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Original Article

International Variation in the Incidence of Hip Fractures: Cross-National Project on Osteoporosis for the World Health Organization Program for Research on Aging

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Abstract. A cross-national study of hip fracture incidence was carried out in five geographic areas – Beijing, China; Budapest, Hungary; Hong Kong; Porto Alegre, Brazil; and Reykjavik, Iceland – during the years 1990–1992. Cases of hip fracture among women and men of age 20 years and older were identified using hospital discharge data in conjunction with medical records, operating room logs, and radiology logs. Estimated incidence rates varied widely, with Beijing reporting the lowest rates (age-adjusted rate per 100 000 population for men 20 years and older = 45.4; women = 39.6) and Reykjavik the highest rates (men = 141.3; women = 274.1). Rates were higher for women than for men in every area except Beijing. In every area except Budapest, review of the operating room or radiology logs identified additional cases that were not reported in the discharge list, increasing the estimated number of hip fractures by 11% to 62%, depending on the area. Review of medical records identified miscoding of hip fractures (ICD9 820) as 'shaft of femur and other femur fractures' (ICD9 821) in the discharge lists of every area except Budapest, increasing the estimated number of hip fractures by 1% to 30%. The final estimates of hip fracture incidence taking into account all investigated sources of undercount and overcount ranged from 15% lower to 89% higher than an estimate based on the discharge diagnoses alone. Although these results indicate substantial limitations in relying on hospital discharge data alone to estimate hip fracture incidence rates, the extent of errors found in the discharge lists is smaller than the large international variation found here and previously reported in incidence rates. The findings support the conclusion that the differences reported among countries mainly reflect genuine variation in the hip fracture incidence rates.

Keywords: Hip fracture; Hospital discharge data; Incidence rates; International comparison; Osteoporosis

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Introduction

Hip fracture incidence rates based on hospital discharge lists vary widely from one region of the world to another

[1,2]. Incidence rates appear to be highest in northern Europe and the United States and lowest in Asia and Africa. However, some of the variation in reported hip fracture incidence rates may be due to differences in case identification rather than to real differences in the incidence rates. One limitation of hospital discharge data is that transfers between and within hospitals may be counted as separate discharges, leading to an overestimation of cases. On the other hand, cases may not appear on the discharge list because of clerical error or because the patient was treated outside the hospital, resulting in an undercount of cases. In addition, there may be miscoding of hip fractures in the discharge lists. A survey was therefore undertaken to ascertain the incidence rates of hip fracture in several countries, using methods that would address these limitations.

Methods

The areas included in this study were Beijing, China; Budapest, Hungary; Hong Kong; Porto Alegre, Brazil; and Reykjavik, Iceland. These five urban areas were selected to represent different geographic regions with a range of reported incidence rates. The same general approach to the data collection was used in all areas. First, all hospitals that provided initial treatment for hip fracture for residents of the study area were identified by the principal investigator of each study site. Second, all hospital discharges coded ICD9 820 (hip fracture) or ICD9 821 (shaft or other femur fracture) for patients 20 years of age and older were ascertained for a specified period of time during 1990–1992. ICD9 821 discharges were included because of preliminary reports from the study in Beijing that this was a common miscoding of hip fractures in the discharge lists. Femur fractures due to pathologic conditions such as neoplasm were included since these fractures could not reliably be distinguished in all the discharge records. Previous studies of hip fracture incidence rates have varied in their treatment of pathologic fractures with most, but not all, reporting results for all hip fractures [1]. Patients identified in the discharge lists as residing outside the study area were excluded.

Third, multiple discharges for hip fracture for the same patient were identified. In Hong Kong and Reykjavik, this was accomplished by comparing unique patient identifiers recorded in the discharge lists. These were assumed to be transfers or readmissions for the same fracture since a second hip fracture within the study period of 1–3 years is a relatively rare event [3]. In Beijing, Budapest and Porto Alegre, multiple discharges were identified through the review of individual patient records, described in the next step. Fourth, to verify the coding in the discharge list, the individual patient record was reviewed, using the radiology report of the fracture, if available, as the final diagnostic criterion. The medical record was also used to confirm that the patient was a resident of the study area. The immediate cause of the hip fracture was abstracted from the medical record. Fifth, samples of the operating room (OR) or radiology logs for the hospitals were searched to find all operations or radiographs for the first treatment of a hip fracture. The cases found by the search of the logs were compared with those on the discharge list to identify any cases that were not reported on the discharge list. Except in Porto Alegre, further review was undertaken of the additional identified cases to confirm the coding of hip fracture.

Data from all sites except Beijing were sent to the study Coordinating Center at Stanford University for computer entry and analysis. Hip fracture incidence rates were estimated by first correcting the reported count from the discharge list to exclude transfers and readmissions, and then correcting for errors in coding the diagnosis and for cases found in the radiology or OR logs that were not in the discharge list. This corrected estimate was divided by the population figures for the most recent census in the area. Incidence rates were calculated separately by gender and 5-year age groups. The incidence rates were age-adjusted to the 1990 US non-Hispanic white population using direct standardization to facilitate comparison across countries.

