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Secular trend in the incidence of hip fractures in the world

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Summary
Osteoporosis is the most common metabolic bone disease and the main effector of the development of fractures in people over 50 years. When analyzing the evolution of the incidence of hip fracture it is important to consider the effects of the implementation of the strategies undertaken to prevent and treat early forms of disease and falls.

In most chronic diseases with an environmental etiological component, identified or not, an interval of several decades occurs between initial exposure to the main causative agent and the clinical onset of the disease. The systematic study of the secular trend of a disease shows different phenomena that help to understand its pathogenesis. At the same time, it constitutes an activity of surveillance that allows warn about its future relevance.

The evolution of the incidence rate of hip fractures has not been uniform over time in different countries. It is a matter of great interest to identify whether the observed temporal changes in rates are associated with an aging population or the result of a large number of circumstances of the same population over time.

In this paper we review the main studies published around the world that explore, in greater or lesser extent, in the analysis of the secular trend in the incidence of hip fracture in order to bring this concept to the reader and offer an overview on the evolution of the incidence of hip fracture and the causes of this evolution.

Key words: *epidemiology, hip fracture incidence, secular trend, osteoporosis.*

Introduction

Osteoporosis is the most common metabolic bone disease and the main cause of fracture in people over 50 years of age[1]. Health promotion programs carried out by public institutions in most Western countries over the past 50 years have led to enhanced health care[1], access to medicines and rehabilitation programs, accessible to most of the population in industrialized countries. This fact, which has improved the health of many and has conditioned an increase in life expectancy, is also responsible for a change in the specific causes of mortality, an overall increase in morbidity and in the expression of different diseases, including osteoporosis.

When analyzing the evolution of the incidence of hip fracture it is important to consider the effects of the implementation of strategies undertaken to prevent and treat early forms of the disease and osteoporosis-related falls. Numerous reports detect variations in hip fracture incidence, including but not limited to geographical factors. Most of these studies concur that a crude increase in the number of hip fractures in both male and female patients over 50 in the second half of the last century. However, as a result of the "demographic transition" described by Omran[2], more people are living longer, and therefore more at risk of suffering a hip fracture, specific age-adjusted rates are required for analytical purposes. Thus, it would be possible to ascertain the real evolution of the incidence of this type of fracture and the factors responsible for this evolution beyond the mere aging population.

Secular trend of hip fracture

The term "secular trend" implies systemic change in the age-specific rates depending on the time described. It represents an intricate set of social, epidemiological and demographic factors present in a population over time. In most chronic diseases with an environmental etiological component, whether identified or not, an interval of several decades occurs between initial exposure to the main causative agent and the disease's clinical onset. Thus, changes in the observed secular trends correspond to variations in the exhibitions produced years previous when the individuals under study were young. Therefore, the analysis of the data, with particular attention to the specific incidence rates by age, is very useful in interpreting secular trends and helps explain the phenomena observed in a given period. The models of age-period-cohort commonly used in descriptive epidemiology studies to analyze the trend in the incidence and mortality from different diseases, but, in general, they are applied to any situation to assess the effect the temporal occurrence of an event.

Thus, the systematic study of the secular trend of a disease shows different phenomena that help to understand its pathogenesis. At the same time, it constitutes a surveillance function that warns of its future relevance. Secular trends may provide information on the effects of programs such as early detection, prevention strategies or the impact of new drug therapies. Correct interpretation also contributes to decision making regarding the distribution of resources, a fact that becomes particularly relevant in the current historical moment.

In assessing the change in disease frequency over a period of time and in the same population, one may observe certain factors that basically depend on three effects: the effect of age, the period effect and the effect of the date of birth[3].

1) Effect of age

This refers to the process of aging. It is observed when there is a change with age in the frequency of a particular disease. Many diseases have a tendency to increase in prevalence with age, a fact that reflects the aging, defined as the combination of biological, social and psychological changes, influences the susceptibility to present a specific disease process.

