A Systematic Review of Community-Based Osteoporosis Prevention Programs on Calcium Intake and Weight-Bearing Exercise

Abstract

Osteoporosis is a serious public health concern worldwide, and community-based osteoporosis prevention programs that increase osteoporosis preventive behaviors are ideal to combat this major public health issue. To analyze and assess the effectiveness of community-based osteoporosis prevention programs, a systematic review was conducted to examine these programs and their impact on increasing osteoporosis preventive behaviors like calcium intake and weight-bearing exercise. Results showed the community-based osteoporosis prevention programs varied in numerous ways and had mixed results in increasing osteoporosis preventive behaviors, although three-fourths of programs were successful in significantly increasing calcium intake compared to only one-third of programs that were successful in significantly increasing weight-bearing exercise. Regarding calcium intake, while most community-based osteoporosis prevention programs were successful, all of the ones that implemented at least one theoretical behavior change model, such as the health belief model, or implemented bone mineral density (BMD) testing were successful in significantly increasing calcium intake. Findings demonstrate that community-based osteoporosis prevention programs should be utilized in public health to increase calcium intake, but more research is needed to determine ways to increase weight-bearing exercise.

Keywords

Osteoporosis, Prevention, Community, Calcium, Exercise

Introduction

Osteoporosis is a severe bone disease that increases morbidity and mortality in individuals, and is also a serious public health concern in populations all around the world. Osteoporosis is a disease of weakened bones that are more susceptible to fragility factures, particularly in the hip, spine and wrist, and is clinically diagnosed as having a bone mineral density (BMD) of 2.5 standard deviations below the adult peak mean (Kanis, Melton, Christiansen, Johnston, & Khaltaev, 1994). Osteoporosis is typically diagnosed at older age (after 50 years of age) and is currently incurable as there are no treatments that can fully replenish reduced BMD cause by the disease, and this disease decreases the quality of life (Lips & van Schoor, 2005) and increases mortality (Johnell et al., 2004; Leboime et al., 2010) in individuals diagnosed with it, and is a major public health issue as it affects hundreds of millions of individuals worldwide (Cooper, Campion, & Melton, 1992). Tens of millions of Americans have osteoporosis or are at high risk of the disease in the United States (U.S. Department of Health and Human Services), and even the United States Surgeon General has addressed the importance of promoting bone health and preventing osteoporosis in public health (Benjamin, 2010), as osteoporosis and osteoporotic fractures, especially hip fractures, can lead to permanent physical disability, loss of self-sufficiency, hospitalization, and an increased risk of mortality, further needing public health osteoporosis prevention interventions to prevent the disease and premature death (Leboime et al., 2010). Fortunately, the National Institute of Health Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy (2001) states that although osteoporosis affects all populations, this disease is preventable by achieving maximal BMD with the osteoporosis preventive behaviors of engaging in adequate calcium intake and weight-bearing exercise. Therefore, to combat this global public health problem, leadership in

public health must implement osteoporosis prevention programs that will increase those osteoporosis preventive behaviors to promote bone health and prevent this disease.

Public health leadership should place focus on preventing osteoporosis and approach it with the implementation of strategies that increase osteoporosis awareness and promote osteoporosis preventive behaviors throughout the population (Morales-Torres, 2007). In public health practice, osteoporosis prevention programs that are community-based and implemented to communities will be more impactful towards improving the health of populations than the more common programs designed for individuals in health care settings. As osteoporosis is becoming a growing public health concern with demographic trends showing an increased number of individuals living longer (past 65 years of age), there will also be an increased number of cases of osteoporosis and osteoporotic fractures which require significant health care resources for treatments and rehabilitation (Cauley, 2013). However, health care resources to treat and manage osteoporosis will become scarcer as the number of cases increase (Melton, Johnell, Lau, Mautalen, & Seeman, 2004), showing the need for public health measures to prevent the disease. Treating osteoporotic fractures is already a great economic burden that will only increase as the world population becomes more elderly (Harvey, Dennison, & Cooper, 2010), and the implementation of osteoporosis preventive measures in public health could provide cost-effective measures that alleviate health care and medical costs, as policies and spending on community-based programs can reduce the need and substantial costs of long-term institutionalization, such as in nursing home residences, due to hip fractures typically cause by osteoporosis (Blackburn, Locher, Morrisey, Becker & Kilgore, 2016). Even partial adherence to osteoporosis prevention and management programs can have significant cost-effectiveness (Kanis et al., 2011), making these programs more valuable. Furthermore, decreased BMD and clinically diagnosed

osteoporosis can predict an increased risk of osteoporotic fractures in populations (Marshall, Johnell, & Wedel, 1996), making community-based programs in public health designed and intended to prevent osteoporosis reduce the rate of fracture occurrences throughout entire populations.

As osteoporosis prevention programs that are community-based are ideal for improving bone health and preventing osteoporosis in public health, their effectiveness must be analyzed to determine whether there should be increased emphasis to utilize community-based osteoporosis prevention programs in public health leadership, and how they should be implemented in public health practice. Therefore, a systematic review is needed to determine the effectiveness of community-based osteoporosis prevention programs, particularly the effectiveness of increasing the osteoporosis preventive behaviors of calcium intake and weight-bearing exercise, to evaluate their utilization in public health.

Methods

For this systematic review of published studies on the effectiveness of community-based osteoporosis prevention programs in public health, a research question was developed consisting of a setting, exposure, outcome, and population:

- "Do community-based osteoporosis prevention programs increase osteoporosis preventive behaviors among individuals undiagnosed with osteoporosis?"

In this research question, "community-based" is the setting, "osteoporosis prevention programs" is the exposure, "osteoporosis preventive behaviors" is the outcome, and "individuals undiagnosed with osteoporosis" is the population. The emphasis on "community-based osteoporosis prevention programs" applies to public health more so than individual-based

osteoporosis prevention programs. The application of "osteoporosis preventive behaviors" would include only studies measuring outcomes of actual behaviors in their analyses. And as the focus is on osteoporosis prevention and not osteoporosis treatment, "individuals undiagnosed with osteoporosis" were the selected population, especially since it is more ideal and likely cost-effective to prevent osteoporosis in public health than treat osteoporosis in health care. It is also understood that osteoporosis is considered to be a "silent" disease that can be asymptomatic and many individuals may have the disease and not know it; therefore, "individuals undiagnosed with osteoporosis" are populations of individuals who may be healthy or appear healthy, and do not have osteoporosis or at least not yet diagnosed with osteoporosis.

The search strategy for this systematic review used four databases: PubMed (United States National Library of Medicine at the National Institutes of Health), PsycINFO (American Psychological Association), ERIC (Education Resources Information Center: Institute of Education Sciences of the United States Department of Education), and Google Scholar. Search terms entered into these databases were "osteoporosis community" and reference results that included "osteoporosis" along with synonymous terms such as "bone health" and "fractures" with either the terms: "community," "community-based," "community-dwelling," and/or the synonym "population," in the title and/or abstract were retrieved and preliminarily considered for this systematic review (n = 127).

For all published studies that were retrieved and preliminarily considered from the database search (n = 127), in order to consider those that analyzed "community-based osteoporosis prevention programs," every publication that did not include the analysis of a community-based osteoporosis prevention program or the analysis of any type of community

intervention was immediately excluded from this systematic review (n = 74), leading to those making the first round of potentially eligible studies for inclusion (n = 53).

