

Economic Consequences of Epidemiological Changes in Diabetes in Middle-Income Countries

The Mexican case

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OBJECTIVE — To identify the costs and economic consequences of expected changes in the demand for health care services for type 2 diabetes in the three main public institutions of the Mexican health care system.

RESEARCH DESIGN AND METHODS — The cost evaluation method to estimate direct and indirect costs was based on instrumentation and consensus techniques. To estimate the costs and epidemiological changes for 2003–2005, three probabilistic models were constructed according to the Box-Jenkins technique.

RESULTS — Comparing the economic impact in 2003 versus 2005 ($P < 0.05$), there is a 26% increase in financial requirements. The total amount for diabetes in 2005 (in U.S. dollars) will be \$317,631,206, including \$140,410,816 in direct costs and \$177,220,390 in indirect costs. The total direct costs, representing financial requirements to provide health care for expected cases of type 2 diabetes and its main complications in the three main public institutions in Mexico, up to 2005, will be \$37,079,587 for the Ministry of Health (or Secretaría de Salud [SSA], serving the uninsured population) and \$103,331,235 for the Mexican Social Security Institute, or Instituto Mexicano del Seguro Social (IMSS), and the Institute for Social Security and Services for State Workers, or Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (ISSSTE), both of which serve the insured population.

CONCLUSIONS — Our data suggest that changes in the demand for health care services for patients with diabetes will continue with an increasing trend, mainly in the insured population. In economic terms, the results of direct and indirect costs are one of the main challenges to be solved to decrease the economic burden that diabetes represents for the population, the health care institutions, and for society as a whole.

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The identification of financial requirements for chronic diseases is necessary for a rational allocation of resources (1,2). In the case of diabetes, the economic burden of the demand for health care services constitutes one of the main challenges to the individual, society,

and the health care system, particularly to this system's public institutions (3). Studies exist in which estimates of direct and indirect costs of diabetes provide conclusive evidence of both the challenge involved in the identification of economic requirements to satisfy the demand for

services related to this health care problem as well as the challenge involved in the search for the most rational way to provide these health care services (4,5).

In the case of countries with middle incomes, this takes on added relevance because, as has been pointed out by certain authors, services for diabetes and other chronic diseases are on the rise and compete, in a context of scarce economic information for decision-making, with demands from and resources directed to infectious diseases (6,7).

Estimates of direct and indirect costs of diabetes are being generated in several health care systems around the world, with diverse results depending on the method used and on the health complications included in the evaluations (8,9). These studies set forth the need to evaluate the existing economic impact and to estimate the financial requirements for more rational and efficient decision-making in the management of financial resources, depending on the characteristics of the national health care systems.

In the case of Mexico, health care services for diabetes have a demand and costs that are differentiated by the type of institution, which is a characteristic of health care systems in most middle-income countries. Thus, direct and indirect health care costs, as well as financial requirements for diabetes, also differ according to the institutions constituting the health care system. The Mexican health care system was formed, from the beginning, with a component of public institutions in order to offer health care services to both the uninsured population, who had no salaries and scarce economic power (Ministry of Health, or Secretaría de Salud [SSA]), as well as the insured population, represented by salaried workers from the formal economy (the Mexican Social Security Institute, or Instituto Mexicano del Seguro Social [IMSS], and the Institute for Social Security and Services for State Workers, or In-

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Abbreviations: IMSS, Instituto Mexicano del Seguro Social; ISSSTE, Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado; SSA, Secretaría de Salud.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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Item	SSA	IMSS	ISSSTE	Total Cost
DIRECT COSTS				
Consultations/diagnostic	6,455,557	14,571,899	3,409,364	24,436,820
Drugs	14,375,755	32,499,886	7,592,250	54,467,891
Hospitalization	4,316,064	9,742,498	2,279,437	16,337,999
Treatment of Complications	11,932,212	26,934,156	6,301,740	45,168,106
Retinopathy	(1,312,543)	(2,962,757)	(693,191)	(4,968,491)
Cardiovascular disease	(1,193,223)	(2,693,415)	(630,174)	(4,516,810)
Nephropathy	(8,710,514)	(19,661,936)	(4,600,272)	(32,972,722)
Neuropathy	(429,559)	(969,629)	(226,862)	(1,626,050)
Peripheral vascular disease	(286,373)	(646,419)	(151,241)	(1,084,033)
Total direct costs	37,079,587	83,748,439	19,582,796	140,410,816
INDIRECT COSTS				
Mortality cost	2,061,476	4,842,457	1,106,427	8,010,360
Cost of permanently disabled patients	42,898,783	100,770,247	23,024,472	166,693,502
Cost of temporarily disabled patients	647,632	1,521,302	347,594	2,516,528
Total indirect costs	45,607,891	107,134,006	24,478,493	177,220,390
TOTAL COSTS				
Direct and indirect costs	82,687,477	190,832,445	44,061,284	317,631,206

