The Incidence of Fractures and Dislocations Referred for Orthopaedic Services in a Capitated Population

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Background: The purpose of this study was to determine the annual incidence rates of non-work-related traumatic fractures and dislocations (excluding head and facial injuries) referred for orthopaedic services in a large population enrolled under a capitated insurance contract.

Methods: The number of fractures and dislocations that were referred for orthopaedic services were recorded prospectively from among an average of 135,333 persons per year who were enrolled under a capitated insurance contract during the three-year study period. These data were used to determine the gender-specific and age-specific incidence rates of fractures and dislocations referred for orthopaedic services.

Results: A total of 3440 fractures and 422 dislocations were referred for orthopaedic services during the three-year study period. The incidence rate of fractures referred for orthopaedic services was 8.47 per 1000 member-years, with a significantly ($p < 0.0001$) higher rate among males. Members between the ages of ten and fourteen years had the highest rate of fractures referred for orthopaedic services (21.52 per 1000 member-years). The lifetime risk of a traumatic fracture referred for orthopaedic services to the age of sixty-five years was one in two for both males and females. The incidence rate of dislocations referred for orthopaedic services was 1.04 per 1000 member-years, which did not differ significantly ($p = 0.75$) between genders. Members between the ages of fifteen and nineteen years had the highest rate of dislocations referred for orthopaedic services (2.75 per 1000 member-years). The lifetime risk of a traumatic dislocation referred for orthopaedic services to the age of sixty-five years was one in sixteen for both male and female members.

Conclusions: Young males had the highest rate of traumatic fractures referred for orthopaedic services. Adolescents of both genders had high rates of traumatic dislocations referred for orthopaedic services. The lifetime risk of a non-work-related fracture referred for orthopaedic services to the age of sixty-five years is approximately equal to that of coronary artery disease.

Level of Evidence: Prognostic study, Level II-1 (retrospective study). See Instructions to Authors for a complete description of levels of evidence.

Each year in the United States, fractures and dislocations require approximately 11.4 million office visits to physicians and nearly one million hospital admissions[1]. The direct medical costs in 1995 that were associated with office visits to physicians for the treatment of fractures and dislocations were over $1 billion. The total direct costs of medical care for fractures alone were over $15 billion[1].

Orthopaedic surgeons are generally recognized as experts in the treatment of fractures and dislocations. Orthopaedic surgeons receive approximately 89% of the referrals that are given for the treatment of fractures and 57% of the referrals that are given for the treatment of dislocations. An estimated 74% of all physician office visits for the treatment of fractures and dislocations are visits to orthopaedic surgeons[1].

Third-party payers that use capitation and other cost-containment strategies view surgical specialties, including orthopaedics, as expensive services[2]. The material and financial resources that are allocated to orthopaedic surgeons to treat fractures and dislocations in a given population should be directly related to the incidence rates of referral of these conditions to orthopaedic surgeons[3,4]. While it is evident that fractures and dislocations are very common, the incidence rate of referrals to orthopaedic surgeons for these injuries among a general population is uncertain.

Most published incidence rates of fracture are limited to specific bones or joints[5-11] or to certain age-groups[12-19]. Similarly, most studies describing incidence rates for dislocation have been limited to specific joints and to certain age-groups[20-26]. While useful for particular purposes, most previous studies do not provide the information necessary to determine the orthopaedic health-care resources that would be required to treat fractures and dislocations in a general population. To the best of our knowledge, no prospective cohort study has been conducted to determine the incidence rate of fractures referred for orthopaedic services and the incidence rate of dislocations referred for orthopaedic services in the United States.

The purpose of this study was to determine the annual incidence rate of fractures and the annual incidence rate of dislocations referred for orthopaedic services among a large cohort enrolled under a capitated insurance contract. The capitated insurance contract stipulated that members receive orthopaedic services exclusively from a single independent physician association that consisted of sixty-two orthopaedic surgeons. We prospectively collected data with regard to the occurrence of traumatic fractures and dislocations over a three-year period. The incidence rate of fractures and the incidence rate of dislocations referred for orthopaedic services were compared among gender groups and age-groups. The lifetime risk of a fracture and the lifetime risk of a dislocation referred for orthopaedic services were estimated. The rate of open fracture, the rate of open dislocation, and the rates of operative treatment for fracture and dislocation were also calculated.

