Heterogeneity in Average Cost per Patient with type 2 Diabetes at Primary Health Facilities in Mexico: Comparing Comprehensive Diabetes Management Medical Offices with General Practice

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Title page

Heterogeneity in average cost per patient with type 2 diabetes at primary health facilities in Mexico: comparing comprehensive diabetes management medical offices with general practice

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Abstract

Background. Despite the high health and financial burden imposed by diabetes in Mexico, few studies have estimated the cost per patient treated. The objective of this study was to estimate the average annual cost per patient (unit cost) with diabetes among 60 primary health facilities in Mexico comparing comprehensive diabetes management medical offices (MIDE) and those from general practice (Non-MIDE). **Methods.** We described the variation in unit costs across these two types of medical offices and explored factors associated. Unit costs were the sum of staff, medications, laboratory tests, and equipment. We show descriptive statistics to analyze the heterogeneity of unit costs, and the distribution of total costs by input and the distribution of staff costs by personnel all by medical office. We estimated a multivariate linear regression model to explore factors associated with the unit costs. **Results**. Unit costs vary from $267.2 USD in Non-MIDE offices to $410.6 for MIDE. Unit costs were negatively associated with scale, Non-MIDE offices, medical competence, patient knowledge of diabetes and positively associated with comorbidities. **Conclusions**. Results from this study might help design more efficient programs for diabetes care in primary health facilities to reduce the burden of diabetes in the system. Investing in staff training and educational interventions to increase patient knowledge of diabetes could be promising interventions to reduce diabetes care costs in primary care settings.

Keywords: Type 2 diabetes; Costs; Efficiency; Mexico; Primary care

1. Background

Type 2 diabetes is a public health problem worldwide and one of the leading causes of death (Barraza-Lloréns M 2015). 80% of diabetes deaths occur in low and middle-income countries where the prevalence has increased more rapidly in the past 15 years (Abegunde DO 2007). In Mexico, the burden of morbidity and mortality associated with diabetes is high, ranking seventh among the ten countries with the highest number of people with diabetes in the world (8.7 million in 2013) (Abegunde DO 2007; Wild S 2004). It is a growing financial burden for the health system, mainly due to the treatment of complications (Stevens G 2008).

Despite the high health and financial burden imposed by diabetes, few studies have estimated the cost per patient treated in Mexico. Four summary points from the literature illustrate the need to carry out more complete and robust studies. First, previous studies have reported discrepant estimates of the magnitude of the financial burden of diabetes in Mexico (Barquera S. 2013; Barceló A. 2003; Arredondo A. 2013). Second, there are few estimates of the average cost per patient on treatment or controlled (Barceló A. 2003; Brandle M. 2003; Rodríguez L.B.R. 2010) and among those few estimates researchers have used inconsistent costing methodologies, which makes comparability difficult. Third, there are no studies on technical efficiency measuring the variability of costs across health facilities (Barquera S. 2013). Finally, no studies have analyzed differential costs of alternative delivery models such as comprehensive diabetes management or multidisciplinary risk assessment and management programs for patients with diabetes. A better understanding of heterogeneity in costs across health facilities and its determinants is

essential to identify potential savings and strategies to achieve metabolic control at lower costs.

The second largest segment of the Mexican Social Security system is the Institute of Security and Social Services of State Workers (ISSSTE). It covers the population employed by the government – about 13.2 million beneficiaries in 2017 (ISSSTE 2017). Among this population, the prevalence of diabetes was 13.4% in 2014 when it reached the fifth cause of hospital morbidity (Díaz I. 2011). In 2013, ISSSTE introduced the program Comprehensive Diabetes Management by Stages (MIDE, in Spanish *Manejo Integral de Diabetes por Etapas*) to reduce complications in patients with diabetes. The core elements of the program include increasing the time spent with patients from 15 to 30 minutes, promoting the use of insulin at earlier stages of the disease, frequent monitoring (at least 3 visits per year) and improving self-care (Díaz I. 2011). Although MIDE treats any patient with diabetes, those with a clinical condition that reflects an inadequate response to previous treatments receive priority (glycosylated hemoglobin equal or greater than 7% (53 mmol/mol) or pre-prandial glycemia greater or equal to 130mg/dl). MIDE medical offices are located—along with general practice offices—in primary health care facilities.