Figure 1—Direct, indirect, and total costs attributable to diabetes in three main public institutions of the Mexican health care system (in U.S. dollars, year of estimation 2005). Data were calculated using 95% CI with the Box-Pierce statistical test ($P < 0.05$). The exchange rate was 1 U.S. dollar = 9.35 Mexican pesos, corresponding to January 2003. The source for the data was Arredondo A, et al.: Costos y Consecuencias Financieras del Cambio en el Perfil Epidemiológico en México. INSP-Universidad de Montreal-Internacional Development Research Centre, 1999. Actualización de Modelos Probabilísticos, January 2003.

stituto de Seguridad y Servicios Sociales de los Trabajadores del Estado [ISSSTE]). The other component of the health care system refers to the private sector, with a broad array of institutions offering health care services to the population with purchasing power (10, 11).

The present study determines direct and indirect costs attributable to type 2 diabetes within the three most important public institutions in Mexico: the Ministry of Health (SSA), the Mexican Social Security Institute (IMSS), and the Institute for Social Security and Services for State Workers (ISSSTE). Later, we present and discuss results on epidemiological changes expected for the next 3 years as well as results on the financial requirements for diabetes at the institutions under study.

RESEARCH DESIGN AND METHODS

Direct costs of health care services were obtained from the management of standardized cases, adjusted by type of institution. The cost-evaluation

method was designed according to an instrumentation technique that identified production and supply functions for each case management, a diagnostic-related group variant adjusted for Mexico (12). Eight tools were used to establish costs per production function, which were concentrated in cost-evaluation matrices, according to the institution.

Case management was defined for an average case with the corresponding adjustments for each institution. For each disease and event to be evaluated, management of the average case was defined on the basis of the disease's natural history and the results of shadow study reviews. The point of view of a group of expert clinicians and administrators was considered in order to obtain a homogeneous opinion of how to manage each case. These definitions refer to the demand of hospital or ambulatory services, according to each disease.

As explained above, standard management was defined per disease/event to be cost evaluated, considering the natural

history of the disease, results found in the clinical files review and the shadow study, and the opinions of a group of expert clinicians and administrators. Results obtained depended on hospital or ambulatory management, the case, and the institution's regulations.

Direct costs refer to all monetary resources required to satisfy health care services demanded by users; these included consultation/diagnosis, drugs, hospitalization, and treatment of complications. Following the human capital approach to calculate indirect costs in Latin America (3,13), the model included three categories of monetary costs attributable to type 2 diabetes in three public institutions: mortality costs, cost of permanently disabled patients, and cost of temporarily disabled patients. The annual demand for health care services for diabetes was calculated from the number of cases being treated, adjusted by type of institution. This information was obtained from the statistics bulletin on health impairment of

TYPE OF DEMAND/ INSTITUTION	YEAR		
	2003	2004	2005
SSA:			
TOTAL CASES			
*IC	301,172 (298,867-303,477)	314,698 (311,598-317,798)	338,009 (330,409-345,009)
Hospital case	30,117	31,469	33,801
Ambulatory case	271,055	283,229	304,208
IMSS			
TOTAL CASES			
*IC	393,279 (389,369-397,189)	399,402 (393,801-405,003)	417,612 (410,412-424,812)
Hospital case	55,059	55,916	58,466
Ambulatory case	338,220	343,486	359,146
ISSSTE			
TOTAL CASES			
*IC	125,607 (122,996-128,218)	130,111 (126,123-134,099)	139,201 (134,576-143,826)
Hospital case	15,073	15,613	16,704
Ambulatory case	110,534	114,498	122,497

Figure 2—Expected cases for the period 2003–2005 by type of demand and institution. The source for the data was Arredondo A, et al.: *Costos y Consecuencias Financieras del Cambio en el Perfil Epidemiológico en México*. INSP-Universidad de Montreal-Internacional Development Research Centre, 1999. Actualización de Modelos Probabilísticos, January 2003. *95% CI with the Box-Pierce statistical test ($P < 0.05$).

the National Health System, 1989–2002 (14,15).

To determine the financial requirements, a time series was performed from 1989 to 2002, with a probabilistic design according to the Box-Jenkins technique (16), using a 95% CI with $P < 0.05$. Analysis variables included changes in morbidity for the study period and changes in health care policies and programs for diabetes and chronic diseases. The following methodological phases were considered in the development of the probabilistic models: identification, estimation, diagnostic check, and prediction.

