Secular Trends of Hip Fractures in Lebanon 2006 – 2017:

Implications for Clinical Practice and Public Health Policy in the Middle East Region

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ABSTRACT

Country-specific hip fracture incidence rates (IRs) and longevity allow FRAX to be adapted to individual countries. Secular trends can affect tool calibration. Data on hip fracture IRs in the Middle East is scarce, and long-term secular trend studies are non-existent. Using the Ministry of Public Health hip fracture registry, we calculated age and sex-specific hip fracture IRs in Lebanon, from 2006-2017, among individuals aged ≥50 years. We used Kendall's tau-b (τb) test to determine the correlation between time and hip fracture IRs, and calculated both the annual % change in IRs and the % change in IR compared to the baseline period (2006-2008). The registry recorded 6,985 hip fractures, 74% at the femoral neck, 23% inter-trochanteric, and 3% sub-trochanteric. Men constituted 32% of the population, and were significantly younger than women (76.5±11.0 years vs. 77.7±10.3 years; $p<0.001$). Annual overall IRs, per 100,000, ranged from 126.6 in 2014 to 213.2 in 2017 in women, and 61.4 in 2015 to 111.7 in 2017 in men. The average women to men IR ratio was 1.8 (range 1.5-2.1). IRs steadily increased with age, and IR ratios increased in parallel in both sexes, with a steeper and earlier rise (by 5 years) in women. Data showed a consistent decline in hip fracture IRs starting in 2006 in women, and in 2009 in men. There was a significant negative correlation between time (2006-2014) and hip fracture IRs in women ($\tau b=-0.611$, $p=0.022$) but not in men ($\tau b=-0.444$, $p=0.095$). The steady decrease in IRs reversed after 2015 in both sexes. This long-term data on secular trends in the Middle East is novel and consistent with worldwide changes in hip fracture rates. The impact of such changes on national FRAX-derived estimates is unclear, should be assessed, and may necessitate an update in the FRAX Lebanon calculator.

KEYWORDS

Hip fracture, Osteoporosis, Secular trends, Middle East, Population studies.

INTRODUCTION

Osteoporotic hip fractures are the most dreaded and costly of all fragility fractures (1). Considering increased life expectancy worldwide, this is anticipated to add substantially to the disease burden incurred by other non-communicable diseases worldwide (2). In addition to long recognized wide variations in hip fractures, opposing secular trends in East versus West have been more reported (3, 4), but the reasons for both observations are not totally understood (4-7).

The Middle East and Africa International Osteoporosis Foundation's audit estimated that the number of hip fractures is projected to double and even quadruple in countries in this region, due to rapid demographic changes and increased urbanization (8). However, data on population-based, hip fracture incidence rates (IRs) from the region are scarce, and long term data is practically non-existent (3, 8).We previously reported on hip fracture IRs in Lebanon for the years 2006 to 2008, using the national hip fracture registry that was established by the Ministry of Public Health (MOPH) (9). These IRs allowed the launch of FRAX Lebanon, the first country-specific FRAX in the Middle East, and provided the basis for updating the national FRAX- based osteoporosis practice guidelines (10).

Country-specific hip fracture incidence and longevity are key variables that allow FRAX to be adapted to each country, taking into account nation specific data (11). The Lebanese FRAX calculator has been updated since its launch in 2009, taking into account increased longevity (12). Secular trends of hip fractures have equally important implications in terms of tool calibration and performance (11). We therefore investigate changes in age and sex specific hip fracture IRs in Lebanon for the years 2006 to 2017.

METHODS

Number of Hip Fracture Cases

The national Lebanese hip-fracture registry was established by the MOPH, and functions under its jurisdiction. It was established in 2006 and is populated prospectively on an ongoing basis. It captures all hospitalized patients receiving care for hip fracture and who are covered solely by the MOPH as the "insurer of last resort". Patients are granted a hospitalization approval based on a referral by the treating physician. The approvals are then automated and International Classification of Disease (ICD-10) codes are assigned in the MOPH centers located all over the Lebanese territories. The process is operated through an online system linked directly to the MOPH central offices. Data are updated as soon as the patient gets hospitalized, and the diagnosis gets confirmed once the bills get claimed. The MOPH provided us with the number of hip fracture cases per year, according to sex and as per age group, and classified according to the ICD-10 codes: S72.0 for femoral neck, S72.1 for inter-trochanteric and S72.2 for sub-trochanteric fractures.

Population Studied

The only population census in Lebanon was conducted in 1932. Lebanon is currently relying on population estimates generated by the Central Administration of Statistics (CAS) , based on household surveys, to generate the population figures. The latest Household Living Conditions Survey in Lebanon was conducted in 2007 (13). Since then, the MOPH publishes an annual bulletin that estimates the total Lebanese population distribution, by both age and sex, using the 2007 projections (14).

The population investigated included all uninsured Lebanese individuals, aged 50 years and above, who sustained a hip fracture between January 1, 2006 and December 31, 2017, and are solely under the health coverage of the MOPH. In the 2007 CAS Living Conditions Surveys, the proportions of uninsured Lebanese patients, who are solely covered by the MOPH, were published stratified by sex and grouped into 5-year age subgroups (50-54, 55-59, 60-64, 65-69, 70-74, 75-79, and 80 years and above) (13). Using these

proportions, we derived the number of individuals covered by the MOPH, for each sex and age subgroup, from the total Lebanese population. We then calculated age and sex specific hip fracture IRs in this population.

ANALYSIS

Patients and Fracture Characteristics

We summarized fracture demographics using frequencies and percentages, n (%), for categorical variables, and mean ± standard deviation, n ± SD, for continuous variables. We compared the age at fracture between men and women and between the different types of fracture using the independent sample t-test.

