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ORIGINAL RESEARCH

Osteoporosis and Health-Related Quality-of-Life Outcomes in the Alameda County Study Population

Krista Kotz, PhD, MPH, Stephane Deleger, MS, Richard Cohen, MA,
Alisa Kamigaki, MPH, John Kurata, PhD, MPH

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Abstract

Introduction

The objective of this study was to identify physical and mental outcomes of osteoporosis that affect quality of life in women.

Methods

Data were from the Alameda County Study, a longitudinal study of health and mortality that since 1965 has followed a cohort of 6,928 American persons aged 16 to 94 years at baseline. Subjects for this analysis were women who survived until at least 1994 (N = 1,171). The variables analyzed as possible outcomes of osteoporosis included measures of physical health, quality of life, and mental health. Sequential logistic regression models were run, and associations were presented as odds ratios.

Results

After controlling for age, ethnicity, education, financial strain, and physical activity, subjects with osteoporosis in 1994 were more likely to report the following outcomes in 1999: frailty, difficulty with balance, weakness, problems with activities of daily living, fair/poor perceived health, never going out for entertainment, and not enjoying free time much. When controlling for chronic medical conditions, the odds ratios were reduced, but remained significant for difficulty with balance and weakness (odds ratio = 2.48) and problems with activities of daily living (odds ratio = 2.80).

Conclusion

From this study, it appears that people with osteoporosis are at higher risk of developing problems with physical frailty and difficulties with activities of daily living, and may be at risk for reduced quality of life in terms of going out for entertainment and enjoying free time. Therefore, care should be taken to maintain the quality of life for people with osteoporosis by helping them to keep as physically functional as possible.

Introduction

This study focused on the effects of osteoporosis on health-related quality of life. Studies on fractures — the most obvious health outcome of osteoporosis — are common. The usual fracture sites associated with osteoporosis are the vertebra, hip, or wrist. The lifetime risk for any of these fractures is 39.7% for women (1). These fractures can lead to considerable disability. Hip fractures usually require lengthy hospital stays, often followed by permanent disability and dependence (2). Vertebral fractures can lead to disfigurement, chronic back pain, and functional loss (2,3).

In addition to bone fractures, there are less obvious, but perhaps equally serious, health outcomes that may be associated with osteoporosis. Several health-related quality-of-life outcomes have been shown to be associated with osteoporosis, including cognitive decline (4), depression (5), poor perceived health (6), and less social support (7).

The fear of fracture among individuals with osteoporosis can lead to a limitation of activities, which can greatly reduce quality of life (6,8). Disability due to osteoporosis can limit normal daily activities, which can rob osteoporosis sufferers of their usual social roles in work, family, and pleasure (7). Frailty has been associated with reduced activities, poorer mental health, and lower life satisfaction (9). Finally, poor perceived health has been shown to be positively associated with mortality in previous studies (10).

Other factors, such as age, ethnicity, education, physical activity, financial strain, and other chronic medical conditions are considered important determinants of risk for physical health disability, quality of life, and mental health (9,11-14).

The intent of the study was to find associations between having osteoporosis in 1994 and subsequent problems, in terms of important health-related quality-of-life outcomes, in 1999. By removing from the study subjects who had the outcomes of interest already in 1994, it was possible to establish a temporal relationship. Therefore, the results of the study can be used to assess which negative outcomes were associated with osteoporosis and occurred after the onset of the disease.

Methods

The Alameda County Study

This study was performed using data from the Alameda County Study (ACS), a longitudinal study of health and mortality that has followed a cohort of 6,928 adults since 1965, who ranged in age from 16 to 94 years at baseline. Subjects were originally selected through a stratified random sample of Alameda County households to be representative of Alameda County, California, in the United States (10); subjects have been followed regardless of residence since the initial survey. Survivors were surveyed again in 1974, 1983 (50% sample), 1994, and 1999. The percent response rates for the 5 surveys ranged from 85% to 96%. All data are self-reported.

Subjects

Subjects eligible for inclusion in the analysis (N = 1,210) were women who had responded to questionnaires in 1994 and 1999. Only women with no missing data on osteoporosis, risk factors, and other variables used in the different statistical models were kept in the analysis (N = 1,171). In 1994, 92 subjects had osteoporosis and 1,079 did not.