The doubling time for hip fracture incidence rates was also estimated in order to compare how rapidly the rates increase with age in the different areas. The increase in hip fracture incidence rates with age for 50- to 89-year-olds was estimated using an exponential regression model. Doubling time for hip fracture incidence rates was calculated from the slope of the regression model [4]. Unlike the age-adjusted rates, the doubling time is not influenced by under- or over-ascertainment of the total hip fractures, although it would be affected by ascertainment that differed according to age.

The following sections provide specific details and explain exceptions to the five steps of data collection described above.

Beijing, China

The methods for the hospital survey in Beijing have been previously reported [5]. Briefly, the 76 civilian and military hospitals that serve the 10 urban and suburban districts of Beijing submitted reports on discharges for 1988 through 1992. A second review of the discharge lists was undertaken because of problems identified in the original reports. For 34 hospitals, the review was conducted by the study investigators. In the remaining 42 hospitals, the second review was undertaken by hospital staff who had attended a special training session. In 11 hospitals OR logs for 1991–92 were compared with the discharge lists. Census data for Beijing were available for 1990. For Beijing the study was carried out in consultation with the Coordinating Center at Stanford University to insure that comparable methods were employed. However, data collection, review and analysis were conducted separately.

In a separate study, the Beijing Osteoporosis Study [5], the 27 hospitals surrounding Beijing were surveyed

to ascertain whether Beijing residents were being admitted to outlying hospitals for treatment of hip fracture. Among the 1176 hip fracture cases reported by these hospitals for 1988–92, none were Beijing residents. To assess how often traditional healers were used instead of hospitals, the Beijing Osteoporosis Study also included interviews regarding sources of care for fractures with a random sample of women aged 50 years or more from Beijing. Of the 2113 women interviewed, 381 reported a previous fracture; 365 (96%) of them indicated that the fracture had been treated at a hospital. A previous hip fracture was reported by 7 women (0.3%), and all had been treated in a hospital. Thus, it seems that almost all hip fracture cases among Beijing residents were treated in one of the urban hospitals.

Budapest, Hungary

Discharge lists for the four acute care hospitals in Budapest East were reviewed for 1992. Budapest East is one of four areas into which emergency medical care in Budapest is divided for administrative purposes. Ambulances take Budapest East residents with medical emergencies such as hip fracture to one of the four hospitals serving that area. Prior to 1992, the four administrative areas did not exist so this survey was limited to 1992. Population census data for the five districts comprising Budapest East were available for 1990.

The radiology logs for 1992 were reviewed to identify any hip fracture cases that were not included on the discharge lists.

Hong Kong

Discharges lists for 1991 were reviewed from the nine public acute care hospitals in Hong Kong. An additional four private hospitals admitted hip fracture patients but did not allow access to their discharge lists. Two of the private hospitals did, however, allow a review of OR logs for 1991. These figures were used to estimate the number of hip fracture discharges for the four private hospitals, by assuming the number of cases was proportional to the number of beds. Population census data for Hong Kong were available for 1991. Transfers and readmissions were identified by comparing Hong Kong identification numbers, medical record numbers and names.

For individual medical record review, the Coordinating Center selected a sample from the discharge list by taking every seventh discharge from those coded ICD9 820. From those coded ICD9 821, every third discharge was selected at five hospitals and every fourth discharge at the remaining four hospitals.

For each public hospital, the OR logs were reviewed and compared with the discharge list for 2 or 3 months, selected by the Coordinating Center so that each hospital was sampled at more than one time of the year, during the period January through October, 1991.

Porto Alegre, Brazil

Cases of hip fracture or shaft of femur fracture in 1990 through 1992 in Porto Alegre, Brazil, were ascertained by two methods. A survey of the 20 acute care hospitals in Porto Alegre indicated that 11 hospitals admitted hip fracture cases. At 6 of these 11 hospitals, discharge lists were reviewed. Four hospitals did not have adequate discharge information; therefore, the surgery department records were reviewed. (Cases identified through either method are referred to as ‘discharges.’) One hospital in the region refused permission to review records. Population census data for Porto Alegre were available for 1991.

Medical records were reviewed at the 10 participating hospitals for discharges in 1992 with the patient identified as either a resident of Porto Alegre or with unknown residency. To confirm the identification of non-residents in the discharge list, 37 cases (19%) from the 197 identified in the 1992 discharge lists as residing outside Porto Alegre were also reviewed. For all these cases the medical record confirmed that the patient was not a resident of Porto Alegre. No further review of discharges identified as non-residents was undertaken. For three hospitals the OR logs were reviewed for January through November, 1992, and compared with the discharge lists. Additional cases of hip fracture identified from the OR logs were not confirmed by review of other records. Analysis of cases was restricted to discharges in 1992 since more complete information was available for this year than for 1990 and 1991.

