**Background**

Thriving with Diabetes utilizes concepts of the socio-ecological model to address the improved health and wellness of adults who are diagnosed with type II diabetes through aerobic exercise, community support, and patient education. When managed properly, individuals diagnosed with type II diabetes can lead full, healthy lives and our goal is to provide the tools and support necessary to maximize their quality of life and overall health. Through the implementation of evidence-based outcome measures participants will minimize the deficit associated with their diagnosis and maximize their health outcomes.

Both high intensity aerobic training (HIAT) and moderate intensity continuous training (MICT) are supported as safe intervention approaches to increase the aerobic fitness of individuals with type II diabetes. Therefore, participants have a choice in which form of aerobic exercise suits them for this portion of our program. All participants will have their peak heart rate measured and recorded prior to participation so that they can work at their own, personalized work rate and fitness level. One study suggests a 10-minute warm-up at 70% peak heart rate followed by the participants preference of aerobic exercise and ending with a 5-minute cool down. The HIAT group will undergo 4x4-minute bouts of exercise at 90% of their peak heart rate interspersed with 3x3-minute bouts of exercise at 70% of their peak heart rate for a total of 25 minutes, while the MICT group will complete 32 minutes of exercise maintaining 70% of their peak heart rate. Not only may the participant choose between HIAT and MICT, but also which type of aerobic exercise they enjoy.1,2 This can be brisk walking, cycling, or any form of exercise that combines the use of large muscle groups with an increase in heart rate.3 If participants are unsure of which form of exercise suits them, they will be provided with a description of each type of exercise and, through consultation with a health professional on staff, will discuss which form suits their needs and preferences.

Evidence supports both HIAT and MICT as evidence-based interventions for individuals with type II diabetes through an increase in aerobic capacity which is associated with improved insulin action, blood glucose control, fat oxidation, fat storage, cardiovascular health, and reduced mortality in individuals with type II diabetes. Additionally, HIAT is supported to decrease HbA1c levels, which directly reduces cardiovascular complications in this population.4 These exercise sessions will be group-based and supervised by a professional to not only ensure that participants are reaching their heart rate goals, but also to increase clinical, lifestyle, and psychosocial health outcomes through use of the socio-ecological model.3,5,6 Aerobic fitness will be measured through periodic implementation of the 6-Minute Walk Test (6MWT) and compared to norms for the participants patient population. The 6MWT is a reliable form of evaluation of aerobic capacity for adults with type II diabetes, is easy to perform, and will allow a standardized measure of aerobic fitness progression.7

Alongside exercise intervention, Thriving with Diabetes will also incorporate group discussion on living with diabetes and education provided by a professional to guide participants on their path to decrease the risk and comorbidity associated with their diagnosis, and that are informed by the socio-economic model. These group sessions will involve self-management techniques through an empowerment-oriented approach, which has been shown to not only positively impact metabolic and physiological outcomes, but also those of psychological and mental health.6,8 Since type II diabetes is a chronic, progressive condition management not only includes self-efficacy and personal motivation, but also maintenance of a healthy diet and physical activity- all of which are addressed and discussed in these group sessions. By allowing participants to express their knowledge, attitudes, beliefs, and personalities in a group setting, we can gain an understanding of the unique health influences to that person and address them directly. These sessions also foster a sense of community that will play a role in support of the individual on their health journey.

The first step to successful self-management of type II diabetes is ensuring that participants have a solid grasp on the physiological manifestation of their disease.5 Studies have shown that education specific to self-management and glycemic control results in improved HbA1c levels; therefore, a portion of group discussion will surround these topics with time for questions and group discussion.9 Self-management techniques such as regular monitoring of blood glucose levels, attending routine appointments, routinely checking areas of neuropathy, management of common symptoms, and handling stress will be taught and encouraged.10