The objectives of this study were: 1) to estimate the average annual cost per patient with type 2 diabetes (unit cost) per facility among 60 ISSSTE primary health facilities comparing MIDE and general practice (Non-MIDE) offices, 2) to describe the cost per patient variation across medical offices, and 3) to explore factors associated with the average annual cost per patient with type 2 diabetes.

2. Methods

The study was approved by the Institutional Review Board (Ethics Committee) at the National Institute of Public Health in Mexico (IPF Code 3627801) and the Ethics Committee at ISSSTE.

2.1 Study design

There are four types of primary health facilities in ISSSTE: hospital clinics, family medicine units, family medicine health facilities (FMHF) and specialized family health facilities (SFHF). We selected FMHF and SFHF because they provide care to 62% of beneficiaries and 61% of MIDE medical offices at the time of data collection. SFHF are different then FMHF because some of them have medical specialties such as general surgery, gynecology and obstetrics, internal medicine and pediatrics, among others.

We selected 60 health facilities for the study using a two-step stratified sampling strategy. The two strata were FMHF and SFHF. We selected 50 FMHF and 10 SFHF; including the six largest FMHF that have at least 150,000 beneficiaries each one and four SFHF units with more than 100,000 beneficiaries, with probability 1. We selected the remaining facilities with probability proportional to the size of their catchment areas in both strata. Given the distribution of the facilities in the country, Mexico City concentrated 40% of the sampled facilities.

All health facilities in the sample had a general practice office (from now on called Non-MIDE), and 55 had a MIDE office. However, we excluded two Non-MIDE offices and three MIDE offices due to lack of data on the number of outpatient visits or missing values in the vignettes. Thus, the analytical sample consisted of 58 Non-MIDE and 51 MIDE medical offices (Figure 1).

Fig. 1. Analytical sample flow chart

2.2 Measurements

Data for this study were collected retrospectively for each month of the entire 2015 fiscal year. In table 1 we gathered information on outputs, inputs, and quality of services using five questionnaires.

Table 1. **Measurement instruments**

Category of analysis	Questionnaire (instruments)	Mode of administration	Respondent	Data sources	Indicator/information for cost analysis
Outputs	Health facility questionnaire	Direct interview / Document review	Staff in charge	Facility administrative records	Number of outpatient diabetes visits
	Clinical records	Review of clinical records	N/A	Medical record	Number of visits per year
Inputs	Clinical records	Review of clinical records	N/A	Medical record	Medications prescribed, laboratory tests performed
	Time motion	Direct observation to health personnel	N/A	N/A	Time allocated to diabetes patients
	Health facility questionnaire	Direct interview / Document review	Staff in charge	Facility administrative records	Staff positions, hours and months worked, equipment
	Administrative sources	Documents	N/A	N/A	Prices (salaries, equipment, laboratory tests, medications)
Process Quality	Exit interview	Direct interview	Patients with diabetes	Patient interviewed	Process quality Knowledge of diabetes

	Vignette questionnaire	Direct interview	Health personnel	Health personnel interviewed	Process quality

Inputs included staff positions, hours/months worked by health providers; medications prescribed to patients; laboratory tests and equipment. Input prices (salaries, medications, laboratory tests, and equipment) were retrieved from administrative records among other sources (Additional file 1).

Because most of the staff provide care to patients with other diseases and ailments besides type 2 diabetes, we used a time-motion observation instrument to measure time allocated to diabetes care by health staff. In each facility, we observed three providers for two hours. At each facility, we randomly selected for observation two physicians (excluding the in-charge of MIDE because he/she spends 100% of its time to diabetes care) and one medical health personnel (nurse, physical activity instructor, nutritionist, psychologist, dentist). Interviewers recorded the time each provider spent in the following activities: diabetes visit, educational session, meetings or administrative work, refills of medications, and other services.

We measured diabetes process quality of care through clinical vignettes designed following the Mexican Clinical Practice Guideline (Gil-Velázquez L.E. 2013) and two specific clinical cases. Three physicians who treated patients with diabetes at Non-MIDE offices and the physician in charge of MIDE were randomly selected to answer the clinical vignettes. We also conducted exit interviews - survey polls- with randomly selected patients after their medical visit. The exit interviews collected information on activities

performed by the physician in the medical appointment and included the same items as the vignettes for process quality; and questions related to the patient's knowledge of diabetes.

