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Long-term effects of a ten-year osteoporosis intervention program in a Swedish population—A cross-sectional study

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ABSTRACT

The aim of the study was to explore long-term effects seven years after the completion of a ten-year community-based osteoporosis intervention program in Vadstena, Sweden. The association between calcaneal bone mineral density and several life style factors, and the impact of risk factors for sustaining a fracture after the age of 50 were also studied. Previous participants in the intervention group, and matched subjects were invited to calcaneal bone mass measurement by a portable device including the dual X-ray and laser (DXL) technology by Calscan, and to complete a questionnaire in 2006. A total of 417 persons (63% of those invited) in the intervention (I) group, and 120 persons (47% of those invited) in the control (C) group participated. Mean age was 63 years (37–94 years). There was somewhat more knowledge of osteoporosis in the I-group (M = 18) than in the C-group (M = 17) ($p < 0.05$), and more use of shoe/cane spikes in elderly women in the I-group (67%) than in the C-group (40.5%). The fully adjusted model of logistic regression showed that participants with an osteoporotic DXL T-score (≤−2.5) had a 3-fold increased risk (95%CI 1.48–6.89) of having a history of a self-reported fracture after the age of fifty compared to women with a calcaneal T-score > −2.5. The long-term effects of a ten-year, community-based, osteoporosis intervention program on knowledge and behavior were modest seven years after its completion.

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1. Introduction

Osteoporosis and fragility fractures are major, worldwide health problems. Sweden has one of the highest incidences of osteoporotic fractures in the world (Kanis et al., 2002). Primary healthcare has the main responsibility for the prevention of osteoporosis and fragility fractures, as stated by WHO (Kanis and on behalf of the World Health Organization Scientific Group, 2007), and community-based intervention strategies are needed to address the problem. The lifetime risk for a hip, spine or forearm fracture at the age of 50 is estimated at 46% for women, and 22% for men, in Sweden (Kanis et al., 2001). The mean age of hip fracture is 80 years for women, and 76 years for men, in Sweden (Johnell and Kanis, 2005). The costs of hip fractures are high for the society and has been estimated at approximately US $21,000 for the first year (Hernlund et al., 2013). High morbidity and increased mortality after hip fracture have been seen in many studies. About 20–30% of hip fracture patients die during the first year after hip fracture (Kanis et al., 2003).

Low bone mineral density (BMD) is a strong risk factor for fractures. The T-score is defined by WHO as a BMD value, minus the mean value for a reference group of "young adult women", divided by the standard deviation (SD) for this reference group. A T-score measured by dual energy X-ray absorptiometry (DXA) equipment at the spine, hip or midradius sites, of not more than 1 SD below the mean value of peak bone mass in young adult women, is defined as normal. A T-score value greater than 1 SD below the young adult mean, but less than 2.5 SDs below this value, is defined as osteopenia, and a T-score of 2.5 SDs or more below the mean is defined as osteoporosis (Anon, 1994). Peripheral measurements of BMD are not recommended for diagnostic purposes (http://www.iscd.org/), but all measurements sites can be predictive of fractures, and may be used for risk estimation (Cummings et al., 1993; Brismar et al., 2010). Stationary DXA equipment, as well as the portable dual X-ray and laser (DXL) equipment, are used as tools for fracture risk estimation. BMD of the calcaneus, as measured by the DXL, has shown good predictive ability for hip fractures in a prospective study of Swedish women (Brismar et al., 2010). A recently published prospective study of hip fractures in

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elderly women that compared DXL scans of the calcaneus with DXA scans of the hip, including the FRAX tool (www.shef.ac.uk/FRAX), showed that BMD of the calcaneus had a fracture-predictive ability similar to BMD of the femoral neck, measured by DXA and FRAX (Lundin et al., 2015).

A ten-year community-based intervention program "the Vadstena Osteoporosis Prevention Project (VOPP)", was carried out in Vadstena community, Sweden 1989–1999. The health-education program addressed personnel working at schools, kindergartens, social welfare offices, nursing homes and municipal home-help service units, retired people's associations, study circles, sports clubs, grocery stores, larger companies and catering services. Collaboration was established with shops to encourage the use of good lighting, sturdy shoes, and spikes. Walking, weight-bearing and balance training groups were initiated. A gymnasium with sequence training equipment was expanded at the primary health care centre (PHCC). Checklists of environmental hazards for osteoporosis and falls were distributed via the pharmacy and the PHCC. The individual intervention comprised a personal letter to the participants in the intervention group and included a health profile and a note with specific advice about how to decrease possible risk behavior for osteoporosis. Individuals aged 65 years and over also received written advice concerning how to make their living environment safer (Waller et al., 1997, 2002; Grahn Kronhed et al., 2006, 2005). The ten-year intervention program showed no effect between the intervention and the control groups concerning knowledge of osteoporosis (27 questions) (Waller et al., 2002). Elderly participating at follow-ups in the intervention group reported more use of shoe/cane spikes and more moderate level of physical activity than the control group (Grahn Kronhed et al., 2006). Forearm fracture incidence decreased in women in the intervention area, but the decrease was not found in the control area (Grahn Kronhed et al., 2005).

