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Potential Savings In Mexico From Screening And Prevention For Early Diabetes And Hypertension

ABSTRACT This study analyzes the potential economic benefits of identifying and treating patients with so-called prediabetes and prehypertension through the Mexican prevention program known by its Spanish acronym PREVENIMSS. The results show that for each US dollar invested in prevention, \$84–\$323 would be saved over a twenty-year period. For this and other reasons, providing preventive care for prediabetes and prehypertension patients is better than the current routine care model, in which care is provided in most cases when the disease has progressed substantially. Yet data show that screening and preventive care services are still not being used widely enough in Mexico, are provided too late, or are not sufficiently targeted to the most at-risk individuals. Investing in preventive care for patients with prediabetes and prehypertension is cost saving.

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Hypertension and type 2 diabetes contribute greatly to cardiovascular disease, disability, and premature mortality.¹ In 2000 the worldwide prevalence of hypertension had reached 26.4 percent,² and that of type 2 diabetes was estimated to be 6.6 percent.³

Hypertension and type 2 diabetes have recognizable preclinical stages, known as prehypertension and prediabetes, that can be detected by screening. Detection makes it possible to start preventive care before symptoms appear.

The natural progression from prediabetes to type 2 diabetes takes five to eleven years, on average. Once the disease is established, it will give rise to acute and chronic complications.⁴ Individuals with prehypertension who eventually progress to hypertension are at increased risk of heart disease, stroke, and death.^{5,6} In Mexico approximately 35 percent of patients have both type 2 diabetes and hypertension.

Detection And Screening

Prediabetes and prehypertension are identifiable through screening. Prediabetes can be identified and treated early, thus delaying the progression to type 2 diabetes by up to several years. Lifestyle interventions^{7,8} such as diet modifications can also help delay the onset of type 2 diabetes. These interventions can reduce the incidence of the disease by up to 58 percent.^{9,10} This reduction is a health gain that is observable at the population level, and there are equivalent gains at the individual level in the delay of the onset of clinical manifestations.⁴

The risk for cardiovascular events—such as a heart attack or stroke—varies according to sex, age, blood pressure,¹¹ and blood glucose levels.¹² A person with prehypertension has 1.8 times the risk of cardiovascular disease as someone with neither prehypertension nor prediabetes. The risk increases to 2.12 times in a person with both conditions, and to 3.7 times for a person with prehypertension and type 2 diabetes. These calculations suggest the importance of assessing the risk of cardiovascular events by considering blood pressure and glucose levels together

rather than independently.

Timely detection of prehypertension or hypertension without cardiovascular disease reduces cardiovascular events. Lowering diastolic blood pressure by 5 mm Hg reduces the risk of stroke by 34 percent and of ischemic heart disease by 21 percent, compared to any pretreatment level.¹¹

ECONOMIC EVALUATION OF SCREENING PROGRAMS Screening programs for type 2 diabetes or hypertension have an acceptable cost-effectiveness ratio because they are low cost and have the potential to reduce cardiovascular events and delay or prevent the onset of clinical disease.^{13–17} However, no general recommendation or protocol exists for how to conduct screening.¹⁸ Some economic evaluations have reported that the savings realized from a screening program were observed a few years after a program was implemented.^{8,19} The magnitude of the savings varied depending on the horizon of the study and the strategy of prevention.

MEXICO'S SCREENING AND PREVENTIVE PROGRAM The Mexican Institute of Social Security (Instituto Mexicano del Seguro Social, or IMSS) provided social, health, and economic benefits to 48.9 million people in 2008. The prevalence of type 2 diabetes among beneficiaries older than age twenty was 14.8 percent; for hypertension, 35.6 percent.²⁰ Both prevalences exceeded the national averages. These conditions cause the most visits to Mexican primary care clinics, and their complications are among the top causes of hospitalization.²¹

Mexico's Integrated Health Programs strategy, known as PREVENIMSS (for Prevention in IMSS) is the institute's national preventive program. It provides four major preventive care benefits: health education; nutritional information; disease prevention; and screening for highly prevalent diseases, including type 2 diabetes and hypertension.²² Preventive care is available for people with risk factors for type 2 diabetes or hypertension. For example, people who are overweight or obese are referred to support groups with the aim of improving lifestyle through education about exercise and diet. Nutritionists and social workers also provide individual care.

