PHYSICAL ACTIVITY ASSESSMENT AND REPORTING IN COMMUNITY TRANSLATIONS OF THE DIABETES PREVENTION PROGRAM: A SYSTEMATIC REVIEW

by

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Submitted to the Graduate Faculty of

the Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Master of Public Health

University of Pittsburgh

2014

UNIVERSITY OF PITTSBURGH

Graduate School of Public Health

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ABSTRACT

Background*:* The Diabetes Prevention Program (DPP) achieved a 58% reduction in diabetes incidence and a 41% reduction in the metabolic syndrome using an intensive lifestyle intervention (ILI). The DPP goals included 7% weight loss and 150 minutes of moderate intensity physical activity (PA) per week. The DPP-ILI has been modified and implemented in a variety of community settings, using the same weight loss and PA goals. Translation efforts have been reviewed for their effectiveness at achieving weight loss and improvements in cardio-metabolic risk factors. The purpose of this review is to summarize the PA component, a key part of the DPP-ILI, in terms of assessment and reporting among community-based DPP translations.

Methods: PubMed database was searched to identify publications on DPP-based programs for adults at-risk for diabetes, limited to English language articles published in 2002-2014, searching titles and keywords 'diabetes', 'pre-diabetes', 'metabolic syndrome', 'translation', 'adults', and 'diabetes prevention program'.

Results: Of 74 potentially eligible studies, 52 met eligibility criteria. All articles included a PA goal as part of intervention, 73% included an assessment of PA, and 54% reported PA results.

***Public Health Significance*:** Approximately half of DPP translation studies conducted in the United States include results for changes in PA due to intervention. Given recent National

Health and Nutrition Examination Survey estimates that only half of Americans meet the CDC recommendation of 150 minutes of moderate PA per week, consistent assessment and reporting of PA in community-based lifestyle programs is needed to establish effective methods for increasing and maintaining levels of PA for improvement of diabetes and cardiovascular disease risk factors in at-risk adults.

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PREFACE

I would like to acknowledge my friends, family, and mentors who provided support to reach this milestone. Specifically, Drs. Bob Alman and Madeline Bayles for encouraging me to pursue my graduate education at Pitt; and Carey, Von, and Kelly for reminding me why I started when it was difficult to keep going. Lastly, thank you to my committee of Drs. Kramer, Arena, and Kriska for guiding me through this process and providing support as I continue my education.

Definition of Acronyms:

CDC- Centers for Disease Control and Prevention

CVD- Cardiovascular Disease

DPP- Diabetes Prevention Program

ILI- Intensive Lifestyle Intervention

MET-hour- Metabolic equivalent hour

NDRP- National Diabetes Recognition Program

NHANES- National Health and Nutrition Examination Survey

PA- Physical Activity

PRISMA- Preferred Reporting Items for Systematic Reviews and Meta-Analysis

1.0 INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC), an estimated 25.8 million people in the United States have diabetes, with 27% of those being undiagnosed.[1] An additional 79 million adults are estimated to have pre-diabetes, a condition which is defined as having elevated blood glucose levels between 100-125 mg/dL.[2] Without attempts to improve blood glucose levels, 15-30% of people with pre-diabetes will develop type 2 diabetes within 5 years.[3] Risk factors for diabetes are overweight, physical inactivity, older age, race/ethnicity (non-white and ethnic minorities), and family history of diabetes.[1] Complications of diabetes include heart disease, stroke, kidney disease, and retinal neuropathy. In 2012, diagnosed diabetes cost the U.S. health care system approximately $245 billion in direct and indirect costs, with personal health care expenditures being 2.3 times higher for persons with diabetes than for persons without.[4] Preventing type 2 diabetes and its complications will have an enormous impact on the individual patient as well as the entire health care system.

The Diabetes Prevention Program (DPP), a multi-center national trial funded by the National Institutes of Health (NIH), demonstrated that an intensive lifestyle intervention (ILI) with the goals of losing 7% of initial body weight and increasing moderate physical activity (PA) to 150 minutes per week was effective at lowering the risk for diabetes.[5] The PA goal of the DPP-ILI was derived from the 1996 Surgeon General's report on Physical Activity and Health[6] and aligns with the American College of Sports Medicine and American Diabetes Association

joint statement on PA and the CDC recommendation for PA for the prevention of chronic disease.[7, 8] At the conclusion of the trial, the DPP demonstrated a 58% reduction in diabetes incidence and a 41% decrease in the metabolic syndrome due to lifestyle intervention. Participants in the DPP-ILI increased PA significantly, with 74% of DPP-ILI participants meeting the 150 minute per week PA goal at the end of the 16-session core and 58% meeting the PA goal at the end of follow-up (average 2.8 years).[9]

With the success of the DPP-ILI, translation efforts have arisen in a variety of diverse community settings utilizing various strategies for program delivery in order to maximize community reach. Less dramatic results, but with similar trends, may be expected in community translation due to the decrease in resources available compared to the DPP.