Sex- Specific Incidence Rates

We calculated both age and sex-specific crude IRs for every study year, per 100,000 individuals, by dividing the number of cases in each age and sex subgroup, over the number of individuals in that specific category who are covered by MOPH. To minimize the impact of unexplained systematic errors that may have been introduced in IRs reported in any specific year, we derived means for IRs over 3-consecutive years (2006-2008, 2009-2011, 2012-2014, 2015-2017) for the duration of the observation. This was done by dividing the total number of hip fracture cases (n) in patients aged 50 years and above, by the total MOPH covered population (N), in the three consecutive years of interest, as follows

$$\text{3year average IR per 100,000 individuals} = 100{,}000 \times \frac{n1 + n2 + n3}{N1 + N2 + N3}$$

We also calculated exact incidence rate ratios (IRR), for men and women, and for consecutive paired 5-year age groups (55-59 compared to 50-54, 60-64 compared to 55-59, 65-69 compared to 60-64, 70-74 compared to 65-69, 75-79 compared to 70-74 and >80 compared to 75-79).

We derived two sided 95% confidence intervals (95% CI) via the Taylor series approach using the open source calculator- TwobyTwo (OpenEpi, Version 3) (15).

Secular Trends in Hip Fracture Incidence Rates

We used Kendall's tau-b (τb) correlation coefficient test to determine the relationship between time (years) and hip fracture IRs, and we assessed secular trends through two methods:

a. We calculated the % change in each of the 3-year interval (2009-2011, 2012-2014, 2015-2017) average IR compared to the 3-year baseline period (2006-2008), as follows:

$$\%\ \text{change from baseline} = 100\ \times \frac{(3\ \text{year average IR}) - (2006\ \text{to}\ 2008\ \text{average IR})}{(2006\ \text{to}\ 2008\ \text{average IR})}$$

b. We also calculated the annual change (expressed as %) in hip fracture IRs in a specified time period by subtracting the IR of hip fractures of the first time point from that of the last time point, and dividing the difference by the first IR, and number of years between the two time points in that period (3, 4), as previously described:

$$\%\ \text{annual change} = 100\ \times \frac{IR_2 - IR_1}{IR_1\ X\ \text{n years in between the two time points}}$$

SPSS version 23 (IBM, Chicago, USA) was used to conduct statistical analysis and a two-sided p value of < 0.05 was considered as significant. We rounded numbers to the nearest decimal. Findings were tabulated and presented in graphs created using Microsoft Excel (Version 16.21.1) and StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.

RESULTS

Patients and Fractures Characteristics

The overall proportion of uninsured women was 51.3% (ranged from 51.5% of women aged 50-55 years to 61.2% of women aged 80+ years; Table 1), and that of uninsured men was 52.0% (ranged from 46.3% of men aged 56-59 years to 55.7% of men aged 80+ years; Table 2). The total number of hip fractures recorded, during the 12-year period, in the overall study population was 6,985 fractures, of which 2,269 (32%) occurred in men. Men were significantly younger than women, 76.5 ± 11.0 years and 77.7 ± 10.3 years, respectively, $p < 0.001$. The majority of hip fractures occurred at the femoral neck (74%), followed by inter-trochanteric fractures (23%), and sub-trochanteric fractures (3%). This breakdown was similar between sexes (data not shown). Patients who sustained a femoral neck fracture were significantly younger than those who sustained an inter-trochanteric fracture, 76.8 ± 10.7 versus 78.7 ± 9.8, respectively, $p <0.001$.

Sex- Specific Incidence Rates 2006-2017

The overall IRs varied across the years and ranged between 126.6 in 2014 to 213.2 in 2017 per 100,000 individuals in women (Table 1) and 61.4 in 2015 to 111.7 in 2017 per 100,000 individuals in men (Table 2). The four discrete three-year average IR estimates showed a steady decrease in the first three periods, from 175.2 to 147.9 in women and from 99.9 to 81.5 in men. In 2015-2017, we observed a small rise to 164.0 in women, whereas the IR plateaued in men (Fig 1).

We evaluated hip fracture IRs by age and sex for seven separate age groups (50-54, 55-59, 60-64, 65-69, 70-74, 75-79, and >80 years). The IRs increased steadily with age, in both sexes (Fig 2). The sharpest increase was after the age of 75-79 years in both women (Fig 2-A) and men (Fig 2-B). The calculated women to men IRR remained stable, with a mean of 1.8, and ranging between 1.5 to 2.1, across the 12- year period (Supplement Fig 2). However, as shown in Fig 3, we observed parallel increases in both sexes when comparing IRRs by age

range, with a possible increase in women observed five years earlier than in men (65-69 age category vs. 70-75 age category).

Secular Trends in Hip Fracture Incidence Rates

For each of the 3-year time periods, the % IR change from the baseline 2006-2008 IR is shown in Fig 4-A. Compared to the 2006-2008 rate, there was an incremental decline in the 3-year % change. In women, the decline was 8% for 2009-2011, 16% for 2012-2014 period and 6% for 2015-2017. In men the decline was 6% for the 2009 to 2011 time period, and 18% for both the 2012 to 2014 and the 2015 to 2017 periods.

The annual % change in hip IR started to decline from 2006 in women and 2009 in men (Fig 4-B). Between 2006 and 2009, there was a 3.2%/year decrease in hip fracture rates in women and a 5.7%/year increase in men. This was followed by a plateau in women and a small decline of 3%/year in men between 2012 and 2009, followed by a decline of 5.4%/year and 8.9%/year in women and men, respectively, between 2012 and 2015. A trend break is evident in the last three years (2015-2017), where the IRs increased by 21.3%/year in women and by 27.3% in men, Fig 4-B. There was a significant negative correlation between time (2006-2014) and IRs of hip fractures in women (τb= -0.611, p= 0.022) but not in men (τb= -0.444, p= 0.095). When assessed without the first year (2006) of the launch of the registry, the negative secular trend of hip fracture IRs in men becomes significant (τb= -0.643, p= 0.026).

DISCUSSION

Our study provides robust data on the epidemiology of hip fractures in Lebanon spanning over a decade. The majority of fractures were at the femoral neck, and rates were, on the average, 1.8 times higher in women than in men. IRs steadily increased with age, with the sharpest rise noted after the age of 75-79 years in both sexes. There was a steady

declining trend in hip fracture IRs in Lebanon since the 2006 launch of the national hip fracture registry, with a slight delay in men starting after 2009, and a possible reversal in the last 2 years that needs to be assessed over longer intervals. The negative correlation between time and hip fracture IRs was significant in women, and when assessed without the first year (2006), the year the registry was launched, it was also significant in men.