These preventive services are appropriate for patients with prehypertension and prediabetes. However, little has been done to provide health care for these patients, although services are available. For this study, we used two models: a preventive-care model, including patients who received screening and prevention activities; and a routine-care model for all other patients.

Our primary objective was to analyze the potential economic benefits of providing preven-

tive care for patients with prediabetes and prehypertension compared with routine care. A secondary objective was to explore whether there is an unmet need for screening and preventive care for adults ages 20–29, and to assess the potential gain of meeting that need.

Study Data And Methods

The study consisted of two components: an analysis of the results of the PREVENIMSS screening program for type 2 diabetes and hypertension; and an analysis of the potential economic benefits of providing preventive care to patients in preclinical stages of type 2 diabetes, hypertension, or both.

POPULATION In 2006 the Mexican Institute of Social Security conducted a nationwide household survey, known as ENCOPREVENIMSS, to evaluate coverage of preventive activities among its members.²⁰ The survey included a subsample of participants whose blood pressure and glucose levels were measured. We used information from the survey to determine the prevalence of preclinical stages of type 2 diabetes and hypertension, and to evaluate the screening program in terms of the percentage of people screened for the two conditions.

We divided the participants into five risk groups: young adults, male and female (ages 20–29); adults, male and female (ages 30–59); and older adults (age 60 and older).

LIMITATIONS This was a secondary data analysis of a survey, which means that information regarding participants' follow-up care was not available. Therefore, we could not verify assumptions concerning the health gain attributable to early detection of type 2 diabetes and hypertension.

We based our assumptions concerning the progression from prediabetes or prehypertension to clinically established type 2 diabetes or hypertension on literature reviews and focused on the more severe stages of the diseases. This could have resulted in an underestimation of the savings from timely detection over a decade or so.

Our analysis did not include indirect or non-medical costs (such as loss of productivity), which would increase the economic burden that preventive care could avoid. Including these costs would reinforce our findings.

Information regarding cardiovascular events in young adults was not available. For that group, we used the same risk rates for such events that we used for the entire group of adults according to sex. In the survey, younger adults with prehypertension had blood pressure at least 20 percent above the expected level for their age group.¹¹ In addition, the survey found a high

frequency of prediabetes. The risk of diabetes could be greater in young adults, which would imply that we might have underestimated health care costs and potential savings. A study by the US Centers for Disease Control and Prevention (CDC) reached a similar conclusion.¹³

We did not consider the effect of preventive care on premature mortality from cardiovascular events. But because these costs correspond to cardiovascular acute events and not to chronic states, and only some events are fatal, we believe that excluding mortality should have only a minimal impact on our results.

COVERAGE ANALYSIS We estimated the main results of the current screening program. The actual data came from the 2006 survey that we used to measure the health status of users of the screening program.²⁰ We used these results to model the potential economic impact of the program on the preclinical conditions. The details of this analysis are in the Technical Appendix.²³

ECONOMIC ANALYSIS The economic analysis compared the preventive- and routine-care models. The first model consisted of screening followed by preventive activities including lifestyle changes, dietary counseling, and physical exercise for people found to have preclinical conditions. The second model consisted of clinical detection of the conditions, followed by confirmation of the diagnosis and provision of curative care at primary care facilities. It did not include preventive activities.

For each model, we estimated the health care costs associated with type 2 diabetes and hypertension over a period of twenty years. We also estimated costs for a ten-year period for older adults, given their lower remaining life expectancy.

Our assumptions included the progression of the diseases, health gains attributable to preventive care, and health care costs. We calculated the incremental costs of the preventive-care model, as opposed to the routine-care model. We also estimated the savings per dollar invested in screening and the average savings per user covered.

DETAILS OF THE PREVENTIVE-CARE MODEL The preventive-care model implied a change in the criteria for the screening program—adding the detection of preclinical stages of type 2 diabetes and hypertension, and the provision of preventive care. The specific interventions should be tailored to each patient's characteristics. The sensitivity of the test for prediabetes was reported as 58.3 percent, and its specificity as 58.6 percent.²⁴ (Sensitivity refers to the percentage of the people tested who had the condition and tested positive for it; specificity refers to the percentage tested who did not have the condition

and tested negative for it.) We used these values in our economic analyses.

