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Quality of Diabetes Care in Blended Fee-for-Service and Blended Capitation Payment Systems.

Mary Aderayo Bamimore

Rose Anne Devlin

Gregory S Zaric

Amit X Garg

Sisira Sarma
sisira.sarma@schulich.uwo.ca

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Author Names and Affiliations:
Mary Aderayo Bamimore, PhD(c)[1] Rose Anne Devlin, PhD[2] Gregory S. Zaric, PhD[3,1] Amit X. Garg, MD, PhD[1,4,5] Sisira Sarma, PhD[1,5*]

[1] Department of Epidemiology and Biostatistics, University of Western Ontario, London, Ontario, Canada
[2] Department of Economics, University of Ottawa, Ottawa, Ontario, Canada
[3]Ivey Business School, Western University, London, Ontario, Canada
[4]Department of Medicine, Western University, London, Ontario, Canada
[5]Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada

*** Corresponding Author:**
Telephone: (519)-661-2111 x.87583, E-mail: ssarma2@uwo.ca, Address: Western University, Kresge Building, Room K201, London, Ontario, Canada, N6A 5C1

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Abstract

Objectives: In the mid- to late-2000s, many family physicians switched from Family Health Group (FHG) (a blended fee-for-service model) to Family Health Organization (FHO) (a blended capitation model) in Ontario, Canada. The evidence on the link between physician remuneration schemes and quality of diabetes care is mixed in the literature. We examined whether physicians who switched from the FHG to FHO model provided better care for individuals living with diabetes relative to those who remained in the FHG model.

Methods: Using longitudinal health administrative data from 2006 to 2016, we investigated the impact of physicians switching from FHG to FHO on eight quality indicators related to diabetes care. Since FHO physicians are likely to be systematically different from FHGs, we employed propensity-score based inverse probability weighted fixed-effects regression models. All analyses were conducted at the physician-level.

Results: We found that FHO physicians were more likely to provide $HbA1_c$ testing by 2.75% (95% confidence interval (CI): 1.89%, 3.60%), lipid assessment by 2.76% (CI: 1.95%, 3.57%), nephropathy screening by 1.08% (CI: 0.51%, 1.66%), and statin prescription by 1.08% (CI: 0.51%, 1.66%). Patients under FHOs had lower estimated risk of mortality by 0.0124% (CI: 0.0123%, 0.0126%) per physician per year. However, FHG and FHO physicians were similar for annual eye examination, prescription of angiotensin-converting-enzyme inhibitors (or angiotensin II receptor blockers), and patients' risk of avoidable diabetes-related hospitalizations.

Conclusions: Compared to blended fee-for-service, blended capitation payment is associated with a small but statistically significant improvement in some aspects of diabetes care.

Introduction

One goal of primary care reform in many developed countries is to improve the delivery of high quality patient care [1]. In Canada, the province of Ontario witnessed primary care reform in the early 2000's, rolling out primary care models with various remuneration schemes for family physicians. Among such models are the blended fee-for-service (FFS) Family Health Group (FHG) and the blended capitation Family Health Organization (FHO), introduced in 2003 and 2006, respectively [2]. Prior to the reform, over 90 per cent of family physicians in Ontario were paid through pure FFS [2]; today, most are paid either by blended FFS or by blended capitation. These new models are further characterized by formal patient enrollment, the mandatory provision of after-hours care, and a variety of pay-for-performance (P4P) schemes including the 'Diabetes Management Incentive (DMI). The DMI rewards physicians $60 per patient per annum for organizing, rendering and documenting care processes that meet the clinical guidelines of Diabetes Canada. Essential care services of the DMI include testing glycated hemoglobin ($HbA1_c$), measuring lipid profile, screening for nephropathy, retinopathy, and prescribing statins [3,4].

The evidence on the relationship between physicians' remuneration and quality of diabetes care is mixed. The effect of P4P incentives on physicians' provision of diabetes care is, by and large, inconclusive as some studies failed to find any effect [5–10] while others found increases in diabetes-related services under P4P schemes [11–17].

Scott et al. (2009) used an Australian panel data set spanning 2002 to 2007 and found that general practitioners in the 'Practice Incentive Program' P4P scheme were 20% more likely to order a $HbA1_c$ test for their diabetes patients compared to physicians not in the program [13]. In a similar vein, Chen et al. (2010) used a Hawaiian panel data set from 1999 to 2006, and found

that persons with diabetes cared by P4P participating physicians were more likely to receive at least two $HbA1_c$ tests and one lipid assessment per year relative to non-P4P participating physicians [14]. A review by Gupta and Ayles (2019) found that, in Taiwan, P4P incentives increased physicians' care continuity for persons with diabetes [7]. This review also reported that P4P incentives were associated with a reduction in 5-year risk of all-cause mortality. A more recent paper again using Taiwanese data corroborated these findings [18].

Kontopantelis et al. (2013), using a pre-post analyses on patient-level data from 148 UK primary care practices between 2000 and 2006, found that the quality of diabetes management improved after a P4P based on a Quality and Outcomes Framework was introduced in 2004. In this study, care quality for diabetes was a composite score of 17 indicators related to the management of diabetes; they found that the quality of care improved by 14.2% in the year P4P was introduced; however, three years after the magnitude of this improvement fell [15].

Not all of the literature has concluded that diabetes P4P measures improved care. Difference-in-differences analyses by Chien et al. (2012) found no improvement in diabetes care processes, including $HbA1_c$ testing and eye examination, after the introduction of the Hudson Health Plan, a P4P plan serving a region of New York (United States) [5]. A similar study from Colorado (United States) also found that the P4P did not improve lipid testing or dilated eye exams [8]. Using 2000 to 2015 data from Portugal, Dimitrovová, Perelman and Serrano-Alarcón (2020) concluded that the addition of a P4P incentive for diabetes care did not reduce diabetes-related avoidable hospitalizations [9]. Pawaskar et al. (2010) found that persons with diabetes under pure capitation payment plans were more likely to be hospitalized relative to those under pure FFS payment plans in the United States [19].

Three studies using data in Ontario are particularly relevant for our paper. Jaakkimainen et al. (2011) using administrative data from 2004 to 2007 reported no difference in the annual eye examination and prescription of statins between family physicians remunerated through blended FFS and blended capitation [10]. By contrast, a cross-sectional study by Kiran et al. (2014) found that the likelihood of individuals with diabetes receiving eye examination, $HbA1_c$ testing and lipid measurement altogether was greater in blended capitation than in blended FFS [17]. Kiran et al. (2015) found that patients with blended capitation physicians were more likely to get recommended tests for diabetes care [16].

The goal of our paper is to examine whether physicians switching from FHGs to FHOs behave differently when it comes to diabetes management. By using a longer follow-up, more outcome variables and sophisticated empirical methods, we contribute to the literature on the impact of physician remuneration on diabetes care. It is important, however, to understand why the FHG and FHO models may affect quality of care differently. Because capitated physicians receive a fixed payment per patient per time, they arguably have the financial flexibility to coordinate care and ensure continuity of care, leading us to hypothesize that physicians switching from the FHG to the FHO model would increase adherence to diabetes care. The health economics literature further suggests that blended capitation provides better incentives for primary care physicians than pure FFS for the efficient supply of health services [20–22]. In Ontario's FHO, capitation adjusts for the age and sex of enrolled patients, but not comorbidity – meaning that 'sicker' individuals may be eschewed by capitated physicians (the 'cream skimming' phenomenon), which would mitigate against the positive incentive effects of capitation. Our empirical strategy controls the average health of patients in order to deal with this potential issue. Moreover, various P4P incentives and access bonus (incentive to ensure that

enrolled patients do not seek in-basket services from physicians outside of the practice) are designed to attenuate cream-skimming behaviour in FHOs.

Methods

Study design

We used a retrospective cohort study design, with observations between April 1st, 2006 and March 31st, 2016. Our sample is comprised of physicians practicing in FHGs and FHOs, and their patients diagnosed with diabetes mellitus. At the baseline (April 1st, 2006), all physicians were in FHGs; we defined a 'switcher' as a FHG physician who switched to a FHO at any point within the study period and remained in the FHO after switching (i.e. the exposure group). A 'non-switcher' is a FHG physician who remained in this model throughout the study period (i.e. the control group). We examined whether switching from FHG to FHO affected physicians' behaviour in terms of six care processes for diabetes management: $HbA1_c$ testing, lipid profile testing, nephropathy screening, eye examination, prescription of angiotensin converting enzyme inhibitors or angiotensin II receptor blockers (ACEIs/ARBs), and prescription of statins. These indicators are consistent with Diabetes Canada clinical practice guidelines [4]. We also investigated the impact of switching on patients' mortality risk score, and their risk of hospitalization for an ambulatory care sensitive condition (ACSC) related to diabetes; by definition, ACSCs are avoidable in persons aged below 75 years if ambulatory care is efficient [23].

Data Sources

All data were obtained from the ICES which houses numerous Ontario health administrative databases. Persons with diabetes mellitus were identified through the Ontario Diabetes Dataset (ODD), a validated database with a sensitivity and specificity of 86.1% and 97.1%, respectively [24,25]. Although ODD excludes gestational diabetes, it does not distinguish between the type 1 and type 2 forms; most individuals identified in ODD would be type 2 since we included patients whose diagnosis of diabetes mellitus occurred at age 30 years or above [17]. Patients enrolled to physicians in FHGs and FHOs were identified through the client agency program enrollment database. The ICES physician database and corporate provider database provided physician characteristics and their practice model. The registered persons database provided patient characteristics. The income quintile was based on the census dissemination area-level data [26]. Laboratory testing and prescription services were identified using the Ontario Health Insurance Plan (OHIP) database and Ontario Drug Benefit claims database.

