**Project Definition**

*Needs Statement*

Stroke is a leading cause of death and long-term disability in the United States.1 More specifically, stroke is the third leading cause of death in North Carolina, ranking the state sixth in the nation for highest stroke death rate.2 Geographically speaking, the coastal plain of North Carolina is in the nation’s stroke buckle – a popular term for three southern states (North Carolina, South Carolina, and Georgia) – where the death rate from stroke is twice as high as the national average.2 Furthermore, within North Carolina, African Americans have higher stroke death rates than Caucasians and as a whole, African Americans tend to have strokes at a younger age, making them more likely to be disabled from stroke.2

Stroke is s significant health concern because it can result in multiple impairments and functional limitations, including muscle weakness, pain, spasticity, poor balance, and decreased mobility. It is imperative that these impairments are addressed properly because they put the stroke survivor at increased risk of subsequent medical complications, including falls, recurrent stroke3, diabetes, glucose intolerance, heart disease, and depression.4 Therefore, activities and programs that promote mobility and fitness are essential for the prevention of such complications.3

Hospital-based rehabilitation programs are usually the first line of treatment for stroke survivors. Those who quality for these programs remain in the hospital for an extended period of time and receive direct services from rehabilitation professionals. These services typically include helping stroke survivors re-learn skills that were lost due to brain damage (i.e. coordination during walking), teaching stroke survivors new ways to perform tasks (i.e. bathing/dressing with one hand, effective verbal communication), and promoting independent movement (i.e. regaining range of motion in certain joints, regaining strength, walking without assistance).5

While these programs are successful in reducing stroke-related functional impairment and disability, they rarely extend beyond one year post-stroke and the resources provided by such programs are becoming increasingly limited due to rising health care costs.3 In North Carolina alone, the direct and indirect cost of stroke is estimated at more than $1.05 billion per year, including direct costs of initial hospitalizations, subsequent hospitalizations, inpatient and outpatient physician costs, and drug costs.2 For the individual stroke survivor, the mean lifetime cost of ischemic stroke is approximately $140,048, which includes inpatient care, rehabilitation, and follow-up care.2

There is a need for programs that enable stroke survivors to continue to make functional gains after hospital discharge beyond one year. Community-based exercise programs can improve and retain mobility, functional capacity, and balance, as well as overall fitness.3,6 In addition, they are easily accessible to community-members and are economical since they do not require one-on-one supervision.7 However, at this point in time, there is a lack of accessible and appropriate community-based exercise programs for chronic stroke survivors.3 This is especially true for rural regions like the coastal plain of North Carolina, where the management of stroke is variable and the recommendations for acute and subacute care and management of risk factors after discharge are often not implemented.8 Given the current limited rehabilitation resources, it would be ideal to develop safe and cost-effective community-based exercise programs that are available to a large number of individuals, as they have the potential to improve activity tolerance and reduce the risk of secondary complications common to stroke.3

*Background*

There are multiple studies that support the development and implementation of community-based exercise programs for chronic stroke survivors. While the exercise programs presented in each study emphasize different components, each one has been shown to result in functional gains for the participant. The proposed interventions target multiple functional impairments and include a wide variety of exercises that could be completed by participants of varying functional ability.

To begin, Eng et al. developed a community-based intervention that focused on balance, strength, and functional capacity.3 The intervention group completed a 1-hour exercise session, 3 times per week, for 8 weeks where the Berg Balance Scale (BBS), the 12-meter walk test, gait speed, stair climbing speed, the Normal Living Index (RNL), and the Canadian Occupational Performance Measure (COPM) were used to measure change. Significant improvements were found for all physical measures and the effects were retained at 1-month post-intervention for the exercise group.3

In a study conducted by Stuart et al., a program entitled Adaptive Physical Activity program for stroke (APA-stroke) was implemented in order to improve muscle strength, joint flexibility, balance, and cardiorespiratory function in chronic stroke survivors.4 The intervention group completed a 1-hour exercise session, 3 days per week, for 6 months where the Six-Minute Walk Test (6MWT), the Short Physical Performance Battery (SPPB), the BBS, the Stroke Impact Scale (SIS), the Barthel Index, the Hamilton Rating Scale for Depression, and the Index of Caregivers Strain were used to measure change. There were significant improvements in gait velocity, balance, SPPB score, and SIS score in the exercise group and individuals with depressive symptoms at baseline improved, whereas controls were unchanged.4

Pang et al. developed a community-based exercise program to improve motor recovery and functional abilities of the paretic upper extremity in persons with chronic stroke.7 The intervention group completed a 1-hour exercise session, three times per week, for 19 weeks where the Wolf Motor Function Test (WMFT), the Fugl-Meyer Assessment (FMA), hand-held dynamometry (grip strength), and the Motor Activity Log were used to measure change. The intervention group demonstrated significant improvement in WMFT and FMA scores.7