Location of Hip Fractures

Three-quarters of hip fractures were of the femoral neck, less than a fourth were inter-trochanteric, and only 3% were sub-trochanteric. In a previous retrospective paper, we assessed 2011-2015 hip fracture data at our tertiary referral hospital in Lebanon, and showed that femoral neck was indeed the most common type of hip fracture (50%), followed by inter-trochanteric (42%) and sub-trochanteric fractures (8%) (16). A comparable trend is noted in Northern Europe (17, 18) and the United States of America (USA) (19). However, data from Asia including Taiwan (20) and Japan (21), and from the Mediterranean and Middle East regions including Crete (22) and Iran (23), demonstrate higher proportions of trochanteric fractures. These geographic disparities might stem from the significant differences that exist between individuals who sustain trochanteric fractures and those who sustain femoral neck fractures (17-19, 21). Patients with trochanteric fractures are usually older (17-19, 24) as we documented here, shorter (18, 24), thinner, have lower bone mass and are more likely to have experienced previous fragility fractures (18, 19, 24).

Age and Sex Ratios

In our study, the average women to men IRR was 1.8 (range 1.5-2.1), which is consistent with ratios in other countries (5, 25, 26). IRRs were reported at 1.7 in Jordan in 2008 (26), 1.4 in both Tunisia in 2001 (26) and Iran in 2011-2012 (23), 1.3-1.5 in 2009-2012 in Kuwait (27), and 1.2 in Morocco (range 0.9-1.2) from 2006-2009 (28). In Saudi

Arabia, men experienced slightly higher incidence of hip fractures in 2001-2006, and IRR was 0.83 (29). Data from the SCOPE study, which included all 27 European Union countries, revealed women to men ratios ranging from 1.4 in Romania to 2.7 in Portugal (30). As for Asian countries, women to men hip fracture ratio are 3.4-3.7 in Japan (31), 2.1-2.2 in both South Korea (32) and Hong Kong, China (33), 1.3 in Tangshan, China (34), and 1.5 in Taiwan (20). The reasons for such wide differences worldwide are unclear but may relate to genetic factors, environmental factors and country-specific lifestyle differences between sexes including, smoking, alcohol consumption, sun exposure, vitamin D status, obesity, and migration status.

Secular Trends

There was an overall steady decrease in IRs over the last 10 years that reversed after 2015. The annual data presented in the supplemental materials indicated a sharp IR dip in 2010. We investigated potential causes for this unexpected dip by reviewing registry operations with MOPH staff. There was a possible delay in data processing carrying over from 2010 to 2011, so by combining data over 3 consecutive years, we provide more robust estimates over time.

The decline in hip fracture IRs in Lebanon may be attributed to multiple factors including the publication (35) and later update of the first Lebanese osteoporosis assessment and treatment guidelines in 200f7 (36), the increase in 25-hydroxy-vitamin D measurements, and the widespread use of calcium and vitamin D supplementation (16). Although it also coincided with the launch of the Lebanese FRAX calculator in 2009, and the introduction of the FRAX based Lebanese Osteoporosis guidelines in 2013 (10), we think the latter two are unlikely to account for the observed decline, as we would have expected the putative interventions stemming from implementation of a risk calculator and national guidelines to take their effect with some lag time. There is no published

representative data in Lebanon regarding the use of bone-sparing agents, however the increase in the use of bone-sparing medication in western populations was found to correlate with a decrease in hip fracture rates (37).

Most data regarding hip fracture secular trends come from Northern and Central Europe, Northern America and South-East Asia (3), where rates have experienced an initial rise followed by either a plateau or decline in the last three decades (3, 4, 37-40). Conversely, most Asian countries, with the exception of Hong-Kong, Singapore and Taiwan (20, 41, 42), register a continuous increase in hip fracture IRs (4, 32, 43, 44). The trend of decreasing hip fracture rates noted in Lebanon is similar to the established decline seen in Western societies. Very limited data is available from the Middle East and North Africa (MENA) (8), Eastern Europe, and South America (45). Most studies from the MENA report on hip fracture prevalence and/or incidence within relatively short time spans (8, 29, 46). To the best of our knowledge, the only studies to examine secular trends in the MENA are from Morocco (28) and Kuwait (27). In Morocco, hip fracture rates have remained stable from 2006 to 2009 (28), while in Kuwait, there was a slow IR increase from 2009 to 2012 attributed to the 16.9% increase in the subpopulation aged ≥ 50 years (27).

As for the increase observed after 2015, reasons are unclear. Hip fracture IRs from USA were recently noted to be higher than projected (6). This was attributed to a decline in DXA screening and underutilization of bone active drugs, particularly post fragility fractures (6, 47). Furthermore, as with other silent chronic diseases, compliance with treatment is usually poor (48). The recent decline in bisphosphonate drug prescription may be associated with the Food and Drug Administration mandated amended labeling for risk of osteonecrosis and atypical femur fractures (47, 49).

Implications for the Middle East

Worldwide variance in IRs are high, thus national fracture incidence data represents the most valued information for risk prediction (50). FRAX was launched in Lebanon in 2009, and similar to other countries, this led to an update of the Lebanese osteoporosis guidelines, incorporating FRAX into clinical care pathways (10). Originally, due to insufficient national data to construct country-specific FRAX models in the Middle East, and since there are little ethnic disparities, both in life expectancy and fracture rates, FRAX Lebanon was used as a surrogate for other countries in the region (51). Still, great disparity persists in the uptake of FRAX worldwide (51-53). FRAX models are now available for 7 countries from the Middle East (Abu Dhabi, Iran, Jordan, Kuwait, Lebanon, Palestine, and Syria) (54). Assessing for secular trends in these countries and the ensuing possible need to calibrate these country specific calculators becomes a must.