The Technical Appendix presents a graphic depiction of the paths from screening services to primary care, with all of the possible outcomes.²³ When screening found normal levels of blood glucose or pressure, we excluded the patient from our study. When a diagnosis confirmed a preclinical stage of disease, we assumed conservatively that only a fraction of those patients would receive appropriate care.

Patients who received appropriate care included those identified by the screening program who received preventive activities. Patients who received inappropriate care included those identified by the screening program who nonetheless did not receive preventive services, as well as those who were not identified by the screening program but who did have preclinical type 2 diabetes or hypertension. We assumed that the people in the inappropriate-care group experienced no health gains.

We based the estimated proportion of patients receiving appropriate care on reports from the Mexican Institute of Social Security concerning the adequate control of patients' type 2 diabetes or hypertension in primary care services (83 percent for hypertension, 30 percent for type 2 diabetes).²⁵ For cases in which both screening results were abnormal, we assumed that the proportion of patients receiving appropriate care was 30 percent.

MODELING DISEASE PROGRESSION We modeled the progression of the patient's health status depending on the initial state of health and the stage of disease (preclinical or clinical) detected by the screening.

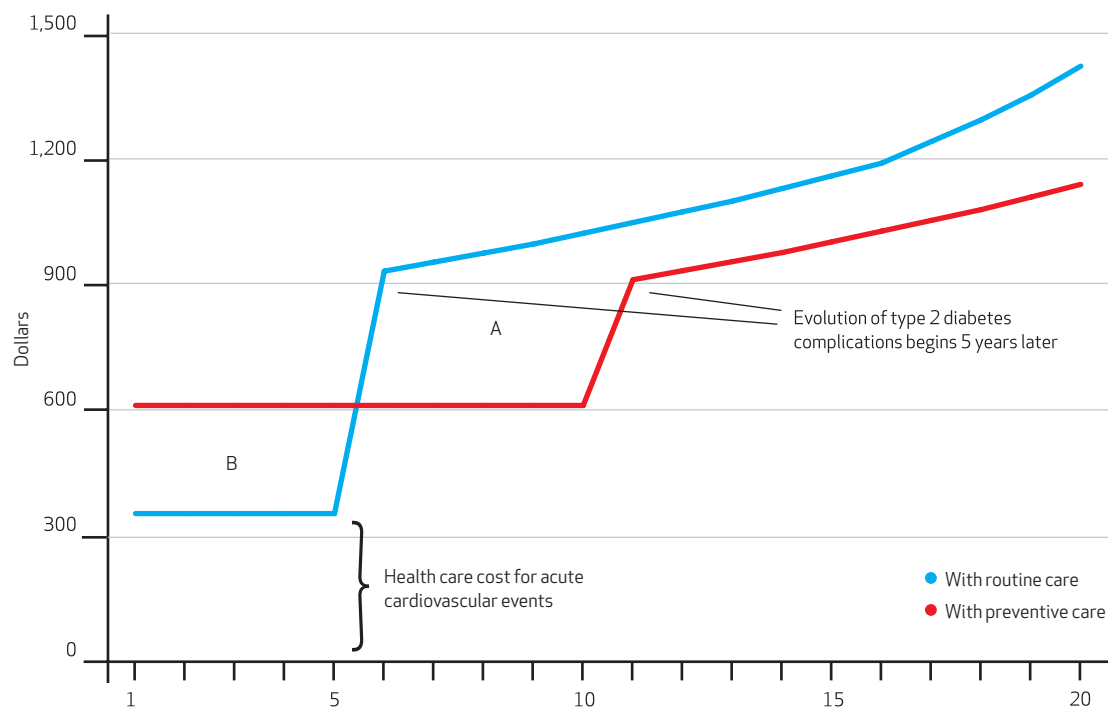
We assumed that every patient with prediabetes would progress to type 2 diabetes within five years without preventive care, and within ten years with preventive care. For patients with prehypertension, we estimated the risk of a cardiovascular event according to sex and age. We used three disease progressions: from prediabetes to type 2 diabetes; from type 2 diabetes to chronic complications such as neuropathy, amputation of a lower extremity, end-stage renal disease, and diabetic retinopathy;^{26,27} and from prehypertension to acute cardiovascular events, such as acute myocardial infarction (heart attack) and stroke.^{12,28} The Technical Appendix provides a complete description of the assumptions in our models.²³

