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Enrollment, Engagement, and Effectiveness of a Large-Scale Diabetes Prevention Program Using Synchronous Distance Technology

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Abstract: The Centers for Disease Control and Prevention (CDC) indicates that individuals with prediabetes are significantly less likely to develop type 2 diabetes if they participate in a lifestyle change program that results in at least 5% weight loss and 150 min of physical activity per week. The CDC recognizes distance learning as an effective delivery mode for lifestyle change programs to prevent type 2 diabetes. The purpose of this study was to assess enrollment, engagement, and effectiveness of a type 2 diabetes prevention program (DPP) using synchronous distance technology. Eat Smart, Move More, Prevent Diabetes (ESMMPD) is an intensive 12-month DPP delivered using synchronous distance technology. Throughout 26 lessons, participants focused on healthy eating, physical activity, and mindfulness behaviors. Study findings showed a significant decrease in A1C (-0.24 $p < 0.0001$). Weight loss averaged 5.66% for those who completed the program. Based on the Wilcoxon signed-rank test, participants demonstrated statistically significant changes in self-reported confidence in their ability to perform all 18 health-promoting behaviors assessed ($p < 0.0001$). Participation in the program also resulted in the adoption of health promoting behaviors. A DPP using synchronous distance technology is an effective delivery mode to help participants adopt healthy behaviors, increase physical activity, and achieve the weight loss necessary to prevent or delay the onset of type 2 diabetes.

Keywords: prediabetes; national DPP; synchronous distance technology; distance learning delivery mode; lifestyle change program; diabetes prevention recognition program (DPRP)

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1. Introduction

Prediabetes is a metabolic disorder characterized by elevated blood glucose levels higher than normal but below the threshold of a type 2 diabetes diagnosis [1]. The American Diabetes Association indicates individuals with prediabetes as an intermediate group at risk of diabetes with a hemoglobin A1C (A1C) level between 5.7% and 6.4% [1]. The frequency of prediabetes is increasing as the prevalence of obesity rises in the United States (CDC, May 2022). It is estimated that 38% of all US adults have prediabetes, which puts many at an increased risk of developing type 2 diabetes, as well as cardiovascular disease [2]. These two chronic conditions have a well-documented economic and population health burden [3,4].

Prediabetes and its progression towards more serious chronic conditions can be significantly delayed or reversed. The available scientific evidence for type 2 diabetes prevention through lifestyle modification is compelling and includes intensive, structured, yearlong educational programs focused on moderate weight loss (5–7%), increasing self-efficacy

around engagement in one's health, and moderate increases in physical activity over time [5–7]. The oft-cited landmark Diabetes Prevention Program (DPP) study published in 2002 and the subsequent translation studies demonstrated the effectiveness of a structured lifestyle change program in preventing or delaying the onset of type 2 diabetes [8–11].

Given the demonstrated benefits of the DPP, Congress authorized the Centers for Disease Control and Prevention (CDC) to establish the National Diabetes Prevention Program (National DPP). The two major goals of the DPP are for participants to achieve and maintain a modest weight loss of at least 5% and increase weekly physical activity to at least 150 min [12]. In an effort to translate the DPP to allow widespread adoption and community level implementation, the CDC's National DPP created the Diabetes Prevention Recognition Program (DPRP) [13]. The DPRP provides recognition status, quality assurance, technical assistance, and data collection standardization to organizations that have demonstrated their ability to effectively deliver the DPP [14].

Per the National DPP, organizations may offer the program through any or all of the four delivery modes: in-person, online, via distance learning, or a combination of these modes [15]. The online delivery model defines participation as logging in for an asynchronous class session from a computer, tablet, or smartphone, with coach interaction taking place outside of the self-paced sessions; synchronous distance learning is defined as the coach being present in one location while participants simultaneously call in or video conference from another location [15]. Regardless of delivery mode, all organizations that provide the DPP must use an approved curriculum that meets the duration, frequency, and reporting requirements described in the DPRP standards. The variety of delivery modes increases accessibility and convenience by removing some of the barriers, such as transportation, commonly associated with in-person gatherings [16].

Despite large-scale investments, there is evidence to suggest that the current DPP infrastructure is underutilized and that more methods are needed to increase access and engagement [17]. A contributing factor may be that very few payment structures support any of the NDPP delivery modes, especially the distance learning and online delivery modes. For most community based DPP providers, Medicare DPP (MDPP) is the main payment structure available outside of occasional time-limited grant opportunities. Additionally, many DPP providers find the cost of becoming an MDPP supplier outweighs Medicare reimbursement due to the increased administrative burden, blood glucose eligibility criteria, and allowable service delivery modes [18]. MDPP suppliers are not permitted to have regularly scheduled online sessions or to provide services entirely online [19]. This decision was made even given that the coronavirus disease 2019 (COVID-19) pandemic triggered a boom in telehealth services in 2020 [20]. In response, the MDPP did temporarily relax regulations to allow current suppliers to offer sessions by virtual delivery; however, fully virtual providers who are arguably more experienced in remote delivery are still not eligible to become MDPP suppliers. The COVID-19 pandemic catalyzed the rapid adoption of telehealth, changing how we communicate, which has shifted what is possible in chronic disease prevention via virtual platforms [21].

