RESEARCH

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A POPULATION STUDY TO IDENTIFY FRACTURE RISK IN LIVERPOOL, ENGLAND

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BACKGROUND: Fractures are in most cases treated by Accident and Emergency (A&E) departments and they have a substantial financial impact on health budgets. The epidemiology of fractures in the Liverpool city region has not been systematically investigated in recent years. This study aims to address this issue by providing valuable data that could aid in the design of fracture prevention strategies.

METHODS: Population fracture data was collected by the Liverpool Primary Care Trust between February 2009 and July 2010, accounting for the majority of fractures registered in the city. The data was sorted by type, age, sex and upper/lower body in order to observe patterns in different groups.

RESULTS: The data highlighted a significant difference between the sexes where anatomical sites varied greatly. Females suffer from fractures of the femur and the arm bones in a higher frequency, while males exhibit their highest fracture rates in the femur, lower arm and hand and craniofacial regions. Women also tend to have fractures later in life while most men fracture bones earlier.

CONCLUSION: This finding corresponds with numerous sources in the medical literature. The present work supports the development of strategies designed to reduce fractures in specific age groups.

Keywords Population, Fracture risk, Public health policy, Liverpool, England

INTRODUCTION

Identifying fracture risk within a population is an important part of public health policy, as an increasing and aging population can have a significant economic impact on the health system [1]. There is therefore a growing interest in the types of fractures that affect a particular age group or sex and the underlying reasons. This type of population-based study is lacking for the north-west of England, but it can help identify particular age groups within each sex that could be focused on to reduce the fracture rates for the region and thus National Health Service (NHS) expenditure. Bone fractures are very common in both developed and developing countries. Fractures can be caused by high impact force, repetitive stress or other underlying conditions such as osteoporosis or bone cancer [2].

Osteoporosis (OP) is a major health concern for the elderly and is accountable for the significantly high incidence of fractures in this age group. OP is a metabolic disease, in which the bone becomes fragile. This in turn results in a higher risk of fractures than normal bone. OP occurs when the metabolism of the skeleton is in a negative balance. In this condition there is a loss of minerals, such as calcium, faster than the body can replace them. Women tend to lose bone at a higher rate than men at all ages, but their rate increases significantly after menopause, when the depressing effect of oestrogen on the osteoclast activity is lost [3]. Certain fractures are associated with this decrease in bone density and are well documented in the literature, such as Colles' fracture and fracture of the neck of the femur. In addition, vertebral fractures are often encountered in the elderly and are the result of falls [4, 5]. The measurement of bone mineral density (BMD) aids in the diagnosis of osteoporosis. BMD is measured as grams of bone mineral (hydroxyapatite) per cubic centimetre [3].

Socioeconomic status (SES) is a sociological and economic measure of a person's position relative to other individuals within the population. Socioeconomic status is typically divided into three categories: high, middle and low. The lower the SES, the greater the risk is to an individual's health, including fractures [5, 6]. A low SES does reflect a lower standard of living, a low income and poor education and frequently leaves the individual vulnerable to physical and mental health problems. Poor social conditions may also result in an increase in anti-social behaviour, crime and general environmental hazards. This in turn may cause a higher fracture incidence, particularly in younger males. Interestingly, some studies have demonstrated low fracture rates among younger males in areas with a high SES [6]. However, a person's SES alone does not necessarily reflect all their epidemiological aspects. Personal circumstances also play a role; living with someone has been associated with a decreased risk of any fracture in all ages, but an increased fracture risk among people over the age of sixty. Being at work has been associated with a decreased hip fracture risk among subjects greater than forty years of age and alcoholism is a significant predictor of fractures in all age groups [7]. A link has also been found between low SES and a lower health status. This could explain the higher rates of fractures and greater use of primary care services and lesser of secondary care services in areas with a low SES [7].