Since only around 34% of individuals with type II diabetes are referred to a dietician following diagnosis, a large portion of group-based education will be surrounding nutrition. This will include utilizing the socio-ecological model to address socioeconomic status, food deserts, and time available to prepare meals; along with encouraging healthy changes within the family unit for increased maintenance of healthy habits.6,11 Ensuring patients are able to track and manage their HbA1c levels is important for avoiding acute and chronic complications associated with diagnosis of type II diabetes, and much of this can be handled through proper nutrition and dietary intervention involving carbohydrate portioning and blood sugar monitoring. A low carbohydrate diet has been shown to improve the blood glucose, regulate blood lipids, and decrease the overall weight of individuals with type II diabetes. One study showed a significant decrease in HbA1c levels when a staple, starchy food was replaced with either peanuts or almonds.12 There are excellent online resources from the CDC that will also be provided to participants as a guide for meal planning, grocery shopping, understanding food labels, and carbohydrate counting.13

The third aspect of patient education that is addressed in Thriving with Diabetes is the importance of regular physical activity. The CDC currently recommends 150 minutes of moderate-intense activity per week for individuals with type II diabetes.14 One benefit of regular exercise is healthy weight loss; and since being overweight or obese is a major risk factor for diagnosis of type II diabetes, it is something we address in the program. One study shows weight loss of >10% following diagnosis of type II diabetes doubles the likelihood of remission from the disease in 5 years without any intensive lifestyle changes or caloric restriction.15 This can be utilized as a motivating factor within this population and demonstrates the health benefits from regular physical activity. Participants will be asked to keep a physical activity log and track their steps using a pedometer or smart watch from week to week to encourage self-efficacy, management of their chronic condition, and keep track of their progress. Literature supports the use of both a pedometer and activity log to promote an increase in physical activity in this population. In this study, individuals who utilized these tools took more steps and participated in a greater amount of physical activity than those who did not.16

Utilizing the WHO Quality of Life-BREF (WHOQOL-BREF) questionnaire, Thriving with Diabetes also measures participants quality of life when it comes to activities of daily living, general health, life participation, mental health, quality of life and social relationships. One study notes the extensive impact that type II diabetes has on the quality of life of those diagnosed with the disease, particularly when assessing the physical health, psychological, social, and environmental domains.17,18 Our interventions directly impact these domains of quality of life through increased aerobic fitness, self-efficacy, and community support. Given the widespread impact of this diagnosis on participants, and the WHOQOL-BREF’s consideration of the individuals culture, values, personal goals, standards, and concerns- we can address their progress from a socio-ecological standpoint at the individual level and support them through all aspects of their health journey.

 Providing handouts with the benefits of participation in the program, including the direct benefit of HIAT or MICT exercise, nutrition guidelines for management of blood glucose levels, physical activity guidelines, and a schedule with support group meetings will provide increased adherence and understanding of Thriving with Diabetes to its participants. Thriving with Diabetes utilizes evidence-based intervention and outcome measures to increase the health and wellness of adults in the community diagnosed with type II diabetes, leading to improved health outcomes and quality of life.

**Program Goals**

The goal of Thriving with Diabetes is to utilize evidence-based intervention to increase the health and wellness of adults in the community diagnosed with type II diabetes, leading to improved health outcomes and quality of life. The following goals are worked toward over the 12-week program:

1. Participants will improve their 6MWT scores by 54 m to meet the minimal clinical important difference for change in this outcome measure and demonstrate improved aerobic capacity by the end of the 12-week Thriving with Diabetes community program.7,19
2. Participants will demonstrate a score of at least 49 on physical health, 53 on psychological health, 58 on social relationships, and 53 on environment subcategories of the WHOQOL-BREF to score within normative data for this patient population on this outcome measure and demonstrate an improved quality of life by the end of the 12-week Thriving with Diabetes community program.17
3. Participants will report compliance with 150 minutes of moderate-intense activity per week through an activity log outlining type of exercise and daily step count to demonstrate an increase in physical activity by the end of the 12-week Thriving with Diabetes community program.14
4. Participants will attend at least 12 group-based sessions to demonstrate positive health behavior change, and improved clinical, lifestyle, and psychosocial outcomes by the end of the 12-week Thriving with Diabetes community program.5

