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Variation between general practitioners in type 2 diabetes processes of care

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ABSTRACT

Aims: To explore variation in general practitioners' (GPs') performance of six recommended procedures in type 2 diabetes patients <75 years without cardiovascular disease.
Methods: Cross-sectional study of quality of diabetes care in Norway based on electronic health records from 2014. GPs (clustered in practices) were divided in quintiles based on a composite measure of performance of six processes of care. We fitted a multilevel partial ordinal regression model to identify GP factors associated with being in quintiles with better performance.
Results: We identified 6015 type 2 diabetes patients from 275 GPs in 77 practices. The GPs performed on average 63.4% of the procedures; on average 46% in the poorest quintile to 81% in the best quintile with a larger range in individual GPs. After adjustments, use of a structured follow-up form was associated with GPs being in upper three quintiles (OR 12.4 (95% CI 2.37–65.1). Routines for reminders were associated with being in a better quintile (OR 2.6 (1.37–4.92). GPs' age >60 years and heavier workload were associated with poorer performance.
Conclusion: We found large variations in GPs' performance of processes of care. Factors reflecting structure and workload were strongly associated with performance.

1. Background

Type 2 diabetes is a complex disease placing high demands on both patients and health care professionals. General practitioners are supposed to counsel patients in self-management and lifestyle modifications, monitor risk factors, screen for and treat complications, pursue individualized treatment targets and manage medications for hyperglycemia, hypertension and hyperlipidemia. A gap in the quality between the recommended and actual care for type 2 diabetes patients is well documented [1,2], as well as variations in quality within provider levels, regions and countries [3–9]. Some variation might reflect patient-centered care, whereas some variation is unwarranted and cannot be fully explained by disease severity or patient preferences [10]. Identifying the sources of unwarranted variation can provide a basis for quality improvement strategies.

According to Donabedian's model of quality of care, structural factors influence processes of care, which also has an influence on outcomes. Therefore, the quality of care could be measured by assessing these three aspects: structure, process and outcome [11]. Potential strategies to improve quality in diabetes care [12] or to increase guideline adherence [13], include interventions within the

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structural aspect, addressing both material and human resources and organizational structure.

In assessing provider-level variation in the quality of care for type 2 diabetes patients, the process measures, rather than the clinical outcomes, are more likely to reflect the physician's working style [14,15]. Process measures in diabetes care also show larger variation at the provider levels than clinical outcomes [16,17]. Furthermore, these measures have been regarded as high-impact quality indicators in primary health care [18].

In Norway, type 2 diabetes patients are primarily treated in general practice. We recently reported that processes of care for diabetes patients were suboptimal with, for example, only one third of the patients having had a measurement of albuminuria or foot examination during the past 15 months [2].

Thus, our primary objective was to explore the variation in the general practitioners' (GPs') overall performance of six recommended procedures and to identify GP and practice factors associated with the performance of these procedures in a population of type 2 diabetes patients aged <75 years without diagnosed cardiovascular disease (CVD). We hypothesized a large variation between the GPs, and that structural factors were associated with the quality of care, in line with Donabedian's model [11].

2. Research design and methods

The ROSA 4 study (acronym for participating regions) is a population-based cross-sectional study of the quality of care in 2014 for diabetes patients from general practice in five of 11 counties in Norway. In total, 77 practices (73%) with 282 GPs (77%) agreed to participate.

All GPs within each practice participated, and 11 428 diabetes patients 18 years or older were identified in their electronic health records (EHR). Details about recruitment and data collection have been previously published [2]. Briefly, research nurses manually validated the diabetes diagnoses and collected patient data (time of diagnosis, blood pressure, screening procedures and complications) from the EHRs. Laboratory results and information about prescribed medications were automatically extracted. Furthermore, questionnaire data were collected about the characteristics of the GPs, the practices and routines for management and the follow-up of diabetes patients (data from 100% of practices, and from 99% of GPs) [19]. Patient information about education level and ethnicity was obtained by linkage to data from "Statistics Norway". The Regional Ethics committee approved the study.

