Comparison of fracture patterns between rural and urban populations in a developing country

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ABSTRACT

Introduction: The pattern of fracture, including the anatomical location and age distribution, may differ among urban and rural populations due to various factors such as the inhabitants' occupation and living environment.

Methods: This was a retrospective multicentre study involving two urban and three rural hospitals in Malaysia. The demographic data and anatomical location of fracture of patients admitted in 2007 were collected for analysis.

Results: A total of 7,973 patients were admitted for fractures between January and December 2007. The femur was the commonest fracture site that required admission in the urban population (21.9 percent), followed by the tibia-fibula (18.7 percent), while the radius-ulna was the commonest site among the rural population (22.0 percent), followed by the tibia-fibula (19.4 percent). The rates of head and pelvic fractures were comparatively higher in the urban population, while hand fractures were more common in the rural population. The higher rate of femur fracture in the urban group, especially among the elderly, may be due to the higher incidence of osteoporosis or a higher proportion of older people in the population.

Conclusion: The anatomical locations of common fractures differed between the urban and rural populations. A higher rate of upper limb fractures was observed in the rural areas, while femur fractures in the elderly was the main cause of fracture admission in the urban areas. The relatively high rate of hand fractures in the rural areas, especially among children and young adults, may require further investigation.

Keywords: bone fractures, developing countries, rural population, urban population

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INTRODUCTION

Fracture is a common problem that contributes greatly to the clinical load of a hospital.[1] With the increasing costs of medical services in general, the management of fractures, especially those that require inpatient treatment and operative fixation, is gradually becoming a burden to the healthcare system.[2] Most fractures result in a temporary loss of function for the patient, and sometimes, a loss of work time for the parents, children or other caretakers of the injured patient. With the growing number of elderly in the population, osteoporotic fracture, which is associated with a higher rate of morbidity and mortality, has become a real challenge for healthcare providers.[3,4]

Fracture patterns differ depending on the geographical location.[5-7] Variations in the activities of daily life and in the nature of work, especially between urban and rural populations, are two of the most likely contributing factors. In many developing countries, planning for trauma services is mostly based on audits of selected major hospitals. The literature on the patterns of fracture is based mainly on the data collected in developed countries.[5,6] Road transport systems also differ between developed and developing countries, but there is very little relevant information in the literature concerning the types of fractures encountered in urban and rural areas of developing countries, especially those located in the tropical zones. This study was conducted to describe the patterns of fracture observed in five hospitals in various parts of Malaysia, and to compare between fractures sustained in rural and urban environments.

METHODS

This was a retrospective multicentre study involving five hospitals in Malaysia. Two of the hospitals are situated around the national capital of Kuala Lumpur, and mainly provide treatment to patients living in the urban environment (the Klang valley). The other three hospitals, located in the Northern and Southern regions of Peninsular Malaysia and the Eastern region of East Malaysia, have a larger proportion of their

Table I. Demographic data of the patients included in the study (n = 7,973).

Variable	No. (%)	
	Urban (n = 2,357)	Rural (n = 5,616)
Gender		
Male	1,703 (72.25)	4,303 (76.62)
Female	654 (27.75%)	1,313 (23.38)
Race		
Malay	876 (37.17)	3,645 (64.90)
Chinese	601 (25.50)	724 (12.89)
Indian	581 (24.65)	327 (5.82)
Others	299 (12.69)	920 (16.38)
Age (yrs)*		
< 15	219 (9.32)	954 (17.03)
15–< 30	821 (34.94)	2,290 (40.87)
30–< 45	510 (21.70)	1,008 (17.99)
45–< 60	315 (13.40)	632 (11.28)
> 604	485 (20.64)	719 (12.83)

*Data was missing for 7 urban and 13 rural participants.

