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ORIGINAL ARTICLE

Direct costs of osteoporosis and hip fracture: an analysis for the Mexican healthcare system

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Abstract
Summary This study reports the direct costs related to osteoporosis and hip fractures paid for governmental and private institutions in the Mexican health system and estimates the impact of these entities on Mexico. We conclude that the economic burden due to the direct costs of hip fracture justifies wide-scale prevention programs for osteoporosis (OP).

Methods To estimate the total direct costs of OP and hip fractures in the Mexican Health care system, a sample of governmental and private institutions were studied. Information was gathered through direct questionnaires in 275 OP patients and 218 hip fracture cases. Additionally, a chart review was conducted and experts' opinions obtained to get accurate protocol scenarios for diagnoses and treatment of OP with no fracture. Microcosting and activity-based costing techniques were used to yield unit costs.
Results The total direct costs for OP and hip fracture were estimated for 2006 based on the projected annual incidence of hip fractures in Mexico. A total of 22,233 hip fracture cases were estimated for 2006 with a total cost to the healthcare system of US$ 97,058,159 for the acute treatment alone ($4,365.50 per case). We found considerable differences in costs and the way the patients were treated across the different health sectors within the country.
Conclusion Costs of the acute treatment of hip fractures in Mexico are high and are expected to increase with the predicted increment of life expectancy and the number of elderly in our population.

Keywords Direct cost · Economics · Health care system · Hip fracture · Osteoporosis

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Introduction

Osteoporosis (OP) and its associated fractures is a highly prevalent condition, and have become a focus of attention in developed countries since their economic impact and resource utilization is very high [1]. There is little or no information on costs related to this disease in the literature from developing countries where OP and OP-related fractures are frequent [2, 3]. In Mexico, an annual rate of

hip fractures of 169 women and 98 men per 100,000 person years was reported in the year 2000, and 1 out of 12 women and 1 out of 20 men will sustain a hip fracture after 50 years of age, making hip fractures a frequent condition in the Mexican population [4]. According to the World Health Organization (WHO) more than 1 million Mexican women could have OP, and in a random community sample of Mexican women 23% of them were found to have OP of the hip according to the WHO classification criteria [5, 6]. Literature regarding the economic impact of OP in Mexico is scarce and focused only on one health system: the Mexican Institute of Social Security in which the cost per hip fracture was reported to be between US$3,000 and US$4,500 [7].

The world demographics dynamic shows that the population over 65 years of age is increasing, and the life expectancy has also increased in most populations; these increments will go on for the next few decades and the projections have estimated these effects to be larger in the developing countries [8]. In Mexico the life expectancy at birth has increased from 42 years in 1940 to 74.5 years in 2006 and is expected to be over 80 years by the 2050, and the population over 65 years old will double by the same year [9–11]. These two factors will threaten the health system in our country, and steps have to be taken to be prepared to face the coming health demands of aging and chronic diseases. The burden of OP and its fractures will impact our economy and the way the health resources need to be structured in the near future. Therefore, we implemented the present study with the aim of estimating the total direct costs of patients with a diagnosis of OP and 1 year of treatment after diagnosis, and the costs related to the acute phase after hip fracture occurrence in a sample of governmental and private institutions from the Mexican health system: Mexican Institute of Social Security (IMSS), Ministry of Health (SS), and the private sector.

Materials and methods

Setting

The current structure and financing mechanisms of the Mexican health systems are diverse: The government maintains multiple parallel systems for different population groups, and in addition, there is a private sector. It is difficult to estimate with precision the coverage of the different institutions, although broadly speaking, governmental institutions cover the majority of the population (98%) and a large private system that is entirely financed by out-of-the-pocket money covers around two million enrollees [10].

