

A call to action for osteoporosis research in sub-saharan Africa

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Ghana Med J 2020; 54(1): 58-67 DOI: <http://dx.doi.org/10.4314/gmj.v54i1.9>

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Conflict of interest: None declared

SUMMARY

Data abounds on osteoporosis in developed countries unlike developing countries, particularly those in sub-Saharan Africa. This review was done to confirm the paucity of data the authors suspected and to encourage studies in this field. AJOL (African Journals Online), MEDLINE and EMBASE databases were searched for studies published from January 1980 to August 2018. The eligibility criteria for inclusion were observational studies evaluating osteoporosis prevalence or incidence rates of fragility fractures. Out of 1,170 articles identified, six met the eligibility criteria. Prevalence of osteoporosis ranged from 18.2% to 65.8% across a heterogenous at-risk population. Bone mineral density assessment was limited by the measurement method, with most studies using quantitative ultrasound instead of standard bone densitometry.

From the available studies, the prevalence of osteoporosis and fragility fracture incidence may not be low in Sub-Saharan Africa; what is, however, evident is the paucity of good quality data from this region. Considering an expected aging population in sub-Saharan Africa, future research should be encouraged and aimed at clarifying the burden of this non-communicable disease. This will guide healthcare policy in this medically underserved part of Africa.

Keywords: osteoporosis, incidence, prevalence, hip fracture, fragility fracture

Funding: None declared

INTRODUCTION

Osteoporosis is defined as a disease characterized by low bone mass and micro-architectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk.¹ Before the widespread use of bone densitometry, fragility fractures were attributed to aging. Bone densitometry based on single bone mineral density measurements has resulted in an increased prevalence and subsequent treatment of this silent condition.²

Hip fractures, which represent a major contributing factor to the morbidity and mortality of osteoporosis, are projected to increase from 1.66 million in 1990 to 6.26 million by 2050.³ Osteoporosis has for decades been assumed to be rare in sub-Saharan Africa.^{4,5} This low fracture risk has been attributed to a multitude of reasons including but not limited to low life expectancy and relatively high levels of physical activity in sub-Saharan Africans.^{6,7}

This study aims to review published research on osteoporosis and fragility fracture prevalence in sub-Saharan Africa, excluding South Africa. We selected this region due to the similarities in healthcare inequality among individual countries, compared to the rest of Africa. A WHO report showed that the lowest overall efficiency of health expenditure per capita was in Sub-Saharan Africa. This region had the lowest health resource inputs as well, compared to the rest of the world.⁸

We anticipate a lack of research from this part of Africa, and hope to sensitize policymakers, stakeholders and development partners about this silent non-communicable disease. It is increasingly becoming evident that risk assessment tools like the FRAX (Fracture Risk Assessment Tool) score should be standardized based on regional epidemiologic data.⁹ Assumptions about fracture risks which are not based on findings from locally derived comparative cohorts lends itself to misinterpretation.

METHODS

The review was done in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis) guidelines.¹⁰ We did not seek ethical clearance before carrying out this review since it involved previously published studies. We defined the burden of osteoporosis based on prevalence rates of osteoporosis and fragility fracture incidence in the study region.

The working definition of osteoporosis was based on the World Health Organization (WHO) diagnostic criteria - Bone Mineral Density (BMD) measured at the lumbar spine, femur neck or total hip that falls 2.5 Standard Deviations (SD) below the mean for healthy young adults of the same sex.¹¹ Fragility fracture was defined as a fracture sustained after low-level trauma, equivalent to falling from a standing height or less.¹² Fragility fracture assessment was restricted to hip-specific fragility fractures. A protocol was not registered before this study was undertaken.

