ADAPTATION OF THE STRONGWOMAN STRENGTH TRAINING PROGRAM NEW S.T.E.P.S FOR BREAST CANCER PREVENTION, EARLY DETECTION, AND SURVIVORSHIP IN SIX RURAL APPALACHIA PENNSYLVANIA COUNTIES

A Thesis in
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by
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ABSTRACT

**Background:** Elevated mortality and incidence rates for breast cancer have been found in Appalachia. In addition, Appalachian Pennsylvania has one of the highest percentages of late stage breast cancer diagnoses within the Appalachian region; 35% of breast cancer cases were diagnosed at late stage, when treatment is less effective. This area is characterized by a high prevalence of risk factors for breast cancer, including obesity, physical inactivity, no recent screening mammograms, and limited availability of preventative health care. **Methodology:** This study was a multiple-site (n=9) intervention study that delivered the proven StrongWomen strength-training program with a breast health component (StrongWomen: New STEPS) to 139 women at least 40 years of age who resided in Appalachian Pennsylvania. Participants completed the pre- and post-StrongWomen Personal Fitness Evaluation and the StrongWomen Process Evaluation. **Results:** A total of 113 completed the program. In all, 82% of participants increased upper body strength, 87% increased lower body strength, 43% increased upper body flexibility and 71% increased lower body flexibility. A total of 75% of participants indicated improved general health as a result of the program. A total of 5% of participants increased their mammography habits with 77% maintaining their yearly mammography habits before and after the program (n=91); 18% increased their annual clinical breast exam habits by varying degrees while 74% maintained (n=89); and 4% increased breast self exam habits by varying degrees with 39% maintaining (n=87). There were 38% of participants who increased their idea of the importance of early detection while 62% stayed the same as a result of the program. Women reported the StrongWomen program most beneficial due to 45% attitude. **Conclusion:** StrongWomen: New STEPS shows promising outcomes and may be a potential model to address breast cancer prevention, early detection, and survivorship among women residing in rural Appalachia Pennsylvania counties. Further, the program seems to be sustainable due to it being
community-based, using an evidence-based program, and being conducted by two community networks with a history of and capacity for health interventions.
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Chapter 1

Introduction

Elevated mortality and incidence rates for breast cancer have been found in Appalachia [1,2]. Figures 1-1 and 1-2 show the cancer mortality rates in rural and non-rural Appalachia and non-Appalachia US counties [5]. Pennsylvania is one of the 13 states that make up the region of Appalachia.

In addition, Appalachia Pennsylvania has one of the highest percentages of late stage breast cancer diagnoses within the Appalachian region; 35% of breast cancer cases were diagnosed at late stage [3,4], when treatment is less effective. This area is characterized by a high prevalence of risk factors for breast cancer, including obesity, physical inactivity, no recent screening mammograms, and limited availability of preventative health care [2-4]. These issues must be addressed to enhance cancer prevention, early detection and survivorship.

Figure 1-1: Breast Cancer Mortality Among White Women in Appalachia and Non-Appalachia, by Rural and Non-Rural County, 1969-2007.
Figure 1-2: Breast Cancer Mortality Among White Women in Appalachia and Non-Appalachia, by Age, 1969-2007.

Statement of Need/Problem

This study is needed due to the cancer burden in rural Appalachia Pennsylvania where breast cancer mortality, incidence, and stage at late diagnosis are elevated [1-4]. Furthermore, women in this region have a high prevalence of risk factors for breast cancer - no recent screening mammogram, obesity and physical inactivity [3,4]. Appalachian women also tend to be under-insured or have no health insurance at all, along with having limited access to health care providers [2].

Breast cancer was the most frequently diagnosed cancer among females, making up an estimated 26% of invasive cancers in the United States in 2008 [3,4]. Figure 1-3 illustrates the cancer burden in Appalachian counties; the cancer death rates among white women ages 65 and older is much higher in the Northern region of Appalachia including Pennsylvania, for women
under 65 years of age, the difference between the Northern region and the rest of Appalachia is not as but it does appear to be slightly higher than the rest of Appalachia [2].

**Figure 1-3:** County Level Breast Cancer Death Rates Among White Women in Appalachia 1990-1997

A proven program that can be executed within the local community, by community members they know and trust can help these at-risk Appalachian women. This program is needed to help reduce their risk of breast cancer and improve chances of surviving breast cancer, should it be diagnosed. The StrongWomen: New STEPS (Strength Through Exercise, Physical fitness and Support) program will fill that gap by working towards improving awareness of and access to timely breast health care in underserved and hard to reach populations; in addition to enhancing the quality of life for breast cancer survivors. The StrongWomen: New STEPS program is the first to adapt the evidence-based StrongWomen strength-training program for breast cancer prevention, early detection, and survivorship.
Aims

The four aims of the StrongWomen: New STEPS study include: (1) to adapt the StrongWomen program to include breast cancer risk reduction, early detection, and quality of life for breast cancer survivors; (2) to equip six sites and train 12 site leaders (two/site) to deliver the adapted StrongWomen program; (3) to deliver the adapted StrongWomen program to 120 participants (~20 per site); and (4) to evaluate the process and outcomes of the adapted StrongWomen program.

Research Questions

Research Question #1: Can we address the physical activity needs of breast cancer survivors by adapting the published StrongWomen evidence-based program with a breast health component (StrongWomen: New STEPS) in six rural Appalachian counties in Pennsylvania?

a. Hypothesis: The StrongWomen: New STEPS program will help address the physical activity needs of breast cancer survivors and show positive outcomes when adopted for breast cancer prevention, early detection and survivorship among the rural Appalachia women residing in the six Pennsylvania counties.

Research Question #2: Can differences in selected risk factors (fruit and vegetable intake, screening behaviors, yearly screening, clinical breast exam, and self-breast exam), and perceived importance of early detection be attributed to the StrongWomen: New STEPS program offered in the six rural Appalachia counties of Pennsylvania?
a. **Hypothesis:** The selected risk factors (fruit and vegetable intake, screening behaviors, yearly screening, clinical breast exam, and self-breast exam) will improve at post- from pre-test (baseline).

b. **Hypothesis:** Improvements will be observed to the same degree in all women, at all six rural Appalachia counties of Pennsylvania.

*Research Question #3:* Which of the attitude, social-influence, self-efficacy and health belief model constructs (attitude, cognitive, self efficacy, social influence) will show higher prevalence percentage for “What was most beneficial?” about the StrongWomen: New STEPS program offered in the six rural Appalachia counties of Pennsylvania?

a. **Hypothesis:** That a social influence will have a higher percentage, followed by attitude, cognitive, and self-efficacy.

b. **Hypothesis:** This pattern will be observed across all six rural Appalachia counties of Pennsylvania sites.