For those publications that did include analysis of community-based osteoporosis prevention program or any type of community intervention (n = 53), in order to consider those that measured the outcome of osteoporosis preventive behaviors, studies that did not include any measure of osteoporosis preventive behaviors were excluded. Studies that did not include behavior measures but only included outcome measures such as osteoporosis awareness, osteoporosis knowledge, osteoporosis health beliefs, osteoporosis preventive behavior intentions, osteoporosis screening, osteoporosis diagnoses, fractures and/or falls were excluded. Although the increase of osteoporosis awareness and osteoporosis knowledge, alteration of osteoporosis health beliefs, increasing osteoporosis preventive behavior intentions, and/or results of osteoporosis screening can lead to the initiation and maintenance of osteoporosis preventive behaviors, they in themselves are not actual osteoporosis preventive behaviors, nor do they guarantee the initiation and maintenance of osteoporosis preventive behaviors to prevent the disease. And while the decrease in the risk, prevalence, and incidence of osteoporosis, fractures, and falls can relate to the adoption of osteoporosis preventive behaviors, without the measure and analysis of behaviors any causal inference can be linked to numerous other factors. Thus, all studies without any osteoporosis preventive behavior measure were excluded (n = 34), leading to those making the second round of potentially eligible studies for inclusion (n = 19).

And for the studies on community-based osteoporosis prevention programs that focused on increasing osteoporosis preventive behaviors (n = 19), in order to determine their application for osteoporosis prevention in individuals undiagnosed with osteoporosis, studies that were only conducted on populations of individuals with osteoporosis were excluded (n = 5), but studies

including a combination of undiagnosed individuals along with individuals diagnosed with osteoporosis were included as prevention still applies to those who are undiagnosed, resulting to those studies making the third and final round of eligible studies for inclusion in the systematic review (n = 14). Figure 1 illustrates the inclusion process for the systematic review.

Once the studies for inclusion in the systematic review were finalized (n = 14), a review was conducted on each individual study to examine certain aspects, such as details and description of the community-based osteoporosis prevention program, types and outcomes of osteoporosis preventive behaviors, depictions and descriptions of participants, among other variables such as study design and duration, and setting and location.

Results

Table 1 provides specifics of the different aspects of each of the 14 studies on community-based osteoporosis prevention programs selected in the systematic review (Oh et al., 2014; Plawecki & Chapman-Novakofski, 2013; Babatunde, Himburg, Newman, Campa, & Dixon, 2011; Teems, Hausman, Fischer, Lee, & Johnson, 2011; Francis, Matthews, Van Mechelen, Bennell, & Osborne, 2009; Hien et al., 2009; Kronhed, Blomber, Lofman, Timpka, & Moller, 2006; Rohr, Clements, & Sarkar, 2006; Hamel et al., 2005; Pearson, Burkhart, Pifalo, Palaggo-Toy, & Krohn, 2005; Tussing & Chapman-Novakofski, 2005; Cerulli & Zeolla, 2003; Brecher et al., 2002; Ribeiro & Blakeley, 2001). Various study designs were used to investigate their effectiveness of increasing osteoporosis preventive behaviors that included the use of experimental, intervention, and prospective cohort designs, and the duration of these studies varied from as short as 6 weeks to as long as 5 years, with 1 study not reporting duration. The community-based osteoporosis prevention programs studies were also conducted in various

community settings and in various locations globally, including locations in North America, Europe, Asia, and Australia, which was expected as osteoporosis affects millions of individuals worldwide. The specific designs and implementations of the studied community-based osteoporosis prevention programs varied from study to study, with various components used in different studies that included, but was not limited to, BMD testing, use of theoretical behavior change models, lectures and lessons on various osteoporosis-related topics, presentations, demonstrations, counseling, group discussions, and hands-on activities. All 14 studies included participants that were women who were mostly older adults, with only 6 that included men that were mostly a very small portion of the total participants in their respective studies.

All studies, with the exception of 1 study, measured the osteoporosis preventive behaviors of calcium intake and/or weight-bearing exercise, with 8 studies measuring both osteoporosis preventive behaviors, 4 studies only measuring calcium intake, and 1 study only measuring weight-bearing exercise. One of the 8 studies that measured both calcium intake and weight-bearing exercise also measured fall preventive home safety behaviors. The 1 study that did not measure either calcium intake or weight-bearing physical activity instead measured health-directed behaviors, such as positive and active engagement of life, skill and technique acquisition, and social integration and support, and although these are general health behaviors, they can be applied to osteoporosis preventive behaviors, such as calcium intake and weight-bearing exercise.

Results varied in addressing the research question: "Do community-based osteoporosis prevention programs increase osteoporosis preventive behaviors among individuals undiagnosed with osteoporosis?" with 9 of the 12 studies (75%) reported significant increases in calcium intake, and only 3 of the 9 studies (33%) reported significant increases in weight-bearing

exercise (1 study reported increases in both calcium intake and weight-bearing exercise, but did not report statistical significance). Significant increases were also reported in the 1 study that measured fall preventive home safety behaviors, as well as the 1 study that only measured health-directed behaviors. The community-based osteoporosis prevention programs varied in numerous ways, but notable trends that in those with significant increases in osteoporosis preventive behaviors, particularly in calcium intake, were the inclusion of at least one theoretical behavior change model or BMD testing for osteoporosis screening. Four of the 14 studies were based on at least one theoretical behavior change model, as all 4 of those studies implemented the Health Belief Model (HBM) and 2 of them implemented both the HBM and the Theory of Reasoned Action (TRA), and all 4 of those studies (100%) measured and significantly increased calcium intake, but only 2 of those 4 studies also measured weight-bearing exercise with only 1 of the 2 studies (50%) resulting in a significant increase. Three of the 14 studies implemented BMD testing, and all 3 of those studies (100%) measured and increased calcium intake (2 significantly increased, 1 did not report statistical significance), but only 2 of those 3 studies also measured weight-bearing exercise with only 1 of those 2 studies (50%) resulting in an increase (did not report statistical significance). Although the studies that implemented at least one theoretical behavior change model or implemented BMD testing were 100% successful in significantly increasing calcium intake, no study implemented both the use of at least one theoretical behavior change model combined with the use of BMD testing.

Discussion

Findings of this systematic review showed that community-based osteoporosis prevention programs have been implemented at various locations and in numerous ways with mixed results

in increasing the osteoporosis preventive behaviors of calcium intake and weight-bearing exercise. With the studies assessed and analyzed, notable and important results were found in the effectiveness of community-based osteoporosis prevention programs. It was noteworthy that every community-based osteoporosis prevention program that either implemented at least one theoretical behavior change model or BMD testing was successful in significantly increasing in calcium intake, but the success was limited in significantly increasing weight-bearing exercise. The exclusion of a theoretical behavior change model or BMD testing does not necessarily result in an unsuccessful community-based osteoporosis prevention program, as there were successful community-based osteoporosis prevention programs in this systematic review did not include the implementation of either, but the inclusion of either of them can substantially increase the likelihood of success in significantly increasing certain osteoporosis preventive behaviors, particularly calcium intake.

The four community-based osteoporosis prevention programs that applied at least one theoretical behavior change model all applied the HBM, which was constructed by Rosenstock (1966), and when applied to osteoporosis prevention, predicts the increase of osteoporosis preventive behaviors, such as calcium intake and weight-bearing exercise, by altering specific health beliefs, such as 1) increasing the perceived susceptibility to osteoporosis, 2) increasing the perceived severity of osteoporosis, 3) increasing the perceived benefits of calcium intake and weight-bearing exercise to prevent osteoporosis, 4) decreasing the perceived barriers to calcium intake and weight-bearing exercise, and 5) increasing self-efficacy for calcium intake and weight-bearing exercise. Although each of the four community-based osteoporosis prevention programs that implemented the HBM (and two that also implemented the TRA) were successful in significantly increasing calcium intake, other attempts of interventions implementing the

HBM were unsuccessful in changing osteoporosis preventive behaviors of calcium intake and weight-bearing exercise (Sedlak, Doheny & Jones, 2000), but they were not community-based osteoporosis prevention programs like the ones in this systematic review. It is unclear if and how an osteoporosis prevention program being community-based may increase the success of implementing the HBM or other theoretical behavior change models to increase osteoporosis preventive behaviors like calcium intake, though it may be a factor in its success as community dynamics could add certain elements, such as increased social support or even peer-pressure, to aid in changing particular behaviors.

