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ORIGINAL ARTICLE

Disease burden of osteoporosis and other non-communicable diseases in Lebanon

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Abstract

Summary Osteoporosis is more common than most feared non-communicable diseases in the Middle East. This justifies the need to place osteoporosis as a health priority in the region.

Introduction Osteoporosis is a common disease associated with severe debilitating consequences. The objective of this study is To evaluate and compare disease burden from osteoporosis and other non-communicable diseases (NCDs) in Lebanon.

Methods We assessed the prevalence of osteoporosis and other NCDs, such as obesity, diabetes, hypertension, dyslipidemia, and cardiovascular diseases, based on a published population-based study of Lebanese ≥ 65 years. We compared incidence rates of hip fractures and major osteoporotic fractures (MOF) (spine, hip, humerus, and forearm) to the five commonest cancers in women ≥ 50 years. Rates were based on the national hip fracture and cancer registry data, provided by the Lebanese Ministry of Public Health. MOF incidence rates were derived from national hip fracture incidence rates and MOF/hip fractures incidence rate ratios from the literature.

Results Over 70% of elderly Lebanese had osteoporosis defined by densitometric criteria or prevalent morphometric vertebral fractures. This by far exceeded the prevalence of other NCDs, such as hypertension (53%), diabetes (21%), dyslipidemia (31%), and cardiovascular diseases (30%). Morphometric vertebral fractures (grades 2 and 3) were present in 19% of women and 12% of men. The incidence rates for MOF were 1.6 times greater than those for breast cancer, and 7.4–9.9 folds higher than those for the next commonest cancers of the lungs, colon, and ovaries. Hip fracture incidence rates were lower than those of breast cancer but were 2.1–2.8 folds higher than those of the above-mentioned cancers.

Conclusion This first of its kind study in the Middle East demonstrates that osteoporosis is a common disease, more common than most feared NCDs. Our findings are comparable to those in western populations and justify placing osteoporosis on the top of NCDs' priority list in our country and possibly the region.

Keywords Hip fractures · Osteoporosis · Major osteoporotic fractures · Middle East · Non-communicable diseases

Introduction

Non-communicable diseases (NCDs) are a major public health epidemic contributing to 70% of mortality worldwide [1]. This burden is driven by urbanization, globalization of unhealthy diets, lack of physical activity, and aging populations [2]. Cardiovascular diseases (CVD), cancer, chronic respiratory diseases, and diabetes account for the majority of deaths caused by NCDs and for 80% of premature deaths occurring in those younger than 70 years [2]. In Lebanon, the probability of premature deaths from the four main NCDs is 18%, and NCDs account for almost 80% of all-cause mortality, CVD accounting for 47% [3, 4].

Osteoporosis is a silent yet costly disease of the elderly, with fracture-induced disabilities, as well as social and psychological consequences [5]. It is associated with increased mortality, decreased quality of life, and loss of functional independence best recognized in post-hip fractures [6]. The yearly incidence of hip fractures is rapidly increasing, findings explained by increased global life expectancy that is most accelerated in developing countries [7, 8]. In the USA, the lifetime risk of osteoporotic fracture at the hip, spine, and forearm was estimated to be

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around 40% and comparable to that of CVD in women above the age of 50 years [9]. In US elderly women, the yearly incidence of fractures greatly exceeded that of other NCDs, such as heart attacks, breast cancer, and stroke by 2, 4.7, and 8.5 folds, respectively [10]. In Lebanon, up to 1/5 women were found to have moderate to severe vertebral morphometric compression fractures [11], and hip fracture incidence rates were comparable to those in Southern Europe [12–14].

In this study, we aimed to systematically evaluate disease burden from osteoporosis and compare it to other NCDs, in Lebanon. We assessed disease burden based on the number of individuals affected using prevalence and incidence rates for the commonest NCDs.