*Research Question #4:* Can differences in the StrongWomen Personal Fitness Assessment (chair stand, arm curl, 2 minutes step, chair sit and reach, back scratch, 8 foot up and go, and height and weight) from pre- and post- test be attributed to the StrongWomen: New STEPS program offered in the six rural Appalachia counties of Pennsylvania?

a. **Hypothesis:** The StrongWomen Personal Fitness Assessment results will improve at post- from pre-test (baseline).

b. **Hypothesis:** This pattern will be observed across all six rural Appalachia counties of Pennsylvania sites.

c. **Hypothesis:** There will be an inverse relationship between age and StrongWomen Personal Fitness Assessment improvements.
Summary

Appalachia Pennsylvania is a region experiencing many health disparities that have added to the elevated rates of breast cancer mortality, incidence, and late stage diagnosis within this region [3,4]. The need for a proven program to help the women of this area is of high importance.
Literature Review

Chapter 2

Breast Cancer

Among women, breast cancer is the most frequently diagnosed cancer making up an estimated 26% of all invasive cancer cases in the US [3,4]. It is the second leading cause of cancer death; approximately one in eight US women will develop invasive breast cancer over the course of her lifetime [6]. The good news is that some of the risk factors are controllable, including diet and exercise. Studies have shown that women who are physically active have a 30% to 40% lower risk of developing breast cancer compared with sedentary women [7].

Breast cancer survivorship has increased over the years thanks to advances in adjuvant treatments, but these treatments come with complications and have the potential to cause symptoms of depression, fatigue and weight gain. They can also cause the onset of early menopause and osteoporosis. The most effective treatment for early menopause and osteoporosis is hormone replacement therapy (HRT), but more than 60% of women with breast cancer have tumors that are estrogen-receptor positive, where estrogen may promote tumor growth, eliminating HRT as a treatment option [8]. Another option is physical activity and strength training; recent reports have emphasized physical activity and regular weight bearing exercise as an optimal strategy for maintaining bone health after a breast cancer diagnosis [8, 9].

Breast Cancer and Physical Activity

The American College of Sports Medicine suggests that cancer survivors avoid inactivity, continue normal daily activities as much as possible during and after non-surgical treatments and to return to these activities as quickly as possible after surgery (CITE). The physical activity recommendations for cancer survivors are the same as recommendations for all Americans: 150
minutes weekly moderate intensity activity and strength training twice a week, each major muscle group, 8-10 repetitions, 1-3 sets per exercise. Being physically active during and after breast cancer diagnosis has extensive benefits that include both physical and psychological benefits on quality of life for survivors [9, 10]. Studies have found that breast cancer survivors who are physically active have significantly lower rates of recurrence, as well as disease-specific and over-all mortality than those who are sedentary [10]. Around 20 minutes of moderate-intensity physical activity once a day can decrease the risk of death after diagnosis by 40-50% [7].

Breast Cancer and Appalachia

Rural women constitute one of the largest medically underserved groups of breast cancer survivors [11]. The Appalachian PA region has high rates of breast cancer incidence and mortality along with a high percentage of late stage breast cancer diagnoses, with 35% of 2002-06 breast cancer cases being diagnosed at late stage [3, 4]. Early detection through regular mammogram screenings reduces the likelihood of a late stage diagnosis; however, in 2002-06, 25% of women 40 years and older in Appalachian PA had not had a mammogram in the past 2 years [3, 4]. Likewise, about 26% of Appalachian women reported no physical activity in the past month, along with 25% of Appalachian women reporting that they were obese [3, 4].

As shown in Figure 2-1, Appalachia is located in all or part of 13 states, including fifty-two of the 67 counties of Pennsylvania. Appalachia follows the spine of the Appalachian Mountains and has high rates of, unemployment, limited access to health care, behavioral health risks, and poverty. According to several studies, high poverty is linked to cancer incidence and mortality [12]. The National Cancer Institute has designated Appalachia as an area experiencing cancer health disparities [3,4].
The Northern Appalachia Cancer Network (NACN)

The Northern Appalachia Cancer Network (NACN) previously known as the National Leadership Initiative on Cancer (NALIC) has grown since it’s beginning in 1992. One of the initial efforts of the NALIC was to establish cancer coalitions through efforts of local agents of Cooperative Extension and staff from the American Cancer Society with the objective to raise cancer awareness in rural communities through cancer-related outreach and education. Composed of a cross-section of community members, including health care providers, educators, volunteers, businesspersons, and cancer survivors, coalitions seek to reduce the burden of cancer in their own
Currently, 6 NACN coalitions in Pennsylvania serve 6 counties (Clearfield, Crawford, Elk, Greene, Indiana, and Lawrence). NACN also provides cancer education, prevention and control to additional Komen service counties, including Centre, Huntingdon, Juniata, Mercer, and Mifflin [13].

Today, Penn State College of Medicine in Hershey PA serves as the NACN’s headquarters, with Dr. Eugene Lengerich as the Principal Investigator. The NACN has recently developed as a community-academic partnership guided by a 27-member advisory committee dedicated to reducing the cancer burden among the underserved and hard to reach populations. The NACN conducts community-based participatory research, emphasizing data-based assessment of cancer burden in coalition counties. The research done by the NACN is prevention-oriented and relevant to the individual rural communities [13].

StrongWomen Published Program

The StrongWomen Program is a national evidence-based community exercise and nutrition program for women 40 years of age and older. The program was developed based on research conducted by Dr. Miriam Nelson, a professor of Nutrition at the Friedman School of Nutrition Science and Policy and founder and director of the John Hancock Research Center on Physical Activity, Nutrition, and Obesity Prevention at Tufts University and colleagues [14]. It started with a NIH grant in 1989 to examine how strength training might affect bone density and risk factors for osteoporosis for women midlife and older. The study was the first to show that women midlife and older could strength train at a high intensity and become more youthful over time. This success of this study led Dr. Nelson to write the book *StrongWomen Stay Young* in
order to bring the successful research-based exercise direction to women across the country; the book soon became a New York Times bestseller [14]. The StrongWomen program has grown to include both StrongWomen Strength Training and StrongWomen – Healthy Hearts. With requests from a cooperative extension in Alaska to develop an actual curriculum that they could use to teach strength training in a community setting, Dr. Nelson developed the StrongWomen Strength Training Program.