**Methods**

1. **Personnel**
	1. Local physical therapists and health professionals will be recruited to volunteer during weekly sessions that include both exercise intervention and group discussion, along with the days of initial enrollment and final assessment; however, they are welcome to assist during recruitment and any other days of the program. Upon volunteering, access to a google sheets document will be provided to manage sign-up and organize the schedule.
	2. Local volunteers will also be recruited through email to local high school and college programs, along with flyers at local events, to assist health professionals during exercise and group discussion settings, assisting with recruitment and enrollment, and participate in fundraising.
	3. Two health professionals are required at each exercise session during the 12-week Thriving with Diabetes program. Both will oversee monitoring of the participants heart rate during exercise and ensuring safe participation in activity. One local volunteer per 10 participants is required per session to assist health professionals with motivating participants, setting them up on appropriate equipment, providing administrative tasks, timekeeping and maintaining a clean environment.
	4. At least one health professional is required at each group discussion to lead the discussion and answer questions. At least one local volunteer is also required at each group discussion to aide in timekeeping, group discussion, and administration.
	5. Fundraising will be organized and executed by volunteers at local community events, schools, and churches. The money raised will go toward purchasing pedometers, activity logs, and heart rate monitors utilized by participants to track their physical activity, a pool of $50 to assist participants who cannot pay the $10/month fee, and the rest will be donated to the Diabetes Research Institute to support their critical research toward a cure for diabetes.20
2. **Location**
	1. Local physical therapy clinic- Registration, assessment, and group discussion location. This will occur outside of operating hours at a volunteer clinic.
	2. Planet Fitness- Exercise classes will take place at a local gym to ensure enough equipment and space for all participants. Participants will be required to pay a $10/month fee for access to the facility throughout the duration of the 12-week program.
3. **Enrollment and Program Schedule**
	1. Participants will be recruited to the program through local flyers throughout the community: churches, healthcare facilities, gyms, and community events. We will also encourage volunteers to spread the word to their patients, family, and friends.
	2. Flyers will direct participants to an online survey where they will express their interest and receive directions to attend an enrollment session at the local physical therapy clinic. Each 12-week program is capped at 20 participants unless more volunteers are available for each exercise and group discussion session.
	3. The first session will be held on Monday evening at the volunteer physical therapy clinic. Participants will be educated on the requirements of the program including the maintenance of 150 minutes of moderate-intense physical activity per week in addition to attending sessions. They will also be asked to complete a printed survey of the amount of physical activity they were participating in prior to the start of the program for a baseline measure of fitness. At this time, consultation regarding which form of exercise they would like to partake in will occur. Participants will be encouraged to utilize either a treadmill or a stationary bike for their exercise; however, if they wish to complete another form of exercise this will be discussed with a health professional who will determine the feasibility. Sign-ups for which weekly sessions participants will attend (at least 12 group discussions and 3 exercise sessions per week over the course of the 12-week program) will take place and a printed schedule of their planned sessions will be provided to them. A pedometer and activity log will also be provided per participant, along with education on appropriate use Additionally, under guidance of a health professional, baseline vitals, including peak heart rate, will be measured; the 6MWT will be administered; and the WHOQOL-BREF will be administered and turned in. Participants will also fill out a form to be reviewed by a health professional stating their comorbidities, risk factors, experience with exercise and medications to ensure safe participation in exercise sessions. At this point, participants can also request financial aid- which will be provided based on need and available funding.
	4. An example schedule is provided above, and sessions will run at these times each week throughout the 12-week program. Each group discussion will begin with 30 minutes of education, followed by 15 minutes of group discussion and 15 minutes of Q&A.
	5. Participants will choose 3 exercise sessions a week to attend where they will participate in either HIAT or MICT depending on their consultation with a health professional upon enrollment. Sessions will last 1 hour to allow time for warm up, exercise and cool down. At initial assessment, each participant will receive their peak heart rate, along with 70% and 90% of that number, to understand their heart rate goals during each exercise session.
	6. At the completion of the 12-week program, participants will attend a final assessment where they will complete the 6MWT, WHOQOL-BREF, and turn in their activity log supervised by a health professional. If patients have received HbA1c testing from a PCP over the course of the 12-week program, that data will also be requested to track progress.
4. **Intervention Specifics**