Similar success was found in each of the three community-based osteoporosis prevention programs that implemented BMD testing as to those that implemented at least one theoretical behavior change model, as all were able to significantly increase calcium intake but were not always successful in increasing weight-bearing exercise. There have been numerous community-based BMD testing studies conducted in community pharmacies, and community pharmacists have been shown to successfully conduct community-wide BMD testing and screening for osteoporosis, which leads to an increase in participants' osteoporosis awareness and osteoporosis knowledge, as well as knowledge of osteoporosis preventive behaviors (Law & Shapiro, 2005; MacLaughlin et al., 2005; Brookhart, Brown Fountain, and Moczygemba, 2015), and the findings of this systematic review show that BMD testing can also actually increase certain osteoporosis preventive behaviors, particularly calcium intake. The perceived benefits of and perceived barriers to community pharmacy-based BMD testing osteoporosis screening are motivating factors in the decision to engage in osteoporosis preventive behaviors (Deo, Nayak, & Rajpura, 2013), and community pharmacists in community practice can further promote BMD testing with use of national health observances listed from the federal Office of Disease

Prevention and Health Promotion as opportunities for BMD testing, osteoporosis screening, and osteoporosis education in the community (Ciardulli & Goode, 2003). Both public health authorities and community pharmacists believe that pharmacists should be significantly involved with osteoporosis prevention and treatment, but the actual involvement of pharmacists does not nearly meet their ideal levels (Laliberte, Perreault, Damestoy, & Lalonde, 2013). If community pharmacists begin to be more involved in osteoporosis prevention in their communities, physicians do recommend that community pharmacy osteoporosis screening programs use materials and resources from the National Osteoporosis Foundation (Elliott et al., 2002). Community-based BMD testing and osteoporosis screening services in community pharmacies have not only been shown to be effective in identifying osteoporosis, but these services are also sustainable for years (Liu et al., 2007), especially as people are willing to pay for osteoporosis screenings at community pharmacies (Cerulli & Zeolla, 2003; Goode, Swiger, & Bluml, 2004) and third-party payers are willing to compensate pharmacists for these services as well (Goode et al., 2004). In addition to community pharmacies, other community settings such as local senior centers, living facilities and health fairs are also effective locations for BMD testing and osteoporosis screening (Rohr, Sarkar, Barber, & Clements, 2004). Dual x-ray absorptiometry is the most commonly used BMD testing and osteoporosis screening tool, but devices using qualitative ultrasound imaging is also a relatively quick and effective screening method that has the added advantage of portability for community-based screenings (Kim, Han, Kim, & Cho, 2001; Barris Blundell et al., 2006). And to improve rates of BMD testing and osteoporosis screening in communities, electronic communication channels, such as telephonic interactive voice responses, are more effective in motivating individuals in the populations to attend than traditional communication channels, such as mailing (Heyworth et al., 2014).

Only a few of the community-based osteoporosis prevention programs were successful in motivating participants to significant increase weight-bearing exercise. The explanations and reasons for how and why the osteoporosis preventive behavior of weight-bearing exercise is more difficult to increase compared to calcium intake is unclear. In relation to the previously discussed HBM, and particularly the beliefs on perceived benefits, perceived barriers, and self-efficacy, perhaps it is easier to increase the perceived benefits of calcium to prevent osteoporosis, decrease the perceived barriers to calcium intake, and/or increase self-efficacy for calcium intake, but it could be much more difficult to increase the perceived benefits of weight-bearing exercise to prevent osteoporosis, decrease the perceived barriers to weight-bearing exercise, and/or increase self-efficacy for weight-bearing exercise. Calcium intake and weight-bearing exercise are vastly different behaviors and the factors and variables related to adopting and maintaining either one are likely numerous and very different as well, and the explanations and reasons could vary between each community and/or each individual. As most studies in this systematic review were unsuccessful in increasing weight-bearing exercise, more research is needed to investigate how this particular osteoporosis preventive behavior can be motivated and increased in community-based osteoporosis prevention programs. There were numerous studies of community-based exercise programs that focused on the participation of weight-bearing exercise for osteoporosis prevention and bone health as the basis of their programs, but were not included in this systematic review as they did not motivate or measure this osteoporosis preventive behavior, but required it during program attendance to measure outcomes. One community-based exercise program did increase BMD, muscle strength and power, and balance for osteoporosis and fall prevention (Gianoudis et al., 2014), while other community-based exercise programs were ineffective in increasing BMD intended to prevent osteoporosis (Lord,

Ward, Williams, & Zivanovic, 1996; McNamara & Gunter, 2012; Duckham et al., 2015), although some could decrease fall risk to prevent falling that can result in bone fractures (Lord et al., 1996; Carter et al., 2002; Duckham et al., 2015). But those community-based exercise programs that implemented weight-bearing exercise decreased fall risk for fall prevention were unable to increase BMD for osteoporosis prevention, resulting in the need for further research to determine what minimal weight-bearing exercise amounts and intensities are necessary to actually increase BMD (Lord et al., 1996; Duckham et al., 2015).

Community-based osteoporosis prevention programs that implement either at least one theoretical behavior change model or BMD testing can significantly increase calcium intake, although there was not a community-based osteoporosis prevention program that implemented both at least one theoretical behavior change model and BMD testing in combination with each other. It is unclear if combining those two successful elements would lead to a stronger effect and even higher increases in calcium intake, have a conflicting effect and actually decrease calcium intake, or have no additional effect and the combination of the two will not increase calcium intake more so than implementation of just one or the other, although additional research examining these two elements in combination compared to independently may be valuable in determining differences in effect size and possible influence on other osteoporosis preventive behaviors, such as weight-bearing exercise. It is also unknown how other theoretical behavior change models besides the HBM or TRA could effectively significantly increase calcium intake and/or weight-bearing exercise or not, and additional research can also examine the effectiveness of other theoretical behavior change models on those osteoporosis preventive behaviors. In addition, other studies have findings that also warrant additional research for community-based osteoporosis prevention programs, such as different community settings that were not often used

in the studies in this systematic review, including worksites/workplaces (Tan, Lamontagne, Sarmugam, & Howard, 2013) and faith-based locations (Forster-Burke, Ritter, & Zimmer, 2010), both which have shown promise in successful implementation in osteoporosis prevention programs and are worth consideration for future programs.

Research and practice in bone health promotion and osteoporosis prevention in public health should focus more on entire populations, which can include more attention on men who account for 20-25% of osteoporosis cases (Szulc, Garnero, Marchand, & Delmas, 2001). Less than half of the studies in this systematic review included men as participants, and nearly all of them comprised of men at a much smaller percentage than 20-25% of the total participants, which is the portion of osteoporosis cases affecting men. Osteoporosis in men is a major, yet still largely neglected, public health issue (Szulc, Kaufman, & Orwell, 2012), especially since the perceived susceptibility to the disease is low in both older men (Sedlak, Doheny, & Estok, 2000) and particularly younger men (Johnson, McLeod, Kennedy, & McLeod, 2004), and more studies on community-based osteoporosis prevention programs should include men and at higher percentages of the total sample of participants that were used, such as 20-25% of participants, which corresponds with the proportion of osteoporosis cases that they make. In addition, individuals with intellectual disabilities and/or developmental disabilities that are confined in communities that are institution-dwelling are also at high risk of osteoporosis (Lin et al., 2015), and community-based osteoporosis prevention programs should be considered for this community of individuals and community setting as well.