Fracture incidence is most prevalent in males aged approximately ten to thirty five and then most prevalent in elderly women aged over sixty five years. In regards to fractures in younger males, the higher incidence is supported by a study carried out on children's femoral shaft fractures [8]. It was found that 69.7% of fractures among children from birth to seventeen years were in males and 30.3% in females. It has been shown that most fractures in children involve the long bones and almost a third of these are due to sport or leisure activities [9]. The high male incidence of fractures at younger ages has also been found to be associated with facial trauma. A study found that the male to female ratio of facial trauma was 3:1 and that the most prevalent age group was sixteen to thirty years of age [10]. It was identified that this was primarily due to interpersonal violence and motor vehicle accidents. This male dominance of fractures does however change depending on age.

A recent study found that the ratio of male to female long bone fractures changed from 2:1 in individuals aged less than fifty to 1:3 in individuals aged greater than fifty [11].These findings mirrored previous work [12] which outlined this switch of dominance in fracture rates between males and females. This study outlined that hip fractures were generally related to the elderly and that there is no significant difference between sexes from the ages of fifteen to sixty years of age, as hip fractures are very uncommon within the young. Over the age of sixty however, there is evidence that there are approximately twice as many fractures in females than males. It has been shown that there is an exponential increase in female fractures from the age of sixty five, with male incidence lagging behind that of females by approximately ten years [12].

The aims of this study are to identify fracture patterns within the geographically defined area of Liverpool, England and to propose strategies to reduce fracture rates with corresponding health and economic benefits for both the local population and the National Health Service.

METHODS

This study has utilised fracture data obtained by the Liverpool Primary Care Trust covering a period from February 2009 until July 2010. The data had been anonymised and available to the public according to the Data Protection Act 1998 [13]. The Liverpool Primary Care Trust is responsible for commissioning all health services for the population in this area. It is also responsible for bringing together services offered by general practitioners, community nurses, practice nurses, community services and agencies dealing with health matters across the city. The sample consisted of a total of 6,947 fractures with 3,415 of those in males and 3,612 in females. A small proportion of fractures (approximately 80) were excluded from the final sample due to the fact that they were not clearly defined in the records. The majority of these fractures were unclassified as to their type.

The 2011census carried out by the Office for National Statistics collected population statistics for Liverpool, Merseyside [14]. The census concluded that the total population of Liverpool, Merseyside consisted of 466,415 individuals with 230,483 males and 235,932 females. There is a greater number of females that males in the population. Some may argue that this difference may explain, at least in part, the significantly higher proportion of fractures in females compared to males. The variation between the age groups of the population is also considerable, as there were 78,100 individuals between the ages 0-15, 211,755 individuals aged 16-44, 111,092 aged 45-64 and 65,466 individuals aged over 65 years. Data also shows that more than half (289,857) of the population of Liverpool is aged under 30 years, indicating a young population, which is usually associated with traumatic injury [15]. This population data from the Office of National Statistics does provide evidence that Liverpool has a stable SES. For instance, the unemployment rate is 6.7% and although higher than the national average (4.4%), it is still a low figure, indicating that a significant part of the population is economically active. However there are aspects of the census that could provide evidence for concern. For example, research has linked a higher fracture risk to those individuals that live alone [7]. The census indicates that 39.2% of all households in Liverpool are occupied by a single individual. Further possible causes for concern were the qualification levels, as 28.7% of Liverpool residents aged 16 or over have no formal qualification [14]. The data presented above provide a good indication of population trends, although there is a degree of error associated with it. It is possible that not all of the population took part in the census or did not complete the census fully and truthfully, and therefore this data should just be used as an approximate guide.