2.3 Estimation of unit costs

For each facility, we estimated the unit costs as the sum of the total annual costs of staff, medications, equipment, and laboratory tests, divided by the number of outpatient visits or patients:

$$UC_{jk} = \frac{\sum_{i=1}^{i=4} IC_{ijk}}{O_{jk}}$$

Where UC is the unit cost at facility j, medical office k (MIDE or Non-MIDE); IC represents the total cost of each of the four inputs *i* at facility *j*, medical office *k*, for the following categories: staff, medications, laboratory tests, and equipment. *O* is the output measured either as the number of diabetes visits or the number of patients with diabetes. We added the monthly outpatient diabetes visits over the entire year to obtain annual estimates. We divided the yearly number of outpatient visits by the average number of medical visits per patient as reported in medical records to estimate the number of patients with diabetes that received care during 2015.

2.3.1 Staff costs

The annual cost of staff was estimated as follows:

$$SC_{j,k} = Hw_c * H_{i,c,j,k} * D_{i,c,j,k} * W * M_{i,c,j} * P_{i,c,j}$$

Where SC represents the annual cost of staff i in salary category c (based on three ISSSTE categories by type of personnel) in facility j, medical office k. Hw is the hourly wage for the following personnel categories: general practitioner, medical specialist, registered general nurse, social worker, nursing assistant, general technical nurse, nurse specialist, dietitian, psychologist, psychology intern, dentist, and physical activity instructor. H represents the hours worked per day for each staff, D the days worked per week, W the four weeks of the month and M the number of months worked during the fiscal year.

P represents a weight for staff costs according to the proportion of time allocated to diabetes patients by each type of health personnel, derived from the time-motion instrument. Since most of the medical staff treats patients with different conditions besides diabetes, we weighted the total annual salary to assign the appropriate costs of staff to the diabetes program in both types of offices. We attributed a weight of 1 to staff that reported exclusively attending to patients in the MIDE office. Since we did not interview all non-medical providers in each facility, we imputed their time using the average time providers spent across all facilities. If the staff attended patients both in MIDE and Non-MIDE offices, we assigned the salary according to the percentage of time spent on each one.

2.3.2 Cost of medications

We estimated the total annual cost of medications using information from medical records on medicines prescribed and prices of each medicine. The medications, which included both oral and injected, were used for the management of type 2 diabetes, including medications for hypertension and dyslipidemias experienced by patients with diabetes. Clinical files recorded doses or changes in medication or doses only the first time the

medication was prescribed over the year. We thus assumed that patients used the prescribed medications throughout the year, i.e, we imputed all prescriptions and changes between visits. Medication costs were estimated as follows:

$$DC_{i,j,k} = \sum_{1=1}^{n} P_B \frac{T_{i,m}}{TB_m} * P_m$$

Where DC is the annual cost of medicines for patient i, in facility j, and medical office k. T represents tablets or insulin doses and B is the number of tablets or insulin doses per bottle. P is the price of each bottle for medication m.

2.3.3 Equipment costs

The survey included information on the availability of medical equipment. To estimate the annual cost of medical equipment we used the following formula:

$$EC_{j,k} = \sum_{i=1}^{x} E_{c,j,k} * P_c$$

Where EC is the total annual cost of equipment that belongs to health facility j, medical office k. E is the number of equipment c and P its price. If the equipment was with other offices, we divided the cost based on the proportion of outpatient visits in each office.

2.3.4 Laboratory tests costs

We first estimated the number of laboratory tests per visit, which is the number of laboratory tests per patient divided by the number of visits per patient in the year. We then

multiplied the average number of laboratory test per visit by the average outpatient visits in each facility and the price of each test:

$$LC_{j,k} = \sum_{i=1}^{x} \frac{L_{i,j,k}}{v_{i,j,k}} * V_{j,k} + P_x$$

Where LC represents the annual costs of laboratory tests in facility j, and medical office k; L is the number of tests per patient i, v is the number of visits per patient, V is the number of outpatient visits at the facility level, and P is the price of each laboratory test x.

2.4 Statistical analysis of unit costs

2.4.1 Composition and distribution of unit costs

To analyze the variability and heterogeneity of the cost per visit and cost per patient (unit costs), we show descriptive statistics of these two indicators by facility and medical office. We also present the distribution of total costs by input: medicines, personnel, laboratory tests, and equipment, to illustrate the relative contribution of each category. Similarly, we show the distribution of staff costs by personnel.