Governmental sector

The two largest public health care systems within Mexico are the Mexican Institute of Social Security (IMSS) and the Ministry of Health (SS). The IMSS coverage includes all formally employed workers and their families, and delivers health care to nearly 50 million Mexicans (approximately half of the population); the SS delivers health care to uninsured people through health care facilities owned and operated by them directly and this amounts to nearly 48 million Mexicans. For the purposes of this study we included the following governmental institutions: the Traumatology and Emergency Department and Osteoporosis Clinic from the "National Rehabilitation Institute SS"; the emergency room and hip fracture department from the Traumatology and Orthopedic Hospital "Magdalena de las Salinas" IMSS, and the Osteoporosis Clinic from "La Raza Medical Center", IMSS.

Private sector

Private medical care in Mexico is extraordinarily heterogeneous in the quality and the level of services provided. The great majority of these institutions are for profit, and these services are provided for people of almost all levels of socioeconomic status.

For the purposes of this study we included information on two OP clinics: one covering people with a high socioeconomic status and a second one that covers middle to middle-low income people. For the hip fracture information we selected two general hospitals that covered the same type of population and the OP Clinic from COMMOP (Mexican Committee of Osteoporosis Prevention) to gather information on OP diagnoses and treatment; direct information on patients and charts was obtained for one of the hospitals (Hospital Mocel), and the list of prices from different private institutions such as ABC Hospital, Medica Sur, and Trinidad were obtained to estimate and compare the costs. In several cases the patients' balances were also obtained to check accuracy of costs and procedures and resource utilization.

Sample

From June 2004 to September 2005 we collected a total sample of 275 patients with OP and no fractures and 218 patients with hip fractures. The OP patients were diagnosed according to the WHO classification criteria so that OP was defined as a T score of less than −2.5 SD [5] and were recruited from the three different Mexican health systems: 107 from the IMSS, 81 from the SS, and 87 private cases. For hip fracture cases a total of 218 patients were included: 118 from the IMSS, 61 from SS, and 39 from the private

sector. Hip fractures included individuals over 50 years of age who had their fracture as a consequence of moderate to minor trauma and the hip fracture was confirmed by X-rays.

Questionnaires

Two sets of questionnaires were designed specifically for the study to be used for direct patient interviews: one to gather information from OP cases and the second to gather information from the hip fractures cases. These questionnaires included all relevant information regarding demographics, diagnoses, and resource utilization for the disease (e.g., numbers of consultations, X-rays, densitometries, laboratory, treatment) for 1 year, and in the case of hip fractures the relevant information during the hospitalization was requested (e.g., days of hospitalization, intensive care, surgical time, type of surgery and prosthesis, etc.).

A chart review was carried out in order to check the information given by the patients and to extract data on information not known by the patients or that they could not recall.

Procedure

Osteoporosis and hip fracture patients were included in a consecutive manner for the study. Research personnel were trained to apply the questionnaire and extract the required data from charts. After written consent and an explanation of the study objectives, the patients were interviewed by the research assistants in the different hospitals and clinics where the study was carried out. All questionnaires were collected at the Clinical Epidemiology Unit where the information was captured in a database designed for this study and was ready for analysis. The protocol was approved by the local institutional review board at the participant Institutions.

Estimation of costs and analysis

To estimate the direct costs, we used all the information gathered from the patient interviews and the chart review from all participant institutions; expert opinion was requested to confirm some data regarding the protocols followed for the diagnosis of OP and the treatments offered in the different institutions (average number of services per patient, treatment options, laboratory and X-rays, etc.).

The costs of drugs for governmental institutions were calculated on the basis of the wholesale prices listed in the 2006 biddings of the IMSS [12] and in the case of private settings we based costs on lists of unit prices. Costs per unit were calculated by dividing the cost per package by the number of units contained. The overall cost of each drug per patient was calculated by multiplying the unit cost by the number of intakes during the last year reported by each patient.