Our study has several strengths. It provides annual crude age stratified IRs of hip fractures, for both men and women, in a Lebanese population, using data from the MOPH that extends over a decade. This population represents 50-58% of the entire Lebanese population, depending on age category. To the best of our knowledge, this is the first population-based study to assess secular trends in hip fracture rates across a 12-year period in the region. It employs a standardized prospective data-capture-method through a national registry which utilizes ICD 10 codes. The study has some weaknesses. National registry based studies can be subject to inaccurate coding and reporting, and the data as obtained did not allow for identification of secondary diagnosis to exclude pathologic or traumatic fractures. Double counting of fractures cannot be excluded, but the latter should account for less than 10% of fractures reported. Lebanon does not have updated population census figures. It has been in a state of political turmoil since the end of the civil war in 1990, in addition to the wave of almost 1,5 million Syrian refugees, with resultant possible administrative disruptions that might have affected the collection of data. However, we are

confident that hip fractures incurred by refugees were not included in the MOPH registry in view of its regulatory considerations.

Our study is the first in the Middle East to provide sex-specific long-term data on secular trends in hip fracture. Understanding the epidemiology of diseases in general, and hip fractures in particular, is instrumental to disease management. It helps define disease burden and allows the update of risk calculators, care pathways and appropriate allocation of public health resources. The impact of the observed secular trends on national FRAX-derived estimates is unclear, should be assessed, and may necessitate an update in the FRAX Lebanon calculator. Our study also raise the possibility for similar secular trends in the region, that may require adjustments in country-specific FRAX calculators in the Middle East.

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FIGURE LEGENDS

Figure 1 Secular trend in hip fracture incidence per 100,000 individuals expressed as 3-year aggregate data. Error bars depict 95% confidence intervals.

Figure 2 Three-year average point estimates for hip fracture incidence per 100,000 individuals stratified by age in women (A) and in men (B).

Figure 3 Average age and sex-specific hip fracture incidence rate ratios, for 2006 to 2017, for consecutive paired age groups (e.g. 55-59 vs. 50-54, …etc.). Error bars depict 95% confidence intervals.

Figure 4 Sex specific secular trend in hip fractures IRs. (A) Percent change in 3-year average hip fracture IR compared to the baseline period from 2006-2008. This is calculated by subtracting the IR of hip fractures of the 2006-2008 time period from the corresponding IR for that time period, and dividing the difference by the 2006-2008 IR. (B) Annual change in hip fracture IR is calculated between two time points, in a specified time period, by subtracting hip fracture IR of the first time period from the IR of the last time period, and dividing the difference by the first IR and number of years in-between. For example, in women annual % change in IR for 2006-2009 time period = (IR 2009 – IR 2006)/ (4 years X IR 2006) = -3.2 % / year.

Table 1 Crude yearly incidence rates of hip fractures per 100,000 in women, over 12 years

Age groups (years)	Proportion Uninsured* (%)	2006 IR	2006 95%CI Lower-upper	2007 IR	2007 95%CI Lower-upper	2008 IR	2008 95%CI Lower-upper	2009 IR	2009 95%CI Lower-upper	2010 IR	2010 95%CI Lower-upper	2011 IR	2011 95%CI Lower-upper
50-54	51.5	18.7	9.3-36.2	6.3	1.2-19.6	22.9	12.2-41.5	12.0	4.8-26.8	13.7	6.0-29.0	40.4	26.1-62.2
55-59	54.3	16.1	7.1-34	28.1	15.5-49.7	27.6	15.2-48.8	54.5	35.9-82.2	20.9	10.3-40.5	41.1	25.5-65.4
60-64	52.9	57.2	37.6-86.3	40.4	24.3-66.2	39.7	23.9-65.1	53.5	34.9-81.4	40.6	24.8-65.5	51.6	33.6-78.5
65-69	52.5	105.9	75.3-148.5	113.8	81.8-158.0	77.8	52.1-115.3	83.5	57.7-120.4	62.2	40.6-94.8	88.9	62.5-125.8
70-74	56.9	289.5	224.9-372.2	284.2	219.8-367.0	213.2	158.8-285.8	177.4	135.9-231.2	174.2	133.5-227.1	171	131.0-222.9
75-79	57.2	494.3	390.0-625.8	530.8	421.6-667.6	443.5	345.3-568.9	319.4	249.7-408.2	299.1	232.3384.5	356.1	283.2-447.3
80+	61.2	1680.3	1459.0-1934.0	1446.7	1241.0-1686.0	1528.5	1318.0-1771.0	997.6	865.7-1149	845.7	725.8-985.0	1164	1023.0-1324.0
Overall	**51.3**	**187.5**	**169.8-206.9**	**174.4**	**157.3-193.3**	**163.9**	**147.5-182.2**	**163.3**	**147.8-180.3**	**138.1**	**124.1-153.7**	**182.9**	**166.6-200.5**
Age groups (years)	Proportion Uninsured* (%)	**2012** IR	**2012** 95%CI Lower-upper	**2013** IR	**2013** 95%CI Lower-upper	**2014** IR	**2014** 95%CI Lower-upper	**2015** IR	**2015** 95%CI Lower-upper	**2016** IR	**2016** 95%CI Lower-upper	**2017** IR	**2017** 95%CI Lower-upper
50-54	51.5	36.0	22.6-56.6	29.8	17.9-48.9	23.9	13.5-41.3	12.7	5.6-26.7	21.4	11.8-37.9	36.9	23.8-56.7
55-59	54.3	60.6	41.3-88.6	35.4	21.3-58.0	32.7	19.3-54.4	32.2	19.0-53.6	27.5	15.6-47.6	56.3	38.3-82.2
60-64	52.9	69.1	48.1-99.1	47.7	30.7-73.3	35.8	21.5-58.6	48.5	31.6-73.8	43.7	20.9-56.9	62.1	42.9-89.5
65-69	52.5	79.2	54.7-114.2	64.5	42.9-96.5	74.2	50.9-107.6	62.7	41.6-93.7	82.3	57.9-116.6	96.3	69.8-132.6
70-74	56.9	128.4	94.6-174.0	108.4	77.9-150.5	80.1	54.5-117.0	87.7	61.0-125.7	112.4	81.8-154.0	116.4	85.4-158.3
75-79	57.2	378.6	303.9-471.4	242.3	184.3-318.2	252.5	69.6-159.5	248.9	190.7-324.4	254.2	195.7-329.7	522.8	436.8-625.6
80+	61.2	945.9	820.8-1090.0	1088	954.5-1240.0	840.2	724.3-974.2	895.1	776.1-1032.0	1055.4	926.5-1202.0	1395.8	1248.0-1561.0
Overall	**51.3**	**165.9**	**150.8-182.7**	**151.6**	**137.3-167.5**	**126.6**	**113.6-141.1**	**129.8**	**116.7-144.3**	**147.7**	**133.8-163.0**	**213.2**	**196.6-231.3**

***** Proportion of Lebanese women, for whom healthcare is covered by the Lebanese Ministry of Public Health, as the insurer of last resort, adapted from the 2007 Central Administration of Statistics (13), stratified by age group.