2.4.2 Factors associated with facility-level variation of diabetes care costs

To explore factors associated with facility-level variation of unit costs, we first present the correlation between unit costs and scale (number of patients with diabetes) for MIDE and Non-MIDE offices on a log-log scale, using a locally weighted scatter plot smoothing test for non-linear associations.

We then fitted a multivariate linear regression model to explore factors associated with unit costs at the medical office level. The dependent variable was the facility-level unit cost, log transformed as the costs are not normally distributed. We included in the model several variables categorized under supply- and demand-side characteristics (Table 2).

Table 2. Variables included in the regression model

Characteristic	Variable		Definition/question (questionnaire)
Supply-side	Annual number of patients with diabetes	Logarithm	Sum of number of visits for each month of 2015 (facility questionnaire) divided by the average annual medical visits (clinical files).
	Medical office	Binary variable: 1=Non-MIDE 0=MIDE	Does the health facility have a MIDE office? (facility questionnaire)
	Proportion with subspecialists	Continuous (mean of proportion of subspecialists at facility level)	What studies did you do after your medical degree? (Vignettes)
	Performance (score) of quality process based on exit interviews to patients with diabetes	Score between 0-100: sum of all correct answers for each procedure (1 if frequency as recommended by the guidelines, 0 if less than the frequency) From the score we created a binary variable (divided the sample in 2 quantiles): 1 if score greater than 40.	Questionnaire that list all medical procedures required in a year based on clinical guidelines (measurements, laboratory tests, recommendations and medical references). Patients enrolled in care for at least one year respond the frequency for each procedure (exit interview)
	Competence (score) of quality process based on vignettes applied to medical doctors	Score between 0-100: sum of all correct answers for each procedure (1 if frequency as recommended by the guidelines, 0 if less than the frequency) Binary variable (divided the sample in 2 quantiles): 1 if score greater than 88.	Questionnaire where medical doctor list all procedures required in a year based on clinical guidelines (measurements, laboratory tests, recommendations and medical references). (Vignettes)
Demand side	Patient knowledge of diabetes on exit interview to patients with diabetes	Continuous (score)	Questionnaire that evaluates the patient's knowledge about his illness, through the exploration of topics such as nutrition, laboratory studies, complications, self-care and treatment.
	Proportion of patients with obesity Proportion of patients with hypertension	Continuous (means of proportions at facility level)	From the following list, please select which of the following comorbidities is recorded in the file during January 2015 to December 2015.

	Proportion with nephropathy Proportion with retinopathy Proportion with neuropathy	Continuous (means of proportions at facility level)	From the following list, please select which of the following complications is recorded in the file during January 2015 to December 2015.

Although MIDE treats any patient with diabetes, those with a clinical condition that reflects an inadequate response to previous treatments receive priority (Díaz Sanchez I. 2011). Therefore, as patients in MIDE and Non-MIDE offices may be different, the regression model adjusts for the following variables: the proportion of specialists, the proportion of the most common comorbidities (obesity and hypertension) and complications (nephropathy, retinopathy and neuropathy). As MIDE and Non-MIDE offices are located in the same health facility, we used robust standard errors clustered at the facility level.

3. Results

Additional file 2 shows the average number of visits and patients with diabetes per facility and medical office. The number of visits and patients with diabetes is lower in MIDE offices as health facilities have only one MIDE office and 16 Non-MIDE offices on average. The average number of visits per patient per year was 4.7, similar in both medical offices.

Table 3 shows the average facility-level unit costs. Mean average cost per patient was $304.5 USD at the facility level, $267.2 USD for Non-MIDE and higher for MIDE ($410.6

USD). The table also shows the distribution of mean unit costs by staff, medications, laboratory tests and equipment.

Table 3. Average annual cost per patient with type 2 diabetes by medical office in USD,

	All	Non-MIDE	MIDE
Unit costs			
Mean	**304.5**	**267.2***	**410 .6***
Standard deviation	138.7	185.8	240.7
Minimum	75.5	75.5	172.3
25th percentile	227.5	186.4	272.7
Median	283.6	242.7	381.1
75th percentile	343.9	293.2	482.3
Maximum	808	1,373.90	1,787.90
Average input unit costs in USD			
Staff	78 .0	82.7	107.2
Medications	220.2	178.9	291.9
Laboratory tests	1.7	1.0	6.6
Equipment	4.6	4.6	4.9

2015

* Statistically significant difference in mean unit costs between MIDE and Non-MIDE using Mann Whitney U test.