Outcome Variables

Outcome variables were defined for each year. Each of the six care processes was quantified as a proportion using OHIP billing codes (Appendix Table A1.2). For the laboratory-based indicators (HbA1c testing, lipid assessment and nephropathy screening) and eye examination, the denominator value represented the total number of a physician's patients with diabetes who were alive in the given year, and the numerator is a subset of the denominator population that received the respective process care at least once in that year. For the two drug-based indicators (ACEI/ARB, and statin prescription), the denominator was the total number of a physician's patients who were alive and aged at least 65 years in the given year; the numerator represented

the subset of the denominator population who filled the prescription at least once in the respective year.

An individual's mortality risk score corresponds to his/her one-year risk of all-cause mortality based on the algorithm of Austin and Walraven [27]. An ACSC hospitalization due to diabetes refers to a hospital admission that occurs in persons aged below 75 years and is associated with a diabetes-related hospitalization (codes in Appendix Table A1.3). Appendix A contains detailed information on data sources and variable definitions.

Statistical analyses

All analyses were conducted at the physician-level, hence, all patient-level information were aggregated to the physician-level. We excluded physicians who were not present every year (e.g., retirees and new graduates were excluded), yielding a balanced panel of 2,120 physicians. Following previous research, physicians with fewer than 20 patients with diabetes were excluded to focus on physicians with a stable practice of patients with diabetes who are likely to be up to date with the best practices for diabetes management [28].

Since the choice to remain in a FHG or switch to a FHO was voluntary, FHO physicians may be different from FHG physicians leading to a selection bias that could influence the outcomes. We employed a two-stage estimation procedure to deal with selection bias. The first stage accounts for the differences between FHO and FHG physicians using an inverse-probability-weighted technique based on estimated propensity scores. This approach ensures that the two groups of physicians were similar in terms of their observable characteristics at baseline (before switching to FHO). The second stage estimates the impact of switching from FHG to FHO on processes of care for diabetes and related outcomes using inverse-probability-weighted

fixed-effects regressions. This two-stage estimation approach has been employed in recent publications to study the impact of reform on other outcomes [29–31].

Propensity score model

We begin with estimating a propensity score model using a logistic regression. A general guideline is to include covariates in a propensity score model that are likely to be associated with both the outcome and exposure variable [32,33]. Following the literature, we include: physicians' expected income gain by switching from FHG to FHO and its squared term, age, international medical graduate status (graduates outside of Canada and the United States), group size, number of enrolled patients, physician sex, average age of patients in the physician's practice, proportion of female patients in the practice, patients' average comorbidity score based on the Johns Hopkins Aggregated Diagnosis Groups, proportion of patients from low income area, proportion of patients living in rural areas, and the outcome variables in the baseline year [29,30,34].

The estimated value of a FHG physician's income after joining a FHO is the expected gain in income from switching. To assist FHG physicians in deciding whether to join a FHO, the Ministry of Health and Long-term Care provided them with an estimate of their potential gain in income [29,30]. The estimated income gain is based on the services a FHG physician provided to their enrolled and non-enrolled patients in the 12 months preceding April 1st, 2006. The estimated potential income in an FHO used the following: (i) income from capitation rate of $144.08 multiplied by the age-sex modifier for enrolled patients as of April 1st 2006, (ii) income from shadow billing, which was 10% of FFS value for in-basket services in 2006, (iii) income from providing out-of-basket services to both enrolled and non-enrolled patients based on 100%

of FFS value, (iv) income from the "hard cap" based on 100% of FFS value for in-basket services to non-enrolled patients up to $47,500, and (v) special payments for providing hospital services, obstetrical care, home visits and prenatal care [29,30]. Out-of-basket services refer to services that are not under the capitation basket. Inclusion of the expected gain in income is a crucial variable in the propensity score model as this variable influences a FHG physician's decision on whether or not switch to FHO.

Once the propensity score model was estimated, we used the estimated propensity scores ("predicted probabilities") to construct weights based on kernel matching. Since our objective is to estimate the effect of switching to a FHO, every FHO physician was given a weight of one and the FHG physicians were weighted based on the distance between their propensity scores and that of a FHO physician within a bandwidth of 0.06 [33,35]. Physicians who did not fall within this criteria (outside the range of common support) were excluded. We used t-tests and the standardized bias to assess the balance of covariates [36]. Finally, given that the misspecification of a propensity score model and covariate imbalance can result in biased estimates, we used two alternative weighting procedures as robustness checks: the covariate balancing propensity score (CBPS) [37] and entropy balancing (EB) weights [38].

Fixed-effects regressions

Fixed-effects regressions account for unmeasured time-invariant confounding by controlling for variations by physicians not captured by included covariates [39,40]. For each of the eight quality indicators, we ran both unweighted and inverse-probability-weighted pooled and fixed-effects regressions; the weights were derived from kernel, CBPS and EB weighting. The process indicators were analysed using a random-effects model with group means, equivalent to a fixed-

effects regression [41]; mortality risk score, a continuous variable, was analyzed using a linear weighted fixed-effects regression [30]; and diabetes-related ACSC hospitalizations were analysed using a weighted fixed-effects Poisson regression. The equation below describes the linear fixed-effects regression:

$$Y_{it} = \alpha_i + \delta FHO_{it} + \beta X_{it} + \varepsilon_{it}.$$

Here Y_{it} represents the outcome variable of physician *i* in time period *t*, FHO is a dummy variable that takes a value of one if physician *i* switched to FHO at time *t* and zero if remained in FHG; δ is the estimated coefficient of interest capturing the effect of a physician's switch to FHO on Y; X_{it} is the vector of covariates previously listed; α_i captures unmeasured time-invariant physician-specific factors and ε_{it} is the error term. We use fractional years to account for the duration a physician was in the FHO model during the first year of switch.

Sub-group analyses were undertaken separately by sex of the physician, their age (below 55 and 55+ years at the baseline), and by four switching cohorts (2008-2009; 2010-2011; 2012-2013; 2014-2015). The purpose of these subgroup analyses was to identify whether the effect of switching to FHO was different across various sub-populations of physicians. All analyses employed the statistical software *Stata* version 15.1 [42].

Ethics

The use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Results

We observed 2,120 physicians over 10 years (21,200 physician-year observations): 1,291 switched to FHOs and 829 remained in FHGs throughout the study period. Table B1.0 in Appendix B presents the mean values of explanatory and outcome variables for those switched to FHOs and those remained in FHGs across all years. Prior to kernel weighting, all covariates were significantly different between these two groups of physicians except physician's sex. Non-significant *p*-values, and a standardized bias of no greater than 7% were revealed for all covariates after weighting (Table 1). The robustness of these results was confirmed with CBPS and EB weights (Tables B1.1 and B1.2 in Appendix B). In addition, graphs of propensity scores as well as standardized difference in means and variance ratios confirmed reasonable covariate balance between those switched to FHOs and those remained in FHGs after weighting (Figures B.1 and B.2 in Appendix B).

Our inverse-probability-weighted fixed-effects estimates found that the marginal effects of switching to FHO increased a physician's $HbA1_c$ testing, lipid assessment, nephropathy screening and statin prescription, at least once a year, by 2.75% (95% Confidence Interval (CI): 1.89%, 3.60%), 2.57% (CI: 1.72%, 3.44%), 2.76% (CI: 1.86%, 3.49%) and 1.08% (CI: 0.56%, 1.69%), respectively. These results reveal substantially more patients receiving care from FHOs: based on 2,131,830 total diabetes patient-year observations in FHOs in our data with 1,081,528 of them over 65 years, switching from FHG to FHO resulted in 58,625 (CI: 40,291, 76,745) more patients receiving $HbA1_c$ testing, 54,788 (CI: 36,667, 73,121) more patients receiving lipid assessment, 58,838 (CI: 41,570, 76,106) more patients receiving nephropathy screening and 11,680 (CI: 5,515, 17,953) more patients receiving statin prescription over 10 years. On average, patients enrolled to FHOs had a 0.197 lower mortality risk score (CI: -0.33, -0.060) (Table 2), suggesting that the risk of dying within one-year was reduced by approximately 0.0124% (CI:

0.0123%, 0.0126%) or 265 (CI: 262, 268) fewer total deaths in FHO physicians' patients. The risk of ACSC hospitalizations was not different between FHG and FHO physicians' patients (Table 2). The corresponding results based on CBPS and EB weighted results were qualitatively similar.

For physicians who were male, female, younger (aged below 55 in 2006), and older (aged 55+ years in 2006), switching to FHO was associated with more $HbA1_c$ testing, lipid assessments, nephropathy screening and statin prescriptions (Table 3, Tables B1.3-B1.6 in Appendix B). While the effect of switching to FHO was slightly higher in male physicians (3.0%) relative to females (1.7%) for $HbA1_c$ testing, lipid assessments (2.6% vs. 2.4%) and nephropathy screenings (2.9% vs. 2.4%), the respective confidence intervals overlapped (Table 3). Similarly, the effect of switching on statin prescription was higher for females compared to males (1.4% vs. 1.0%), but the respective confidence intervals overlapped (Table 3). In the four subgroups of physicians (male, female, young and old), we found no difference for eye examinations and ACEI/ARB prescriptions (Table 3); except for female physicians, we found no difference in patients' risk of ACSC hospitalizations. For female physicians, switching to FHO was associated with a decreased risk of ACSC hospitalizations (relative risk=0.610, CI: 0.403, 0.912) (Table 3), and this finding was corroborated by both CBPS and EB results (Table B1.4 in Appendix B). The effect of switching to FHO was associated with a statistically significant decrease in the mean mortality risk score of patients of male physicians and older physicians; the impact of switching to FHO on mortality risk score was non-significant for physicians who were female or younger (Table 3).

Switching to FHO was associated with an increase in $HbA1_c$ testing, lipid assessment and nephropathy screening for both early and late switching to FHOs compared to those remained in

FHGs. Though the effect on these three care processes was slightly greater for those switched to FHOs earlier, there was considerable overlap in the respective confidence intervals (Table 4, Table B1.7 in Appendix B). The impact of switching to FHO model on statin prescription was associated with a significant increase only for those switched earlier; no effect was observed for those switched later, and these two groups of FHO physicians were statistically similar for ACEI/ARB prescriptions and ACSC hospitalizations. The impact of switching to FHO was associated with a slight decrease in eye examinations only for those switched to FHOs between 2012 and 2013. Significantly lower mortality risk scores for patients were found for those switched to FHOs earlier as well as those switched to FHOs between 2010 and 2011 (Table 4, Table B1.7 in Appendix B).