2) Effect of period

This implies a change that uniformly affects all age groups and all population cohorts. The diagnostic measures determine the identification of a specific disease in a given period of time and are applicable to all age groups, as in the case of diagnostic and therapeutic improvements, such as bone densitometry and the spread of anti-osteoporotic drugs in the case of osteoporosis. Furthermore, changes in the criteria of the International Classification of Diseases (ICD), are listed as changes in trends associated with the timing of the event.

3) Effect of date of birth (cohort effect)

People born at a certain time, carry with them throughout their entire life a greater chance of developing a disease at some point. This effect is seen in the case of subjects exposed to natural disasters, war, radiation or toxic drugs (as in the case of thalidomide). However, it may also reflect its effect of individuals' the type of feeding during infancy and even the diseases that have been submitted during the first years of life. This cohort effect implies an unexpected change that would result in the distribution of cases depending on the age group.

Epidemiological significance

In developing countries, it is expected that the global population and life expectancy will double over the next 25 years. Regarding Western countries, although population is not expected to increase significantly in the coming years, forecasts indicate that the percentage of the elderly population in Europe will increase by 33% in the next three decades. It has been estimated that in 2050 the number of hip fractures will be 6.26 million, of which approximately 50% will occur in Asia[4]. The clinical and care relevance of hip fracture, therefore, implies one of the greatest challenges facing health authorities in the next four decades.

For these reasons, there is considerable interest in identifying whether the observed temporal changes in rates are associated with an effect of age, a period effect or a birth cohort effect, an objective which is not always possible, given accurate linear relationships between these factors.

Table 1 summarizes the main epidemiological characteristics and the results of published studies worldwide that, to a greater or lesser extent, delve more deeply in the analysis of the secular trend in the incidence of hip fracture.

Incidence of hip fracture in North America

There are numerous published studies in the United States (US) and Canada that suggest the possibility of an effect of age, period and birth cohort effect[5] in the evolution of the incidence of hip fracture.

USA

Melton et a.l[6,7] found a 5-fold increase in hip fracture incidence in the period from 1928 to 1942 and 1973 to 1982, which encompassed 135.8 to 675.8 per 10^5 inhabitants. This change was due almost entirely to the increase in the incidence of hip fracture in women until 1950, and in men until 1980, observed in all age groups. The decline in incidence rates thereafter led to a 9% drop in the rate of hip fractures in the period between 1973 and 1982 and between 1983 and 1992, reaching 612.7 per 10^5 inhabitants. They also noted an increase of 13.7 years in the age at which the first hip fracture appeared, a fact explained by the aging of the population.

Bacon[8] observed a linear increase in the incidence of hip fracture in males ≥80 years. However, rates did not change significantly in women or the group of young men.

Brauer et al.[9] obtained information about drugs consumption through a survey conducted between 1992 and 2005 and, with these data, extrapolated the trend of the use of bisphosphonates, estrogen and estrogen receptor modulators. During the study period, the average annual hip fractures in women was 957.3 per 10^5 inhabitants and 414.4 per 10^5 inhabitants in men. The age-adjusted incidence increased between 1986 and 1995 and then declined steadily between 1995 and 2005. In both men and women, the increase in the incidence of hip fracture between 1986 and 1995 was more pronounced in subjects over 75 years.

The Framingham study, a cohort study of population base carried out between 1948 and 1996, confirmed a gradually increasing incidence rate of hip fracture during the second half of the past century[10]. This study suggests the presence of a birth cohort effect on the risk of hip fracture rates by 20% and 40% higher among women born between 1901 and 1910 and between 1911 and 1921, respectively, compared with those born in the previous decade. Samelson et al.[11], based on the premise that bone strength in old age is a function of accumulated bone mass in the first two decades of life, as well as a loss of bone mass from middle age, they determined the rates of hip fracture from the age specific Framingham Study, and studied the relationship between birth cohort and hip fracture risk. For each birth cohort they found an exponential relationship between age and the risk of hip fracture, both among women and men. Compared with women born in 1900, the incidence was 1.2 and 1.4 times higher among women born between 1901 and 1910 and between 1911 and 1921, respectively. In males, compared with the oldest birth cohort (1887-1900), fracture risk was 50% higher in men born between 1901 and 1910 and twice as high for those born in the last study period (1911-1921).