In order to assess fracture risk in the north-west of England, the raw fracture data acquired from the Liverpool Primary Care Trust was analysed in Microsoft Excel® 2010 in order to achieve a simplified data set that could be used for statistical analysis. Tables were created according to age, sex and anatomical region (Table 1). Once the data had been organised into an appropriate format, a suitable statistical test was identified (G test) in order to test for a significant difference between the observed values and the expected values for fracture incidence for age and sex. The G-test is a variation of the Chi-Square test and is used to test homogeneity and goodness of fit of frequencies arranged in a one-way classification. In order to use this test all expected frequencies must be greater than 5 and observed frequencies greater than 0. The statistical null hypothesis is that the number of observations in each category is equal to that predicted by a biological theory. The formula for G (the test statistic) is given in equation ‘‘(1)’’:

$$\mathbf{G = 2\sum [O \ln(O/E)]} \qquad (1)$$

O is the observed frequency and E is the expected frequency. The expected values are formulated by dividing the total observed by the number of age groups. Once G has been determined, a correction factor CF (Williams’ correction) is applied to the G-test and this is irrespective of the number of degrees of freedom. The formula for CF is given by equation ‘‘(2)’’:

$$\mathbf{CF = 1+(a2 - 1)/6nv} \qquad (2)$$

a is the number of categories (such as age groups or sex), n is the total number of observed frequencies and v is the degrees of freedom (a – 1).

Therefore the final test statistic G^{adj} is given by equation ‘‘(3)’’:

$$\mathbf{G^{adj} = G/CF} \qquad (3)$$

G^{adj} is then compared against the chi-square distribution table. For any given degrees of freedom (DF) the observed value is significant at a given level of probability if it is equal to or larger than the critical value shown in the table of chi-square statistics.

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Table 1 - Anatomical regions used for analysis in the study

Anatomical region
Pelvic Girdle
Foot
Fibula
Neck of the Femur
Femur
Tibia
Patella
Face/Nose
Skull
Mandible
Shoulder(Clavicle/Scapula)
Radius/Ulna
Humerus
Vertebrae
Hand
Ribs/Sternum

Table 2 - G-test results presenting differences between the expected and the observed values between the sexes

Anatomical region	Females (N)	Males (N)	G	Critical value	Significance
Pelvic Girdle	234	75	86.19	12.12	0.0005
Foot	175	233	8.27	7.88	0.005
fibula	41	50	0.88	<1.32	NOT SIGNIF
Neck of the femur	870	345	234.50	12.12	0.0005
Femur	448	212	84.30	12.12	0.0005
Tibia	199	240	3.78	2.07	0.01
Patella	33	26	0.83	<1.32	NOT SIGNIF
Face/Nose	85	313	138.76	12.12	0.0005
Skull	19	61	23.06	12.12	0.0005
Mandible	28	243	195.17	12.12	0.0005
Shoulder (Scapula/Clavicle)	52	121	28.22	12.12	0.0005
Radius/Ulna	641	534	9.75	9.14	0.0025
Humerus	269	263	0.08	<1.32	NOT SIGNIF
Vertebrae	200	159	4.70	3.84	0.0500
Hand	144	333	76.90	12.12	0.0005
Ribs/Sternum	79	112	5.72	5.41	0.02

RESULTS

The results demonstrated that there was a significant difference of fracture patterns between males and females. Table 2 indicates that thirteen out of sixteen anatomical regions showed a significant difference between the expected and observed values. Three anatomical sites were also identified as showing no significant difference between the expected and observed values.

Age was identified as having a substantial effect on fracture risk and fracture trends. All of the anatomical sites demonstrated a significant difference between the expected and observed values between male age ranges. It was also shown that in females fifteen of sixteen anatomical regions differ significantly between the expected and observed values. Female skull fractures showed that there was no significant difference between the incidence and the age of individuals.

Male fracture rates are seen to be significantly higher than those of females at a younger age and peak in the age group of 20 – 29 years with 571 fractures (Figure 1). Fractures in males then gradually decline until the age of 70 – 79 where the incidence rates rise again. Female rates are very low in comparison to males in early life and reach the lowest frequency in the 30 – 39 age group with only 96 fractures. From this point female fracture rates rise steadily until 60 – 69 years where a sharp increase is evident (Figure 1). Fracture rates were seen to differ considerably depending on anatomical site. Figure 2 shows that females predominantly suffer from lower body fractures, whereas males are more prone to upper body fractures. In particular, females are more likely to fracture the neck of the femur, as the total of 870 fractures indicates. The results also show that males are more likely to suffer injuries to the face/nose and mandible, as these combined total 556 fractures. The data also shows that both sexes have a high fracture incidence of the radius and ulna.

