

Background

This community-based health promotion program for postmenopausal women with osteopenia and osteoporosis will be guided by the Health Beliefs Model (HBM), address individual and interpersonal determinants of health, consist of evidence-based interventions that share a common goal of reducing fracture risk among participants, and utilize outcome measures that demonstrate program efficacy and progress toward the program goal.

The first program intervention is an education and skills training class focused on improving diet, specifically increasing calcium and vitamin D intake to meet daily recommendations (800-2000 IU/day of vitamin D and 1000mg/day of calcium) and decreasing alcohol and caffeine intake, to improve bone health and reduce fracture risk.¹ Education will highlight HBM constructs such as perceived susceptibility to and severity of fractures as well as perceived benefits of and barriers to diet modification.²⁻⁵ Education will improve participants' knowledge and health literacy, which are important health determinants at the individual level, and are associated with performance of health behaviors.^{6, 7} Skills training will also improve participants' self-efficacy by facilitating mastery experiences related to diet behaviors, including reading food labels, identifying calcium rich foods, and meal planning, which will ultimately increase independent performance of these behaviors.³⁻⁶ Studies have shown that diet education and skills interventions, particularly those that utilize a behavior change model like the HBM, are effective at significantly increasing vitamin D and calcium intake.^{3-5, 8} Three such studies implemented education and skills programs that used the same interventions as described above in approximately 1 hour sessions over the course of 4,

8, and 10 weeks.³⁻⁵ Each of these programs was successful at significantly increasing calcium and vitamin D intake among participants, and helped participants meet the daily recommended value of 1000mg/day for calcium intake, therefore improving bone health and reducing fracture risk.^{1, 3-5} One of these interventions also resulted in significant increases in participant self-efficacy, as demonstrated by improvements in Osteoporosis Self-Efficacy Scale scores.³ To reproduce these positive health outcomes, this program will hold classes 1 hour weekly for 3 months using the evidence-based education and skills interventions described above.

The second program intervention is a high intensity resistance and impact training (HiRIT) group exercise class to improve bone health and reduce fracture risk. This exercise class will be guided by HBM constructs of perceived benefits and self-efficacy to increase exercise performance. Program leaders will teach participants about the benefits of exercise and facilitate mastery experiences among participants to increase their likelihood of exercising.⁶ This group exercise class will also facilitate social support among participants, which is a health determinant at the interpersonal level that facilitates behavior change and improved self-efficacy.⁶ Group-based weight-bearing exercise interventions are more successful in promoting exercise participation among women with osteoporosis than individually based-interventions, likely due to the effects of social support.⁸ Studies have shown that HiRIT, when performed at 80-85% of a participant's 1 repetition maximum (1RM) to ensure adequate bone stimulation, can increase bone mineral density (BMD) at the lumbar spine and femoral neck in women with osteoporosis.⁸⁻¹¹ 5 sets of 5 repetitions of resistance exercises such as deadlifts, overhead press, and back squats at this intensity in addition to impact loading by

jumping chin ups and drop landings, stepping, stamping, jumping, and running will be performed as a part of this program intervention.^{10,11} These activities, when performed between 1 and 3 hours weekly for 8 to 12 months, can increase lumbar spine, femoral neck, and total femoral BMD, indicating improved bone health.^{10,11} Therefore, to reproduce these positive health outcomes, this program will hold 1 hour HiRIT classes weekly for 12 months using the exercises and parameters described above.

The third program intervention is a balance training group exercise class to reduce falls and therefore fracture risk. In the same manner as the second intervention, this class will be guided by HBM constructs of perceived benefits and self-efficacy and facilitate social support to improve performance of exercise among participants.⁶ Twice weekly, hour long balance interventions that include 2 sets of 8-12 repetitions of moderately intense back, torso, and lower extremity muscle strengthening as well as dynamic balance activities have shown to significantly improve balance and falls efficacy over the course of 12 weeks as evidenced by improvements in Four Square Step Test (FSST), 30 Second Sit to Stand, and Falls Efficacy Scale- International scores.¹² In addition, moderately to highly challenging balancing training that is performed for the slightly longer duration of at least 50 hours, or 2 hours per week for 25 weeks, has been shown to effectively reduce falls risk.¹³ One program that exceeded these parameters and implemented similar interventions to those described above resulted in fewer falls and lower relative risk of falling among participants compared to controls as well as significant improvements in balance as demonstrated by Berg Balance Scale and TUG scores.¹⁴ To reproduce both the benefits of improved balance

and decreased falls risk among participants, this program will hold 1 hour balance classes weekly for 12 months utilizing the exercises and parameters described above.