2.1. Setting

Norway has universal health care with small patient co-payments. Almost all citizens are registered with an individual GP. The GPs are organized in practices with varying size and are paid according to the number of patients listed with the individual GP, consultations and types of procedures performed. GPs get no external reimbursement for GP staff members but there is a small economic incentive for a yearly diabetes control with recommended procedures. No benchmarking, pay-for-performance initiatives or universal chronic care models have been introduced by the national health authorities. Neither is there a tradition for structured population management.

2.2. Outcome

Our primary outcome (at GP level) was a summary measure for each GP, reflecting the performance of six procedures recommended in type 2 diabetes care: measurements of HbA1c, LDL cholesterol, albuminuria, blood pressure and recorded foot examination in the past 15 months (between October 1, 2013 and December 31, 2014); and recorded eye examination in the past 30 months (July 1, 2012–December 31, 2014). For each GP, the proportions of patients receiving each of the six procedures were calculated and the scores were averaged across all process indicators, resulting in a process performance indicator average [20]. The GPs were divided into quintiles based on their indicator average to characterize groups of better- and worse-performing GPs.

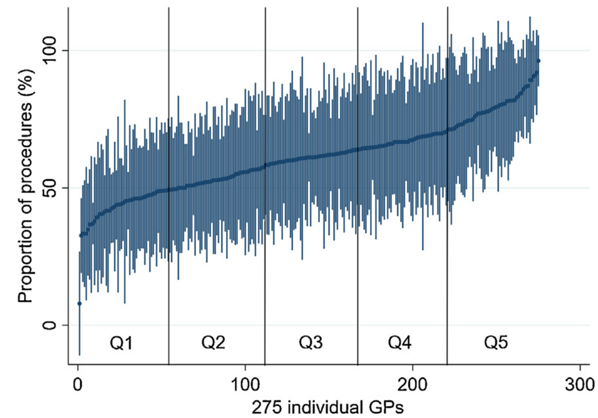

Fig. 1. Distribution and quintiles of the mean proportion of procedures for each of the 275 general practitioners. Standard error bars represent the variation of the number of procedures in the patients of each general practitioner. Q = quintile.

2.3. Sample

For this project there was a fixed available sample of GPs and patients. Of the 11 428 diabetes patients, 10 079 had type 2 diabetes and were registered with a GP (flow chart, Supplementary Fig. 1). We excluded patients ≥75 years and those with CVD to study GP behavior in patients with potentially most to gain (balancing effect versus harm) [21,22]. We also excluded 7 GPs with <5 type 2 diabetes patients, resulting in a study sample of 77 GP practices (100% of enrolled) 275 GPs (98% of all enrolled) and 6015 patients (60% of type 2 diabetes patients).

2.4. Variables

We included available variables relevant for diabetes quality from the literature, and variables potentially associated with quality.

2.4.1. GP variables

Age; gender; specialist status; country of birth; number of type 2 diabetes patients; work load (number of registered patients on each GP's list divided by number of clinical days per week); use of an electronic follow-up form (i.e., the form was applied in ≥10 patients or >50% of their listed type 2 diabetes patients).

2.4.2. GP practice variables

County; number of GPs in the practice; practices with nurses; staff involvement in diabetes care (assigned ≥2 tasks: dietary guidance, tasks in the annual review, patient education (glucose measurements, injection techniques, and/or foot care)); and routines for reminding patients of yearly diabetes control.

2.4.3. Patient variables

Age; gender; duration of diabetes; ethnicity (country of birth); education level; levels of HbA1c, LDL-cholesterol, albuminuria and systolic blood pressure; recordings of foot examination (foot pulses and/or foot sensibility) and eye examination; smoking status; and

Table 1
Descriptive general practitioner (GP) and practice characteristics within quintiles.