Measures

Osteoporosis was assessed retrospectively by asking subjects both in the 1994 and 1999 questionnaires if they ever had osteoporosis, and, if so, what the year of onset was. For subjects who reported a different year of onset in the 2 questionnaires, the midpoint between the 2 years was used, unless the year reported in the 1999 questionnaire was later than 1994. In that case, the year of onset reported in the 1994 questionnaire was used. In other words, subjects were analyzed for outcomes of osteoporosis if they reported osteoporosis prior to 1995.

The outcomes associated with osteoporosis were classified for this paper as physical health disability, quality of life, and mental health.

Physical health disability: Three areas considered under "physical health disability" included frailty, problems with activities of daily living (ADL), and the perception of fair/poor health.

Frailty consisted of 3 domains — physical, cognitive, and sensory — and each was examined individually. Fourteen items were used to define frailty; the scoring system is a modified version of a system used in a previous ACS study (9) (Appendix 1). For each item, subjects checked one of the following: 1 (no difficulty, rarely or never had the problem in the last 12 months); 2 (a little difficulty, sometimes had the problem in the last 12 months); 3 (some difficulty, often had the problem in the last 12 months); or 4 (a great deal of difficulty, very often had the problem in the last 12 months). Subjects scoring a 3 or higher on at least one item in any domain were considered to have a problem or difficulty with that domain. Participants were classified as frail if they were considered to have a problem or difficulty (scoring 3 or higher) with 2 or more domains. Subjects were considered to have problems with ADL if they had difficulty with any of the following: walking across a small room, bathing, brushing their hair or washing their face, eating, dressing, moving from bed to chair, and using the toilet. This scale has been used in a previous ACS study (15).

Participants rating their health as "excellent" or "good" were compared with those assessing it as "fair" or "poor."

Quality of life: Quality of life was assessed using several measures. Activities such as going out for entertainment and visiting family and friends were dichotomized into "often" or "sometimes" versus "never." Subjects enjoy-

ing free time "a lot" or "some" were compared to those enjoying it "not very much." Subjects attending religious services at least monthly were compared to those attending it once or twice a year or less. Subjects pleased at how things in their lives had turned out were compared to those who were not. Finally, happiness was dichotomized as "very happy" or "pretty happy" versus "not too happy."

Mental health: Mental health was assessed by examining depression, cynical distrust, pessimism, social support and relationships, and self-perception of mental health. Depression was evaluated using a score of 5 or more on the 18-item scale of depressive symptoms developed by Roberts and O'Keefe (16) (Appendix 2). Subjects were considered to have high levels of cynical distrust if they agreed with at least 4 of the 7 items from a modified version of a previously published scale (17) (Appendix 3). Subjects were considered pessimistic if they scored 8 or more on a scale ranging from 0 to 18. Other items examined included whether respondents felt loved "somewhat," "little," or "very little" and felt "somewhat" or "not at all" satisfied with their relationships.

Social isolation was also assessed using a scale based on an isolated response to 2 questions related to the number of relatives and close friends they had and how often they saw them. This measure has been shown to be associated with general mortality and morbidity in previous ACS studies (9,18).

Respondents rating their mental health as "excellent" or "good" were compared with those assessing it as "fair" or "poor."

Other variables: Other variables were examined including age, ethnicity, education, physical activity, financial strain, and chronic medical conditions.

A physical activity scale was constructed using responses to 4 questions regarding how often subjects engaged in physical exercise, took long walks or went swimming, participated in active sports, or worked in the garden. The possible responses to these questions were 0 (never), 2 (sometimes), or 4 (often). The physical activity scale ranged from a score of 0 to16, with a score of 4 or less considered low physical activity, 5 to 8 considered medium, and 9 or more considered high.

Subjects were considered to be under financial strain if they did not have enough money to buy clothes, fill a prescription, see a doctor, pay rent or mortgage, or buy food.

Subjects were classified according to the number of chronic conditions that resulted in a visit to a physician in the previous 12 months. These conditions included the following: heart trouble, high blood pressure, asthma, chronic bronchitis, arthritis, emphysema, diabetes, stroke, cancer, and circulatory problems. The number of conditions were summed and then categorized as none, 1 condition, or 2 or more chronic medical conditions in the previous 12 months resulting in a visit to a physician.

All scales and measures are described in detail in a previous publication (10).