Direct non-medical costs, such as transportation and meals, were also assessed for patients with hip fracture and for their relatives who took care of them during the acute phase. A mixture of microcosting and activity-based costing techniques were used to yield unit costs for governmental institutions in 2006 supplemented by the official published cost lists of these institutions. It is important to note that these estimates do not include subsidies for governmental institutions, which are larger for SS, since it provides medical attention to the lowest income population. In the case of the patients treated in the private sector the lists of unit prices from several hospitals were gathered in Mexico City. The relevant units of every resource use per episode (OP or hip fracture) were multiplied by the unitary cost/price to estimate the total cost per patient, according to the following formula: $TotalCostperpatient = \sum_{i=1}^{n} Qix * Pi$ where: Q_{ix} = number of units of resource "*i*" used by patient "x" or their relatives (in the case of hip fracture patients), including non-medical resources such as transportation and meals. P_i = unit cost/price for resource "*i*".

We summed all these costs to calculate the total estimated costs of diagnosis and a 1-year treatment for OP, and the acute treatment for hip fracture. The total cost per patient was calculated as the total cost divided by the total number of patients either with OP or with hip fracture. We also calculated the average total cost per patient with OP or with hip fracture by health sector: IMSS, SS, and private sector. The perspective of the public provider of health services was adopted for the governmental institutions, but we also included some out-of-pocket costs in the case of hip fracture patients. For the private sector we assumed the patient's perspective under two scenarios, one for high and the other for medium to low-medium socioeconomic status. An incidence-based model was used to calculate the total costs of OP and hip fractures in Mexico for 2006, taking into account data from administrative records and rates of prevalence and incidence obtained in previous population studios (SS, IMSS, etc.).

Results

A total of 493 patients were included in the study. The 275 OP cases with no fractures had a mean of 63.9 years of age (7.9), and the majority of them were women (96.7%). There were significant ($p<0.0001$ and $p=0.0073$ respectively) differences between the age of patients attending the SS sector (67.0 years [8.7]) vs. those attending the IMSS (61.8 years [7.4]) or those attending the private sector (63.7 years [7.0]). The majority of the patients in the

sample were married (65.0%) and only 12.7% were currently working. The number of patients currently working was higher at the SS (22.2% cases) than in the other two systems (IMSS 7.5% cases and private sector 10.3% cases). Only one-third of the sample referenced had a pension (Table 1).

The 218 people with hip fractures had a mean age of 78.9 years (11.0). Women were older at an average of 79.4 years of age (10.4) while men were 77.8 years old (12.3) (data not shown). The mean age for the IMSS patients was lower than that of the SS patients (77.5(10.6) years vs. 81.2(10.5) years; $p=0.02$). Seventy percent of the patients suffering hip fractures were women. Almost 40% of the sample with hip fractures were married, but there were differences among institutions: 44.1% of IMSS patients were married compared with 32.8% and 30.8% of the SS and private sector patients respectively. Only a small percentage of patients were currently working (5%) and a high proportion of these patients did not receive any pension (65.6%). Among the health systems, the IMSS patients had the highest proportion of patients receiving a pension (47.5%). The demographic characteristics are shown in Table 2.

Osteoporosis costs

Per patient the average of every medical resource used for the diagnosis and 1 year of follow-up was estimated based on patient interviews and chart information from each institution. Resources included outpatient consultation, dual energy X-ray absorptiometry (DXA), bone profile (which included bone alkaline phosphatase, osteocalcin, urine N-telopeptide, hydroxyproline, pyridinoline and deoxypyridinoline) X-rays, and other lab tests (blood and urine tests) were counted and presented in Table 3. The resources used for each of these items were very similar in the three health systems with the exception of urine tests, which were used more frequently at the IMSS (5.1) and less frequently at the SS (3.7).

The average costs of diagnosis and 1 year of treatment, including the different type of drugs according to the different treatment options per institution are presented in Table 4. The highest costs were found for high-income patients in the private sector with an estimated expenditure of $2,236.40, followed by the IMSS ($979.50), the SS sector with $848.60, and the lowest costs were found for medium to low-income enrollees in the private sector ($595.00).

Hip fracture costs

Total direct costs per patient with a hip fracture were estimated for each health sector. The medical costs included surgery, medical staff, prosthesis and other devices, average days of hospitalization, physician's honorarium in private patients, and various other items that are shown in Table 5. Also, direct non-medical costs, such as transportation and meals, were estimated according to the information given by patients in an interview.