Using appropriate PA assessment methods is a fundamental component of evaluating the effect of behavioral lifestyle change interventions on increasing PA. Physical activity assessment is completed in two ways, objectively via activity monitors and subjectively via logs, diaries, and questionnaires. Both methods of PA assessment have strengths and limitations in the context of population-based interventions. Physical activity monitors record trunk movement during activities similar to walking. Pedometers record steps taken and accelerometers record counts of activity, both during time of wear. The strengths of assessing PA objectively include the ability to capture patterns of behavior, ability to provide total activity for a specified time period, and ability to compare results to available standards.[10, 11] In particular, two strengths of accelerometers include the ability to classify activity counts by intensity and that the measurements do not rely on participant recall of activity, thus eliminating missing information and potential reporting bias.[10]

The limitations of using activity monitors to assess PA levels in population-based studies include the cost, ease of collection, requirement of specialized analysis software, and potential inconvenience to the participant with wearing the monitor.[10, 11] Additionally, pedometers do not distinguish the type, duration, or intensity of activity and rely on the participant to record the daily step values and reset the device.[11]

Subjective measures of PA include questionnaires, population-based surveillance surveys, and activity logs/diaries. Questionnaires can assess varying time frames, from a 24-hour period to a person's lifetime. Questionnaires have been designed to capture moderate and vigorous activities as well as time spent in sedentary behaviors such as reading, TV viewing, or sitting.[11] Many questionnaires have been tested for reliability and validity in diverse populations[12] and have been made available to health researchers and practitioners.[13]

Diaries and logs are used as self-monitoring tools in behavioral change programs. Diaries capture PA throughout the day in pre-determined increments and are valuable tools for tracking patterns of activity. Daily logs capture total PA with information on type and duration. The logs and diaries used in behavioral research can monitor moderate and vigorous intensity activities as well as time spent sedentary.

Strengths of using subjective measurements include the ease of use in large population studies, low cost, adaptability for specific populations, inclusion of information on type of activity performed, and the ability to capture activity patterns without altering participant behaviors.[11, 12] Limitations of using subjective measurements include cautious interpretation of results relative only to populations similar to that being studied, potential recall and reporting bias of the information gathered,[12] and the participant burden for frequent recording.

At the present time, DPP translation studies have been reviewed for effectiveness regarding achievement of weight loss goals and modification of diabetes and cardiovascular disease risk factors (CVD);[14-18] however, no such review exists for the role that PA plays in the success of these efforts. The purpose of this review is to summarize the inclusion of PA goals, PA assessment methods, and PA results in DPP-based community translation studies in order to guide future prevention efforts.

2.0 METHODS

An article search was performed in PubMed database to identify publications detailing lifestyle interventions for the prevention of type 2 diabetes. The search was limited to abstracts and full-text articles published in English language, with human subjects, and date range of 2002-2014. The date range was selected to include articles published after the original publication of the Diabetes Prevention Program results.[5] Keywords used included *diabetes*, *pre-diabetes, metabolic syndrome, translation*, *adults,* and *diabetes prevention program,* searched in article text and titles. The keyword search was conducted on March 3, 2014. A comprehensive collection of diabetes prevention articles maintained at the University for the purpose of staying up-to-date on the latest translation research was also accessed for additional publications not identified in the online database search.

After the keyword search, each title and abstract was screened for potential inclusion in the review. Inclusion criteria included peer-reviewed articles of original research conducted in the United States, including an adult population at high-risk for type 2 diabetes and/or CVD and using an intervention design with a minimum six session intervention based on the DPP-ILI theory or curriculum.

Abstracts that indicated the content was a systematic review, method and/or implementation article, or that included only diabetic participants were not included. In addition,

studies that were not conducted in the United States, were not based on the DPP, and were not related to the research question were excluded.

The primary author extracted data from each publication to include the design of the study, participant demographics, the location of the program (city/state), the setting in which the intervention was delivered, the format of intervention delivery, length of intervention and follow-up, PA goal, inclusion of PA sessions as part of intervention, PA measurement and assessment, PA results, and information related to primary and secondary study outcomes. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 27-item checklist was used to guide evidence acquisition and synthesis.