Study Results

HEALTH GAINS AND COSTS Exhibit 1 is a graphical representation of our comparison of preventive care with routine care. The figure shows the

EXHIBIT 1

Progression Of Health Care Costs For Prehypertension And Prediabetes With Routine Or Preventive Care For Adult Men, Mexico



SOURCE Authors' estimates of data from ENCOPREVENIMISS 2006 (see Note 20 in text). **NOTES** The area labeled A, between the lines for routine and preventive care, represents the savings on health care costs produced by preventive care. The area labeled B represents the investment in providing preventive care. Data shown are for adult men. The area between the routine-care line and the horizontal axis represents the cost of the risk of an acute cardiovascular event.

health gain attributable to preventive care for a typical male patient with prediabetes and prehypertension. (Exhibit A in the Technical Appendix provides comparable information for the other health states.)²³

We modeled the health gain for routine care, assuming that the patient remained in the pre-clinical condition for five years. The patient then moved to the clinical stage and progressed toward chronic complications. For preventive care, the preclinical condition lasted for ten years, after which type 2 diabetes and chronic complications began.

Exhibit 1 shows that at the fifth year, the cost of routine care exceeds the cost of preventive care because complications have arisen with routine care. The preventive care model will save money as long as the area marked A (the cost of routine care) is greater than the area marked B (the cost of preventive care).

We used one-way sensitivity analysis²⁹ to evaluate how changes in the unit cost of screening tests, the proportion of patients receiving preventive care, and the coverage and timeliness of the screening affected the average savings per

screening-program patient. The analysis was performed using the statistical package SPSS, V17-IBM, and Microsoft Excel 2007.

DISTRIBUTION OF HEALTH STATUS Exhibit 2 shows the distribution of the health status of the participants associated with prediabetes and prehypertension. The proportion of people with normal levels of blood glucose and blood pressure varied according to age and sex. Young women had the highest proportion of normal levels; older adults had the lowest proportion. Prehypertension was the most frequent abnormal health state. Regardless of blood pressure levels, prediabetes was most common among adult women.

SCREENING PROGRAM Exhibit 3 presents the analysis of the screening program. More than 80 percent of young adults and adults were in need of both screening tests—for hypertension and type 2 diabetes—while the percentage was lower for older adults because most of them had already been diagnosed.

Older adults and adult women had the highest coverage levels—meaning that they received all of the screening tests they needed—and young

EXHIBIT 2
Distribution Of Health Status Associated With Type 2 Diabetes And Hypertension, Mexico, 2006

Health state	Young adults (20-29)				Adults (30-59)				Older adults (60+)	
	Women		Men		Women		Men			
	N	%	N	%	N	%	N	%	N	%
NORMAL LEVELS OF BLOOD PRESSURE OR GLUCOSE										
All	961	40.8	562	27.8	1,330	21.6	662	13.8	417	7.5
ELEVATED LEVELS OF BLOOD PRESSURE OR GLUCOSE										
Prehypertension only	1,012	43.0	1,128	55.7	2,450	39.8	2,299	48.3	1,170	21.2
Prediabetes only	57	2.4	23	1.1	102	1.7	47	1.0	21	0.4
Prehypertension and prediabetes	67	2.8	45	2.2	212	3.4	168	3.5	98	1.8
Hypertension only	182	7.7	192	9.5	1,129	18.3	865	18.2	1,764	31.9
Diabetes only	18	0.8	12	0.6	106	1.7	60	1.3	121	2.2
Diabetes plus prehypertension	29	1.2	37	1.8	275	4.5	241	5.1	486	8.8
Prediabetes plus hypertension	14	0.6	17	0.8	120	1.9	85	1.8	140	2.5
Diabetes plus hypertension	16	0.7	10	0.5	436	7.1	332	7.0	1,307	23.7
Subtotal	1,395	59.2	1,464	72.2	4,830	78.4	4,097	86.2	5,107	92.5
Normal plus elevated levels	2,356	100.0	2,026	100.0	6,160	100.0	4,759	100.0	5,524	100.0

SOURCE Authors' estimates of data from ENCOPREVENIMISS 2006 (see Note 20 in text).

adults had the lowest. The screening program detected preclinical conditions in time for preventive action most often in young and adult

men, and least often in young women.