	1. Exercise sessions will take place at the local Planet Fitness and last 1 hour. Every participant should provide understanding of their heart rate goals prior to each session by bringing the sheet provided at initial assessment. However, health care professionals will have this information and be able to educate participants as needed. Each session will begin with distribution of heart rate monitors and completion of 10 minutes of warm up at 70% of their peak heart rate. The HIAT group will then undergo 4x4-minute bouts of exercise at 90% of their peak heart rate interspersed with 3x3-minute bouts of exercise at 70% of their peak heart rate for a total of 25 minutes. Meanwhile, the MICT group will complete 32 minutes of exercise maintaining 70% of their peak heart rate. This exercise will be completed on a treadmill or stationary bicycle unless accommodations were made with a health professional at the initial assessment. Health professionals will be available for questions and to ensure safe participation in activity; while volunteers will time keep and motivate participants. At the end of their session, each participant will undergo a 5-minute cooldown. Heart rate monitors will be collected at the end of each exercise session, where volunteers will sanitize and prepare them for their next use.
	2. Each group discussion session will consist of 30 minutes of education, followed by 15 minutes of group discussion and 15 minutes of Q&A with each day of the week corresponding to a different education topic. Attendance will be recorded at the start of each session by a volunteer to ensure participants are meeting their minimum number of sessions required. If a session is missed, the participant will be contacted. If three sessions are missed without a 24-hour notice and reschedule, the participant will be removed from the program. The education schedule is as follows: Tuesday/Thursday-self management techniques and physiological manifestation of type II diabetes; Wednesday/Friday- nutrition and diet; Monday/Saturday- education on the importance and implementation of regular physical activity along with checking in on the participants progress with their activity log. Each participant is required to attend at least 4 sessions of each education topic. Education sessions will include but are not limited to depending on group discussion and questions:
		1. Self-management techniques and physiological manifestation education: promotion of self-efficacy, motivation, physical manifestation of type II diabetes (common side effects, the bodies inability to regulate sugar, basic anatomy involved in the diagnosis of diabetes), the risks of not properly managing the disease (eye/vision problems, amputation, cardiovascular complication, kidney disease, nerve damage, oral disease, etc.), how to regularly monitor blood glucose levels, tracking and managing HbA1c levels, the importance of attending routine healthcare appointments, routinely checking areas for nerve damage, management of common symptoms, and handling stress will be taught and encouraged.
		2. Nutrition and diet: carbohydrate portioning, blood sugar monitoring, meal prepping, eating healthy and grocery shopping on a budget, reading and understanding food labels, and offering free resources to access at home i.e. the CDC website for diabetes and nutrition.
		3. The importance and implementation of regular physical activity: understanding the CDC guidelines for physical activity (150 minutes of moderate-intense activity per week), how physical activity impacts an individual with type II diabetes (increases sensitivity to insulin, decreased risk of cardiovascular disease, decreased risk of nerve damage, etc.), healthy weight loss, different types of exercises that participants can try to reach their health goals, assistance with use of activity log and pedometer, and discussion on progress with maintaining required amount of weekly exercise.
	3. The group discussion portion of the discussion session will focus on how everyone is handling the program, any struggles or complications with the program, community support, and group brainstorming on how to remain motivated and successful during the 12-week program. The purpose of these sessions is to promote a sense of community, encourage self-efficacy, and motivate those who are participating in the program while allowing a space to express individual knowledge, attitudes, beliefs, and personalities surround their experience living with type II diabetes. A volunteer will take minutes throughout the session, leaving out identifiable information, that can be accessed at future sessions to show progress or by individuals participating in the session who want a written version of what was discussed.
	4. Final assessment will include participants turning in their activity log for assessment of adherence to the physical activity guidelines and pedometer for use in future programs. Failure to return the pedometer will result in a $12 fee for replacement. Participants will then complete the 6-minute walk test (6MWT) with supervision from a health professional. The 6MWT requires a measuring wheel to track total distance walked, a stopwatch, and the script for a standardized 6MWT. The WHOQOL-BREF will also be provided to participants to fill out and will be compared to their original scores. Volunteers will assist with organization and paperwork during the final assessment. Volunteer health professionals will analyze the results of participants and provide a final assessment sheet indicating participant progress with aerobic capacity and quality of life measures, along with their final activity log, to take home upon completion of the program. A handout, created by volunteers, including contact information, the CDC physical activity guidelines, basic nutrition information with links to the CDC diabetes nutrition site, and a motivational quote will be provided to all participants upon graduation from the program.