Leslie et al.[12] identified 570,872 patients hospitalized with a principal diagnosis of hip fracture between 1985 and 2005. During the 21 years analyzed, rates of hip fracture decreased in both sexes and all age groups with a decline in women from 118.6 to 80.9 fractures per 10^5 person-years in men and from 68.2 to 51.1 fractures per 10^5 person-years. The sharpest absolute decline occurred in the group of subjects over 85 years, in both women and men. Regression analysis identified a change in slope in about 1996.

Jean et al.[13] analyzed whether the pattern observed by Leslie's group could be explained by a period effect, a birth cohort effect, or both. They appreciated significant period effects both in men and women. Compared with incidence rates of hip fracture between 1985 and 1989, the observed rates between 2000 and 2004 were reduced by 21% and 32% in males and females, respectively. Birth cohort effects were also observed in both sexes. Thus, the cohorts born before 1950 had a higher risk of hip fracture, while those born after 1954 had a lower risk.

Incidence of hip fractures in Europe

Scandinavia

The countries of Scandinavia (Finland, Sweden, Norway and Denmark) show the highest incidence of hip fracture in the world. There are many studies that have analyzed the secular trend in the incidence of hip fractures in the different countries of this northern Europe region. Overall, the incidence of hip fractures in the Scandinavian countries increased between 1950 and 1990. Over the past two decades there seems to have been a decline, which was most evident among both women and men.

Sweden

In Sweden, Zain et al.[14] analyzed the incidence of hip fracture during the years 1965, 1970, 1975 and 1980. In each five-year period, the crude number of hip fractures increased between 21% and 25%. The incidence of hip fractures in the population increased from 430 per 10^5 inhabitants in 1965 to 650 per 10^5 inhabitants in 1980. The age-specific incidence increased, especially in individuals over 85 years. A subsequent study in Malmo Sernbo et al.[15] also showed an increase in hip fracture incidence between 1950 and 1985, among both men and women.

Table 1. Studies on the incidence of hip fractures in the world

Country	Author (appointment)	Period	Study population	Code ICD	Incidence rate (10^5/year)	Yearly % change
USA						
	Melton et al.[6]	1928-1982	≥65 years	ICD 9:820-9	Δ +540	+2
	Melton et al.[7]	1983-1992	≥65 years	ICD 9:820-9	Δ -63	-0.8
	Bacon[8]	1965-1993	≥50 years	NA	NA	Not change
	Brauer et al.[9]	1985-1995	≥65 years	ICD 9:820-9	Δ F +87; Δ M +64	+0.9
		1995-2005			Δ F -256; Δ M -64	
	Framingham[10]	1948-1996	≥50 years	NS	NA	+1
Canada						
	Leslie et al.[12]	1985-2005	No age restriction	ICD 9:820-9 ICD 10-CA:S72.0-.2	Δ F -39	-1.6
					Δ M -17	
Sweden						
	Zain et al.[14]	1965-1980	≥55 years	ICD 9:820-9	Δ +220	+2.2
	Sernbo et al.[15]	1950-1985	≥55 years	NS	Δ F +530	NA
					Δ V +240	
	Rogmark et al.[54]	1992-1995	≥50 years	NS	F 850	-0.5
					M 360	
	Rosengren et al.[16]	1987-2002	≥50 years	ICD 9:820-9 ICD 10-CA:S72.0-:2 ICD 9 841.82x or - ICD 10 NFB, NFJ	Δ F -90	1987-1996 -0.11
						1996-2002 -1.37
					Not change	1987-1996 +0.35
						1996-2002 -0.66
Norway						
	Omsland et al.[17]	1999-2008	≥50 years	ICD 9:820-9 ICD 10-CA:S72.0-2	Δ F -110	NA
					Δ M -30	
Finland						
	Kannus et al.[18]	1970-1997	≥50 years	ICD 8:820.X ICD 9:820-9 ICD 10:S72.0-2	Δ F +175	+2.2
					Δ M +121	
	Kannus et al.[19]	1997-2004	≥50 years	ICD 8:820X ICD 9:820-9 ICD 10:S72.0-2	Δ F -82	-2.4
					Δ M -15	