3.0 RESULTS

The literature search strategy is detailed in Figure 1. The PubMed keyword and title search yielded 1,004 publications and after careful review of article title and/or abstract for relevance, 127 abstracts were identified for possible inclusion. Of those, 66 met eligibility criteria for full-text review. An additional article was identified from article reference lists and seven articles were included from the diabetes translation publication collection for a total of 74 full-text articles assessed for inclusion. After reading full-text articles, 22 additional articles were excluded because they were not based on the DPP and/or non-US,[19-25] were methods or evaluation articles,[26-35] included only diabetic patients,[36, 37] were cross-sectional in design,[38] or utilized a single lifestyle session as intervention.[39, 40]

A total of 52 articles, representing 44 unique study populations, met the inclusion criteria for the evaluation of DPP-based intervention programs for reporting of PA goals, measurement, and outcomes. A brief summary of participant demographics, program setting and delivery, and study design will be provided before detailing PA goal inclusion, assessment methods, and results (Table 1).

3.1 STUDY DESIGNS AND PARTICIPANT CHARACTERISTICS

The majority (n=30) of DPP-based translation efforts utilized a prospective, non-randomized design with pre-post analysis methods to evaluate the effect of intervention on study outcomes. Fourteen studies used a randomized controlled trial to compare multiple intervention methods or to compare an intervention to usual care,[41-54] four studies used a cluster-randomized design to assign intervention and/or control,[55-58] three studies used a quasi-experimental design,[59-61] and one study used a cross-sectional analysis to evaluate participant characteristics related to post-intervention weight loss success.[62]

A variety of study designs resulted in a range of participant enrollment from 10 to 1,003. The range of mean age of participants was 32.2 to 60 years, with a majority of mean ages falling between 45 and 55 years. The proportion of females enrolled ranged between 47-93%, with one exception of 3%. Racial and ethnic diversity of participants varied from studies of only minority populations (African American, Hispanic/Latino, Asian/Pacific Islander) to studies of 19-100% White, non-Hispanic participants.

3.2 PROGRAM SETTING AND DELIVERY

Part of the DPP-based translation process is evaluating effective dissemination of lifestyle intervention programs in diverse settings. The DPP-translation efforts reviewed were delivered in multiple settings including churches,[57, 63-68] community centers or community service providers,[48, 50, 54, 58, 60, 69-75] Diabetes Education Programs,[42, 43] health-care facilities,[52, 61, 62, 76-83]

primary care practices,[45-47, 49, 51, 56, 84-86] universities,[87] worksites,[41, 59, 88-90] and YMCAs.[44, 53, 55, 91, 92]

Translation of the DPP into community-based lifestyle programs has taken on a multitude of delivery methods. A majority (71%) of the studies utilized a group-based format for delivery of lifestyle intervention. Four studies maintained an individual delivery format,[49, 56, 79, 87] four studies exclusively used remote technologies (phone, DVD, internet) to deliver intervention and communicate with participants,[46, 52, 81, 85] and seven studies used multi-component interventions or had multiple intervention arms testing a variety of delivery methods, including group, DVD, video-conferencing, and/or internet.[45, 47, 51, 59-61, 90] Programs were offered with varying session frequency, to include more frequent contact during the initial phase of the program and transitioning to less frequent contact[41, 45-47, 81, 84, 87, 92] or a consistent weekly or monthly approach for the time frame of the intervention being reported.[52, 54, 56, 58, 60, 66, 68, 69, 71, 72, 75, 78, 85]

3.3 LIFESTYLE INTERVENTION: PHYSICAL ACTIVITY CONTENT AND GOALS

Session content related to physical activity varied, but included the key principles of the DPP including a focus on ways to safely increase PA, addressing barriers to PA, and changing environmental and social cues relating to PA. Eleven studies included PA sessions or supervised exercise as an option for participants,[45, 54, 61, 62, 71, 76, 77, 79, 82, 87, 92] three studies offered free fitness center membership,[75, 88, 89] and four studies offered participants access to onsite resources for PA.[41, 44, 55, 91]

As a key component of lifestyle interventions, all 52 studies provided a goal for PA. The DPP goal of 150 minutes of moderate PA was utilized by 48 studies and four studies established alternative goals including two with 180 minutes of moderate PA per week,[42, 43] one with 200 minutes of moderate PA per week,[48] and one with 4,000 steps per day above baseline PA level.[50]