The Eat Smart, Move More, Prevent Diabetes (ESMMPD) program was established in 2016 and is a partnership between NC State University and the North Carolina Division of Public Health. As compared to in-person delivery, ESMMPD's distance learning delivery was uniquely positioned to scale up and absorb the demand for virtual DPP as a result of the COVID-19 pandemic. ESMMPD has full plus recognition status from the CDC under the distance learning delivery mode. Full plus recognition is granted for a total of 5 years to DPP providers that have demonstrated effectiveness by achieving basic recognition criteria as well as additional requirements involving attendance, weight loss, and eligibility as outlined in the DPRP standards [15].

The purpose of this study was to assess enrollment, engagement, and effectiveness of the distance learning delivery mode of ESMMPD. In addition to validating previous research regarding virtual delivery modes, this study aimed to also demonstrate the specific value of synchronous delivery as an effective DPP delivery method and to assess changes in

weight, A1C, and behaviors related to diabetes prevention. A variety of effective delivery modes are needed to reach both high-risk populations as well as the general population. The distance learning delivery mode removes several barriers to in-person attendance and therefore has the potential to be more effective in reaching a larger audience at risk for developing type 2 diabetes.

2. Materials and Methods

2.1. Study Design

A total of 2549 participants enrolled in the distance learning delivery mode of ESMMPD from January 2019 through June 2022. The study population consisted of the ESMMPD distance learning modality participants who agreed to share their program data for research purposes (n = 2390). All enrolled participants had the same programmatic experience regardless of whether or not they choose to share their program data for research purposes. Data were collected from registration information, participant self-reported weight, physical activity, and A1C data entry throughout the program, as well as optional end-of-program evaluation surveys.

2.2. Participants

The inclusion criteria for this study followed the CDC requirements for DPP participation. Participants must be 18 years or older and have a body mass index (BMI) over 25 (or 23 and higher for Asian Americans). Participants cannot have a previous diagnosis of type 1 or type 2 diabetes or be pregnant at the time of enrollment. Additionally, participants must have at least one of the following qualifications: a history of gestational diabetes, a blood test in the prediabetes range within one year of program enrollment, or a score of 5 or higher on the CDC risk test. The blood test result must be from within one year of enrollment and can be a fasting glucose of 100 to 125 mg/dL a plasma glucose of 140 to 199 mg/dL, or an A1C of 5.7% to 6.4%. The CDC risk test assesses multiple factors such as age, sex at birth, gestational diabetes diagnosis, family history, high blood pressure diagnosis, physical activity levels, and weight category to create a total score to assess eligibility for DPP enrollment [15]. Notably, DPP organizations that are not MDPP suppliers are allowed to use the CDC risk test as a participant eligibility option. Thus, individuals may not have an official diagnosis of prediabetes but must be at high risk for type 2 diabetes.

The ESMMPD online registration system screens participants for eligibility based on the DPRP criteria described above. All participants are required to complete registration on the ESMMPD website (https://esmmpreventdiabetes.com/enroll/, accessed on 26 September 2023). Informed consent was obtained from program participants to use their deidentified data for research purposes, and participants had the option to opt out of their data being used. Participants were not compensated for opting in to the study as the program experience is the same regardless of study participation.

2.3. Description of the Program

The synchronous delivery mode of ESMMPD features real-time interaction with a trained lifestyle coach and cohort of classmates. The ESMMPD program team developed an independent curriculum that has undergone CDC review and approval. The curriculum is copyrighted by NC State University. Key concepts of this curriculum include planning, tracking, and living mindfully to prevent type 2 diabetes. Mindfulness strategies were incorporated into the curriculum based on research showing the benefits of mindful eating practices as a successful component of weight management programs [22].

The program is 12 months in duration, with two 6-month phases consisting of 26 total lessons. The ESMMPD program refers to the two 6-month phases as Phase 1 and Phase 2, which are more commonly referred to as Core (months 1–6) and Core Maintenance (months 7–12) in DPRP parlance. Each cohort meets in real time using synchronous distance technology on the same day and time for the 26 lessons. The real-time format allows for interaction among program participants during the live classes to share suc-

cesses/challenges and provide support for one another. Each live class is recorded for make-up session purposes only. Participants are required to attend at least 9 out of 18 Phase 1 classes to proceed to Phase 2 of the program. ESMMPD defines program completion as attending at least 9 out of 18 Phase 1 and 5 out of 8 Phase 2 classes.

Participants track their weekly weight, minutes of physical activity, and progress on mindfulness strategies using a secure online portal, called the My Progress Portal, developed by the program team. The My Progress Portal is vital for participant engagement and serves as a platform for one-on-one communication between lifestyle coaches and participants. To facilitate continued engagement, coaches send personalized weekly messages to participants through the My Progress Portal to motivate and support them throughout the yearlong program. Participants are also encouraged to find a 'buddy' in the class or a family member or friend outside of the class to provide support toward achieving their healthy behavior goals.

2.4. Statistical Analysis

All data were analyzed using SAS 9.4 (Cary, NC, USA). Summary statistics including frequency tables, means and standard deviations, and medians and ranges were calculated for all variables including demographic information.