Methods

Data sources and population studied

Prevalence rates of NCDs

We assessed the prevalence of osteoporosis (defined by densitometric criteria or morphometric vertebral fractures), diabetes (type II), hypertension, dyslipidemia, and CVD. We also retrieved data for obesity, a major public health problem in Lebanon and the region and a major risk factor for NCDs. Due to the lack of official NCD registries in Lebanon, we extracted data for osteoporosis and vertebral fractures from a database of a population-based study, conducted in 2007 on Lebanese residents aged 65–84 years, selected randomly from the Greater Beirut area [11]. We chose this particular study because it collected data on osteoporosis as well as other NCDs. Height, weight, and bone mineral density (BMD) were measured [11]. Patients with any disease or medication that might affect bone metabolism, steroid intake for more than 6 months, bed rest, history of spine or hip surgeries, or previous chemotherapy or radiotherapy exposure were excluded from the study. None of the fractures were pathologic and 68% of reported fractures were reported to be due to a fall from standard height. Radiographs were taken to assess the presence of morphometric vertebral fractures. Information on NCDs was self-reported and collected by questionnaires at study entry, but had not been previously reported [11].

Incidence rates

We assessed incidence rates for hip fractures, major osteoporotic fractures (MOF), and the five most common age-specific cancers in women in Lebanon. Rates were determined based on data from the national hip fracture and cancer registries at the Lebanese Ministry of Public Health (MOPH) [15]. Both national registries were based on the same population of uninsured Lebanese subjects across Lebanon, which constitutes around 52% of the total Lebanese population [16].

The national hip fracture registry was established in 2006 and includes cases from uninsured Lebanese patients who sustained a hip fracture and received their care exclusively through the MOPH, ever since. Due to the lack of a national registry for spine, humerus, and forearm fractures, we calculated the MOF incidence rates, based on MOF/Hip incidence rate ratios (IRRs) from Malmo Sweden (see calculations in the "Incidence rates" section below).

The national cancer registry was established in 2005 and includes all cancer cases, as reported by physicians or histopathological and hematological laboratories across the country, ever since. In order to compare fracture and cancer rates, we used selected data provided by the Lebanese MOPH that is based on the same population which only includes uninsured patients who received their cancer treatment exclusively through the ministry. This data was only available for the period 2012–2017; we therefore restricted our comparisons for all incidence rates to this period.

Definitions and calculations

Prevalence rates

We defined osteoporosis as the proportion of individuals with osteoporosis by BMD [17] or with a moderate or severe morphometric vertebral fracture by radiography. BMD was measured in two different centers the American University of Beirut Medical Center and Hotel-Dieu de France. The scans were assessed independently by two ISCD-certified physicians. Cross-calibration was performed on a subset of patients in both centers, and all BMD evaluations were therefore considered as if measured with a Hologic 4500 A densitometer [11]. Osteoporosis by BMD was defined as having at least one of the following: T-score ≤ -2.5 at the total hip, femoral neck, or forearm. As recommended by the IOF and ISCD, we used the universal NHANES female database to derive total hip and femoral neck T-scores [18, 19] and the manufacturer-derived database for the forearm. We derived hip and femoral neck T-scores using the following two formulas: T-score (total hip) = (BMD total hip − 0.924)/0.122 and T-score (femoral neck) = (BMD femoral neck − 0.858)/0.12 [20]. T-score at the spine was not considered due to the high prevalence of degenerative disease in the elderly [11]. The presence of vertebral fractures was assessed by radiography using the technique described by Genant [21]. Only moderate (grade 2) and severe (grade 3) vertebral fractures were considered in the analyses to avoid misclassification [22]. X-rays were assessed in two different radiology centers with an agreement of 80.6% [11]. Self-reported osteoporotic fractures were excluded due to the lack of adjudication.

Incidence rates

The crude incidence rates of interest were derived as total incidence rates in women ≥ 50 years for the 2012–2017 period. In this study, we decided to include data on women only due to the fact that the data collected from men by the MOPH still needs to be validated. Age was divided into eight subgroups (50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84 and ≥ 85 years).

Hip fractures We first calculated the number of hip fracture cases in women ≥ 50 years, by adding the number of cases reported in each age subgroup. We then calculated crude incidence rates for hip fractures in women ≥ 50 years for each calendar year as follows:

$$\text{IR hip fracture} = \frac{n \text{ hip fractures in uninsured women} \geq 50 \text{ years}}{N \text{ uninsured women} \geq 50 \text{ years}} \times 100,000$$

n is the number of hip fractures cases provided by the MOPH national hip fractures registry.

N is the uninsured Lebanese women population ≥ 50 years.