Table 1. Studies on the incidence of hip fractures in the world *(cont.)*

Country	Author (appointment)	Period	Study population	Code ICD	Incidence rate (10^5/year)	Yearly % change
Denmark						
	Giversen[55]	1987-1997	≥50 years	ICD 8:82000-3 ICD 10:S72.0-2	Δ F +18 Δ M +8	+4.1
	Abrahamsen et al.[20]	1997-2006	≥60 years	ICD 10:S72.0-2	F -22% M -20%	+1
United Kingdom						
	Spector et al.[21]	1968-1995	Without age restrictions	ICD 9:820	1968-1978 F +61% 1968-1979 M +73%	+2
	Evans et al.[22]	1968-1986	≥65 years	ICD N820, N821	Δ F +120 Δ M +20	+6 (until 1978)
	Wu et al.[23]	1988-2008	≥45 years	ICD 10:S72.0-2	Not change	NA
Netherlands						
	Boereboom et al.[24]	1986-1993	≥65 years	NA	Δ F +120 Δ M +110	+1.3
	Goettsch et al.[25]	1993-2002	NA	ICD 9:820-9	Δ -10	-0.5
Austria						
	Mann et al.[26]	1994-2006	≥50 years	ICD 9:820-9 ICD 10:S72.0-2	Δ F +121 Δ M +86,5	+0.8
Germany						
	Icks et al.[27]	1995-2004	No age restriction	ICD 9:820-9 ICD 10:S72.0-2	Δ +20	+0.5
Italy						
	Agnusdei et al.[28]	1980-1991	≥50 years	NA	Not change Δ M +3.62	NA
	Rossini et al.[29]	1999-2002	≥45 years	ICD 9:820.9;821.1	+9%	NA
	Piscitelli et al.[31]	2003-2005	≥45 years	ICD 9:820.9;821.1	Δ F +38 Δ M +30	NA
	Piscitelli et al.[32]	2000-2009	≥65 years	ICD 9:820.9;821.1	+29.8%	NA

Table 1. Studies on the incidence of hip fractures in the world *(cont.)*

Country	Author (appointment)	Period	Study population	Code ICD	Incidence rate (10⁵/year)	Yearly % change
China						
	Chalmers et al.[39]	1965-1967	Without age restrictions	NA	F 262 M 176	NA
	Lau et al.[42]	1966-1995	≥50 years	NA	F x 2.5 M x 1.7	+7.5
	Koh et al.[43]	1991-1998	≥50 years	ICD 9: 820.0;820.2;820.8	F 402 M 152	F +1.2 M +0.7
India						
	Dhanwal et al.[45]	2009	≥50 years	ICD 10:S72.0-2	F 159	NA
Japan						
	Orimo et al.[44]	1987-2007	≥39 years	NS	Δ F 89 Δ M 21	NA
Australia						
	Crisp et al.[37]	1997-2007	≥50 years	ICD 9:820-9 ICD-10 S720-2, ICD-10-AM W00, W01, W03-W08, W18, W19, W22, W50, W51, W548	Δ F -75 Δ M -26	NA
New Zealand						
	Rockwood et al.[33]	1950-1987	≥65 years	NA	NA	+2
	Fielden et al.[34]	1988-1999	≥65 years	ICD 9:820	NA	-1.2
	Stephenson et al.[35]		≥65 years	821, 827, 828, 804, 820	NS	NS
Cameroon						
	Zebaze et al.[47]	1996-1998	≥65 years	NS	F 24,4 M 20,7	NA
Morocco						
	El-Maghraoui et al.[46]	2006-2009	Without age restrictions	NS	F 86 M 73	-0.4 +3.1

ICD: international classification of diseases; F: females; M: males; NA: not available; NS: not specified.

