The Impact of Social Health Insurance on Diabetes and Hypertension Process Indicators among Older Adults in Mexico

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Objective. To examine the impact of *Seguro Popular* (Mexican social health insurance for the poor; *SP*) on diabetes and hypertension care, intermediate process indicators for older adults (>50 years): pharmacological treatment, blood glucose tests, the use of complementary and alternative medicine (CAM), and adherence to their nutrition and exercise program. (CAM was defined as products or practices that were not part of the medical standard of care.)

Data Sources/Study Setting. Repeated cross-sectional surveys from *Encuesta Nacional de Salud y Nutrición* (Mexican Health and Nutrition Survey, ENSANUT), a nationally representative health and nutrition survey sampling $N = 45,294$ older adults in 2000, $N = 45,241$ older adults in 2005–2006, and $N = 46,277$ older adults in 2011–2012.

Study Design. Fixed-effects instrumental variable (FE-IV) repeated cross-sectional at the individual level with municipality fixed-effects estimation was performed.

Principal Findings. We found a marginally significant effect of *SP* on the use of insulin and oral agents (40 percentage points). Contrary to that expected, no other significant differences were found for diabetes or hypertension treatment and care indicators.

Conclusions. Social health insurance for the poor improved some but not all health care process indicators among diabetic and hypertensive older people in Mexico.

Key Words. Health insurance, health care access, Seguro Popular, diabetes, hypertension

To reduce health inequalities and improve access to health care services, the Mexican government embarked on a major health care reform starting in 2001. *Seguro Popular* (People's Health Insurance; *SP*) was intended to provide coverage to the otherwise uninsured population. After more than a decade of experience with *SP*, evidence suggests that, compared to those uninsured,

program enrollees have better access to health care services, which includes access to diagnosis and treatment of diabetes and hypertension (Bleich et al. 2007; Sosa-Rubi, Galarraga, and Lopez-Ridaura 2009). However, most of these studies have focused on short-term effects of earlier implementation periods and were based on young adult samples. With the increased aging of the Mexican population, it is important to evaluate current policies and programs and determine their effectiveness in improving health care access and outcomes among the older populations.

The main objective of this paper was to provide a better understanding of *SP* in the treatment and care process indicators for older Mexicans diagnosed with diabetes or hypertension. First, we examined the impact of *SP* on diabetes self-management, including use of treatment (insulin and/or oral medication), blood glucose tests, the use of complementary and alternative medicine (CAM), and adherence to nutrition and exercise programs, focusing on the older adult population (age >50). Similarly, we evaluated the effect of *SP* on hypertension treatment and care, use of oral medication, CAM, and adherence to nutrition and exercise programs, focusing on the older adult population (age >50). We focused on diabetes and hypertension among older adults because: (1) the high rates of these conditions in Mexico are attributed to the aging of the population (World Health Organization [WHO] 2013); (2) these conditions are among the major causes of death among older adults in Mexico in 2011 (Instituto Nacional de Estadística y Geografía 2013a); and (3) there are high costs associated with diabetes and hypertension management and related complications (Barquera et al. 2013; Instituto Nacional de Salud Pública 2013).

The Mexican Health Care System

The Mexican health care system is composed of multiple insurance providers. The *Instituto Mexicano del Seguro Social* (Mexican Institute of Social Security [IMSS]) provides medical services to private sector employees and the *Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado* (Institute of

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Part of this research was presented at the Population Association of America 2014 Annual Meeting and the AcademyHealth 2014 Annual Research Meeting.

Social Security and Services for the State's Workers [ISSSTE]) provides coverage for government workers. In 2000, about half of the population was insured by these providers, but the other half did not have any type of health insurance (Frenk et al. 2003). *SP* was introduced in 2001 as a pilot program to provide insurance to those who were excluded from the health care system due to their labor or social status (e.g., employment in the informal sector, self-employed, and low-income people).

The program was rolled out from 2002 to 2005. In 2002, 20 states implemented it. It was introduced in five more states in 2003, and another four joined in 2004. By 2005, the remaining three (Chihuahua, Mexico City, and Durango) were integrated into the program (<http://www.seguro-popular.salud.gob.mx/>). This is also shown by the high rates of people with *SP* in the Census 2010 compared to 2005, which showed that in 2005 approximately 50 percent of the national population was still uninsured; by 2010, this decreased to 34 percent. In addition, among those who were insured in 2005, approximately 15 percent were enrolled in *SP*, and by 2010 this increased to 36 percent (INEGI 2010).

The process of how municipalities adopted the program was complex and somewhat arbitrary (Barros 2009). Initially, it was intended to incorporate municipalities with high poverty levels. However, health care institutions needed to be accredited to serve *SP* enrollees. Accredited institutions must have resources and infrastructure to offer all the services included in the essential package of health services (Frenk, Gomez-Dantes, and Knaul 2009). Moreover, there were political motivations to achieve universal health care, so states and municipalities with smaller populations were given priority. As a result of health infrastructure capacity and political factors influencing the roll-out process, *SP* supply was not correlated with economic or health factors, but *was* correlated with population size (Barros 2009; Frölich et al. 2014). This information is important for our identification strategy.

Personal affiliation with *SP* is voluntary and there is no copayment for all practical purposes. Nevertheless, affiliation may be at least partially determined by health care system infrastructure capacity at the local level. According to INEGI, in 2010 among those insured: 49 percent were enrolled in IMSS, 8 percent in ISSSTE, and 36 percent in *SP* (Instituto Nacional de Estadística y Geografía 2013b). *SP* numbers have substantially increased since the last Census; by December of 2012, there were 52,908,011 people enrolled in *SP*, and the goal for 2013 was to have enrolled a total of more than 55 million people (Secretaría de Salud 2013).