DISCUSSION

In recent years, several studies have examined the cost of injuries on the health service. An example of such a study comes from The Netherlands where it was found that treating injuries in young males and elderly females accounts for a significant share of health care costs [16]. This increased cost is related to the injury patterns observed in these two groups which are very similar to those found in the Liverpool area. What is also interesting about the Dutch study is that a general trend emerged: cost appears to increase with the age of the patient. This is partially explained by the fact that treatments for injuries associated with older individuals, such as hip fractures, have a higher treatment cost [16]. The epidemiology of specific fracture types within populations has also been extensively studied [17, 18]. The present study examines the incidence of fractures throughout the body, in all ages and both sexes and it is representative of a population from the north-west of England who have sought medical care. It was shown that women over the age of sixty tend to suffer from fractures more than men, whereas men under the age of forty years have more fractures than women of the same age. Moreover, some specific fractures are associated with these age ranges. This indicates that the variation in fracture risk is caused primarily by age. These findings do mirror similar findings in the literature which demonstrate a high fracture incidence in young males and older females [12, 19].

Children

Fracture incidence in children aged 0 – 19 was extremely varied depending on sex. Male fracture rates made a steady, considerable increase into adulthood while female rates slowly declined into adulthood. There are many factors that must be taken into account in order to explain these changes such as age, season, culture, environment and behaviour variation. In terms of separating fractures according to their mechanism of injury, this can be a difficult task, as children do not always remember or admit to the exact circumstances of the injury. The present study indicates that young children tended to suffer from fractures of the radius and ulna to a higher degree than any other fracture. Young males

Figure 1 - Fractures in males and females according to age

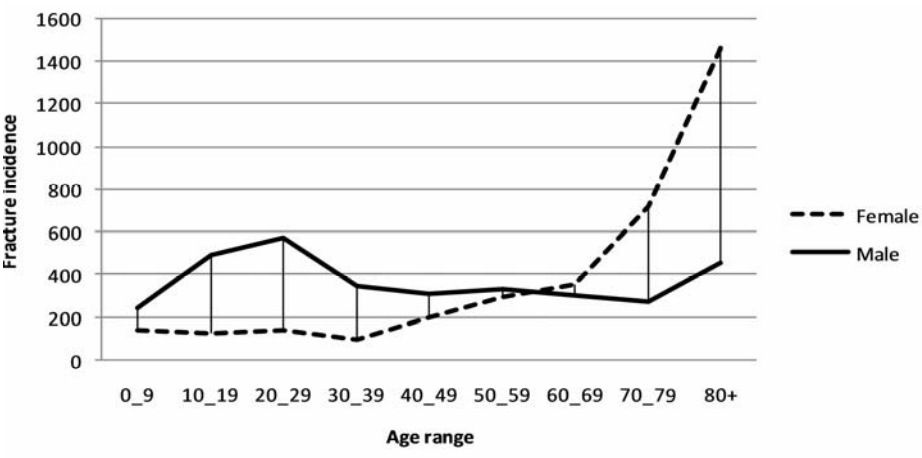
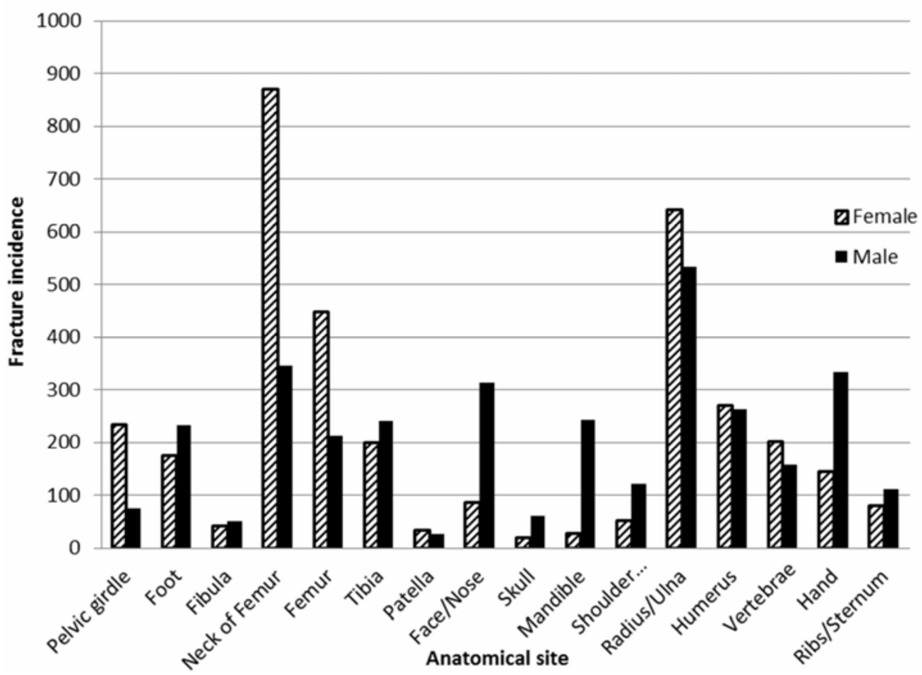