Discussion

In Ontario, relative to those who remained in a FHG, family physicians who switched to the FHO model had an increase in $HbA1_c$ testing, lipid assessment, nephropathy screening, and statin prescription for individuals with diabetes. Patients of these FHO physicians had a lower mortality risk compared to patients of physicians who remained in FHG. However, FHO and FHG physicians were not different in terms of annual eye examinations, ACEI/ARB prescription and patients' risk of ACSC hospitalizations. Patients of physicians who switched to FHO between 2012 and 2013 had slightly fewer eye examinations than FHG physicians' patients; patients of female FHOs, on average, had marginally lower ACSC hospitalizations relative to FHG physicians' patients. We also implemented a before-and-after analysis using only those switched to FHO model, and these results were in the similar direction with relatively higher effects compared to our main analysis (Table B1.8 in Appendix B).

Our study has various strengths. Compared to previous literature, our identification strategy allows for stronger conclusions. For instance, the studies by Kiran et al. (2014) and Jaakkimainen et al. (2011) compared care quality in different payment models using cross-sectional regressions and did not account for time-invariant physician-specific confounding; nor did these studies address potential selection into physician practice models. Our two groups of practice models were based on similar observed characteristics and outcomes at the baseline; in our study, blended capitation and blended FFS each constituted only one practice model, unlike Kiran et al. (2014) where, blended capitation included FHOs and Family Health Networks. Our longer follow-up period allowed physicians time to adjust to the new remuneration scheme, arguably capturing a more accurate measure of physicians' behaviour in these models.

Our study has some limitations. Although laboratory services identified through OHIP include services provided in hospitals, it may not be captured completely. It is possible that some patients were given a laboratory requisition but they did not follow through. For the prescription-based process indicators, the information in the Ontario Drug Benefit database captures patients' records of prescriptions filled by patients who are aged 65 years or older. It is possible, therefore, that a physician prescribed medications which the patient did not fill; moreover, we could not capture the prescriptions of those under 65 years of age [43]. A proportion of FHO physicians are also part of the family health team and the effects found in our study can be interpreted as the combined effect of blended capitation and team-based primary care. While process and outcome indicators are established metrics for measuring care quality [44–46], they have limitations: more testing and prescriptions are not always synonymous with better care, and health outcomes such as risk of mortality and hospitalization can be influenced by factors beyond physician (life style choices and economic circumstances). Our identification strategy that combines propensity-score

based weights with fixed-effects regression cannot definitively confirm a causal effect of remuneration on quality of care because of the potential for residual confounding. Nonetheless, including the expected income gain of switching to FHO and its squared term along with a rich set of physician- and patient-characteristics in the propensity score model combined with the inverse-probability-weighted fixed-effects regressions arguably minimize the influence of residual confounding.

Our work suggests important positive influences of P4P incentives for diabetes management in a blended capitation payment system, consistent with some of the findings of previous work. We can explain some of the discrepancies between our paper and those of other papers. For instance, our conclusions for eye examinations are inconsistent with Kiran et al. (2014) [17]; their study was based on data over two years (2006-2008), while ours used a decade of data. Our inverse-probability-weighted strategy accounts for potential differences between the two groups before switching to FHO. Finally, policy-level factors can reconcile the discrepancy between Kiran et al. (2014) and our study. Prior to November 1st, 2004, retinal examinations were covered by the OHIP for Ontario residents of any age, but, after that date it was delisted with the exception of individuals with diabetes. The delisting of eye examination for non-diabetes patients was associated with unintended consequences of decline in eye examination for persons with diabetes [47].

In the absence of randomization, propensity score based inverse-probability-weighted fixed-effects regressions is a reasonable approach to identify associations that are closer to causal. With this identification strategy on a balanced panel of family physicians spanning over a decade, our study provides stronger empirical evidence that the switching of Ontario's family physicians from Family Health Groups to Family Health Organizations increased physicians'

adherence to many process measures for diabetes management. Future studies can use Ontario's natural experiment setting to investigate the effect of physicians' switching from a blended FFS to a blended capitation model on quality of care indicators for other patient populations.

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Table 1 Means and standardized bias results before and after kernel weighting

Covariate	Means and standardized bias prior to kernel weighting					Means and standardized bias after kernel weighting				
	FHO	**FHG**	**Bias**	**t-statistic**	**p-value**	**FHO**	**FHG**	**Bias**	**t-statistic**	**p-value**
Physicians' characteristics										
Expected income gain (in thousand $)	137.13	108.15	34.3	24.74	0	137.13	137.21	-0.1	-0.02	0.98
(Expected income gain)^2	25022	19737	17.1	12.19	0	25022	25294	-0.9	-0.23	0.82
Age (years)	54.43	56.55	-23.2	-16.56	0	49.93	50.43	-5.5	-1.5	0.14
Age^2	3041.9	3283.5	-23.8	-17.01	0	2564.1	2614.2	-4.9	-1.49	0.14
Female (proportion)	0.27	0.26	1.2	0.84	0.4	0.27	0.26	0.8	0.2	0.85
IMG (proportion)	0.13	0.22	-24.6	-17.92	0	0.13	0.13	-0.2	-0.05	0.97
Group size	31.65	54.04	-35.1	-25.7	0	39.33	41.31	-3.1	-0.89	0.38
Number of enrolled patients	1744.6	1856.3	-14.7	-10.7	0	1811.5	1802.1	1.2	0.33	0.75
Patients' characteristics										
Female (proportion)	0.52	0.51	4.8	3.44	0.01	0.52	0.52	0.8	0.19	0.85
Rural areas (proportion)	0.11	0.06	28	19.26	0	0.11	0.11	-1.1	-0.22	0.83
Average age (in years)	42.56	41.67	15.3	10.93	0	40.25	40.38	-2.2	-0.6	0.55
Low income quintile (proportion)	0.36	0.4	-26.6	-19.08	0	0.37	0.38	-2.9	-0.77	0.44
Average ADG	3.23	3.39	-38.7	-27.74	0	3.34	3.34	-0.8	-0.2	0.85

Outcome variables

$HbA1_c$ testing (proportion)	0.61	0.59	15	10.68	0	0.57	0.56	5.7	1.37	0.17
Lipid assessment (proportion)	0.57	0.57	0.3	0.18	0.86	0.55	0.54	6.8	1.65	0.1
Nephropathy screening (proportion)	0.66	0.64	13.4	9.5	0	0.64	0.63	4.5	1.05	0.3
Eye examination (proportion)	0.05	0.05	-12.7	-9.11	0	0.05	0.05	1.4	0.37	0.72
ACEI or ARB prescription (proportion)	0.65	0.63	16	11.4	0	0.69	0.69	0.2	0.06	0.96
Statin prescription (proportion)	0.71	0.7	10.2	7.32	0	0.66	0.65	4.8	1.08	0.28
Mortality risk score	51.03	49.98	23.6	17.15	0	49.72	49.84	-2.9	-0.74	0.47
ACSC hospitalization	0.162	0.173	-2.3	-1.68	0.094	0.192	0.189	0.8	0.17	0.86

Abbreviations: FHG: Family Health Group, FHO: Family Health Organization, IMG: International Medical Graduate, ADG: Aggregated Diagnosis Groups (Johns Hopkins), $HbA1_c$: glycated hemoglobin, ACEI: Angiotensin converting enzyme inhibitors, ARB: Angiotensin II receptor blocker, ACSC: ambulatory care sensitive condition due to diabetes.
FHO represents physicians who switched from FHG to FHO at any point within the observation period; FHG represents physicians who remained in a FHG model throughout the study period.

Table 2 Effect of switching to FHO on process of care and health outcomes for persons with diabetes mellitus

Outcome variable[a]	Pooled		Fixed-effects	
	Unweighted	**Kernel**	**Unweighted**	**Kernel**
$HbA1_c$ testing (%)	3.86***	4.00***	2.62***	2.75***
	(2.58 - 5.15)	(2.23 - 5.77)	(1.95 - 3.29)	(1.89 - 3.60)
Lipid assessment (%)	3.09***	4.25***	2.67***	2.57***
	(1.85 - 4.32)	(2.58 - 5.93)	(2.00 - 3.34)	(1.72 -3.43)
Nephropathy screening (%)	3.85***	4.07***	2.73***	2.76***
	(2.65 - 5.06)	(2.36 - 5.78)	(2.09 - 3.37)	(1.95 - 3.57)
Eye examination (%)	-0.0912	0.412**	0.0196	-0.0622
	(-0.429 - 0.247)	(0.0901 - 0.734)	(-0.162 - 0.201)	(-0.240 - 0.115)
ACEI or ARB prescription (%)	0.757**	0.251	-0.221	0.403
	(9.87e-03 - 1.50)	(-0.635 - 1.14)	(-0.730 - 0.288)	(-0.199 - 1.01)
Statin prescription (%)	2.09***	1.38***	0.926***	1.08***
	(1.28 - 2.90)	(0.397 - 2.36)	(0.441 - 1.41)	(0.508 - 1.66)
Mean mortality risk score	0.0628	-0.207	-0.384***	-0.197***
	(-0.161 - 0.287)	(-0.495 - 0.0806)	(-0.497 - -0.270)	(-0.334 - -0.0597)

Risk ACSC hospitalization	1.069	1.008	0.998	1.004
	(0.960 - 1.192)	(0.883 - 1.151)	(0.865 - 1.152)	(0.850 - 1.186)

Abbreviations: OLS: ordinary least squares, $HbA1_c$: glycated hemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker, FHO: Family Health Organization; ACSC: ambulatory care sensitive condition, FHO: Family Health Organization

Notes:

*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses.