Materials and Methods

The study population consisted of a cohort that was enrolled under a specialty capitated insurance contract for orthopaedic services, which included only professional fees (clinical and surgeon's fees). The capitation contract for orthopaedic services was part of a global services health maintenance organization (HMO) insurance plan, which included capitated and noncapitated contracts for other medical services. The capitated population consisted of employed adults, and their dependents, who were enrolled under this HMO through their employers. The types of employers offering this plan included large petrochemical companies, engineering companies, shipping companies, manufacturing and distributing companies, communications companies, and public school districts in the immediate geographic area. All orthopaedic services were provided exclusively by a private independent physician association that consisted of sixty-two orthopaedic surgeons in the greater metropolitan Houston region of southeastern Texas. Access for orthopaedic services was made through a primary care physician for less emergent care or through an emergency department for more serious conditions or injuries. Orthopaedic services were provided either in the offices of the independent physician association or in one of the numerous hospitals enrolled under the HMO. No individuals in this study used Medicare or Medicaid as the primary source of health insurance.

Under the capitated orthopaedic contract described in the present study, the primary care physician did not have any incentive to either over-refer or under-refer patients to an orthopaedic specialist. The arrangement between the insurance company and the primary care physicians did not involve such incentives. Referral to an orthopaedic surgeon was made on the basis of the judgment of the primary care physician with regard to the need for specialty care, which is identical to the traditional method of medical referral. There were no diagnostic or surgical codes that were used to specify services that were the exclusive responsibility of either primary care providers or orthopaedic surgeons.

Under the capitated arrangement, the orthopaedic surgeon was reimbursed from the pooled capitated income of the independent physician association on the basis of the services he or she provided according to the Resource Based Relative Values Scale (RBRVS). Specifically, each physician received a percentage of the monthly revenue of the independent physician association that was calculated on the basis of the ratio of his or her total RBRVS (for office visits, surgery, and in-hospital consultations) for the month divided by the total RBRVS (for office visits, surgery, and in-hospital consultations) of the entire group of sixty-two orthopaedic surgeons for the month. Nonemergent surgical services underwent a utilization review process by a group of three orthopaedic surgeons in the independent physician association.

During the period from January 1, 1998, through December 31, 2000, data were prospectively collected as members of the cohort sought orthopaedic care for non-work-related injuries and conditions. Although the mechanism of injury was not available in the current data, a previous study in the same region showed that most fractures (85%) are typically due to motor vehicle accidents, falls, motor vehicle-pedestrian accidents, and gunshot wounds[27].

The number of members in the capitated plan, the number of days that each member was enrolled, and the gender and age of the members were recorded each month from the enrollment lists of the insurance carrier. The investigators did not have access to the full database of the insurance company but received a digital enrollment list from the insurance company each month in order to confirm coverage as members were referred for treatment. The digital enrollment list was used to update the independent physician association's centralized computer database in order to maintain a current list of plan members. The number of members who had one or more office visits, the total number of office visits, the dates of service for orthopaedic care, the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes[28], and the American Medical Association's *Current Procedural Terminology* (CPT)[29] codes were recorded in the centralized computer database of the independent physician association. The database served many administrative purposes (tracking billing and collections, for example), but it had also been constructed to facilitate prospective data collection for utilization and epidemiological research using the specified cohort. The ICD-9-CM and CPT codes were recorded by the physician using preprinted optical scan sheets (White Plume Technologies, Birmingham, Alabama) that were read into the centralized computer database. The scanning forms also included blanks so that codes that were not preprinted could be entered manually.