The StrongWomen vision statement states that “StrongWomen envisions a diverse community of women who are fit, strong, and healthy; in turn these empowered women become agents of change for their families, communities, and beyond.” They state that they will accomplish this vision in three ways: (1) Creating, evaluating, and sustaining community-based nutrition, physical activity, and obesity prevention programs across the nation targeting at risk women. (2) Conducting innovative research investigating large scale, sustainable behavior change. (3) Driving social change by empowering women to be agents of change in the area of nutrition, physical activity, and obesity prevention [14]. Today there are thirteen StrongWomen Ambassadors that hold workshop in 8 states, since 2003, over 2,500 leaders have been trained throughout the US and Canada.

The StrongWomen Strength Training Program helps women maintain muscle mass, strength and function as they age. Strength training benefits for older women have shown to: increase muscle mass and strength; improve bone density and reduce risk for osteoporosis and related fractures; reduce the risk for diabetes, heart disease, arthritis, depression, and obesity; and improve self-confidence, sleep and vitality [15]. StrongWomen is a 12-week program (two 1-hour classes per week on nonconsecutive days with participants expected to independently perform the exercises on a third nonconsecutive day of the week) that includes progressive resistance training, balance training, and flexibility exercises. The program utilizes a group setting and educates participants on the effects of diet and exercise on bone health and attaining and maintaining peak
bone mass, along with the support to make appropriate lifestyle changes. The classes, designed for all activity levels, typically last about an hour and include eight to twelve participants. The classes consist of a five to ten minute warm up followed by resistance training, concluding with a five to ten minute cool-down; incorporating a combination of dumbbells, adjustable ankle weights, and body weight, the resistance training exercises work all the major muscle groups.

StrongWomen programs are implemented in local communities by StrongWomen Leaders who are trained in the StrongWomen curriculum. The foundation of the StrongWomen Program is the written manual (the tool kit) and the hands-on training for the program leaders (the workshop) [16]. The program leaders learn how to instruct participants on the strength training and flexibility exercises. Most SW program leaders in addition to the StrongWomen Strength Training Program operate subsequent sessions as a maintenance program. The StrongWomen program leaders also encourage participants to make lasting change; leaders distribute fact sheets with nutrition and exercise information as well as provide information on other local health-related opportunities (e.g., walking clubs).

Theoretical Framework

Attitudes, Social Influences, Self-Efficacy (ASE) Model

The Attitudes, Social Influences, Self-Efficacy (ASE) model is used to explain health behaviors as determined by three proximal cognitive factors: attitudes, social influences, and self-efficacy expectations, as depicted in Figure 2-2. Measuring the outcome expectations of a behavior in a two-step process allows you to assess a person’s attitude. First, determining the pros and cons of a particular behavior, then by measuring both cognitive and emotional outcome beliefs. There are three types of social influences characterized by the ASE model: social norms, perceived behaviors of others, and direct pressure or support to perform a particular behavior. The
level of difficulty in performing a particular behavior and/or the confidence a person has in his or her ability to perform a particular behavior can be measured to determine self-efficacy expectations. One thing the ASE model tells us is that behavior change needs to thought of as a process and to remember that predisposed factors can influence this process, but they can also be changed through interventions [17].

**Figure 2-2: Attitudes, Social Influences, & Self-Efficacy (ASE) Model Schema**

![Attitudes, Social Influence, & Self-Efficacy (ASE) Model](image.png)

Abraham et al., 2000.

**Health Belief Model (HBM)**

The Health Belief Model is a guide to understanding and predicting a person’s health related behavior. This is due to their perception of four important issues: (1) the perceived threat of a potential illness, (2) the person’s susceptibility to that illness, (3) the benefits of taking a preventative action, and (4) the perceived barriers to taking a preventative action (shown in Figure 2-3). Another important aspect of the HBM is “cues to action” (a reminder from a health care provider, or an illness of a family member or friend, etc.), which can provoke or maintain a
certain pattern of behavior. Other modifying factors predisposing a person to a health behavior also need to be considered, such as demographic variables and self-efficacy or a person’s confidence in his or her ability to successfully perform a behavior [18,19].

**Figure 2-3: Health Belief Model Schema**

![Health Belief Model Schema](image)

Chapter 3

Methodology

Risk factors for breast cancer – physical inactivity, obesity, lack of recent screening mammogram, and limited preventive health care are found in higher concentrations within Appalachian Pennsylvania. We addressed these issues by adapting the published StrongWomen evidence-based program with a breast health component in six rural Appalachia counties in Pennsylvania.

This study was a multiple-site (n=6) intervention study with pre- and post-test measurement among 139 women at least 40 years of age who resided in Appalachian Pennsylvania. Prior to beginning the 12-week program, participants completed medical forms and attended an information session. Participants also completed the pre- and post- StrongWomen Personal Fitness Assessment and the post- StrongWomen Process Evaluation.

A team of two site leaders and a Certified Cancer Exercise Trainer (CET) taught the StrongWomen program locally with 8-15 participants at each of the 9 sites. A CET is certified through the American College of Sports Medicine and is a fitness professional who trains cancer patients and survivors; they perform appropriate fitness assessments and make exercise recommendations while demonstrating a basic understanding of cancer diagnoses, surgeries, treatments, symptoms and side effects. Two site leaders are beneficial in order to safely monitor the specific needs and safety of individual participants and are particularly important if women need individualized attention. The site leaders attended a training session that was one and a half days in length and was geographically central to the 9 participating sites. The first day of training followed the standard StrongWomen training program, including small group facilitation, safety, use of the equipment, and expected outcomes. The final half-day of training focused on breast
cancer prevention, early detection, survivorship, and adaptation of the StrongWomen exercises for breast cancer survivors. The site leaders were required to engage in personal strength conditioning for six months after the training but before the StrongWomen program.

**Participant Recruitment/Eligibility Criteria**

Site leaders were recruited through the NACN and the cooperative extensions. The site leaders, coalition partners and instructors promoted the program by use of flyers, posters, newspaper advertising and word of mouth. Two of the counties had existing StrongWomen programs which provided participants who were already participating in a StrongWomen program and helped get the word out about the StrongWomen: New STEPS program. Additional flyers, posters, and newspaper advertising were used to specifically target breast cancer survivors. The eligibility criteria included women who lived in one of the six Appalachian counties of Pennsylvania, who were 40 years and older and who were ready for physical activity as per the Physical Activity Readiness Questionnaire, or had their doctor’s permission to engage in a strength-training program.