	Total	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	p for trend
Number of GPs in each quintile	275	54	56	55	55	55	
Number of patients in each quintile	6015	1174	1160	1262	1195	1224	
Performance of procedures							
Proportion of procedures performed	63.4	45.8 (43.7–47.8)	56.5 (55.8–57.1)	63.5 (63.1–63.9)	69.6 (69.0–70.2)	81.3 (79.8–82.9)	
LDL measured*	85.3	65.9 (59.1–72.8)	85.7 (82.8–88.6)	89.1 (86.1–92.1)	90.0 (87.6–92.4)	95.6 (94.0–97.2)	
Blood pressure measured*	85.8	74.6 (69.8–79.4)	83.4 (80.6–86.3)	87.9 (85.3–90.6)	88.5 (86.3–90.7)	94.1 (92.2–96.1)	
HbA1c measured*	90.0	80.5 (76.1–84.8)	87.3 (85.0–90.0)	91.0 (89.0–93.0)	90.4 (88.5–92.4)	95.5 (93.9–97.0)	
Albuminuria assessed*	34.6	8.5 (9.1–13.8)	17.4 (12.8–22.1)	32.6 (26.8–38.5)	48.3 (43.3–53.3)	66.1 (60.6–71.6)	
Retinopathy screening documented*	54.8	33.7 (29.1–38.3)	48.2 (44.0–52.4)	53.1 (48.8–57.4)	64.1 (60.4–67.8)	74.5 (70.8–78.2)	
Foot examination recorded*	30.9	11.5 (9.1–13.8)	16.9 (14.2–19.6)	27.1 (23.1–31.0)	36.4 (32.4–40.5)	62.3 (56.4–68.2)	
Characteristics of the GPs							
Proportion of GP age groups							
<40 years	22.9	11.1 (5.0–22.8)	28.6 (18.2–41.9)	27.3 (17.0–40.6)	30.9 (20.0–44.4)	16.4 (8.7–28.8)	0.491
40–60 years	53.5	46.3 (33.4–59.7)	48.2 (35.4–61.3)	50.9 (37.8–63.9)	50.9 (37.8–63.9)	70.9 (57.5–81.5)	0.015
>60 years	23.6	42.6 (30.0–56.2)	23.2 (13.9–36.2)	21.8 (12.7–34.8)	18.2 (10.0–30.8)	12.7 (6.1–24.6)	< 0.001
Female GPs	44.7	29.6 (18.9–43.2)	48.2 (35.3–61.3)	41.8 (29.5–55.3)	50.9 (37.8–63.9)	52.7 (39.5–65.6)	0.022
GP specialists	67.6	61.1 (47.4–73.2)	62.5 (49.1–74.3)	72.7 (59.4–83.0)	63.6 (50.1–75.3)	78.2 (65.2–87.3)	0.077
GPs born in Norway	81.4†	77.8 (64.6–87.0)	78.6 (65.8–87.5)	89.1 (77.6–95.1)	75.9 (62.6–85.6)	85.5 (73.3–92.6)	< 0.001
Workload (listed patients per clinical day)							
<250 patients	25.1	7.4 (2.8–18.3)	23.2 (13.9–36.2)	20.0 (11.3–32.8)	41.8 (29.5–55.3)	32.7 (21.6–46.3)	< 0.001
250–350 patients	54.9	55.6 (42.0–68.3)	51.8 (38.7–64.6)	61.8 (48.3–73.8)	56.4 (42.9–68.9)	49.1 (36.1–62.2)	0.696
>350 patients	20.0	37.0 (25.2–50.7)	25.0 (15.3–38.1)	18.2 (10.0–30.8)	1.8 (0.2–12.1)	18.2 (10.0–30.8)	< 0.001
Number of type 2 diabetes patients listed							
<20 T2D¤ patients	50.2	48.1 (35.1–61.5)	55.4 (42.1–67.9)	49.1 (36.1–62.2)	47.3 (34.4–60.5)	50.9 (37.8–63.9)	0.898
20–35 T2D patients	38.6	40.7 (28.4–54.4)	35.7 (24.2–49.2)	41.8 (29.5–55.3)	43.6 (31.1–57.1)	30.9 (20.0–44.4)	0.575
>36 T2D patients	11.3	11.1 (5.0–22.8)	8.9 (3.7–19.9)	9.1 (3.8–20.3)	9.1 (3.8–20.3)	18.2 (10.0–30.8)	0.286
GP uses follow-up form	24.7	0	7.1 (2.7–17.7)	27.3 (17.0–40.6)	30.9 (20.0–44.4)	58.2 (44.7–70.5)	< 0.001
Practice characteristics							
GPs with nurse (incl. diabetes nurse)	43.6	27.8 (17.4–41.3)	39.3 (27.3–52.7)	45.5 (32.7–58.8)	43.6 (31.1–57.1)	61.8 (48.3–73.8)	< 0.001
Staff involved in diabetes care	34.9	14.8 (7.6–27.0)	25.0 (15.4–38.0)	41.8 (29.6–55.2)	45.5 (32.8–58.7)	47.3 (34.5–60.4)	< 0.001
Routine for reminders of yearly control	24.9	7.4 (2.8–18.3)	28.6 (18.2–41.9)	25.5 (15.6–38.7)	23.6 (14.1–36.8)	32.7 (21.6–46.3)	0.013
County (proportion in each quintile)							
Oslo/Akershus	35.6	57.4 (43.9 - 69.9	48.2 (35.5–61.2)	34.5 (23.2–48.0)	27.3 (17.1–40.5)	10.9 (5.0–22.3)	< 0.001
Hordaland	14.9	16.7 (8.8–29.2)	25.0 (15.3–38.1)	16.4 (8.7–28.8)	5.5 (1.7–15.8)	10.9 (4.9–22.4)	0.040
Nordland	26.9	11.1 (5.0–22.8)	21.4 (12.5–34.2)	16.4 (8.7–28.8)	41.8 (29.5–55.3)	43.6 (31.1–57.1)	< 0.001
Rogaland	22.6	14.8 (7.5–27.1)	5.4 (1.7–15.5)	32.7 (21.6–46.3)	25.5 (15.6–38.7)	34.6 (23.1–48.1)	< 0.001
Size of practice							
1–2 GPs	14.6	20.4 (11.6–33.2)	8.9 (3.8–19.8)	14.5 (7.4–26.5)	12.7 (6.2–24.4)	16.4 (8.7–28.6)	0.795
3–4 GPs	34.6	31.5 (20.5–45.0)	28.6 (18.3–41.7)	27.3 (17.1–40.5)	41.8 (29.6–55.2)	43.6 (31.2–56.9)	0.063
5–9 GPs	50.9	48.1 (35.2–61.4)	62.5 (49.2–74.2)	58.2 (44.8–70.4)	45.5 (32.8–58.7)	40.0 (27.9–53.4)	0.113