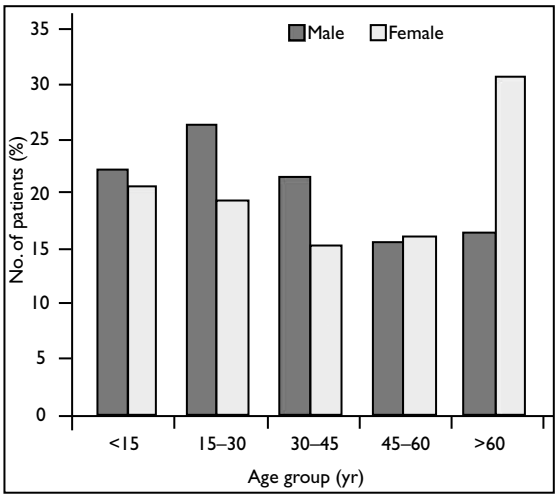

Fig. 1 Graph shows the gender distribution of the patients between the age groups.

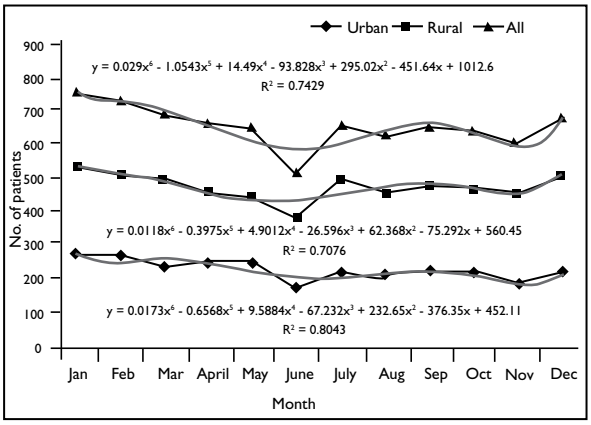

Fig. 2 Graph shows monthly distribution of admissions due to fracture in 2007.

patients from the rural environment. Information on the patients admitted to the orthopaedic department between January 1, 2007 and December 31, 2007 was collected from either the hospital admission database or the ward admission records of these five hospitals. Patients who were treated as outpatients were excluded from this study. For patients with multiple fractures, only one of the bones that required operative treatment was considered. Patients with more than one episode of fracture during the study period were considered as separate cases. The information obtained from the hospitals was organised and tabulated according to the demographic characteristics and fracture patterns before the patients were grouped and analysed.

Based on the patient demographics, we divided the patients into urban and rural groups and examined the distribution of fractures across months and anatomical distribution. We also studied the fracture distribution among various age groups. A comparison between age groups was made using Microsoft Excel 2007 (Microsoft, Redmond, WA, USA). Polynomial regression analysis was used to determine the monthly trend in the number of injured patients. The underlying model corresponding to each variable was as follows:

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 X^2_i + \beta_3 X^3_i + \ldots + \beta_p X^p_i + e_i$$

where 'X_i' is the month, 'Y_i' is the number of injured patients and 'e_i' is the error terms. The forward selection procedure was applied to determine the appropriate order of the polynomial model.

RESULTS

A total of 7,973 patients were involved in the study, which consisted of 6,006 (75.3%) male and 1,967 (24.7%) female patients. Slightly more than half were Malay (56.7%), followed by Chinese (16.6%), other races (including foreign nationals) (15.3%) and Indian (11.4%). In terms of the age groups, the highest incidence of fracture occurred among those aged 15–30 years (39.1%). Patients aged < 15 years and > 60 years each accounted for about 15% of the study (Table I). A significant predominance of males was observed in both the urban and rural patient groups, with more male patients present in the age groups < 45 years of age. The gender difference was reduced among those aged > 45 years, and women dominated the age group ≥ 60 years (Fig. 1). Malays accounted for more than half (64.9%) of the patients in the rural group, while race in the urban group was more evenly distributed (Table I). The majority of the patients from the rural population were < 30 years of age (57.9%), with the largest rural age group being those