**Program Evaluation Measures**

The StrongWomen Personal Fitness Assessment is an objective measure of change in physical parameters that relate to program participation, including muscular strength, endurance, agility, flexibility, and balance [16]. This fitness assessment was excerpted from the Senior Fitness Test [20], which provides norms for each of the physical assessments for women aged 60 or older. The StrongWomen Personal Fitness Assessment was administered immediately prior to the program for a baseline and then immediately following completion of the 12-week program.
This allowed for comparisons between pre- and post-test. At completion of the program the StrongWomen Process Evaluation was administered to evaluate participants’ attitudes and opinions about the program. The process evaluation also gathered information about health and lifestyle changes that may or may not have occurred during the program. To assess the change in participants’ knowledge, attitudes, and behaviors related to breast cancer prevention, early detection, and survivorship; the standard StrongWomen Process Evaluation was adapted to measure these parameters. These survey questions were modified from already existing national surveys (e.g., Behavioral Risk Factor Survey) along with Penn State Hershey medical forms.

**Assessment of Key Outcome Measures**

**StrongWomen Personal Fitness Assessment - Strength:**

Key outcome measures included: upper and lower body strength, upper and lower body flexibility, agility, and aerobic fitness. The StrongWomen Personal Fitness Assessment measures upper body strength using an arm curl exercise (weight used: 2,3,4,5,6,7,8, etc.); the aim of this test is to do as many arm curls as possible in 30 seconds. This test is conducted on the dominant arm side (or stronger side). Lower body strength is measured using a chair-stand exercise; the chair-stand test is similar to a squat test to measure leg strength.

**StrongWomen Personal Fitness Assessment - Flexibility:**

Upper body flexibility is measured using a back scratch exercise, which measures how close the hands can be brought together behind the back. Lower body flexibility is measured using a chair sit-and-reach; the participant sits on the edge of a chair with one leg extended out in front, the other stays flat on the ground. The participant bends at the hips reaching for their toes and holds the reach for two seconds. The distance is measured between the tip of the fingertips and the toes.
**StrongWomen Personal Fitness Assessment - Balance:**

Together, agility and aerobic fitness measured balance. Agility is measured using an eight-foot up-and-go test, which measures the time it takes the participant to go from a seated position and walk eight-foot and back to the sitting position. Aerobic fitness is measured using a two-minute step where the participant marches in place for two minutes. Their score reflects the number of times they were able to raise their knee up to a certain height; this height is determined by the height between their kneecap and the top of their hip bone.

**StrongWomen Process Evaluations**

All process measures were self-reported using the StrongWomen Process Evaluation. Participants completed the StrongWomen Process Evaluation at completion of the program that included eight parts: (1) Motivation for attendance; (2) Nutrition; (3) Health; (4) Change in medication for chronic disease; (5) Suggestions for improving StrongWomen; (6) Personal comments, story, improvements; (7) Questions from First Time Participant Evaluation; (8) Questions from Continuing Participant Evaluation.

**Breast Health Survey Questions**

Within the StrongWomen Process Evaluation, we assessed breast health habits by asking the participants how often they performed the following: breast self-exams, clinical breast exams, and screening mammograms. Participants were also asked about the importance of breast cancer screening changed during the StrongWomen: New STEPS program.

**Statistical Analyses**

All data analyses were completed using SAS version 9.2. Microsoft Excel 2011 was used to create charts and to calculate percent differences. The dependent variables included the fitness test results from pre- to post-test, and the change in breast health habits as a result of the program. The independent variables included: county, breast cancer survivors, age categories, and questions 1-6 from the process evaluation. The relative differences of each of the six individual
fitness tests were calculated using the formula: $(100 \times (\text{post} - \text{pre})/\text{post})$ in order to measure the change in fitness from pre- to post-test. Ages were categorized into five age categories: 40-50, 51-60, 61-70, 71-80, and 81-90 years.

Means and frequencies for the relative difference for the six fitness tests were calculated and stratified by county, breast cancer history, and age. Paired $t$-tests were calculated to compare the means of the pre- and post- fitness tests to determine if there was a statistically significant difference between the two.

Chi-square tests were calculated to test the relationship between: breast cancer survivors and the relative difference in fitness tests (non-stratified and stratified by age category and county); and between age categories and the relative difference in fitness tests (non-stratified and stratified by breast cancer survivors and county). Chi-square tests were also used to test the relationship between the completion rates of the counties and participation and completion rates of breast cancer survivors within the counties.

Univariate two-way analysis of variances (ANOVA) with an interaction term (county*breast cancer survivors) was used to test the difference of the means of the dependent variables (relative difference of the 6 fitness tests) by the levels of the independent variables (county, breast cancer survivors and age categories). Two-way multivariate analyses of covariance (MANCOVA) were completed in order to determine if strength (chair-stand and arm curl), flexibility (chair sit-and-reach and back scratch) and balance (2-minute step and 8-ft up and go) differed between the independent variables (county, breast cancer survivors, and age categories). An overall MANCOVA was calculated to determine if there was an overall effect of the dependent variables and the independent variables.

All tests were two-side with $p<0.05$ for statistical procedures. Study materials and methods were approved by the Penn State University Institutional Review Board.
Chapter 4

Results

Participants/Sample Size

The participants were rural Appalachian Pennsylvania women of at least 40 years of age. The average age was 59.8 years, with a range of 41-86 years of age. The majority (57%) of the participants were overweight with a BMI above 26, 41% had a normal (19-25) BMI and 1% had a below average (<18) BMI. A total of 139 of women began the program with 113 completing the program. A total of 24 breast cancer survivors started the program with 16 completing the program (67%). In all, 97 participants completed both the pre- and post-StrongWomen Personal Fitness Assessment.

Study Sites

There were nine StrongWomen classes within the six counties: Crawford County (n=18 participants); Elk County (n=44 participants); Greene County (n=13 participants); Indiana County (n=35 participants); Lawrence County (n=11 participants) and Mercer County (n=18 participants).

StrongWomen Personal Fitness Assessment

The StrongWomen Personal Fitness Assessment was given immediately prior to and after the 12-week strength-training program. Table 4-1 shows the results of the paired t tests of pre-
and post-fitness tests, which revealed significant results for five out of six of the fitness assessments.