Proportions within each quintile in % with 95% confidence intervals, trend. The quintiles are based on each GP's (n = 275) proportion of performance of six procedures and measurements in their patients. *Average proportion of patients who had these procedures performed. † n = 274. ¤ Type 2 diabetes.

Table 2
Regional differences in use of follow-up form (2014). n = 275 GPs.

Region	n	Users (%)	Non-users (%)
Oslo/Akershus	46	5 (5.1)	93 (94.9)
Hordaland	41	5 (12.2)	36 (87.8)
Nordland	74	33 (44.6)	41 (55.4)
Rogaland	62	25 (40.3)	37 (59.7)

medications from the last 15 months: glucose-lowering, lipid-lowering and antihypertensive medications.

2.5. Statistical methods

The GPs were the unit of analysis (level 1), practices were level 2, accounting for clustering of GPs in practices. We used descriptive statistics with means and proportions with 95% confidence intervals (CI). Differences across the quintiles were established from tests for trends (prop.trend.test in R for proportions, and nptrend in Stata for continuous variables).

We first tried to fit a multilevel ordinal logistic model to identify factors associated with GPs being in different quintiles of process performance, as the quintiles represent an ordered categorical dependent variable. The assumption of proportionality between quintiles in an ordinal model was violated for some variables. Thus we fitted a multilevel partial ordinal logistic model with random effects at GP practice level using gologit2 [23]. To check for multicollinearity, we calculated variance inflation factors. Continuous GP and practice factors (exposure variables) were grouped in categories driven by the distribution of the data. Patient level factors were aggregated at GP level as means or proportions, representing case-mix adjustments (confounders). For variables fulfilling the assumption of proportionality, we obtained four equal OR estimates in four binary models representing the odds of being higher than a certain quintile. For the remaining variables we obtained different ORs for the four binary models comparing different combinations of quintiles. We fitted one model including only GP characteristics (supplementary table S2) whereas the main model also included aggregated patient characteristics (Table 3). Among the 275 participating GPs, we could include 274 in the adjusted models, so missingness was a negligible problem.