For the purpose of the present investigation, data were abstracted with regard to patients with traumatic fractures and dislocations of the axial and appendicular skeleton (ICD-9-CM codes 805 through 839.9), excluding injuries to the head or face. Fractures were identified by ICD-9-CM codes 805 through 829.1. Dislocations were identified by ICD-9-CM codes 831 through 839.9, excluding codes 836.0 through 836.2 (tear of meniscus of the knee). Fracture-dislocations were identified by two ICD-9-CM codes, one for the fracture and one for the dislocation. For estimating the incidence rates, fracture-dislocations were counted as a fracture. The ICD-9-CM codes allowed identification of the anatomical locations of the injuries. The ICD-9-CM codes were also used to identify whether the fractures and dislocations were open or closed.

Treatment was classified as either operative or nonoperative, as determined by the CPT codes. Operative treatment was defined as any service that required anesthesia or open treatment or percutaneous fixation at any time during the patient's course of treatment, as defined by CPT codes 10000 through 69999. Nonoperative treatment was defined as any service that did not require anesthesia, open treatment, or percutaneous fixation. The initial date of service for each patient was used to identify potential seasonal variations in the incidence of fractures and dislocations. The seasons (winter, spring, summer, and fall) were defined by the celestial equinoxes and solstices.

Statistical Methods

The length of time that each member was enrolled under the capitated insurance contract varied. The number of days that each member was enrolled during the study period was divided by 365 to calculate each member's enrollment time in years. The data were expressed in member-years by summing across all members enrolled in the capitated insurance contract during the study period.

The total member-years in the cohort and the member-years in the various gender-specific and age-specific groups served as the denominators for the calculation of the incidence rates. The corresponding numerators were the counts of fractures and dislocations referred for orthopaedic services that occurred across and within the various gender-specific and age-specific groups. The independent physician association's centralized computer database assigned every plan member a permanent and unique identification number. Before data analysis, this identification number was used to sort and screen the data that had been abstracted for the current study to determine whether any injury appeared more than once. By sorting with the unique member identification numbers, the abstracted data were cleared of all duplicate reporting of injuries. Each injury was therefore counted only once during the calculation of incidence rates.

Incidence rates and 95% confidence intervals were calculated and expressed per 1000 member-years. Relative risk ratios, 95% confidence intervals, and the corresponding p values were calculated to determine whether either gender was at greater risk of fractures or dislocations referred for orthopaedic services and to compare age-groups. The lifetime risk and the lifetime probability of a fracture and the lifetime risk and the lifetime probability of a dislocation referred for orthopaedic services were estimated[30,31]. These statistics were adjusted for age-specific all-cause mortality with use of the 1999 death rates for the United States population[32].

The means and standard deviations were calculated for age. Chi-square goodness-of-fit tests were used to analyze the distributions of the categorical variables. Chi-square tests of independence were used to analyze the association between gender and the anatomical location of the injuries. Spearman rank correlation coefficients (r_s) were used to analyze the associations among age, age-specific group size, the fracture incidence rate, and the dislocation incidence rate.

For all analyses, a p value of ≤ 0.05 was considered significant.

Results

During the three-year study period, 343,574 members (173,157 females and 170,417 males) were enrolled in the insurance plan for one month or more. The total enrollment time of these members during the three-year study period was equivalent to that of 406,000 member-years, or an average annual enrollment of 135,333 members (67,823 females and 67,510 males).

The average age of the cohort was 28.9 ± 17.3 years (range, zero to ninety-nine years [28.7 ± 16.9 years for females and 29.0 ± 17.7 years for males]). The number of member-years in a particular age-group decreased significantly ($r_s = -0.50$, $p = 0.007$) with increasing age (see Appendix). The largest age-groups were those with members between thirty-five to thirty-nine years old (40,448 member-years) and between forty to forty-four years old (41,213 member-years). Because no member was using Medicare as the primary source of health insurance, the sixty-five-year and older age-group was the smallest (2949 member-years).

During the study period, 3440 fractures referred for orthopaedic services occurred in the cohort for an incidence rate of 8.47 fractures per 1000 member-years (95% confidence interval = 8.15 to 8.75). A total of 422 dislocations referred for orthopaedic services occurred for an incidence rate of 1.04 dislocations per 1000 member-years (95% confidence interval = 0.94 to 1.14).