**Program Evaluation**

 Thriving with Diabetes will perform an initial assessment on day one of the program and a final assessment on the last day of the 12-week program. With this population, the research supports a longer duration of exercise intervention to see positive health outcomes, therefore we are doing one final assessment at the 12-week mark.1,2 However, the group discussions will provide a space for participants to check in with a healthcare provider with any questions, concerns, or progress made up to that point in the program.

Upon final evaluation, initial scores will be compared to final scores to evaluate progress with the 6MWT, adherence to the physical activity guidelines, and WHOQOL-BREF scores, along with group session attendance. By the final assessment, participants should see an increase in their 6MWT score by 54 meters to demonstrate meaningful change in aerobic capacity7,19; a score of least 49 on physical health, 53 on psychological health, 58 on social relationships, and 53 on environment subcategories to demonstrate normative values of quality of life for this population17; have participated in at least 4 of each type of group discussion session to demonstrate improved clinical, lifestyle, and psychological outcomes along with positive behavior change5; and have logged 150 minutes of moderate-intensity physical activity per week to demonstrate an increase and maintenance of regular physical activity.14

A final satisfaction survey including a section for feedback will be provided to volunteers and participants in the program upon final assessment. This, along with outcome measure scores and adherence to the program, will allow Thriving with Diabetes to assess its strengths and weakness for the next session. Our goal is to create a program that improves the health outcomes of the adults within our community, and we want to ensure that this program is tailored to that population specifically. Therefore, if scores are lower than expected, changes will be made to the program to ensure improved positive outcome and participant experience.21

**Conclusion**

Thriving with Diabetes utilizes evidence-based intervention and outcome measures to reach our goal of increased health and wellness of adults in the Durham community diagnosed with type II diabetes, leading to improved health outcomes and quality of life. Type II diabetes is a chronic condition that requires life-long management, and our program provides those diagnosed with the tools necessary to avoid the negative health implications brought on by untreated diabetes. By providing exercise intervention, community support, and education to these individuals on how to self-manage their disease and maximize their health- we are setting them up to lead full, healthy lives and even reach a state of remission from their condition.15 Considering the healthcare costs of one individual diagnosed with diabetes is close to $17,000 per year; our program not only lessens the financial burden placed on the healthcare system, but also decreases the individual burden of those residing in our community.22 The interventions provided through Thriving with Diabetes increase the fitness, health behavior, and quality of life of its participants, along with improved psychological, social, environmental, and community outcomes. The results of our program allow participants to move forward with self-management of their disease and provide the tools necessary to maximize the quality of their life within the community. This program not only encourages community members to support one another through volunteer work and community involvement to promote the overall health and happiness of society; but also gives those adults diagnosed with type II diabetes a community of individuals undergoing similar experiences to thrive alongside of.