For the multivariate analysis, independent variables with $p \leq 0.2$ in univariate analysis were included. The capital region (Oslo and the surrounding Akershus County) were merged as both had very few GPs using follow-up form and characteristics elsewhere were similar. We checked for interactions and found interactions between the variables "county" and "nurse", and "county" and" use of follow-up forms". However, the model fit, assessed by the Akaike Information Criterion, did not improve with interactions terms included in the models.

Intracluster correlation (ICC) estimates were obtained to explore the variance in the GP procedure performance that was attributable to the GP practice level, intended to evaluate how strongly the GPs within each practice resemble one another.

Analyses were performed in StataSE 16 (StataCorp, College Station, USA) and R 3.4.3 (The R Foundation for Statistical Computing, Vienna, Austria) and the significance level was set at $\alpha = 0.05$.

3. Results

Each quintile of GP performance included 54–56 GPs and 1160–1262 patients (Table 1). On average, the GPs performed 63.4% of the six procedures on their patients, ranging from 7.8% to 96.3% between the individual GPs (Table 1 and Fig. 1). GPs in quintile 1 on average performed 45.8% of the procedures, while GPs in quintile 5 performed 81.3% of the procedures. On average, the GPs in

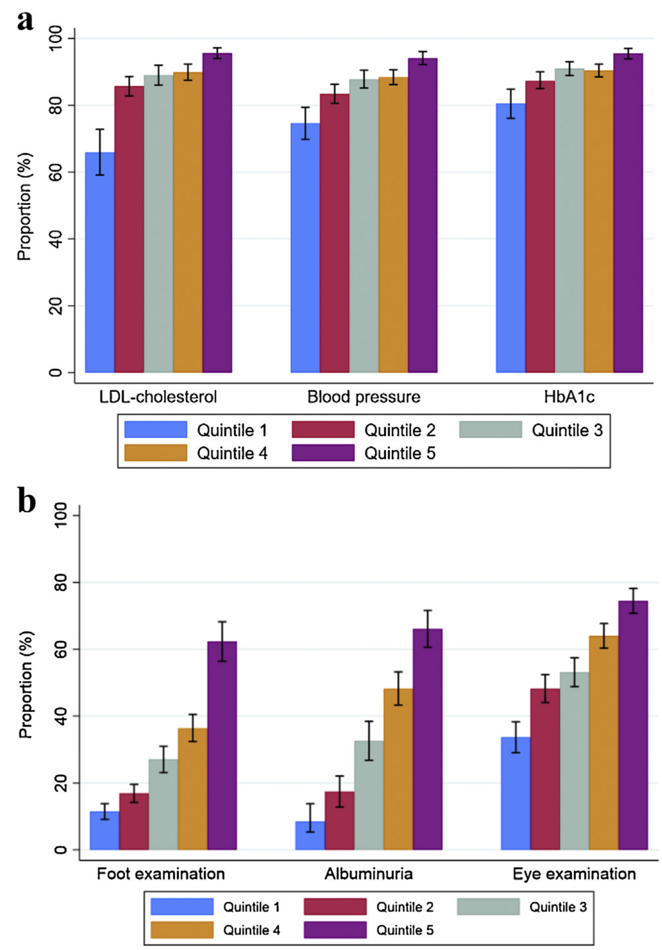

Fig. 2. a) Average proportions (%) (with 95% confidence intervals) of performed measurements of LDL cholesterol, blood pressure and HbA1c within the quintiles. b) Average proportions (%) (with 95% confidence intervals) of performed foot examination, measurement of albuminuria and recorded eye examination within the quintiles.

quintiles 2–5 performed measurements of HbA1c, blood pressure and LDL-cholesterol on more than 80% of the patients, significantly more than GPs in quintile 1 (Fig. 2a). The variation between the quintiles was largest for the microvascular screening procedures (Fig. 2b). On average, the GPs in quintile 1 measured albuminuria in only 8.5% (95% CI 9.1–13.8) of their patients compared with 66.1% (60.6–71.6) for GPs in quintile 5.