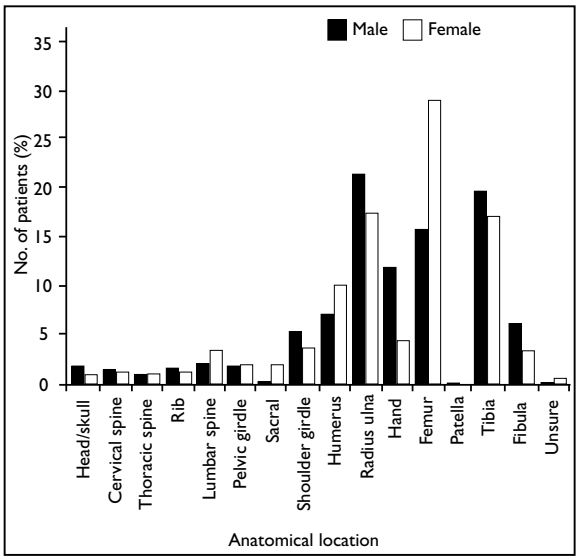

Fig. 3 Graph shows the anatomical distribution of fractures according to gender.

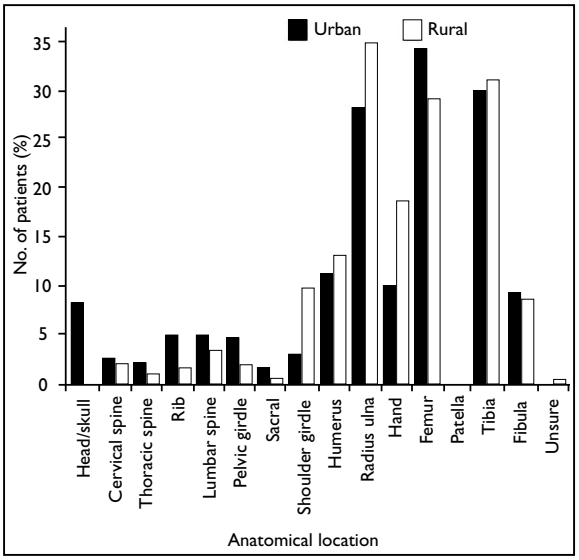

Fig. 4 Graph shows the anatomical distribution of fractures from injuries sustained in urban and rural areas.

aged 15–30 years (40.9%). The age distribution for the patients from the urban population was more evenly spread out, where there were more patients older than 30 years of age than below this age (55.7% and 44.3%, respectively) (Table I).

In general, more fracture cases were admitted to the hospitals at the beginning and end of the year compared to the middle of the year. The lowest incidence of admission was recorded in the month of June. This trend was observed in both the urban and rural hospitals. However, there was a slight increase in the admission rate in July (Fig. 2). When the polynomial regression of degree 'p' for the different values (p = 1, 2, 3, 4, 5 and 6) were fitted on the number of injured patients by month, it was found that the polynomial of degree six gave the best fit as a model for both the urban and rural populations, as well as for all samples (Fig. 2). Fig. 2 also shows that 74% ($R^2 = 0.7429$), 71% ($R^2 = 0.7076$) and 80% ($R^2 = 0.8043$) could explain the monthly variation in the number of fractures when the six-degree polynomial model was applied to the whole group, the rural, and urban population, respectively. All the parameters of the fitted models were statistically significant ($p < 0.05$).

In terms of the anatomical locations, radius-ulna fracture was the most common type of fracture (20.7%) among the patients who were admitted for treatment. This was closely followed by femur (19.3%) and tibia-fibula (19.2%) fractures. A female predominance was most obvious for femur fracture, while males outnumbered females slightly for forearm and tibia-fibula fractures (Fig. 3). Among rural patients, the most common type of fracture was radius-ulna (22.0%), followed by tibia-fibula (19.4%) and femur (18.2%) fractures. Among urban patients, the most common type of fracture was femur (21.9%), followed by tibia-fibula (18.7%) and radius-ulna (17.8%) fractures. Among the less common types of fracture, there was a higher incidence of head/skull fracture among urban (5.3%) compared to rural (0.1%) patients. The rates of pelvic and rib fractures were also higher among urban patients. On the other hand, fractures involving the hand were more common among patients in the rural group (11.8%) compared to those in the urban group (6.6%) (Fig. 4).