Services are limited in scope as there are some health conditions that may not be covered, and medical services are offered through *SP*'s own network of health centers. Nevertheless, compared to those uninsured, *SP* enrollees appear to have better access to health care services. *SP* enrollees can gain the access to health care services that are crucial to the diagnosis and treatment of diabetes and hypertension (Seguro Popular 2013). According to previous work (Sosa-Rubi, Galarraga, and Harris 2009), *SP* has had a significant impact on obstetrical services. Similarly, other research (Bleich et al. 2007) found that hypertensive adults with insurance through *SP* were more likely to be treated (enrollees were 50 percent more likely to receive treatment than those uninsured) and more likely to control their blood pressure to target levels. Besides hypertension, diabetes is another condition which requires services that are in high demand among *SP*'s beneficiary population. Diabetes services are mostly limited to ambulatory and urgent care, but in 2012 these services included limited coverage for patients with chronic renal failure. In another previous study (Sosa-Rubi, Galarraga, and Lopez-Ridaura 2009) using data from ENSANUT 2006, it was noted that adults with diabetes who were *SP* enrollees were more likely to check their blood sugar, go to the physician at least four times per year, and had slightly better glucose control than those who were uninsured. However, the medium-term impact of *SP* on older participants has not been studied.

Our study adds to the literature because we used instrumental variables with pseudo-panel data to explore the medium-term effects of *SP* a decade after its initial implementation. On the basis of prior studies for younger adult populations, we hypothesized that older adults with *SP* would have better diabetes and hypertension treatment and care process indicators than their uninsured counterparts.

METHODOLOGY

Data

Individual Characteristics. Repeated cross-sectional data from the ENSA 2000, ENSANUT 2005–2006, and ENSANUT 2011–2012 surveys were used to assess the effect of *SP* on diabetes and hypertension process indicators: access to treatment, blood glucose tests, use of CAM, and performing other self-management activities such as exercise and diet (<http://ensanut.insp.mx/>). The ENSA/ENSANUT are nationally representative health and nutrition surveys that had a sample of $N = 45,294$ older adults in 2000; $N = 45,241$ older adults

in 2005–2006; and $N = 46,277$ older adults in 2011–2012 (Instituto Nacional de Salud Pública 2012).

Physician-diagnosed diabetes and hypertension was reported by the participants. There were a total of $N = 7,017$ adults over 50 diagnosed with diabetes: $n = 1,988$ in 2000; $n = 1,896$ in 2005–2006; and $n = 3,133$ in 2012. Excluding participants that were enrolled in IMSS, ISSSTE, or private insurance providers, there were $n = 731$, $n = 868$, and $n = 1,416$ older adults with diabetes in 2000, 2005–2006, and 2012, respectively. In terms of physician-diagnosed hypertension, there were $n = 3,450$, $n = 3,701$, and $n = 4,979$ older adults in 2000, 2005–2006, and 2012, respectively. Also, excluding participants that were enrolled in IMSS, ISSSTE, or private insurance providers, there were $n = 1,339$, $n = 1,696$, and $n = 2,272$ older adults over 50 years diagnosed with hypertension that were enrolled in *SP* or were uninsured, for the same corresponding periods. Participants answered exactly the same questions about current treatment, access to laboratory tests, and alternative/complementary control methods in all three rounds of the survey. A decade after its launch, *SP* had reached a greater number of people: Enrollment in *SP* increased dramatically from 27 percent in 2005–2006 to 75 percent in 2012 ($p < .0001$) among people diagnosed with diabetes or hypertension. Since *SP* was launched in 2001, the survey round of 2000 does not have *SP* information, and thus it serves as a “pretreatment” observation.

State and Regional Characteristics. Mexican Census (INEGI) and Mexican Department of Health Information (SINAIS): Data regarding the total number of *SP* enrollees and the uninsured population at the state level were obtained from the *Seguro Popular's* website (<http://www.seguro-popular.gob.mx/>) and from the Mexican Census (<http://www.inegi.org.mx/>). Information about the states' human and physical resources (total number of doctors, number of nurses, and number of hospitals) from 2000, 2005, and 2009 came from SINAIS (<http://www.sinais.salud.gob.mx/basesdedatos/index.html>).

Variables

Dependent Variables. Five binary dependent variables were considered regarding diabetes treatment and care process indicators, including (1) use of blood glucose control tests per month; (2) treatment with insulin or other oral agents; (3) use of alternative/complementary control methods; (4) following a diabetic diet; and (5) exercise program.

Similarly, there were four binary dependent variables of interest for hypertension treatment and care process indicators, including (1) use of anti-hypertensive medication; (2) CAM; (3) adherence to a nutrition program; and (4) exercise program.

Control Variables. We controlled for individual factors such as sex, age, education, ethnicity, BMI, time since disease diagnosis, and family assets. (Family asset index was calculated based on the following assets: household infrastructure, household materials, and assets. This is a proxy for household's wealth [Filmer and Pritchett 2001]. It was calculated using principal components analysis. This measure is centered at 0, and negative values indicate lower household wealth.) We included states' physical resources (number of doctors, number of nurses, and number of hospitals per 100,000 people), literacy rate, and rural characteristics of the area to control for some unobservable regional factors that may influence diabetes and/or hypertension treatment and care.

Analytic Strategy

The unit of analysis was individuals with fixed effects at the municipality level. The strategy was to compare diabetes and hypertension treatment and care process indicators for two groups of older adults: the treated group with *SP* versus those without any health insurance. However, health insurance status is not a random event. A number of factors influence the decision to enroll in a specific insurance program such as *SP*. If these factors also impact health care utilization, the estimated parameters for health insurance and health care access and treatment utilization may be endogenous. The potential endogeneity of health insurance on health care utilization has been widely researched (Newhouse, Phelps, and Marquis 1980; Duan et al. 1983; Rossiter and Wilensky 1984; Manning et al. 1987, 1987; Porell and Miltiades 2001).