Consistent patterns across the quintiles were found for several GP characteristics (Table 1), with a strong trend for the use of an electronic follow-up form – from 0% in quintile 1 to 58.2% in quintile 5 ($p < 0.001$). Regional variations in the use of a follow-up form is presented in Table 2.

For patient characteristics, there were some differences across the quintiles in proportions of ethnic minority groups, medications, mean HbA1c and LDL levels and estimated 10-year risk of CVD events (Supplementary Table S1).

After adjustment for GP and patient factors, the factor most strongly associated with being in a higher quintile was the use of a structured form in the follow-up (Table 3). Further, GPs with the heaviest workload had lower odds of being in a higher quintile, especially the combined upper two quintiles, compared to those with <250 patients/day. The oldest doctors (61–70 years) had lower odds of being in a higher quintile compared to GPs between 40 and 60 years, whereas specialists and GPs in larger practices were less likely to be in the worst quintile. GPs in the capital region (Oslo/Akershus) performed worse across all quintiles, whereas GPs

Table 3
Factors associated with being in better quintiles of general practitioner performance (2014).

GP characteristics	Q2-Q5 vs Q1	Q3-Q5 vs Q1-Q2	Q4-Q5 vs Q1-Q3	Q5 vs Q1-Q4
GP gender (ref. male)	1.38 (0.78–2.43)	1.38 (0.78–2.43)	1.38 (0.78–2.43)	1.38 (0.78–2.43)
Specialist (ref. no)†	4.94 (1.85–13.2)***	3.38 (1.39–8.19)**	1.10 (0.49–2.47)	0.51 (0.14–1.79)
Workload (ref. <250 patients/clinical day)	1	1	1	1
250–350 patients	0.33 (0.14–0.75)**	0.33 (0.14–0.75)**	0.33 (0.14–0.75)**	0.33 (0.14–0.75)**
>350 patients†	0.18 (0.06–0.52)**	0.08 (0.03–0.22)***	0.05 (0.01–0.15)***	0.98 (0.22–4.35)
Number of type 2 diabetes patients listed (ref <20)	1	1	1	1
21–35	1.24 (0.67–2.30)	1.24 (0.67–2.30)	1.24 (0.67–2.30)	1.24 (0.67–2.30)
>36	3.38 (1.18–9.72*	3.38 (1.18–9.72*	3.38 (1.18–9.72*	3.38 (1.18–9.72*
GP country of birth (ref. Norway)†	1.24 (0.43–3.55)	0.40 (0.15–1.12)	1.43 (0.52–3.90)	0.30 (0.07–1.26)
Age of GPs (ref. 40–60 years)	1	1	1	1
27–39 years†	5.62 (1.43–22.0)*	1.51 (0.55–4.10)	0.43 (0.19–1.03)	0.11 (0.03–0.37)***
61–70 years†	0.32 (0.13–0.79)*	0.85 (0.37–1.96)	0.39 (0.18–0.81)*	0.18 (0.06–0.49)**
Follow-up form (ref. non-user)†	¤	12.4 (2.37–65.1)**	2.92 (1.30–6.53)*	7.50 (3.12–18.0)***
GP practice characteristics				
County (ref. Nordland)	1	1	1	1
Oslo/Akershus	0.27 (0.10–0.75)*	0.27 (0.10–0.75)*	0.27 (0.10–0.75)*	0.27 (0.10–0.75)*
Hordaland	0.40 (0.10–1.59)	0.40 (0.10–1.59)	0.40 (0.10–1.59)	0.40 (0.10–1.59)
Rogaland†	0.43 (0.08–2.19)	3.66 (1.05–12.7)*	0.97 (0.31–3.06)	2.97 (1.05–8.31)*
Routines for reminders (ref. no)	2.60 (1.37–4.92)**	2.60 (1.37–4.92)**	2.60 (1.37–4.92)**	2.60 (1.37–4.92)**
Staff involved in diabetes care (ref. no)	0.79 (0.39–1.64)	0.79 (0.39–1.64)	0.79 (0.39–1.64)	0.79 (0.39–1.64)
Size of practice (ref. 1–2 GPs)	1	1	1	
3–4 GPs	2.51 (0.99–6.3)	2.51 (0.99–6.3)	2.51 (0.99–6.3)	2.51 (0.99–6.3)
5–9 GPs†	6.87 (2.52–18.7)***	2.08 (0.75–5.80)	2.82 (1.08–7.37)*	1.33 (0.47–3.73)
Nurse employed (ref. no)	0.64 (0.26–1.58)	0.64 (0.26–1.58)	0.64 (0.26–1.58)	0.64 (0.26–1.58)