Completion rates for Phase 1 and program completion were compared across race, ethnicity, and educational attainment using Chi-squared or Fisher's exact Tests, depending on the expected cell counts. Because participants could check all options that apply, each race and ethnicity category was treated separately.

Differences between average physical activity per week between participants that completed Phase 1 or not and participants who completed the program or not were evaluated using two-sample *t*-tests. Changes in self-reported A1C before and after program participation were compared using a paired *t*-test. Weight was changed to a percentage of body weight loss ((post-weight—pre-weight)/pre-weight) and compared to the CDC goal of 5% weight loss using a one-sample *t*-test.

For self-reported pre-program and post-program confidence in the ability to perform each of the 18 behaviors measured, participants were able to answer on a scale of 1 (very low) to 5 (very high). The differences in post-program values compared to pre-program values for each participant were calculated, and a Wilcoxon signed-rank test was run for each behavior.

For self-reported adoption as a result of program participation of 21 behaviors measured, participants were able to answer No, Yes, Already Doing, or Not Applicable. The percentage of participants who answered Yes out of all participants who answered either Yes or No was calculated along with confidence intervals.

All tests were evaluated using a 0.05 level of significance, but Bonferroni's correction for multiple testing was performed within each group of tests.

3. Results

3.1. Demographics

Of the 2390 participants who agreed to share their data, 74.0% (1768) completed Phase 1 and 46.9% (1120) completed both Phase 1 and Phase 2. The average age of participants who agreed to share their data was 54.9 years (standard deviation 10.15) with a minimum age of 18 and a maximum age of 88. The sex of participants who agreed to share their data were 89.2% (2132) female and 10.8% (257) male, which is representative of our participant population.

3.2. Completion Rates by Race and Ethnicity

Phase 1 completion rates did not differ across race and ethnicity categories. The categories tested were African American (Yes/No, $p = 0.794$), American Indian (Yes/No, $p = 0.710$), Asian (Yes/No, $p = 0.447$), Hawaiian/Pacific Islander (Yes/No, $p = 0.168$), White

(Yes/No, $p = 0.803$), and ethnicity (Hispanic or Latino/Not Hispanic or Latino/Prefer not to answer, $p = 0.755$).

Program completion rates also did not differ across race and ethnicity categories. African American (Yes/No, $p = 0.067$), American Indian (Yes/No, $p = 0.871$), Asian (Yes/No, $p = 0.867$), Hawaiian/Pacific Islander (Yes/No, $p = 1.00$), White (Yes/No, $p = 0.105$), and ethnicity (Hispanic or Latino/Not Hispanic or Latino/Prefer not to answer, $p = 0.2695$).

3.3. Completion Rates by Highest Level of Education

There were statistically detectable differences in completion rates across levels of education for Phase 1 ($p = 0.002$), but after adjusting for running Fisher's exact tests on educational levels for both Phase 1 and program completion, the difference at the program completion level did not meet the new statistical significance threshold of 0.025 ($p = 0.036$). Table 1 shows how the completion rate increases with education level. While only 40% of those who "completed some high school" completed Phase 1, nearly 65% of those with a high school education or equivalent completed Phase 1. For participants who graduated from college, the Phase 1 completion rate reached 75.5%.

Table 1. Phase 1 Completion by Education.

Phase 1 Completion	Education Level					
	Attended Some High School	**High School Graduate or GED**	**Attended 1–3 Years of College**	**Graduated from College**	**Prefer Not to Answer**	**Total**
No	6	31	100	477	8	1270
	60%	35.23%	31.75%	24.47%	28.57%	
Yes	4	57	215	1472	20	1120
	40%	64.77%	68.25%	75.53%	71.43%	
Total	10	88	315	1949	28	2390

Table 2 shows the program completion rates follow a similar pattern across education levels, although with smaller differences. While only 30% of those who "completed some high school" completed the program, more than 40% of those with a high school education or equivalent or some college completed the program. For participants who graduated from college, the completion rate reaches 57%.

Table 2. Program Completion by Education.

Program Completion	Education Level					
	Attended Some High School	**High School Graduate or GED**	**Attended 1–3 Years of College**	**Graduated from College**	**Prefer Not to Answer**	**Total**
No	7	52	188	1011	12	1270
	70%	59.09%	59.68%	51.87%	42.86%	
Yes	3	36	127	938	16	1120
	30%	40.91%	40.32%	48.13%	57.14%	
Total	10	88	315	1949	28	2390

3.4. Physical Activity Changes by Completion

Participants who completed Phase 1 reported, on average, 92 more minutes of physical activity each week than participants who did not complete Phase 1 (Yes: mean = 101.6, SD = 100.6; No: mean = 9.7, SD = 22.0; $p < 0.0001$). Participants who completed the program reported, on average, 93 more minutes of physical activity each week than participants who

did not complete the program (Yes: mean = 127.3, SD = 110.5; No: mean = 33.9, SD = 50.5; $p < 0.0001$). Due to unbalanced data and unequal variances, Satterthwaite's approximation was used for these tests.