ECONOMIC EVALUATION RESULTS The unit cost estimated for the type 2 diabetes screening test

EXHIBIT 3
Results Of The PREVENIMSS Screening Program For Type 2 Diabetes And Hypertension, Mexico, 2006

Results of effective coverage	Young adults (20–29)				Adults (30–59)				Older adults (60+)	
	Women		Men		Women		Men			
	N	%	N	%	N	%	N	%	N	%
NEED										
No need	6	0.3	0	0.0	253	4.1	169	3.6	867	15.7
In need of										
Type 2 diabetes screening	59	2.5	23	1.1	679	11.0	348	7.3	1,386	25.1
Hypertension screening	12	0.5	14	0.7	309	5.0	259	5.4	711	12.9
Both screenings	2,279	96.7	1,989	98.2	4,919	79.9	3,983	83.7	2,560	46.3
Subtotal	2,350	99.7	2,026	100.0	5,907	95.9	4,590	96.4	4,657	84.3
Total, no need and need	2,356	100.0	2,026	100.0	6,160	100.0	4,759	100.0	5,524	100.0
COVERAGE										
No coverage	1,056	44.9	1,128	55.6	1,716	29.1	1,707	37.2	1,203	25.8
Coverage										
Partial coverage	385	16.4	224	11.1	618	10.4	475	10.3	346	7.4
Complete coverage	909	38.7	674	33.3	3,573	60.5	2,408	52.5	3,108	66.8
Subtotal	1,294	55.1	898	44.4	4,191	70.9	2,883	62.8	3,454	74.2
Total, no coverage and coverage	2,350	100.0	2,026	100.0	5,907	100.0	4,590	100.0	4,657	100.0
TIMELINESS										
Normal levels of blood pressure and glucose found	508	39.3	206	22.9	973	23.2	405	14.0	288	8.3
Delayed screening	75	5.8	51	5.7	585	14.0	317	11.0	1,086	31.4
Timely detection	711	54.9	641	71.4	2,633	62.8	2161	75.0	2,080	60.3
Total	1,294	100.0	898	100.0	4,191	100.0	2,883	100.0	3,454	100.0

SOURCE Authors' estimates of data from ENCOPREVENIMISS 2006 (see Note 20 in text). **NOTES** "No need" denotes that a patient has already been diagnosed for both type 2 diabetes and hypertension. "Need" denotes that a patient has no information about his or her levels of blood pressure, glucose, or both, as indicated. "No coverage" denotes that a patient received none of the needed screening tests. "Partial coverage" denotes that a patient received only one test but needed both. "Complete coverage" denotes that a patient received as many tests as he or she needed. "Delayed screening" denotes that detection of prediabetes or prehypertension occurred too late for preventive action. "Timely detection" denotes that detection occurred in time for preventive action to be taken.

was US\$1.40; for the hypertension test, US\$1.00.

We estimated the costs of care over twenty years associated with each of the nine health states for hypertension and type 2 diabetes. Appendix Exhibit C presents the present value of the cost of treating acute and chronic complications. Appendix Exhibit D presents the percentage reduction of health care costs for each of the health states according to the coverage level of the screening test.²³

A substantial reduction in cost (14–16 percent) is associated with the timely detection of prediabetes. However, if an individual had prediabetes combined with prehypertension, the risk of a cardiovascular event increased, and so did the associated costs, reducing the potential savings. In these cases, timely detection of prediabetes produced greater savings than timely detection of prehypertension. However, if hypertension (instead of prehypertension) was present, the risk of a cardiovascular event, and the savings, increased. For patients who needed both screenings but got only one, administering diabetes screening produced more savings than administering hypertension screening.

In our economic analysis of costs over ten years for older adults, detecting prediabetes produced only negligible savings for patients who also had prehypertension or hypertension, as their risk of acute cardiovascular events was equal to or greater than their risk of developing chronic diabetic complications. Detecting prehypertension led to greater savings for older adults (8.7 percent) than for adult women (1.9 percent), while detecting hypertension produced greater savings for adult women (13.7 percent) than for adult men.

POTENTIAL ECONOMIC BENEFITS OF THE PROGRAM Exhibit 4 compares the preventive care and routine care models and shows the corresponding savings. For all age groups, the screening program saved money. Highest total costs and savings were realized with older adults.