n = 274 GPs. Partial ordinal regression with quintiles as the dependent variable. Model with aggregated patient characteristics (age, gender, diabetes duration, education level and ethnicity).
*p < 0.05; **p < 0.01; ***p < 0.001. Q = quintile. ¤There were no users of follow-up form in quintile 1. †Categories that did not fulfil the assumption of proportionality (the odds ratios do not vary between the different comparisons of quintiles).

in practices with routines of reminders performed better across all quintiles.

Estimates of ICC of 0.5 and 0.34 in the variance component model and the adjusted model respectively, implied that 34% of the total variance of the indicator average could be explained by differences between the practices.

4. Discussion

In the present study we found a consistent pattern of substantial variation in the GPs' overall performance of six recommended procedures in type 2 diabetes patients. The average performance ranged from 46% in the poorest quintile to 81 percent in the best quintile, with a substantially larger range between individual GPs.

Use of a follow-up-form, patient reminders and more diabetes patients on GPs' lists were associated with better performance, whereas older age of GPs and a large workload and were associated with poorer performance.

4.1. Strengths and limitations

The ROSA 4 study used high-quality data, manually validated by research nurses, including information on patient socioeconomic status and structural factors. GPs and patients are considered representative of Norwegian GPs and type 2 diabetes patients [2,24]. We used quality indicators considered to be of high-impact for primary care [18], recommended in Norwegian diabetes guidelines since 1995.

Recordings of blood pressure, eye and foot screening were manually identified in the records and thus not dependent on a structured documentation in the EHR. Using process measures instead of patient outcomes reduces the risk of misclassifying the GPs due to factors over which they may have little influence, and a composite measure further increases the reliability [15]. Analyzing at the GP level rather than the patient level, enabled us to highlight the large variation between the best-performing and the worst-performing quintiles of GPs.

By adjusting for aggregated data on patients' age, gender, diabetes duration, education level and ethnicity, much of the heterogeneity in the patient lists was accounted for. For example, some categories of patients may be less willing to attend. Although case-mix adjustments might conceal real differences in the quality of care [16,25], only minor changes in the estimates were observed when adding patient characteristics.

However, the cross-sectional design limits inferences about causality. Moreover, the reliability of the estimates for performance is lower in GPs with fewer patients, and we lack information about the patients' total comorbidity.

Although we consider the practices to be fairly representative for the five counties, practices in two counties (Nordland/Rogaland) have been more exposed to quality improvement strategies and promotion of the use of the follow-up form than other counties in Norway. If some selection bias is operating, the included GPs might perform slightly better than the average Norwegian GPs.

4.2. Comparison with existing literature

Previous studies about variation among GPs in processes of care for type 2 diabetes patients [3,15,16], mostly report practice level factors only [8,9,26]. Studies on the GP level are primarily related to development of methods for "physician profiling" in the UK and the US [14–16], reporting performance of cost and quality rather than individual physician's characteristics. Further, direct comparisons are hampered by different measures for processes of care.