3.5. A1C Changes from Pre- to Post-Program

A1C was self-reported both pre- and post-program. Values below 4 and above 20 were excluded from the analysis, and 482 participants reported valid pre- and post-values for A1C. During the program, there was a detectable reduction in A1C of 0.24 units (SD = 0.45, $p < 0.001$) as shown in Table 3.

Table 3. Changes in A1C.

Variable	N	Mean	Std Dev	Min	Max	*t*-Value	*p*-Value
A1C Current	482	5.69	0.47	4.2	9.4		
A1C Pre	482	5.94	0.50	4.1	9		
A1C Current—A1C Pre	482	−0.24	0.45	−3.6	3	−11.86	<0.0001

3.6. Weight Changes from Pre- to Post-Program

Weight was self-reported both pre- and post-program. One participant self-reported a 192% increase in weight and their data was excluded from these calculations. Table 4 shows that participants lost, on average, 5.66% of their body weight, which is a higher loss ($p = 0.0032$) than the CDC goal of 5%.

Table 4. Changes in Weight.

Variable	N	Mean	Std Dev	Min	Max	*t*-Value	*p*-Value
Weight 1	834	212.31	48.27	121	441		
Weight 2	834	199.87	45.20	96	428		
Weight 2—Weight 1	834	−12.56	14.99	−112	74	−24.19	<0.0001

3.7. Changes in Confidence in Ability to Perform Behavior

For each behavior measured, the change in self-reported confidence in ability to perform the behavior was calculated by subtracting the pre-program value from the post-program value. Every ability showed a measurable positive change ($p < 0.0001$ for all) even after controlling for multiple testing. Table 5 shows the abilities sorted in rank order from the highest mean change to the lowest mean change.

Table 5. Change in Confidence in Ability to Perform Behaviors.

Behaviors	N	Mean
Eat smaller portions	750	1.6
Preventing relapse	768	1.6
Achieve and maintain a healthy weight	785	1.5
Be physically active at least 30 min most days	776	1.5
Eat fewer calories	770	1.5
Eat less fast food	738	1.4
Eat 2–3 cups of vegetables on most days	771	1.4
Eat 1-1/2–2 cups of fruit on most days	765	1.4
Be physically active at least 60 min most days	776	1.3

Table 5. *Cont.*

Behaviors	N	Mean
Include strength training in your physical activity routine	780	1.3
Prepare and eat more meals at home	774	1.2
Pack healthy lunches	760	1.2
Plan for holidays and traveling	771	1.2
Drink fewer calorie-containing beverages	776	1.1
Be physically active at least 90 min most days	766	0.9
Eat breakfast most days	766	0.9
Limit the amount of screen time (TV and computer) I get each day	774	0.9
Manage Stress	760	0.9

3.8. Changes in Adoption of Behaviors

Participants were able to respond Yes, No, Already Doing, and Not Applicable regarding their self-reported adoption of 21 separate behaviors as a result of program participation. After examining the full frequency distribution, the percentage of Yes responses out of Yes and No responses was calculated for each behavior, along with a confidence interval. All of the confidence intervals were entirely above 50%, suggesting that the majority of participants who were able to change behavior in a positive direction did so during the course of the program. Table 6 shows the behaviors sorted in order of highest to lowest percent 'Yes' responses.

Table 6. Adoption of Behaviors as a Result of Program Participation.

Behaviors	% Yes
Am more mindful of what and how much I eat	98.41
Drink fewer calorie-containing beverages	96.4
Am more mindful of getting physical activity each day	95.5
Eat less fast food	94.82
Prepare and eat more meals at home	94.58
Eat smaller portions	93.3
Eat fewer calories	93.26
Pack healthy lunches for myself	93.15
Plan for holidays and traveling	92.06
Eat 2–3 cups of vegetables on most days	87.97
Eat breakfast most days	87.5
Am physically active at least 30 min most days	86.94
Eat 1-1/2–2 cups of fruit on most days	86.54
Manage stress	85.26
Sleep better	80.8
Pack healthy lunches for my family	76.83
Limit screen time (TV and computer) for myself	63.68
Include strength training in my physical activity routine at least 2 times per week	59.37
Limit screen time (TV and computer) for my family	59.19
Am physically active at least 60 min most days	43.21
Am physically active at least 90 min most days	16.64

4. Discussion

4.1. Principal Findings

This study aimed to demonstrate that a DPP using synchronous distance technology is an effective delivery mode to help participants adopt healthy behaviors, increase physical activity levels, and achieve the weight loss recommended to prevent or delay the onset of type 2 diabetes. Our findings support this aim. The average weight loss for those who completed the program was 5.66% and the average weekly minutes of physical activity was 127 min. Most importantly, our findings found a statistically significant decrease in A1C (-0.24 $p < 0.0001$). Based on the Wilcoxon signed-rank test, there were statistically significant changes in participants' self-reported confidence in their ability to perform all 18 health-promoting behaviors assessed ($p < 0.0001$). By demonstrating the overall effectiveness of a large-scale distance learning DPP, this study contributes to the existing literature on the CDC NDPP delivery mode options.