Advances in osteoporosis prevention have focused much on application and implementation for health care settings, but more focus should be placed in application and implementation in public health settings. An example in health care settings, such fracture

liaison services, which is a model of care on secondary prevention intended to prevent secondary osteoporotic and fragility fractures, have been shown to be effective in increasing adherence to osteoporosis treatment and management therapies (Eekman et al., 2014) while being cost-effective in preventing secondary osteoporotic and fragility fractures (Yong, Masucci, Hoch, Sujic, & Beaton, 2016). Fracture liaison services are valuable in treating individuals with osteoporosis who have already sustained an osteoporotic fracture in the prevention of secondary osteoporotic and fragility fractures; however, although there a numerous models used to analyze and determine cost-effectiveness on preventing osteoporotic fractures (Si, Winzenberg, & Palmer, 2014), the cost-effectiveness of secondary prevention of osteoporotic and fragility fractures in health care is unlikely to be as substantial as the cost-effectiveness of primary prevention of osteoporosis and osteoporotic fractures from occurring in the first place in public health. Furthermore, post-secondary osteoporotic and fragility fracture interventions used in health care have not been found to be based on theoretical behavior change models (Sujic, Gignac, Cockerill, & Beaton, 2011), which is a disadvantage compared to community-based osteoporosis prevention programs in public health that more often utilize theoretical behavior change models to successfully and significantly increase certain osteoporosis preventive behaviors, particularly calcium intake.

Public health leaders should implement community-based osteoporosis prevention programs as they show success in increasing osteoporosis preventive behaviors in public health, particularly calcium intake, while encouraging more research that is needed to further investigate the effectiveness of different programs in different communities, and how to increase other osteoporosis preventive behaviors, particularly weight-bearing exercise. Public health practitioners should examine how effective programs have different elements and characteristics

that can be utilized, but may need to be modified for each and every individual community it is implemented in. For instance, each and every community is unique and the application of a community-based osteoporosis prevention program could be different depending on each individual community's characteristics and qualities. For example, different community characteristics that could require modification of community-based osteoporosis prevention program implementation can include, but are not limited to, population size and demographics, place size and location, geography, weather and climate, wealth and affluence, urban and rural areas, economics, culture, government, public health infrastructure, food sources and supplies, availability and access to health services and health professionals, along with numerous other variables, and all of the many community characteristics must work together within in themselves in order to have a successful community-based osteoporosis prevention program unique to its own community needs and resources. As more research is conducted and the body of knowledge grows, all individual communities can determine common and universal elements of success to implement, such as use of theoretical behavior change models or BMD testing, and identify common and universal elements of failure to avoid, as well as conducting its own individual assessment to see how a program must be tailored and customized for its own unique community, in order to implement their own successful community-based osteoporosis prevention programs in public health that will prevent the disease that affects millions of individuals in countless communities around the world.

Compliance with Ethical Standards

The author declares that there are no conflicts of interest.

References:

Babatunde O. T., Himburg S. P., Newman F. L., Campa A., and Dixon Z. (2011). Theory-driven intervention improves calcium intake, osteoporosis knowledge, and self-efficacy in community-dwelling older black adults. *Journal of Nutrition Education and Behavior, 43(6),* 434-440.

Barris Blundell D., Rodriguez Zarzuelo C., Sabio Sanchez B., Gutierrez Alverez J. L., Navarro Visa E., Munoz Valdes O., Garrido Jimenez B., and Sanchez Gomez R. (2006). Screening for osteoporosis among post-menopausal women in community pharmacy. *Pharmacy Practice, 4(2),* 95-101.

Benjamin R. M. (2010). Bone health: Preventing osteoporosis. *Public Health Reports, 125(3),* 368-370.

Blackburn J., Locher J. L., Morrisey M. A., Becker D. J., and Kilgore M. L. (2016). The effects of state-level expenditures for home- and community-based services on the risk of becoming a long-stay nursing home resident after hip fracture. *Osteoporosis International, 27(3),* 953-961.

Brecher L. S., Pomerantz S. C., Snyder B. A., Janora D. M., Klotzbach-Shimomura K. M., Cavalieri, T. A. (2002). Osteoporosis prevention project: A model multidisciplinary educational intervention. *The Journal of the American Osteopathic Association, 102(6),* 327-335.

Brookhart A. L., Brown Fountain K. M., Moczygemba L. R., and Goode J.-V. R. (2015). Community pharmacist-provided osteoporosis screening and education: Impact on patient knowledge. *Innovations in Pharmacy, 6(3),* 213.

Carter N. D., Khan K. M. McKay H. A., Petit M. A., Waterman C., Heinonen A., Janssen P. A., Donaldson M. G., Mallinson A., Riddell L., Kruse K., Prior J. C., and Flicker L. (2002). Community-based exercise program reduces risk factors for falls in 65- to 75-year-old women with osteoporosis: Randomized controlled trial. *Canadian Medical Association Journal, 167(9),* 997-1004.

Cauley J. A. (2013). Public health impact of osteoporosis. *The Journal of Gerontology Series: Biological Sciences and Medical Sciences,* glt093.

Cerulli J., and Zeolla M. M. (2003). Impact and feasibility of a community pharmacy bone mineral density screening and education program. *Journal of the American Pharmacists Association, 44(2),* 161-167.

Ciardulli L. M., and Goode J. V. (2003). Using health observances to promote wellness in community pharmacies. *Journal of the American Pharmacists Association, 43(1),* 61-68.

Cooper C., Campion G., and Melton L. J. (1992). Hip fractures in the elderly: A world-wide projection. *Osteoporosis International, 2(6),* 285-289.

Deo P., Nayak R., and Rajpura J. (2013). Women's attitudes and health beliefs toward osteoporosis screening in a community pharmacy. *Journal of Osteoporosis, 2013,* 1-8.

Duckham R. L., Masud T., Taylor R., Kendrick D., Carpenter H., Iliffe S., Morris R., Gage H., Skelton D. A., Dinan-Young S., and Brooke-Wavell K. (2015). Randomised controlled trial of the effectiveness of community group and home-based falls prevention exercise programmes on bone health in older people: The ProAct65+ bone study. *Age Ageing, 44(4),* 573-579.

Eekman D. A., van Helden S. H., Huisman A. M., Verhaar H. J. J., Bultink I. E. M., Geusens P. P., Lips P., and Lems W. F. (2014). Optimizing fracture prevention: The fracture liaison service, and observational study. *Osteoporosis International, 25(2),* 701-709.

Elliott M. E., Meek P. D., Kanous N. L., Schill G. R., Weinswig P. A., Bohlman J. P., Zimpel C. L., Jensen B. C., Walters D. R., Sutter S. L., Peterson A. N., Peterson R. M., and Binkley N. C. (2002). Osteoporosis screening by community pharmacists: Use of the National Osteoporosis Foundation resources. *Journal of the American Pharmacists Association, 42(1),* 101-111.

Forster-Burke D., Ritter L., and Zimmer S. (2010). Collaboration of a model osteoporosis prevention and management program in a faith community. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 39(2),* 212-219.

Francis K. L., Matthews B. L., Van Mechelen W., Bennell K. L., and Osborne R. H. (2009). Effectiveness of a community-based osteoporosis education and self-management course: A wait list controlled trial. *Osteoporosis International, 20(9),* 1563-1570.

Gianoudis J., Bailey C. A., Ebeling P. R., Nowson C. A., Sanders K. M., Hill K., and Daly R. M. (2014). Effects of a targeted multimodal exercise program incorporating high-speed power training on falls and fracture risk factors in older adults: A community-based randomized controlled trial. *Journal of Bone and Mineral Research, 29(1),* 182-191.

Goode J.-V., Swiger K., and Bluml B. M. (2004). Regional osteoporosis screening, referral and monitoring program in community pharmacies: Findings from the Project ImPACT: Osteoporosis. *Journal of the American Pharmacists Association, 44(2),* 152-160.