[a]This table reports the average marginal effects of a physician's switch from FHG to FHO on processes of care. For example, results show that switching from FHG to FHO increases a physician's ordering at least one $HbA1_c$ test by 2.75% per physician per year. This table also reports patients' risk of diabetes-related ACSC hospitalization and patients' mean mortality risk score of those who switched from FHG to FHO.

Table 3 Effect of switching to FHO on process of diabetes care and patients' health outcomes for various subgroups of physicians

Outcome variable[a]	**Subgroup**			
	Male	**Female**	**Younger**	**Older**
$HbA1_c$ testing (%)	3.03***	1.68**	2.08***	3.67***
	(2.01 - 4.06)	(0.287 - 3.07)	(0.983 - 3.19)	(2.12 - 5.22)
Lipid assessment (%)	2.59***	2.38***	2.26***	3.00***
	(1.58 - 3.60)	(0.859 - 3.90)	(1.14 - 3.37)	(1.44 - 4.55)
Nephropathy screening (%)	2.91***	2.43***	2.36***	3.29***
	(1.85 - 3.96)	(1.02 - 3.84)	(1.32 - 3.41)	(1.80 - 4.78)
Eye examination (%)	-0..118	0.104	-0.142	0.0515
	(-0.323 - 0.0865)	(-0.238 - 0.446)	(-0.354 - 0.0702)	(-0.260 - 0.363)
ACEI or ARB prescription (%)	0.285	0.612	0.491	0.135
	(-0.382 - 0.951)	(-0.742 - 1.97)	(-0.273 - 1.26)	(-0.823 - 1.09)
Statin prescription (%)	0.942***	1.40**	0.822**	1.41***
	(0.311 - 1.57)	(0.166 - 2.64)	(0.0936 - 1.55)	(0.516 - 2.31)
Mean mortality risk score	-0.252***	-0.069	-0.134	-0.321***
	(-0.412 - -0.0920)	(-0.331 - 0.193)	(-0.306 - 0.0386)	(-0.537 - -0.104)
Risk of ACSC hospitalization	1.089	0.610**	0.991	1.055

	(0.910 - 1.304)	(0.403 - 0.921)	(0.799 - 1.229)	(0.811 - 1.373)
n	15,660	5,540	13,510	7,690

Abbreviations: HbA1c: glycated hemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker, FHO: Family Health Organization, ACSC: ambulatory care sensitive condition due to diabetes, n: physician-year observations.
Notes:
Only results from kernel weighted fixed effects regression are reported in this table
*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses.
[a] For the four subgroups of physicians, this table reports the average marginal effects of a physician's switch from FHG to FHO on processes of care. This table also reports patients' risk of diabetes-related ACSC hospitalization and patients' mean mortality risk score under the four subgroups of physicians switched to FHOs and those remained in FHGs.

Table 4 Effect of switching to FHO on process of diabetes care and patients' health outcomes for different cohorts of physicians switching to FHOs

Outcome variable[a]	switched between 2008 and 2009	switched between 2010 and 2011	switched between 2012 and 2013	switched between 2014 and 2015
$HbA1_c$ testing (%)	2.70***	1.30***	2.07***	0.552
	(1.98 - 3.41)	(0.472 - 2.13)	(0.857 - 3.29)	(-1.68 - 2.78)
Lipid assessment (%)	2.88***	1.20***	1.18*	0.314
	(2.13 - 3.63)	(0.339 - 2.07)	(-0.129 - 2.49)	(-2.06 - 2.69)
Nephropathy screening(%)[b]	2.60***	1.51***		
	(1.89 - 3.30)	(0.727 - 2.29)		
Eye examination (%)	-0.081	-0.242	-0.455***	0.313
	(-0.269 - 0.107)	(-0.536 - 0.0509)	(-0.748 - -0.162)	(-0.0869 - 0.713)
ACEI or ARB prescription (%)	-0.0265	0.11	0.106	0.791
	(-0.561 - 0.508)	(-0.535 - 0.755)	(-0.719 - 0.932)	(-0.352 - 1.93)
Statin prescription (%)	1.51***	0.336	-0.683	-0.403
	(1.03 - 1.99)	(-0.261 - 0.934)	(-1.50 - 0.132)	(-1.35 - 0.545)
Mean mortality risk score	-0.375***	-0.364***	-0.159	0.0853
	(-0.503 - -0.247)	(-0.514 - -0.214)	(-0.373 - 0.0542)	(-0.179 - 0.350)
Risk of ACSC hospitalization	1.089	0.923	1.158	0.977

	(0.910 - 1.302)	(0.699 - 1.218)	(0.700 - 1.917)	(0.369 - 2.588)
n	19,071	11,410	5,840	2,991

Abbreviations: $HbA1_c$: glycated hemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker, FHO: Family Health Organization, ACSC: ambulatory care sensitive condition, n: sample size

Notes:

*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in Xit, 95% confidence interval in parentheses.

-Only results from kernel weighted fixed effects regression are reported in this table.

[a] This table reports the average marginal effects of a physician switching from FHG to FHO in each cohort of physicians switching to FHOs on processes of care relative to those remained in FHGs. This table also reports patients' risk of diabetes-related ACSC hospitalizations and patients' mean mortality risk of each cohort of physicians switching to FHOs relative to those remained in FHGs.

[b] Estimates for nephropathy screening could not be computed for physicians who switched as of 2012 because the main independent variable predicted outcome perfectly.

Appendix A

A1.1 Schematic for creation of study population

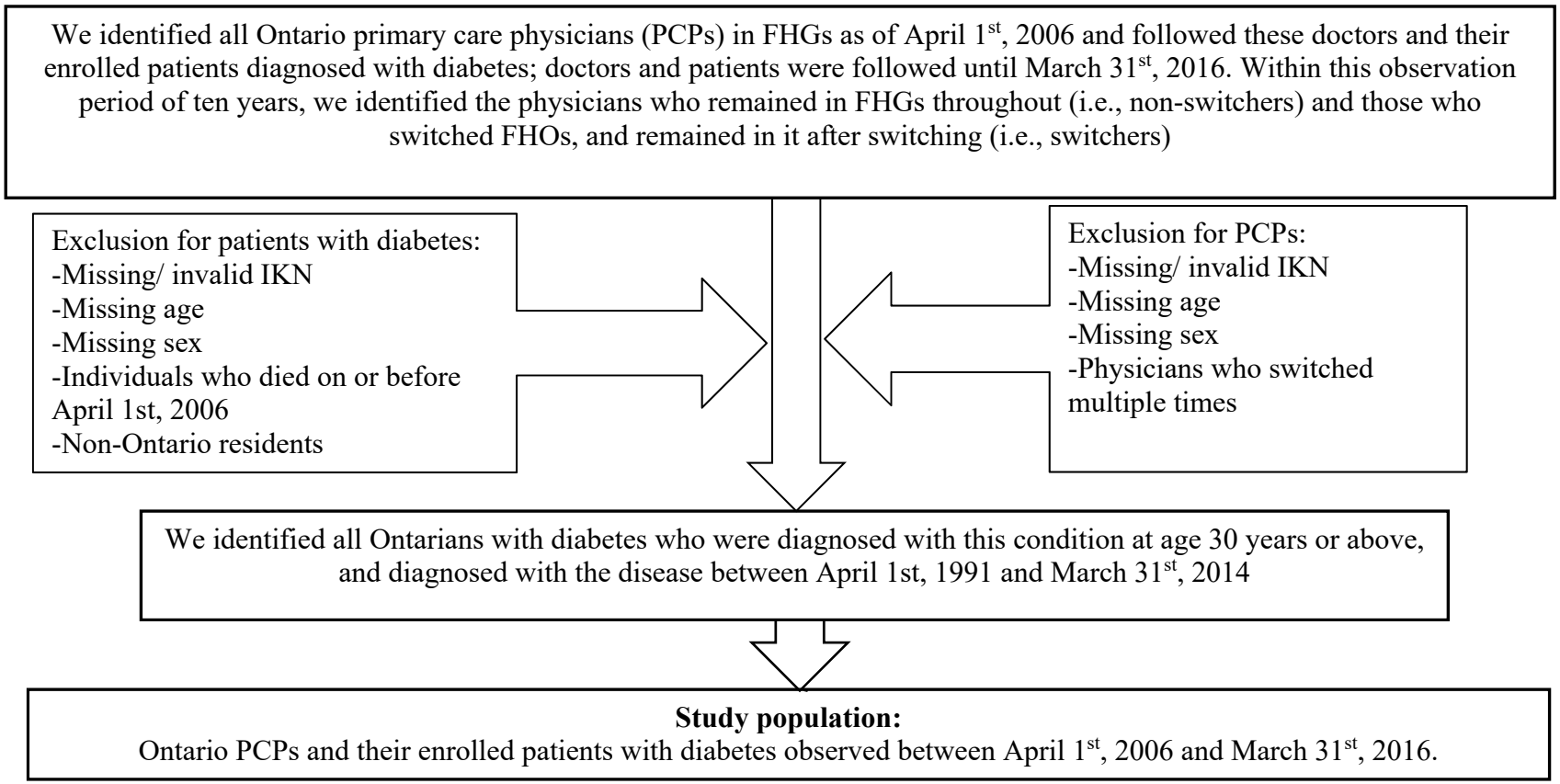

Figure A1.1 Schematic for creation of study population.