Table 2 Crude yearly incidence rates of hip fractures per 100,000 individuals in men, over 12 years

Age groups (years)	Proportion Uninsured* (%)	2006 IR	2006 95%CI Lower-upper	2007 IR	2007 95%CI Lower-upper	2008 IR	2008 95%CI Lower-upper	2009 IR	2009 95%CI Lower-upper	2010 IR	2010 95%CI Lower-upper	2011 IR	2011 95%CI Lower-upper
50-54	47.8	14.2	5.7-31.8	16.8	7.4-35.5	30.7	17.4-53.1	19.3	9.0-38.8	22.9	5.7-31.8	16.3	7.1-32.4
55-59	46.3	31.0	16.0-57.9	15.7	5.6-38.0	34.0	18.2-61.7	46.2	27.3-77.0	32.1	5.3-36.5	32.7	17.5-59.3
60-64	48.4	41.3	23.3-71.4	38.7	21.3-68.4	47.6	28.1-79.2	31.3	16.1-58.4	47.4	7.4-41.2	54.2	33.7-86.4
65-69	51.2	64.1	40.3-100.7	78.7	51.8-118.7	53.9	32.4-88.3	53.4	32.7-86.2	74.4	7.4-41.4	42.4	24.5-71.9
70-74	54.4	72.4	44.3-116.9	103.8	79.0-155.2	131.9	92.2-187.8	84.3	56.5-125.0	70.4	60.9-130.7	68.3	44.0-105.0
75-79	54.6	190.2	129.5-277.8	250.2	178.9-348.9	239.1	170.1-335.1	207.2	153.8-278.7	134.0	85.1-182.5	168.0	121.2-232.2
80+	55.7	664.3	525.2-839.4	838.1	679.1-1033.0	701.3	558.0-880.4	543.8	449.4-657.7	462.2	305.6-479.6	553.9	460.2-666.5
Overall	**52.0**	**88.1**	**75.5-102.8**	**106.5**	**92.5-122.7**	**105.3**	**91.5-121.2**	**108.1**	**94.9-123.2**	**95.2**	**61.6-84.6**	**101.9**	**89.3-116.3**
Age groups (years)	Proportion Uninsured* (%)	2012 IR	2012 95%CI Lower-upper	2013 IR	2013 95%CI Lower-upper	2014 IR	2014 95%CI Lower-upper	2015 IR	2015 95%CI Lower-upper	2016 IR	2016 95%CI Lower-upper	2017 IR	2017 95%CI Lower-upper
50-54	47.77	22.9	11.8-42.8	15.8	6.9-33.3	15.5	6.8-32.8	15.3	6.7-32.3	10.8	3.8-26.0	26.8	18.1-39.4
55-59	46.34	32.1	17.2-58.3	23.0	10.8-46.3	22.7	10.6-45.6	30.7	16.4-55.8	35.8	20.2-61.9	21.7	13.3-35.0
60-64	48.37	47.4	28.5-77.7	29.2	15.0-54.5	17.2	6.9-38.6	22.7	10.6-45.6	33.5	18.5-59.3	17.6	9.9-30.4
65-69	51.15	74.4	49.9-110.4	32.3	17.2-58.5	26.0	12.8-50.2	28.5	14.7-53.2	30.9	16.5-56.0	27.3	17.2-42.9
70-74	54.43	70.4	45.9-107.1	63.0	40.1-97.9	71.3	47.0-107.6	48.9	29.4-80.2	36.2	19.9-64.0	45.9	31.5-66.6
75-79	54.56	134.0	93.1-192.0	162.7	117.4-224.8	99.6	65.6-150.3	123.9	85.5-178.5	159.9	115.9-220.0	87.2	63.2-120.1
80+	55.65	462.2	377.8-565.0	426.3	346.1-524.7	368	294.5-459.5	279.1	216.4-359.6	352.9	282.0-441.3	313.8	262.8-374.4
Overall	**52.0**	**95.2**	**83.1-109.1**	**81.6**	**70.6-94.4**	**68.1**	**58.1-79.7**	**61.4**	**52.1-72.5**	**72.1**	**62.0-83.4**	**111.7**	**99.0-126.0**

***** Proportion of Lebanese men, for whom healthcare is covered by the Lebanese Ministry of Public Health, as the insurer of last resort, adapted from the 2007 Central Administration of Statistics (13), stratified by age groups.