The findings of the study provide further support for the effectiveness of the distance learning delivery of the NDPP [23–25]. This study is novel in its analysis of a community based not-for-profit program serving over 2000 participants with a distance learning DPP. A previous study looking at cumulative enrollment in the NDPP by delivery mode between January 2012 and December 2019 showed that online and distance learning participants were overwhelmingly enrolled in programs run by organizations classified as for-profit businesses or insurers [26]. Additionally, the findings highlight the importance of program completion on weight loss and A1C reduction, aligning with previous research emphasizing the importance of longer program engagement for weight loss and diabetes prevention [27–30].

In developing the ESMMPD program, the ability to scale the monthly class offerings based on demand was a driving factor. The program is able to offer and launch a new set of yearlong classes 9 months out of the year (excluding the months of July, November, and December). As a community-based program, ESMMPD's primary aim was to serve program participants. None of the participants were enrolled specifically for research. The study sample consisted of 2390 program participants who enrolled between January 2019 and June 2022 and provided their consent to use their data for research purposes. The study participants were 89.2% (2132) female and 10.8% (257) male. Previous studies have shown men are underrepresented in weight maintenance and weight loss programs for which there are many theories, but it is believed to be in part due to the different societal norms and pressures to lose weight between the sexes [29,31].

Participants often face challenging constraints that affect retention, yet success in the NDPP lifestyle change program is strongly associated with retention [32]. ESMMPD defines program completion as attending at least 9 out of 18 Phase 1 and 5 out of 8 Phase 2 classes. Of the 2390 study participants, 74.0% (1768) completed Phase 1 and 46.9% (1120) completed both Phase 1 and Phase 2. The program completion rates did not differ across race and ethnicity categories as outlined in the 2021 DPRP Standards.

There were statistically detectable differences in completion rates across levels of education for Phase 1; however, the difference at the program completion-level was not statistically significant. Nearly 65% of those with a high school education completed Phase 1, compared with 40% for those with "some high school" education. The Phase 1 completion rate for college graduates was 75.5%. The program completion rates are similar across education levels compared with the Phase 1 completion rates, but with smaller differences. Only 30% of those who completed "some high school" completed the program, while more than 40% of those with a high school education or equivalent completed the program. There was a 57% completion rate among those who graduated from college.

Program completers lost on average 12.56 pounds or 5.66% of their body weight during the program. Previous papers have highlighted that longer engagement in a DPP is associated with larger weight loss [27–30]. Participants of the ESMMPD program reached the weight loss goal set by the NDPP lifestyle change program which states that if individuals with pre-diabetes achieve a moderate 5–7% weight loss (along with 150 weekly

minutes of physical activity), they can prevent the onset of type 2 diabetes by 58%. A study that examined predictors of long-term weight loss among DPP participants found that greater weight loss at the end of 12 months predicted long-term weight loss in all treatment groups. Further, incidence of type 2 diabetes over a 15-year period was lower among those who achieved ≥5% weight loss than those achieving <5% weight loss at Year 1 [33].

Unless an organization is a MDPP supplier, participants are not required to report an A1C when enrolling in a CDC-recognized program. Organizations with full recognition status from the DPRP must show at least 35% of completers in the evaluation cohort are eligible for the program based on either a blood test that indicates prediabetes or a history of gestational diabetes mellitus. For the study participants that voluntarily reported pre- and post-program changes in A1C values (n = 482) a detectable reduction in A1C of −0.24 units (SD = 0.45, $p < 0.001$) was found. This finding compares favorably with past research on technology-driven DPPs that have reported reductions in A1c ranging from −0.1% to −0.4% [17,34–37]. Though the A1C test is a powerful diagnostic tool, it does have limitations due to genetic differences in erythrocyte metabolism, as medical evidence suggests. Despite the fact that their plasma glucose levels may be similar, African American, Hispanic, and Asian populations may have higher A1C levels when compared to White Caucasian individuals [38]. Strategies to increase the accessibility and affordability of A1C testing are needed to allow more robust analysis of reductions in A1C based on DPP participation.

One of the two main goals of the NDPP is to increase weekly physical activity to at least 150 min. Our findings suggest there is a need for improvement in achieving the weekly physical activity recommendations. For the study participants who completed the program (n = 1120), the average weekly minutes of physical activity was 127 min. Program completers, on average, reported 93 more minutes of weekly physical activity than of participants who did not complete the program. Interestingly, participants reported high levels of confidence in their ability to be physically active for at least 30 min most days. Participants also reported that as a result of the program, they are more mindful of getting physical activity each day. Being confident in one's ability to perform the recommended amount of physical activity and mindful of the physical activity recommendations does not appear to result in engaging in 150 min of weekly physical activity. Future studies should investigate factors that increase physical activity levels to meet the recommendations set by the Physical Activity Guidelines for Americans.

The goal of ESMMPD is to not only help participants achieve specific weight, A1C, and physical activity NDPP benchmarks, but to also provide knowledge and tools that empower participants to adopt and sustain health-promoting behaviors throughout their lifetime. Our findings showed statistically significant changes in participants' self-reported confidence in their ability to perform each assessed health-promoting behavior pre-program and post-program, listed in Table 5. This demonstrates significant participant learning and comprehension in distance learning lessons, pointing to the overall effectiveness of synchronous distance learning as an NDPP delivery mode.