3.4 PHYSICAL ACTIVITY ASSESSMENT

Thirty-eight of the 52 studies described the method used for assessment of PA (Table 2). Of the 38 studies including PA assessment, the majority (94.7%) used subjective measures to assess PA with daily activity logs the most frequently used PA measurement tool (52.6%), followed by questionnaire (42.1%). The questionnaires included the International Physical Activity Questionnaire (IPAQ; long- and short-forms), the Baecke Questionnaire of Habitual PA, the Modifiable Activity Questionnaire (MAQ), the Rapid Assessment Physical Activity scale (RAPA), an adapted Community Healthy Activities Model Program for Seniors (CHAMPS) survey, a modified Bandura Self-Efficacy Scale, and the Physical Activity Questionnaire (PAQ). One article did not specify an assessment method, but made reference to the original trial which included the Stanford 7-Day Physical Activity Recall.[47] One study used an accelerometer to objectively measure PA level.[52] In addition, three studies included assessment of physical fitness or physical function via submaximal treadmill testing or the 6-minute walk test.[70, 88, 89] Fourteen studies did not mention a PA measurement in the methods.

3.5 PHYSICAL ACTIVITY REPORTING AND RESULTS

Of the 38 studies including PA assessment, 74% reported PA results, equating to 54% of the total DPP translation efforts included in this review. Seventeen studies reported statistically significant results for improvements in PA measures (Table 3) derived from a variety of methodologies (i.e. intention to treat, last observation carried forward, and including those who complete a certain number of intervention sessions and/or assessment visits). Fifteen articles report on the proportion of participants who met the PA goal and/or the mean minutes of PA per week during intervention.[50, 54, 56, 61, 62, 69, 71, 74, 76-78, 82, 87, 92] Other methods of reporting included aerobic fitness,[70, 88, 89] days/week of moderate/vigorous PA,[70] MET-hours per week ,[68, 79] self-efficacy,[86] kilocalories expenditure per week,[67] PA level,[41, 59] and/or proportion of participants reporting regular activity (>=3 days per week).[90] In addition to primary PA outcomes, five articles report on the significant positive relationship between achieving PA goals and/or high PA level and achievement of weight loss goals.[56, 62, 73, 76, 77] Three studies included the proportion of participants submitting PA diaries/logs during intervention, but did not report any information on PA level or frequency.[48, 58, 81]

3.6 ACHIEVEMENT OF PHYSICAL ACTIVITY GOALS

For the 11 studies reporting results for the proportion of participants meeting the 150 minute per week PA goal, follow-up ranged from 12 weeks to 12 months. The proportion of participants meeting goal prior to intervention ranged from 19.6-53.6%.[54, 56, 71, 87] After the core portion of intervention, or at the first follow-up assessment, the range was 41.2-75%.[54, 56, 69, 71, 76, 78, 82, 83, 92]

After post-core, or at the final assessment, the range was 61.5-78%.[71, 82, 83, 87] Seven studies included mean minutes of PA per week at the end of core, ranging from 197-251 minutes.[50, 61, 76, 82, 87, 92] Two studies reported a mean of 250 and 258 minutes per of PA week at the end of post-core.[82, 87]

4.0 DISCUSSION

The DPP-based translation efforts included in this review demonstrated the feasibility of collecting physical activity data, mostly in the form of self-monitoring records, across a broad spectrum of settings and populations. The proportion of participants meeting the PA goal in the translation efforts is similar to the latest National Health and Nutrition Examination Survey (NHANES) estimate of 53.4% for adults meeting PA guidelines[93] and approached the DPP trial results of 74% of participants meeting the PA goal at the end of intervention.[9]

Although all of the DPP-based translation articles in this review included a PA goal as part of the intervention, only 54% reported on some component of PA, and only 21% actually provided results for meeting the PA goal. Similarly, in a systematic review and meta-analysis of lifestyle interventions delivered in routine clinical care, authors noted that changes in PA were generally not reported. [16] Only 29% of studies reported results in a format that can be interpreted relative to the PA goal and thus used to evaluate the effectiveness of the lifestyle interventions for increasing PA to meet recommended guidelines. Not all studies reporting the proportion of participants meeting the PA goal or minutes per week of activity reported pre-intervention values in the results, making it difficult to compare the PA levels at the end of intervention with pre-intervention activity.