Every year, The MOPH publishes a bulletin, including an estimate of the total Lebanese population stratified by age and sex [23]. The proportions of uninsured Lebanese population, who are exclusively covered by the MOPH, were published in the latest Household Living Conditions Survey in Lebanon conducted in 2007 [16], stratified by sex and age groups. We used this data to derive the N for the uninsured women population by multiplying the above-mentioned proportions by the total Lebanese women population. The same calculated uninsured population ≥ 50 years was used for all outcomes.

We also calculated the mean 3-year (2012–2014, 2015–2017) average incidence rates in women by dividing the total number of hip fracture cases (n) in women ≥ 50 years by the total MOPH covered female population (N), in the 3-year period as follows:

$$\text{mean 3-year IR} = \frac{n1 + n2 + n3}{N1 + N2 + N3} \text{x } 100,000$$

Major osteoporotic fractures (MOF) We defined MOF as fractures in the hip, spine, proximal humerus, and distal forearm, but such data is not available in our registry. We therefore used data from Malmo Sweden, with information on age, sex, and fracture (site)-specific incidence rates to derive age-specific MOF/hip IRR in women [24]. We then derived the actual number of MOF cases in women within each age group in our population by multiplying the number of cases of hip fractures by the above calculated MOF/hip IRR from Malmo. We ultimately calculated total MOF incidence rates for women ≥ 50 years for each calendar year and means for the 2012–2014 and 2015–2017 periods, as described above for hip fractures.

To be noted that the online calculator FRAX [25] develops and publishes country-specific calculators that provide MOF risk estimates, using the Malmo-derived MOF/Hip IRR [26, 27], although such approach needs validation [28].

Cancers For each of the five most common cancers, we first calculated the number of cases in women ≥ 50 years as mentioned above for hip fractures. We then calculated crude incidence rates for each cancer in women ≥ 50 years for each calendar year as follows:

$$\text{IR cancer} = \frac{n \text{ cancer in uninsured women} \geq 50 \text{ years}}{N \text{ uninsured women} \geq 50 \text{ years}} \times 100,000$$

We also calculated the 3-year average incidence rates for each cancer as mentioned above for hip fractures.

Statistical analysis

We used the data in the elderly study dataset to calculate the prevalence of osteoporosis, vertebral fractures, and other NCDs [11], using SPSS version 25.0 (IBM, USA) for simple descriptive summary statistics. We compared prevalence of each NCD to the prevalence of osteoporosis using a chi-square test through the open source calculator—TwobyTwo (OpenEpi, Version 3.01) [29]. We also compared the incidence rate of each cancer to the incidence rate of major osteoporotic fractures and hip fractures in women in each time period, using the same calculator. This calculator provided us with 95% confidence intervals for each risk ratio (prevalence ratio or incidence rate ratio, as applicable), which were considered statistically significant if they did not include 1.

Results

Prevalence rates

We have included 460 elderly participants in our population-based study. We had data for obesity and overweight for 458 participants and data on osteoporosis for 453 participants. Close to one third of the participants were smokers (30.4%), had a history of falls (31.5%), or had a personal history of fragility fractures (28.9%); 13.5% had a family history of fragility fractures. Data on self-reported NCDs such as diabetes, CVD, dyslipidemia, and hypertension were only available for 195 participants. These participants with complete data were similar to those with incomplete data in terms of BMI, gender, and lumbar spine BMD; however, they were slightly younger (72.3 ± 5.1 v/s 74.4 ± 5.1 years) and had higher total hip BMD (0.776 ± 0.130 v/s 0.738 ± 0.145 g/cm^2). The prevalence of osteoporosis defined by BMD or presence of vertebral fracture was 72% [11]. The majority, 54% of elderly had osteoporosis

by BMD criteria only, while 3% had osteoporosis by the presence of vertebral fracture alone, and 13% had osteoporosis confirmed by both BMD and the presence of fracture (data not shown). Morphometric vertebral fractures were present in 19% of women and 12% of men. The overwhelming majority of participants, 84% of women and 67% of men, with vertebral fracture(s) had osteoporosis confirmed by BMD (data not shown). The prevalence of osteoporosis by femoral neck BMD was 25% (31% in women and 13% in men), 20% by total hip BMD (28% in women and 4.4% in men), and 64% by forearm BMD (67% in women and 59% in men). The prevalence of osteoporosis by hip BMD (total or femoral neck) was 30% (38% in women and 15% in men) (data not shown).