Park et al. incorporated community-based ambulation training with conventional physical therapy.9 All subjects received routine physical therapy, but the experimental group received community-based ambulation training 1-hour per day, 3 days per week, for 4 weeks where the 10-meter walk test, 6MWT, community walk test, walking ability questionnaire, and activities-specific balance confidence scale (ABC) were used to measure change. The experimental group showed significant differences in all measures, whereas the control group only showed a significant difference in the walking ability questionnaire.9

Pang et al. also designed a community-based fitness and mobility exercise (FAME) program for older adults with chronic stroke that emphasized cardiorespiratory fitness, mobility, leg muscle strength, balance, and hip bone mineral density.10 The intervention group completed a 1-hour exercise session, 3 days per week, for 19 weeks where maximal oxygen consumption during exercise, the 6MWT, force output during isometric knee extension, the BBS, the Physical Activity Scale for Individuals with Physical Disabilities, and dual-energy x-ray absorptiometry were used to measure change. The intervention group had significantly more gains in cardiorespiratory fitness, mobility, and paretic leg muscle strength than controls. Femoral neck BMD was maintained in the intervention group, while a significant decline occurred in the control group. Both groups improved in balance and PASIPD score, with no significant differences between groups.10

Leroux developed an exercise program that was offered by a community organization and designed to improve motor performance in individuals with chronic stroke.11 The intervention was designed to improve balance, mobility, coordination, walking endurance, and strength on the hemiparetic side through various functional exercises. The intervention group completed the program 2 times per week for 8 weeks where the stroke impairment assessment set, the BBS, the step test, the Timed Up-and-Go, and the 6MWT were used to measure change. The intervention group showed significant improvements for all measures, except for the 6MWT.11

It is clear that community-based exercise programs are effective in reducing functional impairment and level of disability and in improving overall quality of life for chronic stroke survivors. It can be concluded that community-based exercise programs are helpful in preventing secondary disease10 and in improving self-care3, walking ability3,4,9-11, motor performance7,9,11, upper-extremity function7, muscle strength 3,4,10,11, flexibility4, balance4,9-11, cardiorespiratory function4,9,10, and quality of life3,4 in chronic stroke survivors.

Although these studies emphasize the many benefits of exercise in this population, there is a need for further study regarding the frequency, intensity, and duration of the intervention. While five out of the six studies present programs that require participants to complete a 1-hour exercise session 3 times per week, the long-term duration varies between studies, ranging from 4 to 19 weeks. Therefore, further study is needed to determine an effective long-term duration that results in retention of the intervention effects. In addition, even though it has been shown that community-based exercise programs have the potential to improve functional impairment and decrease disability, larger clinical trials are needed in order to further assess treatment efficacy and the cost effectiveness of such programs.7 Lastly, each study targets different outcomes, resulting in variation between exercise interventions. Therefore, before implementing such interventions, variables of interest need to be established so that the most appropriate intervention may be selected.

In order to further emphasize the need for community-based exercise programs, the Health Belief Model may be considered.12 This model is a value-expectancy theory of health-related behavior, where a person must have a desire to avoid illness or to get well (value) and must believe that a specific health action will prevent illness (expectation).12 According to Janz, Champion, and Strecher, it is believed that people will take action to control ill-health conditions “if they regard themselves as susceptible to the condition, if they believe it would have potentially serious consequences, if they believe that a course of action available to them would be beneficial in reducing either their susceptibility to or the severity of the condition, and if they believe that the anticipated barriers to taking the action are outweighed by its benefits.”12 In order for chronic stroke survivors to take control of their health, they must value exercise and believe that community-based exercise programs can be effective in reducing disability and improving quality of life. Therefore, exercise programs need to be implemented at the community level so that people can access them and so that the effectiveness of such programs can be displayed.

**Project Description**

*Objectives*

1. To develop a safe, effective, and affordable community-based exercise program for chronic stroke survivors.
2. To increase balance in 12 weeks as evidenced by a gain of 12 points on the Activities-Specific Balance Confidence Scale (ABC) and 2.5 points on the Berg Balance Scale (BBS) from baseline to 1-month post intervention.
3. To improve gait speed in 12 weeks as evidenced by an increase of 0.1m/s during the 10-m walk test from baseline to 1-month post intervention.
4. To increase quality of life in 12 weeks as evidenced by an improvement of 9.2 points in the strength domain, 5.9 points in the ADL/IADL domain, and 4.5 points in the mobility domain of the Stroke Impact Scale (SIS) from baseline to 1-month post intervention.
5. To increase lower extremity strength in 12 weeks as evidenced by a full grade of improvement in manual muscle test (MMT) score for hip flexors, extensors, abductors, and adductors; knee flexors and extensors; and ankle plantarflexors and dorsiflexors from baseline to 1-month post intervention.
6. To increase cardiorespiratory endurance in 12 weeks as evidenced by a gain of 50m in distance covered during the 6-Minute Walk Test (6MWT) from baseline to 1-month post intervention.
7. To encourage a sense of empowerment and community-involvement in program participants, indicated by an attendance of 95% over the course of the 12-week intervention.

