between the GP groups (Table 1).

### Processes of care

The GPs measured HbA1c in 89%, BP in 88% and LDL-cholesterol in 68% of T2DM patients. They performed U-albumin and foot examination in only 32% and 30% of patients, respectively. Significant differences in the processes of care between the GP groups were observed, data not shown. After adjustments for patient characteristics, several differences persisted (Table 2). Female GPs, specialists, GPs born in Norway and GPs who graduated in Western Europe performed

**Table 1.** Characteristics of the general practitioners ($n = 277$) and their patients with type 2 diabetes ($n = 10082$).

| | Gender | | Specialist status | | Country of birth | | Region of graduation | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Specialist | Non-specialist | Norway | Other | Western Europe | Other |
| **General practitioners** | | | | | | | | |
| Valid cases, n | 153 | 124 | 187 | 90 | 210 | 46 | 222 | 33 |
| Age (years) | 58 (39,65) | 47 (35,61)*** | 57 (40,65) | 42 (31,64)*** | 56 (36,65) | 50 (39,61)*** | 57 (37,65) | 46 (37,52)*** |
| Years as GP in Norway | 27 (7,35) | 15 (2,32)*** | 25 (8,35) | 8 (2,25)*** | 25 (5,35) | 15 (5,26)*** | 24 (5,35) | 10 (3,20)*** |
| Listed patients, n | 1372 (1057,1861) | 1171 (794,1453)*** | 1317 (1019,1763) | 1171 (656,1667)*** | 1292 (903,1691) | 1222 (935,1927) | 1292 (903,1709) | 1218 (832,1776)*** |
| Practice localisation (%) | | *** | | *** | | *** | | * |
| Urban practice | 88 | 83 | 92 | 72 | 88 | 85 | 88 | 89 |
| Rural practice | 12 | 17 | 8 | 28 | 12 | 15 | 12 | 10 |
| Practice size (%) | | *** | | *** | | *** | | *** |
| 1–2 GPs | 21 | 9 | 14 | 23 | 15 | 23 | 16 | 20 |
| 3–6 GPs | 64 | 77 | 69 | 68 | 70 | 58 | 69 | 54 |
| ≥7 GPs | 15 | 15 | 17 | 9 | 15 | 20 | 15 | 26 |
| **Patients** | | | | | | | | |
| Valid cases, n | 6281 | 3604 | 7086 | 2799 | 7368 | 1773 | 7952 | 1160 |
| Patients with diabetes, n | 58 (31,77) | 39 (21,61)*** | 52 (27,77) | 41 (21,68)*** | 48 (25,75) | 52 (28,74) | 51 (25,74) | 48 (28,77)*** |
| Male (%) | 61.5 | 43.8*** | 55.4 | 54.2 | 55.7 | 54.0 | 55.1 | 56.8 |
| Age (years) | 66 (48,82) | 64 (46,81) | 65 (47,82) | 65 (47,81) | 66 (48,82) | 62 (44,78) | 66 (48,82) | 62 (44,79)*** |
| Diabetes duration (years) | 8 (1,18) | 7 (1,18) | 7 (1,18) | 7 (1,19) | 7 (1,18) | 7 (1,18) | 7 (1,18) | 7 (1,19) |
| Macrovascular complications (%)[a] | 28.6 | 25.0*** | 27.7 | 26.2** | 28.2 | 23.7*** | 27.8 | 23.9** |
| Ethnicity (%) | | *** | | ** | | *** | | *** |
| Norwegians | 83 | 76 | 81 | 78 | 85 | 62 | 83 | 62 |
| South Asians | 6 | 11 | 7 | 9 | 5 | 19 | 6 | 18 |
| Others | 11 | 13 | 11 | 13 | 10 | 20 | 19 | 20 |
| Education (%) | | ** | | ** | | *** | | *** |
| Pre- and primary | 35 | 39 | 35 | 39 | 35 | 43 | 36 | 41 |
| Secondary | 46 | 43 | 46 | 44 | 46 | 40 | 46 | 40 |
| Tertiary | 19 | 18 | 19 | 17 | 19 | 17 | 18 | 19 |

Data are median (10, 90 perc.) unless otherwise stated.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
The independent-samples T-tests were used to compare mean differences of numerical variables between different GP groups while associations between GP and patient factors with GP groups were established from the Chi-square tests.
[a]Macrovascular complications: Coronary heart disease (Myocardial infarction, angina or percutaneous transluminal angioplasty) or stroke (transient ischemic attacks excluded) or arterial surgery.