Osteoporosis was significantly more common than all the other individual NCDs assessed in our analyses (Fig. 1). This difference was statistically significant for all NCDs ($p < 0.001$). In the overall group, hypertension was the next most common NCD (53%), followed by obesity (44%), and dyslipidemia (31%). Rates were twice as high in women compared to men for the above three NCDs (Fig. 1).

Incidence rates

In women ≥ 50 years, yearly total incidence rates of hip fractures ranged between 126.6 (lowest) and 213.2 (highest) per 100,000 for years 2012–2017, and those of MOF ranged between 424.3 (lowest) and 740.2 (highest) per 100,000 (Table 1). There was a decrease in hip fracture rates between 2012 and 2015, followed by a reversal thereafter. The incidence of major osteoporotic fractures was almost 3.5–4 folds greater than that of hip fractures alone for women (Table 1, Fig. 2).

In women ≥ 50 years, the most common cancers reported in descending order were breast, colon, lung, ovarian cancer, and non-Hodgkin's lymphoma (NHL) (Table 1). In the 2012–2017 period, the average incidence rate of major osteoporotic fractures was 3.5 folds higher than that of hip fractures and higher than any of the five most common cancers in women ≥ 50 years (Fig. 2). The incidence of MOF was 1.6 times greater than the incidence rate of breast cancer, the most common cancer in women. It was also several folds greater than that of cancer of the colon, lungs, ovaries, and non-Hodgkin's lymphoma ($p < 0.001$ for all outcomes) (Table 2). The incidence rates of hip fractures were 2.2 times lower than those of breast cancer but higher than those of lung, colon, ovarian, and non-Hodgkin's lymphoma by 2.1, 2.3, 2.8, and 6.4 times respectively ($p < 0.001$ for all outcomes) (Table 2).

Discussion

In this study, the prevalence of osteoporosis, defined by BMD at the hip or forearm, or prevalent morphometric fractures, was 72% in the Lebanese elderly. It exceeded that of other NCDs such as hypertension, diabetes, dyslipidemia, and CVD. In addition, the incidence rates of MOF exceeded that of the five most common cancers in women ≥ 50 years. In particular, it was 1.5–1.7 greater than that of breast cancer, the commonest cancer in women. In women, hip fracture incidence rates were higher than rates of colon, lung, ovarian cancers, and NHL.

Noteworthy, the prevalence of osteoporosis at the femoral neck in our study is higher than proportions reported in Europe [30]. This can be explained, in part, by the fact that BMD in the Lebanese is on average 0.2–0.9 SD lower compared to NHANES [31]. Our results cannot be compared to those from the NHANES study where spine and hip were combined [32]. The prevalence of vertebral morphometric fractures in our study is consistent with similarly captured data from western populations in women of comparable age range. These include SOF [33], EPIDOS [34], and LASA [35]. We