The estimated hip fracture rates for Porto Alegre are reported as a range because of the limitations in the records available for review. Medical records could be reviewed for only 486 (88%) of the 553 hip fracture discharges. This medical record review, combined with the medical record review of shaft of femur fracture discharges, forms the basis for the low estimate that we report, since we are most certain about the hip fractures identified through this review. We believe that this estimate is probably too low, however, for two reasons. First, some of the 12% of hip fracture discharges for which a medical record could not be reviewed are likely to have been hip fractures. Second, our review of the OR logs indicates that a substantial number of hip fractures were not reported on the discharge list. We report the hip fracture incidence that includes a correction for the OR log review as a high estimate because of limitations in the OR logs. These limitations are that the diagnosis listed in the OR logs was not always sufficient to distinguish hip and shaft of femur fractures, the place of residence was not directly identified, and the information was not confirmed by review of other records.

Reykjavik, Iceland

The hospital discharge lists for the three acute care facilities serving the greater Reykjavik area were reviewed for 1990 through 1992. Transfers and discharges for treatment of an old fracture were identified by the investigators in Iceland using social security numbers in the discharge list and were excluded from the report sent to the Coordinating Center. Patients residing outside the greater Reykjavik area were also identified and excluded from the report. Population census data were available for the greater Reykjavik area for 1991.

To confirm the coding of the diagnosis in the discharge list, the individual medical record was reviewed for half the discharges and the individual radiography files were reviewed for the remaining discharges. The Coordinating Center selected a sample of every other discharge from the discharge list for the medical record review. For 8 discharges (1.5%), the medical record or radiography file could not be located for review. To confirm the coding for discharges identified as ICD9 821, the log for each hospital's department of orthopedics was reviewed. If the orthopedic log was not available for a discharge, the radiology or OR logs were consulted.

The radiology logs at the three hospitals were reviewed for a sample of 6–15 months in the 3-year period 1990 through 1992. During this review of the radiology logs, hip fractures were found that had been recorded on the discharge list but were missed because of clerical errors in the first review of the discharge list. A second review of the discharge list was therefore undertaken to obtain a more accurate count. In addition, hip fractures were found through the radiology logs that were not on the discharge list.

Results

The results of the review of discharge lists, medical records, OR logs and radiology logs for the five geographic areas are presented in Table 1.

Beijing, China

In Beijing [5] the first review of the discharge lists, provided by hospital staff, identified 3136 discharges coded ICD9 820 for 1988–92. In the second review of the discharge lists, records in 34 hospitals were reviewed by the study investigators. In the remaining 42 hospitals, the second review was conducted by hospital staff after a training session with the study investigators. In the 34 hospitals reviewed by the study investigators, 1741 discharges had been initially reported as ICD9 820. An additional 178 hip fracture discharges were found in the second review. The medical records identified 12 discharges (0.6%) as treatments for previously treated hip fractures and 17 discharges (0.9%) as misclassified. Medical record review of the ICD9 821 discharges found 622 cases that should have been coded as hip fractures. In the 42 hospitals that were reviewed by trained hospital staff, 1395 discharges had originally been reported as ICD9 820. The second review from these hospitals included an additional 697 discharges that had been missed and 587 cases that had been incorrectly coded as ICD9 821. In all 76 hospitals, the reviews identified 3109 discharges coded ICD9 821, of which 1209 were found to be hip fractures, increasing the number of hip fractures by 30%. In addition, the review of a sample of OR logs in 11 hospitals indicated that 13% of hip fractures in the logs were not included in the revised discharge list.

When analyzed separately by year, the rate of hip fracture increased across the 5 years of the study. The rise in rates might reflect less accurate capture and coding of fractures in 1988 and 1989, the first years that the ICD9 codes were introduced in the hospitals. Therefore, incidence rates were calculated based on the 3269 confirmed cases for 1990–92, adjusted upward based on the OR log review by 13.3% for an estimated incidence of 3704.

Immediate cause of the hip fracture was not determined in the medical record reviews.

Budapest, Hungary

In 1992 there were 411 discharges coded ICD9 820 and 15 coded ICD9 821 identified through the discharge lists as residents of Budapest East. Medical records were located and reviewed for all discharges. In the medical record review, four patients were found with two discharges for the same hip fracture in 1992. For each patient the later discharge was deleted from the list of hip fracture discharges. The total number of hip fracture discharges was reduced to 407 (99%). The coding in the discharge list for all discharges was confirmed by the medical record review. The review of the radiology logs did not reveal any hip fractures that were not also included in the discharge list. Even hip fracture cases that were treated conservatively were initially admitted to the emergency unit of a hospital, and no hip fractures occurred in hospital during the study period.

An additional 23 hip fracture patients were admitted to the Budapest East hospitals in 1992 who were residents of one of the other administrative areas of Budapest. Assuming that a similar number of Budapest East patients were treated at other Budapest hospitals, about 6% of the hip fracture cases among area residents would not have been found in the Budapest East discharge lists. For 1992, discharges for 166 hip fracture patients residing in other areas of Hungary or abroad were found. However, the number of Budapest residents treated outside the city is likely much smaller since more complete medical facilities are available in Budapest.

The immediate cause of the hip fracture was recorded in 98% of the medical records.