Figure 2 - Fractures in males and females according to anatomical sites



had an incidence of 252 fractures (47.4% were radius/ulna fractures) and young female incidence was 88 (13.7% were radius/ulna fractures). It can clearly be seen that male incidence is much higher than female incidence at young ages and this is possibly attributed to sex differences in the participation in athletic activities at this age [20]. Young males and females have dissimilar social behaviour patterns and these have been linked to the difference in fracture rates seen in children.

Research supporting these findings examined auto-pedestrian childhood injury. The study found that both sexes peaked at the age of 5-8 years and both sexes had equal exposure, but males had a higher injury rate. According to the authors, this was caused by differences in behaviour [21]. The humerus was also indicated to be a significant childhood fracture although Table 2 shows that there was no significant difference between the expected and observed values for the sexes as both had a similar fracture incidence.

The pattern that arose from this study was that children tended to suffer primarily from fractures of the upper extremities and this finding does mirror previous work [18, 22]. The fractures at this age are likely to be due to the type of recreational activity that children take part in. The playground is an essential element of a child's life, but has been documented as being the cause of an increasing fracture incidence in children [23]. Falls from climbing frames, swings and monkey bars can cause high impact injuries to the child. Slightly older children would probably suffer from the same type of injury but also from different types of recreational activities such as skateboarding or bicycle-riding. These types of high impact injuries of teenagers have been documented in the literature [24].

Adults

Male fracture incidence continues to rise into adulthood (Fig. 1) and peaks in the age range of 20 – 29 with a total of 571 fractures. Female incidence continues to fall into adulthood and bottoms out in the age range of 30-39. The variation in fracture incidence between males and females up to the age of 39 is due to sex-specific behaviours, recreational activities and social standards [15]. Females have a very low incidence of 234 fractures within this age range (20 – 39) while males have their highest incidence with a total of 917 fractures. This sex variation is highly significant, as the results of the statistical analysis indicate. The incidence rates show that males have 3.9 times as many fractures as women in young adulthood. In 32% of these injuries, facial or mandibular fractures were present and are usually caused by interpersonal violence or motor vehicle accidents. This corresponds with findings of previous research which found that 55% of mandible fractures were due to assaults and 66% of facial fractures were due to motor vehicle accidents [10]. When it comes to interpersonal violence, poverty, personal problems and use of alcohol are usually related factors [15]. This could also explain a large increase in male hand fracture, as young males had more hand fractures than females, although this variation could be due to predominantly male manual labour occupations. With motor vehicle accidents, alcohol appears to be one of the main contributing factors. These findings were also identified in several other studies [25-28].