Although panel data would be ideal to follow individuals over time and understand their behaviors, and why they are more likely to have *SP*, only repeated cross-sectional data were available in Mexico. Considering corrections for the potential biases, we conducted a municipality and year fixed-effects instrumental variable (FE-IV) estimation using individual data.

Our instrumental variable exploits the fact the expansion of *SP* over the study period was not evenly distributed across all municipalities and the pro-

gram focused on relatively rural municipalities with low population density. Thus, during the first year of our study (in 2000) *SP* was not in operation and none of the individuals in our study was insured. As *SP* was gradually implemented between years 2001 and 2005, the share of insured population increased at a higher rate in low population density municipalities. Bosc and Campos-Vázquez (2010) found that municipalities in smaller states joined *SP* earlier than their counterparts; this was partially so the federal government could claim the success of the program before presidential elections in 2006 (Díaz-Cayeros, Estévez, and Magaloni 2006).

To capture this slower expansion of *SP* in high population density municipalities, we defined our instrumental variable as the interaction between the logarithm of population density at the municipality level in 2000 and a dummy variable for whether the survey was conducted in 2005–2006. A similar IV has been used in prior studies (Rahman, Zinn, and Mor 2013). (We also explored the interaction between the logarithm of population density at the municipality level in 2000 and a dummy variable for whether the survey was conducted in 2011–2012.) In the present study, 2005–2006 was the period when *SP* was new and was targeted to smaller state populations to improve access of care to these areas and achieve universal coverage at a faster rate (Presidencia de la Republica 2005). We assumed that high population density areas eventually caught up with their municipality counterparts in terms of *SP* enrollment rate as the program matured. To illustrate this idea (see Figure 1), we plotted the share of the individuals in our sample who were enrolled in *SP* with respect to population density of the municipality separately for year 2006 and 2012. After 2006, *SP* coverage expanded to more highly populated areas, and higher coverage became comparable in rural and urban areas. As an important note, our model includes municipality fixed effects to capture heterogeneity across municipalities including difference in population density and year fixed effects to capture trends.

Given that the process of *SP* accreditation that occurred at the *municipality and state levels* was driven by several independent factors, including an important push to achieve universal coverage in less densely populated areas, there was temporal and geographic variation that helped to identify *individual* enrollment into *SP*, independent of diabetes and hypertension outcomes. This approach seeks to isolate the effects of aggregate-level shifts in health care access and utilization that can be associated with changes in individual insurance status that are associated with the availability of health insurance (Long, Coughlin, and King 2005).

Figure 1: Percentage of People Enrolled in *Seguro Popular* by Logarithm of Population Density in 2000 for 2006 and 2012 Surveys

Notes. Less-populated areas had higher SP coverage rates. Our instrumental variable is the interaction between the logarithm of population density at the municipality level in 2000 and a dummy variable for whether the survey was conducted in 2005–2006. The interaction term between the logarithm of population density at the municipality level in 2000 and a dummy variable for whether the survey was conducted in 2011–2012 was explored as well, but results indicated that this second instrument was weak and therefore was included as a covariate.

The main explanatory variable analyzed was enrollment into the SP program (SP_{imt})

$$SP_{imt} = \alpha_0 + X_{imt}\alpha_1 + \alpha_2 Z_{imt} + \gamma_t \alpha_3 + \theta_m + e_{imt} \quad (1)$$

$$Y_{imt} = \beta_0 + X_{imt}\beta_1 + \beta_2 SP_{imt} + \gamma_t \beta_3 + \phi_m + u_{imt} \quad (2)$$

Equation (1) describes the first stage where the i subscript represents individuals from the same municipality (m subscript), and the t subscript represents the time period; Z_{imt} is the instrumental variable (the interaction term between population density at the municipality level where the individual resides and whether the individual was part of the 2005–2006 wave of the

survey); enrollment into *SP* would be determined by sex, age, marital status, indigenous background, education, employment status, family assets, time since disease diagnosis, BMI, rurality and illiteracy rate of the area of residency, and number of physicians, nurses, and hospital per 100,000 people (X_{imt} covariate vector)¹; γ_t denotes the time trends (to control for coverage and technology change, and to capture any other secular trends), θ_m and ϕ_m represent municipality fixed effects that capture differences across markets including population density; finally, e_{imt} and u_{imt} represent the individual-level error terms. The dependent variables were whether the individual used diabetes or hypertension treatment and care process indicators described above (Y_{imt}). For those individuals with missing values in the sociodemographic independent variables (<20 percent), the mean or median municipality value was used.

In the analysis, we first assessed whether the instrumental variable (IV) was a valid instrument for health insurance coverage in the regression models, under the assumption that the instrument would affect the probability of a person being part of *SP*, but it would not be correlated with the error term in the outcome equations. We tested the relevance of the instrument with the *F*-test of excluded instruments (Wooldridge 2010). Then we conducted FE-IV using STATA XTIVREG2 command. Standard errors were clustered at the municipality level. Sensitivity analyses were also conducted including older adults age 20 and older.

RESULTS

Diabetes and Hypertension Treatment and Care and Sample Characteristics by Insurance Status

Descriptive statistics for older adults that are either uninsured or *SP* enrollees in the sample are contained in Table 1 for people with diabetes, and in Table 2 for people with hypertension. There were 3,015 older adults aged over 50 diagnosed with diabetes and 5,307 diagnosed with hypertension. Among those diagnosed with diabetes, 237 people were affiliated to *SP* in 2006 (27 percent) and this number increased to 1,068 in 2012 (75 percent). Similarly, among those diagnosed with hypertension, there were 471 (27 percent) and 1,714 (75 percent) people enrolled in *SP* in 2006 and 2012. (Hence, approximately 25 percent of those diagnosed with diabetes or hypertension did not have health insurance in 2012.)