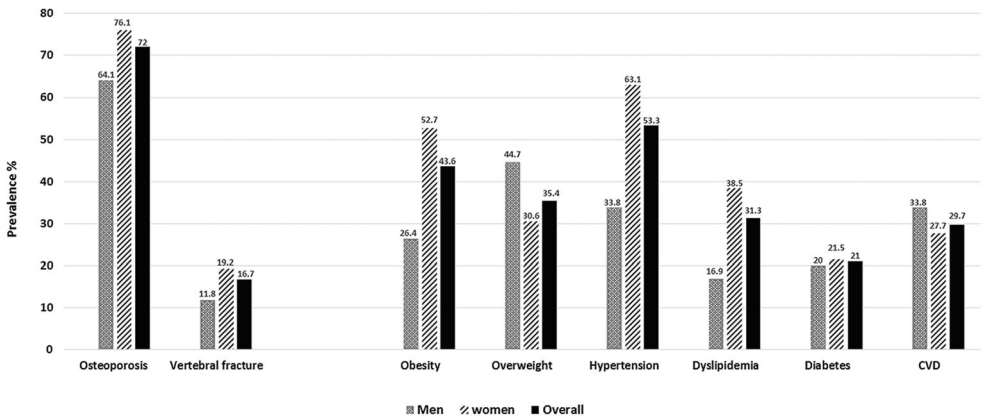

Fig. 1 Prevalence of osteoporosis and morphometric vertebral fractures and other non-communicable diseases among 460 elderly (65–85 years) in Lebanon overall and by gender (adapted from Baddoura et al. [11]). Osteoporosis defined as BMD T-score ≤ 2.5 at the total hip, femoral neck, or forearm or the presence of morphometric vertebral compression fracture by radiography. Only moderate and severe fractures were considered (Genant et al. [22]). Obesity: BMI ≥ 30 kg/ m^2, overweight: 25 ≥ BMI <30 kg/m^2. Hypertension, dyslipidemia, diabetes, and cardiovascular diseases (CVD) were self-reported

Table 1 Total incidence rates per 100,000 of major osteoporotic fractures[1], hip fractures[2] and the five most common cancers[3] in Lebanese women ≥50 years

	2012	2013	2014	2015	2016	2017	2012–2017
Major osteoporotic fractures	648.2 [617.6–680.4]	532.1 [504.6–561.1]	450.5 [425.4–476.9]	424.3 [400.2–449.9]	484.1 [458.4–511.1]	740.2 [708.7–773.3]	546.9 [535.5–558.6]
Hip fractures	165.9 [150.8–182.6]	151.6 [137.3–167.5]	126.6 [113.6–141.0]	129.8 [116.7–144.3]	147.7 [133.8–163.0]	213.2 [196.5–231.3]	156.1 [150.0–162.4]
Breast cancer	408.7 [384.5–434.4]	345.2 [323.2–368.7]	336.2 [314.6–359.2]	316.6 [295.8–338.8]	308.9 [288.6–330.7]	334.3 [313.3–356.8]	341.0 [332.0–350.3]
Lung cancer	80.0 [69.7–91.8]	74.1 [64.2–85.4]	62.1 [53.3–72.5]	74.2 [64.5–85.4]	73.5 [63.9–84.5]	77.6 [67.8–88.8]	73.6 [69.5–77.9]
Colon cancer	93.1[81.9–105.8]	67.4 [58.1–78.3]	66.4 [57.2–77.1]	55.2 [46.9–64.9]	62.6 [53.8–72.9]	61.0 [52.3–71.0]	67.4 [63.4–71.6]
Ovarian cancer	53.3 [45.0–63.1]	60.7 [51.9–71.1]	60.6 [51.8–70.8]	58.2 [49.7–68.2]	46.1 [38.7–55.0]	51.7 [43.8–61.0]	55.1 [51.5–58.9]
Non-Hodgkin's lymphoma	28.3 [22.4–35.9]	26.3[20.7–33.3]	20.8 [15.9–27.2]	19.0 [14.4–25.1]	25.9 [20.4–32.7]	25.5 [20.1–32.3]	24.3 [22.0–26.8]

[1] Incidence rates of major osteoporotic fractures were derived on Lebanese data on hip fractures and on derived MOF/hip incidence rate ratios (see the "Methods" section)

[2] Incidence rates of hip fractures were derived from the national registry of hip fracture

[3] Incidence rates of cancers were derived from the national registry of cancer

are unaware of any study in the region investigating the prevalence of morphometric or clinical fractures [8]. This is also consistent with the data on the lower discrepancy in vertebral fractures rates worldwide [13].