The proportion of appropriate care was the most important variable on the potential savings of the preventive care program. Savings for young and adult men were less sensitive to changes in the proportion of patients with preventive care than the savings for adult women and older adults. Our analysis also showed low sensitivity to changes of unit screening costs, coverage, and timeliness (see Appendix Exhibit E).²³

This analysis shows the potential contribution of preventive care for prehypertension and prediabetes patients in delaying the clinical manifestations of the diseases and the development of chronic complications. It also shows that implementing this service can save costs over one or

two decades. Prevention programs are a fundamental component of health policies, and the infrastructure of primary care facilities in Mexico would allow the implementation of innovative models of preventive care, although further investment in screening and treatment capacity would be necessary.

Discussion And Conclusion

CURRENT SCREENING PROGRAM LIMITATIONS The level of screening for type 2 diabetes and hypertension in adults and older adults (69 percent) was low even though both conditions were highly prevalent in these age groups. In young adults, coverage reached 55 percent (for women) and 44 percent (for men). Given that these age groups are not included in PREVENIMSS screening for type 2 diabetes and hypertension, these percentages are high and an unexpected finding.

Men used screening services less often than women. Screening tests are available to all potential users, but further action is needed to encourage men to use these services.

The timeliness of detection in the screening program was higher for men than for women (Exhibit 3). Women who were screened were more likely to be healthy than men who were screened (normal levels). In the future, it would be worthwhile to refine criteria to identify high-risk groups and to promote the use of screening to those groups. This would be feasible because screening is such a low-cost activity.

Our analysis shows that there is wide room for improvement in the screening program in terms of coverage and timeliness. Further research is needed to uncover reasons why the services are not being more widely used and are being provided too late or to the wrong patients. For young and adult men, the main problem is low coverage; for women and older adults, it is late detection. The screening program should target young age groups more deliberately, since more than 50 percent of young adults who were screened showed some abnormality.

POTENTIAL BENEFITS OF PREVENTIVE CARE Our economic analysis focused on modeling the potential impact of preventive care on health care costs in terms of its actual performance rather than in a controlled clinical trial. The results showed that providing preventive care for patients with prediabetes and prehypertension is better than the current routine-care model.

The costs of the current screening activities represent on average only 0.5 percent of the present value of the savings in the medium term (twenty years). Therefore, the cost of the preventive-care model will be lower than the cost of routine care for patients who eventually develop

EXHIBIT 4
Potential Economic Benefit Of The Screening Program For Each Group At Risk (Present Value For The Next 20 Years), Mexico, 2006

Group of risk	Present value of health care cost of type 2 diabetes and hypertension (thousands US\$)					Difference in cost from preventive care	Savings per US\$ invested in screening	Savings per person screened (US\$)
	With preventive care				Without preventive care (routine care)			
	Screening	Appropriate care	Routine care	Total cost				
Young adult women (20-29)	2.6	3,117.0	6,758.3	9,877.9	10,077.8	-199.9	78.2	154.5
Adult women (30-59)	8.4	16,207.0	33,834.3	50,049.7	51,591.4	-1,541.7	183.1	367.8
Young adult men (20-29)	1.8	2,732.2	6,821.7	9,555.8	9,693.6	-137.9	75.3	153.5
Adult men (30-59)	5.8	11,124.4	24,830.8	35,961.0	36,543.7	-582.7	100.8	202.1
Older adults	6.0	19,048.2	52,972.4	72,026.6	73,628.7	-1,602.1	267.8	463.8
Older adults (10-year model)	6.0	10,158.4	27,657.9	37,822.2	38,668.7	-846.5	141.5	245.1

SOURCE Authors' estimates of data from ENCOPEVENIMISS 2006 (see Note 20 in text).

type 2 diabetes, hypertension, or both conditions.

On average, for each dollar invested on screening, US\$141 will be saved in the medium term, depending on the group at risk. The highest savings per case covered were observed in older adults, and the lowest in young adults. These findings are consistent with the results of a previous study.¹³ The low unit cost of the screening tests means that the program would continue to save money even if many healthy people were screened.

These economic benefits can be obtained only by providing preventive activities as a complement to screening. The Mexican Institute of Social Security does not currently offer preventive services for patients with preclinical conditions. Our results indicate that it would gain from doing so.

SENSITIVITY ANALYSIS The sensitivity analysis demonstrated that appropriate care in primary care facilities is the most influential variable on the potential savings of the screening program.