A1.2 Data sources for variables

The Client Agency Program Enrollment (CAPE) database records patients registered with a physician who practices in any of the patient enrolment models [1]; we used CAPE to identify patients who are either enrolled with a FHG or FHO physician. We used the Ontario Diabetes Dataset (ODD) to identify individuals diagnosed with diabetes mellitus; ODD is a registry of Ontarians diagnosed with diabetes mellitus since 1991. The algorithm for identifying individuals with diabetes in the ODD is the occurrence of the following within two years: at least one hospital discharge with a diabetes diagnosis or at least two physician service claims with a diabetes diagnosis. ODD had been validated and has a sensitivity of 86.1%, a specificity of 97.1% and a positive predictive value of 80% [2,3]. While ODD excludes individuals with gestational diabetes, ODD does not distinguish between type 1 and type 2 diabetes mellitus; nevertheless, the vast majority of individuals identified in ODD would be persons with type 2 diabetes [4]. Demographic information, such as sex, date of birth, and payment model type for primary care physicians are obtained from the Corporate Provider Database (CPDB) [5,6]. The Canadian Institute for Health Information - Hospital Discharge Abstract Database (CIHI-DAD or simply DAD) contains clinical and administrative inpatient information for individuals who are discharged from hospitals. As of 2002, DAD uses the 10th revision of the International Classification of Diseases (ICD-10) [1,7]. We used DAD for identifying ACSC hospitalizations due to diabetes mellitus. The ICES Physician Database (IPDB) contains encrypted physician numbers, yearly demographic information, and some practice characteristics on all physicians in Ontario. We used IPDB to identify physicians' characteristics, including age, sex, year of graduation, and country of medical education (i.e., international medical graduate or Canadian medical graduate). The Canadian Institutes for Health Information-National Ambulatory Care Reporting System (CIHI-

NACRS or simply NACRS) contains information on outpatient visits to hospital and community-based ambulatory care facilities such as emergency departments [1,7]. We used information from OHIP, DAD and NACRS for mortality risk score. The Ontario Drug Benefit Claims Database (ODB) contains claims data for prescription medications covered by the Ontario Drug Benefit Program, which is a provincial program that provides coverage for various prescription medications to Ontarians aged 65 years and above, as well as to social assistance recipients [7]. We used ODB for identifying prescription-based process measures (i.e., ACEI/ARB and statin prescriptions). The Ontario Health Insurance Plan Database (OHIP) contains claims data of all insured services provided by licensed healthcare providers (including primary care physicians) to Ontario residents eligible for the provincial healthcare coverage. Information recorded under OHIP includes the type of service provided, the person who provided the service, the person who received the service, the date the service was provided, and the fee code(s) associated with the service [1,7]. We used OHIP to identify laboratory-based process measures (i.e., $HbA1_c$ testing, lipid assessment, nephropathy screening and eye examination). The Registered Persons Database (RPDB) is a registry that houses demographic information for Ontarians with provincial healthcare coverage; the information includes individuals' sex, date of birth, and date of death [1,7]. We used RPDB to identify patients' characteristics, including age and sex. Postal codes from the RPDB is used to obtain census dissemination area level income quantile.

Table A1.1 Eligible patient population and outcome for quality indicators

Quality indicator	Eligible patient population (i.e., denominator)	Outcome (i.e., numerator)
Glycated hemoglobin ($HbA1_c$) testing	For each year, only include patients diagnosed with diabetes and who are alive in that year	For each year, include patients who received $HbA1_c$ testing at least once
	Data sources: ODD, RPDB, OHIP	
Lipid assessment	For each year, only include patients diagnosed with diabetes and who are alive in that year	For each year, include patients who received testing for lipid profile at least once
	Data sources: ODD, RPDB, OHIP	
Nephropathy screening	For each year, only include patients diagnosed with diabetes and who are alive in that year	For each year, include patients who received ACR testing and creatinine testing at least once
	Data sources: ODD, OHIP, RPDB	
Eye examination	For each year, only include patients diagnosed with diabetes and who are alive in that year	For each year, include patients who had retinal eye examination done at least once
	Data sources: ODD, OHIP,RPDB	
Prescription of ACEI or ARBs	For each year, only include patients diagnosed with diabetes and who are alive in that year. Also, only include patients who are aged 65 years or older	For each year, include patients who received a prescription for ACEI or ARB at least once
	Data sources: ODD, ODB, RPDB	

Prescription of statins	For each year, only include patients diagnosed with diabetes and who are alive in that year. Also, only include patients who are aged 65 years or older	For each year, include patients who received a statin prescription at least once
	Data sources: ODB, ODD, RPDB	
Risk of hospitalization for diabetes mellitus as an ambulatory care sensitive condition (ACSC)	For each year: -identify inpatients records from acute care hospitals with diabetes as the most responsible diagnosis -only include diabetes patients who are below 75 years of age -only include diabetes patients who are alive within that year	
	Data sources: DAD, NACRS, ODD	
Mortality risk score	For each year, calculate patients' mortality risk score as per the algorithm by Austin and Walraven (2011) [8]	
	Data Sources: RPDB, OHIP, DAD, NACRS	

Abbreviations: CAPE: Client Agency Program Enrollment Registry, CPDB: Corporate Provider Database, DAD: Canadian Institute for Health Information - Hospital Discharge Abstract Database, ICES: Institute for Clinical Evaluative Sciences, IPDB: ICES Physician Database, NACRS: National Ambulatory Care Reporting System, ODB: Ontario Drug Benefit Claims Database, ODD: Ontario Diabetes Dataset, OHIP: Ontario Health Insurance Plan Database, RPDB: Registered Persons Database, ACSC: ambulatory care sensitive condition, $HbA1_c$: glycated haemoglobin, ACR: albumin-to-creatinine ratio, ACEI: Angiotensin converting enzyme inhibitor, ARB: Angiotensin II receptor blockers

Notes:

The first six outcomes were quantified as proportions; avoidable diabetes-related hospitalizations (i.e., the seventh outcome variable) were quantified as counts, and mortality risk score (i.e., the eighth outcome variable) were quantified as means.

Table A1.2 Codes for identifying diabetes process measures

Variable	**Code(s)***
$HbA1_c$ testing	L093
Lipid testing	L055, L117, L243
Nephropathy screening: creatinine testing	L065,L067,L068
Nephropathy screening: ACR testing	G009, G010, L253, L254
Eye examination	V406, A234, A233, V409, A235, V404, A112, A115, A239, A236, G460, A110, A252, A254, A230, A237, G461, A250, A111, A114

Note:
*The code(s) correspond to fee codes in the Ontario Health Insurance Plan (OHIP) database
Abbreviation: ACR: Albumin-to-Creatinine Ratio, $HbA1_c$: glycated hemoglobin

Table A1.3 ICD-10-CA codes for ACSC hospitalization due to diabetes mellitus

Codes	E10.0, E10.1^, E.10.9, E11.9, E13.0, E13.9, E14.0, E14.63, E14.9, E11.0^, E11.1^, E13.0^, E13.1^, E14.0^, E14.1^, E10.2^, E10.3^, E10.4^, E10.5^, E10.6^, E10.7^, E11.2^, E11.3^, E11.4^, E11.5^, E11.6^, E11.7^, E13.2^, E13.3^, E13.4^, E13.5^, E13.6^, E13.7^, E14.2^, E14.3^, E14.4^, E14.5^, E14.6^, E14.7^

Abbreviation: ICD-10-CA: International Classification of Diseases and Related Health Problems (10th edition), Canada, ACSC: ambulatory care sensitive condition.
References: https://www150.statcan.gc.ca/n1/pub/82-622-x/2011007/definition-eng.htm , http://cmajopen.ca/content/suppl/2017/10/06/5.4.E746.DC1/2017-0007-2-at.pdf

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Appendix B

Table B1.0 Mean values of outcome and explanatory variables for the switchers (n= 1,291) and non-switchers (n= 829)

Variable	Switcher	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Outcome variables											
$HbA1_c$ testing	0	0.548	0.555	0.579	0.585	0.593	0.596	0.578	0.593	0.596	0.59
	1	0.563	0.57	0.592	0.603	0.617	0.621	0.606	0.625	0.634	0.63
Lipid assessment	0	0.557	0.563	0.57	0.571	0.58	0.576	0.546	0.557	0.556	0.542
	1	0.545	0.553	0.563	0.571	0.583	0.583	0.551	0.563	0.563	0.548
Nephropathy screening	0	0.627	0.629	0.64	0.642	0.647	0.648	0.627	0.637	0.634	0.627
	1	0.631	0.637	0.647	0.658	0.67	0.676	0.655	0.666	0.667	0.663
Eye examination	0	0.059	0.054	0.051	0.048	0.049	0.046	0.043	0.043	0.042	0.043
	1	0.049	0.045	0.045	0.043	0.043	0.041	0.038	0.039	0.037	0.038
ACEI or ARB prescription	0	0.66	0.66	0.652	0.641	0.641	0.621	0.607	0.6	0.591	0.585
	1	0.682	0.68	0.67	0.656	0.653	0.636	0.622	0.616	0.607	0.604
Statin prescription	0	0.636	0.66	0.679	0.695	0.708	0.712	0.712	0.717	0.718	0.722
	1	0.654	0.681	0.696	0.712	0.72	0.723	0.721	0.721	0.722	0.724
Mortality risk score	0	48.39	48.59	48.91	49.27	49.63	50	50.37	50.86	51.47	52.3
	1	49.72	49.83	50.09	50.44	50.67	51.08	51.4	51.77	52.26	53.09
ACSC hospitalization	0	0	0.179	0.174	0.141	0.195	0.189	0.193	0.187	0.162	0.141
	1	1	0.192	0.160	0.136	0.182	0.161	0.175	0.139	0.143	0.177
Physician characteristics [a]											
Age (in years)	0	52.042	53.042	54.042	55.042	56.042	57.042	58.042	59.042	60.042	61.042
	1	49.925	50.925	51.925	52.925	53.925	54.925	55.925	56.925	57.925	58.925