The patients with these injuries attended a total 30,038 office visits to receive orthopaedic care (see Appendix). Fractures required significantly more office visits than did dislocations ($p < 0.0001$). Patients who received operative treatment had significantly more office visits than did patients who received nonoperative treatment ($p < 0.0001$). Body region ($p = 0.387$) and injury type (open or closed, $p = 0.741$) did not significantly affect the number of office visits. Because of the robust statistical power afforded by the sample size, age was significantly correlated with the number of office visits ($p < 0.001$), but the size of this effect was negligible ($r = 0.08$; that is, the equivalent of one additional office visit for every forty years of age).

A summary of the injuries referred for orthopaedic services by anatomic location is shown in the Appendix. The most common sites of fracture were the forearm (25%), the hand (19%), and the foot (13%). These sites accounted for 57% of all fractures. Seventeen (0.5%) of the 3440 fractures were fracture-dislocations. Seven of the seventeen fracture-dislocations were of the patella. Of the 3440 fractures, seventy-two (2%) were open. Overall, 46% of the patients with fractures received operative treatment. The incidence of fractures referred for orthopaedic services did not vary significantly by season (chi square = 0.12, $p = 0.99$).

The most common sites of dislocations referred for orthopaedic services were the patella (55%), the shoulder (13%), and the acromioclavicular joint (10%). These sites accounted for 78% of all dislocations. Of the 422 dislocations, ten (2%) were open. Overall, 38% of the 422 patients with dislocations received operative treatment. The incidence of dislocations referred for orthopaedic services did not vary significantly by season (chi square = 0.08, $p = 0.99$).

Gender

A table in the Appendix shows the gender-specific and age-specific annual incidence rates of fracture and annual incidence rates of dislocation referred for orthopaedic services.

Overall, males had a significantly ($p < 0.0001$) higher annual incidence rate of fractures referred for orthopaedic services than did females (relative risk for males = 1.30; 95% confidence interval = 1.22 to 1.39). The unadjusted lifetime risk of a fracture referred for orthopaedic services to the age of sixty-five years was one in two both for females (lifetime probability = 42.7%) and males (lifetime probability = 46.1%). After adjustment for age-specific mortality[30,31], the lifetime risk of a fracture referred for orthopaedic services to the age of sixty-five years was one in three for females (lifetime probability = 39.0%) and one in two for males (lifetime probability = 42.2%).

Males had a significantly ($p < 0.0001$) higher rate of upper extremity fractures referred for orthopaedic services compared with females, with a relative risk of 1.16 (95% confidence interval = 1.11 to 1.23). Females had a significantly ($p < 0.0001$) higher rate of lower extremity fractures referred for orthopaedic services compared with males, with a relative risk of 1.32 (95% confidence interval = 1.20 to 1.44). The rates of spine fractures, trunk fractures (ribs or sternum), and pelvic fractures referred for orthopaedic services were not significantly ($p = 0.57$) different between males and females.

The rate of open fractures referred for orthopaedic services was not significantly ($p = 0.45$) different between females and males (relative risk for males = 1.54; 95% confidence interval = 0.51 to 4.72). The rate of operative treatment of fractures was not significantly ($p = 0.96$) different between females and males (relative risk for males = 1.00; 95% confidence interval = 0.85 to 1.19).

Across all age-groups, the annual incidence rate of dislocation referred for orthopaedic services was not significantly ($p = 0.75$) different between females and males (relative risk for males = 0.95; 95% confidence interval = 0.79 to 1.14). The unadjusted lifetime risk of a dislocation referred for orthopaedic services to the age of sixty-five years was one in fifteen for both females (lifetime probability = 6.7%) and males (lifetime probability = 6.6%). After adjustment for age-specific mortality, the lifetime risk of a dislocation referred for orthopaedic services to the age of sixty-five years was one in sixteen for both females (lifetime probability = 6.4%) and males (lifetime probability = 6.1%).