Participants also reported high rates of adoption of health-promoting behaviors as a result of participating in ESMMPD, as shown in Table 6. To highlight behaviors directly pertaining to NDPP goals, 98% of participants reported being more mindful of what and how much they eat. A total of 96% reported being more mindful of getting physical activity every day, with 87% reporting being physically active at least 30 min most days. Participants not only gained confidence in their ability to perform health-promoting behaviors shown to prevent diabetes onset, but also gained tools to adopt and implement these behaviors into their lives. Notably, as a result of the program, 92% of participants said they were able to better plan for holidays and travel, 85% reported they were able to manage stress, and 80% reported sleeping better. ESMMPD's distance learning delivery mode helps participants adopt specific behaviors to reach NDPP benchmarks proven to prevent diabetes, as well as adopt other behaviors that promote overall health and sustained behavior change.

4.2. Limitations

This study is not without limitations as it was not an experimental design. This limits our ability to determine that outcomes and behaviors were a direct result of the program especially as the proportion of women participants is significantly higher than men.

Another limitation is that all data were self-reported by participants. While there are conflicted findings regarding the reliability and validity of self-reported anthropometric measurements and BMI, they continue to be frequently used in public health research due to their feasibility and cost-effectiveness [39,40]. The NDPP is largely built on self-reported data and thus requires DPP providers to submit deidentified data biannually to the DPRP to assure the quality of recognized organizations. ESMMPD participant data were collected from digital registration forms, weekly weight, and physical activity entries in the My Progress Portal platform, and digital end-of-program evaluation surveys. Though extreme and unlikely outliers were excluded from the dataset, it is possible that participants mistakenly entered incorrect values for their data due to difficulties with digital platforms or other reasons. When self-reporting data, participants may have experienced phenomena such as social desirability bias, recall bias, and measurement error bias, reporting incorrect data often more desirable to the participant than their actual data [41]. This can threaten study validity and has shown to be especially pertinent to self-reported physical activity [42].

4.3. Implications for Future Research

The results of our study encourage the expansion of the NDPP, which will rely on increasing prediabetes awareness, referral pathways, and program funding. The question of program funding is vital to the future of the NDPP, as very few supportive payment structures exist for any of the NDPP delivery modes, particularly distance learning and online. To further support those with prediabetes, experimental research is needed to assess the economic impacts of DPP participation to encourage and increase supportive payment structures.

5. Conclusions

A DPP using synchronous distance technology is an effective delivery mode to help participants adopt healthy behaviors, increase physical activity, and achieve the weight loss necessary to prevent or delay type 2 diabetes. Through participation in ESMMPD, participants reduced their risk of type 2 diabetes and increased their overall health, contributing to a healthier U.S. population.