We conducted electronic searches on AJOL, OVID MEDLINE and EMBASE to identify studies on the prevalence of osteoporosis and fragility fracture incidence in sub-Saharan Africa. We determined the burden of disease by searching for the following terms, 'osteoporosis', 'postmenopausal osteoporosis', 'low bone density', 'prevalence', 'prevalence rates', 'incidence', 'incidence rates' and 'epidemiology'. Additional search terms were 'hip fractures', 'osteoporotic fractures', 'fragility fracture' and 'femoral neck fractures'. This was restricted to publications in the English language. Review articles and the references of included articles were explored for potential studies not identified in our initial search. References to abstracts at national and international meetings were reviewed as well.

The following search strategy was performed on AJOL, EMBASE and OVID MEDLINE as an example:

1. "osteoporosis":ti,ab OR "post-menopausal osteoporosis":ti,ab
2. "fracture": ti,ab OR "vertebral deformity":ti,ab
3. "incidence" OR "prevalence" OR "cohort" OR "longitudinal" OR "prospective" OR "observational stud*"
4. "Africa": ti,ab OR "Sub-Saharan Africa":ti,ab

Inclusion criteria

1. Study population: Included subjects aged > 50 years. Studies conducted in clinical settings

restricted to a well-defined target population in sub-Saharan Africa, excluding South Africa.

2. Study design: observational studies or randomized control trials.
3. Study period: A period spanning January 1980 to August 2018.
4. Study outcomes: Studies measuring the prevalence of osteoporosis and incidence rates of hip fractures (or other fragility fractures).

Exclusion Criteria

1. Studies carried out in populations with specific medical comorbidities as a way of elucidating osteoporosis prevalence or fragility fracture risk in those subgroups were excluded. Studies involving study populations with connective tissue diseases, infectious diseases, metabolic diseases, endocrinological conditions, gastrointestinal disease, nutritional or hematological diseases were excluded.
2. Case series and case reports were excluded.
3. Studies evaluating the prevalence of osteoporosis with less than 150 participants were excluded.
4. Studies evaluating the incidence of hip fractures or fragility fractures, which did not provide age and sex-matched estimates based on local census data were excluded.
5. Reported fragility fractures without a clear ascertainment of the mechanism of injury.

Data collection process

Two investigators (YA and AQ) independently extracted data using prespecified data collection criteria. Uncertainties about study eligibility were resolved by consensus. We collected the following from selected studies: country of study, year of publication, first author, sample size, size of the target population (if available), type of equipment used in BMD (Bone Mineral Density) estimation, the prevalence of osteoporosis and incidence of fragility fractures (where applicable)

Quality assessment

Since all the studies reviewed were observational, we applied the Modified Newcastle-Ottawa Quality Assessment Scale in selecting studies. These study selection criteria have been described elsewhere.¹³ In addition, due to the anticipated lack of publications in this unique region of Africa, unless there were obvious major methodological flaws, studies of fair quality were selected for final review.