Figure 2 illustrates the distribution of total costs and staff costs. Medications represent the largest proportion of total costs (higher for MIDE) followed by staff salaries. Within staff costs, general practitioners and medical specialist represent more than 50% of total staff costs.

Fig. 2. Total diabetes costs and staff cost breakdown

We explored the association between unit costs and scale (number of patients) in Figure 3. First, the graph shows a negative association between costs and scale. Second, in general, Non-MIDE offices provide care to a larger number of patients at a lower cost compared

with MIDE offices. Scale and type of medical office explains 31% of unit costs variation (data not shown). Third, at any level of scale, there is a large variation in unit costs between facilities.

Fig. 3. Unit costs and number of patients with diabetes

Table 4 shows descriptive statistics of the sample stratified by medical office. Results show statistically significant differences in several characteristics. Unit costs were higher in MIDE offices compared to Non-MIDE. Non-MIDE offices attend more patients compared to MIDE. Higher proportion of specialists, higher average scores on performance, competence and patient knowledge of diabetes are seen in MIDE. The proportion of patients with hypertension and neuropathy are higher in MIDE as expected given that they provide care to uncontrolled patients. A higher percentage of patients using insulin was found in MIDE offices.

Table 4. Descriptive characteristics of the 109 medical offices

Variable	**Non-MIDE**	**MIDE**	**p-value test for differences***
Annual unit cost per patient (ln)	8.2	8.7	0.000
Annual unit cost per patient (USD)	4,123.5	6,405	0.000
Annual number of patients (ln)	7.6	6.3	0.000
Annual number of patients	3,219.1	721.5	0.000
Proportion with specialists	51.7%	76.4%	0.007
High performance	27.5%	72.5%	0.000
High competence	34.4%	64.7%	0.001

Patients' knowledge of diabetes	7.0	7.6	0.023
Proportion of patients with obesity	21.4%	23.9%	0.244
Proportion of patients with hypertension	55.5%	51.1%	0.073
Proportion of patients with nephropathy	7.9%	11.9%	0.307
Proportion of patients with retinopathy	21.2%	25.9%	0.310
Proportion of patients with neuropathy	25.3%	36.6%	0.058

**T test for difference of means*

In Table 5 we explored the influence of the characteristics presented in Table 4 on unit cost variation. We present the results of three regression models incrementally adding more variables. Model 3 explained 45% of the total variation in unit costs across facilities. A 10% increase in the number of patients was associated with a 19% reduction in unit costs. Unit costs in Non-MIDE medical offices were 19% lower compared with MIDE. A higher competence (quality process from vignettes) score was associated with 26% lower costs compared with a lower competence score. Higher patient knowledge of diabetes is associated with lower costs. The proportion of patients with neuropathy was associated with higher costs.

Table 5. Factors associated with the logarithm of the annual cost per patient with diabetes

Variable	**Model 1**	**Model 2**	**Model 3**
Annual number of patients (ln)	-0.27*	-0.21*	-0.19*

	(0.05)	(0.06)	(0.06)
Medical office (Non-Mide=1)		-0.19†	-0.19‡
		(0.10)	(0.10)
Proportion with subspecialists		0.09	0.13
		(0.09)	(0.09)
Performance (high=1)		0.16‡	0.16
		(0.08)	(0.09)
Competence (high=1)		-0.23†	-0.26†
		(0.10)	(0.10)
Patient knowledge of diabetes			-0.06‡
			(0.03)
Proportion with obesity			0.61
			(0.42)
Proportion with hypertension			0.18
			(0.41)
Proportion with nephropathy			0.30
			(0.26)
Proportion with retinopathy			0.15
			(0.15)
Proportion with neuropathy			0.32†
			(0.15)
Constant	10.29*	9.92*	9.87*
	(0.33)	(0.43)	(0.55)
Observations	109	109	109
R-squared	0.29	0.38	0.45

*Standard errors in parentheses. * p<0.01, † p<0.05, ‡ p<0.1*

4. Discussion

We estimated the average annual cost per patient with diabetes in a representative sample of primary health care facilities in ISSSTE, a subsystem that serves 7.7% of the Mexican population (INEGI 2015). We identified variation in unit costs of two models of care for diabetes patients in this subsystem. MIDE offices offer more specialized and personalized services compared to Non-MIDE offices (general practitioner offices). The average unit costs range from $267.2 USD in Non-MIDE offices to $410.6 for MIDE. Costs in MIDE are expected to be higher as they have access to more expensive medications, particularly

insulin that is introduced at early stages as well as more frequency of laboratory tests to monitor patients.