**Table 2.** Performed processes of care for patients with type 2 diabetes according to the general practitioner's characteristics adjusted for patient characteristics.

| | General practitioner's characteristics | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Gender | | Specialist status | | Country of birth | | Region of graduation | |
| Features recorded in EMRs | Male $n = 153$ | Female $n = 124$ | Specialist $n = 187$ | Non-specialist $n = 90$ | Norway $n = 210$ | Other $n = 46$ | Western Europe $n = 222$ | Other $n = 33$ |
| HBA1c[a] | 89.0 | 90.0 | 90.2 | 87.0*** | 89.8 | 87.7 | 90.0 | 85.3*** |
| Blood pressure[a] | 87.4 | 89.1* | 89.3 | 84.7*** | 89.0 | 84.7** | 88.7 | 84.7** |
| S-LDL-cholesterol[a] | 66.3 | 70.7*** | 68.3 | 66.8 | 67.1 | 70.3 | 67.7 | 67.3 |
| S-Creatinine/S-eGFR[a] | 82.3 | 85.6*** | 84.3 | 81.3** | 83.9 | 82.2 | 83.9 | 80.6* |
| U-Albumin[a] | 32.6 | 34.1 | 34.4 | 29.9 | 32.9 | 35.1 | 34.0 | 28.8 |
| Body height[b] | 69.5 | 68.9 | 71.1 | 64.5*** | 71.7 | 61.1** | 70.8 | 61.6*** |
| Body weight[a] | 53.3 | 52.0* | 54.9 | 47.7*** | 55.5 | 46.0** | 54.6 | 47.7** |
| Eye examination[c] | 56.0 | 57.8 | 58.1 | 53.2** | 57.2 | 53.2* | 57.7 | 47.1*** |
| Foot examination[a] | 28.8 | 31.4* | 31.1 | 26.3*** | 31.2 | 25.7** | 30.3 | 29.4 |
| Smoking habits[b] | 80.5 | 78.0*** | 80.4 | 77.4*** | 81.0 | 72.7*** | 80.4 | 72.6*** |
| Referral to ophthalmologist[c] | 18.6 | 16.9 | 18.1 | 17.9 | 18.7 | 15.1* | 18.7 | 13.4** |
| Referral to endocrinologist[d] | 3.5 | 4.6* | 3.8 | 4.5 | 4.2. | 2.9 | 4.1 | 2.7* |
| Referral to other internist[d] | 7.7 | 9.2* | 7.9 | 9.1 | 8.4 | 6.8 | 8.2 | 7.2 |

Data are % unless otherwise stated.
EMRs: Electronic medical records.
Data from [a]: Oct. 1st 2013 to Dec. 31st 2014 (15 months); [b]: Jan. 1st to 2010 Dec. 31.st 2014 [c]: Jul. 1st 2012 to Dec. 31st 2014 (30 months); [d]: Jan. 1st 2013 to Dec. 31st 2014 (24 months).
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$. Multilevel binary logistic regression models with random effects at GP practice level were used to compare the differences in proportions between the general practitioner groups after adjusting for patient age, gender, ethnicity, education level and counties.

recommended procedures more frequently than their counterparts.

## Medication

Overall, GPs treated 32% of patients with lifestyle modification (i.e. advice about diet and physical activity) alone and 68% with glucose lowering agents. GPs prescribed antihypertensive- and lipid lowering-gents to 65% and 54% of patients, respectively. Differences in prescriptions of relevant medication were observed between the GPs groups. GPs born outside Norway and GPs who graduated outside Western Europe prescribed glucose lowering more frequently and antihypertensive agents less frequently than their counterparts, data not shown. However, after adjustments for patient characteristics and diabetes duration, there were no differences in prescriptions of glucose lowering, antihypertensive- and lipid lowering agents by GP groups (Table 3).

## Intermediate outcomes

Overall, the GPs achieved HbA1c $\leq 7.0\%$ for 62% of their T2DM patients, SBP $\leq$ 135mmHg for 50% and DBP $\leq$ 80mmHg for 46% of patients, respectively. They also achieved LDL-cholesterol $\leq 1.8$ mmol/L in 29% of patients with macrovascular complications and LDL-cholesterol $\leq 2.5$ mmol/L in 40% of patients without macrovascular complications.