**Table 4-1: Pre- and Post- Fitness Assessments Paired t-tests**

<table>
<thead>
<tr>
<th>Test</th>
<th>N</th>
<th>Difference: Posttest-Pretest (Mean ± SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair Stand</td>
<td>89</td>
<td>4.47 ± 3.27</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Arm Curl</td>
<td>94</td>
<td>4.31 ± 4.27</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Back Scratch</td>
<td>86</td>
<td>0.67 ± 2.05</td>
<td>0.0034</td>
</tr>
<tr>
<td>Sit-and-Reach</td>
<td>82</td>
<td>2.14 ± 2.53</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Up-and-Go</td>
<td>93</td>
<td>0.15 ± 2.99</td>
<td>0.6189</td>
</tr>
<tr>
<td>2-Min Step</td>
<td>71</td>
<td>19.45 ± 26.33</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

The univariate two-way ANOVA showed statistically significant results at the alpha level of p<0.05 for two of the fitness assessment tests when modeled with county, breast cancer survivors, age categories and the interaction between county and breast cancer survivors. The chair-stand test to measure lower body strength model was significant (p<0.0001) as was the variable county (p<0.0001) and the interaction variable of county and breast cancer survivors (p=0.0001). The chair sit-and-reach test to measure lower body flexibility model was significant (p=0.0040) with the interaction (county*breast cancer survivors) being close to reaching significance (p=0.0544). The two-way ANOVA models for the arm curl test, 2-minute step, back scratch, and the 8-ft. up-and-go test were not found to be significant at the p<0.05 level. All chi-square tests were found to be invalid due to low numbers and missing data.

**Completion Rates:**

Completion rates were calculated for each county with completion of the program defined by completion of the pre- and post-StrongWomen Personal Fitness Evaluation. Differences between completion rates between counties were statistically significant, chi-square
p<0.0001. There was an overall program completion rate of 80% for all participants; among breast cancer survivors, there was a program completion rate of 67% as compared to an 83% completion rate among participants that did not have breast cancer.

Upper and Lower Body Strength:

The adjusted mean for participants without breast cancer who improved lower body strength was 41.5 (95% CL:29.0, 54.0) and 44.7 (95% CL:14.2, 75.2) for breast cancer survivors. The mean difference was -3.2 (95% CL:-33.4, 27.1) p=0.8344. The adjusted mean for participants with improved upper body strength (arm curl) was 24.2 (95% CL:11.1, 37.4) the mean improvement for breast cancer survivors was 28.9 (95% CL:-3.2, 60.9). The mean difference was -4.6 (95% CL:-36.5, 27.2) p=0.7703. Multivariate analysis of covariance for strength (as measured by the chair stand and arm curl exercises) were statistically significant when compared with county, Wilks’ Lambda p<0.0001 and age categories Wilks’ Lambda p=0.0001, but not for breast cancer survivors p=0.2142. The fitness tests used to measure strength (arm curl and chair stand) had a partial correlation coefficient of 0.2448.

Table 4-2: MANOVA Adjusted Means for Individual Fitness Tests

<table>
<thead>
<tr>
<th>MANOVA Adjusted Means for Individual Fitness Tests</th>
<th>Breast Cancer Survivors</th>
<th>LSMEAN (95% CL)</th>
<th>Difference Between Means (95% CL)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair Stand</td>
<td>No</td>
<td>41.5 (29.0, 54.0)</td>
<td>-3.2 (-33.4, 27.1)</td>
<td>P=0.8344</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>44.7 (14.2, 75.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm Curl</td>
<td>No</td>
<td>24.2 (11.1, 37.4)</td>
<td>-4.6 (-36.5, 27.2)</td>
<td>P=0.7703</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>28.9 (-3.2, 60.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back Scratch</td>
<td>No</td>
<td>-45.1 (102.3, 12.1)</td>
<td>2.4 (-136.4, 141.2)</td>
<td>P=0.9719</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>-47.5 (187.1, 92.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chair Sit-and-Reach</td>
<td>No</td>
<td>124.7 (20.1, 229.4)</td>
<td>60.3 (-193.4, 314.0)</td>
<td>P=0.6331</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>64.4 (-190.8, 319.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Minute Step</td>
<td>No</td>
<td>24.4 (14.5, 34.3)</td>
<td>-2.3 (-26.2, 21.7)</td>
<td>P=0.8492</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>26.7 (2.6, 50.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-ft. Up and Go</td>
<td>No</td>
<td>21.8 (-25.4, 69.1)</td>
<td>18.3 (-96.3, 132.9)</td>
<td>P=0.7487</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3.6 (-111.7, 118.9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4-3: MANOVA Test Criteria for No Overall Effect

<table>
<thead>
<tr>
<th>MANOVA Test Criteria for No Overall Effect</th>
<th>Wilks’ Lambda P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength (arm curl + chair stand)</td>
<td>County: P&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>Breast Cancer Survivors: P=0.2142</td>
</tr>
<tr>
<td></td>
<td>Age Categories: P&lt;0.0001</td>
</tr>
<tr>
<td>Flexibility (back scratch + chair sit-and-reach)</td>
<td>County: P=0.8606</td>
</tr>
<tr>
<td></td>
<td>Breast Cancer Survivors: P=0.4254</td>
</tr>
<tr>
<td></td>
<td>Age Categories: P=0.7505</td>
</tr>
<tr>
<td>Balance (2-minute step + 8-ft. up and go)</td>
<td>County: P=0.9897</td>
</tr>
<tr>
<td></td>
<td>Breast Cancer Survivors: P=0.8234</td>
</tr>
<tr>
<td></td>
<td>Age Categories: P=0.5008</td>
</tr>
<tr>
<td>All (Strength + Flexibility + Balance)</td>
<td>County: P=0.8553</td>
</tr>
<tr>
<td></td>
<td>Breast Cancer Survivors: P=0.9954</td>
</tr>
<tr>
<td></td>
<td>Age Categories: P=0.1735</td>
</tr>
</tbody>
</table>

All chi-square tests (stratified (by county, breast cancer survivors, and age categories) and non-stratified) testing the relationship between the measures of strength (chair stand and arm curl) and county, breast cancer survivors, and age categories, were invalid due to low numbers and/or missing values.

A total of 82% (n=94) of the participants had an increase in upper body strength (arm curl), and 87% (n=89) had an increase in lower body strength (chair stand). Figure 4-1 shows percent of participants who improved, stayed the same and decreased across all counties.
Upper and Lower Body Flexibility:

The adjusted means for participants who improved the chair sit-and-reach were 124.7 (95% CL:20.1, 229.4), and 64.4 (95% CL:-190.8, 319.6) for breast cancer survivors. The mean difference was 60.3 (95% CL:-193.4, 314.0) p=0.6331. The adjusted means for the back scratch test were -45.1 (95% CL:102.3, 12.1) and for breast cancer survivors: -47.5 (95% CL:187.1, 92.1); the difference between the means was 2.4 (95% CL:-136.4, 141.2) p=0.9719.