The first program outcome measure will be the FRAX score, which will determine changes in fracture risk based on participation in bone health interventions such as the diet and HiRIT classes. The FRAX score represents the 10-year probability of sustaining a hip fracture or major osteoporotic fracture of the spine, hip, forearm, or humerus.¹⁵ The score considers multiple individual risk factors, including body weight, alcohol consumption, and femoral neck BMD, which are all factors targeted by interventions in this program.¹⁶ If program interventions are effective in creating behavior change and improving bone health, the FRAX score will be affected and participants will demonstrate reduced fracture risk as a result of program participation. Medical treatment of osteoporosis, versus conservative lifestyle management, is recommended when probability of hip fracture is greater than 3% and probability of major osteoporotic fracture is greater than 20%.¹⁵ Therefore, these percentages will be considered as cut-offs to demonstrate the efficacy of diet education and HiRIT as conservative management methods for postmenopausal women with osteoporosis.

The second program outcome measure will be the FSST, which will determine changes in falls risk due to participation in program interventions guided by the HBM. The FSST measures dynamic balance as participants step forward, backwards, and laterally over obstacles.¹⁷ The FSST involves a timed trial of stepping over four canes arranged in a plus sign pattern while facing forward in both clockwise and counterclockwise patterns.¹⁷ FSST times of 15 seconds or greater suggest high risk for multiple falls in older adults similar to those who will be participating in this program.¹⁷

The FSST will be used to demonstrate improvements in dynamic balance and reduction in falls risk as a result of participation in the program balance intervention using the above cut-off score. Because recurrent falls can contribute to fracture risk, this outcome is important to monitor to ensure the program is holistically and adequately reducing fracture risk among participants.

The final program outcome measure will be the TUG, which will determine changes in falls and fracture risk based on participation in the balance training class. The TUG is a part of the US CDC STEADI tool kit for determining falls risk in older adults, and involves a timed trial of standing from a chair, walking 10 feet, returning to the chair, and sitting down.¹³ TUG times of 12 seconds or greater suggest high falls risk.¹³ Additionally, among adults with osteoporosis, a TUG time of greater than 20 seconds is associated with lower lumbar spine and femoral neck BMD and a higher estimated 10 year hip and major/fragility fracture risk, making this test even more relevant to this population.¹⁸ Therefore, the TUG will be used to measure the balance training intervention goal of reducing falls risk and the overall program goal of reducing fracture risk among participants using the above cut-off scores.

By considering the interventions and results of these individual studies and applying the HBM to develop one community-based health promotion program with three bone health and balance interventions for postmenopausal women with osteopenia and osteoporosis, this program will achieve excellent outcomes, including reduced fracture risk among participants, that will be described by several outcome measures.

Program Goals

The overarching goal of this community-based program is to decrease fracture risk among postmenopausal women with osteopenia and osteoporosis by increasing performance of health behaviors related to diet and exercise through participation in program interventions guided by the HBM. Achievement of the following goals will demonstrate that this program successfully improved participant health by increasing performance of health behaviors, improving bone health, reducing falls risk, and reducing fracture risk.

1. At the conclusion of this year long program, participants on average will demonstrate a 10-year probability of hip fracture of 3% or less as calculated by the FRAX score to demonstrate program efficacy in conservatively improving bone health through diet education and HiRIT group exercise classes.¹⁵
2. At the conclusion of this year long program, participants on average will achieve FSST times of 15 seconds or less to demonstrate reduced risk of multiple falls as a result of participation in this program.¹⁷
3. At the conclusion of this year long program, participants on average will achieve TUG times of 12 seconds or less to demonstrate reduced risk of falling and 10-year probability of hip and major osteoporotic fracture as a result of participation in this program.^{13,18}
4. At the conclusion of this year long program, participants will self-report consuming 1000mg/day of calcium and 800-2000IU/day of vitamin D to demonstrate adequate performance of bone health nutritional behaviors and reduced fracture risk as a result of participation in this program.¹

Program Methods

Personnel

One physical therapist will be primarily responsible for administering all aspects of this program, including enrollment, interventions, and assessments, with the assistance of volunteers. The physical therapist will be present for every session of every intervention and will be responsible for providing all diet and exercise related education as well as group exercise class instruction. The physical therapist will recruit and train volunteer undergraduate and graduate students from UNC Chapel Hill to assist in enrollment and delivering diet skills training, maintaining participant safety during HiRIT and balance training classes, and administering patient self-reported and performance-based assessments. Two to six volunteers will be recruited through emails disseminated to allied health programs to ensure adequate supervision of participants.