Table 1: Characteristics of Older Adults (Age >50) with Diabetes Insured by Seguro Popular versus Uninsured (N = 3,015) in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012)

Explanatory Variables (N = 3,015)	Year 2000 (Pre-SP)			Year 2006			Year 2012		
	Uninsured (731)	Uninsured (631)*	SP Insured (237)	p-value	Uninsured (348)*	SP Insured (1,068)	p-value		
Time since disease diagnosis [†]	115.06 (154.64)	103.04 (93.36)	96.76 (91.08)	.3742	116.35 (105.48)	111.94 (107.63)	.5048		
Female	0.68 (0.47)	0.31 (0.48)	0.70 (0.46)	.0411	0.57 (0.50)	0.62 (0.48)	.0649		
Age	62.69 (8.93)	63.82 (9.44)	63.46 (9.13)	.6158	64.34 (9.80)	63.27 (8.87)	.0586		
Married	0.53 (0.50)	0.46 (0.50)	0.54 (0.50)	.0578	0.45 (0.50)	0.53 (0.50)	.0126		
Indigenous background	0.08 (0.26)	0.08 (0.27)	0.13 (0.33)	.0317	0.09 (0.29)	0.15 (0.36)	.0118		
No education	0.08 (0.27)	0.30 (0.46)	0.32 (0.47)	.6295	0.26 (0.44)	0.27 (0.45)	.6889		
Primary education	0.58 (0.49)	0.60 (0.49)	0.64 (0.48)	.3476	0.57 (0.50)	0.62 (0.49)	.1043		
Employed	0.29 (0.45)	0.31 (0.46)	0.25 (0.43)	.0651	0.39 (0.49)	0.35 (0.48)	.1515		
Family assets**	−0.27 (2.07)	−0.25 (1.36)	−0.49 (1.26)	.0177	−0.35 (2.04)	−0.66 (1.79)	.0065		
BMI_1 [§]	0.39 (0.49)	0.32 (0.47)	0.36 (0.48)	.2830	0.34 (0.47)	0.35 (0.48)	.8020		
BMI_2 [¶]	0.28 (0.45)	0.26 (0.44)	0.30 (0.46)	.2506	0.24 (0.43)	0.29 (0.45)	.0480		
Rural	0.65 (0.48)	0.55 (0.50)	0.47 (0.50)	.0355	0.70 (0.46)	0.56 (0.50)	<.0001		
Physicians ^{††}	56.59 (19.95)	63.00 (19.77)	76.42 (24.67)	<.0001	81.60 (25.28)	86.16 (28.19)	.0073		
Nurses ^{††}	75.11 (25.59)	78.89 (23.60)	96.49 (29.92)	<.0001	103.19 (32.29)	110.52 (36.86)	.0009		
Hospitals [†]	13.69 (5.96)	14.44 (6.48)	16.21 (6.30)	.0003	14.79 (7.34)	15.84 (7.07)	.0176		
Illiteracy	0.06 (0.05)	0.06 (0.05)	0.07 (0.04)	.0587	0.05 (0.06)	0.06 (0.05)	.0007		

Continued

Table 1: Continued

Diabetes Care and Treatment Indicators (N Varies by Indicator)	Year 2000 (Pre-SP)	Year 2006			Year 2012		
	Uninsured	Uninsured	Insured	p-value	Uninsured	Insured	p-value
Blood sugar monitoring	(n = 716) 0.72 (0.44)	(n = 631) 0.77 (0.42)	(n = 237) 0.82 (0.39)	.1626	(n = 348) 0.65 (0.48)	(n = 1,068) 0.74 (0.44)	.0026
Insulin/oral medication	(n = 636) 0.90 (0.28)	(n = 576) 0.94 (0.23)	(n = 221) 0.96 (0.18)	.1459	(n = 348) 0.83 (0.38)	(n = 1,068) 0.90 (0.30)	.0002
Diet	(n = 634) 0.21 (0.38)	(n = 571) 0.21 (0.39)	(n = 219) 0.26 (0.43)	.1393	(n = 348) 0.20 (0.40)	(n = 1,068) 0.20 (0.40)	.9731
Exercise	(n = 525) 0.05 (0.20)	(n = 483) 0.07 (0.23)	(n = 180) 0.10 (0.27)	.1664	(n = 348) 0.07 (0.30)	(n = 1,068) 0.07 (0.26)	.9406
CAM	(n = 608) 0.17 (0.35)	(n = 500) 0.10 (0.27)	(n = 176) 0.09 (0.24)	.4742	(n = 348) 0.10 (0.30)	(n = 1,068) 0.10 (0.30)	.9808

Notes. The table presents mean values and standard deviations in parentheses for participants reporting physician-diagnosed diabetes. SP = Seguro Popular. SP was launched in 2001; thus, the survey in 2000 does not have a SP column and serves as a “pretreatment” observation. The reported p-value is from a comparison of SP versus uninsured populations (t-test for continuous variables, or chi-square test for categorical variables). CAM = complementary and alternative medicine (medical products or practices that are not part of standard of care).

*The comparison groups in 2006 and 2012 are the uninsured (73% in 2006 and 25% in 2012 from this sample); that is, those without any private insurance, IMSS, ISSSTE, PEMEX, SEDENA, or any other type of health insurance.

^aTime since diagnosis is measured in months.

^bPhysicians, nurses, and hospitals are per 100,000 people.

^cBMI_1 = Body mass index overweight (>25 kg/m²).

^dBMI_2 = Body mass index obese (>30 kg/m²).

**Family asset index based on the following assets: household infrastructure, household materials, and assets. This is a proxy for household’s wealth. It was calculated using principal components analysis. This measure is centered at 0, and negative values indicate lower household wealth.