All chi-square tests (stratified by county, breast cancer survivors, and age categories and non-stratified) testing the relationship between the measures of flexibility (chair sit-and-reach and back scratch) and county, breast cancer survivors, and age categories, were invalid due to low numbers and/or missing values. The MANOVA model for flexibility was not statistically significant when compared to county, breast cancer survivors and age categories; the measures of flexibility (chair sit-and-reach and back scratch) had a partial correlation coefficient of -0.034.
Figure 4-2 shows 45% (n=86) of participants showed an increase in upper body flexibility (back scratch test) from pre- to post-test. Lower body flexibility (chair sit-and-reach) increased for 71% (n=82) of participants.

**Figure 4-2: Change in Upper and Lower Body Flexibility by County**

![Change in Upper and Lower Body Flexibility](image)

**Balance:**

The adjusted mean for participants who increased in the 2-minute step was 24.4 (95% CL:14.5, 34.3), the mean for breast cancer survivors was 26.7 (95% CL:2.6, 50.8). The difference in means was -2.3 (95% CL:-26.2, 21.7) p=0.8492. The adjusted mean for participants improving the back scratch test was 21.8 (95% CL:-25.4, 69.1) and for breast cancer survivors 3.6 (95% CL:-111.7, 118.9); the difference between the means was 18.3 (95% CL:-96.3, 132.9) p=0.7487.

All chi-square tests (stratified (by county, breast cancer survivors, and age categories) and non-stratified) testing the relationship between the measures of balance (2-minute step and chair sit-and-reach) and county, breast cancer survivors, and age categories, were invalid due to low numbers and/or missing values. When compared using MANOVA, to county, breast cancer survivors, and age categories, balance was not statistically significant; the measures of balance (2-minute step and chair sit-and-reach) had a partial correlation coefficient of 0.489.
Figure 4-3 shows the 2-minute step test for aerobic fitness improved for 90% (n=71) of the participants from baseline to the post-test and that there were 70% (n=93) of participants that had an increase in agility (8ft up-and-go) from baseline to completion of the program.

**Figure 4-3: Change in Balance by County**

<table>
<thead>
<tr>
<th>% Who Increased</th>
<th>% Who Stayed the Same</th>
<th>% Who Decreased</th>
<th>% Who Increased</th>
<th>% Who Stayed the Same</th>
<th>% Who Decreased</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Minute Step</td>
<td>8ft. Up-and-Go</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Balance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The StrongWomen Process Evaluation assessed participant’s attitudes and opinions about the StrongWomen class included 91 new participants and 16 continuing participants with a total of 107. When participants were asked about their motivation to attend the StrongWomen strength-training program, 92% of participants stated that it was to improve strength, flexibility and balance (n=106). As a result of the StrongWomen program, nearly 47% reported an increase in fruit and vegetable intake, while 58-72% remained reported the same with fiber, whole grains, healthy fats, calcium and vitamin D consumption. One person decreased calcium intake with medical advice (n=106). In response to the extent in which the StrongWomen program helped participants with various aspects of their health, participants reported the following moderate to considerable improvements (n=107): 87% self-reported increased upper body strength, 83%
increased flexibility, 82% indicated increased lower body strength, 77% improved balance and increased ability to do everyday activities, and 75% indicated improved general health. Only 4% had a decrease in medications they were taking for chronic diseases (such as cholesterol, osteoporosis, blood pressure, glucose control, or other) as a result of participating in the SW program with 55% staying the same, and 41% were not taking medications for chronic disease (n=106). When participants were asked to describe their satisfaction with the social support provided during the StrongWomen Program, a little over 91% reported being satisfied to very satisfied with the social support provided in the program (n=105).

**Breast Cancer StrongWomen Process Evaluation Questions**

The StrongWomen Process Evaluation asked participants about their personal breast cancer early detection habits and how they changed from before the program. About 39% of the participants maintained monthly breast self-exam (BSE) habits both before and after the program (n=87). There were about 14% of the participants that had never practiced monthly BSEs and had made no change in their BSE habits after the program. 18% reported varying degrees of increasing their BSE habits; no participants decreased their BSE habits as a result of the program. In regards to clinical breast exams, a little more than 74% of the participants maintained monthly clinical breast exams (CBE) before and after the program. About 2% had never had a CBE and had no change in CBE behavior after the program. There was an increase in CBE behavior in 4% of the participants (n=89). In response to their screening mammogram habits, nearly 77% of participants maintained yearly screening mammograms and one participant received her first mammogram as a result of the StrongWomen program (n=91). When asked about the idea of importance of early detection, approximately 38% of the participants increased their idea of the importance of early detection, while 62% stayed the same as a result of the program (n=92).
What was Most Beneficial using the ASE/HBM models?

The comments and suggestions that participants stated in the SW Process Evaluation were coded into four categories of the ASE/HBM: attitude, cognitive, self-efficacy, and social influence. The participants’ comments/suggestions of what they felt was most beneficial about the New STEPS program was 45% attitude-based, 26% self-efficacy, 24% cognitive, and 5% social influence.

Figure 4-4: What was Most Beneficial About the StrongWomen: New STEPS Program by County
Chapter 5

Discussion

The present study examined the results of the StrongWomen: New STEPS program in six different Appalachian Pennsylvania counties among women 40 years of age and older. The results of the StrongWomen Personal Fitness Assessment show improvement in all six of the fitness tests, demonstrating the efficacy of the StrongWomen: New STEPS program. This improvement indicates positive results for increased strength and mobility and thus improved quality of life. These improvements could motivate participants to continue and increase their daily physical activity, which could help breast cancer survivors decrease their chances of recurrence.

The results showed that participant outcomes varied for lower body strength and lower body flexibility depending upon the county and whether or not the participant was a breast cancer survivor. This difference between counties and participants implies that close attention to the program and the participant is needed. These differences between counties could be due in part to the program leaders at these locations. When looking at the measures of strength simultaneously, we saw a significant difference between county and age categories; this difference between results could be due to a small effect of the independent variables (county, breast cancer survivors, and age categories) or due to missing data.