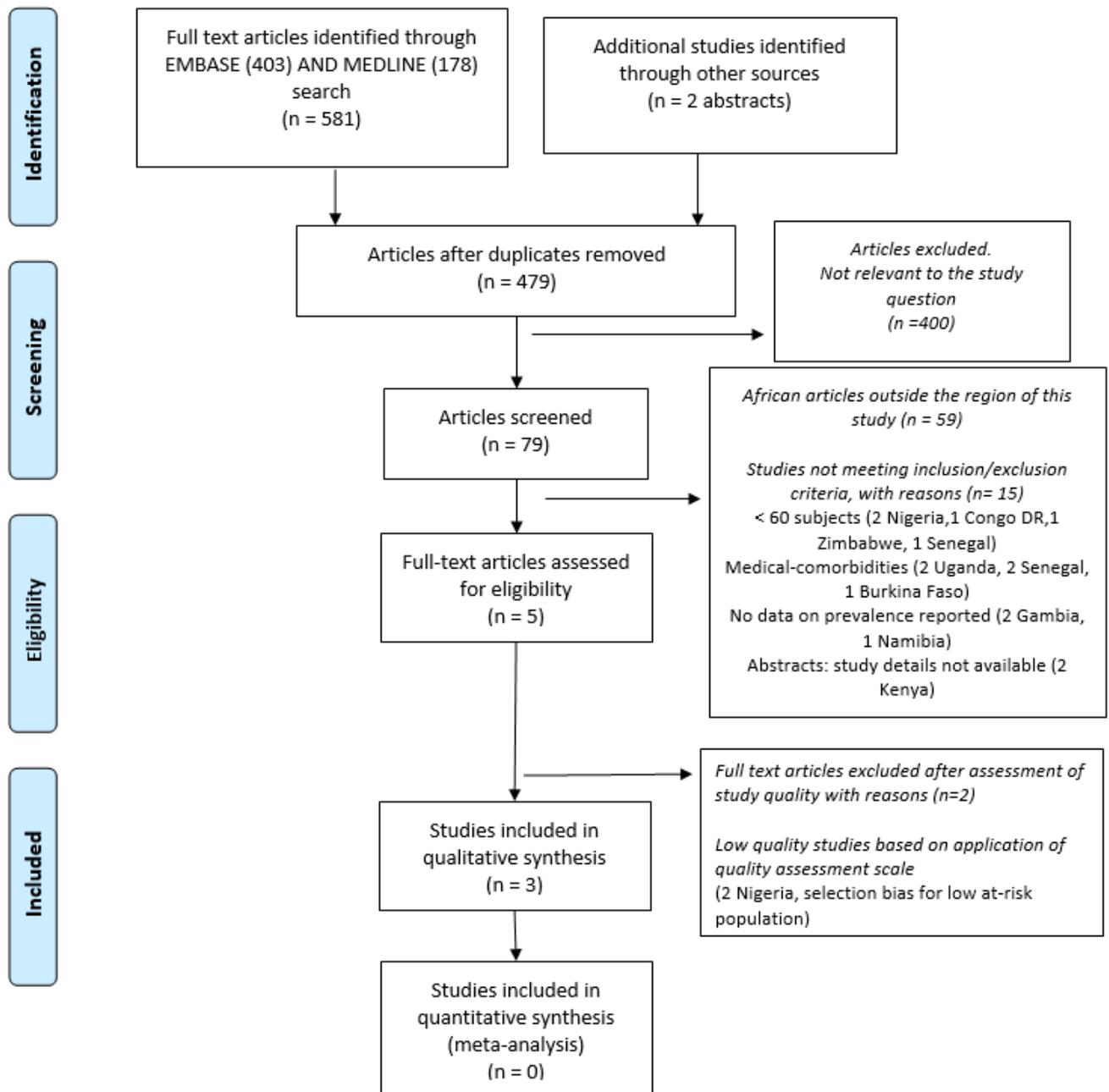


Figure 1 Evaluation of the prevalence of osteoporosis in Sub-Saharan Africa

Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

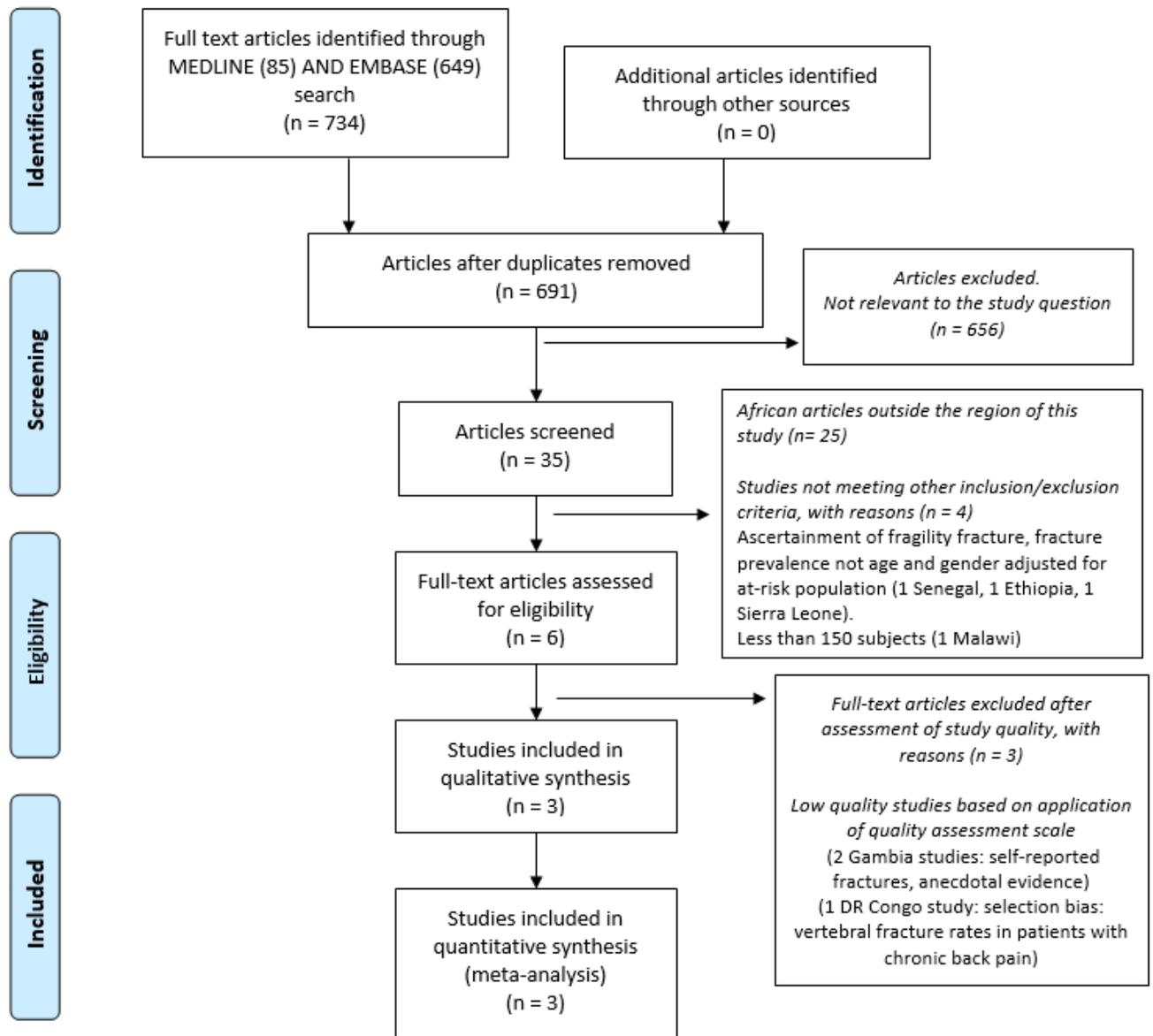


Figure 2 Evaluation of the incidence of hip-specific fragility fractures in Sub-Saharan Africa

Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

RESULTS

The lack of publications of osteoporosis research in sub-Saharan Africa was evident during our extensive literature search. Studies were carried out mainly in The Gambia, Nigeria, Kenya, and Cameroon. Most of the studies were observational and involved single healthcare facilities. There was wide variability in study quality.

Bone mineral density was estimated using either a surrogate quantitative ultrasound or a formal DEXA (Dual Energy X-ray Absorptiometry).

