**Background**

“Healthy Habits for Stroke Survivors” would greatly benefit community-dwelling individuals with stroke by aiming to reduce modifiable risk factors and prevent secondary stroke. This program will incorporate two interventions, aerobic training, and self-management support, with an approach based on the Health Belief Model. Outcome measures will cover variables that indicate risk level and self-efficacy to demonstrate the impact of the program on participants.

Aerobic training will be a key aspect of this program to promote health outcomes in individuals with stroke. Physical activity training is safe in this population and clinically meaningful, with functional improvements in walking speed, balance, walking capacity, and cardiorespiratory fitness.1 Findings from a meta-analysis have shown that aerobic training interventions made significant impacts on systolic blood pressure (SBP) and fasting glucose after stroke, which are pivotal stroke risk factors.2 Hypertension is highly associated with stroke, and a reduction of 5.1 mmHg in SBP is correlated with a decrease of 22% in recurrent stroke risk.2 Diabetes also contributes to risk of stroke, and a decrease of 1 mmol/L of fasting glucose leads to a 20% reduced total stroke risk.3 By lowering these vascular and metabolic risk factors, aerobic training can make a substantial difference in preventing the recurrence of stroke. In the meta-analysis by Brouwer et al., the intensity of aerobic training ranged from 50-85% of heart rate reserve (HRR), while frequency, time, and type of training were similar among interventions. My program’s intervention will consist of walking or cycling for 30-40 minutes at an intensity of 50-85% HRR in alignment with other study protocols.2 Another meta-analysis found that exercise-based interventions made significant positive effects on additional factors of fasting insulin and HDL cholesterol in individuals after stroke.3 When combined with resistance training, aerobic exercise has been shown to additionally reduce diastolic blood pressure (DBP), and combined training appears to have a comparable effect on SBP and fasting glucose as aerobic exercise alone.4 While aerobic training seems to have the most benefits when mixed with strength training, this program will only focus on aerobic exercise to best overcome barriers. Strength training requires a specialized facility and specifically trained instructors, whereas aerobic exercise is more accessible and can be home-based after the program to promote long-term habits.2 The most common barriers to physical activity among stroke survivors have been reported as lack of motivation, lack of knowledge, and environmental factors, such as program cost, lack of awareness of a local fitness center, and lack of transportation.5,6 On the other hand, social support and the need to be able to perform daily tasks are the most common motivators.5 The program will aim to address these barriers and motivators to ensure participants are able to access the program and gain the most long-term benefits. In accordance with the Health Belief Model, it should be portrayed that the benefits of aerobic exercise outweigh the perceived barriers to best promote lasting change. It will also be important to increase awareness of the participants’ susceptibility to recurrent stroke, its consequences, and provide evidence to support how aerobic exercise can benefit their stroke risk.7

For the second intervention, this program will provide participants with education and support on adopting self-management strategies. With many stroke risk factors being modifiable, guiding stroke survivors to self-manage their health is a valuable component of secondary stroke prevention. Lifestyle interventions include behavior changes that target physical inactivity, obesity, cigarette smoking, heavy alcohol use, hypertension, lipid profile, and medication adherence.8 Also, aerobic exercise interventions have been shown to have the greatest effect when supplemented with an educational component, making this a complementary part of the program.4 A RCT utilized an education program that encouraged physical activity for heart attack and stroke prevention in adults with hypertension.9 Theory principles guided the intervention at each stage, comprising of eight weekly sessions of lectures, counseling calls, and group meetings. The earlier sessions worked on knowledge enhancing, skill training, and personalized coaching, while later sessions strived to cultivate social support and self-confidence. The intervention demonstrated significant results of reduced heart attack and stroke incidence, reduced blood pressure, and increased physical activity. Inspired by the Transtheoretical Model, Model of Personalized Medicine, and Social Capital Theory, this intervention addressed barriers of knowledge, psychosocial support, and self-confidence. The program was facilitated by available time, individual interest, and willingness to participate.9 By adding an educational component to “Healthy Habits for Stroke Survivors”, participants will be better informed and equipped to take control of their self-management. Another study promoted healthy lifestyle and blood pressure control in patients with hypertension by incorporating a virtual element to their program.10 The intervention was based on Bandura’s theory of self-efficacy. The program involved six months of in-person education, personalized self-care videos, self-monitoring blood pressure on an online platform, receiving feedback, interacting with others on a message board, and other informational videos. As a result, significant positive differences in pulse pressure, serum triglycerides, and low-density lipoprotein cholesterol were observed. Additionally, participants had higher self-efficacy and self-care scores.10 A central takeaway from this study is how the unique web-based program led to behavior change and improved self-efficacy through providing knowledge, motivation, and frequent feedback. My community program will utilize these ideas. Another study that focused on stroke self-management support led to improvements in self-efficacy, outcome expectation, and satisfaction with self-management behaviors.11 The intervention was also based on the theory of self-efficacy and consisted of goal setting, modeling, and verbal persuasion. Furthermore, higher self-efficacy, a key component of the Health Belief Model, is correlated with a greater reduction in blood pressure, demonstrating the mutual benefits of the interventions in “Healthy Habits for Stroke Survivors” leading to greater stroke risk reduction.12 The educational intervention will use various tools from these studies to empower participants with knowledge, provide support, acknowledge success, reinforce expectations, and foster connections. There will be informational lectures, individualized coach sessions to work on goal setting and discuss strategies for barriers, group sessions, and an online portal where individuals can track their progress and connect with others. Overall, the goal will be to facilitate participants to practice self-management behaviors, such as medication adherence, physical activity, diet, stress management, and smoking cessation.