Design

The study was designed to investigate associations between having osteoporosis in 1994 and health-related and quality-of-life outcomes in 1999. By removing subjects who had outcomes already in 1994, it was possible to establish a temporal relationship between onset of disease and onset of negative outcomes — with the onset of osteoporosis occurring before onset of negative outcomes. While this does not establish causality, it provides more evidence that osteoporosis causes negative outcomes. Criteria widely used in epidemiology to evaluate the likelihood that an association is causal include the following: strength of the association (measured in this article in odds ratios [OR]), temporally correct association, dose-response relationship, consistency of the association, specificity of the association, and biologic plausibility (19). This study assesses the first 2 of these criteria — strength of the association and temporally correct association.

Data Analyses

Statistical analyses were performed to assess the association between osteoporosis and subsequent outcomes related to health disability, quality of life, and mental health. Logistical regression analyses were performed to examine the effect of osteoporosis in 1994 on outcomes in 1999 by removing subjects who had outcomes in 1994.

For the model in which a statistically significant association remained between previous osteoporosis and subsequent incident outcome, sequential logistic regression models were run, where education, financial strain, physical activity, and chronic medical conditions were added to the basic model.

The odds of having a specific outcome for subjects with osteoporosis in comparison to subjects who did not report osteoporosis were calculated in all models, and are shown as odds ratios.

All statistical analyses were performed with SAS® Software (version 6.12).

Results

The distribution of population characteristics and prevalence of osteoporosis in 1994 among the 1,171 female participants in the ACS is presented in Table 1. The average age in 1994 was 62.6 years, with prevalence of osteoporosis increasing with age. Eighty-three percent of the sample was Caucasian, 7.6% was African-American, 3.8% was Hispanic, and 5.5% was composed of other groups. Eighty-eight percent of the sample had 12 years of education or more. Nearly 39% of the subjects had a high level of physical activity, and 46.3% had no chronic medical condition. More than 19% of the subjects experienced financial strain in 1994. The total prevalence of osteoporosis in this population was 7.9%.

Subjects with osteoporosis had greater risk for frailty (OR = 1.96), difficulty with frailty (OR = 2.77), problems with ADL (OR = 3.37), and fair/poor perceived health (OR = 2.18). Subjects with osteoporosis also had a higher risk of never going out for entertainment (OR = 2.26), not enjoying free time much (OR = 3.06), and being pessimistic (OR = 2.06) (Table 2).

After controlling for age, ethnicity (coded as "white" versus "other"), educational level (dichotomized as <12 years versus >12 years), financial strain, and physical activity, subjects with osteoporosis in 1994 were more likely to report the following outcomes in 1999: frailty, difficulty with physical domain, problems with ADL, and fair/poor perceived health (Table 3). When we introduced control for chronic medical conditions, the odds ratios were reduced but remained significant for difficulty with physical domain (OR = 2.48) and problems with ADL (OR = 2.80).

Table 4 indicates that lower quality-of-life indicators such as never going out for entertainment and not enjoying free time much were still significantly associated with osteoporosis in 1994 (OR = 2.10 and OR = 2.69, respectively) when adjusted for age, ethnicity, education, financial strain, and physical activity. Both failed to be significantly associated with osteoporosis when chronic medical conditions were added to the model, but the odds ratio remained somewhat high (OR = 2.00 for never going out for entertainment and OR = 2.39 for not enjoying free time much). The association between osteoporosis and pessimism did not remain significant after adding physical activity and chronic medical conditions to the model adjusted for age, ethnicity, education, and financial strain.

Discussion

The results of this study indicate that osteoporosis may lead to subsequent problems with physical health, such as difficulty with balance and weakness, or problems with ADL. Subjects who reported having osteoporosis anytime before 1995 were more than twice as likely to experience difficulty with physical domain of frailty (balance problems and weakness) later in life and had 2.8-fold greater odds of experiencing problems with ADL, even after controlling for socioeconomic variables, physical activity, or other chronic medical conditions. These results indicate that osteoporosis is independently associated with future physical health disabilities, and subjects with osteoporosis were more likely to become physically challenged later in their lives compared to subjects without osteoporosis. These outcomes were expected because of previous research as well as the pathology of osteoporosis.

An interesting finding of this study is the effect of osteoporosis on quality of life. Osteoporosis reduced pleasure in leisure-time activities such as going out and enjoying free time. Even though this association failed to be significant when adjusted for chronic medical conditions, the odds ratios for never going out for entertainment and not enjoying free time much were larger than 2.00, and P values were both greater than .05 (P = .07 for never going out for entertainment and P = .08 for not enjoying free time much). These findings may result from the low prevalence of osteoporosis in our sample (7.9%), which reduces the power of this analysis when additional variables are added to the model.