Recently, Rosengren et al.[16] analyzed the possible existence of a period-cohort effect. The adjusted incidence rate decreased with age in women, from 680 in 1987 to 590 per 10^5 person-years in 2002. However, the figures for men remained stable. Regression analysis identified a trend toward change in 1996. The existence of a period effect and a cohort effect was more pronounced among women than among men, showing a significant reduction in the incidence of hip fractures in post birth cohorts.

Norway

The NOREPOS[17] study analyzed the annual incidence of hip fracture in Norway and its secular trend between 1999 and 2008. The adjusted rate hip fracture by 10^5 person-years in women was 910 in 1999 and 800 in 2008. In men, the rates were 410 and 380, respectively. These figures correspond to a decrease in the incidence of hip fracture age-adjusted 13.4% in women and 4.8 in men. Among women a statistically significant decrease in all age groups from 70 years was observed. In groups of men 75 to 84 years, there was also a decline in the incidence of fracture, whereas in the other age groups the incidence rates were stable. Despite this decline in the age-adjusted incidence, the absolute number of hip fractures in women was stable and increased in males. The most likely explanation for this was that the number of women and men over 50 increased by 11% and 17%, respectively, over the 10-year period analyzed.

Finland and Denmark

In Finland, Kannus et al. observed that hip fracture rates adjusted for age in subjects over 50 years of age, 20% of women and 6% for men between 1997 and decreased 2004[18,19]. Meanwhile, in Denmark, Abrahamsen reported that in patients over 60 years the incidence of hip fracture between 1997 and 2006 was reduced by 20% in both sexos[20].

United Kingdom

Since the early 1950s there have been numerous studies that have described an increasing trend in the incidence of hip fractures in the United Kingdom. Spector et al.[21] analyzed data from hospital discharge for hip fracture in England and Wales in the 1968-1985 period. They observed an increase in age-adjusted and sex steadily over the first 10 years of the study, followed by a subsequent stabilization, which the authors attributed to the decline in physical activity in the elderly population. Evans et al.[22] observed a similar pattern after analyzing the data of hospital admissions for hip fracture between 1979 and 1985, collected in the Oxford Record Linkage Study. They also found a clear effect of birth cohort, with differences in rates in births between 1883 and 1917, similar to the results of the Framingham cohort.

In a more recent study, Wu et al.[23] found that hip fracture rates have continued to increase in England until 2009. Both the number of hip fractures as well as crude fracture rates increased over a 11-year study period, but there were few changes in the age-adjusted rates. In women, the largest percentage increase in rates of hip fracture was observed in the 55-to-64 age group, and the largest absolute increase in women over 85 years. In males, the largest percentage increase was observed in the 45-54 age group, while the largest absolute increase occurred in men over 85 years.

Netherlands, Austria, Germany and Hungary

In the Netherlands, the incidence of hip fracture, adjusted for age, increased linearly between 1972 and 1987[24], but a subsequent study suggests a stabilization between 1993 and the end of the century[25]. Similarly there has been a stabilization of hip fracture incidence in Austria[26] and Germany[27] between 1990 and 2000. In these two countries, there have also been significant reductions in fracture rates adjusted for age from 2000 to 2005.

Therefore, although initial research Central European countries reported an increase in the incidence of hip fractures adjusted for age in both sexes, recent studies report a stabilization and, more recently, indicate a decline in the incidence of this type of fracture.