Several intermediate outcomes varied significantly according to GP characteristics, data not shown. After adjustments for patient characteristics, GPs age, counties and clustering within practices, significant differences in level of HbA1c and BP between GP groups were observed (Table 4). Compared with non-specialists, specialists achieved significantly lower mean HbA1c and SBP for their patients. More patients cared for by specialists achieved good glycaemic control (HbA1c = 6.0 to 7.0%) than patients of non-specialists (49.1 vs. 44.4%, $p < 0.018$) (Figure 1).

## Discussion

To the best of our knowledge, our study is the first to study the associations between several GP characteristics and the quality of care delivered to patients with T2DM in general practice. Interestingly patient characteristics differed by GP groups. Female GPs, non-specialists, GPs born outside Norway and GPs who had graduated outside Western Europe had a significantly higher proportion of patients born in South Asia and other countries.

The performance of most processes of care varied between all GP groups even after adjusting for confounding factors related to patients and GPs. Female GPs, specialists, GPs born in Norway and GPs who had graduated in Western Europe performed recommended procedures more frequently than their counterparts. Prescription of relevant medication varied little by GP groups. Several intermediate outcomes

**Table 3.** Glucose lowering-, antihypertensive- and lipid lowering therapy for patients with type 2 diabetes according to the general practitioner's characteristics adjusted for patient characteristics.

| | General practitioner's characteristics | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Gender | | Specialist status | | Country of birth | | Region of graduation | |
| Medication (%) | Male $n = 153$ | Female $n = 124$ | Specialist $n = 187$ | Non-specialist $n = 90$ | Norway $n = 210$ | Other $n = 46$ | Western Europe $n = 222$ | Other $n = 33$ |
| **Glucose lowering**[a] | | | | | | | | |
| Lifestyle modification | 31.2 | 32.9 | 32.4 | 30.3 | 32.6 | 26.4 | 31.5 | 30.8 |
| All glucose lowering agents without insulin | 52.5 | 52.2 | 52.0 | 53.6 | 51.8 | 57.9 | 52.8 | 54.0 |
| Insulin only | 5.8 | 5.2 | 5.5 | 5.6 | 5.3 | 6.7 | 5.4 | 6.6 |
| Insulin combined with other glucose lowering agents | 10.4 | 9.7 | 10.0 | 10.5 | 10.3 | 9.0 | 10.3 | 8.6 |
| Metformin | 57.9 | 57.1 | 57.6 | 57.5 | 57.3 | 60.9 | 58.1 | 57.6 |
| Sulfonylurea | 18.5 | 17.4 | 17.6 | 19.6 | 18.0 | 19.0 | 18.2 | 18.2 |
| DPP4 inhibitors | 14.0 | 14.2 | 13.7 | 15.3 | 13.2 | 17.6 | 13.3 | 19.2 |
| GLP 1 agonists | 3.0 | 3.2 | 3.1 | 3.0 | 3.2 | 3.2 | 3.2 | 3.0 |
| SGLT-2 inhibitors | 3.5 | 3.9 | 3.7 | 3.7 | 3.3 | 5.8 | 3.7 | 4.9 |
| Number of glucose lowering agents including insulin | | | | | | | | |
| 1 agent | 35.6 | 35.1 | 35.5 | 35.1 | 35.2 | 39.0 | 35.9 | 35.9 |
| 2 agents | 23.1 | 21.6 | 22.0 | 24.6 | 22.5 | 22.6 | 22.8 | 20.3 |
| $\geq 3$ glucose-lowering agents | 9.8 | 10.4 | 10.0 | 10.1 | 9.7 | 12.0 | 9.7 | 13.1 |
| **Antihypertensive** | | | | | | | | |
| Antihypertensive agents | 65.8 | 65.5 | 62.7 | 66.8 | 66.1 | 66.3 | 66.4 | 63.8 |
| ACE/AII inhibitors | 51.3 | 53.6 | 51.1 | 52.6 | 52.5 | 52.5 | 52.7 | 51.1 |
| Betablockers | 30.7 | 30.2 | 28.2 | 31.4 | 30.8 | 30.9 | 30.9 | 29.7 |
| Calcium channel blockers | 25.8 | 25.4 | 25.2 | 25.8 | 25.6 | 26.1 | 25.8 | 24.3 |
| Tiazides | 26.0 | 27.3 | 25.6 | 26.9 | 27.0 | 25.7 | 26.9 | 25.5 |
| Number of antihypertensives | | | | | | | | |
| 1 agent | 19.4 | 19.1 | 19.1 | 19.4 | 19.6 | 19.1 | 19.6 | 18.2 |
| 2 agents | 20.5 | 19.9 | 18.5 | 21.0 | 20.1 | 21.3 | 20.2 | 20.9 |
| 3 agents | 16.0 | 16.6 | 15.8 | 16.4 | 16.2 | 17.0 | 16.4 | 16 |
| $\geq 4$ antihypertensive agents | 9.9 | 9.8 | 9.3 | 10.1 | 10.2 | 9.0 | 10.1 | 8.7 |
| **Lipid lowering** | 53.8 | 55.5 | 52.6 | 55.2 | 54.7 | 54.5 | 54.8 | 53.8 |