Table 1. Number of hip fracture cases by study site, based on review of discharge lists, medical records and operating room or radiology logs

Study site	ICD9 820: no. on discharge lists		% change	Transfers and re-admissions removed	% change	No. of discharges confirmed by medical record review	% change	With adjustment for coding errors in ICD9 821 discharges	% change	With adjustment for review of OR or radiology logs	% change	With adjustment for hospitals in area without review	% change	Final estimated incidence
	First review	Second review												
Beijing, China: 1988–92														
34 hospitals	1741	1919	10%	1907	–0.6%	1890	–0.9%	2512	33%					
42 hospitals	1395	uk		uk		2092		2679	28%					
Total	3136	uk		uk		3982		5191	30%	*5881*	*13%*	na		*5881*
Budapest, Hungary: 1992														
	411	na		407	–1%	407	0%	407	0%	407	0%	na		407
Hong Kong: 1991														
	2990[a]	na		2711	–9%	*2475*	–9%	*2837*	*15%*	*3199*	*13%*	*3266*	*2%*	*3266*
Porto Alegre, Brazil: 1992														
	553[b]	na		na[c]		248[d]	–55%	270	9%	*437*	*62%*	*472*	*8%*	*472*
Reykjavik, Iceland: 1990–92														
	517	527	2%	na[e]		515	–2%	520	1%	*579*	*11%*	na		*579*

Numbers in *italics* are estimates, based on review of a sample of the total discharges. See text for description of sampling.

ICD9 820, neck of femur (hip) fracture; ICD9 821, shaft or other femur fracture; OR, operating room; na, not applicable; uk, unknown because information was not available.

[a]3002 discharges coded ICD9 820 were found but 12 were excluded because age or gender could not be identified.

[b]Of these discharges, 201 were coded ICD9 820 and identified as Porto Alegre residents. In addition, 113 discharges were coded ICD9 820 but did not have residency information, and 239 discharges did not have ICD9 coding but were probable hip fractures. Medical record review was attempted on all 553 discharges.

[c]Patient identifiers were not available to search for transfers and readmissions in the discharge lists.

[d]486 of 533 medical records were located. 258 were residents with a diagnosis available in the medical record. 250 were confirmed as hip fractures. 2 were identified as readmissions.

[e]Transfers and readmissions were identified and removed before the data were sent to the Coordinating Center.

Hong Kong

Review of the discharge lists for the nine public hospitals identified 3002 discharges coded ICD9 820 and 764 discharges coded ICD9 821. Age was not available for 10 hip fracture discharges and gender was not available for 2 discharges. Since those cases with unknown age or gender represented a very small portion of the hip fractures, they were excluded from the analysis, leaving 2990 hip fracture discharges. Through comparison of records in the discharge list, 279 (9%) records of hip fracture were identified as transfers or readmissions and excluded from the list.

Medical records were reviewed on a sample of 420 discharges coded ICD9 820. Two cases were found to be too young or non-residents and were excluded. Of the remaining 418 discharges, a total of 381 (91%) were confirmed as hip fractures in the medical record. Thirty-one were found to have other diagnoses, and 6 did not have sufficient information to specify a diagnosis. This proportion varied by hospital. We therefore used the proportion for each hospital to calculate a corrected estimate of the number of hip fracture discharges for that hospital, giving a total of 2475 hip fractures. For discharges coded ICD9 821, 195 medical records were reviewed. Five cases were found to be too young or non-residents and were excluded. Of the remaining 190 discharges, the correct coding was found to be hip fracture for 108 (57%) discharges, and for 5 there was insufficient information in the medical record to determine a diagnosis. The proportion of discharges coded ICD9 821 that were found to be hip fractures varied by hospital. We used these proportions and the number of ICD9 821 discharges for each hospital to estimate the number of additional discharges that should have been coded as hip fractures, giving a corrected hip fracture estimate of 2837, an increase of 15%.

The place of residence provided in the discharge list was compared with the information in the medical record for 609 cases. Of the 541 cases listed as residents in the discharge list, only 2 (0.4%) were identified as non-residents in the medical records. For the 68 cases without residence available in the discharge list, all 68 were found to be residents according to the medical records.

In each of the public hospitals, the OR logs were reviewed for 2–3 months in 1991 for a total of 22 months in the nine hospitals together. In the logs, 518 records were found for hip fracture in patients 20 years of age or older. A match was found in the discharge list for 434; 84 were not located. Of these 84, 10 were found to be old fractures or other fractures after further review. Thus, there were 74 OR records of hip fracture that did not appear on the discharge list. The extent of undercount varied by hospital. Adjusting this undercount by hospital and for the total year increased the estimated hip fracture incidence by 13%, for a total of 3199.

In the two private hospitals where OR logs were reviewed for the entire year, we found 38 cases of hip fracture. Based on the number of beds, we estimated that the other two private hospitals treated 29 hip fractures in 1991. This increased the estimated hip fracture incidence to 3266, with private hospitals accounting for an estimated 2% of hip fracture discharges.

The immediate cause of the hip fracture was recorded in 98% of the medical records reviewed in the public hospitals.