Southern Europe

Apart from Spain, only in Italy were studies carried out to assess the secular trend of hip fracture. Agnusdei et al.[28] studied the incidence of hip fracture in the province of Siena, between 1980 and 1991, using records of all cases of hip fracture contained in orthopedics wards of several area hospitals. The secular trend among males increased linearly, from $57.5/10^5$ person-years in 1980 to $108.9/10^5$ person-years in 1991, which represented an annual increase of 3.62 cases per 10^5 person-years. No significant trend was observed in women. The overall incidence rate during this period was $157/10^5$ person-years, much lower than in the countries of northern or central Europe.

Subsequently, Rossini et al.[29] analyzed the incidence of hip fracture. They found an increase of 9% in 2002 in compared with 1999 data.

Piscitelli et al.[30,31] carried out an extension study using data on hospital admissions for hip fracture in subjects over 65 throughout the country, during the years 2003 and 2005. They recorded nearly 90,000 cases, of which 78% occurred in women, 84.3% of whom were 75 or more. Hospitalization for hip fracture in both sexes showed an increasing trend throughout the period under review. Hospital costs increased to € 467 million in 2005, and rehabilitation costs rose to € 531 million in the same year.

The most recent work published in Italia[32] analyzes the epidemiology of hip fracture through registered hospitalizations from 2000 to 2009, incidence rates stratified by sex and age in patients ≥65 years. This work includes a sub-analysis during the 2007-2009 triennium analyzing the incidence of hip fractures in the five-year-older population. From 2000 to 2009, a total of 839,008 hospitalizations were recorded for femoral neck fractures, a figure which corresponded to an overall increase of nearly 30% in the ten years covered by the study period. The incidence per 10,000 population increased markedly in people ≥75, from 158.5 to 166.8 (+5.2%) in women and from 72.6 to 77.5 (+6.8%) in men. In the five-year age analysis conducted during the last 3 years of the study it was observed that patients older than 84 presented a gradual increase in hip fracture incidence, from 35,472 in 2007 to 37,899 in 2008 and 39,244 in 2009. The incidence of hip fractures in women under 75 years of age increased from 2000 to 2004 by 5.9%, but then decreased by 7.9% between 2004 and 2009.

Incidence of hip fracture in Oceania

The evolution of the incidence of hip fracture in New Zealand and Australia has followed a similar pattern to those observed in North America and Europe.

New Zealand

Rockwood et al.[33] analyzed the hip fracture rates adjusted for age in New Zealand between 1950 and 1987. These authors observed a disproportionate increase in the number of fractures in the population group over 75 years, particularly among women over 85, which could not be explained solely by the increase in population in this age group. They performed a regression analysis according to predictions of population growth, and estimated that in 2011 the incidence of hip fracture would double.

Fielden et al.[34] conducted a follow-up study between 1988 and 1999 to compare hip fracture incidence rates in New Zealand during that period of time with those predicted in 1990 by Rockwood. In both men and women, the number of hip fractures between 1988 and 1993 was similar to that expected number, but since 1995 the number was significantly lower than expected.

Stephenson et al.[35] were reconsidered why the results observed by Fielden did not fit the predictions of Rockwood's group. They noted that Fielden's study provided no details regarding case selection. So these authors analyzed the incidence of hip fractures again with special attention to the inclusion criteria.

The design of Stephenson's study had three differences in the inclusion criteria compared with those used by Fielden's team: a) the inclusion of diagnostic codes 821 (fracture of other unspecified parts of femur), 827 (other fractures multiple poorly defined lower extremity), 828 (multiple fractures with involvement of both lower limbs, fractures of the lower limbs and upper limbs, and fractures of the lower extremities with costal involvement and / or sternum) and 804 (multiple fractures involving skull or face with other bones), plus the usual array 820 (femoral neck fracture), used in most published works; b) the inclusion of cases of re-diagnosed hip fracture, and c) the exclusion of patients treated on an out-patient or early readmission basis. Thus, estimates of trends in specific rates of hip fracture by age, especially among women, showed that the decline was much less important than that observed by Fielden et al.

