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CLINICAL CASE REPORT

# Diagnosis of osteoporosis in rural Arctic Greenland: a clinical case using plain chest radiography for secondary prevention and consideration of tools for primary prevention in remote areas

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## ABSTRACT

**Context**: Osteoporosis is a frequent disease in many populations. The hallmark is fragility fractures, which are harbingers of future fractures, disability, mortality and cost on society. The occurrence increases with age, low vitamin D level and smoking. Smoking rates are high, vitamin D is low and life expectancy is rising steeply in Greenland, as is the need for focus on osteoporosis. We report a case that uses a simple and readily available tool to diagnose osteoporosis at the hospital in Sisimiut, a town of 5000 inhabitants on the west coast of Greenland.

**Issues**: A 51-year-old Inuit woman was seen due to lower back pain. No trauma could be recalled. Laboratory results showed a low vitamin D level and normal S-calcium, S-phosphate, S-parathyroid hormone, S-thyrotropin, erythrocyte sedimentation rate, S-creatinine and hemoglobin. The lateral chest radiograph demonstrated a reduction of anterior height of the seventh and ninth thoracic vertebral bodies of 50% and 40% respectively.

**Lessons learned**: Chest radiographs are frequently done in the towns along the vast coastline of Greenland, the world's largest island. They are transferred to the hospital in the capital city Nuuk using existing tele-technology, and specialist evaluations are given in electronic records available at the coastal hospitals. Effective therapies for osteoporosis are available and the identification of

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vertebral fractures that merit treatment may prevent future fractures, morbidity and mortality. Fragility fractures are frequent in old age and the steep rise in life expectancy and in the number of old people in Greenland emphasize the need for a focus on management of osteoporosis. Geography provides a diagnostic challenge to rural and remote areas that can be overcome by the use of lateral chest radiographs as it relies on facilities readily available. Clinical risk assessment tools with high specificity may support further osteoporosis risk prediction in remote Arctic societies.

**Key words:** age, chest radiographs, chronic disease, developing society, fragility fracture, Greenland, risk factor.

## Context

Osteoporosis is a chronic disorder characterized by loss of bone mass and deterioration of bone micro-architecture[1]. The result is in an increased skeletal fragility and increased susceptibility to fracture[1]. Osteoporotic fractures are associated with pain, decreased quality of life, disability, hospital and nursing home admissions and premature death. Also, they are an economic burden on the healthcare system[1,2]. Thus, the diagnosis of osteoporosis is important to promote treatment.

Osteoporosis is common in ageing populations and age is a dominating risk factor[1,3,4]. Life expectancy is rising rapidly in Greenland and a focus on osteoporosis could be relevant as the disease is often overlooked even in societies characterized by frequent fragility fractures and high life expectancy[5]. This may be speculated to be even more relevant in societies with limited awareness of a disease that may be emerging.

The westernized lifestyle is gaining ground in Greenland and hence there is a decreasing intake of traditional food items, which also associates with a decrease in the intake of vitamin D[6,7]. As vitamin D is important for skeletal health this is likely to add to an increased risk of osteoporosis in the ageing population in Greenland.

Risk factors for osteoporosis are common in populations in Greenland[8] and it may be speculated that the rising number of ageing citizens, as well as the changing diet and limited sun exposure during winter[9], further increase the occurrence of osteoporosis among populations in Greenland and throughout the Arctic. This calls for a strategy to diagnose osteoporosis in the Arctic.

Osteoporosis may be diagnosed in two ways: by low bone mineral density (BMD) or by the occurrence of a fragility fracture. BMD is measured by dual energy X-ray absorptiometry (DXA). However, DXA is not available in Greenland. The occurrence of a fracture is assessed by radiographs. The most common fragility fracture is vertebral[10]. Vertebral fractures are visible on lateral chest radiographs, which may be used to diagnose osteoporosis[11-13] that merits treatment[1,2]. The present case from a small hospital on the west coast of Greenland illustrates a procedure for diagnosing osteoporosis outside the referral hospital in Greenland.