Males had a significantly ($p < 0.0001$) higher rate of upper extremity dislocations referred for orthopaedic services, with a relative risk of 2.40 (95% confidence interval = 1.82 to 3.17) compared with females. Females had a significantly ($p < 0.0001$) higher rate of lower extremity dislocations referred for orthopaedic services, with a relative risk of 1.69 (95% confidence interval = 1.43 to 2.00) compared with males.

The rate of open dislocations referred for orthopaedic services was not significantly ($p = 0.90$) different between females and males (relative risk for males = 0.96; 95% confidence interval = 0.51 to 1.80). The rate of operative treatment of dislocation was not significantly ($p = 0.77$) different between females and males (relative risk for males = 0.96; 95% confidence interval = 0.78 to 1.18).

Age

Age was not significantly ($r_s = -0.21$, $p = 0.29$) correlated with the annual incidence rate of fractures referred for orthopaedic services. The Spearman rank correlation coefficient, however, assumes that there is a monotonic (i.e., constantly increasing or decreasing) relation between the variables. The relation between age and the annual incidence rate of fracture referred for orthopaedic services was not monotonic (Fig. 1). The annual incidence rate of fractures referred for orthopaedic services increased from birth to the age of fourteen years, then decreased from the age of fifteen years to the age of twenty-four years. Members between the ages of ten and fourteen years had the highest rate of fracture referred for orthopaedic services (21.52 per 1000 member-years). For members who were twenty-five years of age or older, the annual incidence rate of fractures referred for orthopaedic services increased gradually with age. For those between birth and twenty-four years old, the incidence rate of fractures referred for orthopaedic services (12.35 per 1000 member-years; 95% confidence interval = 11.81 to 12.88) was significantly ($p < 0.0001$) higher than for members who were twenty-five years of age or older (5.81 per 1000 member-years; 95% confidence interval = 5.51 to 6.12). The relative risk of fractures referred

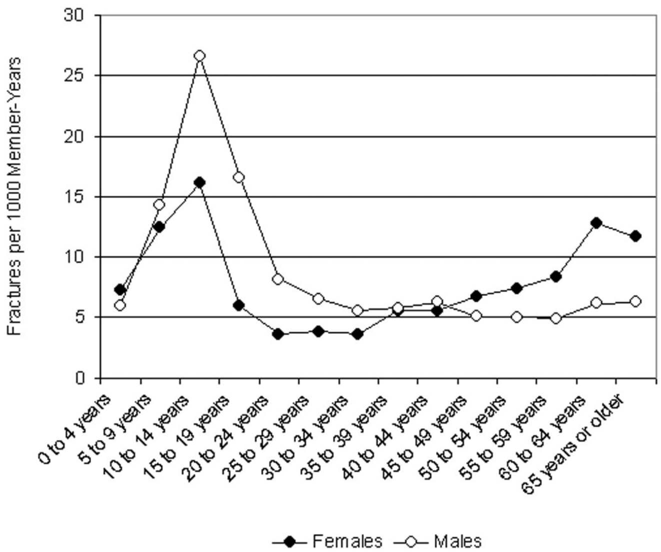

Fig. 1

The incidence rates of traumatic fractures referred for orthopaedic services according to age and gender.

for orthopaedic services for members from birth to the age of twenty-four years was 2.12 (95% confidence interval = 1.98 to 2.27) compared with members who were twenty-five years of age or older.

Females and males had different annual incidence rates of fractures referred for orthopaedic services for the various age-groups (Fig. 1). Males between birth and the age of forty-four years had a significantly ($p < 0.0001$) higher incidence rate of fractures referred for orthopaedic services (10.98 per 1000 member-years; 95% confidence interval = 10.46 to 11.50) than did females in the same age-range (7.21 per 1000 member-years; 95% confidence interval = 6.79 to 7.62). The relative risk of fractures referred for orthopaedic services for males from birth to forty-four years of age was 1.52 (95% confidence interval = 1.41 to 1.64) compared with females of the same age. This gender effect was reversed for members who were forty-five years of age or older, as females in that age-group had a significantly ($p = 0.026$) higher incidence rate of fractures referred for orthopaedic services (7.95 per 1000 member-years; 95% confidence interval = 7.12 to 8.77) than did males in the same age-range (5.22 per 1000 member-years; 95% confidence interval = 4.58 to 5.86). The relative risk of fractures referred for orthopaedic services for females who were forty-five years of age or older was 1.52 (95% confidence interval = 1.05 to 2.02) compared with males of the same age.