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$. Multilevel binary logistic regression models with random effects at GP practice level were used to compare the differences in proportions between the general practitioner groups after adjusting for age, gender, ethnicity, education level, counties and
[a]diabetes duration.

varied by GPs characteristics with specialists achieving lower HbA1c and SBP levels, and a higher proportion of their patients achieved good glycaemic control with HbA1c between 6.0% and 7.0%, though the effect sizes were small. Interestingly, female GPs achieved better glycaemic control for their South Asian patients than male GPs.

## Strengths and weaknesses

This study has several strengths as it is a large nationwide study with a high participation rates for GPs and all their patients were included, indicating little selection bias. The invited practices were of varied size, mostly located in urban, but some also in rural areas. The participating GPs were considered to be fairly representative for the GP population in Norway despite some differences. The proportion GPs with a specialist approval was higher than among all GPs in Norway (67.5% vs. 57.1%) and slightly more had graduated from Western Europe (88.2% vs. 82.1%) [21]. The mean age for the participating female GPs was similar to mean age for all female GPs in Norway (46 years vs. 45 years) while male GPs were somewhat older than

all male GPs (mean age 55 years vs. 50 years). However, the mean number of patients on GPs' lists was close to the mean for all GPs in Norway (GPs in the study 1213 vs. all GPs in Norway 1132) [24]. Another important strength is that we received permission to link patient data with national registry data to obtain information about country of birth and education. Manual verification of diabetes diagnosis and the electronically extracted data by experienced nurses contributes to the internal validity of this study.

However, the study has some limitations. We do not know why 23% of the invited practices declined to participate in the study. Non-specialists were a diverse group, consisting of GPs who were currently undergoing the Specialist Education for General Practice and those who had practiced for a short or long time as a GP without participating in or completing the Specialist Education for General Practice. There were few GPs who had graduated outside Western Europe among the participating GPs, limiting the power to detect group differences. We also lack information about how the GPs approached lifestyle management and data about the patients diabetes self-care including compliance to prescribed medication.

**Table 4.** Intermediate outcomes in patients with type 2 diabetes according to the general practitioner's characteristics adjusted for patient characteristics.