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References

1. American Diabetes Association. Understanding A1C. Updated 2023. Available online: https://diabetes.org/diabetes/a1c (accessed on 28 September 2023).
2. Centers for Disease Control and Prevention. Prevalence of Prediabetes among Adults. National Diabetes Statistics Report Website. Updated 2022. Available online: https://www.cdc.gov/diabetes/data/statistics-report/index.html (accessed on 11 September 2023).
3. Cai, X.; Zhang, Y.; Li, M.; Wu, J.; Mai, L.; Li, J.; Yang, Y.; Hu, Y.; Huang, Y. Association between prediabetes and risk of all cause mortality and cardiovascular disease: Updated meta-analysis. *BMJ Online* **2020**, *370*, m2297. [CrossRef]
4. Echouffo-Tcheugui, J.B.; Selvin, E. Prediabetes and what it means: The epidemiological evidence. *Annu. Rev. Public Health* **2021**, *42*, 59–77. [CrossRef] [PubMed]
5. Knowler, W.C.; Barrett-Connor, E.; Fowler, S.E.; Hamman, R.; Lachin, J.; Walker, E.; Nathan, D. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N. Engl. J. Med.* **2002**, *346*, 393–403. [CrossRef] [PubMed]
6. Tuomilehto, J.; Lindstrom, J.; Eriksson, J.G.; Valle, T.T.; Hamalainen, H.; Ilanne-Parikka, P.; Keinanen-Kiukaanniemi, S.; Laakso, M.; Louheranta, A.; Rastas, M.; et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N. Engl. J. Med.* **2001**, *344*, 1343–1350. [CrossRef] [PubMed]
7. Pan, X.R.; Li, G.W.; Hu, Y.H.; Wang, J.X.; Yang, W.Y.; An, Z.X.; Hu, Z.X.; Lin, J.; Xiao, J.Z.; Cao, H.B.; et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: The Da Qing IGT and diabetes study. *Diabetes Care* **1997**, *20*, 537–544. [CrossRef]
8. Ackermann, R.T.; Finch, E.A.; Brizendine, E.; Zhou, H.; Marrero, D.G. Translating the diabetes prevention program into the community. *Am. J. Prev. Med.* **2008**, *35*, 357–363. [CrossRef] [PubMed]
9. Amundson, H.A.; Butcher, M.K.; Gohdes, D.; Hall, T.H.; Harwell, T.S.; Helgerson, S.D.; Vanderwood, K.K. Translating the diabetes prevention program into practice in the general community. *Diabetes Educ.* **2009**, *35*, 209–223. [CrossRef]
10. Jackson, L. Translating the diabetes prevention program into practice. *Diabetes Educ.* **2009**, *35*, 309–320. [CrossRef]
11. Kramer, M.K.; Kriska, A.M.; Venditti, E.M.; Miller, R.; Brooks, M.M.; Burke, L.E.; Siminerio, L.M.; Solano, F.X.; Orchard, T.M. Translating the diabetes prevention program. *Am. J. Prev. Med.* **2009**, *37*, 505–511. [CrossRef]
12. The Diabetes Prevention Program (DPP) Research Group. The diabetes prevention program (DPP): Description of lifestyle intervention. *Diabetes Care* **2002**, *25*, 2165–2171. [CrossRef]
13. Gruss, S.M.; Nhim, K.; Gregg, E.; Bell, M.; Luman, E.; Albright, A. Public health approaches to type 2 diabetes prevention: The US national diabetes prevention program and beyond. *Curr. Diab. Rep.* **2019**, *19*, 78. [CrossRef] [PubMed]
14. Albright, A.L. and Gregg, E.W. Preventing type 2 diabetes in communities across the U.S. *Am. J. Prev. Med.* **2013**, *44*, S346–S351. [CrossRef]
15. CDC Diabetes Prevention Recognition Program. Centers for Disease Control and Prevention Diabetes Prevention Recognition Program Standards and Operating Procedures. Updated 2021. Available online: https://www.cdc.gov/diabetes/prevention/requirements-recognition.htm (accessed on 28 September 2023).
16. American Diabetes Association. 3. Prevention or delay of type 2 diabetes: Standards of medical care in Diabetes—2021. *Diabetes Care* **2021**, *44*, S34–S39. [CrossRef] [PubMed]
17. Katula, J.A.; Dressler, E.V.; Kittel, C.A.; Harvin, L.N.; Almeida, F.A.; Wilson, K.E.; Michaud, T.L.; Porter, G.C.; Brito, F.A.; Goessl, C.L.; et al. Effects of a digital diabetes prevention program: An RCT. *Am. J. Prev. Med.* **2022**, *62*, 567–577. [CrossRef]
18. Boltri, J.M.; Tracer, H.; Strogatz, D.; Idzik, S.; Schumacher, P.; Fukagawa, N.; Leake, E.; Powell, C.; Shell, D.; Wu, S.; et al. The national clinical care commission report to congress: Leveraging federal policies and programs to prevent diabetes in people with prediabetes. *Diabetes Care* **2023**, *46*, e39–e50. [CrossRef]
19. Centers for Medicare & Medicaid Services. Medicare Diabetes Prevention Program (MDPP)—Frequently Asked Questions. Updated 2023. Available online: https://www.cms.gov/priorities/innovation/innovation-models/medicare-diabetes-prevention-program/faq#recognizing (accessed on 26 September 2023).
20. Keesara, S.; Jonas, A.; Schulman, K. COVID-19 and health care's digital revolution. *N. Engl. J. Med.* **2020**, *382*, e82. [CrossRef] [PubMed]
21. Wosik, J.; Fudim, M.; Cameron, B.; Gellad, Z.F.; Cho, A.; Phinney, D.; Curtis, S.; Roman, M.; Poon, E.G.; Ferranti, J.; et al. Telehealth transformation: COVID-19 and the rise of virtual care. *J. Am. Med. Inform. Assoc.* **2020**, *27*, 957–962. [CrossRef]
22. Dunn, C.; Haubenreiser, M.; Johnson, M.; Nordby, K.; Aggarwal, S.; Myer, S.; Thomas, C. Mindfulness approaches and weight loss, weight maintenance, and weight regain. *Curr. Obes. Rep.* **2018**, *7*, 37–49. [CrossRef]
23. Golovaty, I.; Wadhwa, S.; Fisher, L.; Lobach, I.; Crowe, B.; Levi, R.; Seligman, H. Reach, engagement and effectiveness of in-person and online lifestyle change programs to prevent diabetes. *BMC Public Health* **2021**, *21*, 1314. [CrossRef]
24. Welshons, K.F.; Johnson, N.A.; Gold, A.L.; Reicks, M. Diabetes prevention program outcomes by in-person versus distance delivery mode among ethnically diverse, primarily lower-income adults. *Digit. Health* **2023**, *9*, 20552076231173524. [CrossRef]
25. Gorczyca, A.M.; Washburn, R.A.; Smith, P.; Montgomery, R.N.; Koon, L.M.; Hastert, M.; Suire, K.B.; Donnelly, J.E. Feasibility and comparative effectiveness for the delivery of the national diabetes prevention program through cooperative extension in rural communities. *Int. J. Environ. Res. Public Health* **2022**, *19*, 9902. [CrossRef]
26. Cannon, M.J.; Ng, B.P.; Lloyd, K.; Reynolds, J.; Ely, E.K. Delivering the national diabetes prevention program: Assessment of enrollment in in-person and virtual organizations. *J. Diabetes Res.* **2022**, *2022*, 2942918–2942919. [CrossRef]