References

1. Hwang C-L, Lim J, Yoo J-K, Kim H-K, Hwang M-H, Handberg EM, Petersen JW, Holmer BJ, Leey Casella JA, Cusi K, Christou DD. Effect of all-extremity high-intensity interval training vs. moderate-intensity continuous training on aerobic fitness in middle-aged and older adults with type 2 diabetes: A randomized controlled trial. *Exp Gerontol*. 2019;116:46-53.
2. Støa EM, Meling S, Nyhus L-K, Glenn Strømstad, Mangerud KM, Helgerud J, Bratland-Sanda S, Støren Ø. High-intensity aerobic interval training improves aerobic fitness and HbA1c among persons diagnosed with type 2 diabetes. *Eur J Appl Physiol*. 2017;117(3):455-67.
3. Colberg SR, Sigal RJ, Fernhall B, Regensteiner JG, Blissmer BJ, Rubin RR, Chasan-Taber L, Albright AL, Braun B, American College of Sports Medicine, American Diabetes Association. Exercise and type 2 diabetes: The American College of Sports Medicine and the American Diabetes Association: Joint position statement. *Diabetes Care*. 2010;33(12):e147-67.
4. Shamanna P, Saboo B, Damodharan S, Mohammed J, Mohamed M, Poon T, Kleinman N, Thajudeen M. Reducing HbA1c in Type 2 Diabetes Using Digital Twin Technology-Enabled Precision Nutrition: A Retrospective Analysis. *Diabetes Ther*. 2020;11(11):2703-14.
5. Odgers-Jewell K, Ball LE, Kelly JT, Isenring EA, Reidlinger DP, Thomas R. Effectiveness of group-based self-management education for individuals with Type 2 diabetes: a systematic review with meta-analyses and meta-regression. *Diabet Med*. 2017;34(8):1027-39.
6. Hill JO, Galloway JM, Goley A, Marrero DG, Minners R, Montgomery B, Peterson GE, Ratner RE, Sanchez E, Aroda VR. Scientific statement: Socioecological determinants of prediabetes and type 2 diabetes. *Diabetes Care*. 2013;36(8):2430-9.
7. Lee MC. Validity of the 6-minute walk test and step test for evaluation of cardio respiratory fitness in patients with type 2 diabetes mellitus. *J Exerc Nutrition Biochem*. 2018;22(1):49-55.
8. Hermanns N, Ehrmann D, Finke-Groene K, Kulzer B. Trends in diabetes self-management education: where are we coming from and where are we going? A narrative review. *Diabet Med*. 2020;37(3):436-47.
9. Gagliardino JJ, Chantelot J-M, Domenger C, Ramachandran A, Kaddaha G, Mbanya JC, Shestakova M, Chan J, IDMPS Steering Committee. Impact of diabetes education and self-management on the quality of care for people with type 1 diabetes mellitus in the Middle East (the International Diabetes Mellitus Practices Study, IDMPS). *Diabetes Res Clin Pract*. 2019;147:29-36.
10. Managing Diabetes | Self-Management Education Programs | Self-Management Education: Learn More. Feel Better. | CDC.
11. Chester B, Stanely WG, Geetha T. Quick guide to type 2 diabetes self-management education: creating an interdisciplinary diabetes management team. *Diabetes Metab Syndr Obes*. 2018;11:641-5.
12. Hou Y-Y, Ojo O, Wang L-L, Wang Q, Jiang Q, Shao X-Y, Wang X-H. A Randomized Controlled Trial to Compare the Effect of Peanuts and Almonds on the Cardio-Metabolic and Inflammatory Parameters in Patients with Type 2 Diabetes Mellitus. *Nutrients*. 2018;10(11).
13. Eat Well | Living with Diabetes | Diabetes | CDC.
14. Get Active! | Diabetes | CDC.
15. Dambha-Miller H, Day AJ, Strelitz J, Irving G, Griffin SJ. Behaviour change, weight loss and remission of Type 2 diabetes: a community-based prospective cohort study. *Diabet Med*. 2020;37(4):681-8.
16. Furber S, Monger C, Franco L, Mayne D, Jones LA, Laws R, Waters L. The effectiveness of a brief intervention using a pedometer and step-recording diary in promoting physical activity in people diagnosed with type 2 diabetes or impaired glucose tolerance. *Health Promot J Austr*. 2008;19(3):189-95.
17. Reba K, Birhane BW, Gutema H. Validity and Reliability of the Amharic Version of the World Health Organization’s Quality of Life Questionnaire (WHOQOL-BREF) in Patients with Diagnosed Type 2 Diabetes in Felege Hiwot Referral Hospital, Ethiopia. *J Diabetes Res*. 2019;2019:3513159.
18. Amin MF, Bhowmik B, Rouf R, Khan MI, Tasnim SA, Afsana F, Sharmin R, Hossain KN, Khan MAS, Amin SM, Khan MSS, Pathan MF, Hasan MJ. Assessment of quality of life and its determinants in type-2 diabetes patients using the WHOQOL-BREF instrument in Bangladesh. *BMC Endocr Disord*. 2022;22(1):162.
19. Wise RA, Brown CD. Minimal clinically important differences in the six-minute walk test and the incremental shuttle walking test. *COPD*. 2005;2(1):125-9.
20. Join Our Mission to Cure Diabetes - Diabetes Research Institute Foundation.
21. U.S. Department of Health and Human Services Centers for Disease Control and Prevention. Office of the Director, Office of Strategy and Innovation. Introduction to program evaluation for public health programs: A self-study guide. Atlanta, GA: Centers for Disease Control and Prevention,2011.
22. The Cost of Diabetes | ADA.