Point prevalence rates of osteoporosis in male and female subjects older than 60 years of age, was noted to be as high as 56.9% in a recent study in Nigeria. Prevalence of osteoporosis in women older than 60 years was reported as high as 65.8%.¹⁴

Table 1 Studies measuring prevalence of osteoporosis by Country

Authors and Date of publication	Country	Type of study	Study Population	Outcome measures	Study limitations
Vanderjagt et al (2001)	Nigeria	Observational, cross sectional	218 women (16-95 years) attending an outpatient clinic.	Quantitative ultrasound used to measure BMD. 18.2% of post-menopausal subjects had T-scores less than -2.5SD	Single-center study. Low at-risk population was included.
Sinwe-Ngandeu et al (2008)	Cameroon	Observational, cross sectional	367 women (20-89 years).	BMD estimates by quantitative ultrasound. In women 70 years and older, 55.8 % had osteoporosis. Women > 50years (17.9% had osteoporosis)	Observational (risk of selection bias). Low at-risk population was included.
Alonge et al (2017)	Nigeria	Observational, cross sectional	2401 consecutive subjects (60 years and older) attending an outpatient clinic.	BMD was estimated by DEXA. Point prevalence of osteoporosis was estimated as 56.9% for both men and women. (65.8% for women)	Observational study (risk of selection bias) single center study

N/A Not available

This was based on interpretation of T scores, as stipulated in the WHO working definition for osteoporosis.¹⁵ Dual Energy X-ray Absorptiometry was used in determining BMD in this study.

Two other studies were significant for prevalence rates of osteoporosis, ranging from 18.2% to 55.8% in post-menopausal women. BMD in both studies was determined by quantitative ultrasound.^{16,17}

Table 2 Studies estimating fragility fracture incidence by country

Study	Country	Study Design and objectives	Study Population	Outcome measures	Study limitations
Adebajo et al (1991)	Nigeria	Observational, retrospective registry review.	746,700 people in Ibadan, Nigeria >50 years of age.	Age and sex specific incidence rates (hip and distal forearms) of 2.0 to 2.1 per 100,000 per year in Nigerian females and males aged 65-74 years respectively.	Single tertiary referral center
Zebaze et al (2003)	Cameroon	Observational, retrospective incidence of fragility fractures (both hip and wrist fractures).	513 subjects aged >35 years, who sustained both high and low energy trauma fractures	For men and women between 50-64years, the incidence of hip fractures due to low energy trauma were 20.7 and 24.4 per 100,000 persons per year.	Incomplete medical records (17.2% of cases with inadequate documentation)
Ekezie et al (2011)	Nigeria	Observational, retrospective	38,591 people >50 years of age.	Age and sex-specific incidence of hip fractures of 10 and 17.38 per 100,000 per year in men and women respectively	3 hospitals within the same local area Underreporting due to some patients seeking treatment from non-traditional health workers

Aspray et al. reported a rare incidence of fractures in 1996 after examining mainly anecdotal evidence in The Gambia.⁵ [Insert citation] The incidence rate of fragility fractures, age, and sex-adjusted for the population at-risk was however not provided. An earlier study from Nigeria showed that among subjects 65-74 years of age, age and sex-specific incidence rates of hip fractures were noted to be low as 2.0 and 2.1 per 100,000 per year in women and men respectively. The at-risk population was identified in a large metropolitan area of 746,700 people.¹⁸ A more recent study in Nigeria by Ekezie et al, reported much higher age and gender-specific incidence rates of hip fractures in subjects older than 50 years of age i.e., 10

and 17.38 per 100,000 per year among men and women respectively.¹⁹ Another study from Cameroon reported a significantly higher incidence rate of hip fractures in subjects older than 50 years, it was however limited by lack of complete medical records in the selected cohort.²⁰

The incidence rates of all fractures amongst subjects older than 50 years were widely variable across the 3 selected cohorts. It ranged from 0.67 to 19.99 per 100,000 persons per year. The estimates of hip-specific fragility fractures were higher amongst women compared to men.

DISCUSSION

The burden of osteoporosis in sub-Saharan Africa

Prevalence of osteoporosis ranged from 18.2% to 65.8% across a heterogeneous at-risk population. The wide variability in osteoporosis prevalence may have been due to inherent biases in study design. The methods of measuring bone mineral density varied across studies with most using quantitative ultrasonography of peripheral sites. DEXA studies were seldom used in assessing osteoporosis prevalence, probably due to the lack of bone densitometry machines and the prohibitive cost even when available in this part of Africa.