One key measure this program will use to monitor progress and risk factor reduction is SBP. Evidence supports that aerobic exercise leads to significant reductions in SBP in adults with stroke, so utilizing this parameter will indicate the efficacy of this program. A reduced SBP of participants will reflect reduced risk of stroke recurrence.2 Blood pressure will be measured by healthcare professionals with a mercury sphygmomanometer at rest after participants have relaxed for five minutes, with certain restrictions 30 minutes prior to the reading. To keep readings standardized, the American Heart Association (AHA) guidelines will be followed and two readings will be taken one minute apart and averaged.13 Additionally, change in aerobic endurance and capacity as a result of the aerobic training will be measured using the 6 Minute Walk Test (6MWT). A study of healthy middle-aged men found that those who had high cardiovascular fitness at baseline and those who increased their fitness over time had a significantly lower risk of stroke and mortality.14 This supports the use of fitness as an indicator of stroke risk.The 6MWT is a well-established tool that is acceptable and feasible for stroke with normative values, excellent test-retest reliability, and ability to sensitively detect change.15 The minimal clinically important difference is reported as 34.4 meters, so a significant improvement in exercise capacity would be made from the intervention if individuals achieve this amount of change.16

Self-efficacy is a powerful concept that can help individuals reach lasting and sustainable transformations in their health. The Stroke Self-Efficacy Questionnaire will be used to monitor the confidence of participants in relation to their functional performance and self-management. This 13-item questionnaire has good criterion validity and feasibility.17 It will be helpful to track and use this data to understand the level of self-efficacy participants have in self-management behaviors after the program.

All in all, “Healthy Habits for Stroke Survivors” has been created with evidence-based interventions and theory applications to lead individuals with stroke to reduce their risk of secondary stroke and improve self-efficacy for self-management.

**Program Goals**

The overall goal of this program is to improve the health and wellness of stroke survivors in the community while reducing their risk factors of secondary stroke by increasing aerobic activity and encouraging the adoption of self-management behaviors. The following goals are what “Healthy Habits for Stroke Survivors” hopes to achieve by the end of the 12-week program.

1. Participants will decrease SBP by at least 5.1 mmHg by the end of the 12-week community program to demonstrate a reduced risk of recurrent stroke.2
2. Participants will improve their distance walked on the 6MWT by at least 34.4 meters by the end of the 12-week community program to demonstrate improved aerobic endurance and capacity.16
3. Participants will increase by at least 2 points on at least 6 of the 13 items on the Stroke Self-Efficacy Questionnaire by the end of the 12-week community program to demonstrate improved confidence in self-management and functional performance after stroke.17
4. Participants will report compliance with chosen self-management behaviors for 5 out of 7 days of the week by the end of the 12-week community program to demonstrate improved self-management strategies for secondary stroke prevention and health promotion.