A significant relationship was detected between age and the anatomical location of a fracture referred for orthopaedic services (chi square = 83.85, $p < 0.0001$). Members who were nineteen years of age or younger had a significantly ($p < 0.0001$) higher rate of upper extremity fractures referred for orthopaedic services, whereas members who were twenty-five years of age or older had a significantly ($p < 0.0001$) higher rate of lower extremity fractures referred for orthopaedic services. Age was not significantly related to the rate of open fractures referred for orthopaedic services ($r_s = 0.27$, $p = 0.16$) or to the rate of operative treatment of fractures ($r_s = -0.36$, $p = 0.06$).

Age was not significantly ($r_s = -0.11$, $p = 0.58$) related to the annual incidence rate of dislocations referred for orthopaedic services, and the relation was not monotonic (Fig. 2). The incidence rate of dislocations referred for orthopaedic services for the age-group involving members fifteen to nineteen years of age (a rate of 2.75 per 1000 member-years, 95% confidence interval = 2.20 to 3.30) was much higher than the annual incidence rate of dislocation in any other age-group. No dislocations referred for orthopaedic services occurred among members who were sixty-five years of age or older in this cohort. The female and male incidence rates of dislocations referred for orthopaedic services were not significantly different for the various age-groups ($p \geq 0.33$) (Fig. 2).

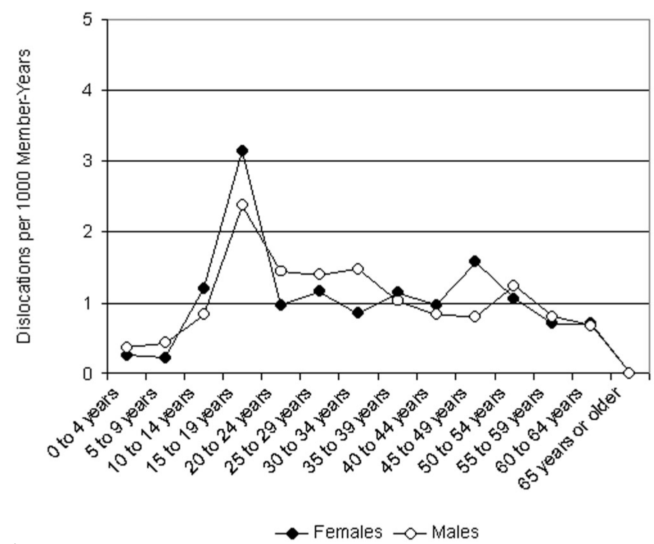

Fig. 2

The incidence rates of traumatic dislocation referred for orthopaedic services according to age and gender.

A significant relationship was detected between age and the anatomical location of dislocations referred for orthopaedic services (chi square = 26.70, $p = 0.0002$). Members who were nine years of age or younger had significantly ($p < 0.0001$) more upper extremity dislocations referred for orthopaedic services compared with members who were ten years of age or older. The distribution of the ten open dislocations referred for orthopaedic services did not differ significantly for the various age-groups ($p = 0.21$). At least one open dislocation occurred in each decade of age from birth to the age of sixty years. No more than two open dislocations occurred in any decade of age. Age was not significantly ($r_s = -0.10$, $p = 0.64$) related to the rate of operative treatment for dislocations.

Discussion

The lifetime risk of sustaining a traumatic fracture that will be referred for orthopaedic services to the age of sixty-five years (one in two) is higher than the estimated lifetime risks of stroke (one in six)[33], type-II diabetes mellitus (one in twenty)[33], major depression (one in five)[34], breast cancer (one in eight for women)[30,35], and prostate cancer (one in six for men)[35]. The lifetime risk of a fracture that will be referred for orthopaedic services to the age of sixty-five years is approximately equal to the lifetime risk of coronary artery disease (one in two for males and one in three for females)[36].