The average cost per patient of $304.5 USD at the facility level is within the range of previous papers reporting costs of diabetes care in Mexico, from $159.86 to $607 USD per patient per year (Barquera S. 2013; Barceló A. 2003; Arredondo A. 2004; Ángeles R.D.L. 2010). However, the variation in costs among these studies are probably explained by differences in the methods used to estimate costs and the health subsystem analyzed. Some estimates are based on secondary sources (Barquera S. 2013; Barceló A. 2003; Arredondo A. 2004); others use average cases and derive input costs based on clinical guidelines (Barceló A. 2003; Arredondo A. 2004); and one simply reports estimated from other studies (Barquera S. 2013). Very few studies use primary data sources to estimate unit costs (Rodríguez L.B.R. 2010). Costs based on an average case vary from a previous report showing a direct outpatient cost of $159 USD (Arredondo A. 2004) to an annual cost per patient of $607 USD (Barceló A. 2003). Even though the inputs included are similar, the difference between these studies is large. A study that used clinical records from the Mexican Institute for Social Security at the three levels of care, found an average annual cost per person of $480 USD ($587 USD for patients with complications and $345 USD without complications) (Rodríguez L.B.R. 2010). The results are higher compared to our estimates (particularly for Non-MIDE offices for two potential reasons: 1) our study estimates average costs for the first level of care which tend to be lower compared to second or third level of care and 2) our costs represent a different health care subsystem.

We found that unit costs were significantly and negatively associated with the number of patients. These results are in line with other studies showing economies of scale (Bautista-Arredondo S. 2018; Marseille E. 2007).

We also found that higher patient knowledge of diabetes was associated with lower costs. This result is consistent with a review of studies that evaluated the effect of educational interventions for patients on costs (Boren S.A. 2009). In those studies, the interventions were associated with higher treatment adherence, better compliance with the medical appointments and frequency of laboratory tests, which in fact resulted in better patient control and therefore in reduction of complications.

Our results also showed that a higher level of competence reduces costs. This result is consistent with the hypothesis that doctors with greater knowledge are more efficient at establishing earlier diagnoses, better management of medications and their combinations, as well as asking for more relevant studies for patients, which translate in more efficient use of resources. These results are consistent with previous findings showing that educational interventions, such as clinical sessions, resolution of clinical cases and use of information technologies managed reduce the costs of care of patients with diabetes (Nuckols T.K. 2018).

Our study has some limitations. The main limitation is that we could not estimate the average cost per patient under control because clinical records had either none or less than two laboratory test results registered for glycosylated hemoglobin and fasting blood glucose to estimate the proportion of patients under control. We also recognize that we lost

information because five facilities did not have a MIDE office, however, we were able to estimate unit costs in these facilities for the Non-MIDE office.

Another limitation is that unit costs do not include real estate and amenities (telephone, electricity, water, maintenance of the property and gardens, diesel or gasoline for the electricity generator machine, inputs for collection of biological-infectious hazardous wastes) because most of the health facilities reported not having this information available and neither was it possible to obtain it at the central offices. However, as shown in other studies, these costs represent a low percentage of the total cost (Rodríguez L.B.R. 2010).

Despite these limitations, as of our knowledge, this study is the first to estimate unit costs based on primary data and to explore factors associated. Findings from this study might be translated into recommendations to improve efficiency in care. For instance, given our findings that a higher level of competence and a higher patient knowledge of diabetes reduces costs, investing in staff training and patient educational interventions could be promising interventions to reduce diabetes care costs in primary care settings

5. Conclusions

We identified variation in unit costs of two models of care for diabetes patients. In average unit costs for MIDE were almost twice as expensive as Non-MIDE, due to MIDE offices offer more specialized and personalized services compared to Non-MIDE offices (general practitioner offices). The costs had a statistically significant and negative association with the number of patients, similar to other studies showing economies of scale. We found that higher the level of knowledge of diabetes by patients, there is an association with lower costs. In the same direction a higher level of competence of the health care personnel is

related to a reduction in costs this is due to doctors with greater knowledge are more efficient in the integral management of the patient.