The main aim of the present cross-sectional study was to explore effects of a ten-year, community-based, osteoporosis prevention program seven years after the completion on the following parameters; calcaneal BMD, life style factors, and the impact of risk factors for sustaining a fracture after the age of 50.

2. Methods

2.1. Context

The core of the ten-year VOPP intervention program was health education to residents of all ages in order to increase awareness of risk factors for osteoporosis, falls and fractures using community-based and individual intervention strategies (Waller et al., 1997, 2002; Grahn Kronhed et al., 2006, 2005). An extension of the original intervention program was initiated in the 2000s and carried on until 2006. This phase implied a more high-risk strategy for those with presumed osteoporosis. A nurse at the PHCC carried out medical check-ups by DXL calcaneal measurements and a questionnaire. Those with low BMD-values and risk factors for falls and fractures were referred to a physician and/or a physiotherapist.

2.1.1. Subjects

A quasi-experimental design was used for the original study. Vadstena the intervention community, and the new matched control area of Kvarnholmen in the Kalmar city centre, are both located in southern Sweden. The control area was selected for its similarity to the study population's age structure, with many elderly people in both areas. Participants were selected from population registries and randomised in 2006. Three groups were invited for measurements in 2006:

1) Follow-up participants from random samples participating in the VOPP 1989, 1992, 1994, and 1999 ($n = 235$) were invited to calcaneal DXL measurements, and to complete a questionnaire.
2) Persons matched to the follow-up group were invited in Vadstena ($n = 424$) for calcaneal measurements and to complete a questionnaire.
3) Age and gender matched persons from the control area ($n = 517$) were invited, where one subgroup ($n = 257$) was offered calcaneal measurements and requested to complete a questionnaire, while another subgroup ($n = 260$) was requested to complete the questionnaire only (Fig. 1). In the present study, those participants who underwent both calcaneal measurements and completed the questionnaire were included.

2.1.2. Test procedure

A questionnaire was mailed to the participants along with a written invitation to bone mass measurements. The questionnaire comprised 74 general questions concerning lifestyle (physical activity levels, smoking and drinking habits, and nutrition), diseases, medication, prior fractures (in adulthood), parents' fractures, and height as young adults. Three questions dealt with the respondent's current level of physical activity. One question concerning physical activity levels at work was rated by four activity grades with respect to skeletal loading (Saltin and Grimby, 1968). The lowest grades 1–2, were called the "light level", and the highest grades 3–4 the "heavy level". Levels of leisure time physical activity were classified by a six-grade scale. Previous evaluation suggests that this scale has acceptable validity in specific for older adults. Grades 1–2 designated a "low level", grades 3–4 designated a "moderate level", and grades 5–6 designated a "high level" (Frändin and Grimby, 1994). The frequency of at least a 30-min brisk walk was estimated for the previous summer and winter seasons. Questions about smoking habits were classified as non-smoker or present/previous smoker. Twenty-four questions dealt with knowledge of osteoporosis (Waller et al., 2002). Some questions were addressed to those ≥65 years and dealt with safety behavior to prevent falls, and anxiety of having a fall (Grahn Kronhed et al., 2005).

A portable device the dual X-ray and laser (DXL) technology by Calscan (Demetech, Solna, Sweden), was used between January and April 2006 to measure calcaneal bone mineral density (BMD). DXL technology by Calscan performed the scan in less than one minute, with a radiation-effective dose administration of <0.2 μSv (Martini et al., 2004; Kullenberg and Falch, 2003). The longitudinal in-vivo precision (coefficient of variation) of the Calscan device has been estimated at 1.2% (Kullenberg and Falch, 2003). The left heel was chosen as the measurement site. BMD values are presented as g/cm^2 (Swanpalmer and Kullenberg, 2000). A Swedish reference population for DXL in women was used for the calculation of T- and *Z*-scores (BMD value adjusted for age by the reference group) (Kullenberg, 2003).

Body weight was measured on a digital balance scale (kg), and height was measured with a stadiometer (cm). Body mass index (BMI) was calculated as weight in kg/(height in metres squared). In the present study those with missing weight and height measurements had their BMI calculated from their reported values in the questionnaire. Experienced nurses at Vadstena and Kvarnholmen PHCCs carried out these measurements.

2.1.3. Statistical analysis

Group characteristics were reported as means (M) and standard deviations (SD). Percentages and 95% confidence intervals (CI) were used for reported physical activity levels, falls, and safety behavior. The independent two-sample *t*-test was used for comparison between groups. Correlations between age and present height, and between calcaneal BMD and height loss, were studied by using the Pearson correlation coefficient (r). Multiple regression analysis of women and men separately was used to study independent variables with possible impact on calcaneal BMD. These variables were checked for multicollinearity. Logistic regression with odds ratios of the risk for self-reported fractures after the age of 50 were checked and adjusted for several independent variables. In the fully adjusted model, DXL T-scores dichotomised into normal/osteopenic and osteoporotic, age, BMI values, leisure time

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