Porto Alegre, Brazil

Among those listed as residents of Porto Alegre, 201 discharges were coded as ICD9 820. An additional 113 discharges were coded as ICD9 820 but did not have information on place of residence. Another 239 discharges did not have an ICD9 code but were identified from the description as probable hip fractures. We were not able to identify transfers and readmissions from the discharge list alone. Medical record review was attempted on all 553 discharges. Medical records were located for 486 (88%) of the discharges. Of those located, 329 (68%) were found to reside in Porto Alegre. Of these, 250 (76%) were confirmed as hip fractures. Two transfers or readmissions were identified and excluded, leaving a total of 248 confirmed hip fracture discharges.

A total of 103 discharges coded as ICD9 821 were identified. In the medical record review, 59 cases were residents of Porto Alegre and also had a diagnosis available in the medical record. Of these, 22 discharges were found to be hip fractures in the medical record review, giving a total of 270 confirmed hip fractures, an increase of 9%.

The review of OR logs found a total of 457 operations identified as hip fractures or as ‘femur fractures’ without a more specific site, excluding second operations on the same patient. When these operations were compared with the discharges, a matching discharge record was found for 309 cases but no match was found for 148. The OR log did not include information on place of residence. The proportion of residents found in the medical record reviews was used to impute residency for the 148 cases, giving an estimated 114.5 hip fracture cases at these three hospitals that were not found through review of the discharge lists. This was a 62% increase over the 186 cases estimated from review of discharge lists and medical records for the three hospitals. For the estimate of hip fractures in Porto Alegre as a whole, an increase of 62% over the cases found from the discharge lists and medical record review gave a total of 437 hip fractures for 1992.

The hospital that refused to disclose information had about 8% of the total hospital admissions in the group of 12 hospitals that admitted hip fractures. When the results of medical record review were adjusted upward accordingly, there were 472 hip fracture cases estimated for 1992.

The race of the patient was identified from the medical record as white, black, mulatto (black/white), Indian (native), Indian/white, Indian/black or unknown. For the

270 records with a diagnosis of hip fracture, 95.0% of the cases were white, 2.7% were black and 2.3% were mulatto (black/white). Because of the small number of black and mulatto cases, results were not analyzed separately by race.

The immediate cause of the hip fracture was available in 79% of the medical records.

Reykjavik, Iceland

In the first review of the discharge lists, 517 discharges for ICD9 820 were identified. The second review found a total of 527 cases in the discharge list. The coding was confirmed by medical record or radiology review for 515 (98%) of the discharges; 8 medical records could not be located and 4 were found to have diagnoses other than hip fracture. For the 83 discharges for ICD9 821, 5 were found to be hip fractures after further record review, representing about 1% of the total hip fractures. For the 252 discharges that had medical record review, residency in greater Reykjavik was confirmed in 250 of the medical records. The remaining 2 medical records did not have sufficient information to identify place of residence.

In the review of radiology logs, 20 cases of hip fracture were found that did not appear on the discharge list. In general, these cases failed to appear on the discharge list because they were being treated on an outpatient basis or because the fracture had occurred in an inpatient after admission for a different diagnosis. Adjusting for the review period at each hospital, we estimated that an additional 59 hip fractures occurred in 1990–92 beyond the 520 confirmed from the discharge list.

The immediate cause of the hip fracture was recorded in 96% of the medical records.

Incidence Rates and Doubling Times

Age- and gender-specific incidence rates for hip fracture for each area, corrected for coding errors, transfers and undercounts in the discharge lists, are presented in Table 2. Because of small numbers of cases in Porto Alegre, the rates are presented in 10-year age groups. For all areas, men tended to have higher rates of hip fracture at younger ages than women. Except in Beijing, women had higher rates than men after the age of 65 years.

Age-adjusted rates for men and women are also presented in Table 2. For men and women, the age-adjusted incidence rates of hip fracture for those 20 years of age and older were highest in Reykjavik and lowest in Beijing. The age-adjusted incidence rates for Hong Kong and Budapest were intermediate, with Hong Kong having slightly higher rates. For Porto Alegre, the low and high estimates of the age-adjusted incidence rates were between the rates for Beijing and Hong Kong. The ratio of rates for women versus men, 50 years and older, was generally higher in those countries with higher age-adjusted rates. The ratio in Reykjavik was 2.0 compared with 0.9 for Beijing. However, Porto Alegre had a female-to-male ratio of 1.9 although the age-adjusted rates were relatively low.

For the age range of 50–89 years, the increase in hip fracture incidence with age was found to be exponential. The coefficient of determination (R^2) for the exponential regression models was greater than 0.90 for all the areas, indicating that this model provides a good description of the data. Beijing had the longest doubling times and had a longer time for women than for men. In other areas, the doubling time was longer for men.

Immediate Cause of Hip Fracture

The proportions of hip fractures reported to be caused by a fall are presented by age and gender in Table 3. Beijing is excluded because information on cause of the hip fracture was not obtained in the medical record review. For all four areas, a fall (from any height) was reported as the immediate cause of hip fracture in a higher proportion of those 50 years and older than at younger ages. For men and women 50 and older, the proportion of hip fractures caused by a fall did not differ widely across countries, ranging from a low of 91% among women in Porto Alegre to a high of 99% among women in Reykjavik. For men in the 20- to 49-year-old group, the proportion of fractures due to a fall ranged from a low of 38% in Porto Alegre to a high of 76% in Hong Kong.