Figure 1

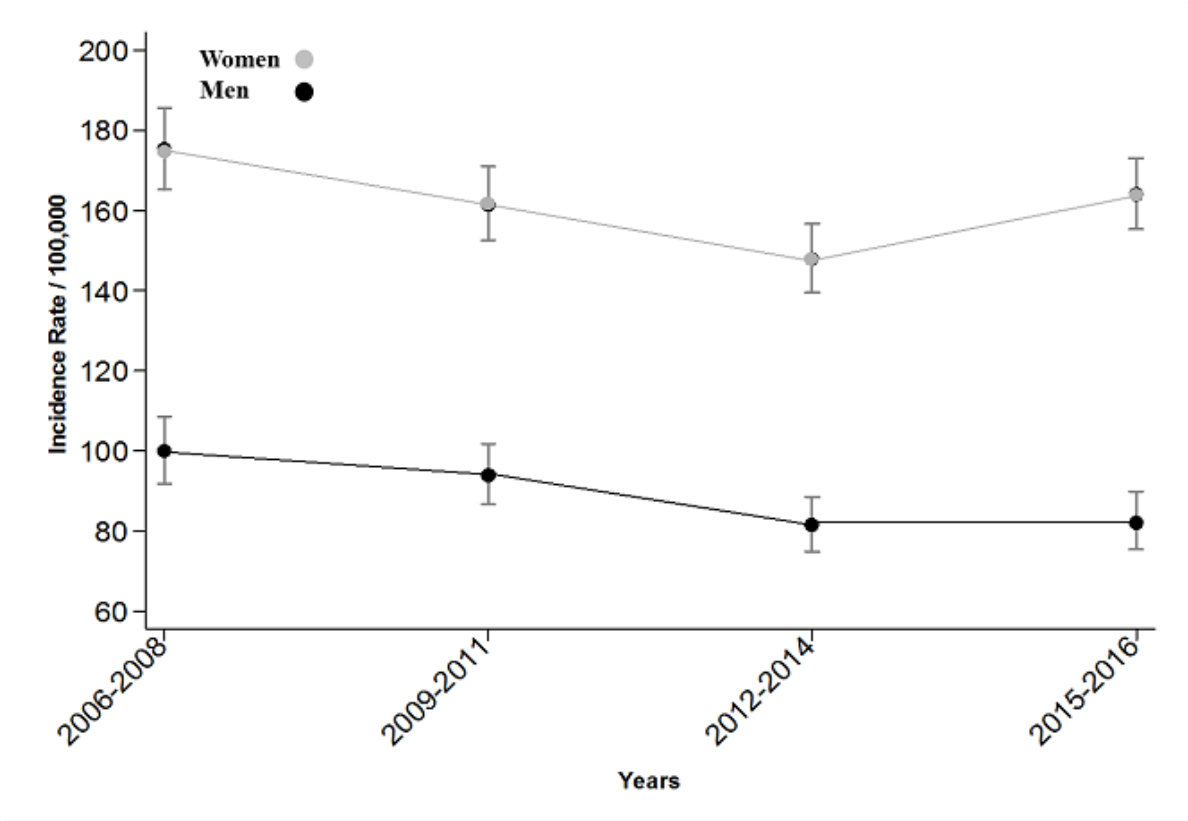

Women
Men
200
180
160
140
120
100
80
60
Incidence Rate / 100,000
2006-2008
2009-2011
2012-2014
2015-2016
Years