## Issues

A 51-year-old Greenlandic woman attended the outpatient clinic at the local hospital in Sisimiut, Greenland, due to lower back pain. The back pain had persisted for months. No trauma could be recalled and the patient had not carried any heavy weight. On the physical examination the patient had normal gait, no neurological deficits and normal muscle strength. Laboratory results showed a low vitamin D level (P-25-OH-vitamin D 28 nM, reference >50 nM) but normal total S-calcium level (2.40 mM, reference 2.2–2.7 mM), S-calcium$^{++}$ (1.26 mM, reference 1.17–1.34 mM), S-phosphate (1.2 mM, reference 0.8–1.5 mM), S-parathyroid hormone 1-84 (2.6 pM, reference 0.3–14.6 pM), S-

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thyrotropin (0.67 miu/L, reference 0.4–3.8 miu/L), erythrocyte sedimentation rate (7 mm, reference <30 mm), S-creatinine (73 µM, reference 44–114 µM) and hemoglobin (9.0 mM, reference 7.0–9.4 mM). A radiograph of the lumbar spine showed severe spondyloarthrosis and slight scoliosis but all vertebrae were of normal height and without fractures. A chest radiograph was taken (Fig1), which demonstrated compression fractures of the seventh and ninth thoracic vertebrae with a reduction of anterior height of the vertebral bodies of 50% and 40% respectively. The patient's risk factors for osteoporosis are listed in Table 1 along with a line-up of the risk factors included in the *QFracture* algorithm and in the FRAX fracture risk calculator. Dual energy X-ray absorptiometry for measurement of bone density is not available in Greenland.

The patient was thus diagnosed with osteoporosis based on the two vertebral compression fractures without trauma. The patient had an insufficient vitamin D level. Treatment with vitamin D was recommended followed by an oral anti-resorptive drug once weekly.

# Lessons learned

The patient presented here illustrates a case of vertebral fractures without trauma and hence osteoporotic fractures. Vertebral fractures associate with a rise in the occurrence of future fractures, acute and chronic pain, deformity, disability, decreased quality of life and a markedly increased risk of premature death[1,2]. It is thus a serious condition that mandates aggressive treatment[1,2]. However, detection and diagnosis depend on a dedicated diagnostic protocol and focus among healthcare providers. The case presented here illustrates a simple diagnostic tool for osteoporosis that is feasible in remote towns in Greenland and may be used elsewhere in rural and remote areas.

Osteoporosis may be common in Greenland. Sørensen et al[11] found that vertebral fractures were very frequent from an evaluation of all lateral chest radiographs performed over a period of 3 months at Greenland's referral hospital in the capital city, Nuuk. This is in keeping with frequent occurrence of radiographically diagnosed fractures at osteoporotic sites without trauma reported in a questionnaire survey in Greenland[8]. These reports support the emergence of osteoporosis in Greenland. In addition, low treatment frequency for osteoporosis was concluded from the evaluation of dispensing records from the National Pharmacy in Greenland[11]. Hence, Sørensen et al demonstrated the usefulness of the readily available lateral chest radiograph to diagnose vertebral fractures that merit treatment, and illustrated a striking contrast between a low treatment frequency for osteoporosis in Greenland and the high frequency of fractures at a single osteoporotic site[11]. This supports the need for a focus on diagnosis of osteoporosis and on the treatment of osteoporosis among the ageing population in Greenland.

The identification of patients at high risk of fragility fractures has become a major topic globally in order to support primary prevention (ie prevent fractures), as effective and cheap therapies are available[1,2]. A number of tools have been developed to predict the risk of fragility fractures. Most of these rely on the assessment of risk factors with or without measurement of BMD (Table 1). Measurement of BMD by DXA may increase the sensitivity of these tools. However, around one in three people with risk factors for osteoporosis and a low BMD suggesting osteoporosis by DXA do not have an osteoporotic fracture at old age[5], and one in five with fragility fractures have non-osteoporotic BMD values[5]. Thus, the added value of DXA is debated. The risk of fragility fractures may be assessed from clinical risk factors for osteoporosis and BMD.

Age is a dominating risk factor for osteoporosis in other populations[1,3,4]. Greenland is a developing society, and life expectancy and the number of older people is rising steeply. It may be hypothesized that this will increase the occurrence of fragility fractures in Greenland. This is supported by the finding that age associates with an increased occurrence of vertebral fractures in Greenland. This is illustrated in Figure 2, which is based on data from the study by Sørensen et al[11] and further supported by the data by Jakobsen et al[8]. Hence, the increase in life expectancy in the developing society warrants a focus on osteoporosis.

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**Table 1: Risk factors for osteoporosis in the patient and whether they are included in two commonly used osteoporosis risk assessment tools, FRAX and *QFracture***