For patients aged < 15 years, radius-ulna and humerus fractures were much more common than lower limb fractures. Humerus fracture (39.7%) was slightly more common than radius-ulna fracture (38.4%) among the under-15-year-old group from the urban population, but radius-ulna fracture (37.7%) was much more common than humerus fracture (21.6%) among patients from this same age group who were from the rural population. A relatively higher rate of hand fractures was observed in the rural group (6.1%) as compared to the urban group (0.9%). Head and skull fractures accounted for 2.74% of those from the urban group for patients under 15 years of age who were admitted for fracture, while no such cases were reported from the rural group (Fig. 5).

For patients aged 15–30 years, lower limb fractures were more common occurrences. Tibia-fibula fracture was the most common anatomical location of fracture among this age group, followed by fracture of the radius-ulna. The rate of femur fracture was also higher than that observed in the younger age group. The distribution of fractures was generally similar among the urban and rural populations, except that a higher rate of hand injury was observed in the rural group (15.3%) compared to

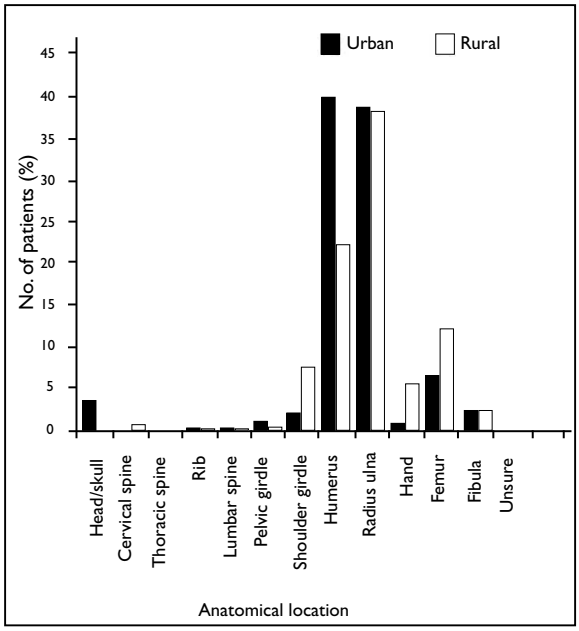

Fig. 5 Graph shows the anatomical distribution of fractures in both urban and rural areas for patients below 15 years of age

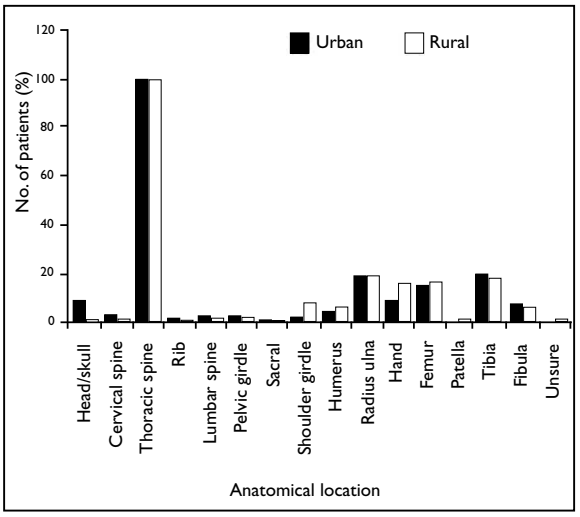

Fig. 6 Graph shows the anatomical distribution of fractures in both urban and rural areas for patients 15–30 years of age.

the urban group (8.3%) (Fig. 6). For the older adults, the pattern generally remained the same except that hand fracture was the third most common, overtaking femur fracture in both the urban and rural groups. Less pelvic, rib and head fractures were observed among patients in the rural areas compared to those in the urban group (Fig. 7).

For patients aged 45–60 years, the most common fracture was tibia and fibula. Among urban patients, femur fractures (16.8%) outnumbered radius-ulna fractures (14.3%). Among rural patients, radius-ulna fractures (19.9%) were the second commonest type of fracture, followed by femur fractures (10.9%) (Fig. 8). In patients > 60 years of age, a significantly higher rate of femur fracture in both the urban and rural groups (54.2% and 45.8%, resepectively) was observed, and these made up more than half of the patients admitted in these groups. Forearm fractures and tibia-fibula fractures were the two other types of fractures that were present, but were much less common (less than 15% of patients in their respective groups) (Fig. 9).