Table 2: Continued

Hypertension Care and Treatment Indicators (N Varies by Indicator)	Year 2000 (Pre-SP)		Year 2006		Year 2012	
	Uninsured		Uninsured	Insured	Uninsured	Insured
Antihypertensive medication	(n = 1,020) 0.72 (0.45)		(n = 1,217) 0.74 (0.44)	(n = 467) 0.76 (0.43)	(n = 545) 0.82 (0.38)	(n = 1,686) 0.83 (0.37)
Diet	(n = 1,107) 0.08 (0.27)		(n = 1,013) 0.20 (0.40)	(n = 411) 0.20 (0.40)	(n = 446) 0.16 (0.36)	(n = 1,404) 0.14 (0.35)
Exercise	(n = 1,017) 0 (0)		(n = 920) 0.12 (0.33)	(n = 361) 0.09 (0.28)	(n = 446) 0.07 (0.26)	(n = 1,404) 0.06 (0.24)
CAM	(n = 1,086) 0.06 (0.24)		(n = 874) 0.08 (0.27)	(n = 344) 0.04 (0.20)	(n = 446) 0 (0)	(n = 1,404) 0 (0)

Notes. The table presents mean values and standard deviations in parentheses for participants reporting physician-diagnosed hypertension. SP = Seguro Popular. SP was launched in 2001; thus, the survey in 2000 does not have a SP column and serves as a “pretreatment” observation. The reported *p*-value is from a comparison of SP versus uninsured populations (*t*-test for continuous variables, or *chi*-square test for categorical variables). CAM = complementary and alternative medicine (medical products or practices that are not part of standard of care).

*The comparison groups in 2006 and 2012 are the uninsured (72% in 2006 and 25% in 2012 from this sample); that is, those *without* any private insurance, IMSS, ISSSTE, PEMEX, SEDENA, or any other type of health insurance.

^aTime since diagnosis is measured in months.

^bPhysicians, nurses and hospitals are per 100,000 people.

^cBMI_1 = Body mass index overweight (>25 kg/m²).

^dBMI_2 = Body mass index obese (>30 kg/m²).

**Family asset index based on the following assets: household infrastructure, household materials, and assets. This is a proxy for household's wealth. It was calculated using principal components analysis. This measure is centered at 0, and negative values indicate lower household wealth.

Overall, there were a few significant sociodemographic differences between those enrolled in *SP* and the uninsured in 2006 and 2012. *SP* beneficiaries with diabetes were more likely to have indigenous background and fewer family assets. The mean family asset index for the uninsured was -0.2 ($SD = 1.4$) compared to -0.5 ($SD = 1.3$) for *SP* enrollees in 2006; and -0.3 ($SD = 2.0$) for the uninsured compared to -0.7 ($SD = 1.8$) for *SP* enrollees in 2012. A smaller percentage of those insured by *SP* lived in rural areas, and the state where they resided had a higher number of physicians, nurses, and hospital per 100,000 people in both years (2006 and 2012). In 2006, the mean number of physicians, nurses, and hospitals in the region of residence for people with *SP* was 76 ($SD = 25$), 96 ($SD = 30$), and 16 ($SD = 6$), compared to 63 ($SD = 20$), 79 ($SD = 24$), and 14 ($SD = 6$) for the uninsured. In 2012, the mean number of physicians, nurses, and hospitals in the region of residence for people with *SP* was 86 ($SD = 28$), 110 ($SD = 37$), and 16 ($SD = 7$), compared to 82 ($SD = 25$), 103 ($SD = 32$), and 15 ($SD = 7$) for the uninsured. (Similar demographic and regional differences were found for those with hypertension.)

In terms of diabetes and hypertension treatment and care, there were a few significant differences by insurance status and year of survey. For those with diabetes, the only differences found were in blood sugar monitoring and insulin/oral medication utilization in 2012. The mean proportion of people monitoring their glucose was 0.6 ($SD = 0.5$) for those uninsured and 0.7 ($SD = 0.4$) for those with *SP*. Similarly, the mean of people using insulin and/or oral medication was 0.8 ($SD = 0.4$) for the uninsured compared to 0.9 ($SD = 0.3$) for *SP* beneficiaries. The only significant difference for people with hypertension was in CAM use in 2006 ($M = 0.08$, $SD = 0.3$ for the uninsured compared to 0.04, $SD = 0.2$ for those with *SP*). (All these differences were significant at $p < .05$.)

Health Insurance and Diabetes and Hypertension Care and Treatment

First Stage. The results showed that the instrumental variable (interaction of log population density at the municipality level in 2000 and a dummy variable for whether the survey was conducted in 2005–2006) was relevant and strong. The instrument had an F value of 19–26 (Table 3) for models with diabetes treatment and care, and an F value of 10–13 (Table 4) for hypertension treatment and care.

We also explored the log population density at the municipality level in 2000 and a dummy variable for whether the survey was conducted in 2011–

Table 3: Diabetes Care and Treatment Outcomes for Older Adults (Age >50) Insured by *Seguro Popular* versus Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012); Results from Fixed-Effects Instrumental Variable Estimation at the Individual Level with Municipality and Year Fixed Effects