Considerable differences in the type of surgery demonstrated that arthroplasty and hemiarthroplasty were the preferred surgery among private patients (92.3%), while this type of surgery was only performed in 21.2% of governmental institutions (IMSS and SS) where internal fixation was preferred. The highest costs were found in the private patients, $13,777.70 for the high-income enrollees and $6,206.30 for the medium-income enrollees. The IMSS estimated costs were $3,921.10 and the SS estimated costs were the lowest, $1,612.70. There were some differences between institutions as the medical staff honorarium that is paid as an independent service directly to the physicians in the private sector is included in the surgery in the governmental institutions, and the prosthesis is included in the price of the surgery package in the private sector but not in the governmental sector. The costs derived from the hospital stay were the highest in the IMSS patients and the reason for this figure is related to the average number of days hospitalized: the IMSS patients had the longest mean hospital stay (10.7 days) compared with 9.3 and 5.2 days in

Table 1 Demographic characteristics of the sample of patients with osteoporosis but no fracture

	IMSS ($n=107$)	SS ($n=81$)	Private ($n=87$)	Total ($n=275$)
Age expressed in years, mean (standard deviation)	61.8 (7.4)	67.0 (8.7)	63.7 (7.0)	63.9 (7.9)
Women, number (%)	105 (98.1)	80 (98.8)	81 (93.1)	266 (96.7)
Civil status, number (%)				
Married	69 (64.5)	38 (46.9)	72 (82.8)	179 (65.0)
Widowed	27 (25.2)	25 (30.9)	7 (8.0)	59 (21.5)
Other (single, divorced, free union)	11 (10.3)	18 (22.2)	8 (9.2)	37 (13.5)
Years of schooling, mean (standard deviation)	6.9 (5.7)	6.0 (4.4)	7.6 (4.4)	6.8 (5.0)
Currently active worker, number (%)	8 (7.5)	18 (22.2)	9 (10.3)	35 (12.7)
Pensioner, number (%)	30 (28.0)	16 (19.8)	36 (41.4)	82 (29.8)

IMSS Mexican Institute of Social Security, *SS* Ministry of Health

Table 2 Demographic characteristics of the sample of patients with osteoporosis and fracture

	IMSS (n=118)	SS (n=61)	Private (n=39)	Total (n=218)
Age expressed in years, mean (standard deviation)	77.5 (10.6)	81.2 (10.5)	79.5 (12.5)	78.9 (11.0)
Women, number (%)	73 (61.9)	47 (77.0)	32 (82.1)	152 (69.7)
Civil status, number (%)				
Married	52 (44.1)	20 (32.8)	12 (30.8)	84 (38.5)
Widowed	49 (41.5)	32 (52.5)	18 (46.2)	99 (45.4)
Other (single, divorced, free union)	17 (14.4)	9 (14.7)	9 (23.0)	35 (16.1)
Years of schooling, mean (standard deviation)	5.8 (4.2)	4.1 (3.9)	10.5 (4.6)	6.2 (4.7)
Currently active worker, number (%)	7 (5.9)	2 (3.3)	2 (5.1)	11 (5.0)
Pensioner, number (%)	56 (47.5)	4 (6.6)	15 (38.5)	75 (34.4)

IMSS Mexican Institute of Social Security; *SS* Ministry of Health

the SS and private sector. Mean costs were larger in women than in men, but the difference was not significant (US $4,508 vs. US$3,940; p=0.1948, data not shown). Although mean costs in older patients (90 and over) were higher than in the other three groups (80–89, 70–79, and <70) they did not reach statistical significance (p=0.6393). Finally, we estimated the economic impact of hip fractures for 2006. According to the projection made by the National Council of Population for this year, the population of individuals over 50 years of age in Mexico is approximately 8,688,141 women and 7,693,753 men. [13] The annual rates of hip fracture in Mexicans were 169 in women and 98 in men per 100,000 person years in the year 2000. Using these data, we expected to have 22,223 hip fractures by this year (7,540 men and 14,683 women). Following the case distribution in our study, we assumed that 54% of the projected hip fractures will receive medical attention at the IMSS, 28% at the SS and 18% in the private sector. We also made the assumption that 50% of the patients in the private sector will be attended in the medium-income hospitals, while the other half will treated at the high-income institutions. The estimated economic impact of hip fractures in Mexico for 2006 is $ 97,058,159 dollars. In Table 6 the expected cases of hip fractures and annual cost per case per institution are presented.