The number of hip fractures attributed to causes other than a fall was small. However, it appears that motor vehicle accidents were the second leading cause of hip fracture among men in both age groups, except in Porto Alegre where they were the leading cause among younger men. Other reported causes included neoplasm, Paget's disease, bicycle accidents, fights and domestic abuse.

Discussion

Hip fracture incidence rates varied widely across the five areas included in our study. With the exception of Porto Alegre, the female to male ratio of rates was greater in those areas with higher rates of hip fracture. In the four areas for which we had data on the cause of the fracture, falls accounted for the majority of hip fractures except for men 20–49 years old in Porto Alegre, where the leading cause was motor vehicle accidents. Among men and women 50 years and older, falls accounted for over 90% of the hip fractures in all four areas.

For Brazil and Hungary, this study is the first available on hip fracture incidence rates. The range of rates that we estimated for Porto Alegre was intermediate between those found for Beijing and Hong Kong. In contrast to the other areas in the study, Porto Alegre had a relatively high female-to-male ratio of 1.9, although the rate for women was relatively low. Our rates for Porto Alegre

Table 2. Hip fracture incidence rates[a] and doubling times by age, gender and study site

	Beijing[b]	Budapest[b]	Hong Kong[c]	Reykjavik		Porto Alegre[b]	
						Low estimated[d]	High estimated[d]
Age group (yr)	Age-specific incidence rates				Age group (yr)	Age-specific incidence rates	
Men							
20–29	2.2	0.0	9.6	9.2	20–29	11.4	18.5
30–39	6.0	5.8	11.8	3.0	30–39	5.5	8.9
40–49	11.1	41.5	13.6	23.8	40–49	12.7	20.5
50–54	18.7	53.7	31.3	48.6	50–59	16.2	26.3
55–59	32.8	72.3	38.3	38.1			
60–64	84.3	128.6	93.1	100.4	60–69	65.6	106.3
65–69	88.2	158.3	126.5	132.7			
70–74	132.5	240.0	254.2	287.2	70–79	97.9	158.5
75–79	160.5	280.2	494.3	563.5			
80–84	281.9	728.3	1014.2	1495.7	80–89	381.5	618.1
85–89	327.8	1498.9	1473.2	1263.8			
90–94	445.2	1872.7		3091.9	90+	705.9	1143.5
95+				6397.0			
20 and older, age-adjusted[e]	45.4	105.6	111.1	141.3		46.3	75.0
50 and older, age-adjusted[e]	107.0	251.0	269.6	348.7		104.7	169.6
Doubling time (yr)[f]	8.8	7.7	5.9	6.2		6.7	
Women							
20–29	1.0	3.4	2.5	6.0	20–29	1.9	3.1
30–39	3.1	5.7	3.8	0.0	30–39	0.0	0.0
40–49	7.6	24.5	9.0	24.1	40–49	7.8	12.6
50–54	17.9	38.7	27.9	36.1	50–59	21.4	34.7
55–59	32.4	46.1	49.2	186.0			
60–64	56.2	84.4	75.0	199.1	60–69	51.7	83.8
65–69	91.2	193.0	194.0	402.5			
70–74	164.1	288.1	438.8	838.0	70–79	327.9	531.2
75–79	141.0	564.8	823.6	1311.1			
80–84	224.2	1100.5	1588.1	1945.3	80–89	779.5	1262.7
85–89	219.2	1652.6	2572.9	3791.9			
90–94	401.0	2217.3		3732.9	90+	1390.2	2252.1
95+				5300.4			
20 and older, age-adjusted[e]	39.6	128.2	168.3	274.1		79.6	129.0
50 and older, age-adjusted[e]	96.0	316.0	428.3	696.6		202.0	327.2
Doubling time (yr)[f]	9.5	6.0	5.1	5.7		5.4	
Ratio women: men, 50 years and older	0.9	1.3	1.6	2.0		1.9	

[a]Per 100 000 population. Corrected for coding errors, transfers and undercounts in the discharge lists.
[b]Census data available only for age group 90+ years.
[c]Census data available only for age group 85+ years.
[d]Low estimate based on 270 hip fractures confirmed by medical record review, with 8% increase for hospital without any review. High estimate includes information from review of the OR logs.
[e]Standardized to 1990 US non-Hispanic white population.
[f]Based on regression of log incidence rate on age for those 50–89 years old.

are higher than previously reported rates for Chile and Venezuela [2] based on hospital discharge records for 1988. However, the female-to-male ratios were similar for Chile, Venezuela and Brazil (1.7 for Chile and Venezuela). Our high estimated rate for men in Porto Alegre is similar to the rate reported for men in La Plata, Argentina, in 1988–89, but the rate reported for women in Argentina was higher than the range we found in Porto Alegre [6]. The variation in reported hip fracture incidence rates for these Latin American countries may reflect differences in available records, the inclusion of both urban and rural areas in the reports for Chile and Venezuela but only urban areas for Argentina and this study, and the underlying heterogeneity of the Latin American countries [7]. Within the United States, Hispanics have been found to have lower hip fracture rates than non-Hispanic Caucasians and Asians [8,9].