Breast cancer survivors and healthy participants did not differ in fitness test improvements. This is consistent with the American College of Sports Medicine’s suggestions that cancer survivors avoid inactivity and maintain the same physical activity recommendations as set for all Americans. Our study findings for all participants from the StrongWomen Personal Fitness Assessment are consistent with other StrongWomen strength-training program studies [21, 22].
Our program showed potentially positive outcomes for breast cancer prevention, early
detection, and survivorship among the six Pennsylvania counties. We saw increases in
participants maintaining monthly breast self-exams, annual clinical breast exams and yearly
screening mammograms as a result of the program. The program also increased the idea of
importance of early detection among 38% of the participants, and there was only one decrease in
BSE, which was due to unknown reasons. These results were consistent across all six counties.

The present study adds to the current body of research by demonstrating positive results
when combining breast health education with the proven StrongWomen program. It also shows
the capability of community-based programs conducted through community networks like the
cooperative extension. Training community members to lead these programs adds to the
program’s success, and thus its sustainability within the rural Appalachian Pennsylvania counties.

**Strengths**

The StrongWomen: New STEPS program was designed to be sustainable. By adding a
breast health component to the solid foundation of the StrongWomen program and training
community members as the program leaders, this program could be sustained at these sites after
completion of the study. The collaborating organizations have helped with sustainability;
Crawford, Indiana, and Greene counties are still running the StrongWomen programs.
StrongWomen is well received in Pennsylvania; the Penn State Cooperative Extension currently
lists 39 counties within Pennsylvania that have StrongWomen programs.

**Limitations**

Without continued funding, the program could start to become expensive for participants,
limiting its availability to Appalachian women. The study sample included a limited number of
breast cancer survivors, and some of the sites experienced weather-related challenges, which kept a number of participants from attending classes. Another limitation was that the pre- and post-StrongWomen Personal Fitness Assessment results were not linked to the StrongWomen Process Evaluation and breast health questions, limiting the analyses between breast cancer survivors and the post survey questions. There also was no demographic data collected on the participants, making it difficult to describe the study participants.

Future Directions

Continuing program evaluations is important for the most reliable evaluations of program effectiveness. This can help programs obtain funding and resources to continue programs within their community. Future studies can look at more comprehensive study population information in order to help determine factors that may contribute to participant and program success.

Conclusion

The StrongWomen: New STEPS program’s initial effort was a success; it shows promising outcomes and may be a potential model to address breast cancer prevention, early detection, and survivorship among women residing in rural Appalachia Pennsylvania counties. Further, the program seems to be sustainable due to it being community-based, uses an evidence-based program, and is conducted by two community networks with a history of and capacity for health interventions. With the StrongWomen program gaining National recognition for its proven program for improvements in strength, flexibility and balance in older women, it is the perfect vehicle to deliver breast health information and a physical activity program to the women of Appalachian Pennsylvania.
References


Appendix A

SAS Code

StrongWomen Process Evaluation SAS Code
PROC IMPORT OUT= WORK.postprogram
   DATAFILE= "C:\Users\Nancy\Desktop\DATA\SW_DataSet.xls"
   DBMS=EXCEL REPLACE;
   RANGE="Post Question$";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;

data new;
set postprogram;
BSE_change= q7_bse_after-q7_bse_before;
if BSE_change^= . then do;
   if BSE_change<=-1 then BSE_change_cat=-1;
   if (-1<BSE_change<1)then BSE_change_cat=0;
   if BSE_change>=1 then BSE_change_cat=1;
end;

CBE_change= q8_cbe_after-q8_cbe_before;
if CBE_change^= . then do;
   if CBE_change<=-1 then CBE_change_cat=-1;
   if (-1<CBE_change<1)then CBE_change_cat= 0;
   if CBE_change>=1 then CBE_change_cat= 1;
end;

Mamm_change= q9_mamm_after-q9_mamm_before;
if mamm_change^= . then do;
   if mamm_change<=-1 then mamm_change_cat=-1;
   if (-1<mamm_change<1)then mamm_change_cat=0;
   if mamm_change>=1 then mamm_change_cat=1;
end;

age_cat=age;
if age^= . then do;
   if (40<=age<=50) then age_cat=1;
   if (51<=age<=60) then age_cat=2;
   if (61<=age<=70) then age_cat=3;
   if (71<=age<=80) then age_cat=4;
if (81<=age<=90) then age_cat=5;
end;
run;

proc sort data=new;
by county;
run;
proc freq;
tables county*BSE_change_cat/chisq;
tables county*CBE_change_cat/chisq;
tables county*mamm_change_cat/chisq;
run;
proc freq;
tables BSE_change_cat CBE_change_cat mamm_change_cat;
run;
proc freq;
tables q1a q1b q1c q1d q1e q1f q1g q1h q1i;
run;
proc sort;
by county;
run;
proc glm;
class county;
model BSE_change_cat=q1a q1i q2_fruit county;
run;
proc glm;
class county;
model CBE_change_cat=q1a q1i q2_fruit county;
run;
proc glm;
class county;
model mamm_change_cat=q1a q1i q2_fruit county;
run;
proc glm;
class county;
model BSE_change_cat CBE_change_cat mamm_change_cat= q1a q1i q2_fruit county;
manova h=q1a/printe printh;
manova h=q1i/printe printh;
manova h=q2_fruit/ printe printh;
manova h=county /printe printh;
run;
proc means;
by county;
var BSE_change_cat CBE_change_cat mamm_change_cat;
run;
StrongWomen Personal Fitness Assessment SAS Code

PROC IMPORT OUT= WORK.twoway
   DATAFILE = "C:\Users\Nancy\Desktop\DATA\SW_DataSet.xls"
   DBMS=EXCEL REPLACE;
   RANGE="Fitness Results$";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;

data new;
set twoway;
reldiff_step=100*(pst_step-pre_step)/pre_step;
   if reldiff_step ^= . then do;
      if reldiff_step <= -1 then rel_diff_step_cat=-1;
      if (-1 < reldiff_step < 1) then rel_diff_step_cat=0;
      if reldiff_step >= 1 then rel_diff_step_cat=1;
   end;

reldiff_stand=100*(pst_stand-pre_stand)/pre_stand;
   if reldiff_stand ^= . then do;
      if reldiff_stand <= -1 then rel_diff_stand_cat=-1;
      if (-1 < reldiff_stand < 1) then rel_diff_stand_cat=0;
      if reldiff_stand >= 1 then rel_diff_stand_cat=1;
   end;

reldiff_arm=100*(pst_arm-pre_arm)/pre_arm;
   if reldiff_arm ^= . then do;
      if reldiff_arm <= -1 then rel_diff_arm_cat=-1;
      if (-1 < reldiff_arm < 1) then rel_diff_arm_cat=0;
      if reldiff_arm >= 1 then rel_diff_arm_cat=1;
   end;