**Methods**

1. **Personnel**
   1. There will be local health professionals to volunteer for assistance with the initial and final days of the program where pre- and post-intervention assessments will be taken. These assessments include the outcome measures of blood pressure, 6MWT, and the Stroke Self-Efficacy Questionnaire.
   2. The program will require two physical therapists to run and supervise the aerobic training sessions for 3 times per week over 12 weeks. These physical therapists will also measure blood pressure and heart rate at the beginning of the first session every four weeks to monitor progress. Participants will also record subjective health and medication updates via a weekly online survey to ensure awareness of any pertinent information.
   3. One of the two physical therapists will also attend and run an educational session once per week, with each therapist alternating every week. Guest speakers will be present according to the lecture, including a physician, registered dietician, psychologist, and occupational therapist. A psychologist will also be needed to conduct counseling phone calls during weeks 5 and 6.
   4. Volunteers will be recruited through social media, phone calls, and flyers posted at local health provider clinics.
2. **Location**
   1. This program will be carried out at the Lakewood YMCA in Durham, NC. This facility offers a range of cardio equipment including treadmills and stationary bikes that will be used for aerobic training.18 Additionally, the group exercise room will be used for the educational sessions. Registration Day with pre-intervention assessments and the Closing Day with post-intervention assessments will also be held at the YMCA.
   2. YMCA membership costs include a $55 one-time joining fee and $49-56 monthly fee for each adult, coming out to a total cost of $202-223 depending on age. Financial assistance is also available if needed.19
3. **Enrollment and Program Schedule**
   1. This program will be advertised through flyers at local health clinics. Relationships will also be developed with local hospitals and inpatient rehabilitation facilities for the referral of eligible patients to the program.
   2. Participation will require medical clearance to ensure patient eligibility. Inclusion criteria for this program are a clinical diagnosis of a stroke or transient ischemic attack, clinical diagnosis of hypertension (BP equal to or greater than 130/80 mmHg)20, adequate level of cognition, over 18 years old, and ability to attend weekly sessions. Exclusion criteria are unstable medical conditions that limit the ability to partake in exercise. Participants may be ambulatory or non-ambulatory, as those unable to walk may use the stationary bike for aerobic training.2
   3. Participants will be able to enroll through an online application once they have been screened by their physician for clearance. The application will include an initial survey to determine the most prominent risk factor behaviors and barriers to self-management of the group. Enrollment will be capped at 24 participants to allow for a safe and feasible practitioner to participant ratio.
   4. Participants will be allotted to a 1-hour time slot on Registration Day and Closing Day to collect outcome measures.
   5. Aerobic training will be carried out 3 times per week on Mondays, Wednesdays, and Fridays at 4pm. Training sessions will each last for 1 hour. On the first Monday of each month, an additional 15-20 minutes will be spent at the beginning of the session to measure blood pressure and resting heart rate by the two physical therapists.
   6. Educational sessions will be held on Wednesdays at 5pm after the aerobic training for 45 minutes. Educational content will incorporate responses from the initial survey to tailor information to the needs of the group. There will be four lectures covering the following topics:
      1. Introduction to High Blood Pressure and Other Stroke Risk Factors
      2. The Importance of Physical Activity for Blood Pressure Control
      3. Diet, Medication, and Other Self-Management Strategies
      4. Stress Management and Community Engagement
   7. After these four lectures, the fifth and sixth weeks will consist of a counseling session with a psychologist over the phone for 30 minutes. For the last 6 weeks, there will be group discussions for skill-sharing and problem-solving on Wednesdays at 5pm for 45 minutes.
   8. Participants will be given access to an online website. This will contain the program schedule, videos to expand on covered topics, and discussion forums to address questions and concerns. The physical therapists will check the forums and respond once a week.
4. **Intervention Specifics**

Aerobic training will be done on the treadmill or stationary bike based on patient factors and preference. Following cardiac rehabilitation guidelines, 10 minutes each will be spent warming up and cooling down with paced walking and stretches.21 The working exercise block will last for at least 30 minutes, with a goal of 40 minutes. The intensity of exercise will be 50-70% HRR, depending on each participant’s fitness level and working to reach 70% HRR by the end of the program. The target HR will be calculated using maximum HR (MHR) and the Karvonen formula.21 (HRR = MHR – HR at rest) (Target HR = (% intensity \* HRR) + HR at rest) The Borg Scale will also be used to verbally monitor the rate of perceived exertion with a goal of “hard” to “somewhat hard”.21 The physical therapists will ensure participant safety for the duration of the exercise protocol. Exercise prescription will be personalized with more frequent breaks for individuals as needed based on exercise tolerance. Exercise frequency will be 3 times per week for 12 weeks. If participants are unable to make a session, they are encouraged to exercise independently.

The educational component of this program will consist of four lectures, two individual counseling sessions, and six group discussions. The four lectures will cover various topics. The first lecture will aim to educate participants on the prevalence of recurrent stroke, risk factors that contribute to them, and how many risk factors are modifiable. The goal of this session is to incite motivation towards behavior change through raising awareness of the participants’ susceptibility to recurrent stroke and its consequences. Objectives of the lesson will focus on the major responses from the initial survey. The second lecture will introduce the role of physical activity in blood pressure management. This will tie in the Health Belief Model and portray the benefits of aerobic exercise towards reducing stroke risk and shifting mindset away from perceived barriers. Participants will be given information on how to achieve regular and moderate physical activity for long-term sustainability. The third lecture will address self-management strategies in addition to physical activity, such as diet and medication adherence. The fourth lecture will focus more on psychosocial factors needed to be successful in self-management for reducing stroke risk. A guest speaker will come to assist with presenting each lecture and answer questions relevant to their field. The individual counseling via telephone will help to set participants’ goals for the remainder of the program and address the participants’ understanding of physical activity and barriers they are facing. A psychologist will utilize motivational interviewing and help with problem-solving. For the six group discussion sessions, opportunities will be provided for enhancing knowledge and practicing skills. For 24 participants, there will be four groups of six and the two physical therapists will supervise and guide the groups. Discussion will branch from topics covered in the lectures and participants will share their experiences to learn from each other and develop a support system. The Health Belief Model will be used to facilitate behavior change and promote self-efficacy. An online website will also be available for participants to connect and receive support from each other. There will be personalized profiles in which participants are encouraged to record their goals, activity logs, reflections, and track their blood pressure progress. The web-based portal will add to the participants’ experience through motivation, self-monitoring, and frequent feedback.