Table 3 Resource utilization for diagnosis and a 1-year treatment in osteoporotic patients with no fracture

Resource utilization[a]	IMSS	SS	Private
Outpatient consultation	4.5	3.9	4.0
DEXA[b]	1.9	2.2	2.0
Bone profile[c]	1.0	1.0	1.0
X-rays	0.8	0.2	0.2
Other laboratory tests[d]	6.9	6.5	6.7
Urine tests[e]	5.1	3.7	4.4

[a] Average per patient according to a panel of experts (for diagnosis) and clinical chart review (for annual treatment)
[b] For IMSS and SS we considered a one-region DEXA; for private patients we assumed central DEXA
[c] Bone alkaline phosphatase, osteocalcin, urine N-telopeptide, hydroxyproline, pyridinoline, deoxypyridinoline
[d] Hematic biometry, blood chemistry test (glucose, urea, and creatinine), and calcium and phosphorus blood tests
[e] Calcium, phosphorus, and creatinine urine tests

Discussion

There are very few data on Mexico and the Latin American region regarding the direct costs of hip fracture. Indeed, this is the first study that estimates the medical resources and costs of the diagnosis of OP with no fractures, and the direct cost of hip fractures in men and women over 50 years including a representative sample of private and govern-

Table 4 Costs of diagnosis and a 1-year treatment in osteoporotic patients with no fracture

Resource utilization[a]	IMSS ($)	SS ($)	Medium to low income private ($)	High income private ($)
Outpatient consultation	436.40	90.00	73.80	553.60
DEXA[b]	76.60	60.60	36.90	261.10
Bone profile[c]	100.80	90.00	92.20	281.00
X-rays	21.80	4.60	5.80	17.00
Other laboratory tests[d]	64.70	59.20	81.10	138.80
Urine tests[e]	48.50	21.40	53.20	89.60
Medication	230.90	522.70	252.00	895.30
Total costs [f] (US Dollars, 2006)	979.50	848.60	595.00	2,236.40

[a] Average per patient according to panel of experts (for diagnosis) and clinical charts review (for annual treatment)
[b] For IMSS and SS we considered a one-region DEXA; for private patients two regions were based on current practice
[c] Bone alkaline phosphatase, osteocalcin, urine N-telopeptide, hydroxyproline, pyridinoline, deoxypyridinoline
[d] Hematic biometry, blood chemistry test (glucose, urea and creatinine), calcium and phosphorus blood tests
[e] Calcium, phosphorus and creatinine urine tests
[f] Adjusted by the Purchasing Power Parity (PPP) Index

Table 5 Total cost per patient with a hip fracture

Resource utilization	IMSS ($)	SS ($)	Medium to low income private ($)	High income private ($)
Surgery	1,110.60	439.20	3,374.80	5,191.90
Medical staff[a]			2,006.90	6,689.50
Prosthesis or fixation[b]	660.50	362.80		
Hospital stay[c]	1,893.30	610.50	361.20	1,190.90
Lab and image test	226.80	178.20	415.50	609.40
Direct medical costs	3,891.20	1,590.70	6,158.40	13,681.80
Transportation	14.60	3.90	21.80	43.60
Meals	15.30	18.10	26.10	52.20
Non-medical costs	29.90	22.00	47.90	95.80
Total costs [d] (US Dollars, 2006)	3,921.10	1,612.70	6,206.30	13,777.70

[a] For private sector it represents the honoraria of one surgeon, two assistants, an anesthesiologist, and an internist. These costs are included in the surgery item for IMSS and SS

[b] In private patients these costs are included in a surgery pack, which consists of surgery, prosthesis or fixation devices, and 4 days in a general ward