| Risk factor | Case descriptive | *QFracture* | FRAX |
|---|---|---|---|
| Age (years) | 51 | 51 | 51 |
| Gender | Female | Yes | Yes |
| Ethnicity | Inuit | – | – |
| Body mass index (kg/m$^2$) | 19.9 | – | – |
| Current smoker | Yes | Yes | Yes |
| Excessive alcohol consumption[†] | No | – | – |
| Limited dairy products | No | | |
| Limited sun exposure | (No)[¶] | | |
| Physical inactivity | No | | |
| History of falls | No | – | |
| Previous fragility fracture | No | – | – |
| Age at menopause (years) | 49 | | |
| Hormone replacement therapy | Never | – | |
| Glucocorticoid use | Never | – | – |
| Tricyclic antidepressants | Never | – | |
| Parental hip fracture | Yes | Yes | Yes |
| Epilepsy or taking anticonvulsants | No | – | |
| Secondary osteoporosis | No | – | – |
| Asthma | No | – | |
| Endocrine disorder[§] | No | – | |
| Diabetes | No | – | |
| Chronic liver disease | No | – | |
| Chronic kidney disease | No | – | |
| Rheumatoid arthritis | No | – | – |
| Cardiovascular disease | No | – | |
| Stroke | No | – | |
| Gastrointestinal malabsorption[‡] | No | – | |
| Dementia | No | – | |
| Cancer | No | – | |
| Parkinson's disease | No | – | |
| Bone mineral density | Not applicable | | – |
| Calculated 10-year risk of any fragility fracture (%) | | 4.6% | 23.5% |
| Calculated 10-year risk of hip fracture (%) | | 0.6% | 5.9% |

[†] ≥3 units/day
[¶] Some sun exposure is still said to be likely, even above the Arctic Circle (ref. 9)
[§] Thyrotoxicosis, hyperparathyroidism, Cushing's syndrome
[‡] Crohn's disease, ulcerative colitis, coeliac disease, steatorrhea, blind loop syndrome
–, risk factor absent in individual

Low levels of vitamin D are associated with an increased risk of fragility fractures[14]. The traditional Inuit diet is of marine origin, rich in vitamin D, and the intake is associated with levels of vitamin D in populations in Greenland[6,7]. A diet based on westernized food items is advancing in Greenland and this may be a harbinger of low vitamin D levels in the population[6,7]. In addition, limited sun exposure with the westernized lifestyle in the Arctic might add to the risk of vitamin D insufficiency[9]. The reduced intake of vitamin D from the diet and from sun exposure may be hypothesized to further increase the risk of osteoporosis in populations in Greenland.

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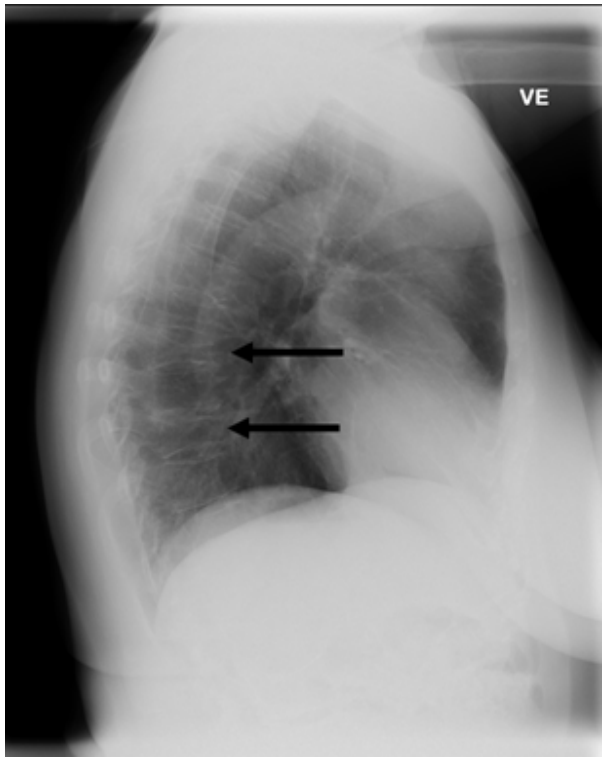


**Figure 1: Lateral chest radiograph taken at Sisimiut Hospital on the west coast of Greenland in a patient with back pain but no trauma. It illustrates two vertebral fractures that are diagnostic of osteoporosis in the patient. Risk factors for osteoporosis included smoking, parental hip fracture and female gender. Vitamin D level was in the range of insufficiency (28 nmol/L) but sedimentation rate was normal, and serum calcium, alkaline phosphatase and parathyroid hormone were within the reference ranges.**

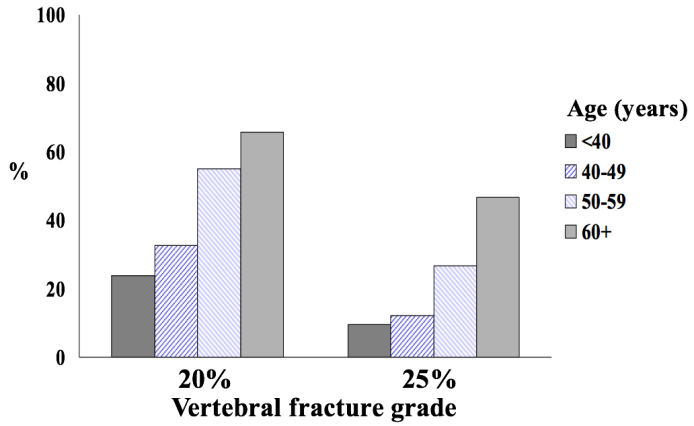


**Figure 2: Occurrence of vertebral fractures increased with age ($p$<0.001). (Data from the study by Sørensen et al[11])**