The resulting models for estimating the expected demand of diabetes have an average movement operator of order 1. As in other studies with similar methods (17), the basis of each model was to include people who received a diagnosis of type 2 diabetes as well as costs of annual hospital or ambulatory management at one of the three institutions under study. We should emphasize that the projection period was limited to 3 years because previous studies have advised against using periods >4 years because they may cause budgeting uncertainty. To calculate costs and financial consequences caused by changes in both the epidemiological profile and the demand by type of institution, an inflationary index projected to 2005 was developed and applied, based on the Banco de Mexico's price index for con-

sumers. Results are in Mexican pesos and U.S. dollars, at the exchange rate of 1 U.S. dollar = 9.35 Mexican pesos, corresponding to January 2003 (18).

RESULTS— Figure 1 shows the estimated direct, indirect, and total costs of type 2 diabetes. This included all people and was only for health care costs that will be demanded of the three main public health care providers in Mexico, up to 2005; it does not include costs of health care demand for diabetes in the private health care sector. The overall contribution of direct costs was 45% of total costs, and indirect costs were 55% of total costs. Regarding the four categories of estimated direct costs, results were: consultations/diagnosis 11.64%, drugs 38.77%, hospitalization 11.64%, and complications 32.18%. With respect to the three estimated categories of indirect costs, the results were: mortality costs 4.52%, costs of permanently disabled patients 94.06%, and costs of temporarily disabled patients 1.42%.

With respect to the costs of complications, the five estimated categories were: costs of retinopathy 11%, costs of cardiovascular disease 10%, costs of nephropathy 73%, costs of neuropathy 3.6%, and costs of peripheral vascular disease 2.4% (Fig. 1). Going into detail about costs, from these results it was possible to establish minimum and maximum ranges of

financing requirements at the three most important health care institutions. The cost of a hospital case ranged from \$613.71 to \$887.14, with the lowest at the SSA and the highest at the IMSS. The same trends were observed for costs of ambulatory cases.

Regarding the effect of the expected epidemiological changes in hospital and ambulatory service demand for 2003–2005, the results are shown in Fig. 2. An increase is expected, although the results show a greater increase for hospital cases. As shown in Fig. 2, the increase tends to be higher among the insured when compared with the uninsured population. Figure 3 shows the trends in the economic resources needed to finance the minimum service demanded by the population. To cover service demand by diabetes patients, IMSS requirements will increase from \$78,813,110 to \$83,689,444; for the ISSSTE they will increase from \$17,670,392 to \$19,582,796; and for the SSA they will increase from \$33,038,568 to \$37,079,578. Increases in the resources required for hospital or ambulatory case management followed along similar lines.

When comparing direct costs for different health care models, depending on the disease and the institution, results were as follows: for hospital cases of diabetes, the IMSS will pay the highest cost, followed by the SSA and ISSSTE, with a