The high annual incidence rate and lifetime risk of fractures referred for orthopaedic services indicate that fractures are a major public health concern. According to our results, approximately one of every 118 persons under the age of sixty-five years sustains a fracture that is referred for orthopaedic services each year. Our data represent the majority of all traumatic fractures that occur, but they exclude the minor injuries that do not require the care of an orthopaedic specialist. According to Praemer et al., approximately three of every four office visits for the treatment of fractures and dislocations are made to orthopaedic surgeons[1]. In addition, they noted that orthopaedic surgeons receive the vast majority of referrals (89%) from other types of physicians for the treatment of fractures. Our data represent persons with fractures referred for orthopaedic services since virtually all of the patients in the current study were referred.

The medical costs of treatment and the socioeconomic costs that are associated with fractures are substantial[1,37-42]. In 2000, the total cost of medical treatment for fractures due to osteoporosis alone was estimated to be between $10 billion and $15 billion per year in the United States[43]. In 1995, the costs of physician office visits for the treatment of fractures was estimated to be $870 million, with the costs of hospital care for the treatment of fractures exceeding $8.9 billion[1]. If the rate of fractures in the United States and the associated medical costs have not changed, the current (2002) annual cost estimates would be $1 billion and $10.4 billion, respectively, after accounting for inflation with use of the consumer price index from the United States Bureau of Labor Statistics (www.bls.gov/cpi/home.htm).

Thus, accurate estimates for gender-specific and age-specific incidence rates of fractures referred for orthopaedic services have tremendous value. Such estimates can be used to determine the resources that would be required to treat traumatic fractures referred for orthopaedic services among known populations, such as persons enrolled under a capitated insurance plan. Also, economic value can be assigned to orthopaedic services on the basis of the need for such services in the population.

For example, dividing the total number of office visits for fractures by the average annual population (135,333 members) yields an estimate of 20,708 office visits per 100,000 members per year (or 398 office visits per week) to treat fractures referred for orthopaedic services. For the sixty-two orthopaedic surgeons in the independent physician association of the current investigation, that was equivalent to an average of 6.4 office visits per surgeon per week. With use of this type of calculation in combination with the payer-mix guidelines and the average number of office visits per year per provider, a group practice can estimate how many providers would be needed to provide fracture care for a given capitated population.

To the best of our knowledge, no prospective study of the incidence rates of fractures referred for orthopaedic services among a known cohort over a predetermined time has previously been performed in the United States. Several studies describing the incidence rate of fractures have been conducted in other countries[44-47]. Most of those studies had higher rates of fracture than did the present study since they examined fracture rates among adults and were not limited to fractures referred for orthopaedic services[44,46,47]. In the study that used a methodology that was most similar to one used in the current study (i.e., all ages and only traumatic fractures receiving orthopaedic services were counted), Donaldson et al. reported that the annual incidence rates of fracture were 8.1 fractures per 1000 persons per year for females and 10.0 fractures per 1000 persons per year for males[45]. These rates are very close to those observed among our population (females = 7.4 fractures and males = 9.6 fractures per 1000 persons per year).

In England, a single health-care system usually provides medical services exclusively for an entire geographic region. Data collected among a geographic cohort under this condition can reasonably be assumed to have captured all fractures[48]. By contrast, most geographic regions of the United States are served by multiple health-care systems. Observation of a geographic cohort in the United States cannot be used to determine the incidence rate of fractures unless the data collection occurs simultaneously in many different health-care systems, or a systematic sampling methodology is used[48].

Consequently, most reports of incidence rates for fracture in the United States rely upon the data of various large-scale surveys conducted by the National Center for Health Statistics at the Centers for Disease Control and Prevention[1,49,50]. Those surveys use a multistage probability sampling methodology in order to obtain representative samples of visits to health-care facilities and visits to health-care providers[49-51]. This method includes fractures treated by all types of physicians. By contrast, the current study determined the incidence rate of fractures referred for orthopaedic services from prospective observations in a known cohort.