Figure 2

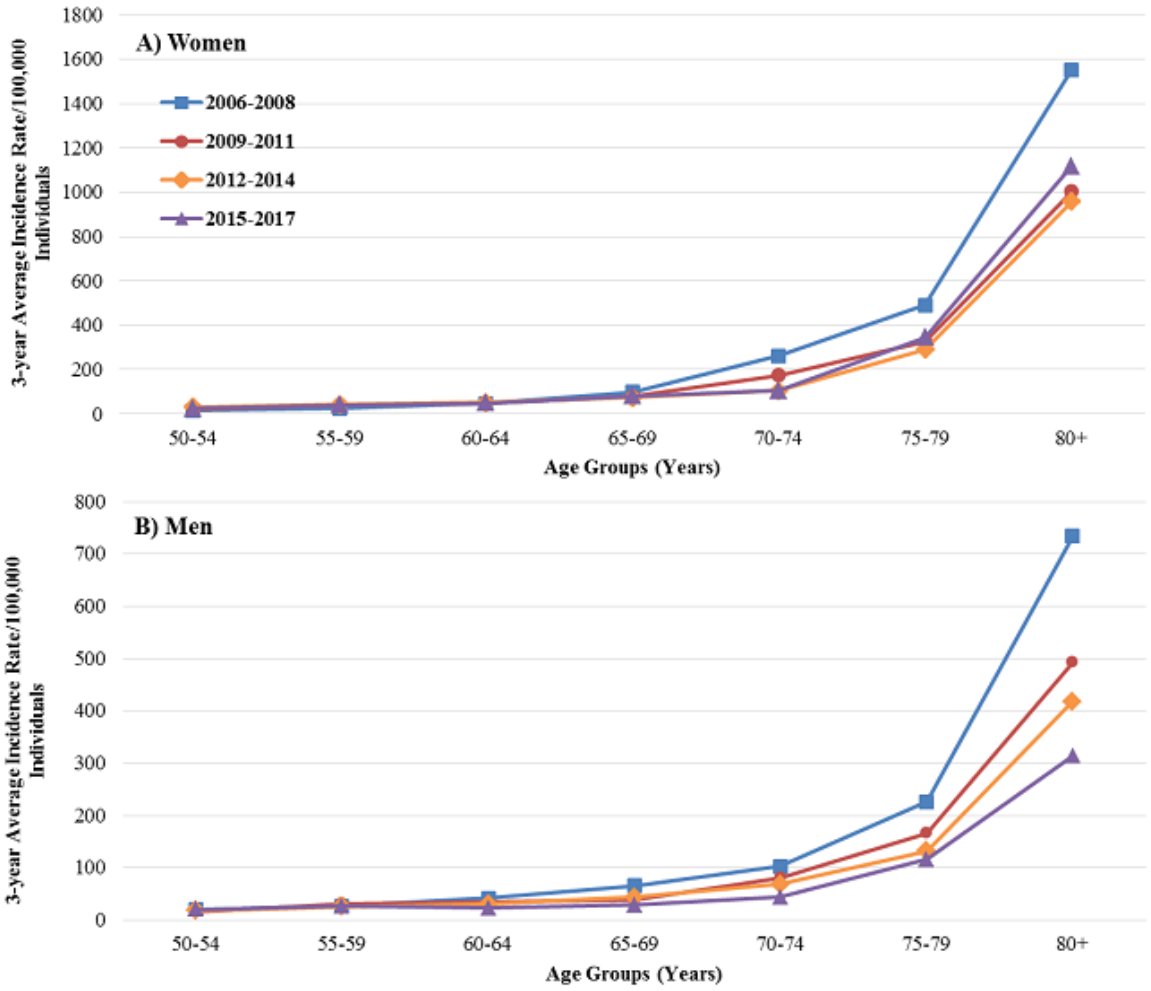
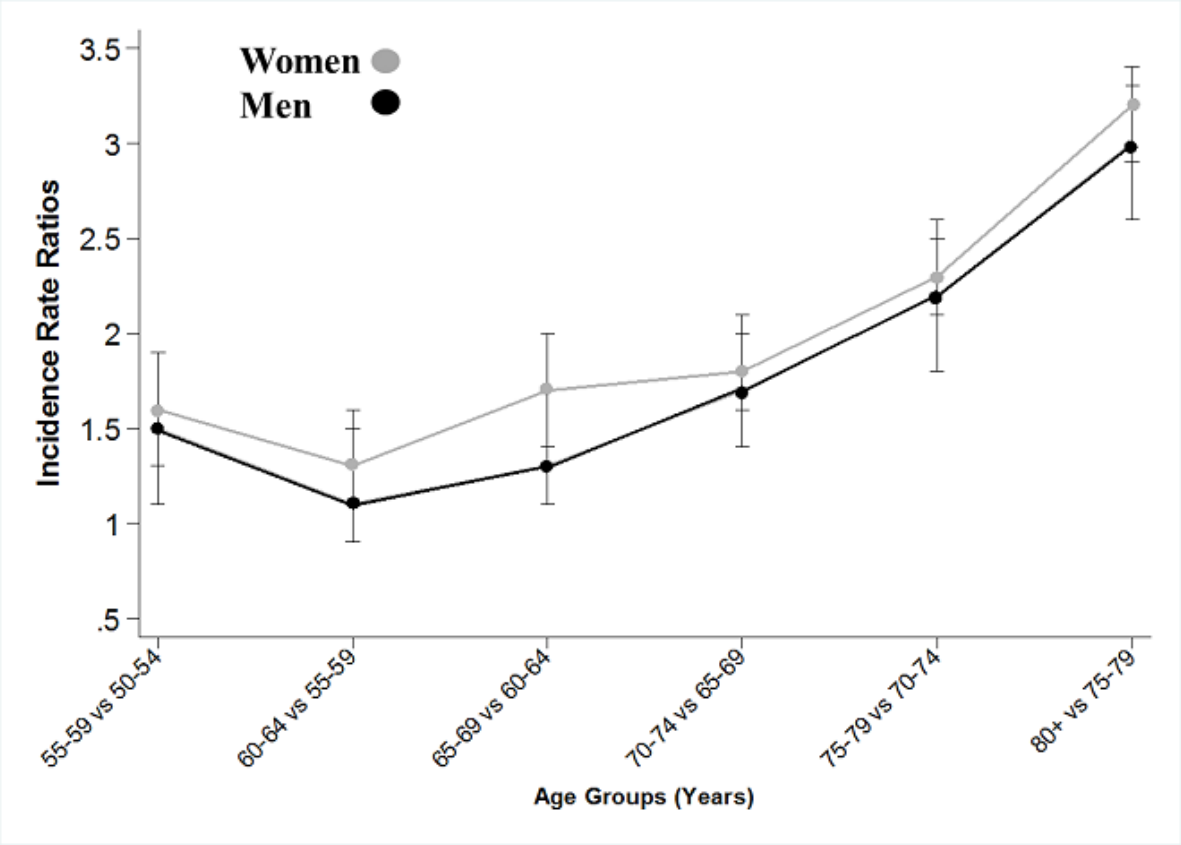
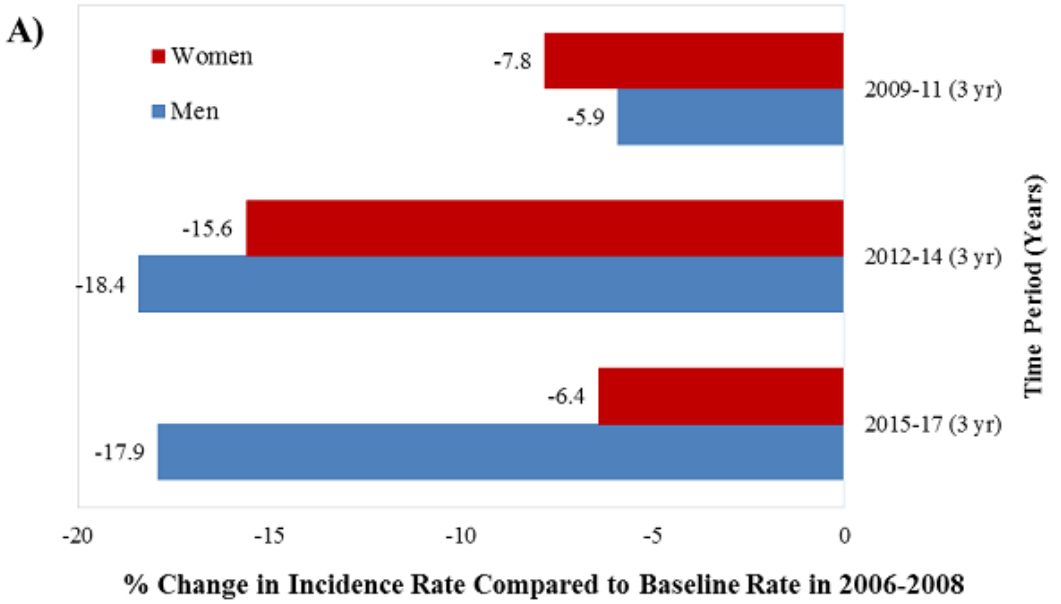
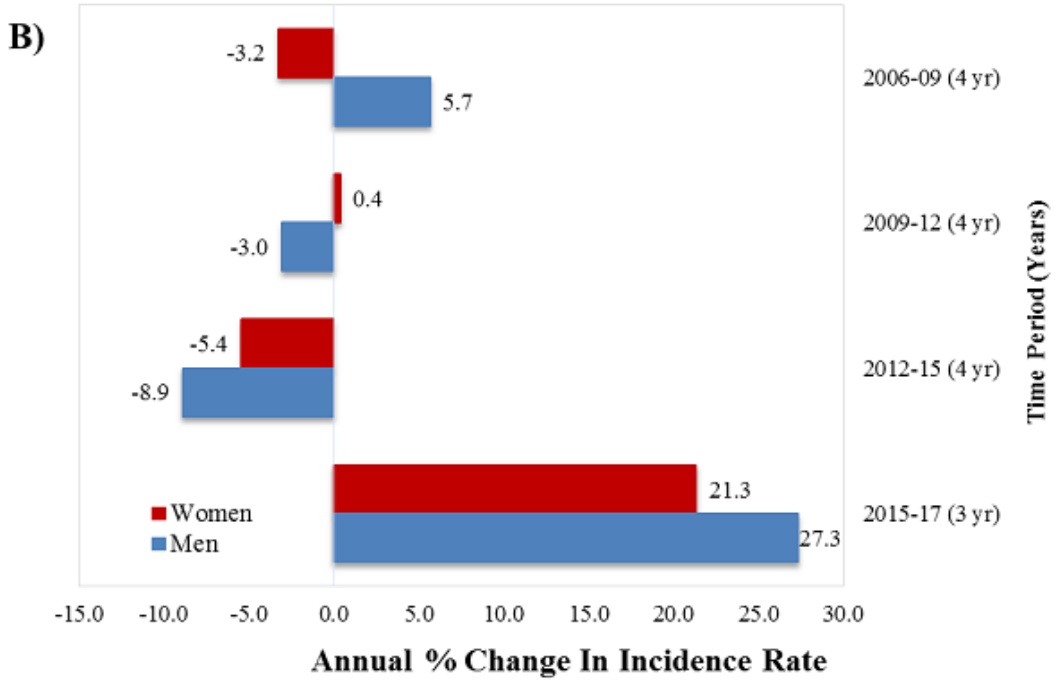