| | | General practitioner's characteristics | | | | | | | |
| | | Gender[d] | | Specialist status[e] | | Country of birth[f] | | Region of graduation[g] | |
| Variable | Patients characteristics | Male $n = 153$ | Female $n = 124$ | Specialist $n = 187$ | Non-specialist $n = 90$ | Norway $n = 210$ | Other $n = 46$ | Western Europe $n = 222$ | Other $n = 33$ |
|---|---|---|---|---|---|---|---|---|---|
| HbA1c (%) | All[a] | 7.19 | 7.20 | 7.14 | 7.25** | 7.19 | 7.20 | 7.20 | 7.19 |
| | Male[b] | 7.24 | 7.32 | 7.22 | 7.34* | 7.27 | 7.29 | 7.28 | 7.28 |
| | Female[b] | 7.15 | 7.09 | 7.08 | 7.16 | 7.12 | 7.12 | 7.14 | 7.11 |
| | Norwegians[c] | 6.83 | 6.87 | 6.79 | 6.91** | 6.86 | 6.84 | 6.86 | 6.83 |
| | South Asians[c] | 7.42 | 7.14* | 7.17 | 7.40 | 7.21 | 7.36 | 7.37 | 7.19 |
| | Others[c] | 7.34 | 7.36 | 7.34 | 7.36 | 7.36 | 7.34 | 7.27 | 7.43 |
| SBP (mmHg) | All[a] | 134.0 | 133.8 | 133.0 | 134.7** | 134.1 | 133.6 | 133.6 | 134.1 |
| | Male[b] | 134.9 | 134.6 | 133.6 | 135.9*** | 134.9 | 134.7 | 134.4 | 135.1 |
| | Female[b] | 134.1 | 133.9 | 133.5 | 134.5 | 134.5 | 133.5 | 133.6 | 134.3 |
| | Norwegians[c] | 139.2 | 139.2 | 138.4 | 140.1** | 139.6 | 138.8 | 138.4 | 140.1* |
| | South Asians[c] | 129.3 | 127.0 | 127.1 | 129.2 | 127.5 | 128.8 | 130.9 | 125.4 |
| | Others[c] | 132.5 | 132.2 | 131.4 | 133.3 | 132.5 | 132.2 | 132.3 | 132.4 |
| DBP (mmHg) | All[a] | 77.3 | 77.1 | 77.0 | 77.4 | 77.2 | 77.2 | 76.6 | 77.8** |
| | Male[b] | 78.7 | 78.5 | 78.0 | 79.2** | 78.7 | 78.5 | 77.9 | 79.3** |
| | Female[b] | 76.3 | 76.0 | 76.6 | 75.7* | 76.1 | 76.2 | 75.6 | 76.7 |
| | Norwegians[c] | 80.8 | 80.8 | 80.5 | 81.1 | 80.8 | 80.8 | 79.9 | 81.6** |
| | South Asians[c] | 77.1 | 75.8 | 77.2 | 75.7 | 79.6 | 76.0 | 76.5 | 76.5 |
| | Others[c] | 78.6 | 77.7 | 78.2 | 78.1 | 77.9 | 78.4 | 77.7 | 78.6 |
| LDL chol (mmol/L) | All[a] | 2.75 | 2.72 | 2.74 | 2.73 | 2.74 | 2.74 | 2.71 | 2.76 |
| | Male[b] | 2.69 | 2.67 | 2.68 | 2.68 | 2.67 | 2.69 | 2.63 | 2.73 |
| | Female[b] | 2.86 | 2.82 | 2.85 | 2.83 | 2.86 | 2.82 | 2.83 | 2.85 |
| | Norwegians[c] | 2.92 | 2.89 | 2.90 | 2.90 | 2.90 | 2.91 | 2.87 | 2.94 |
| | South Asians[c] | 2.92 | 2.89 | 2.97 | 2.84 | 2.94 | 2.87 | 2.87 | 2.92 |
| | Others[c] | 2.82 | 2.87 | 2.86 | 2.83 | 2.83 | 2.85 | 2.83 | 2.86 |

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
Linear multilevel regression with practice random effects were used to estimate the adjusted means and differences in mean values. The models were adjusted for patient age, GP age, and
[a]patient gender, ethnicity, educational level,
[b]patient ethnicity, educational level,
[c]patient gender, educational level,
[d]GP specialist status, country of birth and region of graduation,
[e]GP gender, country of birth and region of graduation,
[f]GP gender, specialist status and region of graduation,
[g]GP gender, specialist status and country of birth.
SBP: systolic blood pressure, DBP: diastolic blood pressure, LDL chol: LDL cholesterol. Others: patients born in other countries.

## Findings in relation to other studies

Educating GPs in endocrinology and diabetes care through specialist-outreach has shown benefits on improving GPs knowlegde [25]. Financial incentives for performance of diabetes care in the United Kingdom has been shown to improve both processes of care and intermediate outcomes for patients with diabetes [5]. Specialist approval itself is in Norway accompanied by a financial incentive which is not related to the performance of processes of care or achievements of treatment targets. The Specialist Education for General Practice is an appropriate way for doctors who have limited experience of practicing as a GP to improve their knowledge about treatment of several diseases including diabetes. To the best of our knowledge, re-certification every fifth year for all specialists in General Practice in Norway is unique and promotes continuous education of GPs holding a specialist approval. Both ways of updating professional knowledge may enhance the GP's competency and improve their clinical practice. This strategy may explain the observed differences between specialists compared with non-specialists in our study. However, the differences in intermediate outcomes between specialists and non-specialists were in clinical terms small. A possible explanation is that the difference between the two groups has been reduced as a large proportion of current non-specialists intend to become specialists and might be currently undergoing the Specialist Education for General practice.