The incidence rate of fractures referred for orthopaedic services varied by gender and by age in the current study, which is similar to the findings in previous reports[1,44-47]. Males who ranged from ten to fourteen years old had the highest annual incidence rate of fractures referred for orthopaedic services when compared with the other gender-specific and age-specific groups. Males had a higher incidence rate of fractures referred for orthopaedic services until middle adulthood (forty-five years old), when the incidence rate among females increased substantially. This gender trend appears in many previous reports and is usually attributed to the onset of osteoporosis among women in later life[1,44-47].

In cohort studies that were conducted in other countries, the incidence rates of fractures reported for persons who were sixty-five years of age or older were two to three times higher than those observed in our cohort[44-46]. For example, in a study of older adults (those who were more than fifty-five years old) in Tasmania, the annual incidence rate of fractures was reported to be 19.2 per 1000 persons per year among women and 12.5 per 1000 persons per year among men[44]. The incidence rate among adults in England and Wales has been reported to be 10.7 per 1000 persons per year among women and 9.9 per 1000 persons per year among men[47]. One explanation of the difference in rates is that we did not include pathological or nontraumatic fractures in our study. Furthermore, those previous studies observed the occurrence of fractures among a geographic cohort, including retirees[44-46]. By contrast, our cohort consisted of members with an average age of 28.9 years who were enrolled under a commercial capitated insurance plan. Our cohort had 95% fewer members in the age-group of sixty-five years or older than would be expected from the 1999 age distribution in the United States[52]. No member of the cohort was using Medicare as primary insurance coverage at the time of the study. The incidence rate of fractures and the costs associated with the treatment of fractures are very high among persons who are more than sixty-five years old[1,42,53]. One limitation of our study is that our results are not likely to be representative of the true incidence rate of fracture among persons who are sixty-five years of age or older in the general population. Our data are useful, however, for the unique group of older adults who are still gainfully employed.

Two age-groups, fifty-five to fifty-nine years old and sixty to sixty-four years old, were also somewhat underrepresented in our cohort (23% fewer members than expected). The incidence rates of fractures referred for orthopaedic services for persons who ranged in age from fifty-five to sixty-five years old should therefore be interpreted in the context of nonretired, actively employed individuals.

This study has several limitations. Since our data were collected in a capitated cohort, it is possible that minor fractures or dislocations (e.g., the phalanges of the foot) were not referred for orthopaedic services and thus were not captured in our study. Our results represent the incidence rates of fractures and dislocations that are typically referred to orthopaedic services. The minor injuries that may have been excluded were assumed to be such that they are typically treated by a primary care physician and do not require the services of an orthopaedic surgeon. As discussed above, our cohort is likely not representative of persons who are sixty-five years of age or older in the general population. Nor is it representative of unemployed persons or employed but uninsured adults. Thus, the rates of injury reported in the present study are likely to be lower than that observed by the typical orthopaedic trauma surgeon in a population that includes uninsured patients and the elderly. These rates also do not include workplace injuries since those patients would have received care under Workers' Compensation arrangements rather than through private medical insurance. However, the rates should be robust for populations of insured persons up to the age of sixty-five years, which constitutes a large portion of the patients seen in the private practice of orthopaedic surgeons.

The present study describes the incidence rates of fractures and dislocations referred for orthopaedic services in a large cohort of working adults and their dependents. The annual incidence rate of fractures referred for orthopaedic services is highest among young males, and the annual incidence rate of dislocations referred for orthopaedic services is highest among young persons of both genders. Males have a higher incidence rate of fractures referred for orthopaedic services through approximately the age of forty-five years, at which point the incidence rate among females exceeds that among males. Nearly half of the fractures and more than a third of the dislocations that are referred for orthopaedic services receive operative treatment. The lifetime risks of fracture and of dislocation referred for orthopaedic services indicate that these conditions are substantial public health issues. The data in this report will be useful for estimating the orthopaedic services required to treat fractures and dislocations among a given population, particularly those typically served by capitated insurance contracts.

Appendix

eA Tables showing fracture and dislocation incidences by gender, age, and anatomic location and office visits by treatment type are available with the electronic versions of this article, on our web site at www.jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

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