Variability in study design, program implementation, intervention length and participant follow-up time, PA assessment, data analysis methodology, and outcomes reported makes

comparison of PA results between studies included in this review challenging. Although ranges for the proportion of participants achieving PA goals can be determined, success at achieving goals must be interpreted cautiously at established time points (i.e. 6 months) because participants may have been at different stages of a lifestyle change program and outcomes were analyzed in a variety of methods. Additionally, since several programs offered opportunities for PA as part of intervention, feasibility and sustainability of reaching PA goals must be carefully evaluated to determine exercise program durability, as pointed out by Koller et al.[94]

All but one of the studies reviewed assessed PA with subjective measurements. Although accelerometry is the gold standard for PA assessment, subjective measurements continue to be the most feasible method in community-based lifestyle programs due to cost and ease of data collection. Since the populations in all of the studies included persons at high-risk for diabetes and CVD, the PA results could be carefully interpreted relative to each other. The use of daily PA logs by a majority of the translation efforts is a positive step towards consistent measurement of PA in community-based lifestyle interventions. However, higher compliance to recording PA behaviors by participants who are most likely to exhibit success in a lifestyle program contributes to information bias and inflates the estimates of PA goal achievement or PA level reached. Objective PA data can provide less biased estimates of PA increases and additional information on PA intensity and patterns of behavior related to PA. As new technology emerges, the validation of interactive monitors against accelerometers is needed to provide user-friendly options for participants and lifestyle coaches alike to track PA and identify key opportunities for behavior change.

4.1 STRENGTHS

The broad search terms used to identify articles for this review ensured that all relevant DPP translations were included. This is the first attempt to examine the inclusion of PA goals, measurement of PA, and subsequent reporting of PA findings among community-based translations of the DPP. This review, which identified issues with PA assessment and reporting, is the first step toward generating comprehensive estimates of PA change due to lifestyle programs with implications for program modification and policy development.

4.2 LIMITATIONS

The current review did not address the magnitude and statistical significance of PA increases and change in proportion of participants meeting the PA goals at different time points during a lifestyle program; however, that was not the purpose of this review. A careful meta-analysis is needed to address these questions, though it may be difficult due to the variability of study components noted above.

The current review excluded behavioral weight-loss and lifestyle modification programs that were not based on the DPP-curriculum.[19, 20, 22, 23, 25] The assessment methods and reporting frequency are expected to be similar among these studies as the translation efforts in this review. Since all DPP-based programs have the same weight loss and PA goals, the review was limited to DPP-based programs in order to effectively compare studies for PA measurement and reporting.

4.3 PUBLIC HEALTH SIGNIFICANCE

In the 2005-2006 cycle of NHANES, it was estimated that 53.4% of American adults meet the recommended guidelines of 150 minutes of moderate intensity PA per week.[93] Decades of research have demonstrated the positive health benefits of physical activity;[95] however, uncertainty exists as to the volume and frequency of PA that is required to elicit substantial health benefits among high-risk populations. Consistent measurement and reporting of PA results in community efforts is essential to determining effective methods for increases and maintaining PA at the recommended level required for improving health and preventing chronic disease. Without the successful inclusion of PA assessment in behavioral research, we will be unable to draw appropriate and accurate conclusions related to PA and health promotion. Establishment of the true relationship between PA increases and improvement in metabolic profile can help guide public policy for coverage of lifestyle programs in national healthcare initiatives, such as Medicare.[94]

5.0 CONCLUSION

This review identified two main concerns with PA measurement and reporting in translation efforts: 1) The absence of PA assessment standards or guidelines for use in community-based translation programs and 2) The under- or inconsistent reporting of PA results in lifestyle change programs. As noted by Koller et al.,[94] it is unclear as to the true effect of PA on the prevention and delay of development of diabetes independent of dietary changes. Without addressing the two concerns identified in this review, researchers will be unable to come to a consensus on the importance of increasing PA for weight loss and the improvement of CVD and diabetes risk factors among populations at high risk.

There is no doubt in the ability of DPP-based lifestyle interventions to achieve successful increases in PA; however, little is known about the long-term effect of these interventions for maintaining increased PA levels. Without consistency in PA assessment and reporting, it is difficult to make appropriate estimates of the effect of PA in lifestyle interventions and to investigate the complex relationship between PA and weight loss, weight maintenance, and change in metabolic profile. Further evaluation of the PA component in DPP-based curriculums can provide useful information on the strategies that are effective for encouraging participants to make lifestyle changes related to PA and to reach PA goals. Recently, the CDC National Diabetes Prevention Recognition Program (DPRP) established standard guidelines for program

implementation and evaluation.[96] It is anticipated that use of the CDC DPRP guidelines may help facilitate a more systematic approach to PA evaluation in DPP translation efforts.