Hamel M. E., Sebaldt R. J., Siminoski K., Adachi J. D., Papadimitropoulos E., Petrie A., and Goldsmith C. H. (2005). Influence of fracture history and bone mineral testing on the treatment of osteoporosis in two non-academic community centers. *Osteoporosis International, 16(2),* 208-215.

Harvey N., Dennison E., and Cooper C. (2010). Osteoporosis: impact on health and economics. *Nature Reviews Rheumatology, 6,* 99-105.

Heyworth L., Kleinman K., Oddleifson S., Bernstein L., Frampton J., Lehrer M., Salvato K., Weiss T. W., Simon S. R., and Connelly M. (2014). Comparison of interactive voice response,

patient mailing, and mailed registry to encourage screening for osteoporosis: A randomized controlled trial. *Osteoporosis International, 25(5),* 1519-1526.

Hien V. T., Khan N. C., Mai le B., Lam N. T., Phuong T. M., Nhung B. T., Nhien N. V., Nakamori M., and Yamamoto S. (2009). Effect of community-based nutrition education intervention on calcium intake and bone mass in postmenopausal Vietnamese women. *Public Health Nutrition, 12(5),* 674-679.

Johnell O., Kanis J. A., Oden A., Sernbo I., Redlund-Johnell I., Petterson C., De Laet C., Jonsson B. (2004). Mortality after osteoporosis fractures. *Osteoporosis International, 15(1),* 38-42.

Johnson C. S., McLeod W., Kennedy L., and McLeod K. (2008). Osteoporosis health beliefs among younger and older men and women. *Health Education & Behavior, 35(5),* 721-733.

Kanis J. A., Cooper C., Hiligsmann M., Rabenda V., Reginster J.-Y., and Rizzoli R. (2011). Partial adherence: A new perspective on health economic assessment in osteoporosis. *Osteoporosis International, 22(10),* 2565-2573.

Kanis J. A., Melton L. J., Christiansen C., Johnston C. C., and Khaltaev N. (1994). Perspective: The diagnosis of osteoporosis. *Journal of Bone Mineral Research, 9(8),* 1137-1141.

Kim K., Han I.-K., Kim H., and Cho N. H. (2001). How reliable is the ultrasound densitometer for community screening to diagnose osteoporosis in spine, femur and forearm? *Journal of Clinical Densitometry, 4(2),* 159-165.

Kronhed A.-C. G., Blomber C., Lofman O., Timpka T., and Moller M. (2006). Evaluation of an osteoporosis and fall risk intervention program for community-dwelling elderly. A quasi-experimental study of behavioral modifications. *Aging Clinical and Experimental Research, 18(3),* 235-241.

Laliberte M.-C., Perreault S., Damestoy N., and Lalonde L. (2013). The role of community pharmacists in the prevention and management of osteoporosis and the risk of falls: Results of a cross-sectional study and qualitative interviews. *Osteoporosis International, 24(6),* 1803-1815.

Law A. V., and Shapiro K. (2005). Impact of a community pharmacist-directed clinic in improving screening and awareness of osteoporosis. *Journal of Evaluation in Clinical Practice, 11(3),* 247-255.

Leboime A., Confavreux C B., Mehsen N., Paccou A., David C., and Roux C. (2010). Osteoporosis and mortality. *Joint Bone Spine, 77(2),* S107-S112.

Lin L.-P., Hsu S.-W., Yao C.-H., Lai W.-J., Hsu P.-J., Wu J.-L., Chu C. M., and Lin J.-D. (2015). Risk of osteopenia and osteoporosis in institution-dwelling individuals with intellectual and/or developmental disabilities. *Research in Developmental Disabilities, 36,* 108-113.

Lips P., and van Schoor N. M. (2005). Quality of life in patients with osteoporosis. *Osteoporosis International, 16(5),* 447-455.

Liu Y., Nevins J. C., Carruthers K. M., Doucette W. R., McDonough R. P., and Pan X. (2007). Osteoporosis risk screening for women in a community pharmacy. *Journal of the American Pharmacists Association, 47(4),* 521-526.

Lord S. R., Ward J. A., Williams P. and Zivanovic E. (1996). The effects of a community exercise program on fracture risk factors in older women. *Osteoporosis International, 6(5),* 361-367.

MacLaughlin E. J., MacLaughlin A. A., Snella K. A., Winston T. S., Fike M. S., Raehl C. R. (2005). Osteoporosis screening and education in community pharmacies using a team approach. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy, 25(3),* 379-386.

Marshall D., Johnell O., and Wedel H. (1996). Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. *BMJ, 312(7041),* 1254-1259.

McNamara A., and Gunter K. (2012). The influence of participation in Better Bone and Balance on skeletal health: Evaluation of a community-based exercise program to reduce fall and fracture risk. *Osteoporosis International, 23(6),* 1813-1822.

Melton L. J., Johnell O., Lau E., Mautalen C. A., and Seeman E. (2004). Osteoporosis and global competition for health care resources. *Journal of Bone and Mineral Research, 19(7),* 1055-1058.

Morales-Torres J. (2007). Strategies for the prevention and control of osteoporosis in developing countries. *Clinical Rheumatology, 26(2),* 139-143.

NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy. (2001). Osteoporosis prevention, diagnosis, and therapy. *Journal of the American Medical Association, 285(6),* 785-795.

Oh E. G., Yoo J. Y., Lee J. E., Hyun S. S., Ko I. S., and Chu S. H. (2014). Effects of a three-month therapeutic lifestyle modification program to improve bone health in postmenopausal Korean women in a rural community: A randomized controlled trial. *Research in Nursing & Health, 37(4),* 292-301.

Pearson J. A., Burkhart E., Pifalo W. B., Palaggo-Toy T., and Krohn K. (2005). A lifestyle modification intervention for the treatment of osteoporosis. *American Journal of Health Promotion, 20(1),* 28-33.

Plawecki K., and Chapman-Novakofski K. (2013). Effectiveness of community intervention in improving bone health behaviors in older adults. *Journal of Nutrition in Gerontology and Geriatrics, 32(2),* 145-160.

Ribeiro V., and Blakeley J. A. (2001). Evaluation of an osteoporosis workshop for women. *Public Health Nursing, 18(3),* 186-193.

Rohr C. I., Clements J. M., and Sarkar A. (2006). Treatment and prevention practices in postmenopausal women after bone mineral density screening at a community-based osteoporosis project. *Journal of the American Osteopathic Association, 106(7),* 396-401.

Rohr C. I., Sarkar A., Barber K. R., and Clements J. M. (2004). Prevalence of prevention and treatment modalities used in populations at risk of osteoporosis. *Journal of the American Osteopathic Association, 104(7),* 281-287.

Rosenstock I. M. (1966). Why people use health services. *The Milbank Memorial Fund Quarterly, 44(3)*, 94-124.

Sedlak C. A., Doheny M. O., and Estok P. J. (2000). Osteoporosis in older men: Knowledge and health beliefs. *Orthopaedic Nursing, 19(3),* 38-46.

Sedlak C. A., Doheny M. O., and Jones S. L. (2000). Osteoporosis education programs: Changing knowledge and behaviors. *Public Health Nursing, 17(5),* 398-402.

Si L., Winzenberg T. M., and Palmer A. J. (2014). A systematic review of models used in cost-effectiveness analyses of preventing osteoporotic fractures. *Osteoporosis International, 25(1),* 51-60.

Sujic R., Gignac M. A., Cockerill R., and Beaton D. E. (2011). A review of patient-centred post-fracture interventions in the context of theories of health behaviour change. *Osteoporosis International, 22(8),* 2213-2224.

Szulc P., Garnero P., Marchand F., and Delmas P. D. (2001). Cross-sectional evaluation of bone metabolism in men. *Journal of Bone and Mineral Research, 16(9),* 1642-1650.

Szulc P., Kaufman J. M., and Orwoll E. S. (2012). Osteoporosis in men. *Journal of Osteoporosis, 2012,* 1-5.