Up to the age of 29 years males have a higher fracture frequency, but this dominance then declines into old age. A significant finding in the identification of fracture risk is the start of an increase of fractures in females from 30 - 39 years. Although male fracture incidence does stay greater than females up until approximately 59 years, this steady increase in female fracture incidence is noteworthy. After 59 years female fracture incidence surpasses male incidence and increases exponentially (Figure 1). These patterns associated with fracture risk are not specific to the Liverpool area but can be observed in many populations [1, 12, 19].

Mature adults

Certain fractures are associated with the elderly and many of them may be attributed to osteoporosis. The pelvic girdle is identified in Table 2 as having a significant difference between the expected and observed values for the sexes and this indicates that one sex has exceptionally greater values than the other. Female and male incidence for individuals over the age of sixty was also indicated as being significantly different than the expected values for that age. Females had a total of 214 while male incidence was 57 fractures. It should be noted that 91.5% of all female pelvic girdle fractures were suffered by individuals over the age of sixty. This is most likely related to the onset of OP and its well-documented link to decreased bone mineral density (BMD) [29]. The elderly tend to have a low body mass index and reduced mobility, which when combined with visual impairment and a reduction of oestrogen due to the onset of menopause in women, may explain the rapid increase in fracture risk (Figure 1). This is not the complete picture however, as research has indicated that male fracture incidence lags behind female incidence by approximately 10 years [12, 30]. The present study supports this finding, as a steady increase can be seen to occur in the age group of 70 - 79 years in males, although not to the extent of the females.

The research presented here has identified fracture of the neck of the femur as having the highest frequency in individuals over the age of sixty. This includes all age groups and all anatomical regions, indicating it is the single most common fracture (Figure 2). Results from Table 2 provide evidence that fracture incidence between males and females differed significantly. Females had a higher risk of fracture at the neck of the femur than males. Figure 1 shows that the 80+ age group dominated the frequency of fracture rates in females. It is very likely that the fractures seen in the elderly can all be traced to a common cause. Falls have been outlined in previous research as being a frequent occurrence and cause of fractures in the elderly [30]. In particular, 30% of individuals over the age of 65 fall at least once a year, while 15% fall multiple times [31]. Therefore when a fall occurs, multiple fractures are likely to take place and this could explain the high incidence of radius/ulna and vertebral fractures in the elderly.

CONCLUSION

This study has identified fracture risk in a population from the north-west of England, although the method of fracture identification may underestimate the population fracture count due to some limitations of the data. For example, numerous studies have outlined the inaccuracies of hospital fracture coding systems [5, 19]. This leads to over and under representation of certain fractures as some patient pathways are not captured by data drawn from emergency departments and fracture clinics. Some minor fractures may not result to patients using the health services but at the other end of the spectrum, patients admitted to hospital for ongoing management of fractures may be over-represented. Patients who die as a result of trauma in which a fracture was sustained may also not be registered. Human error can also play a part, as errors in clinical coding and missed clinical diagnosis may affect a fracture sample [30]. However, it is unlikely that these factors would have significantly influenced the fracture patterns that were identified in this study. Males tended to have a much higher incidence of upper body fractures at a younger age compared to females, while females tended to have a much higher incidence of lower body fractures at an older age compared to males. The patterns identified in the present project are validated by multiple studies with similar results that have been carried out across Europe and North America.

The results can be used in the formation of a public health policy at the local level which will be aimed at reducing fracture rates within the population. In the younger age ranges, males suffer the majority of fractures which are maxillofacial and have been attributed to interpersonal violence and motor vehicle accidents [26, 28]. Causes of violence relate to the individual, relationships, community and society. Interventions must be targeted at these areas. Steps can be taken to modify individual risk factors, such as improving individuals' problem solving ability, anger management and alcohol and substance abuse issues. Relationship and family support interventions, such as positive parenting programmes, can improve family functioning, reduce stress and prevent violence. Good planning, design and management of public places can limit the opportunities for violence to occur and measures to address cultural norms, attitudes, societal structures and inequities that encourage or contribute to violence can help to reduce violence. For motor vehicle accidents, education from a young age and campaigns against drinking and driving can significantly reduce the number of injuries [28].