APPENDIX A: Literature Search Strategy

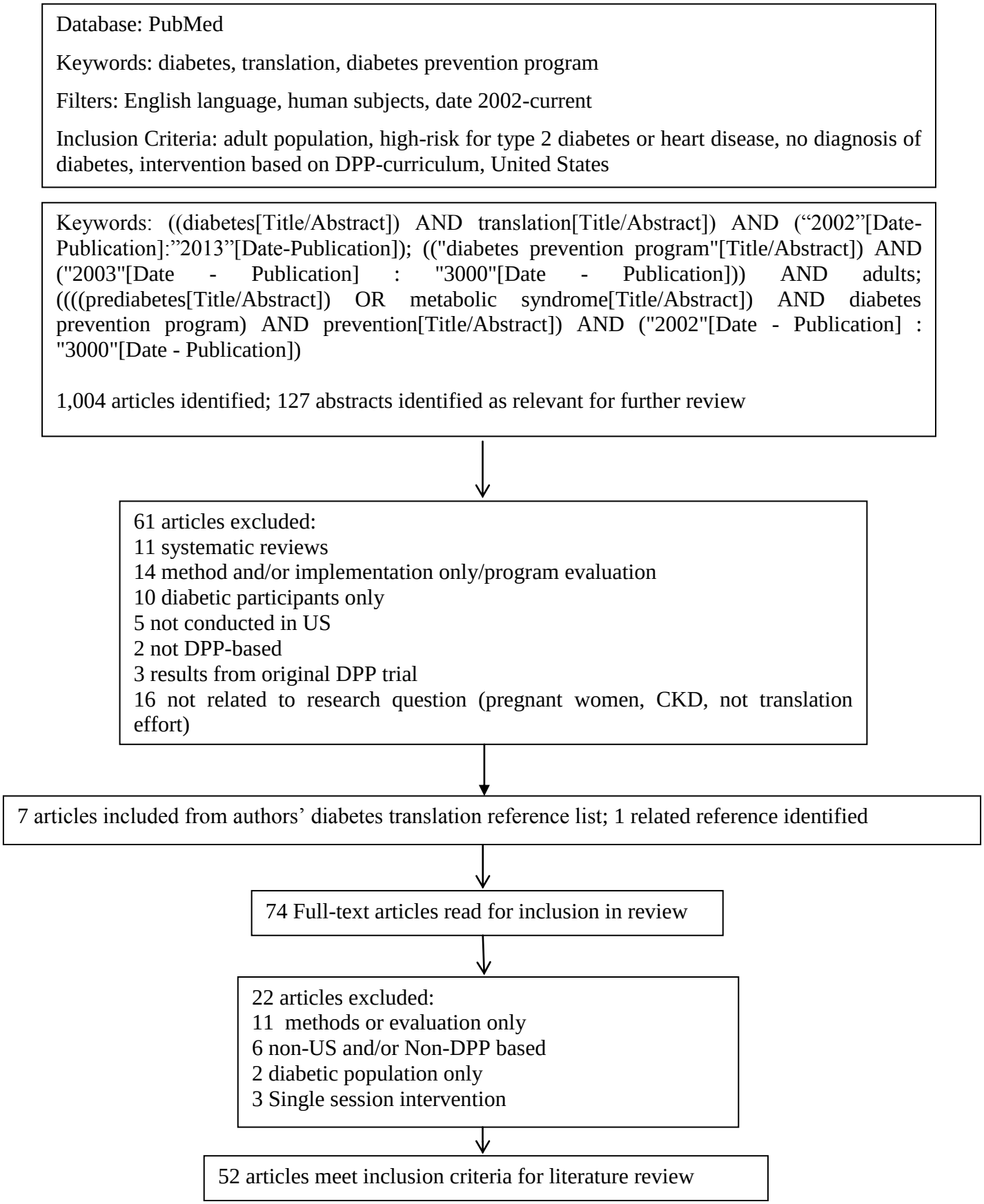

Figure 1. Literature Search Strategy: Translating the Diabetes Prevention Program Into Community Settings

APPENDIX B: Tables

Table 1. Summary of DPP-Translation Efforts Among Adults at High-Risk for Diabetes and Cardiovascular Disease

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Ackermann	2008	YMCA	Group	Cluster-RCT	150 minutes per week	None	4-6 months and 12-14 months from enrollment	None
Ackermann	2011	YMCA	Group	Prospective, Pre-Post	150 minutes per week	None	28 months from start of original intervention	None
Aldana	2005	Worksite	Group	Prospective, Pre-Post	150 minutes per week	Aerobic fitness; submaximal treadmill test Bruce Protocol	12 months	Aerobic fitness[a]
Aldana	2006	Worksite	Group	Prospective, Pre-Post	150 minutes per week	Aerobic fitness; submaximal treadmill test Bruce Protocol	12 and 24 months	Aerobic fitness[a]