DISCUSSION

The overall rate of fracture was higher in men (75.3%) than in women (24.7%) because of the nature of their daily activities and the relative amount of travel. This is particularly true in the Asian population due to the traditional role of men as the breadwinners and women as housewives, especially in the young and middle-age groups. However, this difference was less obvious among children under 15 years of age. This is in contrast to the findings of a large-scale study conducted in Nottingham by Deakin et al, which reported that twice as many males as females were admitted for fracture over a period of four years.[8] In our study, children were defined as patients below the age of 15 years, while Deakin et al included patients up to 16 years of age. They noted that male admissions for trauma rose sharply after 12 years of age.[8] The predominance of males was low in the upper middle age group, and female patients outnumbered males among patients aged ≥ 60 years. Osteoporosis in elderly females is probably the most significant underlying factor for this occurrence.[3,4] In the rural population, Malays remain the majority in most areas in the country as many work in the agriculture or fishery sectors.

The rate of fracture in all the hospitals was generally higher at the end or beginning of the year. We noted a slight drop in the admission rate for fractures in the month of June. Both the rural and urban hospitals showed a similar pattern, and the change was statistically significant. We referred to the national statistics on the occurrence of major road traffic accidents in 2007 and observed that this coincided with one of the two months (February 2007 and June 2007) in which the lowest rate of accidents was reported (Fig. 10).[9] No significant change in climate was noted throughout the year in Malaysia, except for a slightly higher rainfall at the end of the year (between November and January). This change in weather mainly affects fishermen, but most other daily activities remain the same throughout the year. The change in weather generally affects the northern and eastern parts of the country, where two of the hospitals involved in this study are located. The

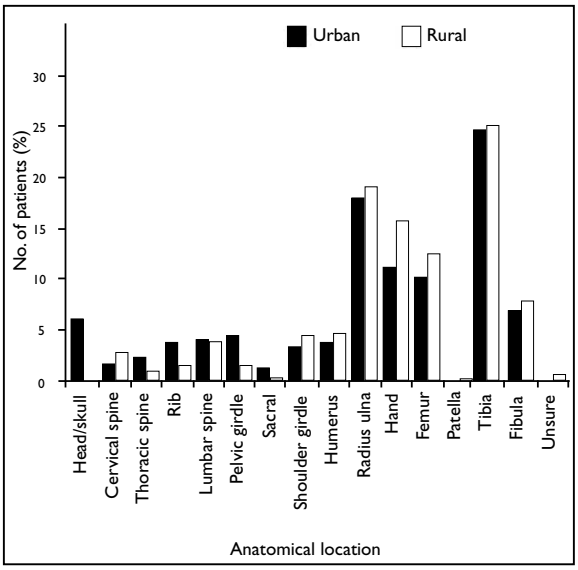

Fig. 7 Graph shows the anatomical distribution of fractures in both urban and rural areas for patients 30–45 years of age.

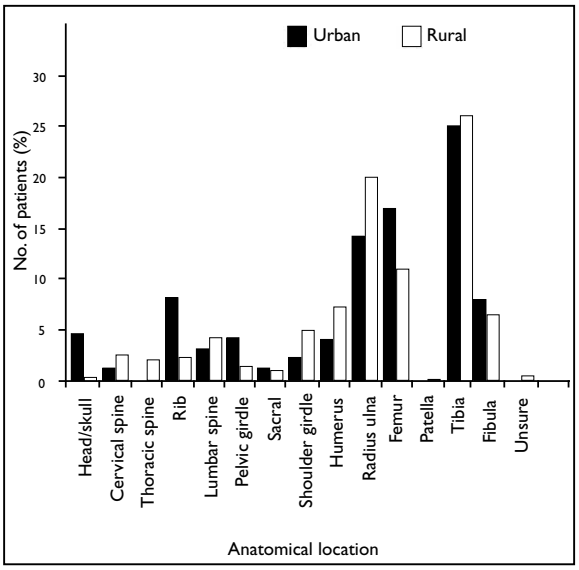

Fig. 8 Graph shows the anatomical distribution of fractures in both urban and rural areas for patients 45–60 years of age.

higher rate of fracture in this study was observed in both the rural and urban groups and thus could not be associated with the weather.