Location

The community-based program will be held at the Orange County Sportsplex (101 Meadowlands Dr, Hillsborough, NC 27278). Through the Passmore Center, which is Orange County's Hillsborough based senior center, membership to the Sportsplex is available at an initial fee of \$50 plus a \$25 monthly fee for Orange County residents 55 years of age and older.^{19,20} Additionally, the Sportsplex accepts insurance based wellness plans such as Silver Sneakers, Silver & Fit, AARP Supplemental Program, and Renew Active which may cover cost of membership for eligible participants.²⁰ These fees also cover participant access to other group exercise classes, the fitness center, and the pool outside of scheduled program meeting times for independent exercise.²⁰

Enrollment and Program Schedule

Flyers advertising the program will be posted at the UNC main hospital and UNC Hillsborough campuses, local primary care offices, local physical therapy offices, and the Chapel Hill Seymour and Hillsborough Passmore Senior Centers. Flyers will contain basic information about the program, included intended participants, interventions, and health benefits provided, as well as contact information for the physical therapist program administrator. Participants will have the option to enroll via email or in person on the first day of the program. Enrollment will be limited to 30 participants to ensure a minimum ratio of 1 staff member per 10 participants to optimize program safety.

The program will begin on the first Monday of the new year (2022) at 8am at the Sportsplex. Participants will gather at an onsite, indoor basketball court where enrollment will be finalized and initial assessments will be administered by the physical therapist and volunteers to gather baseline demographic and outcome measure data (FRAX score, FSST score, and TUG time). Enrollment and baseline assessment will be immediately followed by initiation of weekly classes according to the schedule below.

Diet education and skills training classes will be held from 9-10am weekly on Mondays at an onsite, indoor basketball court with the balance training group exercise class immediately following at the same location from 10-11am weekly. These times were selected as they do not interfere with other Sportsplex or community programs according to a posted schedule.²¹ HiRIT group exercises classes will be held from 9-10am weekly on Wednesdays at an onsite fitness center that contains all necessary exercise equipment. This time was selected as it does not interfere with other Sportsplex group fitness programs according to a posted schedule.²² All classes will be held for either 3 or 12 months, based on evidence as explained in the following section.

Interventions

The diet education and skills training class will consist of both education and skills training regarding the importance of consuming 1000mg/day of calcium and 800-1000IU/day of vitamin D as well as limiting alcohol and caffeine intake to improve bone health and reduce fracture risk.¹ These interventions will increase knowledge and self-efficacy, which are important individual determinants of health and address the constructs of the HBM, to increase performance of diet related health behaviors.^{2,6} Diet education and skills training classes will be held for one hour weekly according to the previously mentioned schedule for a duration of 3 months, as previously conducted research has demonstrated that similar community-based programs of similar durations can effectively increase calcium intake to recommended values among participants.³⁻⁵ The first half of the program will focus on evidence-based diet education topics and the second half will focus on evidence-based skills training as outlined in the table below.³⁻⁵

Diet education		Diet skills training	
Week 1	Perceived susceptibility to fractures	Week 7	Reading food labels to identify calcium and vitamin D
Week 2	Perceived severity of fractures	Week 8	Identifying calcium rich foods
Week 3	Benefits of calcium	Week 9	Tasting calcium rich foods
Week 4	Benefits of vitamin D	Week 10	Caffeine and alcohol cessation skills
Week 5	Benefits of reducing caffeine and alcohol intake	Week 11	Meal planning with calcium rich foods
Week 6	Barriers to diet modification	Week 12	Meal preparation with calcium rich foods

The HiRIT group exercise class will focus on education and performance of this mode of exercise. Again, education and performance of exercise will improve

knowledge and self-efficacy related to exercise, which are important HBM constructs and represent individual determinants of health.^{2,6} The group based nature of the class will also facilitate behavior change by addressing the interpersonal health determinant of social support.⁶ HiRIT group exercise classes will be held for one hour weekly according to the previously mentioned schedule for a duration of 12 months, as previously conducted research has demonstrated that similar programs of similar durations can effectively improve BMD.^{10,11} Each group exercise class will begin with a 10 minute warm up consisting of dynamic stretches and education about the benefits of HiRIT in improving BMD and reducing fracture risk. 5 sets of 5 repetitions of resistance exercises such as deadlifts, overhead press, and back squats will follow.¹⁰ For the first month of the class, resistance exercises will be performed with body weight only or low loads to ensure safety and proper form.¹⁰ For the remaining months of the program, intensity will be set at 80-85% of a participant's 1RM, as this intensity has been shown to improve bone health.⁸⁻¹¹ Participants will also perform at least 5 sets of 5 repetitions of impact exercises such as jumping chin ups with drop landings, stepping, stamping, and jumping.^{10,11} A brief 5-10 minute cool down will conclude each session.