[a]PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Amundson	2009	Health-care facilities	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring record	End of core (16 weeks) and end of monthly follow-up	% Meeting goal and Minutes per week[a]
Azar	2013	Primary Care	Group and Internet/DVD	RCT	150 minutes	Self-monitoring records (online)	15 months	None
Barham	2011	Worksite	Group	RCT	150 minutes per week	Questionnaire (IPAQ)	3,6,12 months (baseline, 3, and 9 months for control group)	PA Level[a]
Boltri	2008	Churches	Group	Prospective, Pre-Post	150 minutes per week	None specified	16 weeks, 6 months, 12 months	None
Boltri	2011	Churches	Group	Prospective, Pre-Post	DPP goals	None	6 and 12 months	None
Cox	2012	Community	Group	RCT	200 minutes per week	Self-monitoring records	12 weeks	No PA results; Self-monitoring frequency of PA
Dallam	2012	Worksite	Multi-component/arm	Quasi-experimental	150 minutes per week	Questionnaire (Baecke Questionnaire of Habitual PA)	26 weeks	PA Level[a]

[a] PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Davis-Smith	2007	Churches	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	End of INT (6 weeks), 6 and 12 months	None
DeJoy	2013	Worksite	Multi-component/arm	Prospective, Pre-Post	DPP goals	Questionnaire [stage of behavioral change single-item measures; self-efficacy 12-item scales (5-point; 5=confident)]	6 and 12 months	% Regular PA[a]; Stage of Change; Self-efficacy
Dodani	2010	Churches	Group	Prospective, Pre-Post	150 minutes per week	Questionnaire (MAQ)		None
Estabrooks	2008	Health-care facilities	Interactive voice response calls	RCT	150 minutes per week	Accelerometer and Questionnaire (RAPA)	3 months	% Meeting Goal and Minutes per Week
Guyse	2011	YMCA	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	16 weeks and 10 months	% Meeting Goal and Minutes per Week
Harwell	2011	Health-care facilities	Group	Prospective, Pre-Post	DPP goals	Self-monitoring records	4 (end of core) and 10 (end of post-core) months	% Meeting goal

[a] PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Islam	2013	Community	Group	RCT	DPP goals	Questionnaire; Self-efficacy via adapted Bandura Self-Efficacy Scale	6 months	% Meeting Goal; Proportion Inactive
Jaber	2011	Community	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	12 and 24 weeks	% Meeting goal[a]
Katula	2011	Diabetes Education Program	Group	RCT	>=180 min mod PA per week	None	12 months	None
Katula	2013	Diabetes Education Program	Group	RCT	>=180 min mod PA per week	None	24 months	None
Kramer	2009	Primary Care	Group	Prospective, Pre-Post	150 min mod PA per week	None	Baseline, post-intervention; 6 and months months post in phase 2	None
Kramer	2010	Primary Care	Technology	Prospective, Pre-Post	150 min mod PA per week	Self-monitoring records	3 months	% >= 3 days/week[a]

[a] PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Kramer	2011	Health-care facilities	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	3-4 months	% Meeting goal and % >= 3 days/week[b]
Kramer	2012	University/YMCA	Group	RCT	150 minutes per week	None	4,8, and 12 months	None
Kramer	2013	Community (WIC)	Group	Prospective, Pre-Post	150 minutes per week	Questionnaire (unspecified); questions about PA monitoring and barriers	12 -15 weeks (end of core)	% Meeting Goal
Kumanyika	2011	Primary Care	Individual	RCT	150 minutes per week	None	12 months	None
Lipscomb	2009	YMCA	Group	RCT	DPP goals	None	4 and 12 months	None
Ma	2013	Primary Care	Multi-component/arm	RCT	DPP goals	None	3,6, and 15 months	None

[b] PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Matvienko	2009	University	Individual	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	6 and 12 months	% Meeting goal and Minutes per week
Mau	2010	Community	Group	Prospective, Pre-Post	150 minutes per week	Questionnaire [Physical Activity Questionnaire (PAQ) 3-item]	12 weeks	Physical function[a]; Frequency of PA
McBride	2008	Health-care facilities	Individual	Pre-post	150 minutes per week	Questionnaire (IPAQ)	12 weeks and 12 months	MET scores[a]
McTigue	2009	Health-care facilities	Group	Prospective, Pre-Post	150 minutes	None	10-14 months	None
McTigue	2009	Health-care facilities	Internet	Prospective, Pre-Post	150 minutes	Self-monitoring records (online); pedometer daily records	12 months	No PA results; Self-monitoring frequency of PA
Ockene	2012	Community	Group	RCT	Increase walking 4,000 steps per day over baseline	Questionnaire (24-hour dietary recall); Intervention tools Pedometer, self-monitoring	12 months	Minutes per week