Australia

In Australia, the population estimates based on secular trends and population growth projections suggest that the number of hip fractures will increase by between 4 and 5 times in the year 2051[36]. Despite this, several studies suggest a decreased incidence in standardized hip fracture by age in this country. Crisp et al.[37] noted that crude numbers of hip fracture increased by 11% in both sexes between 1997 and 2007. This increase was due to an increase in the number of cases in older age groups. The incidence of hip fracture among subjects aged 50 to 79 years either remained stable or declined slightly in both sexes.

Incidence of hip fracture in Asia

It is estimated that about 30% of hip fractures that occur in the world take place in different Asian populations, especially in China[38]. Globally, most studies in Asian populations noted an increasing trend in the incidence rates of hip fracture adjusted for age, in both sexes, until the mid-90s and then decreased the same. More recent studies agree that the upward trend in the incidence of hip fracture is not over yet.

Studies by Chalmers et al.[39] and Lau et al. Hong Kong[40-42] revealed large increases in the incidence of hip fracture adjusted by age, in both men and women, between 1966 and 1985 (1.7 times in men and 2.5 times in women) and were followed by a period of stabilization between 1985 and 1995. In women, there was an increase in the incidence of fractures up to 1996, the year from which a decrease was observed. Hip fracture incidence in men began to stabilize after 1985 and decreased from 2000, when the incidence rates nearly matched those recorded in the UK in the same period.

The incidence of hip fractures in Singapore is among the highest in Asia, and is similar to that seen in Hong Kong. Koh et al.[43] estimated an annual increase of around 1% between 1991 and 1998, compared with the data obtained in a previous study in 1965. In Japan, Orimo et al.[44] observed that the incidence of fracture hip had increased in both sexes between 1992 and 2007. In terms of age groups, however, incidence rates in males 60 to 69 years and women 60 to 79 years were the lowest, but remained much higher in older age groups.

Studies of Hong Kong and Singapore suggest that secular trends may have reached a plateau, but research in Japan indicated that the incidence of hip fractures continues to increase. Recently, Dhanwal et al.[45] have conducted a small retrospective study in Rohtak, a district of northern India, which found rates of hip fracture midway between Western countries and Africa.

Incidence of hip fracture in Africa

No data are available on the secular trend of hip fracture in most African countries. Osteoporosis and fragility fractures are generally considered rare in Africa but in fact, there are no policies or preventive screening programs or specific treatment in most sub-Saharan countries.

Research shows an incidence[46,47] one or two times lower than that found in Western and Asian countries. However, there is no evidence that Africans and present higher BMD levels. This population presents risk factors for osteoporosis, such as low calcium intake, high parity and prolonged breastfeeding[48-50]. The values summarized in Table 1 are most likely the result of the shorter life expectancy in these countries and coding errors, so that the data on Africa are not reliable.

Discussion

As we have seen, the evolution of the incidence rate of hip fractures has not been uniform over time in different countries analyzed. The differences in the patterns of the trend of hip fracture can be related to the changing population demographics, changes in exposure to different risk factors for the occurrence of this type of fracture, with changing life styles and the result of the various measures taken to minimize the effect of such factors. On the other hand, its origin may also be placed under the conditions present at birth and during the first years of life of the people analyzed.

In the research into countries which presented a growing trend of hip fracture, the authors' attempts to justify this trend may be summarized in the presence of an effect of age, a period effect or an birth cohort effect present in the populations studied. Bacon's study[8] indicated the high prevalence of smoking among older men (period effect) as the main culprit for increased incidence of hip fracture in that population sector. Sernbo et al.[15] attributed this trend to the aging of the population (age effect) and the tendency toward a more sedentary life (period effect) increasing the incidence of hip fracture registered in the city of Malmo.