Female (proportion)	0	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259
	1	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264
Group size	0	50.057	50.016	62.162	64.868	62.956	56.536	52.222	50.489	46.602	44.441
	1	39.323	39.313	49.644	47.059	39.138	25.316	21.216	20.8	17.88	16.808
IMG (proportion)	0	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
	1	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128
Number of enrolled patients	0	1858	1930	1938	1932	1895	1870	1843	1800	1772	1731
	1	1812	1864	1861	1811	1772	1739	1703	1665	1634	1591
Patients' characteristics											
Female (proportion)	0	0.514	0.512	0.51	0.508	0.506	0.505	0.504	0.504	0.503	0.501
	1	0.516	0.514	0.513	0.513	0.512	0.511	0.511	0.51	0.509	0.507
Rural (proportion)	0	0.052	0.051	0.051	0.051	0.051	0.051	0.052	0.052	0.052	0.053
	1	0.103	0.102	0.102	0.102	0.101	0.101	0.101	0.101	0.101	0.101
Mean age (in years)	0	39.317	39.795	40.301	40.769	41.276	41.829	42.406	43.056	43.645	44.228
	1	40.25	40.677	41.129	41.69	42.213	42.777	43.358	43.953	44.504	45.036
Low income quintile (proportion)	0	0.41	0.403	0.398	0.394	0.391	0.389	0.387	0.386	0.383	0.377
	1	0.366	0.362	0.357	0.354	0.35	0.349	0.348	0.347	0.345	0.339
ADG	0	3.411	3.38	3.315	3.382	3.418	3.407	3.451	3.394	3.354	3.388
	1	3.337	3.295	3.23	3.279	3.268	3.232	3.243	3.149	3.103	3.121

Abbreviations: IMG: International Medical Graduate, ADG: Aggregated Diagnosis Groups (Johns Hopkins), ACSC: ambulatory care sensitive condition, $HbA1_c$: glycated haemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker

Notes:

0=non-switchers, 1=switchers

[a] Expected income gain for switchers and non-switchers, in 2006, were 137,133 and 108,148 dollars, respectively

Table B1.1 Results from Covariate Balancing Propensity Score weighting

	Means and standardized bias after CBPS weighting				
	FHO	FHG	Bias reduction	t-statistic	p-value
Physician's characteristics					
Expected income gain (in thousand $)	137.13	137.13	100	0	1
(Expected income gain)^2	25022	25022	100	0	1
Age (years)	49.924	49.924	100	0	1
Age^2	2564.1	2564.1	100	0	1
Female (%)	0.26336	0.26336	100	0	1
IMG (%)	39.322	39.322	100	0	1
Group size	0.12703	0.12703	100	0	1
Number of enrolled patients	1811.5	1811.5	100	0	1
Patients' characteristics					
Female (%)	0.51563	0.51563	100	0	1
Rural areas (%)	0.10259	0.10259	100	0	1
Average age (in years)	40.249	40.249	100	0	1
Low income quintile (%)	0.36592	0.36593	100	0	1
Average ADG	3.3363	3.3363	100	0	1
Outcome variables					
HbA1c testing	0.56204	0.56204	100	0	1
Lipid assessment	0.54453	0.54453	100	0	1
Nephropathy screening	0.63066	0.63066	100	0	1
Eye examination	0.04893	0.04893	100	0	1
ACEI or ARB prescription	0.68157	0.68157	100	0	1
Statin prescription	0.65352	0.65352	100	0	1
Mortality risk score	49.711	49.711	100	0	1
ACSC hospitalization due to diabetes	0.192	0.192	100	0	1

Abbreviations: FHG: Family Health Group, FHO: Family Health Organization, IMG: International Medical Graduate, ADG: Aggregated Diagnosis Groups (Johns Hopkins), ACSC: ambulatory care sensitive condition, CBPS: covariate balancing propensity score, $HbA1_c$: glycated haemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker

FHO represents physicians who switched from FHG to FHO at any point within the observation period; FHG represents physicians who remained in a FHG model throughout the observation period.

Table B1.2 Results from Entropy Balancing weighting

	Means and standardized bias after EB weighting				
	FHO	FHG	Bias reduction	t-statistic	p-value
Physician's characteristics					
Expected income gain (in thousand $)	137.13	137.14	100	0	0.997
(Expected income gain)^2	25022	25022	100	0	1
Age (years)	49.924	49.925	100	0	0.998
Age^2	2564.1	2564.2	100	0	0.998
Female (%)	0.26336	0.26323	97.5	0.01	0.994
IMG (%)	39.322	39.323	100	0	1
Group size	0.12703	0.12696	99.9	0.01	0.995
Number of enrolled patients	1811.5	1811.6	99.9	0	0.999
Patients' characteristics					
Female (%)	0.51563	0.51564	99.6	0	0.998
Rural areas (%)	0.10259	0.10259	100	0	1
Average age (in years)	40.249	40.25	99.9	0	0.997
Low income quintile (%)	0.36592	0.36593	100	0	0.999
Average AGD	3.3363	3.3364	99.9	0	0.997
Outcome variables					
HbA1c testing	0.56204	0.56205	99.9	0	0.999
Lipid assessment	0.54453	0.54454	99.9	0	0.999
Nephropathy screening	0.63066	0.63067	99.7	0	0.999
Eye examination	0.04893	0.04893	100	0	1
ACEI or ARB prescription	0.68157	0.68158	99.9	0	0.997

Statin prescription	0.65352	0.65354	99.9	0	0.998
Mortality risk score	49.711	49.712	99.9	-0.01	0.995
ACSC hospitalization due to diabetes	0.192	0.192	100	0	1

Abbreviations: FHG: Family Health Group, FHO: Family Health Organization, IMG: International Medical Graduate, ADG: Aggregated Diagnosis Groups (Johns Hopkins), EB: entropy balancing, $HbA1_c$: glycated haemoglobin, ACEI: Angiotensin converting enzyme inhibitor, ARB: Angiotensin II receptor blockers

FHO represents physicians who switched from FHG to FHO at any point within the observation period; FHG represents physicians who remained in a FHG throughout the observation period.

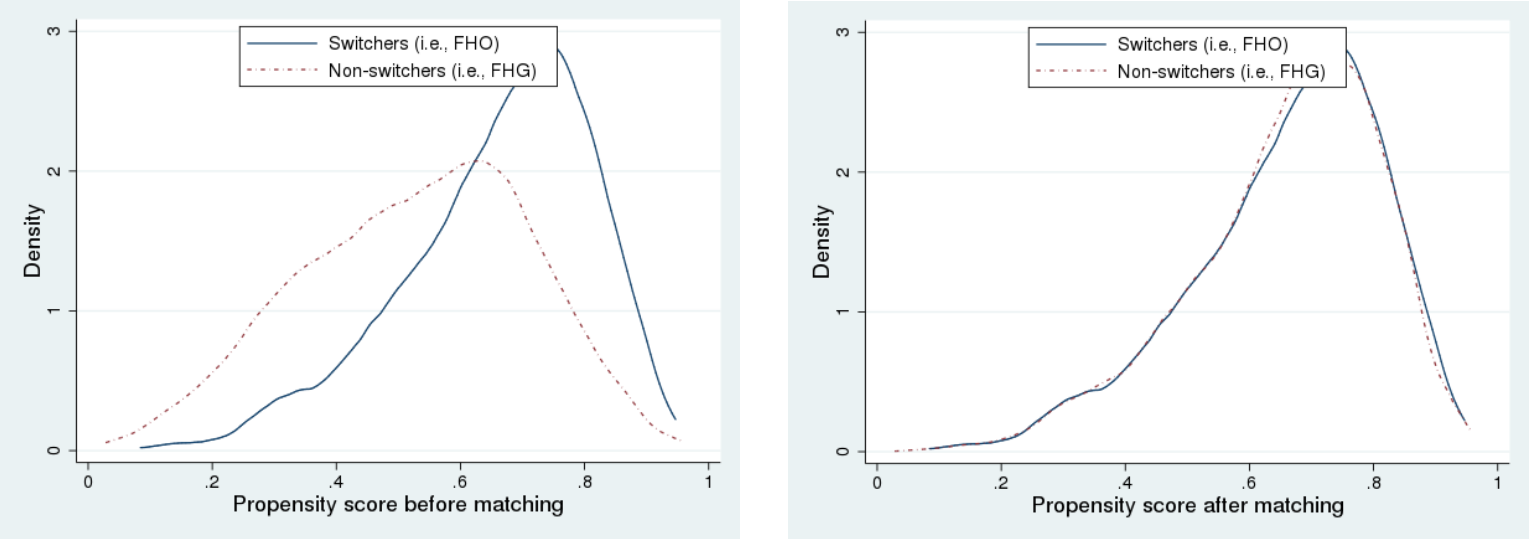

Figure B.1 Distribution of propensity scores before and after kernel weighting.