[a] PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Pagoto	2008	Primary Care	Group	Prospective, Pre-Post	150 minutes per week	Self-report with physician; patient satisfaction survey (Likert scale)	16 weeks	Self-efficacy
Piatt	2012	Community	Group	Prospective, Pre-Post	150 minutes per week	None	24 months	None
Piatt	2013	Community	Multi-component/arm	Quasi-experimental	150 minutes per week	Self-monitoring records; Physical Functioning via Medical Outcomes Study Short Form 12	3 and 6 months	None
Pinelli	2012	Community	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	24 weeks	Weight loss correlated with PA minutes[a]
Ruggiero	2011	Community	Group	Prospective, Pre-Post	Walk 150 minutes per week	Questionnaire (7-Day short version of IPAQ)	6 and 12 months	Minutes per week[a]
Seidel	2008	Community	Group	Prospective, Pre-Post	150 minutes per week	None	3 and 6 months	None
Tang	2014	Churches	Group	Prospective, Pre-Post	150 minutes per week	Questionnaire (CHAMPS)	8 and 20 weeks	Kilocalories per week[a]

[a] PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Vadheim	2010	Health-care facilities	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	16 weeks and post-core (~10 months)	% Meeting goal and Minutes per week
Vadheim	2010	Health-care facilities	Multi-component/arm	Quasi-experimental	150 minutes per week	Self-monitoring records	16 weeks	Minutes per week
Vanderwood	2010	Health-care facilities	Group	Prospective, Pre-Post	150 minutes per week	Self-monitoring records	16 weeks and post-core (~10 months)	% Meeting goal
Vanderwood	2011	Health-care facilities	Group	Cross-sectional	150 minutes per week	Self-monitoring records; follow-up survey assessed monitoring behaviors	12-24 months post-intervention	Minutes per week[a]
Weinstock	2013	Primary Care	Technology	RCT	DPP goals	Self-monitoring records	6, 12, and 24 months	None
West	2011	Community	Group	Cluster-RCT	150 minutes per week	Intervention tools pedometers and self-monitoring diaries	4 months	No PA results; Self-monitoring frequency of PA
Whittemore	2009	Primary Care	Individual	Cluster-RCT	Exercise 30 min 5 days per week (150 min)	Questionnaire (Health Promoting Lifestyle Profile II (8 items with 4-point Likert scale)	3 and 6 months	% Meeting goal[a]

[a] PA results statistically significant in positive direction ($p<0.05$)

Table 1. Con't

Author	Year	Setting	Delivery	Study Design	PA Goal	PA Measurement	Follow-up time	PA Results
Williams	2013	Churches	Group	Cluster-RCT	150 minutes per week	Questionnaire [IPAQ-LF (long form)]	12-14 weeks (3 months) and 12 months	None
Xiao	2013	Primary Care	Multi-component/arm	RCT	150 minutes per week	Not specified; Stanford 7-Day used in original trial	24 months	None
Yeary	2011	Churches	Group	Prospective, Pre-Post	150 minutes per week	Questionnaire	16 week	MET-h per week[a]

[a] PA results statistically significant in positive direction ($p<0.05$)

Table 2. Summary of PA Assessment in Diabetes Prevention Translation Studies

PA Assessment Method	Number (%) of studies using assessment method[c]	Number (%) of studies reporting results for given assessment method[b]
Diaries/logs	20 (38.5)	13 (65)
Questionnaire	16 (30.8)	14 (87.5)
Physical function	3 (5.8)	3 (100)
Accelerometer	1 (1.9)	1 (100)
TOTAL (All Assessment Methods)	38 (73.1)	28 (73.7)
None	14 (26.9)	0 (0)

[c] Percent does not add to 100; One study reported two PA assessment methods and is included in both categories

Table 3. Summary of PA Outcomes in Diabetes Prevention Translation Studies

PA Outcome	Number (%) of studies reporting outcome[d]	Number (%) of studies reporting significant improvement for measured outcome[c]
Proportion Meeting PA Goal	11 (21.2)	4 (36.4)
Minutes per week	5 (9.6)	3 (60)
Regular Activity (>=3 d/wk)	2 (3.8)	2 (100)
Days per week	2 (3.8)	2 (100)
Aerobic Fitness	3 (5.8)	3 (100)
MET-hours per week	2 (3.8)	2 (100)
Kilocalories expenditure per week	1 (1.9)	1 (100)
PA level	2 (3.8)	2 (100)
Self-efficacy	2 (3.8)	1 (50)
TOTAL	28 (53.8)	17 (60.7)

[d] Percent does not add to 100; Several studies reported multiple PA outcomes and are included in multiple categories

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