Screening for type 2 diabetes and hypertension would save more as the proportion of appropriate care increased. But even when the lowest possible percentage of patients received preventive care, the cost of screening still represented a negligible cost.

The sensitivity analysis also demonstrated that a fivefold increase in the screening cost would reduce the average savings per user by less than 3 percent. This shows that it would be worth expanding the screening program, particularly in low-risk groups under the traditional criteria.

CONCLUSION Long-term studies analyzing the effectiveness of preventive care in curbing the progression of type 2 diabetes and hypertension in the Mexican population are advisable. However, our evaluation of the potential economic benefit of implementing preventive care within the existing program for type 2 diabetes and hypertension demonstrated its cost savings. Our study also showed that expanding the program to young adults would result in increased health and economic gains. ■

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NOTES

- 1 Hossain P, Kavar B, El Nahas M. Obesity and diabetes in the developing world—a growing challenge. *N Engl J Med*. 2007;356:213–5.
- 2 Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. *Lancet*. 2005;365:217–23.
- 3 International Diabetes Federation. IDF diabetes atlas [Internet]. Brussels: The Federation; 2010 Mar 8 [cited 2010 Apr 5]. Available from: <http://www.diabetesatlas.org/content/regional-data>
- 4 Waugh N, Scotland G, McNamee P, Gillett M, Brennan A, Goyder E, et al. Screening for type 2 diabetes: literature review and economic modelling. *Health Technol Assess*. 2007;11(17):1–125.
- 5 Sipkoff M. Prediabetes: prevalent and preventable but underdiagnosed and undertreated. *Manag Care*. 2008;17(12):33–4, 40.
- 6 Greenlund KJ, Croft JB, Mensah GA. Prevalence of heart disease and stroke risk factors in persons with prehypertension in the United States, 1999–2000. *Arch Intern Med*. 2004;164:2113–8.
- 7 Kosaka K, Noda M, Kuzuya T. Prevention of type 2 diabetes by lifestyle intervention: a Japanese trial in IGT males. *Diabetes Res Clin Pract*. 2005;67(2):152–62.
- 8 Laatikainen T, Dunbar JA, Chapman A, Kilkkinen A, Vartiainen E, Heistaro S, et al. Prevention of type 2 diabetes by lifestyle intervention in an Australian primary health care setting: Greater Green Triangle (GGT) Diabetes Prevention Project. *BMC Public Health*. 2007;7:249.
- 9 Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002;346(6):393–403.
- 10 Lindström J, Ilanne-Parikka P, Peltonen M, Aunola S, Eriksson JG, Hemiö K, et al. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. *Lancet*. 2006;368(9548):1673–9.
- 11 Law M, Wald N, Morris J. Lowering blood pressure to prevent myocardial infarction and stroke: a new preventive strategy. *Health Technol Assess*. 2003;7(31):1–94.
- 12 Zhang Y, Lee ET, Devereux RB, Yeh J, Best LG, Fabsitz RR, et al. Prehypertension, diabetes, and cardiovascular disease risk in a population-based sample: the Strong Heart Study. *Hypertension*. 2006;47(3):410–4.
- 13 CDC Diabetes Cost-Effectiveness Study Group. The cost-effectiveness of screening for type 2 diabetes. *JAMA*. 1998;280:1757–63.
- 14 Lauritzen T, Griffin S, Borch-Johnsen K, Wareham NJ, Wolffenbuttel BH, Rutten G. The ADDITION study: proposed trial of the cost-effectiveness of an intensive multifactorial intervention on morbidity and mortality among people with type 2 diabetes detected by screening. *Int J Obes Relat Metab Disord*. 2000;24(Suppl 3):S6–11.
- 15 Hoerger TJ, Harris R, Hicks KA, Donahue K, Sorensen S, Engelgau M. Screening for type 2 diabetes mellitus: a cost-effectiveness analysis. *Ann Intern Med*. 2004;140:689–99.
- 16 Colagiuri S, Walker AE. Using an economic model of diabetes to evaluate prevention and care strategies in Australia. *Health Aff (Millwood)*. 2008;27(1):256–68.
- 17 Gillies CL, Lambert PC, Abrams KR, Sutton AJ, Cooper NJ, Hsu RT, et al. Different strategies for screening and prevention of type 2 diabetes in adults: cost effectiveness analysis. *BMJ*. 2008;336(7654):1180–5.
- 18 Engelgau MM, Narayan KM, Herman WH. Screening for type 2 diabetes. *Diabetes Care*. 2000;23:1563–80.
- 19 Lamotte M, Piñol C, Brotons C, Annemans L, Guardiola E, Evers T, et al. Health economic evaluation of low-dose acetylsalicylic acid in the primary prevention of cardiovascular disease. *Rev Esp Cardiol*. 2006;59(8):807–15.
- 20 Gutiérrez G, Acosta B, Pérez L, Aranda J, Medina I, Turrubiate N, et al. Encuesta Nacional de Coberturas 2006. México, DF: Instituto Mexicano del Seguro Social; 2006. Spanish.
- 21 Rulla JA, Aguilar-Salinas C, Rojas R, Rios-Torres JM, Gómez-Pérez FJ, Olaiz G. Epidemiology of type 2 diabetes in Mexico. *Arch Intern Med*. 2005;36:188–96.
- 22 Gutiérrez G, Pérez-Cuevas R, Levy S, Reyes H, Acosta B, Cantón SF, et al. Strengthening preventive care programs: a permanent challenge for healthcare systems; lessons from PREVENIMSS México. *BMC Public Health*. 2010;10:417.
- 23 To access the Technical Appendix, click on the Technical Appendix link in the box to the right of the article online.
- 24 Somannavar S, Ganesan A, Deepa M, Datta M, Mohan V. Random capillary blood glucose cut points for diabetes and pre-diabetes derived from community-based opportunistic screening in India. *Diabetes Care*. 2009;32(4):641–3.
- 25 Instituto Mexicano del Seguro Social. Reporte de gestión [Internet]. México, DF: Instituto Mexicano del Seguro Social; [cited 2010 Nov 10]. Spanish. Available from: http://www.imss.gob.mx/estadisticas/financieras/reporte_gestion.htm
- 26 Eastman RC, Javitt JC, Herman WH, Dasbach EJ, Zbrozek AS, Dong F, et al. Model of complications of NIDDM: I; model construction and assumptions. *Diabetes Care*. 1997;20(5):725–34.
- 27 Barceló A, Aedo C, Swapnil R, Robles S. The cost of diabetes in Latin America and the Caribbean. *Bull World Health Organ*. 2003;81:19–27.
- 28 Reynales-Shigematsu LM, Rodríguez-Bolaños RA, Jiménez JA, Juárez-Márquez SA, Castro-Ríos A, Hernández-Avila M. [Health care costs attributable to tobacco consumption on a national level in the Mexican Institute of Social Security]. *Salud Publica Mex*. 2006;48(Suppl 1):S48–64. Spanish.
- 29 Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. Methods for the economic evaluation of health care programmes. 3rd ed. Oxford: Oxford University Press; 2005.