*Methods*

This intervention will follow a single-group, repeated measures design, where chronic stroke survivors will complete a 12-week community-based exercise program, focusing on strength, cardiorespiratory endurance, balance, and gait. Participants will complete a 1-hour exercise session, 3 times per week and will be recruited from the community, as well as local medical centers and doctor’s offices according to certain inclusion and exclusion criteria. In order to ensure client safety and treatment efficacy, an instructor to participant ratio of 1:3 will be implemented.13 The program will be held in a community space and all necessary equipment will be provided, including chairs, ankle weights, stackable risers/steps, etc.3

The proposed intervention has been adapted from Eng. et al.3 and Marigold et al.13 and consists of the following components, which will all be progressed based on individual ability:

* Warm up consisting of walking and light stretching
* Functional LE strengthening with and without weights – repetitive sit-to-stand, toe raises, heel raises, and marching
* Multisensory dynamic balance tasks
  + Standing in various postures (tandem, single leg stance, and weight shifting)
  + Walking with various challenges (different step lengths and speeds, tandem walking, figure-eight walking, stepping up and over low risers, side stepping, crossover stepping, and stepping over obstacles)
  + Standing perturbations
  + Eyes-closed conditions and foam surfaces will be incorporated when appropriate
* Aerobic stepping
* A walking circuit
* Cool down of light stretching

The following outcome measures will be used to assess change from baseline to 1-month post intervention: ABC, BBS, 10-m walk, SIS, and 6MWT. Each measure will be administered before the intervention, after the intervention, and 1-month post intervention. The ABC is a measure of balance and functional mobility that subjectively measures the client’s confidence in performing various ambulatory activities without falling.14 The BBS is a measure of balance and functional mobility designed to assess static balance and falls risk in adult populations.14 The 10-m walk test is a measure of functional mobility and gait that assesses walking speed in m/s over a short duration.14 The SIS is a measure of health status following stroke that assesses the following 8 domains: strength, hand function, ADL/IADL, mobility, communication, emotion, memory and thinking, and participation/role function.14 The 6MWT is a measure of aerobic capacity and gait that assesses distance walked over 6 minutes.14

**Evaluation**

*Assessment*

Five outcome measures will be used to evaluate the effectiveness of the proposed intervention: the ABC, BBS, 10-m walk test, SIS, and 6MWT. In addition, MMT will be used to assess change in LE strength from baseline to 1-month post intervention. This combination of evaluation tools addresses each domain of the International Classification of Functioning, Disability, and Health, including body structures and function, activity, and participation. The ABC and the BBS are measures of balance and functional mobility that fall under the ICF domain of activity, the 10-m walk test is a measure of functional mobility and gait that falls under the ICF domain of activity, the SIS is a quality of life measure that falls under the ICF domain of participation, the 6MWT is a measure of aerobic capacity and gait that falls under the ICF domain of activity, and MMT is a standardized assessment of muscle strength that falls under the ICF domain of body structures and function. In order to determine whether clinically significant change is achieved from baseline to 1-month post intervention, the minimal detectable change (MDC) and minimally clinically important difference (MCID) value for each outcome measure will be used.

*Limitations*

There are several limitations to implementing the proposed intervention. First, given the rural nature of the coastal plain of North Carolina, there might be a lack of available space to accommodate such a program. In addition to being large, the space will need to contain all necessary equipment, including chairs, ankle weights, stackable risers/steps, etc. Therefore, the ideal setting would be a local YMCA or community center. Second, it might be difficult to recruit an adequate number of participants from the community. Community-members may not be interested in participating in such a program, may not be motivated to consistently attend a 12-week intervention, and may not perceive the benefits of physical activity after stroke. As a result, it would be challenging to assess the efficacy of the proposed intervention. Lastly, there may be a lack of licensed therapists and other support personnel to implement and supervise the proposed intervention. Without an adequate number of instructors, client safety and treatment efficacy may be diminished.

*Relevance*

If this program is successful, indicated by improvements in previously mentioned evaluation tools, then levels of functional impairment and disability would be decreased and quality of life would be increased for chronic stroke survivors in the coastal plain of North Carolina. At this point in time, there is a lack of appropriate community-based exercise programs for this population in the coastal plain. Therefore, an accessible and cost effective community-based exercise program would be beneficial, as they have been shown to improve and retain mobility, functional capacity, balance, and overall fitness for this population.3,6 The proposed model would be easily replicated in other communities, as many geographical areas are in need of such a program, it is cost-effective, does not require large amounts of equipment, and can accommodate a large number of participants.

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