List of abbreviations

1. MIDE
2. Non-MIDE
3. ISSSTE
4. FMHF
5. SFHF

Declarations

- Ethics approval and consent to participate

The study was approved by the Institutional Review Board (Ethics Committee) at the National Institute of Public Health in Mexico (IPF Code 3627801) and the Ethics Committee at ISSSTE.

- Consent for publication

Not applicable.

- Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

- Competing interests

The authors declare that they have no competing interests.

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- Authors´ contributions

A.C.A conceived the study, conducted data analysis and wrote the first draft of the manuscript. R.G. conducted data analysis and wrote the manuscript. R.LR. participated in study design, reviewed analyses and manuscript. D.L.H. participated in study design and reviewed the manuscript. I.S.D participated in study design and reviewed the manuscript. O.S.R participated in the study design, conducted data analysis and reviewed the manuscript. S.B.A conceived the study and reviewed the manuscript. All authors reviewed and approved the submitted version of the manuscript.

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Figures

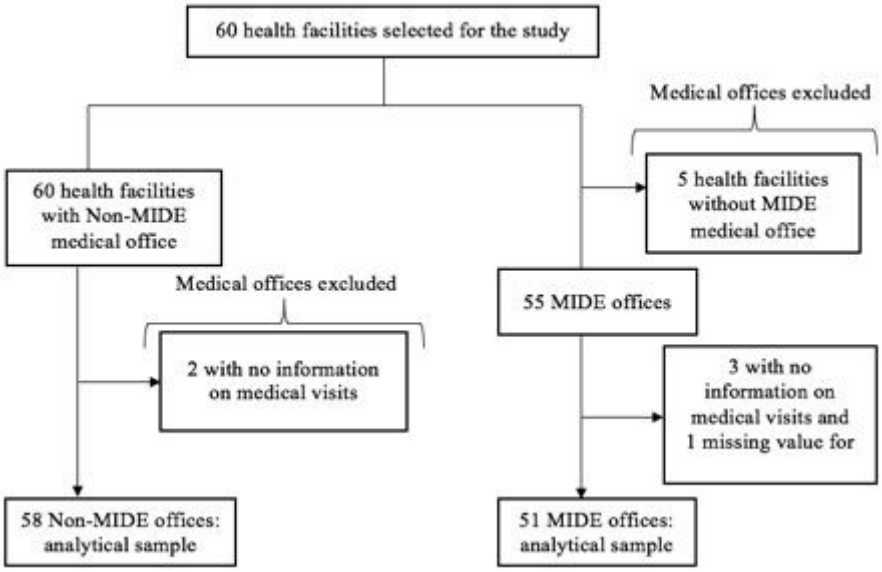

Figure 1

Analytical sample flow chart

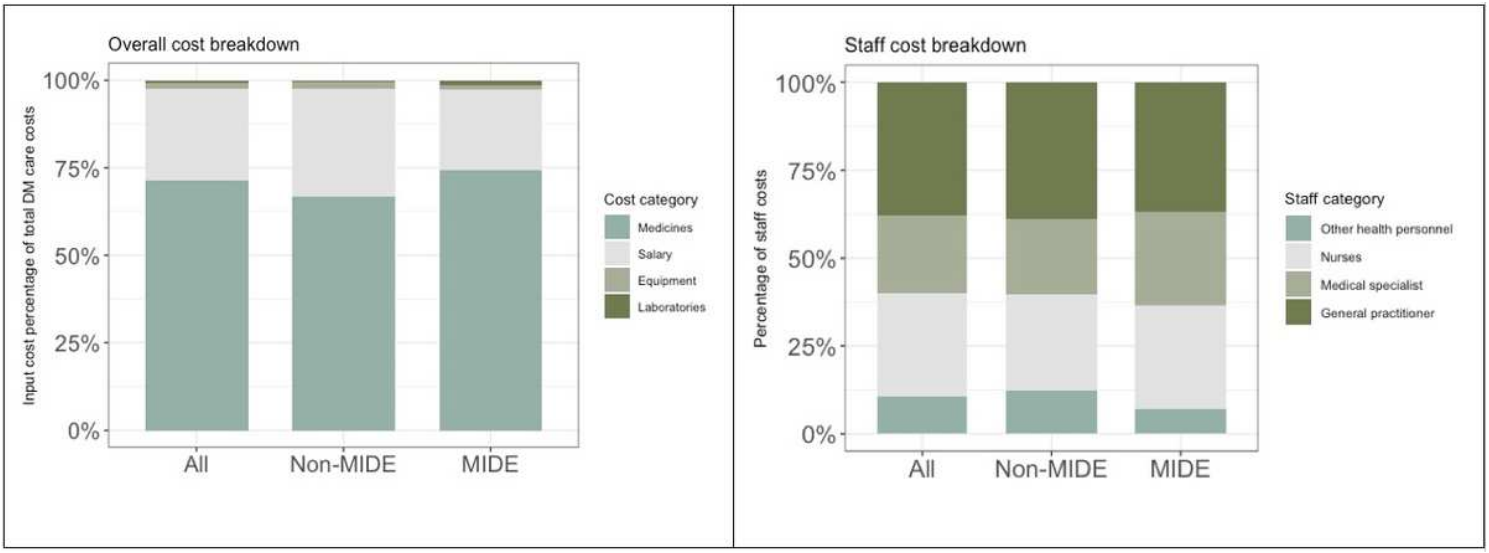

Figure 2

Total diabetes costs and staff cost breakdown

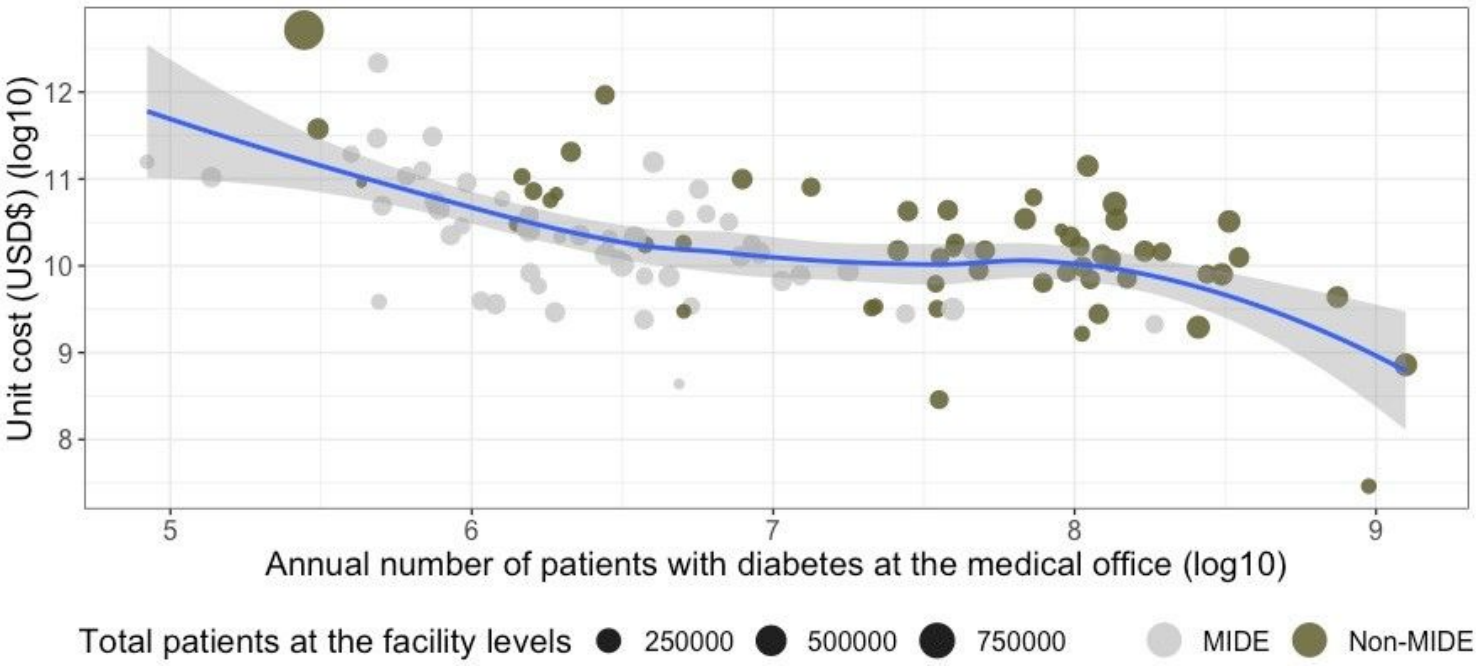

Figure 3

Unit costs and number of patients with diabetes

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