The work of Spector et al.[21], Evans et al.[22] and the Framingham[10] suggest that the effect of environmental factors during the early stages of life affect the acquisition of bone mass, therefore increasing the risk of osteoporosis and fractures present in adulthood (birth cohort effect). As we know, 40-80% of an individual's BMD is determined by genetic factors[51,52]. Some studies suggest that peak bone mass may be the most important factor involved in the development of osteoporosis. Similarly, limited intrauterine growth during the first years of life has been associated with the presence of thinner bones and an increased risk of fractures in adulthood[53].

The studies that report decreasing hip fracture incidence note the coincidence in time of the start of this decline with aminobisphosphonate marketing (period effect), but it is never exclusively attributed to the effect of drug therapies. There is broad consensus in the literature when considering the effect of other measures such as changes in lifestyle, supplementation with calcium and vitamin D, decreased smoking, moderation in alcohol consumption, preventing falls and increased physical activity as agents that could justify the decrease in the incidence of hip fracture (period effect). The lack of reduction of hip fracture in older subjects may reflect less access or willingness to prescribe or take medicine for osteoporosis in these individuals[37,44].

The beneficial effect of bisphosphonates in the evolution of hip fracture incidence, although it may seem obvious, is, at least, controversial. Rosengren[16] indicated that it was unlikely that antiresorptive drugs led to the decrease in the incidence of hip fracture in Sweden, as its use was not widespread until the late 1990s. Similarly, Leslie[12] detected a decreased incidence of fracture before the generalized measuring of bone mineral density and the use of current hip antiosteoporotic drugs. In this sense, Brauer[9] pointed out that the use of these drugs justified only a 9% reduction in the incidence of hip fracture in women in his study (compared to 23% found), and, given their limited use in men could not explain the reported decline among the male population.

In the presence of a birth cohort effect, the studies analyzed in Hong Kong[39-42], Sweden[16] and the US[10] (Framingham) do not rule out their influence on the results. This would mean that patients over 50 during the 1990s, having had unfavorable social and economic situation in their childhood, generally characterized by poor nutrition and poor access to health care, may be predisposed to less healthy bones. During pregnancy, maternal stress affects the development of the fetal skeleton and bone mass acquired during childhood. Similarly, the history of lower intrauterine growth during the first years of life has been associated with the presence of thinner bones and an increased risk of fractures in adulthood[53]. These data suggest that environmental factors influence the acquisition of bone mass during the early stages of life, and therefore the risk of osteoporosis and fractures present in adulthood.

One aspect worth emphasizing, which could influence the disparity in the results that have been reported, is the difference in the design of the different studies. As noted in Table 1, both the criteria used to define what is considered hip fracture as well as the age of the people included have not been homogeneous. For example, the ICD codes have not always been the same. Although in most of the research, the study analyzed population comprised individuals 50 or older, the range was very wide, between 39 and 65. Therefore, the different age ranges could distort the comparison of the results provided by the different authors. Furthermore, the use of different classifications could lead to biases as in the previous case lead to errors in interpreting the data. In this regard, only one of the studies reported in this paper refers to a possible bias of classification of hip fractures in the interpretation of results obtained[35].

Conclusions

The secular trend in the incidence of hip fractures in the world has not been uniform over the past decades. In most developed countries the incidence increased in the second half of the twentieth century up to the last decade, which seems to present a stabilization or even a decline in the incidence. However, in parts of Asia and Africa the trend is still growing.

The detailed analysis of current trends suggests that changes in consumption patterns associated with aging occur slowly over time, and are more closely related to income than to the demographic structure of the population. This complex reality makes it difficult to predict future trends in consumption, since any growth in revenue among the elderly is quite uncertain in the coming decades.

Furthermore, it would be desirable to achieve greater uniformity in the design and methodology of the studies to assess the incidence of hip fracture more accurately. It would also be desirable to carry out more studies to develop a better understanding of the models of age-period-cohort, and to attempt to analyze the incidence of this type of fracture without using a purely numerical interpretation based on the comparison of magnitudes. This would enable us to understand this entity globally and face the challenge of hip fracture in the twenty first century.

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