The balance training group exercise class will also focus on education and performance of this mode of exercise. This class will improve social support, knowledge, self-efficacy, and performance of these health behaviors by addressing determinants of health using the HBM framework.^{2,6} Balance training group exercise classes will be held for one hour weekly according to the previously mentioned schedule for a duration of 12 months, as previously conducted research has demonstrated that similar programs of similar durations can effectively improve balance and reduce falls

risk.¹²⁻¹⁴ Each group exercise class will begin with a 10 minute warm up consisting of dynamic stretches and education about the benefits of balance training in reducing falls and fracture risk. Participants will then perform 2 sets of 8-12 repetitions of back, torso, and lower extremity strengthening exercises such as squats, step ups, upright rows, chest press, and biceps curls at moderate intensity of 13-14 on the Borg Rating of Perceived Exertion (RPE) Scale, with resistance increasing throughout the program from bodyweight to use of free weights or ankle weights to ensure adequate intensity.^{12,14} Participants will also perform 2 sets of 8-12 repetitions of static and dynamic balance activities, including step ups, sideways step ups, exercises on a balance pad, and exercises simulating functional activities, also at moderate intensity as measured by the RPE scale.^{12,14} A 5-10 minute cool down will conclude each session. Participants will be encouraged to attend all classes of all 3 interventions to maximize fracture reduction benefits.

Assessments

As stated previously, an initial assessment of baseline demographic information and program specific outcome measures will be performed on the first day of the program. Attendance will be tracked for every class session and considered when evaluating outcomes. Re-assessments of program specific outcome measures, as well as assessments of participant satisfaction, will be performed on the last Monday of every other month (beginning on the last Monday of February and ending with the final assessment on the last Monday of December), for a total of 7 assessments throughout the program. Assessments, which will be an important component of program evaluation, will be discussed in the subsequent section.

Program Evaluation

Program goals will be assessed by use of outcome measures such as the FRAX score, FSST score, and TUG time as well as self-reported calcium and vitamin D intake on the first day of the program as well on the last Monday of every other month, with the final assessment taking place on the last Monday of December. These outcome measures examine important aspects of the community-based program, including its ability to increase performance of health behaviors, reduce falls risk, and reduce fracture risk.^{13,15,17,18} Therefore, program efficacy will be in part determined by meeting the four aforementioned program goals related to these measures. Self-reported outcomes such as the FRAX score and calcium and vitamin D intake will be anonymously completed by participants with supervision from the physical therapist and volunteers at the beginning of regularly scheduled Monday classes to ensure propriety and cost-effectiveness of the assessment.²³ The physical therapist and volunteers will administer the TUG and FSST to participants at this time and place as well. Although changes on these measures may not be apparent until final assessments due to the nature of expected health outcomes and depending on participant attendance, it is critical to continuously assess program interventions and impact.²⁴

Additionally, participant satisfaction will also be assessed on the last Monday of every other month. The fundamental purpose of evaluating participant satisfaction is to determine if this community-based program has utility to participants by effectively addressing their social determinants of health and health outcomes.²³ Participant satisfaction will be assessed through the administration of anonymously completed paper surveys at the beginning of regularly scheduled Monday classes. Participants will

be asked to comment on the value (both financially and in terms of health benefits), feasibility, and sustainability of program interventions guided by the HBM.²⁴ Information obtained through assessment of participant satisfaction will be used to guide real-time or future improvements in program strategy and implementation as relevant to make the program more meaningful and successful for participants.²⁴

Ultimately, program evaluation will reveal whether or not the program is leading to expected effects in health behavior and health outcome changes and whether or not the program is addressing stakeholder needs.²³ The results of each program evaluation will be shared among the physical therapist, volunteers, and participants by the following Monday classes to transparently demonstrate the effectiveness of the program as well as areas for improvement.²³ Evaluation results will again be used to make real-time collaborative changes to benefit participants as well as guide future iterations of the program.²⁴

Conclusion

Based on a 2019 survey conducted in Orange County, NC, approximately 5.56% of residents report being diagnosed with osteoporosis.²⁵ This represents a significant proportion of the local population; however, no local health promotion programs exist to improve specific health outcomes in this community. Arguably the most important health outcome in this population is fracture risk, as individuals with osteopenia and osteoporosis are more susceptible to fractures, which can contribute to poor health outcomes such as pain, impaired mobility, increased falls risk, loss of independence, disability, reduced quality of life, morbidity, and mortality.^{1,9} This proposed community-based program will implement evidence-based interventions guided by the HBM and

administered by a qualified physical therapist to improve performance of bone health diet and exercise behaviors and reduce falls risk to ultimately reduce fracture risk in this population. This program aims to facilitate performance of targeted health behaviors by improving individual and interpersonal determinants of health, such as knowledge, skills, self-efficacy, and social support through educational and experiential program interventions. By engaging participants in group-based classes and promoting independent performance of health behaviors, this community-based program will result in measurable, meaningful, and sustainable changes in participant health outcomes.

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