[c] General ward and intensive care unit. For private patients only in excess over 4 days in a general ward is taken into consideration, due to the surgery pack including a 4-day hospital stay in a general ward

[d] Adjusted by the Purchasing Power Parity (PPP) Index

mental heath institutions in Mexico. Our methodology, based on direct interviews with patients, chart reviews, a mixture of microcosting and activity-based costing techniques to get the unitary costs, and the lists of unitary prices from the private institutions allow us to have an accurate estimate, and feel confident about the costs involved in the acute treatment of hip fractures as well as the resource utilization and cost per year for OP diagnoses.

We found great variability in the costs among the different health sectors; the highest costs were found in the private sector high-income group and the lowest in the SS governmental sector in both situations.

The resource utilization for diagnosis and a 1-year treatment in osteoporotic patients with no fracture was similar among the institutions with regard to the protocol they use (e.g., number of consultations, lab tests, etc.) (Table 3), but the variability in costs was associated with three main aspects:

1. Differences in the type of laboratory exams ordered: the IMSS and private hospitals requested the bone profile at a higher frequency (alkaline phosphate, osteocalcin, urine N telopeptide, hydroxyproline, pyridoline, and deoxypyridoline).
2. Different patterns of medications: a higher proportion of patients from the SS and the private sector were prescribed alendronate (51.9% and 36.8% respectively); risedronate or raloxifene were prescribed only in the private sector (52.9% patients had at least one of them), calcitriol was frequently used in the IMSS and in private institutions in a high proportion of patients (50.5 and 80.5% respectively). HRT was only used in the IMSS (19.5%) and calcium carbonate was prescribed in 66% of IMSS patients, 37% of SS patients, and 23% of private patients. The difference in costs and patterns of prescription between the private sector and the two governmental institutions reflects the availability of resources in the institutions and the procedure by which patients acquired the drugs. In the government system, drugs are acquired at a lower price from distributors, and in the case of SS patients they can buy the prescription drugs at SS-owned pharmacies at special discounted prices, while the IMSS offer the treatment to their beneficiaries as a benefit of being enrolled in this Security System. Also, neither of these government systems makes any profit from the drugs prescribed. In the private sector, the prescriptions are obtained at regular pharmacies and paid for by the patients as out-of-pocket expenditure where drug prices differ as part of the market rules.
3. Out-patient consultation fees also reflect a difference in cost, being higher at the private institutions following the same reasoning mentioned above. The outpatient consultation fee is determined by the attending physician in

Table 6 Estimation of the economic impact of hip fractures in Mexico, 2006

Institution	Expected cases of hip fracture	Annual cost per case ($)	Economic impact ($)
IMSS	12,000	3,921.10	47,054,380
SS	6,223	1,612.70	10,034,855
Medium to low income private	2,000	6,206.30	12,412,863
High income private	2,000	13,777.70	27,556,061
Total	22,223		97,058,159

the private institutions while at the governmental institutions, the outpatient fee is a fixed fee for service and is included in the system costs.

Regarding the cost per patient for acute treatment of a hip fracture, considerable differences were found in the total cost per patient within the different health systems. The costs were higher in the private sectors ($13,777.70 and $6,206.30 for the high-income patients and medium to low-income patients respectively), followed by the IMSS ($3,921.10) and the least expensive, the SS ($1,612.70). Differences between the protocols in the various health systems were observed in the case of acute treatment for hip fracture as well. Independently of the type of fracture, the private institutions' preference for surgery was hip replacement (arthroplasty or hemiarthroplasty) in virtually all cases, while at the IMSS and SS, reduction and internal fixation were used in over 70% of cases; the difference in mean cost between these two types of surgery differ, since different types of prosthesis and surgery time are required ($401.40 to $898.70 for reduction or internal fixation vs. $816.10 to $1,797.40 for hip replacement, in the SS and IMSS respectively). The medical staff's honoraria are included in the cost of the surgery in the government institutions, unlike the private institutions, where the honoraria are paid as an independent cost with a three-fold increase between the middle to low-income vs. the high-income cases.