Our results for Budapest are lower than those generally reported for northern Europe and the USA [1,2,10]. A study based on national register sources by Johnell et al. [11] that included three eastern European countries (the former German Democratic Republic, former Yugoslavia and Poland) also found lower incidence rates in these countries compared with

Table 3. Immediate cause[a] of hip fracture by age, gender and study site[b]

Cause	Study site/age group															
	Budapest				Hong Kong				Porto Alegre				Reykjavik			
	20–49 years		50+ years		20–49 years		50+ years		20-49 years		50+ years		20-49 years		50+ years	
	No.	Proportion[c]	No.	Proportion[c]	No.	Proportion[c]	No.	Proportion[c]	No.	Proportion[c]	No.	Proportion[c]	No.	Proportion[c]	No.	Proportion[c]
Men																
Fall	11	(0.73)	97	(0.92)	13	(0.76)	127	(0.94)	8	(0.38)	43	(0.93)	6	(0.75)	44	(0.94)
Motor vehicle accident	1	(0.07)	3	(0.03)	3	(0.18)	7	(0.05)	9	(0.43)	1	(0.02)	2	(0.25)	3	(0.06)
Other[d]	3	(0.20)	6	(0.06)	1	(0.06)	1	(0.01)	4	(0.19)	2	(0.04)	0	(0.00)	0	(0.00)
Cause unknown	0		2		1		11		3		6		0		1	
Total	15		108		18		146		24		52		8		48	
Women																
Fall	9	(0.82)	257	(0.95)	5	(0.71)	290	(0.96)	4	(0.67)	129	(0.91)	3	(0.60)	181	(0.99)
Motor vehicle accident	1	(0.09)	3	(0.01)	0	(0.00)	3	(0.01)	0	(0.00)	1	(0.01)	1	(0.20)	1	(0.01)
Other[d]	1	(0.09)	10	(0.04)	2	(0.29)	9	(0.03)	2	(0.33)	11	(0.08)	1	(0.20)	0	(0.00)
Cause unknown	0		3		1		15		2		45		0		9	
Total	11		273		8		317		8		186		5		191	

[a]Reported in medical records.
[b]For Beijing, immediate cause of the hip fracture was not determined in the medical record reviews.
[c]Proportion of records with known cause.
[d]Includes pathologic fractures, bicycle accidents, fights, domestic abuse, etc.

countries in northern and western Europe. Results reported for rural Yugoslavia [12] during 1968–73 were somewhat lower than the rates we found for Budapest.

Johnell et al. [11] reported results for Iceland (1974–84) based on national register sources that were similar to our findings. Our results for Reykjavik are also comparable to rates reported in other northern European countries [1,2,13,14].

The incidence rates for Beijing, reported previously by Xu et al. [5], are much lower than those in the other areas, including Hong Kong. Similarly low rates have been reported recently for rural Turkey [15] and for Korea [16] as well as for Hong Kong in 1965–67 [17]. The results for Beijing are also distinguished by the low female-to-male ratio for hip fracture incidence rates, a phenomenon that has been reported previously for other areas with low rates of hip fracture [1,15,16].

For men in Hong Kong the age-adjusted incidence rates are over twice the rates for Beijing; for women in Hong Kong the rates are over 4 times those for Beijing. Although both are urban areas with Chinese populations, Hong Kong has experienced extensive industrialization over the past several decades while this process has started more recently in Beijing.

The age-adjusted incidence rates for Hong Kong found in this study are higher than those published most recently. For 1988–89, Ho et al. [18] reported incidence rates for those 50 years and older that give an age-adjusted rate of 226 per 100 000 per year for women and 125 per 100 000 per year for men, using the 1990 US non-Hispanic white population as the standard population. An increase of this magnitude in the incidence of hip fracture over a span of a few years seems unlikely. There are several differences in methodology in these studies that could have influenced the results. This survey of discharges was based on lists obtained directly from the hospitals, which may have been more complete than the lists from the Hong Kong Medical and Health Department used in the previous survey. Our figures include an estimate of the hip fracture cases seen at private hospitals, a review of the discharge diagnoses for miscoding, and a review of the OR logs. These differences suggest that the higher rates obtained in the 1991 survey mainly reflect a better ability to identify and include all hip fractures occurring in the population.

The use of multiple sources for records of hip fracture cases in each area revealed limitations in the hospital discharge records that varied substantially across countries. These limitations affect the ability to make comparisons in hip fracture incidence rates across countries using discharge records as well as the ability to determine absolute incidence rates for each area. Previous investigators have noted the problem of transfers [2]. The extent of transfers and their coding in the discharge lists varies across areas. We found that transfers were relatively rare in the discharge lists for Budapest and Porto Alegre but were more common in Hong Kong. Transfers between the emergency hospital and acute care hospitals were routine in Reykjavik but patient identifiers in the discharge lists allowed investigators to identify them.