Tan A. M., Lamontagne A. D., Sarmugam R., and Howard P. (2013). A cluster-randomised, controlled trial to assess the impact of a workplace osteoporosis prevention intervention on the dietary and physical activity behaviours of working women: A study protocol. *BMC Public Health, 13,* 405.

Teems J., Hausman D. B., Fischer J. G., Lee J. S., and Johnson M.A. (2011). Older adults attending Georgia senior centers increase preventive behaviors for falls and fractures following a community-based intervention. *Journal of Nutrition in Gerontology and Geriatrics, 30(1),* 72-85.

Tussing L., and Chapman-Novakofski K. (2005). Osteoporosis prevention education: Behavior theories and calcium intake. *Journal of the American Dietetic Association, 105(1),* 92-97.

U.S. Department of Health and Human Services. (2004). *Bone Health and Osteoporosis: A Report of the Surgeon General*. U.S. Department of Health and Human Services: Office of the Surgeon General, Rockville, MD, USA.

Yong J. H. E., Masucci L., Hoch J. S., Sujic R., and Beaton D. (2016). Cost-effectiveness of a fracture liaison service--a real world evaluation after 6 years of service provision. *Osteoporosis International, 27(1),* 231-240.

Figure 1: Flowchart of studies included in systematic review

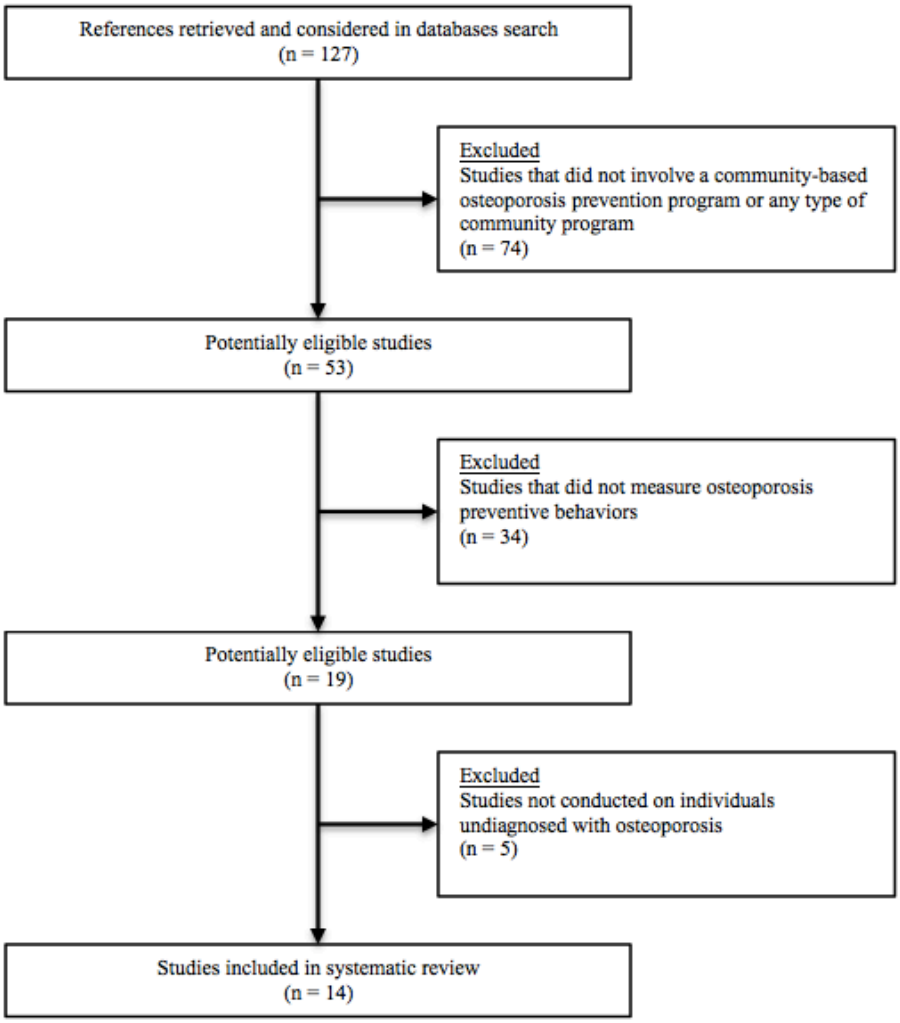

Table 1

Aspects of Community-Based Osteoporosis Prevention Programs and Osteoporosis Preventive Behaviors Among Individuals Undiagnosed With Osteoporosis

Study Reference (n = 14)	Study Design and Duration	Setting and Location	Depictions and Description of Participants	Details and Description of Community-Based Osteoporosis Prevention Program	Types and Outcomes of Osteoporosis Preventive Behaviors
Oh et al., 2014.	Experimental Study, 3 months/12 weeks.	Rural Community; Community Health Care Center in One Province in South Korea.	Treatment Group that received intervention (n = 21): Postmenopausal Korean women, mean age = 65.95 years old (S.D. +/- 8.59). Individuals with osteoporosis at pretest (n = 7, 33%).	Therapeutic Lifestyle Modification (TLM) with 4 parts: (1) Individualized Health Monitoring - general health assessment, blood pressure, pulse rate, body weight, food diary [all twice weekly]; (2) Group Health Education - osteoporosis definition, risk factors, diagnosis and classification, symptoms and treatment, management and prevention; calcium intake for bone health, exercise for bone health pts. 1 & 2, osteoporotic fracture prevention [each 2 weeks]; (3) Group Exercise - "Be BoneWise" warm-up stretching, rhythm aerobics, resistance band strength training, floor exercise, cool-down exercise [twice weekly]; (4) calcium-vitamin D supplementation - 600mg calcium carbonate and 400IU vitamin D [daily].	At Posttest - (1) Calcium Intake: Significant increase in the intake of dairy foods ($p < 0.001$), calcium-rish fish ($p < 0.001$), nuts ($p < 0.001$), and vitamin D-rich foods such as fish ($p < 0.001$) and vegetables ($p < 0.001$) in the TLM group, but slightly in the control group. (2) Weight-Bearing Exercise: Significant increase in regular weekly exercise ($p = 0.005$) in TLM group at baseline and among the control group.
Plawecki & Chapman-Novakofski, 2013.	Experimental Study, 8 weeks.	Osher Lifelong Learning Institute at the University of Illinois at Urbana-Champaign; Illinois, United States.	Treatment Group that received intervention (n = 35). Article included description and demographic information for total participants in the study, but did not include separate description and demographic information for the treatment and control group. For all participants, mean age = 65.5 years old (S.D. +/- 9.6), 83% female, 90% White, 53% retired, 67% with no history of osteoporosis (but did not specify if meant individual and/or family history of osteoporosis), and 81% had previous bone scan.	Bone health program based on 2 theoretical behavioral change theories: Health Belief Model (HBM) and Theory of Reasoned Action (TRA). Each week consisted of 1-hour sessions of topics that included lectures with hands-on active learning. Sessions 1-8: (Topic in quotations with Activities): (1) "Overview of Bone Health, Severity of Bone Health" with bone density testing; (2) "Susceptibility to Osteoporosis and Risk Factors" with body frame measurement and risk factor quiz; (3) "Overcoming Barriers to Reducing Risk Factor: Healthy Bone Diet" with serving size estimation and meal planning; (4) "Self-Efficacy: Achieving Benefits From Reducing Risk Factors: Healthy Bone Diet" with food label critique taste tests; (5) "Overcoming Barriers to Reducing Risk Factors: Improving Exercise Habits" with heel drops; (6) "Overcoming Barriers to Reducing Risk Factors: Fall Prevention & Balance" with balance and posture exercises; (7) "Medications, Supplements & Soy" with smoothie taste testing; (8) "Better Bone Graduate" with bone healthy meal "Bone Health Jeopardy"	At Posttest - (1) Calcium Intake: Significant increase in calcium intake ($p = 0.005$, $p = 0.001$) and vitamin D intake ($p < 0.001$) in the treatment group from the start to the end of the study, but there was no significant difference between the treatment and the control group at the end of the study. (2) Weight-Bearing Exercise: No significant difference in the treatment or control group.
Babatunde, Himburg, Newman, Campa, & Dixon, 2011.	Experimental Study, 6 weeks.	Church and community-based organizations; 3 south Florida counties, United States.	Treatment Group that received intervention (n = 59). All Black adults, 51 women and 8 men, ages 50-92 years of age with mean age = 70.2 years old.	Program based on a revised HBM. Each week consisted of 30-45 minute lessons of topics that included short presentations/lectures, hands-on activities, and demonstrations involving participants to increase their self-efficacy. Lessons 1-6: (1)"Severity of osteoporosis; (2) Susceptibility of osteoporosis; (3) Benefits of changing calcium intake [with hands-on activities]; (4) Barriers to reducing risk factors (calcium intake) - lactose intolerance [with hands-in activities]; (5) Barriers to reducing risk factors - improving vitamin D, reducing alcohol intake and smoking, supplements considerations [with hands-on activities]; (6) Facts and fallacies or additional considerations - other dietary considerations, medications, and bone density testing, with a summary.	At Posttest - (1) Calcium Intake: Significant increase in calcium intake ($p < 0.001$) in the treatment group, but not the control group (wait-list group).