27. Branch, O.H.; Rikhy, M.; Auster-Gussman, L.A.; Lockwood, K.G.; Graham, S.A. Weight loss and modeled cost savings in a digital diabetes prevention program. *Obes. Sci. Pract.* **2023**, *9*, 404–415. [CrossRef] [PubMed]
28. Ely, E.K.; Gruss, S.M.; Luman, E.T.; Gregg, E.W.; Ali, M.K.; Nhim, K.; Rolka, D.B.; Albright, A.L. A national effort to prevent type 2 diabetes: Participant-level evaluation of CDC's national diabetes prevention program. *Diabetes Care* **2017**, *40*, 1331–1341. [CrossRef] [PubMed]
29. Cannon, M.J.; Masalovich, S.; Ng, B.P.; Soler, R.E.; Jabrah, R.; Ely, E.K.; Smith, B.D. Retention among participants in the national diabetes prevention program lifestyle change program, 2012–2017. *Diabetes Care* **2020**, *43*, 2042–2049. [CrossRef]
30. Ely, E.K.; Ng, B.P.; Cannon, M.J. Delivering the national diabetes prevention program: Assessment of outcomes in in-person and virtual organizations. *J. Diabetes Res.* **2023**, *2023*, 8894593. [CrossRef] [PubMed]
31. Pagoto, S.L.; Schneider, K.L.; Oleski, J.L.; Luciani, J.M.; Bodenlos, J.S.; Whited, M.C. Male inclusion in randomized controlled trials of lifestyle weight loss interventions. *Obes. Silver Spring Md.* **2012**, *20*, 1234–1239. [CrossRef]
32. Harwell, T.S.; Vanderwood, K.K.; Hall, T.O.; Butcher, M.K.; Helgerson, S.D. Factors associated with achieving a weight loss goal among participants in an adapted diabetes prevention program. *Prim. Care Diabetes* **2011**, *5*, 125–129. [CrossRef]
33. Apolzan, J.W.; Venditti, E.M.; Edelstein, S.L.; Knowler, W.C.; Dabelea, D.; Boyko, E.J.; Pi-Sunyer, X.; Kalyani, R.R.; Franks, P.W.; Srikanthan, P.; et al. Long-term weight loss with metformin or lifestyle intervention in the diabetes prevention program outcomes study. *Ann. Intern. Med.* **2019**, *170*, 682–690. [CrossRef]
34. Kramer, M.K.; Kriska, A.M.; Venditti, E.M.; Semler, L.N.; Miller, R.G.; McDonald, T.; Siminerio, L.M.; Orchard, T.J. A novel approach to diabetes prevention: Evaluation of the group lifestyle balance program delivered via DVD. *Diabetes Res. Clin. Pract.* **2010**, *90*, e60–e63. [CrossRef]
35. Block, G.; Azar, K.M.; Romanelli, R.J.; Block, T.J.; Hopkins, D.; Carpenter, H.A.; Dolginsky, M.S.; Hudes, M.L.; Palaniappan, L.P.; Block, C.H. Diabetes prevention and weight loss with a fully automated behavioral intervention by email, web, and mobile phone: A randomized controlled trial among persons with prediabetes. *J. Med. Internet Res.* **2015**, *17*, e240. [CrossRef]
36. Bian, R.R.; Piatt, G.A.; Sen, A.; Plegue, M.A.; DeMichele, M.L.; Hafez, D.; Czuhajewski, C.M.; Buis, L.R.; Kaufman, N.; Richardson, C.R. The effect of technology-mediated diabetes prevention interventions on weight: A meta-analysis. *J. Med. Internet Res.* **2017**, *19*, e76. [CrossRef]
37. Grock, S.; Ku, J.; Kim, J.; Moin, T. A review of technology-assisted interventions for diabetes prevention. *Curr. Diab. Rep.* **2017**, *17*, 107. [CrossRef] [PubMed]
38. Fayyaz, B.; Rehman, H.J.; Minn, H. Interpretation of hemoglobin A1C in primary care setting. *J. Commun. Hosp. Intern. Med. Perspect.* **2019**, *9*, 18–21. [CrossRef] [PubMed]
39. Davies, A.; Wellard-Cole, L.; Rangan, A.; Allman-Farinelli, M. Validity of self-reported weight and height for BMI classification: A cross-sectional study among young adults. *Nutr. Burbank Los Angeles Cty. Calif.* **2020**, *71*, 110622. [CrossRef] [PubMed]
40. Lipsky, L.M.; Haynie, D.L.; Hill, C.; Nansel, T.R.; Li, K.; Liu, D.; Lannotti, R.J.; Simons-Morton, B. Accuracy of self-reported height, weight, and BMI over time in emerging adults. *Am. J. Prev. Med.* **2019**, *56*, 860–868. [CrossRef] [PubMed]
41. Althubaiti, A. Information bias in health research: Definition, pitfalls, and adjustment methods. *J. Multidiscip. Healthc.* **2016**, *9*, 211–217. [CrossRef]
42. Brenner, P.S.; De Lamater, J.D. Social desirability bias in self-reports of physical activity: Is an exercise identity the culprit? *Soc. Indic. Res.* **2014**, *117*, 489–504. [CrossRef]