The prevalence rates of NCDs in our study were almost identical to those derived from another population-based study of 356 Lebanese elderly participants ≥ 60 years [36], thus validating our NCD prevalence findings, and the comparison of osteoporosis to other NCDs within the same population (Appendix1). Although the prevalence of obesity has been increasing over the past decade worldwide and in the Middle East, with a more significant increase in women, Lebanon registers some of the lowest rates for obesity and diabetes in the region, as noted in two recent reviews, with the highest rates registered in Saudi-Arabia and Kuwait [37, 38]. Both reviews, quoted the study by Sibai et al., with rates similar to ours [36–38]. A more recent cross-sectional study conducted in greater Beirut in 2017 reported that the prevalence of diabetes in the Lebanese adult population (mean age 45.4 ± 15) was 15% and has been increasing for the past years [39]. In individuals above the age of 40 years, the prevalence of diabetes was 18.8%, which is comparable to the prevalence we report in the elderly Lebanese population [39]. The data on disease burden from NCDs in the elderly from this region is limited. A recent cross-sectional study conducted in 2017 in elderly men (63 ± 7.5 years), from a large city in Saudi-Arabia, reported that 71% had hypertension by sphygmomanometer, 27% had diabetes by glucometer, 16% had self-reported CVD [40], and 78% were obese or overweight by measurements (34% were obese and 43% were overweight) [40]. The higher prevalence of obesity and hypertension in Saudi-Arabia compared to Lebanon might be explained by the differences in lifestyle. If we assume that the rates of obesity and diabetes in Lebanon today are similar to those found in Saudi-Arabia, a country with the highest recorded prevalence in the region, the prevalence of osteoporosis would still exceed that of obesity and diabetes by 1.5 and 2 folds, respectively. Similarly, 65% of the US NHANES population ≥ 60 years had hypertension, 28% had diabetes, and 12% had hyperlipidemia, with a noticeable gender difference similar to our study (17% in women and 7% in men) [41]. We are however unaware of any study directly comparing the prevalence of osteoporosis to that of other NCDs in the region.

The noted decline in hip fracture rates (2012–2015) is consistent with secular trends in hip fracture rates observed in developing countries [42, 43]. It may in part be explained by the dissemination and updates of the Lebanese guidelines, the increase in 25-hydroxyvitamin D measurements, the common use of calcium and vitamin D supplements, and possibly antiresorptive therapy [14]. The increase thereafter may be due to lower compliance with bisphosphonates from fear of atypical femoral fracture and osteonecrosis of the jaw. We compared disease burden incurred from NCDs to osteoporosis by using crude incidence rates for fractures and cancers derived within the same population. Therefore, despite changes in incidence

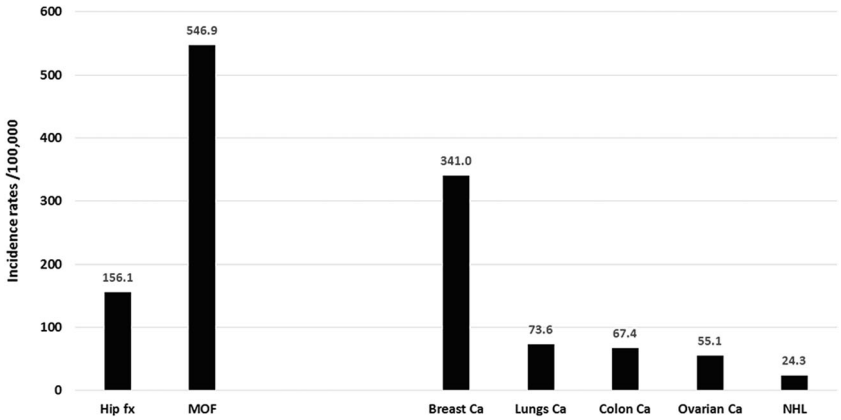

Fig. 2 Average incidence rates per 100,000 of MOF, hip fractures, and the five most common cancers in Lebanese women ≥ 50 years in 2012–2017. MOF, major osteoporotic fractures, and NHL, non-Hodgkin's lymphoma, MOF incidence rates were significantly higher than rates of hip fractures, breast Ca, colon Ca, lungs Ca, ovarian Ca, and NHL for periods 2012–2014 and 2015–2017 (Table 2)