A) Women
2006-2008
2009-2011
2012-2014
2015-2017
3-year Average Incidence Rate/100,000 Individuals
1800
1600
1400
1200
1000
800
600
400
200
0
50-54
55-59
60-64
65-69
70-74
75-79
80+
Age Groups (Years)
B) Men
3-year Average Incidence Rate/100,000 Individuals
800
700
600
500
400
300
200
100
0
50-54
55-59
60-64
65-69
70-74
75-79
80+
Age Groups (Years)

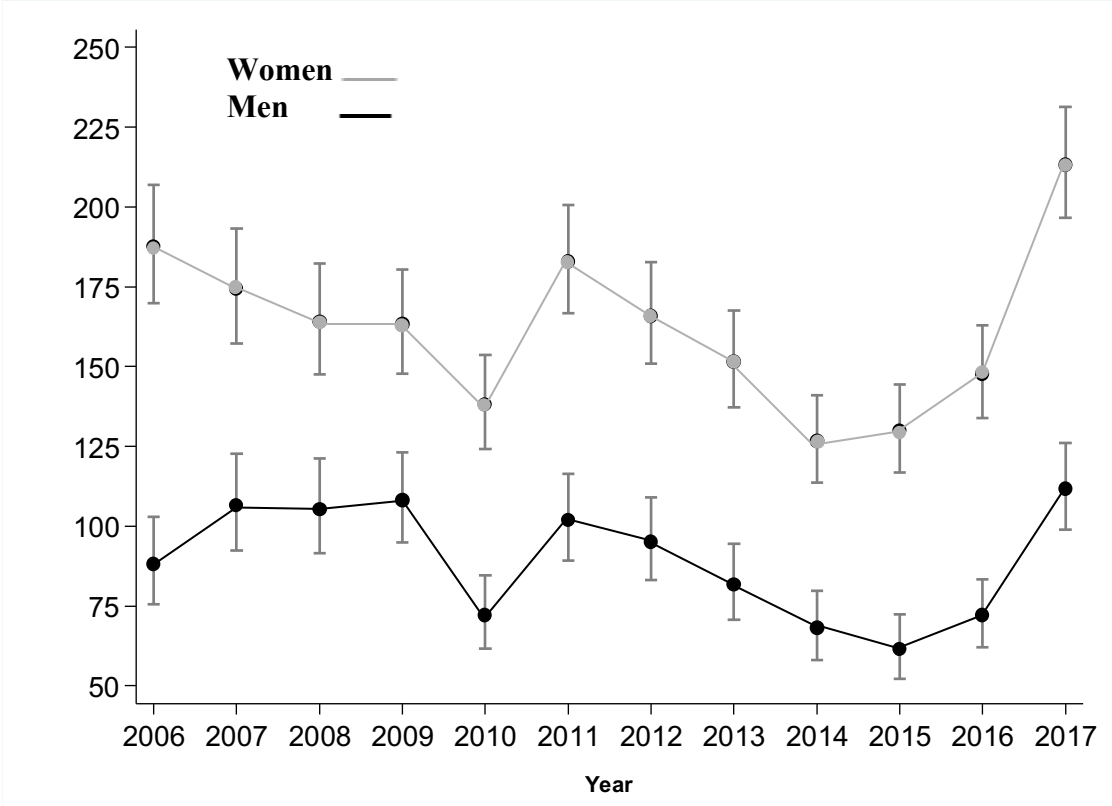
Figure 3


Women
Men
Incidence Rate Ratios
3.5
3
2.5
2
1.5
1
.5
55-59 vs 50-54
60-64 vs 55-59
65-69 vs 60-64
70-74 vs 65-69
75-79 vs 70-74
80+ vs 75-79
Age Groups (Years)


A)
Women
Men
-7.8
-5.9
2009-11 (3 yr)
-15.6
-18.4
2012-14 (3 yr)
-6.4
-17.9
2015-17 (3 yr)
Time Period (Years)
-20
-15
-10
-5
0
% Change in Incidence Rate Compared to Baseline Rate in 2006-2008


B)
-3.2
5.7
2006-09 (4 yr)
0.4
-3.0
2009-12 (4 yr)
-5.4
-8.9
2012-15 (4 yr)
21.3
27.3
2015-17 (3 yr)
Time Period (Years)
Women
Men
-15.0
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Annual % Change In Incidence Rate

Supplement Figure 1 Secular trend in hip fracture incidence per 100,000 individuals by year. Error bars depict 95% confidence intervals.



Supplement Figure 2 Hip fracture incidence rate ratios, for 2006 to 2017, comparing incidence rates in women to incidence rates in men. Error bars depict 95% confidence intervals.