We were unable to identify studies reporting the attribution of variance at the GP practice level of diabetes procedures on GP level data. One study without GP level data found health center characteristics to account for 36% of the total variation in process measures [8]. In another study at patient level, the primary care provider had a moderate effect on measurements of HbA1c and lipids, accounting for 8–9% of the variation at the patient level, while the clinic level accounted for 7–9% of the variation [16].

Many studies have tested different quality improvement strategies in diabetes care [12]. A meta-analysis found that targeting the health care system (through case management, care teams, electronic tools etc.) generally reduced HbA1c more than strategies targeting the individual health care providers [12].

Our finding that the GP practice level explained a large part of the variation in the GPs' performance of type 2 diabetes processes, is in line with a report showing that GPs in the same practice were more likely to act similarly when shared resources were used [27]. A qualitative study found that the practice characteristics associated with high performance across clinical indicators were strategies of clinical quality improvement, care structures supporting screening, checks and recalls, and a biomedical view of care [28]. We also found that shared routines of patient reminders for yearly follow-up, possibly reflecting a common attitude towards structured care, was important. Neither staff involvement in care nor the presence of nurses were independently associated with the GP process performance in our adjusted analysis, in contrast to a meta-analysis which found that team-based care in diabetes improved blood glucose, hypertension and lipid levels [29]. In our study, the association between a higher proportion of nurses and higher quintiles (Table 1) was evened out in the adjusted analysis, probably by the fact that many GPs in practices with nurses also use the structured follow-up form.

A larger practice size reduced the GPs' risk of being in the lowest-performing quintile. Larger practices might facilitate more structured care, but the relation to quality of care is not clear, and other studies have found inconsistent associations of practice size and quality of diabetes care [30].

Among GP factors, use of an electronic structured diabetes care follow-up form designed for general practice and semi-integrated in the electronic health records was strongly associated with better performance of processes of care in our study. Few others have found an effect of a structured form on processes of care [31], whereas a systematic review found some minor effects on patient clinical outcomes but did not evaluate effect on guideline adherence [32]. We have previously shown an association between microvascular screening on patient level and the use of a structured follow-up form in a slightly different patient sample [19].

The inverse association of the workload and the GP performance indicates that time constraints might influence quality of care, in line with a large study using administrative data [33]. A qualitative study also found that a large workload and time pressure was perceived as barriers to delivering appropriate diabetes care [34]. A systematic review, however, found an inconsistent relationship of workload and diabetes care [30].

Older or more experienced doctors seem to follow guidelines to a lesser extent [30,35–37], in accordance with our findings, but they may add other qualities such as psychosocial skills into diabetes care [38], not assessed in the present study.

The geographical variation in the use of the follow-up form may be related to local diabetes plans advocating its use, indicating that its use not only reflects a special interest in diabetes or an attitude favoring guideline adherence, and that implementation strategies are necessary.

In the context of known variation in many aspects of care, it is likely that there is a variation in the GPs' working style in health care systems outside Norway as well. But given the autonomous role of Norwegian GPs, different structures, incentives and roles of supportive staff in other health care systems could modify such variation.

4.3. Implications for research and practice

Our finding of large unwarranted variation clearly demonstrates the need for quality improvement strategies. Generally, quality improvement strategies tailored towards the lowest-performing GPs, or regions where the quality is low, are warranted to reduce the quality gap.

This cross-sectional study suggests some factors that could enhance the quality in the worst-performing GPs, but an intervention trial is necessary to confirm an effect.

Further studies should explore if there is a link between the GPs' process performance and their patients' outcomes. A trial with structured follow-up forms could also explore its specific role and thereby enhance the field.

5. Conclusion

Large variations between GPs in the performance of diabetes processes of care were found.

Factors facilitating structure in care were associated with better processes of care.

Competing interests

J.G.C. and Å.B. have received lecturing fees from Novo Nordisk, Sanofi Aventis, Eli Lilly, AstraZeneca, GSK and MSD.

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Ethical approval

The regional ethics committee, REK-Vest approved the study (reference 2014/1374/REK vest).

Data availability statement

The data underlying this article cannot be shared publicly due to the privacy of individuals that participated in the study. The data will be shared on reasonable request to the corresponding author if approved by the ethics committee.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.pcd.2020.11.018.

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