Teems, Hausman, Fischer, Lee, & Johnson, 2011.	Intervention Study (Non-Experimental), 16 weeks.	Senior Centers; Georgia, United States.	691 participants, mean age = 74.7 years old (S.D. +/- 7.8), 83.9% women and 16.1% men; 53.7% White, 45.6% Black, 0.7% Other.	Program based on the HBM. 16 wellness lectures with 8 lessons about fall and fracture prevention, each administered once and lasting 45-60 minutes and incorporated 30 minutes of physical activity. Lessons 1-8: (Title in quotations and topics) (1) "Five Goals to Fight Falls and Fractures-First Talk To My Doctor" about osteoporosis risk factors and consequences; and introduction to 5 key messages of the program (a) be physically active, (b) eat healthy and use calcium and vitamin D supplements if needed, (c) take doctor-recommended medicines, (d) fall prevention at home, (e) discuss medications, fall risk, vision, bone mineral testing with doctor; (2) "Be Physically Active Everyday" about physical activity benefits; (3) "Calcium and Vitamin D Supplements-Part of Healthy Eating" about reading supplement labels and determining amounts needed; (4) "Eat Healthy-Calcium and Vitamin D in Foods" about calcium and vitamin D sources, lactose intolerance; (5) "Eat Healthy-Other Foods for Bone Health" about foods that positively/negatively affect bone; (6) "Take My Medicines" about medications that treat osteoporosis and increase fall risk; (7) "Fight Falls with a Safe Home" about improving home safety and preventing falls; (8) "Putting it All Together to Fight Falls and Fractures" that reviewed the 5 key messages from Lesson 1.	At Posttest - (1) Calcium Intake: Significant increase in the intake of calcium-rich and vitamin D-rich foods ($p < 0.001$) as well as use of calcium and vitamin D supplements ($p < 0.001$). (2) Weight-Bearing Exercise: Significant increase in days of week of physical activity ($p < 0.001$). (3) Other: Significant increase in fall preventive home safety behaviors ($p < 0.001$).
Francis, Matthews, Van Mechelen, Bennell, & Osborne, 2009.	Experimental Study, 6 weeks.	Australian community; Australia.	Treatment group that received the intervention (n = 103). Article included description and demographic information for total participants in the study, but did not include separate description and demographic information for the treatment and control group. For all participants, mean age = 63 years old, 92% women.	The Osteoporosis Prevention and Self-Management Course (OPSMC). Participants received "Everybody's Bones" course manual and attended 4 weekly 2-2.5 hours sessions for first 4 weeks (posttest 2 weeks after 4th week). Sessions 1-4: (1) Participants identify what osteoporosis means to them and motivational factors for attending, introduction to self-management and osteoporosis [basic bone physiology and osteoporosis consequences], dispelling myths, weight-bearing physical activity benefits and different forms of exercise, starting a personal exercise regimen, and goal setting for osteoporosis prevention or management; (2) Action plan feedback and problem solving, examine osteoporosis risk factors [modifiable and unmodifiable], the importance of exercise and solutions for common obstacles to exercise, and reviewing calcium and how to acquire recommended levels even for lactose intolerance, calcium supplements, and action planning; (3) Bone density measurement techniques and for those who need it, managing emotions, osteoporosis medications, communicating with healthcare professionals, and action planning; (4) Good posture and safe bending/lifting demonstrations, pain management review, outside and local support groups, longer-term goals, review of topics covered in all 4 sessions.	At Posttest - (1) Other: Health-Directed Behavior: Significant difference between groups ($p = 0.020$) and significant increase in positive and active engagement of life ($p = 0.048$), skill and technique acquisition ($p = 0.006$), and social integration and support ($p = 0.033$). (These are general health behaviors, but can be applied to osteoporosis preventive behaviors, such as those related to calcium intake and weight-bearing exercise.)
Hien et al., 2009.	Experimental Study, 18 months.	2 separate community health centers; Thanh Mien rural district of Hai Duong, Vietnam.	Treatment group that received the intervention (n = 57). Article included description and demographic information for total participants in the study, but did not include separate description and demographic information for the treatment and control group, though there were no significant differences between groups. For all participants, all postmenopausal women 55-65 years of age, mean age = 57.6 years old (S.D. +/- 3.0).	Participants attended training courses and were taught about osteoporosis, and explored seasonal and local calcium-rich foods and were taught how to prepare meals with them based on guided menus while being guided with visual aids such as posters, leaflets, booklets and videos. A loudspeaker daily repeated lession summaries and educational messages such as "Take calcium-rich foods everyday to enhance your bone health." and "Take guided menu into your meals to reach enough calcium intake." Participants also tracked calcium-rich foods on recording sheets. And participants attended weekly group discussions with other participants, collaborators, and nutrition experts to share calcium-rich meals brought from home and share experiences in preparing calcium-rich meals in order to assess knowledge and receive feedback from nutrition experts.	At Posttest - (1) Calcium Intake: Significant increase in calcium intake ($p < 0.01$) for the treatment group, but no significant difference in the control group.