The older population and especially females need primary and secondary fall prevention measures, as falls are a major cause of fractures. This has also been recommended by several agencies including the Center for Disease Control (CDC) [32]. The primary prevention strategies should include education, exercise, review of medication used and environmental modifications. Education should be aimed at raising awareness of potential hazards and how to avoid them. Exercise increases muscle strength and improves balance. Medication, in addition to sedatives and hypnotics, may have side effects such as dizziness which make individuals more susceptible to falls. Modifying the environment to make it safer may include interventions as simple as installing a hand rail on a staircase, or changing the lighting.
Secondary prevention strategies are also needed to

prevent hip fractures when falls occur. These can include energy absorbing hip pads, or energy absorbing flooring material. Emphasis should be placed on primary prevention strategies, because studies have shown that the main risk factors for falls are intrinsic and not environmental. Primary prevention strategies are designed to address mainly these intrinsic factors [31, 32].

Public health policies need to be implemented to promote behavioural changes, improve current interventions, and develop new fall prevention strategies. This will not only reduce costs in the health system, but it will lead to a better quality of life for many individuals in the community.

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References

1. JOHANSON, A., EVANS, R., STONE, M., RICHMOND, P., Lo S., WOODHOUSE, K., - ***Fracture incidence in England and Wales: a case study into the population of Cardiff***. International Journal of the Care of the Injured 1997; 28: No. 9-10, 665-660, 1997;
2. KALFAS, I.,-***Principles of bone healing***, Neurosurg Focus 2001; 10: 4: 7-10;
3. 3. ISKRANT, A., SMITH, R., - ***Osteoporosis in Women 45 Years and Over Related To Subsequent Fractures,*** M.D. Public Health Reports 1969; 84: 1: 33-38, 1969;
4. KANIS, J., AARON, J., EVANS, D., THAVARAJAH, M., NETON M., - ***Bone Loss and Age-Related Fractures***. Experimental Gerontology; 25: 7: 289-296, 1990;
5. KANG, H., YANG, K., KIM, Y., MOON, S., CHOI, W., KANG, D., PARK, S., - ***Incidence and mortality of hip fracture among the elderly population in South Korea: a population-based study using the National Health Insurance claims data.*** BMC Public Health 2010; 10: 230-239, 2010;
6. Van der HEYDEN, J., DEMAREST, S., TAFFOREAU, J., Van OYEN, H.,- ***Socio-economic differences in the utilisation of health services in Belgium***. Health Policy 65: 153-165, 2003;
7. BRENNAN, S., HENRY, M., WLUKA, A., NICHOLSON, G., KOTOWICZ, M., PASCO, J. - ***Socioeconomic status and bone mineral density in a population based sample of men***. Bone 2010; 4: 993-999, 2010;
8. EMERY, K., HAMMAN, R., REWERS, R., HEDEGAARD, H., LEZOTTE, D., MENG, K., BATTAN, F., - ***Childhood Femur Fractures,*** Associated Injuries, and Socio - demographic Risk Factors: A Population-Based Study. Paediatrics; 115: 543-552, 2004;
9. LYONS, R., SELLSTROM, E., DELAHUNTY, A., - ***Incidence and cause of fractures in European districts.*** Arch Dis Child 2000; 82: 452-455, 2000;
10. HAUG, R., PRATHER, J., TAND, A., INDRESANO, T., - ***An Epidemiologic survey of facial fractures and concomitant injuries***, J Oral Maxillo facial Surg; 49: 926-932, 1990;