Radius-ulna fracture was the most common type of fracture that required admission (Fig. 3). The location of the fracture may vary across age groups, and we would expect to observe more diaphyseal fractures in younger patients and more distal forearm fractures in elderly females with osteoporosis. A similar pattern may exist for femur fracture, i.e. we would expect more proximal femur fractures in the elderly and more diaphyseal fractures in younger patients. Forearm fracture was the most commonly encountered type of fracture among the rural population in our study, while femur fracture was the commonest in the urban population (Fig. 4). Information on the age distribution among the urban and rural populations may help to explain the differences; however, this is beyond the scope of this study.

For patients under 15 years of age, radius-ulna fracture was the most common type of fracture that required admission, a finding that is consistent with that of other studies.[8,10] This finding was also similar for both the urban and rural populations in our study (38.4% and 37.4%, respectively). However, humerus fracture was more common among the urban patients (39.7%) than the rural patients (21.6%) (Fig. 5). Toys with high travelling speeds, such as bicycles, skateboards and roller skates, may be more readily available in urban areas and may thus have contributed to the higher rates of supracondylar fracture of the humerus found in this group. The higher rate of hand fracture among rural patients (6.1%) compared to urban patients (0.9%) may be due to environmental factors. In rural areas, sharp farming tools and fishing equipment pose a higher risk of hand injuries, including fractures in children. Children in urban areas are more prone to fractures of the head or skull than those from rural areas, probably also due to toys with high travelling speeds. This is consistent with the findings of Halldorsson et al, who reported a much lower incidence of head injuries in rural areas in a nationwide study conducted in Iceland.[11]

For young adults aged 15–30 years, the rates of the three most common types of fracture were similar between the urban and rural populations in our study. However, a distinctly higher proportion of hand fractures was observed among the rural population (15.3%) compared to the urban population (8.3%) (Fig. 6). Agricultural and fishing activities pose a higher risk of injuries to the hand compared to the white and blue collar working environments that are prevalent in urban areas. In addition, victims of high-velocity road traffic accidents on major highways were mostly transported to major hospitals in the urban areas, and this also contributed to the higher rates of fracture in larger bones and the trunk found among the urban population.

In the middle age group (30–45 years of age), hand fracture was the third commonest type of fracture in both the urban and rural populations in our study, with a higher rate in the latter group (Fig. 7). As dexterity may be reduced with age, workers may thus be more prone to injuries to the hand. Hand fracture is usually associated with temporary and sometimes, permanent loss of upper

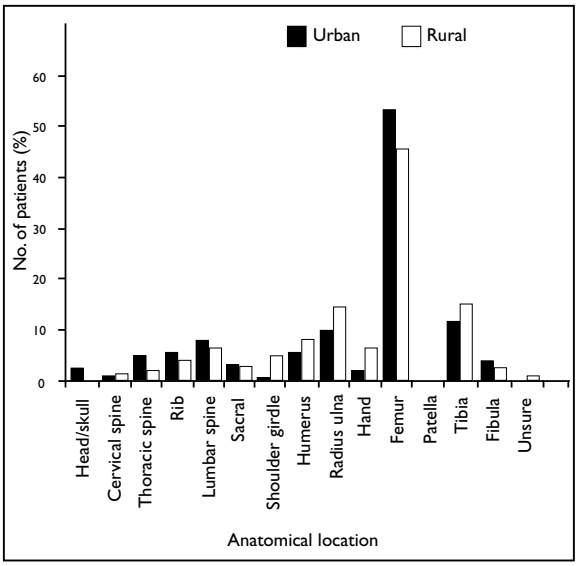

Fig. 9 Graph shows the anatomical distribution of fractures in both urban and rural areas for patients > 60 years of age.