<i>Variables</i>	<i>Blood Sugar Monitoring</i>	<i>Insulin/Oral Agents</i>	<i>Diet</i>	<i>Exercise</i>	<i>Alternative Medicine</i>
<i>SP</i> enrollee	0.08 (0.300)	0.41 (0.209)	-0.18 (0.312)	0.06 (0.180)	-0.09 (0.185)
Sex	0.11*** (0.024)	0.03 (0.019)	0.00 (0.024)	-0.01 (0.016)	0.03 (0.018)
Age	-0.00 (0.001)	0.00 (0.001)	-0.00 (0.001)	-0.00 (0.001)	0.00 (0.001)
Married	0.05* (0.021)	0.01 (0.016)	0.02 (0.021)	0.00 (0.013)	0.01 (0.015)
Indigenous background	-0.06 (0.057)	-0.09* (0.041)	0.01 (0.048)	0.02 (0.028)	-0.05 (0.038)
No education	0.00 (0.035)	0.02 (0.027)	-0.03 (0.034)	-0.02 (0.024)	-0.03 (0.026)
Primary education	0.00 (0.029)	0.02 (0.022)	-0.04 (0.029)	-0.02 (0.020)	0.01 (0.023)
Employed	-0.00 (0.024)	0.01 (0.018)	-0.02 (0.023)	0.02 (0.014)	0.03 (0.018)
Family assets	0.01 (0.007)	0.01 (0.006)	0.00 (0.008)	0.00 (0.005)	-0.00 (0.006)
Time since disease diagnosis	0.00 (0.000)	0.00*** (0.000)	0.00 (0.000)	0.00 (0.000)	0.00 (0.000)
BMI_1	-0.01 (0.028)	0.00 (0.020)	-0.02 (0.028)	0.01 (0.020)	0.02 (0.021)
BMI_2	0.03 (0.031)	0.02 (0.023)	-0.01 (0.031)	-0.02 (0.021)	0.00 (0.022)
Rural	-0.06* (0.026)	-0.01 (0.022)	-0.01 (0.028)	-0.01 (0.017)	-0.02 (0.021)
Physicians	-0.00 (0.003)	-0.00 (0.002)	0.00 (0.003)	-0.00 (0.002)	-0.00 (0.002)
Nurses	0.00 (0.002)	0.00 (0.001)	0.00 (0.002)	-0.00 (0.001)	0.00 (0.001)
Hospitals	0.01 (0.012)	-0.01 (0.010)	0.01 (0.011)	0.01 (0.007)	0.01 (0.010)
Illiteracy	-0.42 (0.422)	0.17 (0.322)	-0.67 (0.481)	-0.43 (0.306)	0.17 (0.347)
Log of population density*year 2012	0.00 (0.012)	0.01 (0.009)	0.00 (0.013)	-0.00 (0.008)	-0.01 (0.009)
Year 2006	0.12 (0.081)	-0.08 (0.068)	0.08 (0.086)	0.04 (0.054)	-0.02 (0.051)
Year 2012	-0.02 (0.224)	-0.38* (0.167)	0.09 (0.235)	0.04 (0.143)	0.06 (0.142)
Observations	2,769	2,611	2,595	2,346	2,459
Number of FE id (municipality)	544	532	525	493	510
<i>F</i> -test [†]	24.51***	26.37***	19.72***	19.74***	19.20***

Notes. The table presents results from a municipality and year fixed-effects instrumental variable (FE-IV) estimation using individual data with cross-sections from 2000, 2006, and 2012, constructed from $n = 3,015$ individuals described in Table 1.

Robust standard errors in parenthesis; standard errors are clustered at the municipality level; log of population density is collinear with municipality fixed effects, and therefore has not been included in the model.

[†]*F*-test of excluded instrument(s) in the IV first-stage regression.

* $p < .05$; *** $p \leq .001$.

Table 4: Hypertension Care and Treatment Outcomes for Older Adults (Age >50) Enrolled in *Seguro Popular* or Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006 and 2012); Results from Fixed-Effects Instrumental Variable Estimation at the Individual Level with Municipality and Year Fixed Effects

<i>Variables</i>	<i>Antihypertensive Medication</i>	<i>Diet</i>	<i>Exercise</i>	<i>Alternative Medicine</i>
<i>SP</i> enrollee	−0.08 (0.317)	0.31 (0.284)	0.09 (0.203)	−0.40 (0.241)
Sex	0.07*** (0.017)	−0.00 (0.016)	−0.01 (0.011)	0.01 (0.009)
Age	0.01*** (0.001)	−0.00 (0.001)	−0.00** (0.000)	0.00 (0.000)
Married	0.01 (0.015)	0.00 (0.016)	−0.00 (0.011)	0.01 (0.011)
Indigenous background	−0.04 (0.045)	−0.03 (0.041)	−0.02 (0.035)	0.04 (0.030)
No education	0.01 (0.037)	−0.07* (0.030)	−0.05** (0.019)	0.02 (0.021)
Primary education	0.02 (0.027)	−0.05* (0.022)	−0.03* (0.014)	0.02 (0.015)
Employed	−0.03* (0.016)	−0.00 (0.017)	−0.00 (0.011)	−0.01 (0.011)
Family assets	0.01 (0.007)	0.01 (0.006)	0.00 (0.004)	−0.01 (0.004)
Time since disease diagnosis	0.00 (0.000)	0.00 (0.000)	0.00 (0.000)	−0.00 (0.000)
BMI_1	0.03 (0.026)	−0.01 (0.021)	−0.02 (0.015)	0.02 (0.017)
BMI_2	0.07** (0.023)	0.03 (0.018)	0.00 (0.013)	0.02 (0.015)
Rural	−0.01 (0.021)	0.01 (0.017)	0.01 (0.014)	0.01 (0.013)
Physicians	−0.00 (0.003)	−0.00 (0.002)	0.00 (0.002)	0.00* (0.002)
Nurses	0.00 (0.002)	0.00 (0.001)	−0.00 (0.001)	−0.00 (0.001)
Hospitals	0.01 (0.010)	0.02* (0.010)	0.00 (0.006)	−0.01 (0.008)
Illiteracy	−0.34 (0.259)	−0.18 (0.220)	−0.04 (0.153)	0.04 (0.167)
Log of population density*year 2012	0.00 (0.009)	−0.01 (0.010)	0.01 (0.006)	0.00 (0.005)
Year 2006	0.03 (0.083)	0.10 (0.075)	0.10* (0.050)	0.09 (0.059)
Year 2012	0.12 (0.213)	0.01 (0.186)	−0.02 (0.133)	0.17 (0.149)
Observations	4,772	4,222	3,970	3,980
Number of FE id (Municipality)	705	679	653	654
<i>F</i> -test [†]	10.23**	10.44**	12.59**	10.68**

Notes. The table presents results from a municipality and year fixed-effects instrumental variable (FE-IV) estimation using individual data with cross-sections from 2000, 2006, and 2012, constructed from $N = 5,307$ individuals described in Table 2. Robust standard errors in parenthesis; standard errors are clustered at the municipality level; log of population density is collinear with municipality fixed effects and therefore has not been included in the model.