Hospital stay was longer in the government institutions; the average duration was 10.7 days at the IMSS, 9.3 at the SS and 5.2 at the private institutions. The short stay in the case of private institutions (half that of the government institutions) is noteworthy. However, wide variations in hospital stay have been reported in other countries, some of them longer than others. In Belgium an average of 26 days was reported in 1996 [14]. In Switzerland in the 1990s, an average of 16.3 days were reported, but these figures have been reduced by 8.4 days for women and 4.7 days for men, leading to a decrease of almost 40% in direct costs related to acute hospitalizations by the year 2000 [15, 16]. Singapore reported an average of 17 days [17] and Austria reported 8.5 to 27 days for women and 16 to 23 for men, while in Sweden 12.2 days for men and 13.1 per women were reported in 1996 [18] The costs of acute treatment of hip fracture (US$97,058,159) are to be compared with the expenses incurred in covering the cost of insulin in Mexico in 2005, which amounted to US$90,000,000 and served around one million insulin-dependent diabetics across the country.

It is difficult to compare our results with other studies of direct costs in other countries, since the country's economic development as well as the size of the economy and the types of the health systems, is different. Also, the methodology and year of publication of some of the studies make them non-comparable. However, some recent publications suggest similarities in the cost of the acute treatment of hip fractures: in Singapore, the cost per case of hip fracture was US$7,367.00 and 82% of the cost was subsidized by the government, and in Austria, a developed country, with an average cost per case of US$9,097.00 [17]. In the present study, subsidies made to the governmental institutions were not included since we have no access to this information. However, the unit costs from the IMSS reflect the opportunity cost with better accuracy. The SS gives medical attention to the lowest income population and therefore the subsidies are larger. This underestimation of the opportunity costs might be an explanation of the large difference compared with the private sector, which also includes profits.

Our study had some limitations inherent to the type of design. We only included a sample from Mexico City, although the governmental institution prices are fixed and published officially at the *Diario Oficial* and are used by the SS and IMSS systems all over the country. Regarding the private institutions, the wide variation between the costs in the high-income vs. the medium to low-income patients probably reflects the costs in different provinces in Mexico.

Although we had a good representation of the health systems in Mexico, small government health care facilities were not included, such as the Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (ISSSTE), the Hospital Militar of Mexico for the army service, or Pemex Hospital for the oil workers. The size of these facilities and the number of beneficiaries are small compared with the IMSS or SS so we believe that no substantial differences would be found with the inclusion of these small institutions.

Because of the nature of this study, we were not able to evaluate whether different outcomes encompass the different protocols within the different institutions (e.g., arthroplasty or hemiarthroplasty vs. reduction or internal fixation) and the different economic estimates in the study. In our sample none of the patients died at the hospital when the collection of data took place. We followed up the patients for 6 months after being discharged from the hospital and these data will be analyzed to assess whether there are differences in the 6-month health outcomes across health systems.

In conclusion, in Mexico considerable variability in costs is present in accordance with the health sector that provides the care, along with differences in the treatment. However, the overall estimate of expenditure due to the diagnosis of OP, resource utilization, and hip fractures represent a high level of expenditure for a developing country where the allocation of health resources does not exceed 6% of our Gross Domestic Product. Our study confirmed the findings of previous research that indicated

that OP is a prevalent condition for which the treatment incurs high levels of expenditure [19, 20]. Our study focused only on OP diagnoses and resource utilization for 1 year and the acute treatment of hip fracture, which represents only part of the OP and fracture costs. Since the prevalence of OP increases with age and the elderly proportion of the population is growing fast in Mexico, well-designed health economic studies that take into account other fragility fractures and incremental costs after acute events are urgently needed.

As in other countries in which programs such as the Bone and Joint Decade have been implemented with success, government and health policy decision-makers in Mexico have to rely on this type of research to evaluate which prevention and screening programs could be modeled in our country in order to be prepared to cover the needs of the health management of this devastating condition.

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