Kronhed, Blomber, Lofman, Timpka, & Moller, 2006.	Quasi-Experimental Study, 3-year and 5-year follow-ups.	2 different communities; Intervention community in Vadstena, a semi-rural town in Ostergotland, Sweden.	Intervention community: 3-year follow-up (n = 352), 5-year follow-up (n = 219). All participants at least 65 years of age. Both men and women in the community, but unspecified percentage of each.	Vadstena Osteoporosis and fall Prevention Project (VOPP). Participants in intervention community received health education to increase osteoporosis and fall awareness and risk factors, and to promote public physical activity. Posters about osteoporosis were displayed throughout the community. Public seminars, local press and cable television repeatedly discussed osteoporosis and fall consequences. Public was informed on fall prevention and where to purchase fall prevention aids, along with available balance training.	At 5-Year Follow-Up - (1) Weight-Bearing Exercise: No significant difference.
Rohr, Clements, & Sarkar, 2006.	Prospective Cohort Study, Follow-up time unspecified.	Screenings at local senior centers, living facilities, and health fairs. Follow-up telephone surveys.	219 older women at follow-up, ages 59-86 years of age with mean age = 74.9 year old. At screening, 77 (35.2%) had normal bone mineral density (BMD), 142 (64.8%) had low BMD (osteoporosis or osteopenia).	Large community-based osteoporosis screening program. Participants were assessed for risk, screening was conducted using dual-energy x-ray absorptiometry (DXA), and referred to follow-up care. Patients also received lifestyle counseling, calcium intake recommendations, and recommendations for follow-up with primary care physicians for osteoporosis prevention and treatment practices.	At Follow-Up - (1) Calcium Intake: Significant increase in calcium supplement use in both groups, for the group of women with normal BMD ($p = 0.002$) and the group of women with low BMD ($p = 0.001$).
Hamel et al., 2005.	Prospective Cohort Study, 3-month follow-up.	2 non-academic BMD testing sites; 1 in eastern Canada in Guelph, Ontario, and 1 in western Canada in Edmonton, Alberta. Follow-up mail.	1057 participants at 3-month follow-up. Article included description and demographic information for total participants at beginning of the study, but did not include separate description and demographic information for only those at follow-up. For all participants at beginning of the study (n = 1323), all were women over 20 years of age with a mean age = 57.8 years old (S.D. +/- 11.6), 29% had history of at least 1 fracture after 20 years of age, 24% had normal BMD, 27% had osteopenia, 46% had osteoporosis.	BMD testing.	At Follow-Up - (1) Calcium Intake: Significant increase in calcium intake ($p < 0.001$) with greatest increase in participants with BMD results showing osteoporosis, followed by participants with BMD results showing osteopenia, but both were not significantly greater than the increase in participants with normal BMD. (2) Weight-Bearing Exercise: No significant difference.
Pearson, Burkhart, Pifalo, Palaggo-Toy, & Krohn, 2005.	Intervention Study (Non-Experimental), 8 weeks with 6-month and 2-year follow-ups.	Community-based setting; unspecified location.	375 participants (367 women and 8 men), ages 44 to 90 years of age with a mean age = 67 years old (81% over 60 years of age), and 98% White.	Highmark Osteoporosis Prevention and Education (HOPE) program. 2.5-hour sessions twice per week for 8 weeks. Each session consisted of supervised exercise with resistance bands and 30-40 minutes of aerobic exercises, and participants were instructed on strength-training exercises and aerobic weight-bearing exercises to complete on their own time to meet recommendations established by the American College of Sports Medicine (ACSM). Participants were advised on calcium and vitamin D intake recommendations established by the National Institutes of Health/National Osteoporosis Foundation. Participants individually met with program pharmacist to discuss pharmacological interventions based on risk factors for fractures and were advised to discuss this with their primary physician. And conducted in-home safety assessments, proper lifting and bending techniques, and proper body mechanics for fall prevention.	At Both 6-Month and 2-Year Follow-Ups - (1) Calcium Intake: Significant increase in calcium intake and vitamin D intake ($p < 0.001$). (2) Weight-Bearing Exercise: Significant increase in strength-training and aerobic weight-bearing exercise ($p < 0.001$).

Tussing & Chapman-Novakofski, 2005.	Intervention Study (Non-Experimental), 8 weeks.	Simulated community class setting; unspecified location.	42 participants, all women, were 32-67 years of age with a mean age = 48 years old. 80% White and 21% had family history of bone fracture.	Osteoporosis prevention education program based on 2 theoretical behavioral change theories: HBM and TRA. Each week consisted of lessons of topics that included short lectures with hands-on activities to increase self-efficacy and distribution of handouts to reinforce learned behaviors. Lessons 1-8: (Topic in quotations with example activities): (1) "Severity of osteoporosis" with bone fragility demonstration; (2) "Susceptibility to osteoporosis" with anthropometric measures and risk factor quiz; (3) "Overcoming barriers to reducing risk factors: calcium intake" with portion size identification of calcium-rich foods; (4) "Achieving benefits from reducing risk factors: changing calcium intake" with food label calculations; (5) "Overcoming barriers to reducing risk factors: improving exercise habits, alcohol intake, smoking, protein, caffeine" with balance exercise demonstrations and posture practice; (6) "Medications, hormone replacement therapy, bone density tests" with portion practice of calcium-rich foods; (7) "Facts and fallacies: supplements, lactose intolerance, vitamin D" with lactose-free milk and soy milk tasting and supplement label reading practice; (8) "You can do it-be a better bone graduate" with high-calcium recipe sharing, luncheon of calcium-rich foods, and recipe contest.	At Posttest - (1) Calcium Intake: Significant increase in calcium intake ($p < 0.0001$).
Cerulli & Zeolla, 2003.	Intervention Study (Non-Experimental), 3-months.	6 community pharmacies; unspecified location.	107 participants completed posttest, all women at least 18 years of age. Article included description and demographic information for total participants at beginning of the study, but did not include separate description and demographic information for only those at follow-up. For all participants at beginning of the study (n = 140), mean age = 61.3 years old (S.D. +/- 13.4); 64 (46%) had low osteoporosis risk, 59 (42%) had medium osteoporosis risk, 17 (12%) had high osteoporosis risk; 16 (11%) were diagnosed with osteoporosis and 47 (34%) were on osteoporosis therapy, and 67 (48%) self-reported calcium supplement use.	Community pharmacy-based BMD screening and education program lasting either 1 or 2 days. BMD testing was conducted with a portable ultrasound BMD device that took approximately 3 minutes. BMD results were printed and pharmacist or final-year doctor of pharmacy student reviewed results with participants to inform their level of osteoporosis risk but reminded that the test did not constitute osteoporosis diagnosis and encouraged reviewing results with their physicians. Education was provided verbally about lifestyle modification on diet, exercise, fall prevention, smoking cessation, and calcium recommendations, with use of supplemented printed education materials from the National Osteoporosis Foundation and the American College of Obstetricians and Gynecologists.	At Posttest - (1) Calcium Intake: Increase in calcium and vitamin D intake (p-value unreported). (2) Weight-Bearing Exercise: Increase in exercise habits (p-value unreported).
Brecher et al., 2002.	Experimental Study, 3 months.	Unspecified setting; unspecified location.	Treatment group that received the intervention (n = 51). For all participants, all community-dwelling women ages 25 to 75 years of age with a mean age = 55 years old (S.D. +/- 13.7), 46 (94%) White and 3 (6%) Asian, 18 (35%) had family history of osteoporosis but 0 (0%) were diagnosed with osteoporosis.	A 3-hour multidisciplinary, interactive primary osteoporosis prevention program. Program consisted of: (1) "Medical Issues" with a presentation on osteoporosis risk factors and consequences, osteoporosis prevention and treatment; (2) "Dietary Recommendations" with an experiential presentation on calcium and vitamin D for osteoporosis prevention and treatment, calcium sources and portion sizes, lactose-free calcium options, and factors that hinder calcium absorption, including food models with tasting opportunities and recipe sharing; (3) "Exercise" with an interactive presentation on exercises for spinal flexibility and posture, resistance training and weight-bearing aerobic exercise, proper exercise technique and injury risk reduction, and most beneficial weight-bearing exercises for osteoporosis prevention, while also using available exercise equipment at the on-site fitness center	At Posttest - (1) Calcium Intake: No significant difference in calcium intake. (2) Weight-Bearing Exercise: No significant difference in exercise activity.

Ribeiro & Blakeley, 2001.	Semi-Experimental, 6 months.	Workshop; Canada.	Treatment group that received the intervention (n = 59). All women, most (81%) were ages 45 to 69 years of age, 63% reached menopause, 6% were diagnosed with osteoporosis..	Workshop developed by a Canadian community health agency designed to educate women about osteoporosis and encourage them to prevent or treat it. Presented information in lecture format, with question-and-answer and discussion sessions, and practice of weight-bearing exercises.	At Posttest - (1) Calcium Intake: No significant difference in calcium intake or calcium and vitamin D supplementation. (2) Weight-Bearing Exercise: No significant difference in weight-bearing exercise.