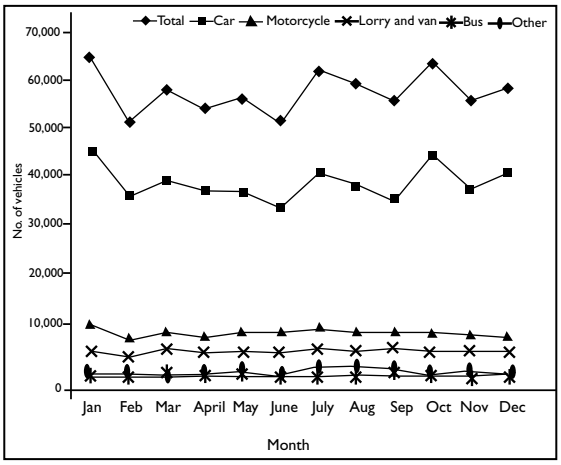

Fig. 10 Graph shows the monthly distribution of number and type of vehicles involved in major road traffic accidents in Malaysia in 2007.

limb function, especially when the dominant side is involved. Improvements to the design of equipment and enforcement of safety measures should help reduce the loss of the workforce in this age group.

In the upper middle age group (45–60 years of age), tibia-fibula fracture was commonest in both the urban and rural populations in our study (25.9% and 25.1%, respectively). However, femur fracture was the second commonest anatomical location of fracture (followed by radius-ulna fracture) among urban patients. For rural patients, the radius-ulna remained the second commonest type of fracture followed by femur fracture (Fig. 8). A study from Thailand has reported that people from rural areas have a higher bone mineral density of the proximal femur than those from the urban areas, and that the difference is pronounced before the age of 50 years in men and before menopause in women.[12] Although we could not identify the actual site of femur fracture, we would expect proximal femur fractures to account for a large proportion. In addition, many patients with distal radius fracture may opt for non-operative treatment because of lower functional expectations for the older spectrum of this age group. The official retirement age in Malaysia in 2007 was 56 years, and this may explain the tendency toward a less aggresssive treatment option.

For the elderly (> 60 years of age) in our study, femur fracture predominated in both the urban and rural populations. In the urban group, more than half the patients were admitted for femur fracture, while in the rural group, the proportion was slighly less than half (Fig. 9). Osteoporosis is common in the elderly, especially among women. In a 12-year population-based Swedish injury register, 67% of patients who sustained a fracture at age ≥ 50 years were women.[4] Most, if not all, patients with osteoporotic fracture of the proximal femur would require admission for surgical treatment, although the most optimal treatment has not been established.[13] Osteoporotic fractures in locations other than the proximal femur are often treated as outpatients and may not be clearly reflected in this study. According to a European epidemiological review, peripheral non-vertebral and non-hip osteoporotic fractures in the elderly significantly affect the quality of life of these patients.[14] In our study, the rates of tibia-fibula and radius-ulna fractures were higher among rural patients than those for urban patients, while the rate of femur fractures was lower. We do not have data on the age distribution of the urban and rural populations, but this may help to explain the difference.

One limitation of this study is the lack of knowledge about the anatomical location of the fracture due to the retrospective nature of the study. Subclassification of some fractures according to the shaft and ends of long bones would definitely contribute toward a better understanding of the fracture patterns of the population. It is difficult to collect data from smaller hospitals that serve a more representative rural population because of smaller patient volume and the lack of complete data for a restrospective review.

In conclusion, this study has found that the rates of fracture in several anatomical locations differed between urban and rural populations. The most common cause of fracture admission in rural areas was radius-ulnar fracture, and this is likely related to the nature of the prevailing occupations in the rural environment. The high rate of femur fracture that was found among urban patients, especially among the elderly, may either be due to the fact

that urban dwellers are at a higher risk for osteoporosis or the higher proportion of elderly in urban areas. The relatively high rate of hand fracture found in rural areas, especially among children and young adults, may require further investigation so that preventive measures may be taken. This information would prove to be useful in the allocation of medical resources and the planning of preventive measures for all fractures.

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