rates for outcomes of interest over time in our population, the rank order for the risk ratio of MOF/other outcomes is quite robust. In Lebanon, age-standardized incidence rates combining major cancers were reported to be 200 per 100,000 and exceeded those reported in Egypt, Syria, Jordan, and Saudi-Arabia [44]. Despite such high rates and the steady annual increase in cancer rates (4.5% in men and 5.4% in women) in Lebanon [45], estimated incidence rates for MOF still exceed those for several leading cancers in women. Indeed, the MOF incidence rates we report herein are almost twice that of breast cancer, the most common cancer in women. In a retrospective cohort study, the incidence of any fracture in post-menopausal women from the USA (fracture free at study entry, mean age 65.5 ± 7.2 years, mean BMI 25.1 ± 4 kg/m^2) was 5.5 times greater than that of CVD and 8.7 times greater than that of breast cancer [46]. In the Women's Health Initiative observational cohort (mean age ranging from 60.4 years in Hispanics to 63.6 years in Asian and white women), the incidence of fractures exceeded the combined incidence for CVD, stroke, and invasive breast cancer, by 1–1.2 folds in all ethnic groups, except for African-Americans [10]. Similarly, in another retrospective cohort study conducted in the USA, osteoporotic fractures accounted for 39% of hospitalization in women > 55 years as compared to MI (28%), stroke (27%), or breast cancer (6%) [47].

Table 2 Incidence rates and risk ratios of MOF over other NCDs (hip fractures and the five most common cancers) in Lebanese women ≥50 years

	IR (per 100,000)	RR	95% CI
2012–2017			
MOF	546.9	1.0	–
Hip fracture	156.1	3.5	[3.4–3.7]
Breast	341.0	1.6	[1.55–1.7]
Lungs	73.6	7.4	[7.0–7.9]
Colon	67.4	8.1	[7.6–8.7]
Ovarian	55.1	9.9	[9.3–10.7]
Non-Hodgkin's lymphoma	24.3	22.5	[20.3–25.0]

CI confidence Interval, *IR* incidence rate, *MOF* major osteoporotic fractures, *RR* risk ratio

This study has several limitations. We used Lebanese vital statistics from 2007, which may have changed over time. Such statistics are however the only ones available In Lebanon and are still currently used by public health officials. Importantly, despite the rising number of refugees in this country, the databases only included Lebanese nationals. Because of the scarcity of national comprehensive NCD registries, we resorted to estimating prevalence and incidence rates using different databases and thus heterogeneous outcomes and may thus suffer from inherent selection biases. Prevalence estimates for osteoporosis and other NCDs were derived from a population-based study and lacked cancer prevalence data, while incidence estimates were derived from the national Lebanese registry for cancers and hip fractures but lacked other NCD incidence rates estimates. Prevalence rates estimates for several NCDs were only available on a subset of subjects who were younger and had higher BMD. This could have resulted in lower rate ratio estimates. Conversely, higher rate ratios could result from underreporting of NCDs by study subjects due to disease denial. We however think this latter possibility is unlikely because the prevalence of NCDs we report is highly concordant with another highly quoted population-based study [36]. We calculated total hip and femoral neck T-scores in Lebanese population based on the female NHANES Western population. However, this practice is widely used and is recommended by the IOF and ISCD [18, 19]. In addition, it was previously shown that fracture risk estimates derived based on BMD were comparable between the local Lebanese population and the universal NHANES population [48]. In fact, for each SD decrease in BMD, the fracture risk increased by approximately 2 folds in both populations [48]. We assumed that the MOF/hip fracture IRRs in Lebanon are the same as the Swedish population, an assumption that is applied worldwide to derive country-specific FRAX calculators [26–28]. This assumption is not tested in this region and could introduce bias in the MOF estimates. However, the hip fracture incidence is solid. For women subjects above the age of 65 years, the MOF/hip fractures ratios were higher or comparable when derived from data in UK, Canada,

Switzerland, and Japan compared to rates from Malmo Sweden [28]. Based on such published data, using MOF/hip fracture ratio from Sweden would not inflate our derived MOF estimates. Therefore, our finding that the incidence of MOFs is more common than cancer incidence rates remains probable [28]. For incidence rates of hip fractures and cancer, we extracted data from two national registries based on the same uninsured female population that constitute 52% of the general Lebanese female population. We reported cancer incidence rates in women from the MOPH population, but were unable to do the same for men as outlined under the "Methods" section. The rates in MOPH uninsured female population were comparable to those reported by the MOPH in the general Lebanese population of women above the age of 50 years [15]. The uninsured MOPH population tends to have lower socioeconomic status (SES) and thus have less access to health care and screening [49]. Such individuals are also more likely to be obese, smokers, and have lower physical activity compared to individuals with higher socioeconomic status [50]. These factors increase the risk of developing all comorbidities of interest including diabetes, cancer, and fractures. Therefore, we would anticipate low SES to affect all health outcomes of interest in this study in a similar qualitative and possibly quantitative way. More importantly, SES would also affect absolute prevalence and incidence rates, but presumably not the rank order of disease burden between the various NCDs of interest. Administrative registries are liable to possible entry errors and duplications. However, we collected the data similarly for both registries, the same methodological drawbacks would apply, but they should not affect comparisons and ratios derived. Therefore, the main conclusion, osteoporosis is a common disease if not more common than other feared NCDs remains valid. Such recognition would be a step forward to closing the care gap from this silent but devastating disease.