**Program Evaluation**

The program will include assessments before and after the duration of the 12 weeks. These assessments will consist of BP reading, the 6MWT, and the Stroke Self-Efficacy Questionnaire. BP will be measured using a mercury sphygmomanometer by the local health professional volunteers following the AHA standard guidelines. BP and HR will also be measured weekly to inform exercise intensity prescription and monitor progress throughout the program. The 6MWT will require a stopwatch, measuring wheel to measure distance, chair, 30-m long hallway, and markings to indicate where to turn around.15 This will be administered by one of the local health professional volunteers. Paper forms of the Stroke Self-Efficacy Questionnaire will be provided to be filled out. Participants will also fill out a survey before and after the program to indicate compliance of chosen self-management techniques. Participants will receive their completed assessment feedback on paper, through email, and their online portal to let them know where they stand.

By the end of the 12-week program, it is intended for participants to decrease their SBP by at least 5.1 mmHg and improve their distance walked by at least 34.4 meters on the 6MWT in agreement with evidence-based indicators of significant change.2,16 Participants will also improve their score by at least 12 points on the Stroke Self-Efficacy Questionnaire and report compliance with chosen self-management behaviors for 5 out 7 days per week.17 Weekly BP readings should trend to indicate progress. After 12 weeks, the program hopes that post-assessments will demonstrate meaningful and significant improvements for participants in risk factor reduction, aerobic capacity, self-efficacy, and self-management behaviors that will carry them through a healthier lifestyle. The program will welcome feedback for future rounds if goals are not met. The physical therapists will also monitor progress of participants’ individualized goals through the online portal on a weekly basis. Participants will be able to self-rate their goal progress on a scale of 0-10 and comment with reflections.

As this will be the first launch of our community program, it will be important to receive feedback and constructive criticism from personnel and participants to improve effectiveness and optimize this program for the future.22 Program evaluations will be conducted at 6 weeks and at the end of the 12 weeks through anonymous online surveys. Evaluations will cover several topics, including implementation, effectiveness, efficiency, cost-effectiveness, and attribution.22 It would be good to understand if the program is feasible and if the current schedule is acceptable for participants and personnel. As well, we would seek to evaluate if the program is accessible, if participants agree with the ratio of personnel, and if they feel their time is being used satisfactorily. Are topics being addressed adequately and is the education being presented in a relatable and comprehensible manner? Is the location of the YMCA convenient and do participants feel the cost of the program is effective? It would also be beneficial to know if resources are being used appropriately. The program will incorporate midterm feedback and adjust the remainder of the program accordingly, which will allow for stakeholders to receive the most benefit.22 At the conclusion of the program, the survey will also address if participants felt the program was worthwhile, whether they would recommend it, and suggestions to improve the program in the future.22 All of the volunteer personnel will meet after the program ends to review survey responses, discuss their own perspectives, and implement changes to be made for the next round of the program. It is crucial to hold program evaluations to ensure stakeholders are satisfied, benefits are provided, and logistics are optimally managed.22

**Conclusion**

“Healthy Habits for Stroke Survivors” aims to reach individuals who have had a stroke in the Triangle Area of NC to prevent vulnerability to recurrent stroke and maximize quality of life. Stroke has detrimental effects and is the leading cause of chronic disability across the world.23 This often leads to a sedentary lifestyle and poor risk factor control for recurrent stroke, making stroke survivors susceptible to another stroke and other disabling health conditions.24 However, many risk factors are modifiable through lifestyle interventions, such as physical activity, nutrition, smoking cessation, and limiting alcohol.8 The interventions in “Healthy Habits for Stroke Survivors” will target these areas through direct aerobic training and comprehensive education. This program will facilitate healthy lifestyle change using the Health Belief Model. It is our goal that individuals will overcome perceived barriers to exercise and they will be able to continue aerobic training in the long-term. The program will convey the importance of self-management strategies for better health and give individuals the tools and confidence they need to be successful on their own. For lasting change, our program will maximize self-efficacy and social connections, which will empower individuals to take control of their health with confidence and support. Secondary stroke prevention is essential in this population and will serve to avoid further medical complications and disability. Our community program will work to improve risk factor control, aerobic capacity, self-efficacy, and self-management behaviors in individuals with stroke for meaningful health and wellness promotion.

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