Prevalence of osteoporosis was neither age nor gender-adjusted for the population at-risk. Studies were carried out in hospital-based settings, thus increasing the likelihood of selection bias. Indeed, none of the studies selected for final review were adequately powered to detect the prevalence of osteoporosis. Hip fractures account for less than a 5th of all osteoporotic fractures worldwide but contribute significantly to the mortality associated with osteoporosis in people older than 50 years of age. A systematic review from 2012 reported a low hip-specific fragility fracture rate of 2 per 100,000 per year in sub-Saharan Africans older than 50 years.²¹ This was most likely an underestimation of the actual fracture risk since a single study from this region was included in the review. Our pooled incidence rate of hip-specific fragility fractures amongst subjects older than 50 years was 13.89 per 100,000 per year (95% CI, 11.01 - 17.52). Despite the limitation of low-quality studies published in our sub-region, more recent evidence lends credence to the fact that osteoporosis-related fractures may have been underestimated in the past.

We identified a higher incidence of fragility fractures in sub-Saharan Africa than has been previously assumed. It is unclear if this is due to changing sociodemographic factors such as increased life expectancy. This conclusion has been extrapolated from a few studies in mainly single healthcare facilities and may not reflect true incidence in the population at risk.

All included studies estimating fragility fracture incidence were limited by ascertainment bias. It is conceivable that some patients presented to “traditional bone-setters” instead of hospitals, after sustaining a fragility fracture.

Paucity of osteoporosis research

Prevalence of osteoporosis and its related fractures has for many years been deemed to be relatively low in black Africans. Studies from 3 decades ago reported a low fracture prevalence in sub-Saharan Africans, though objective data was lacking.^{22,23}

A recent study investigating the prevalence of hip fractures amongst black South Africans showed an age-adjusted hip fracture rate of 69.2 per 100,000 per annum and 73.1 per 100,000 per annum for women and men, respectively.²⁴ This evidence challenges the long-held view that osteoporosis-related fractures are rare in blacks.

Most of the research on osteoporosis prevalence and fragility fracture incidence is limited to North and South Africa. In addition, national osteoporosis treatment guidelines have been published in Tunisia, Libya, Egypt, Morocco, and South Africa.^{25,26} Indeed none of the countries in sub-Saharan Africa, excluding South Africa have a national guideline on the management of osteoporosis.

Challenges of previous studies

The significant variation in fracture incidence rates across various periods and countries could be due to multiple sources of measurement error. First, selected hospital-based sample populations may not be representative of the catchment population. As has been pointed out by previous authors, there was a challenge in the ascertainment of all cases of fragility fracture. This could be due to poor access to healthcare for the at-risk population. Widespread use of quantitative ultrasound of peripheral sites in estimating BMD, instead of standard DEXA may have introduced errors in the estimation of osteoporosis prevalence.

Framework for filling the gaps in knowledge

We propose prospective observational studies involving multiple tertiary referral centers for each country-specific region to estimate the incidence of fragility fractures. Incidence rates of fragility fractures should be age and gender-adjusted based on local census data. Risk assessment tools, e.g., FRAX for individual countries, can subsequently be tailored to fragility fracture and osteoporosis prevalence rates. This will allow appropriate identification of patients with osteopenia or osteoporosis, who might benefit from anti-resorptive therapy.

We propose well-powered cross-sectional observational studies in either hospital or community-based settings, to better characterize the prevalence of osteoporosis in this region. The method of estimating BMD should be based on cost and feasibility at the study site. A meta-analysis in 2005 questioned the accuracy of quantitative ultrasound in identifying patients with osteoporosis.²⁷

The study was, however, limited by a small number of included studies and marked study heterogeneity.