[†]*F*-test of excluded instrument(s) in the IV first-stage regression.

* $p < .05$, ** $p < .01$, *** $p \leq .001$.

2012 as an instrument (see first stage of the 2SLS FE-IV that shows the relationship between *SP* coverage and log population density in 2000 and survey year in Table A1 in the Appendix). However, this second potential instrument was weak (see Appendix Tables A2 and A3).² Thus, the present results

report only the interaction term of log population density in 2000 and whether the survey was conducted in 2005–2006 as an instrument, and we used the interaction of 2012 dummy and population density as a control variable.

Second Stage. The results from fixed-effects instrumental variables (FE-IV) pseudo-panel data estimation are presented in Tables 3 and 4. As discussed above, insurance enrollment may not be a random event, reflecting potentially unobserved factors associated with both treatment and outcomes. This endogeneity problem may lead to bias estimates of the effectiveness of *SP* in diabetes and hypertension treatment and care process indicators. Using FE-IV pseudo-panel estimation to address the potential endogeneity, for people over 50 years and older with diabetes, the only difference we found between the uninsured and those enrolled with *SP* was in diabetes pharmacological treatment (insulin/oral agents). The effect of *SP* on use of insulin and/or oral agents was marginally significant ($p = .051$), showing a tendency that *SP* beneficiaries with diabetes were more likely to use pharmacological treatment (Table 3). This relationship became even more significant when adults 20 and older were included in the sample (see Appendix Table A4). Results were different for Mexican older adults with hypertension. No significant difference was found for antihypertensive medication for *SP* enrollees as opposed to the uninsured.

DISCUSSION

To our knowledge, this is the first study that uses repeated cross-sectional data and instrumental variable fixed-effects models to control for endogeneity to evaluate the impact of the social health insurance program in Mexico (*Seguro Popular*) on diabetes and hypertension treatment and care process indicators among older Mexican adults. We hypothesized that older adults insured by *SP* would have better diabetes and hypertension treatment and care process indicators than the uninsured. However, we only found a marginally significant positive effect on use of pharmacological therapy for people with diabetes (increased by 41 pp). Contrary to that expected, the results showed that *SP* did not have a significant effect on a number of components of diabetes treatment and care among older adults, specifically self-care behaviors such as blood sugar monitoring and following a diabetic exercise plan. In addition, *SP* enrollment did not seem to have an effect on CAM use.

The FE-IV models for older adults with hypertension did not show any significant effects. These results are different than those of Bleich et al. (2007), who used single cross-section data from the Mexican Health and Nutrition Survey 2005–2006, and propensity score matching techniques, to find that adults 20 years and older with hypertension insured through *SP* were more likely to receive antihypertensive treatment than those who were uninsured (50 percent higher rates). However, in our sensitivity analysis, when we included adults 20 and over in our sample, there were not significant differences for *SP* enrollees compared to the uninsured (see Appendix Table A5).

Although we saw a positive and significant difference in the descriptive statistics for blood glucose monitoring and insulin and/or oral medication utilization in 2012, the only effect close to significance in our FE-IV models for people with diabetes was for the use of insulin/oral medication. Recent studies have shown that Mexican adults with diabetes aged 20 and older had poor diabetes management regardless of health insurance status (Aguilar-Salinas et al. 2003). Again, our sensitivity analysis, which included people 20 years and older, only showed that *SP* increased the use of pharmacological therapy by 39 pp (see Table A4).

In additional sensitivity analyses, we also tested Arellano–Bond estimation methods with one-lag, autoregressive (AR1) models at the municipality level, and we did not find any effect of *SP* in either diabetes or hypertension treatment and control (see Appendix Tables A6 and A7).

These results are only partly consistent with those of Sosa-Rubi, Galaraga, and Lopez-Ridaura (2009), who used a single cross-section of the Mexican Health and Nutrition Survey 2005–2006, and propensity score matching, to find that *SP* had a positive result for adults 20 years and older with diabetes. For example, they found that *SP* beneficiaries were more likely to use pharmacological treatment, monitor their blood glucose, and had better HbA1c levels than the uninsured.

However, our results may be different because we are using three waves of data, as well as different models to attempt measuring a causal effect. Both Bleich et al. (2007) and Sosa-Rubi, Galaraga, and Lopez-Ridaura (2009) used propensity score matching and ENSANUT 2006. The *SP* rollout process started in 2002 and was only partially completed in 2005. So those results show the short-term effect of *SP* in the treatment and control of these conditions. As we see in our present results, the number of people enrolled in *SP* with these conditions has increased considerably from 2006 to 2012. So, although *SP* appears to be reaching those in need (and those individuals at high risk are enrolling into the program), it may be difficult to provide

resources and supply medicine to all these patients. Our findings may be possibly related to supply constraints, which we cannot assess with the current data. Yet the lack of fully protective effects of *SP* has been documented by other recent studies. For example, using an experimental design, Spenkuch (2012) found that people enrolled in *SP* were less likely to use preventive care. In addition, Molina and Palazuelos (2014), using qualitative interviews, found that people with lower resources were less likely to use *SP* clinics because they were unable to request medications and the supply chain was weak; hospital inventories were empty and medication never arrived for some patients in this study. Moreover, as it is well known in the econometrics literature, propensity score methods do not fully account for unobservable (unmeasured) confounders. Thus, the differences between the results presented here and the previous propensity score matching research may also be related to the differences between an average treatment effect (ATT) found through matching versus a local average treatment effect (LATE) found through IV-FE pseudo-panel estimation (Wooldridge 2010).