reldiff_reach=100*(pst_reach-pre_reach)/pre_reach;
   if reldiff_reach ^= . then do;
      if reldiff_reach <= -1 then rel_diff_reach_cat=-1;
      if (-1 < reldiff_reach < 1) then rel_diff_reach_cat=0;
      if reldiff_reach >= 1 then rel_diff_reach_cat=1;
   end;

reldiff_scratch=100*(pst_scratch-pre_scratch)/pre_scratch;
   if reldiff_scratch ^= . then do;
      if reldiff_scratch <= -1 then rel_diff_scratch_cat=-1;
      if (-1 < reldiff_scratch < 1) then rel_diff_scratch_cat=0;
      if reldiff_scratch >= 1 then rel_diff_scratch_cat=1;
end;
reldiff_up=100*(pst_up-pre_up)/pre_up;
if reldiff_up= -1 then do;
  if reldiff_up<= -1 then rel_diff_up_cat=-1;
  if (-1<reldiff_up<1) then rel_diff_up_cat=0;
  if reldiff_up>= 1 then rel_diff_up_cat=1;
end;

age_cat=age;
if age<=. then do;
  if (40<=age<=50) then age_cat=1;
  if (51<=age<=60) then age_cat=2;
  if (61<=age<=70) then age_cat=3;
  if (71<=age<=80) then age_cat=4;
  if (81<=age<=90) then age_cat=5;
end;
run;

proc sort data=new;
by county bcsurv;
run;

proc freq data=new;
tables bcsurv*rel_diff_stand_cat/chisq;
tables bcsurv*rel_diff_arm_cat/chisq;
tables bcsurv*rel_diff_step_cat/chisq;
tables bcsurv*rel_diff_reach_cat/chisq;
tables bcsurv*rel_diff_scratch_cat/chisq;
tables bcsurv*rel_diff_up_cat/chisq;
run;

proc freq data=new;
by county;
tables bcsurv*rel_diff_stand_cat/chisq;
tables bcsurv*rel_diff_arm_cat/chisq;
tables bcsurv*rel_diff_step_cat/chisq;
tables bcsurv*rel_diff_reach_cat/chisq;
tables bcsurv*rel_diff_scratch_cat/chisq;
tables bcsurv*rel_diff_up_cat/chisq;
run;

proc freq data=new;
tables age_cat*rel_diff_stand_cat/chisq;
tables age_cat*rel_diff_arm_cat/chisq;
tables age_cat*rel_diff_step_cat/chisq;
tables age_cat*rel_diff_reach_cat/chisq;
tables age_cat*rel_diff_scratch_cat/chisq;
tables age_cat*rel_diff_up_cat/chisq;
run;
proc freq data=new;
  by county;
  tables age_cat*rel_diff_stand_cat/chisq;
  tables age_cat*rel_diff_arm_cat/chisq;
  tables age_cat*rel_diff_step_cat/chisq;
  tables age_cat*rel_diff_reach_cat/chisq;
  tables age_cat*rel_diff_scratch_cat/chisq;
  tables age_cat*rel_diff_up_cat/chisq;
run;

proc sort data=new;
  by age_cat;
run;

proc freq data=new;
  by age_cat;
  tables bcsurv*rel_diff_stand_cat/chisq;
  tables bcsurv*rel_diff_arm_cat/chisq;
  tables bcsurv*rel_diff_step_cat/chisq;
  tables bcsurv*rel_diff_reach_cat/chisq;
  tables bcsurv*rel_diff_scratch_cat/chisq;
  tables bcsurv*rel_diff_up_cat/chisq;
run;

proc sort data=new;
  by county bcsurv age_cat;
run;
proc means data=new;
  by county bcsurv age_cat;
  var rel_diff_step_cat rel_diff_stand_cat rel_diff_arm_cat rel_diff_reach_cat rel_diff_scratch_cat rel_diff_up_cat;
run;

proc glm data=new;
  class county bcsurv;
  model reldiff_stand=county bcsurv county*bcsurv;
run;
proc glm data=new;
  class county bcsurv;
  model reldiff_arm=county bcsurv county*bcsurv;
run;
proc glm data=new;
  class county bcsurv;
  model reldiff_step=county bcsurv county*bcsurv;
run;
proc glm data=new;
  class county bcsurv;
  model reldiff_reach=county bcsurv county*bcsurv;
run;
proc glm data=new;
class county bcsurv;
model reldiff_scratch=county bcsurv county*bcsurv;
run;
proc glm data=new;
class county bcsurv;
model reldiff_up=county bcsurv county*bcsurv;
run;

proc glm data=new;
class county bcsurv age_cat;
model reldiff_up=county bcsurv age_cat county*bcsurv;
means county bcsurv age_cat;
lsmeans county bcsurv/stderr cl pdiff;
manova h=county / printh;
manova h=bcsurv / printh;
manova h=age_cat / printh;
title "StrongWomen Personal Fitness Assessment: Strength";
title2 'Multivariate Analysis of Covariance (MANCOVA)';
run;
proc glm data=new;
class county bcsurv age_cat;
model reldiff_reach reldiff_scratch= county bcsurv age_cat county*bcsurv;
means county bcsurv age_cat;
lsmeans county bcsurv age_cat/ stderr cl pdiff;
manova h=county / printh;
manova h=bcsurv / printh;
manova h=age_cat / printh;
title "StrongWomen Personal Fitness Assessment: Flexibility";
title2 'Multivariate Analysis of Covariance (MANCOVA)';
run;
proc glm data=new;
class county bcsurv age_cat;
model reldiff_step reldiff_reach reldiff_step reldiff_up= county bcsurv age_cat county*bcsurv;
means county bcsurv age_cat;
lsmeans county bcsurv age_cat / stderr cl pdiff;
manova h=county / printh;
manova h=bcsurv / printh;
manova h=age_cat / printh;
title "StrongWomen Personal Fitness Assessment: Balance";
title2 'Multivariate Analysis of Covariance (MANCOVA)';
run;
proc glm data=new;
class county bcsurv age_cat;
model reldiff_stand reldiff_arm reldiff_step reldiff_reach reldiff_scratch reldiff_up= county bcsurv age_cat county*bcsurv;
means county bcsurv age_cat;
lsmeans county bcsurv age_cat /stderr cl pdiff;
manova h=county /printe printh;
manova h=bcsurv /printe printh;
manova h=age_cat /printe printh;

title "StrongWomen Personal Fitness Assessment";
title2 'Multivariate Analysis of Covariance (MANCOVA)';
run;