As has been pointed out by previous authors, quantitative ultrasound is comparable to DEXA in terms of determining BMD.^{28,29,30}

The scarcity of DEXA machines in sub-Saharan Africa and the prohibitive cost of bone densitometry remains a challenge, in terms of facilitating future research. Quantitative ultrasound machines may, therefore, be more practical in sub-Saharan Africa due to their portability and relative inexpensiveness compared to DEXA or quantitative computed tomography.

Research about the determinants of bone health and fracture risk should not be emphasized at this time, in the absence of relevant fragility fracture and osteoporosis prevalence data. Our literature search confirmed our suspicion about the lack of osteoporosis research in Sub-Saharan Africa, excluding South Africa. The presumed low prevalence of osteoporosis in this region of Africa compared to the rest of the world would need to be investigated further.

Study limitations

This review was limited by the lack of high-quality studies from the region under study. Use of quantitative ultrasound instead of formal bone densitometry could have led to measurement errors. We limited our review to publications in the English language, and due to the significant number of Francophone countries in this part of Africa, it is conceivable that other important studies may have been excluded. In addition, other databases including African Index Medicus and Scopus were not included in our search.

CONCLUSION

Without relevant data on fragility fracture rates, application of current international screening recommendations in sub-Saharan Africa may be difficult to justify to healthcare managers and policy makers. With an increasing life expectancy, Africa is facing a new battle with noncommunicable diseases.³¹ The challenges of managing chronic health conditions in an aging population should, therefore, be expected. Healthcare systems have scarce resources and as such widespread screening recommendations for osteoporosis should be guided by locally-derived data.

ACKNOWLEDGEMENT

We would like to thank Professor Andrea Manni of the Division of Endocrinology, Diabetes, and Metabolism (Penn State Medical Center) for his timely suggestions during various phases of preparation of this manuscript.

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APPENDIX

Appendix 1 An assessment of study quality

Modified Newcastle-Ottawa Quality Assessment Scale (Adapted for cross sectional studies)

CRITERIA	OPTIONS	SCORE
Representativeness of the sample	a) Truly representative of the average in the target population. * (all subjects or random sampling) b) Somewhat representative of the average in the target population. * (non-random sampling) c) Selected group of users. d) No description of the sampling strategy.	
Sample Size	a) Justified and satisfactory. * b) Not justified.	
Non-respondents	a) Comparability between respondents and non-respondents characteristics is established, and the response rate is satisfactory. * b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory. c) No description of the response rate or the characteristics of the responders and the non-responders.	
Ascertainment of the exposure (risk factor)	a) Comparability between respondents and non-respondents characteristics is established, and the response rate is satisfactory. * b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory. c) No description of the response rate or the characteristics of the responders and the non-responders.	
Comparability	The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled. a) The study controls for the most important factor (select one). * b) The study control for any additional factor. *	
Assessment of the outcome	a) Independent blind assessment. ** b) Record linkage. ** c) Self report. * d) No description.	
Statistical Test	a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value). * b) The statistical test is not appropriate, not described or incomplete.	

Appendix 2 Summary of hip-specific fragility fractures in women and men older than 50 years.

Study	Gender	Number	Number of fractures	Incidence rate per 100,000 p.y	95% CI
Zebaze et al (2003)	Male	81,320	14	17.24	(9.42 - 28.92)
	Female	93,825	21	22.39	(13.00 - 32.10)
	Total	175,145	35	19.99	(13.92 - 27.80)
Ekezie et al (2011)	Male	17,220	12	10	(5.68 - 17.61)
	Female	21,371	26	17.38	(11.83 - 25.53)
	Total	38,591	38	14.07	(10.24 - 19.82)
Adebajo et al (1991)	Male	385,200	3	0.79	(0.16 - 2.28)
	Female	361,500	2	0.55	(0.07 - 2.0)
	Total	746,700	5	0.67	(0.22 - 1.56)