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Ethnicity may influence the risk of osteoporosis. The risk is influenced by ethnic origins such as Indian, Pakistani, Bangladeshi, other Asian, black African, black Caribbean and Chinese. However, it remains unsettled whether Inuit ethnicity is of importance for the risk of osteoporosis. There is some indication that the accumulation of risk factors, known to influence the risk of fractures in other populations, increases the risk of fracture in populations in Nuuk in Greenland[8]. However, these data are from a questionnaire survey and they need confirmation. Furthermore, the genetic admixture may complicate the discrimination of genetically distinct ethnic groups. Yet, the importance of ethnicity is upheld in osteoporosis risk evaluation by, for example, the *QFracture* algorithm[15] and should be considered in Greenland.

Smoking is an established risk factor for osteoporosis[4,15,16]. Smoking has a high prevalence among populations in Greenland[17] and it adds to the risk of osteoporosis. Additional Arctic risk factors included are the increased risk of falling during the Arctic winter and the frequent occurrence of type 2 diabetes in Greenland[18] as diabetes markedly increases bone fragility[19]. These frequent risk factors add to the need for a focus on osteoporosis in Greenland.

A gap was described in the occurrence and management of osteoporosis between urban and rural areas in Canada[20], with lower health resource utilization rates in small towns and rural areas that was associated with the frequency of fragility fractures[20]. This needs to be addressed, and our case supports focus on management of osteoporosis using existing electronic facilities. Such facilities could be linked to and supported by an electronic consult program such as has been shown recently to improve osteoporosis evaluation and treatment frequency in rural and remote areas[21]. This should not stand alone, and educational programs[22] as well as preventive measures that are likely to reduce the occurrence of fragility fractures[23] may support recognition of symptoms and focus on management of emerging chronic diseases such as osteoporosis.

The case presented here was from the west coast of Greenland. The patient presented at the local hospital with back pain. Clinical risk factors for osteoporosis included current smoking and a parental history of an osteoporotic fracture. On lateral chest radiograph she had two severe vertebral fractures. No relevant trauma could be recalled and she was diagnosed with osteoporosis based on two fragility fractures. This demonstrates the usefulness of a lateral chest radiograph for diagnosing osteoporosis in a remote town. The use of available lateral chest radiograph is a simple tool for diagnosing vertebral fractures and hence osteoporosis that should be treated[1,2].

Treatment should be initiated in all patients with an osteoporotic fracture as a secondary prophylactic measure because these fractures are harbingers of future fracture[24], pain, disability and premature death[1,2]. The detection of fragility fractures from radiographs is highly sensitive given a history that rules out trauma. The sensitivity for any osteoporotic fracture is limited by the area visible, but the lower thoracic spine is a main site for vertebral fractures[11,24], which supports the suggested focus on chest radiographs.

Radiographs are feasible in the absence of other testing. The radiation dose is markedly higher than that of DXA and it is thus unsuitable as an unrestricted screening tool. However, it is suggested to develop a tool to detect those at the highest risk for a targeted high-risk screening program. Existing tools such as FRAX, *QFracture* and others were developed to assess subjects for either screening with DXA for treatment or for plain treatment decisions[25,26]. In the evaluation of these tools, the aim has been a high sensitivity of around 90%. This was a trade-off causing a specificity reduced to around 40–50% for diagnosing osteoporosis by DXA or fracture[25,26]. The more simple screening tools suffice in this context[26], while evaluations are limited for assessment of osteoporosis fracture risk prediction models with a higher specificity. A tool with higher specificity should be evaluated for use in remote populations. This could be further assessed for the benefit of using radiographs for treatment decisions.

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Until an osteoporosis-specific tool has been validated for higher specificity, evaluation of lateral chest radiographs is a simple tool that may be applied throughout remote Arctic societies. The need for this is emphasized by the frequent occurrence of risk factors known to increase the risk of osteoporotic fractures among other populations. There is some indication that the same risk factors account for Inuit but this needs confirmation. If confirmed, a diagnostic protocol such as an Inuit version of FRAX or *QFracture* may guide diagnosis of osteoporosis among Inuit populations. This approach is appealing in rural and remote areas where DXA is unavailable or inaccessible, such as the sparsely populated Arctic.

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