Some variables that may be associated with osteoporosis were not found to be associated in this analysis, perhaps because of the study's design. This analysis looked at potential outcomes of osteoporosis by examining only variables that occurred after the onset of osteoporosis. If a variable was found to be associated with osteoporosis, it was also was found to have the correct temporal relation-

ship for possible causality: that is, onset of disease occurs before the onset of outcomes. In this study, if the correct temporal relationship was not found, an association was not made.

A limitation of this study is that all data are self-reported. Measuring osteoporosis with radiographic or other clinical data may be more valid. Previous research has shown that self-reported prevalence of osteoporosis significantly underestimates true prevalence (20). This may also have decreased the ability of this study to identify the relationship between osteoporosis and outcomes.

From this study, it appears that women with osteoporosis are at higher risk of developing problems with physical frailty and difficulties with ADL, and they may be at risk for reduced quality of life in terms of going out and enjoying free time. Care should be taken to maintain quality of life for people with osteoporosis by helping them to keep as physically functional as possible. Appropriate exercise, education about self-management of the disease, and physical therapy programs seem to improve physical functioning and quality of life in older individuals and those with osteoporosis (21-23). In addition, helping those with osteoporosis to maintain or improve their enjoyment of recreational activities may help to improve quality of life.

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Author Information

Corresponding Author: Krista Kotz, PhD, MPH, Public Health Institute, 174 Glorietta Blvd, Orinda, CA, 94563. E-mail: kjkotz@kotzhealthpolicy.com.

Author Affiliations: Stephane Deleger, MS, and Richard Cohen, MA, Public Health Institute, Berkeley, Calif; Alisa Kamigaki, MPH, and John Kurata, PhD, MPH, California Department of Health Services, Chronic Disease Branch, Division of Chronic Disease and Injury Control, Sacramento, Calif.

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Tables

Table 1.
Characteristics of 1171 Female Study Participants in Alameda County Study, 1994

Population Characteristics	N	%	Osteoporosis Prevalence (%)
Age group, y			
46-55	365	31.2	3.0
56-65	349	29.8	5.4
66-75	323	27.6	11.5
76-94	134	11.4	18.7
Ethnicity			
African American	89	7.6	2.3
Hispanic	44	3.8	2.3
White	973	83.1	9.0
Other	65	5.5	1.5
Education			
< High School	141	12.0	10.6
High School +	1030	88.0	7.5
Level of physical activity			
Low	283	24.2	9.5
Medium	434	37.0	8.1
High	454	38.8	6.6
Chronic medical conditions			
None	542	46.3	2.8
1	360	30.7	8.9
2	180	15.4	15.6
3 or more	89	7.6	19.1
Financial strain			
Yes	227	19.4	7.5
No	944	80.6	7.9

Table 2.
Association Between Osteoporosis in 1994 and Reported Outcomes in 1999 for Participants in Alameda County Study, 1994*

1999 Outcomes	N†	Odds Ratio	95% Confidence Interval
Physical health disability			
Frailty	997	1.96	1.05-3.66
Difficulty with sensory domain	780	1.51	0.80-2.84
Difficulty with cognitive domain	961	1.39	0.68-2.83
Difficulty with physical domain (problems with balance and weakness)	1032	2.77	1.46-5.26
Problems with activities of daily living	1070	3.37	1.82-6.24
Fair/poor perceived health	1005	2.18	1.13-4.22
Quality of life			
Never go out for entertainment	1025	2.26	1.11-4.59
Never go to church or go once a year	485	1.69	0.65-4.39
Do not feel pleased about own life	934	0.64	0.24-1.65
Do not enjoy free time much	1110	3.06	1.22-7.68
Not too happy	1059	1.32	0.49-3.54
Mental health			
Depression using 18-item scale	1030	1.87	0.93-3.76
Cynical distrust	878	0.65	0.27-1.59
Pessimistic	894	2.06	1.04-4.08
Fair/poor perceived mental health	1052	1.25	0.56-2.78
Feel loved somewhat/little or very little	889	1.65	0.84-3.23
Somewhat/not at all satisfied with friendships	884	0.85	0.39-1.86
Social isolation	994	1.73	0.88-3.41

* All models are adjusted for age and ethnicity.
† Ns may differ due to missing data for specific outcomes.