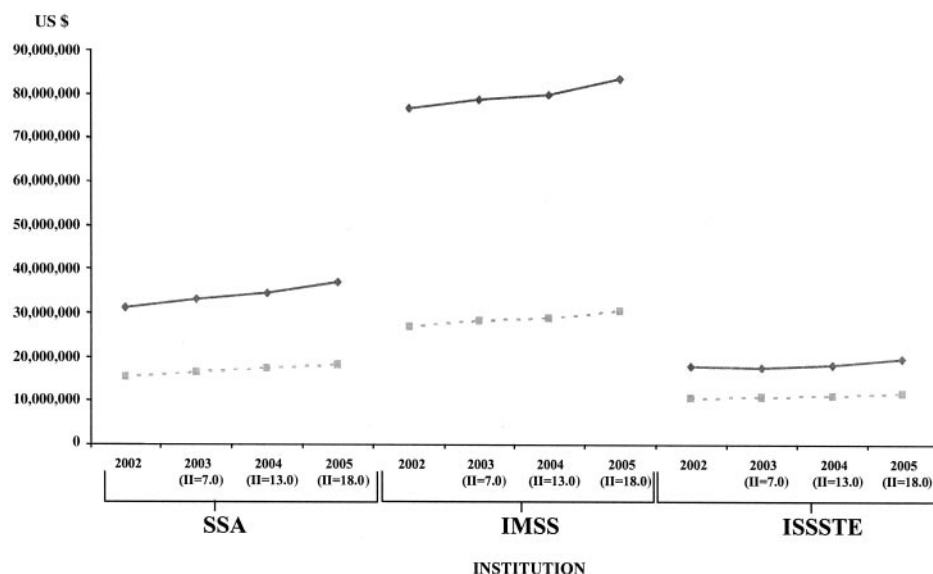


Figure 3—Financial requirements to satisfy health care service demand by type of institution, comparing diabetes versus hypertension. The reference period was 2002–2005 (in U.S. dollars). Data were calculated using 95% CI with the Box-Pierce statistical test ($P < 0.05$). The exchange rate was 1 U.S. dollar = 9.35 Mexican pesos, corresponding to January 2003. II, index of inflation (projected for the period 2003–2005). The sources of information were ref. 18 and Arredondo A, et al.: Costos y Consecuencias Financieras del Cambio en el Perfil Epidemiológico en México. INSP-Universidad de Montreal-Internacional Development Research Centre, 1999. Segunda Actualización de Modelos Probabilísticos y de los Costos de Manejo de Caso, Enero del 2003. ◆, diabetes; ■, hipertension.

lower direct cost (Fig. 4). The same trend is observed in relation to direct costs for ambulatory care. The highest average direct costs per managed case, as well as the economic impact of the global management of diabetes for 2003–2005, were found at the IMSS. Indirect costs showed a similar trend for the three institutions, representing 30% above the total direct costs. Financial requirements for ambulatory and hospital care represent ~4.7% of the total budget assigned to the uninsured population and 6.5% of that allocated to the insured population.

The economic consequences for insured and uninsured populations also have a different impact with respect to the total budget for both population groups. For the low-income uninsured popula-

tion (40% of all Mexicans), in recent years health care expenditure was on average 15% of the total, whereas for the insured population (50% of all Mexicans), health care expenditure was 43% of total expenditures (19). According to the results of our study, including resources required for hypertension, of the total financial burden for annual management of cases of diabetes and hypertension, 25% will be for the uninsured and 75% for the insured population.

CONCLUSIONS— In this study we estimated the costs of type 2 diabetes for the three main public institutions that provide health care in Mexico. We also estimated the financial requirements for the next 3 years, taking into account the

expected changes in the epidemiological profile of diabetes in Mexico.

The estimated costs of our study reported a total of \$317 million, \$140 million in direct costs, and \$177 million in indirect costs. With respect to the cost results, several studies in Mexico on the cost of diabetes reported \$100 million in direct costs and \$330 million in indirect costs (20). Another recently published study reported \$1.9 billion in direct costs and \$13.1 billion in indirect costs. There are differences between our results and those of previous studies because of differences in the estimates of the prevalence of diabetes used in the developed models and because our study only reported costs of type 2 diabetes for the three main public institutions.

Figure 4—Direct costs and financial requirements to satisfy the demand for health services by attention model and type of institution for expected cases of diabetes. The reference period was 2003 versus 2005 (in U.S. dollars). Data were calculated using 95% CI with the Box-Pierce statistical test ($P < 0.05$). The exchange rate was 1 U.S. dollar = 9.35 Mexican pesos, corresponding to January 2003. II, index of inflation (projected for the period 2003–2005). The sources of information were: ref. 18 and Arredondo A, et al.: Costos y Consecuencias Financieras del Cambio en el Perfil Epidemiológico en México. INSP-Universidad de Montreal-Internacional Development Research Centre, 1999. Actualización de Modelos Probabilísticos, January 2003.

ATTENTION MODEL	2003			2005 II=20.0		
	SSA	IMSS	ISSSTE	SSA	IMSS	ISSSTE
ATTENTION MODEL: HOSPITAL	18,672,664.00	49,387,976.00	10,264,604.00	20,956,558.00	52,443,715.00	11,375,505.00
ATTENTION MODEL: AMBULATORY	14,365,904.00	29,425,134.00	7,405,788.00	16,123,029.00	31,245,729.00	8,207,291.00
BOTH MODELS OF ATTENTION	33,038,568.00	78,813,110.00	17,670,392.00	37,079,587.00	83,689,444.00	19,582,796.00

With regard to the out-of-pocket expenses for diabetes, we have to highlight this situation in Mexico. In terms of other costs for the control and follow-up of ambulatory management of diabetes, the use of financial resources attributable to direct user expenditures is a considerable contribution to the annual cost of case management. In Mexico, users must make direct out-of-pocket payments, which are relatively considerable, for control studies, monitoring, group therapy, diabetes education, etc. Although this affects all users of the health care system, this cost has a greater impact on uninsured users. Because the infrastructure needed to carry out studies is not always available, these users have to take on the cost of these studies, without being reimbursed by the health care system.