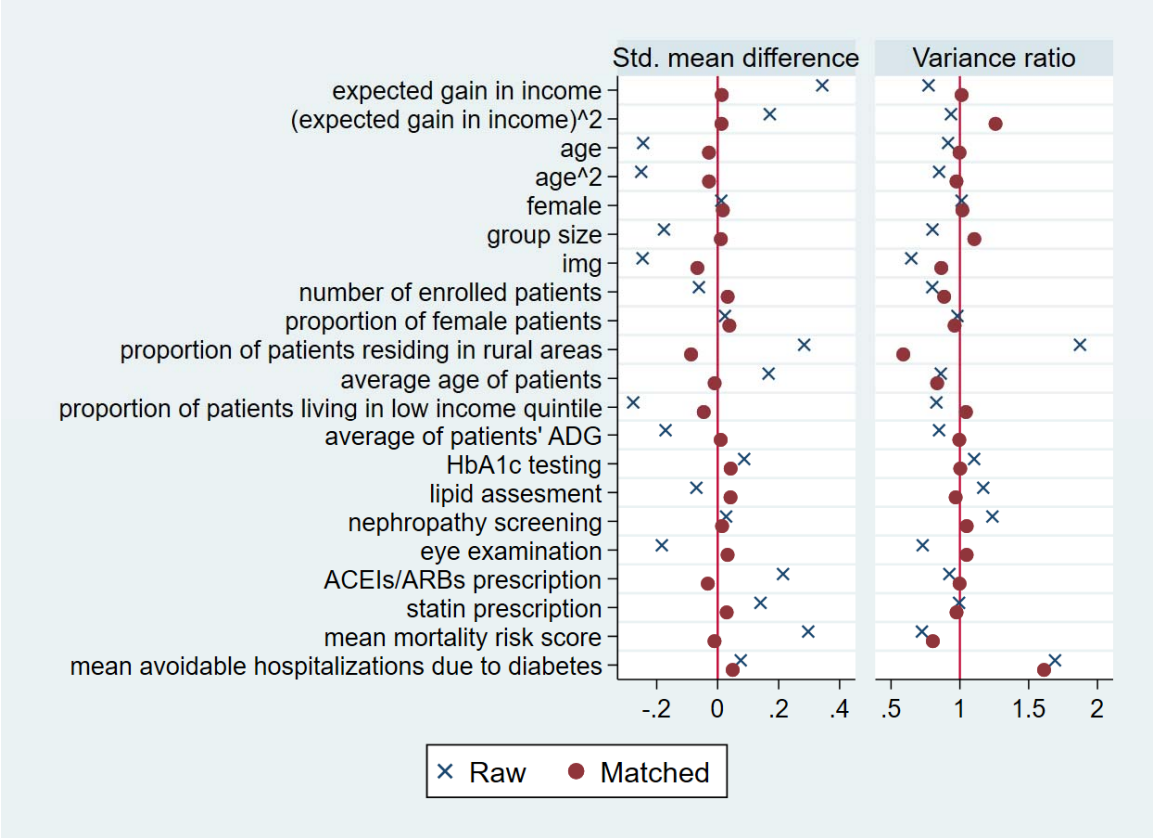

Figure B.2 Standardized mean difference and variance ratio for covariates from the unmatched (i.e., raw) and matched samples.
Abbreviations: IMG: International Medical Graduate, ADG: Aggregated Diagnosis Groups (Johns Hopkins), $HbA1_c$: glycated hemoglobin, ACEI: Angiotensin converting enzyme inhibitors, ARB: Angiotensin II receptor blocker, ACSC: ambulatory care sensitive condition

Table B1.3 Effect of switching to FHO on process of diabetes care and patients' health outcomes, for male physicians

Outcome Variable	Unweighted	Kernel	CBPS	EB
$HbA1_c$ testing				
	0.0248***	0.0259***	0.0261***	0.0256***
	(0.0168 - 0.0327)	(0.0158 - 0.0360)	(0.0159 - 0.0363)	(0.0140 - 0.0373)
Lipid assessment				
	0.0248***	0.0259***	0.0261***	0.0256***
	(0.0168 - 0.0327)	(0.0158 - 0.0360)	(0.0159 - 0.0363)	(0.0140 - 0.0373)
Nephropathy screening				
	0.0266***	0.0291***	0.0284***	0.0305***
	(0.0184 - 0.0348)	(0.0185 - 0.0396)	(0.0179 - 0.0389)	(0.0180 - 0.0430)
Eye examination				
	-0.000222	-0.00118	-0.000974	-0.000351
	(-0.00227 - 0.00183)	(-0.00323 - 0.000865)	(-0.00301 - 0.00107)	(-0.00265 - 0.00195)
ACEI or ARB prescription				
	-0.00439	0.00285	0.0037	0.00688*
	(-0.0101 - 0.00131)	(-0.00382 - 0.00951)	(-0.00300 - 0.0104)	(-0.000370 - 0.0141)
Statin prescription				
	0.00815***	0.00942***	0.00994***	0.0114***
	(0.00279 - 0.0135)	(0.00311 - 0.0157)	(0.00377 - 0.0161)	(0.00400 - 0.0188)
Mortality risk score				
	-0.425***	-0.252***	-0.211**	-0.346***
	(-0.556 - -0.293)	(-0.412 - -0.0920)	(-0.403 - -0.0199)	(-0.510 - -0.182)
ACSC hospitalization due to diabetes	1.081	1.089	1.115	1.098
	(0.926 - 1.262)	(0.910 - 1.304)	(0.931 - 1.336)	(0.884 - 1.365)

Notes:
*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses; effects and corresponding 95% CI are reported as proportions.
Abbreviations: OLS: ordinary least squares, FE: fixed effects, CBPS: covariate balancing propensity score, EB: entropy balancing, FHO: Family Health Organization; ACSC: ambulatory care sensitive condition, FHO: Family Health Organization, $HbA1_c$: glycated haemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker

Table B1.4 Effect of switching to FHO on process of diabetes care and patients' health outcome, for female physicians

Outcome variable	Unweighted	Kernel	CBPS	EB
$HbA1_c$ testing				
	0.0190***	0.0168**	0.0160**	0.0223***
	(0.00650 - 0.0316)	(0.00287 - 0.0307)	(0.00213 - 0.0299)	(0.00736 - 0.0372)
Lipid assessment				
	0.0307***	0.0238***	0.0238***	0.0277***
	(0.0188 - 0.0426)	(0.00859 - 0.0390)	(0.00914 - 0.0385)	(0.0139 - 0.0416)
Nephropathy screening				
	0.0297***	0.0243***	0.0239***	0.0289***
	(0.0181 - 0.0413)	(0.0102 - 0.0384)	(0.0102 - 0.0376)	(0.0159 - 0.0420)
Eye examination				
	0.00169	0.00104	0.00129	-0.00105
	(-0.00195 - 0.00533)	(-0.00238 - 0.00446)	(-0.00220 - 0.00478)	(-0.00615 - 0.00404)
ACEI or ARB prescription				
	0.00347	0.00612	0.0059	-0.00322
	(-0.00745 - 0.0144)	(-0.00742 - 0.0197)	(-0.00764 - 0.0194)	(-0.0303 - 0.0238)
Statin prescription				
	0.0115**	0.0140**	0.0145**	0.0166**
	(0.000954 - 0.0221)	(0.00166 - 0.0264)	(0.00218 - 0.0268)	(0.00382 - 0.0294)
Mortality risk score				
	-0.285**	-0.069	-0.108	0.0685
	(-0.515 - -0.0540)	(-0.331 - 0.193)	(-0.367 - 0.151)	(-0.357 - 0.494)
ACSC hospitalization due to diabetes	0.612**	0.610**	0.621**	0.608**
	(0.417 - 0.897)	(0.403 - 0.921)	(0.413 - 0.932)	(0.406 - 0.910)

Notes:
*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses; effects and corresponding 95% CI are reported as proportions. Abbreviations: OLS: ordinary least squares, FE: fixed effects, CBPS: covariate balancing propensity score, EB: entropy balancing, FHO: Family Health Organization; ACSC: ambulatory care sensitive

condition, FHO: Family Health Organization, $HbA1_c$: glycated haemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker

Table B1.5 Effect of switching to FHO on process of diabetes care and patients' health outcome, for physicians aged below 55 years

Outcome variable	Unweighted	Kernel	CBPS	EB
$HbA1_c$ testing	0.0184***	0.0208***	0.0196***	0.0235***
	(0.00988 - 0.0268)	(0.00983 - 0.0319)	(0.00860 - 0.0306)	(0.0129 - 0.0342)
Lipid assessment	0.0225***	0.0226***	0.0217***	0.0237***
	(0.0138 - 0.0311)	(0.0114 - 0.0337)	(0.0103 - 0.0332)	(0.0126 - 0.0349)
Nephropathy screening	0.0222***	0.0236***	0.0222***	0.0278***
	(0.0140 - 0.0304)	(0.0132 - 0.0341)	(0.0116 - 0.0329)	(0.0173 - 0.0382)
Eye examination	-0.00111	-0.00142	-0.00132	-0.00162
	(-0.00321 - 0.000997)	(-0.00354 - 0.000702)	(-0.00346 - 0.000821)	(-0.00432 - 0.00108)
ACEI or ARB prescription	-0.00245	0.00491	0.00464	0.00272
	(-0.00867 - 0.00377)	(-0.00273 - 0.0126)	(-0.00300 - 0.0123)	(-0.00958 - 0.0150)
Statin prescription	0.00569*	0.00822**	0.00820**	0.0115***
	(-0.000380 - 0.0118)	(0.000936 - 0.0155)	(0.00103 - 0.0154)	(0.00350 - 0.0194)
Mortality risk score	-0.314***	-0.134	-0.0885	-0.116
	(-0.453 - -0.175)	(-0.306 - 0.0386)	(-0.287 - 0.110)	(-0.331 - 0.0998)
ACSC hospitalization due to diabetes	0.952	0.991	1.038	1.043

	(0.793 - 1.143)	(0.799 - 1.229)	(0.836 - 1.290)	(0.810 - 1.343)

Notes:
*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses ; effects and corresponding 95% CI are reported as proportions.Abbreviations: OLS: ordinary least squares, FE: fixed effects, CBPS: covariate balancing propensity score, EB: entropy balancing, FHO: Family Health Organization; ACSC: ambulatory care sensitive condition, FHO: Family Health Organization, $HbA1_c$: glycated haemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker

Table B1.6 Effect of switching to FHO on process of diabetes care and patients' health outcome, for physicians aged 55 years and above

Outcome variable	Unweighted	Kernel	CBPS	EB
$HbA1_c$ testing	0.0376***	0.0367***	0.0384***	0.0433***
	(0.0255 - 0.0498)	(0.0212 - 0.0522)	(0.0233 - 0.0536)	(0.0229 - 0.0637)
Lipid assessment	0.0340***	0.0300***	0.0320***	0.0328***
	(0.0218 - 0.0462)	(0.0144 - 0.0455)	(0.0168 - 0.0471)	(0.0136 - 0.0520)
Nephropathy screening	0.0342***	0.0329***	0.0331***	0.0338***
	(0.0226 - 0.0459)	(0.0180 - 0.0478)	(0.0185 - 0.0477)	(0.0141 - 0.0535)
Eye examination	0.00205	0.000515	0.000774	0.00193
	(-0.00125 - 0.00536)	(-0.00260 - 0.00363)	(-0.00236 - 0.00391)	(-0.00154 - 0.00541)
ACEI or ARB prescription	-0.00239	0.00135	0.00319	0.00776
	(-0.0113 - 0.00649)	(-0.00823 - 0.0109)	(-0.00617 - 0.0126)	(-0.00162 - 0.0171)
Statin prescription	0.0150***	0.0141***	0.0158***	0.0150***
	(0.00690 - 0.0230)	(0.00516 - 0.0231)	(0.00702 - 0.0245)	(0.00422 - 0.0259)
Mortality risk score	-0.518***	-0.321***	-0.381***	-0.463***
	(-0.711 - -0.324)	(-0.537 - -0.104)	(-0.591 - -0.172)	(-0.702 - -0.224)
ACSC hospitalization due to diabetes	1.091	1.055	1.051	1.016
	(0.863 - 1.380)	(0.811 - 1.373)	(0.809 - 1.365)	(0.751 - 1.375)