Compared with male GPs, female GPs provided better performance of the processes of care but achieved similar intermediate outcomes for all patients, except lower HbA1c for South Asians. The results are consistent with that reported by Kim and colleagues [16]. They found that female GPs performed slightly more lipid and HbA1c measurements but achieved comparable intermediate outcomes compared with their
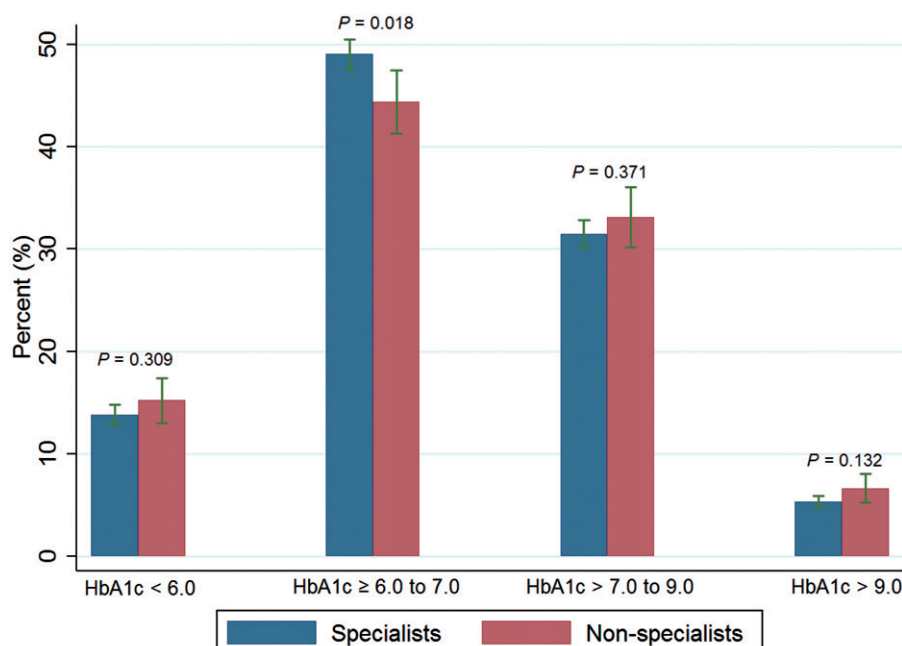
**Figure 1.** Proportion of patients with type 2 diabetes achieving different HbA1c level according to the general practitioner's specialist status adjusted for patient characteristics and general practitioner's age, gender, country of birth and region of graduation.

counterparts. On the other hand, Berthold and colleagues found that female physicians regardless of speciality were more likely to reach target values of HbA1c, BP and LDL-cholesterol which are not in agreement with our results [15]. The patients of female GPs were more often South Asians and less educated probably indicating challenges with language barriers and low health literacy.

According to another Norwegian study, GPs born outside Norway provided care for a different patient population, often in small and rural practices [26], they also had broad cultural competency, worked hard for their patients [27] and their practice pattern differed little from that of GPs born in Norway regarding out-of-hours work [28]. These reports are consistent with our results that GPs born outside Norway provided comparable intermediate outcomes compared with their counterparts. Our results may indicate the ability of these GPs to adapt their clinical practice to provide good care for their T2DM patients.

Regardless of speciality, physicians graduating abroad provided similar quality of care compared with their counterparts in acute myocardial infarction with respect to secondary prevention medications and mortality risk in Canada [29] and mortality in the United States [30]. We found slightly different findings in that GPs who graduated outside Western Europe performed recommended procedures less often and achieved higher diastolic blood pressure than GPs who had graduated in Western Europe.

## Conclusion and implications

Specialists in General Practice provided better care for patients with T2DM compared with non-specialists. Few differences in the quality of T2DM care were found between GP groups stratified according to their gender, country of birth and region of graduation. Interestingly there was considerable potential for improvement in the screening for microvascular complications such as albuminuria and foot examination in all GP groups. Better performance here would probably improve patient outcomes in the long run.

In the future all Norwegian GPs will be required to undertake specialist training and this will probably improve diabetes care. Other national strategies to improve diabetes care in general practice could include reimbursement to GPs who include a diabetes nurse in their practice, better collaboration with endocrinologists for patients with high risk for complications and financial incentives to improve GPs participation in the Norwegian Diabetes Registry. Future research investigating difference in quality of care between specialists and non- specialists in general practice in the management of other chronic conditions would be of interest.

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## Disclosure statement

## Funding

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