A common coding error for hip fractures in Beijing and Hong Kong was the assignment of an ICD9 code of 821 rather than the appropriate code of 820. Before the use of ICD9 codes in Beijing and Hong Kong, intertrochanteric hip fractures were called 'tuberosity' fractures. ICD9 codes did not have a term for 'tuberosity' fractures. When the ICD9 system was introduced, these fractures were often coded as 'ICD9 821: other femoral fracture.' Porto Alegre also had a relatively high proportion of hip fractures that were incorrectly coded as 821 in the discharge list.

In every area except Budapest, we found that some hip fractures were reported in the OR or radiology logs that did not appear on the discharge list, resulting in increases of 11–62% in the estimated cases. Possible reasons for the discrepancies include clerical errors, patients suffering a hip fracture in hospital after admission for a different diagnosis, and hip fracture cases receiving nonsurgical (conservative) treatment on an outpatient basis.

One limitation of our study is the difficulty of identifying cases of hip fracture that were not admitted to one of the hospitals defined as serving the study area. Cases could be missed if they were not admitted to an acute care hospital for treatment or if they were treated outside the study area. For our study areas, except for Beijing, we are not aware of reports on how often hip fracture cases are not admitted to a hospital. Cases of hip fracture might be treated by a traditional healer or given nonsurgical treatment outside of a hospital by a physician. A survey of Beijing residents [5] found that all reported hip fractures were treated in a hospital. In a study of hip fractures in Great Britain in the 1950s, Knowelden et al. [19] found that 5% were treated outside of a hospital. Lyritis and Johnell [20] reported that the use of nonsurgical treatment for hip fracture in 1988–89 varied considerably across southern Europe, ranging from 2% in Toulouse, France, to 49% in Porto, Portugal, although their report does not include information on how many patients receiving nonsurgical treatment were hospitalized. The selection of acute care hospitals to review at each study site was based on the investigators' knowledge of hospital admission patterns in their area and reports from the hospitals regarding the admission of hip fracture cases.

Cases of hip fracture would also be missed in our survey if patients were treated in hospitals outside the area. We believe that this was a rare occurrence in Beijing, Hong Kong, Porto Alegre and Reykjavik. The better medical facilities for these regions are in the study area so patients are not likely to go elsewhere for treatment, unless the fracture occurred while traveling outside the region. This assessment was confirmed in Beijing by a survey of the surrounding hospitals that found no hip fracture admissions for Beijing residents during 1988–92 [5]. The annual hospital reports for Iceland indicate that it is rare for Reykjavik residents to

be admitted elsewhere for any disorder (Dr Pálmi Jónsson, personal communication). For Budapest East, however, there was likely some undercount due to residents of that area using hospitals in other areas of Budapest.

The other difficulty in defining the catchment areas was the possible inclusion of patients from outside the study area. Information on residency provided in the discharge list was confirmed by medical record review for at least a sample of discharges. In all areas except Porto Alegre, additional cases identified through the OR or radiology logs were also reviewed. In Porto Alegre, however, the OR lists did not include residency information and further review of cases identified through these lists was not attempted. This limitation was noted previously as one reason for providing a range of estimated incidence rates for Porto Alegre rather than a point estimate.

This study has several other limitations that affect the ability to make comparisons across these five countries. The records in each country varied in the level of detail available to identify old fractures and to check for transfers. Also, each site was separately responsible for training the reviewers of the discharge lists, radiographs, and other records. There was no central review of records to confirm the diagnosis of hip fracture. Despite these concerns, the current study allowed for more corrections to the estimates of hip fracture incidence than have previous international studies. As a result, the comparisons of hip fracture rates across sites have a sounder methodologic basis.

Our findings underscore the difficulty of using hospital discharge data alone to estimate hip fracture incidence rates. The type and extent of errors in the discharge lists can vary substantially across countries. In this study, correction for transfers and readmissions ranged from 1% to 9% across the sites; correction for coding errors ranged from –55% to 30%; correction for undercounts ranged from 0 to 62%. Cumulatively, the final estimates of hip fracture incidence taking into account all investigated sources of undercount and overcount ranged from 15% lower to 89% higher than an estimate based on the discharge diagnoses without any corrections.

These results also support the conclusion that the differences previously reported among countries mainly reflect genuine variation in the hip fracture incidence rates. For studies in the 1980s, Maggi et al. [1] found a 7-fold difference in age-standardized rates among women and a 6-fold difference among men. In southern Europe, Ellfors et al. [15] reported a 13-fold difference in age-standardized rates among women and a 4-fold difference among men. The magnitude of these differences is too great to be explained by the amount of error that we found in the hospital discharge lists at our various study sites.

In summary, this study of hip fracture incidence in Beijing, Budapest, Hong Kong, Porto Alegre and Reykjavik found substantial limitations in relying on hospital discharge data alone to estimate hip fracture incidence rates. The review of individual patient records, operating room logs and radiology logs found errors in the coding of the discharge diagnosis, often as shaft of femur fracture instead of femoral neck fracture, and also identified cases that were not included in the discharge lists. With the corrected estimates, the study still found large differences in hip fracture incidence rates, with the age-adjusted incidence rates in women being 6 times higher and in men over 3 times higher in Reykjavik compared with Beijing.

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