Notes:

*** $p<0.01$; ** $p<0.05$; * $p<0.1$, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses; effects and corresponding 95% CI are reported as proportions.
Abbreviations: OLS: ordinary least squares, FE: fixed effects, CBPS: covariate balancing propensity score, EB: entropy balancing, FHO: Family Health Organization; ACSC: ambulatory care sensitive condition, FHO: Family Health Organization, $HbA1_c$: glycated haemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker

Table B1.7 Effect of switching to FHO on process of diabetes care and patients' health outcome, for physicians who switched in between 2008 & 2009, 2010 & 2011, 2012 & 2013 and 2014 &2015

switched in between 2008 & 2009 (N=19,071)

Outcome variable	**Unweighted**	**Kernel**	**CBPS**	**EB**
$HbA1_c$ testing	0.0252***	0.0270***	0.0275***	0.0358***
	(0.0186 - 0.0318)	(0.0198 - 0.0341)	(0.0204 - 0.0347)	(0.0243 - 0.0472)
Lipid assessment	0.0244***	0.0288***	0.0284***	0.0353***
	(0.0177 - 0.0311)	(0.0213 - 0.0363)	(0.0209 - 0.0360)	(0.0236 - 0.0471)
Nephropathy screening	0.0247***	0.0260***	0.0260***	0.0324***
	(0.0183 - 0.0310)	(0.0189 - 0.0330)	(0.0190 - 0.0331)	(0.0209 - 0.0439)
Eye examination	-0.000189	-0.00081	-0.000777	0.0004
	(-0.00201 - 0.00163)	(-0.00269 - 0.00107)	(-0.00265 - 0.00110)	(-0.00166 - 0.00246)
ACEI or ARB prescription	-0.00225	-0.000265	-0.000294	-0.000617
	(-0.00719 - 0.00270)	(-0.00561 - 0.00508)	(-0.00557 - 0.00499)	(-0.00694 - 0.00570)
Statin prescription	0.00748***	0.0151***	0.0148***	0.0140***
	(0.00294 - 0.0120)	(0.0103 - 0.0199)	(0.01000 - 0.0196)	(0.00882 - 0.0192)
Mortality risk score	-0.374***	-0.375***	-0.367***	-0.416***
	(-0.487 - -0.261)	(-0.503 - -0.247)	(-0.494 - -0.241)	(-0.571 - -0.262)
ACSC hospitalization due to diabetes	1.046	1.089	1.103	1.071

	(0.895 - 1.222)	(0.910 - 1.302)	(0.920 - 1.323)	(0.875 - 1.311)
switched between 2010 & 2011 (N=11,410)				
$HbA1_c$ testing	0.0162***	0.0130***	0.0131***	0.0123***
	(0.00832 - 0.0240)	(0.00472 - 0.0213)	(0.00471 - 0.0214)	(0.00393 - 0.0206)
Lipid assessment	0.0126***	0.0120***	0.0122***	0.0115**
	(0.00445 - 0.0208)	(0.00339 - 0.0207)	(0.00346 - 0.0208)	(0.00269 - 0.0203)
Nephropathy screening	0.0147***	0.0151***	0.0153***	0.0145***
	(0.00730 - 0.0222)	(0.00727 - 0.0229)	(0.00742 - 0.0231)	(0.00668 - 0.0224)
Eye examination	-0.00146	-0.00242	-0.00228	-0.00225
	(-0.00380 - 0.000874)	(-0.00536 - 0.000509)	(-0.00525 - 0.000687)	(-0.00518 - 0.000680)
ACEI or ARB prescription	0.00158	0.0011	0.00125	0.00112
	(-0.00431 - 0.00747)	(-0.00535 - 0.00755)	(-0.00527 - 0.00777)	(-0.00549 - 0.00773)
Statin prescription	-0.00136	0.00336	0.00336	0.00172
	(-0.00686 - 0.00414)	(-0.00261 - 0.00934)	(-0.00263 - 0.00936)	(-0.00430 - 0.00774)
Mortality risk score	-0.299***	-0.364***	-0.362***	-0.343***
	(-0.441 - -0.157)	(-0.514 - -0.214)	(-0.512 - -0.211)	(-0.495 - -0.190)
ACSC hospitalization due to diabetes	1.03	0.923	0.929	0.925
	(0.808 - 1.314)	(0.699 - 1.218)	(0.702 - 1.229)	(0.700 - 1.223)

switched between 2012 & 2013 (N=5,840)				
HbA1c testing	0.0227***	0.0207***	0.0223***	0.0178***
	(0.0119 - 0.0335)	(0.00857 - 0.0329)	(0.0101 - 0.0345)	(0.00490 - 0.0307)
Lipid assessment	0.0136**	0.0118*	0.0136**	0.0134*
	(0.00190 - 0.0252)	(-0.00129 - 0.0249)	(0.000430 - 0.0267)	(-0.000146 - 0.0270)
Nephropathy screening				
Eye examination	-0.00206	-0.00455***	-0.00473***	-0.00448***
	(-0.00500 - 0.000874)	(-0.00748 - -0.00162)	(-0.00767 - -0.00179)	(-0.00768 - -0.00127)
ACEI or ARB prescription	-0.000438	0.00106	0.00203	0.00445
	(-0.00798 - 0.00710)	(-0.00719 - 0.00932)	(-0.00636 - 0.0104)	(-0.00480 - 0.0137)
Statin prescription	-0.00696*	-0.00683	-0.00683	-0.00346
	(-0.0140 - 5.33e-05)	(-0.0150 - 0.00132)	(-0.0150 - 0.00132)	(-0.0123 - 0.00535)
Mortality risk score	-0.147	-0.159	-0.136	-0.124
	(-0.337 - 0.0422)	(-0.373 - 0.0542)	(-0.352 - 0.0796)	(-0.353 - 0.105)
ACSC hospitalization due to diabetes	1.262	1.158	1.191	1.004
	(0.814 - 1.957)	(0.700 - 1.917)	(0.718 - 1.976)	(0.596 - 1.690)
switched between 2014 & 2015 (N=2,991)				
HbA1c testing	0.0162*	0.00552	0.00705	0.00776

	(-0.00289 - 0.0354)	(-0.0168 - 0.0278)	(-0.0154 - 0.0295)	(-0.0156 - 0.0311)
Lipid assessment	0.0193*	0.00314	0.00397	0.00385
	(-0.000835 - 0.0394)	(-0.0206 - 0.0269)	(-0.0199 - 0.0278)	(-0.0205 - 0.0282)
Nephropathy screening				
Eye examination	0.00357	0.00313	0.00264	0.0028
	(-0.000764 - 0.00790)	(-0.000869 - 0.00713)	(-0.00134 - 0.00662)	(-0.00113 - 0.00673)
ACEI or ARB prescription	0.00649	0.00791	0.00827	0.00681
	(-0.00325 - 0.0162)	(-0.00352 - 0.0193)	(-0.00297 - 0.0195)	(-0.00452 - 0.0181)
Statin prescription	-0.00843*	-0.00403	-0.00431	-0.00526
	(-0.0174 - 0.000573)	(-0.0135 - 0.00545)	(-0.0137 - 0.00510)	(-0.0151 - 0.00455)
Mortality risk score	0.0473	0.0853	0.0777	0.155
	(-0.213 - 0.307)	(-0.179 - 0.350)	(-0.190 - 0.346)	(-0.120 - 0.430)
ACSC hospitalization due to diabetes	1.073	0.977	0.958	0.929
	(0.484 - 2.378)	(0.369 - 2.588)	(0.361 - 2.540)	(0.351 - 2.460)

Notes:
*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses ; effects and corresponding 95% CI are reported as proportions.
Abbreviations: OLS: ordinary least squares, FE: fixed effects, CBPS: covariate balancing propensity score, EB: entropy balancing, FHO: Family Health Organization; ACSC: ambulatory care sensitive condition, FHO: Family Health Organization, $HbA1_c$: glycated haemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker
N=total number of observations

Table B1.8 Effect of switching to FHO on process of care and health outcomes for persons with diabetes mellitus: Results of before-and-after analyses

Outcome variable (n=12,910)	Pooled	Fixed effects
$HbA1_c$ testing (%)	3.43***	2.27***
	(1.94 - 4.93)	(1.57 - 2.96)
Lipid assessment (%)	4.18***	3.09***
	(2.71 - 5.64)	(2.36 - 3.82)
Nephropathy screening (%)	3.67***	2.29***
	(2.23 - 5.10)	(1.60 - 2.98)
Eye examination (%)	0.233	-0.125
	(-0.171 - 0.637)	(-0.321 - 0.0709)
ACEI or ARB prescription (%)	-0.615	-0.0567
	(-1.57 - 0.336)	(-0.563 - 0.450)
Statin prescription (%)	1.39***	2.19***
	(0.366 - 2.42)	(1.71 - 2.66)
Mean mortality risk score	-0.153	-0.368***
	(-0.407 - 0.101)	(-0.478 - -0.259)

Risk ACSC hospitalization due to diabetes	1.191**	0.988
	(1.011 - 1.402)	(0.825 - 1.183)

Abbreviations: $HbA1_c$: glycated hemoglobin, ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker, FHO: Family Health Organization; ACSC: ambulatory care sensitive condition, n: sample size.

Notes:

*** p<0.01; ** p<0.05; * p<0.1, all regressions include all the covariates defined in X_{it}, 95% confidence interval in parentheses

This table reports the effect of switching from FHG to FHO on processes of care and patients' health outcomes.