11. MELING, T., HARBOE, K., SOREIDE, K., - ***Incidence of traumatic long-bone fractures requiring in-hospital management: A prospective age- and gender-specific analysis of 4890 fractures.*** Int. J. Care Injured; 40: 1212–1219, 2009;
12. SINGER, B., ROBINSON, C., McLAUCHLAN, G., CHRISTIE, J., - ***Epidemiology of fractures in 15, 000 adults. The influence of age and gender.*** Bone Joint Surg 80: 2: 243-248, 1998;
13. ***Data Protection Act*** 1998 London: Stationery Office, 1998;
14. Office for National Statistics, 2011 Census. Downloaded from: http://www.ons.gov.uk/ons/guide-method/census/2011/index.html;
15. FRIDRICH, K., PENA-VELASCO, G., OLSON, R., - ***Changing Trends with Mandibular Fractures:*** A Review of 1,067 Cases. *J Oral* Maxillofacial Surg 50: 586-589, 1992;
16. MEERDING, W.J., MULDER, S., van BEEK E.F., - ***Incidence and costs of injuries in the Netherlands***. Eur J Public Health, 16: 271-277, 2006;
17. IIDA, S., KOGO, M., SUGIURA, T., MIMA, T., MATSUYA, T., - ***Retrospective analysis of 1502 patients with facial fractures.*** Int. J. Oral Maxillo facia Surg; 30: 286–290, 2001;
18. TYTHERLEIGH-STRONG, G., WALLS, N., McQUEEN, M., - ***The epidemiology of humeral shaft fractures***. J Bone Joint Surg; 80-B: 249-253, 1998;
19. DONALDSON, L., RECKLESS, I., SCHOLES, S., MINDELL, J., SHELTON, N., - ***The epidemiology of fractures in England.*** J epidemiol community health 62: 174-180, 2008;
20. CHENG, J., SHEN, W. A.,-***10 year study of changes in the pattern and treatment of 6,493 fractures***. J pediatr orthop 19: 344-350, 1999;
21. ROUTLEDGE, D., REPETT-WRIGHT, R., HOWARTH, C.I., - ***The exposure of young children to accident risk as pedestrians.*** Ergonomics 17: 457-480, 1974;
22. IQBAl, Q., - ***Long bone fractures among children in Malaysia***, Int Surg 59: 410-5, 1975;
23. MOTT, A., EVANS, R., ROLFE, K., - ***Patterns of injuries to children on public play grounds.*** Arch dis child 71: 328-330, 1994;
24. SHEEHAM, E., MULHALL, K., KEARN, S.,-***Impact of dedicated skate parks on the severity and incidence of skateboard and rollerblade paediatric fracture patterns***. J pediatr orthop 23: 440-442, 2003;
25. Van ONSELEN, E., KARIM, R., JORIS HAGE, J., RITT, M., - ***Prevalence and Distribution of Hand Fractures***. J Hand Surg, 28: 491-495, 2003;
26. OGUNDARE, B.O., BONNICK, A., BAYLEY, N., - ***Patterns of mandibular fractures in an urban major trauma center***. J Oral Maxillofac Surg 61: 713-718, 2003;
27. BRINK, O., VESTERBY, A., JENSEN, J., - ***Pattern of injuries due to interpersonal violence***. Injury, 29: 705-709, 1998;
28. LEE, K.H., SNAPE L., STEENBURG, L.J., et al.—***Comparison between interpersonal violence and motor vehicle accidents in the aetiology of maxillofacial fractures***. ANZ J Surg.77: 695 – 698, 2007;
29. KANIS, J., BORGSTORM, F., JOHANNSSON, C., JOHNELL, O., JONSSON, B., ODEN, A., ZETHRAEUS, N., PFLEGER, B., KHALTAER, N, - ***Assessment of fracture risk***. Osteoporos Int, 16: 581-589, 2005;
30. O'NEILL, T., VARLOW, J., SILMAN, A. **, -** ***Age and sex influences on fall characteristics.*** Ann Rheum Dis 53: 773-775, 1994;
31. STALENHOFF, P.A., CREBOLDER, H.F.J.M., KNOTTNERUS, A., Van Der HORST, F.G.E.M., - ***Incidence, risk factors and consequences of falls among elderly subjects living in the community***. A criteria-based analysis. Eur J Public Health 7: 328-334, 1997;
32. STEVENS, J.A., OLSON, S., - ***Reducing falls and resulting hip fractures among older women***. Morbidity and Mortality Weekly Report, Centers for Disease Control and prevention, 49: 1-12, 2000.