Table 3.
Association Between Osteoporosis in 1994 and Physical Health Outcomes Reported in 1999 for Participants in Alameda County Study, 1994

Models	Odds Ratio	95% Confidence Interval
Frailty		
Model 1*	2.02	1.08-3.77
Model 2†	1.94	1.03-3.65
Model 3‡	1.67	0.88-3.17
Difficulty with physical domain (problems with balance and weakness)		
Model 1	2.95	1.54-5.65
Model 2	2.89	1.49-5.61
Model 3	2.48	1.26-4.87
Problems with activities of daily living		
Model 1	3.31	1.77-6.18
Model 2	3.33	1.76-6.30
Model 3	2.80	1.46-5.35
Fair/poor perceived health		
Model 1	2.23	1.15-4.34
Model 2	2.26	1.16-4.43
Model 3	1.75	0.87-3.49

* Model 1 = controlling for age, ethnicity, education and financial strain.
† Model 2 = Model 1 + physical activity.
‡ Model 3 = Model 2 + chronic medical conditions.

Table 4.
Association Between Osteoporosis in 1994 and Incidence of Quality-of-Life and Mental Health Outcomes Reported in 1999 for Participants in Alameda County Study, 1994

Models	Odds Ratio	95% Confidence Interval
Never go out for entertainment		
Model 1*	2.18	1.06-4.50
Model 2†	2.10	1.00-4.42
Model 3‡	2.00	0.94-4.26
Do not enjoy free time much		
Model 1	2.88	1.12-7.37
Model 2	2.69	1.03-7.03
Model 3	2.39	0.90-6.38
Pessimistic		
Model 1	1.97	0.99-3.94
Model 2	1.80	0.88-3.67
Model 3	1.53	0.74-3.17

* Model 1 = controlling for age, ethnicity, education and financial strain.
† Model 2 = Model 1 + physical activity.
‡ Model 3 = Model 2 + chronic medical conditions.

Appendix 1. Frailty Items*

Physical domain
- Sudden loss of balance
- Weakness in arms
- Weakness in legs
- Get dizzy or faint when stand up quickly

Cognitive domain
- Difficulty paying attention
- Trouble finding the right word
- Difficulty remembering things
- Forgetting where put something

Sensory domain
- Difficulty reading a newspaper
- Difficulty recognizing a friend across the street
- Difficulty reading signs at night
- Difficulty hearing over the phone
- Difficulty hearing a normal conversation
- Difficulty hearing a conversation in a noisy room

*Adapted from Strawbridge, Shema, Balfour, Higby, Kaplan (9).

Appendix 3. Cynical Distrust Items*

- Most people are honest chiefly because of a fear of being caught.
- It is safer to trust nobody.
- Most people make friends because friends are likely to be useful to them.
- Most people inwardly dislike putting themselves out to help other people.
- Most people will use somewhat unfair means to gain profit or an advantage rather than lose it.
- No one cares much what happens to me.
- I think people would lie in order to get ahead.

* Adapted from Everson, Kauhanen, Kaplan, Goldberg, Julkunen, Tuomilehto, Salonen (17).

Appendix 2. 18-Item Scale of Depressive Symptoms*

Items	Score†
Good appetite	No (1) Yes (0)
Have more or less energy than most people your age	A lot less energy (1) A little less energy (0) A little more energy (0) Much more (0)
Trouble getting to sleep or staying asleep	Often (1) Sometimes (0) Almost never (0)
Getting very tired in a short time in the last 12 months	Yes (1) No (0)
Enjoyment of free time	Not very much (1) Some (0) A lot (0)
Hard to feel close to others Feel left out even with friends Feel too tired to do things that you like to do Never quite satisfied with what you do	True (1) False (0)
Can usually relax easily	False (1) True (0)
Feel on the top of the world Feel excited or interested in something Feel pleased about having accomplished something	Never (1) Sometimes (0) Often (0)
Feel very lonely or remote from other people Feel depressed or very unhappy Feel bored Feel so restless you couldn't sit long in a chair Feel vaguely uneasy about something without knowing why	Often (1) Sometimes (0) Never (0)

*From Roberts and O'Keefe (16).
†Total score is sum of scores for all 18 items.