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Angelica Castro-Ríos, Svetlana Vladislavovna Doubova, Silvia Martínez-Valverde, Irma Coria-Soto, and Ricardo Pérez-Cuevas studied screening for prediabetes and prehypertension in Mexico and the corresponding use of preventive care to delay complications; their paper in this issue of *Health Affairs* reports their findings.

Their research group, which spans several prominent Mexican institutions, has worked for several years to examine possible innovations in health care services and evaluate their outcomes. In this study they assessed the potential epidemiologic and economic impacts of an enhanced preventive care program, PREVENIMSS, that went beyond routine screening services to include education and lifestyle changes. They found that even with conservative assumptions, such a program would be hugely cost saving.

Decision makers in Mexico have now taken these results into account to make prevention part of the regular provision of care for patients with early-stage diabetes and hypertension. Pérez-Cuevas

says that the impact could be even more powerful if policy makers extended preventive services to younger adults, who are not currently eligible for the program in Mexico. "We were surprised to discover that even among young adults [ages 20–29], there is a high prevalence of the preclinical status of such conditions, and that potential savings could be significant if preventive care is appropriately implemented," he says.

All of the authors have master's degrees in health economics or health systems.

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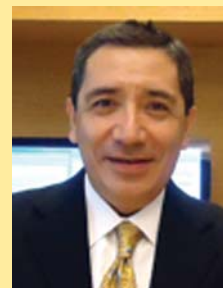
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