This has important repercussions in terms of quality of care. The health care system proposes integral management of the diabetic patient, including monitoring, control and follow-up with laboratory studies, health education, group therapy, etc. However, in view of the lack of infrastructure in the system, the patient is the one who finally determines his/her ambulatory care, making integral management more difficult. For this reason, the quality of care with which diabetic patients are managed requires adjustments and corrections to improve this quality and decrease the financial impact on the user's pocket.

With respect to the epidemiological changes expected for diabetes and their effects on financial requirements, we should point out that financial pressure will not only depend on the changing disease epidemiology but also on the type of population to be served. For example, in the case of insured patients at the IMSS, the demand for services for diabetes is much lower than the demand for other chronic diseases such as hypertension. Health care needs for patients with diabetes only at the IMSS are almost the same as those at the SSA; however, they are much greater than the corresponding service needs for insured patients with diabetes at the ISSSTE. On the other hand, if risk factors and the different ambulatory and hospital care models remain more or less as they are in the three studied institutions, the financial burden will be higher for the IMSS, followed by the SSA and then the ISSSTE.

The repercussions of all of the above will have a greater relevance for health care services for the uninsured because the pressure of inequality in resource allocation will be added to that caused by the relatively large increase in service demand for chronic or degenerative diseases. These services will be part of the popular health care insurance that the present national health care program (2001–2006) intends to implement for the low-income population with no social security coverage (21,22). In terms of the financial pressure generated from both, the epidemiological changes and changes required in the new health care programs will present different challenges for health care planning at all three institutions. For example, expected financial consequences suggest the need to redesign and invest more in programs for health promotion and prevention in order to reduce demand for hospital services and promote treatment of diabetes in an ambulatory setting. The greatest challenge will be for the social security services because, since their creation, these services have received the greatest amount of funding for treatment and rehabilitation programs.

Estimations of financial requirements are basic information for strategic planning. The financial consequences of the expected epidemiological changes are a basis and justification not only for more investment in diabetes or management of chronic diseases but also for the allocation of more resources for their prevention, thus minimizing and controlling the disease and lessening the economic burden on the health care systems of middle-income countries. This means that despite our evidence for the need to increase health care expenditures, the present economic situation does not seem to favor this and instead points to a decrease in health care expenditures, not only for 2003 but at least until 2005.

In terms of the validity of our results, it is important to highlight that, in relation to epidemiology, the expected results were validated by reference to trends established during the previous 10 years. The models used in our projections were similar to those in the statistics bulletin of the National Health System for 1990–2002. The number of expected cases follows trends that are similar to those projected by the International Diabetes

Federation for Latin American countries (23). Case management costs are within the management range of diabetes found in previous studies at the national and international level.

We show that the models are internally valid and predict direct and indirect costs and financial requirements for the next 3 years. These results and the relative weight of each category of costs (complications, hospitalization, mortality, disability, etc.) are consistent with those observed in the reference population and institutions under study. We extrapolate the results only to the costs of diabetes in public institutions because we recognize that it is much more difficult to prove external validity without data on the entire health care sector, particularly when we do not have access to data in the private sector. The models developed in other studies (24–25) are intentionally conservative and are unlikely to overestimate the economic impact of diabetes.

On the other hand, it is important to emphasize that studies in the U.S. (26) and Canada (27) reported that direct costs are higher than indirect costs. In our results, as we showed before, they were similar: direct costs accounted for 45% and indirect costs for 55% of the total costs. As we have seen in other studies on the economic impact of diabetes, our study has limitations basically because of the methodological difficulties found in developing probabilistic models in countries where there is no access to (or an absence of) data, particularly from private institutions.

Despite the above-mentioned limitation, results reported several relevant aspects of the diabetes problem: in the first place, if risk factors and health care programs for the main public institutions continue as they are in 2003, the economic burden of direct costs to satisfy future demands of health care services will go beyond the resources these institutions have allocated for diabetes. In the second place, the economic burden represented by indirect costs is a challenge that should be faced by individuals, society, and the health care system as a whole. In other words, the indirect cost of the diabetes problem establishes the need to involve different sectors of society with a greater commitment to action.

Finally, total reported direct and in-

direct costs set forth, as challenges to be solved, the prevention of diabetes and its complications within the health care sector as well as in other sectors, particularly that of education. As actions to be taken to face these challenges, we propose the following strategies: a greater investment of financial resources allocated to prevention in order to decrease the burden attributable to complications and new cases of diabetes; a greater rationality by type of institution in the allocation and use of financial resources for diabetes; and, just as importantly, a greater promotion of educational programs directed toward the general population, and particularly for the population with diabetes. These programs should be promoted and coordinated by the health care sector, but with strong and ample participation of various social actors (nongovernmental organizations; researchers; other sectors from federal, state, and municipal government levels; community leaders; and users).

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