The strengths of this study lie in its novelty for such data in the region, its innovative approach to assess the burden of osteoporosis using both prevalence and incidence rates, and the use of population-based studies and registries spanning a robust time span of 6 years. The use of the same MOPH-based registries for hip fracture and cancer incidence insure internal consistency. Our investigation underscores the substantial burden from osteoporosis compared to other NCDs in the region. This calls for action to increase awareness of the public and professionals alike and to allocate public health resources towards its identification, prevention, and treatment.

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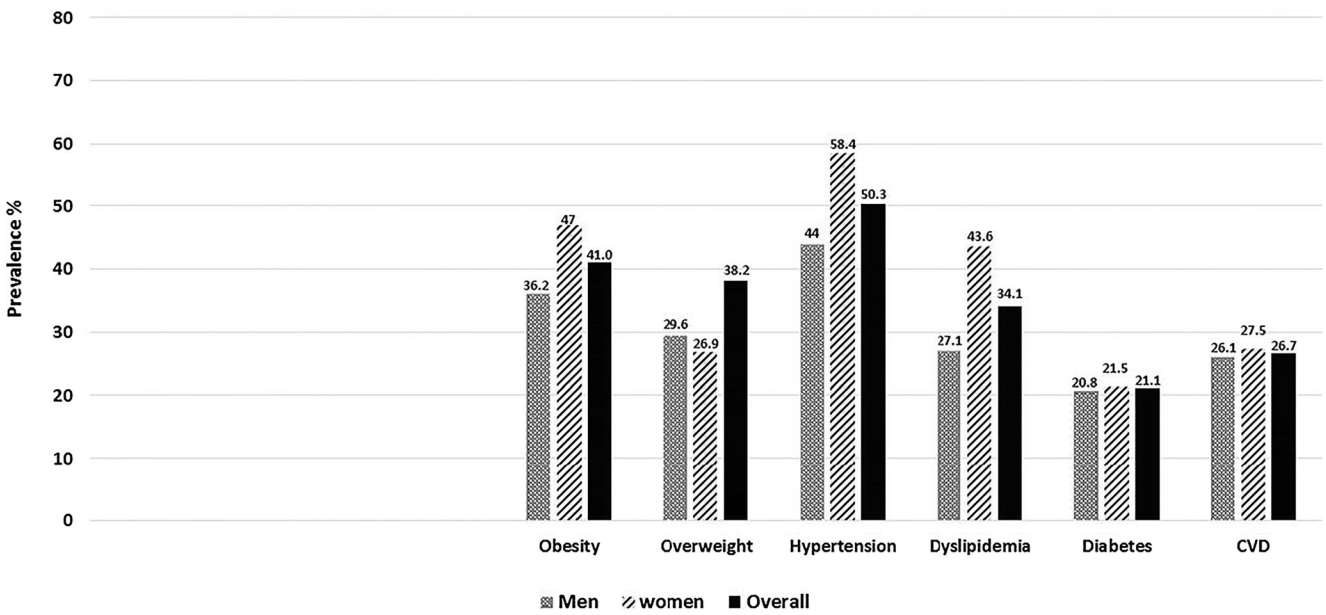
Compliance with ethical standards

Conflict of interest Conflicts of interest None.

Appendix



Prevalence of non-communicable diseases among 356 elderly (≥ 60 years) in Lebanon overall and by gender (adapted from Sibai et al. [36]).

Obesity: BMI ≥ 30 kg/ m^2, overweight: 25 ≥ BMI <30 kg/m^2.

Hypertension: blood pressure ≥ 140/90 mmHg.

Dyslipidemia, diabetes, and cardiovascular diseases (CVD) were self-reported.

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