Future research should explore whether people with diabetes enrolled in *SP* receive adequate and effective diabetes education. This may help to disentangle whether the results are related to lack of knowledge or motivation and skills to engage in diabetes self-care practices or whether this is a compliance issue. For example, a recent study by Barquera et al. (2013) illustrated that a very low percentage of people with diabetes in Mexico understand the importance of diet (24 percent) and exercise (2 percent) as important components of diabetes management. In addition, Baca Martínez et al. (2008) found that people with diabetes living in Culiacán, Mexico, have poor knowledge about diabetes care and treatment (conventional medicine, nutrition, and exercise). Participants in their study did not have formal diabetes education. Similarly, Saldaña et al. (2007) found that health center patients middle-aged and older of rural and urban communities in Jalisco, Mexico, had poor knowledge of glycemic control, especially diet and exercise knowledge, and thus poor glycemic control (15 percent had target HbA1c levels). *SP* does not cover diabetes education classes.

Although health insurance and poor diabetes knowledge impacts diabetes management, these are not the only factors influencing diabetes treatment and care. The National Institute of Public Health stated that current challenges in the Mexican health care system included shortfalls in pharmacological treatment, lack of specialized care and physicians, poor infrastructure, medical equipment, and laboratory facilities (Instituto Nacional de Salud Pública 2010). This suggests that health clinics may not be fully prepared to

provide specialized care for people with diabetes and this may include facilities that are part of the *SP* network.

These findings should be interpreted with caution, as this study has limitations. First, the findings reflect medium-term effects of *SP* on self-management activities and intermediate process indicators. Future research should explore long-term effects of *SP* on self-management behaviors, health care utilization, and biological outcomes for people with diabetes and hypertension. It would be also important to incorporate access to physicians and clinics and distance to health care facilities to explore differences in health care utilization and health outcomes. Second, the data used in this study are repeated cross-sections; using panel data following individuals over time could be more informative.

Despite the limitations, our results suggest that access to *SP* improves may improve pharmacological treatment for diabetes. However, policy makers and practitioners need to better address the burden of diabetes in Mexico among older populations. Education programs for consumers and health care providers for diabetes prevention and management should be incorporated into health care institutions to ameliorate poor quality of diabetes care in Mexico. Having the *SP* insurance card may only be the beginning in achieving better health outcomes; improved quality of care is needed to increase quality of life and decrease morbidity and mortality among older adults with diabetes.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: This project was supported by grant number T32HS000011 from the Agency for Healthcare Research and Quality. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality. Dr. Galarraga was partially supported by an NIH Center Grant (R24 HD041020) to the Population Studies and Training Center (PSTC). No conflicts of interest or financial disclosures are declared by any author of this study.

Disclaimers: None.

NOTES

1. The direct effect of log of population density was collinear with municipality fixed effects, and therefore it was not included in the model.

2. A quadratic term was also explored for the interaction of population density and survey year, but the instrument vector was not sufficiently strong.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Table A1: First-Stage Results of the Two-Stage Least Squares (2SLS) Regression FE-IV Analysis for the Use of Diabetes Pharmacological Treatment (Insulin and/or Oral Agents).

Table A2: *Diabetes* Care and Treatment for Adults (Age >50) Insured by *Seguro Popular* versus Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012); Results from Fixed-Effects Instrumental Variable Estimation at the Individual Level with Municipality and Year Fixed Effects (*Using Two Instruments*: Interaction Term of Log of Population Density

in 2000 by Year of Survey 2006 and Interaction Term of Interaction Term of Log of Population Density in 2000 by Year of Survey 2012).

Table A3: *Hypertension* Care and Treatment for Adults (Age >50) Insured by *Seguro Popular* versus Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012); Results from Fixed-Effects Instrumental Variable Estimation at the Individual Level with Municipality and Year Fixed Effects (Using *Two Instruments*: Interaction Term of Log of Population Density in 2000 by Year of Survey 2006 and Interaction Term of Interaction Term of Log of Population Density in 2000 by Year of Survey 2012).

Table A4: *Diabetes* Care and Treatment Outcomes for Older Adults (Age ≥ 20) Enrolled in *Seguro Popular* or Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012); Results from Fixed-Effects Instrumental Variable Estimation at the Individual Level with Municipality and Year Fixed Effect (Using Interaction between Logarithm Population Density in 2000 and Whether Survey Was Conducted in 2006).

Table A5: *Hypertension* Care and Treatment Outcomes for Older Adults (Age ≥ 20) Enrolled in *Seguro Popular* or Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012); Results from Fixed-Effects Instrumental Variable Estimation at the Individual Level with Municipality and Year Fixed-Effects (Using Interaction between Logarithm Population Density in 2000 and Whether Survey Was Conducted in 2006).

Table A6: *Diabetes* Care and Treatment for Older Adults (Age >50) Insured by *Seguro Popular* versus Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012); Results from One-Lag Autoregressive (AR1) Arellano–Bond Analysis at the Municipality Level.

Table A7: *Hypertension* Care and Treatment for Older Adults (Age >50) Insured by *Seguro Popular* versus Uninsured in Mexico: Mexican Health and Nutrition Surveys (2000, 2006, and 2012); Results from One-Lag Autoregressive (AR1) Arellano–Bond Analysis at the Municipality Level.