In 2015, there were an estimated 415 million adults aged 20–79 years living with diabetes worldwide (1). An additional 318 million adults had impaired glucose tolerance. Approximately 9.4% of the US population has diabetes and the prevalence is expected to reach 25% by 2050 (2,3). About 35% of US adults have pre-diabetes with a four-fold increased risk of progressing to diabetes compared to those who are normoglycemic (4). Persons with diabetes are at-risk of macrovascular and microvascular complications (5). Sedentary behavior, physical inactivity, and poor diet and nutrition are important public health issues that contribute to the population burden of diabetes (6). In the US, about one-third of adults are physically inactive and about 35% of adults are obese (6-8). Elevated rates of diabetes and obesity and associations of diabetes and obesity with cardiovascular disease and certain cancers have increased interest in identifying effective ways to improve physical activity, diet, and...
nutrition.

Impaired glucose tolerance is an intermediate condition between normal glucose tolerance and overt diabetes; persons with impaired glucose tolerance are at-risk of type 2 diabetes (5). Results from randomized controlled trials conducted in the US, Finland, Sweden, Japan, and China indicate that intensive lifestyle interventions can reduce the risk of progression to diabetes in persons with impaired glucose tolerance or impaired fasting glucose (5,9-11). Lifestyle changes were also shown to have a beneficial effect on hypertension and hyperlipidemia (5). The interventions tested in the trials have consisted of structured, interventions focused on encouraging physical activity and improved dietary intake through counseling, goal-setting, providing feedback, and monitoring at-risk participants (9,10). These interventions have shown that weight loss ≥3.5 kg can be achieved with lifestyle interventions and that the incidence rate of new-onset diabetes can be lowered by 30% to 58% (5,12). Substantial reduction in diabetes risk was seen with modest weight loss and increased physical activity. Results from the trials indicate that caloric restriction, physical activity, and behavioral support are effective in improving glucose tolerance and preventing or delaying the onset of diabetes. In the Diabetes Prevention Program in the US, a 34% reduction in incidence of diabetes was sustained for 10 years following the intervention (11).

Increasing efforts have been made to translate the intensive, structured interventions tested in these trials into primary care where there are constraints on resources and time (13-20). Primary care providers often deal with competing health priorities in their practice including pre-diabetes and a variety of other health conditions. Primary care providers are increasingly called upon to address multiple health care problems during health care visits. Cardona-Morrell et al. (12) conducted a systematic review of randomized controlled trials, before/after evaluations, and cohort studies of lifestyle interventions to reduce diabetes risk conducted in routine clinical settings and delivered by healthcare providers. The patients recruited in the studies were at high-risk of diabetes based upon impaired glucose tolerance, obesity, metabolic syndrome, or a combination of these. In some of the studies reviewed, researchers modified intensive, structured interventions that had been found to be effective in randomized controlled trials by shortening the duration of program, delivering group sessions rather than individual one-on-one counseling, and reducing one-on-one or group counseling sessions (12). A positive intervention effect on weight was observed in all of the studies. A meta-analysis of results from four of the studies showed that the lifestyle interventions in clinical settings had a positive effect on weight after one year but no effect on physiologic measures (12).

Mobile health (mHealth) technologies provide opportunities in patients with pre-diabetes to assist in preventing or reducing progression to diabetes through increased physical activity and healthy diet and nutrition (21-24). Examples of wearable technology include Fitbit and Jawbone devices, where users can measure a variety of activity-related outcomes including steps, distance, flights of stairs, active minutes, heart rate, and calories. Additionally, smartphone app and web interfaces attached to wearable devices allow users to compete in group challenges and socialize with friends. Several studies have utilized Fitbit devices in lifestyle interventions to increase physical activity and reduce obesity (22,25-33). Research on the use of consumer-directed wearable devices to promote and monitor physical activity in pre-diabetic persons is limited. There are several advantages to incorporating wearable devices in healthy lifestyle interventions. In many instances, the resource-intensive and time-consuming methods of established interventions for physical activity and weight loss limit full participation and widespread dissemination. Additionally, costs associated with wearable devices for monitoring physical activity are often less than several types of exercise equipment or becoming a member of a gym (34). There are several wearable devices available to consumers that monitor and track physical activity, and sales of these wearable devices are projected to exceed 82 million by 2019 (35).

There is limited research on the use of smartphone technology applications to promote and track physical activity in at-risk pre-diabetic populations (36-39). The diabetes and technology for increased activity (DaTA) pilot study consisted of an 8-week intervention in which participants with two or more risk factors for metabolic syndrome were given Blackberry smartphones and pedometers (36,37). The technology allowed self-monitoring of physical activity and resulted in improvements in daily physical activity, along with a better overall awareness of how healthy lifestyle changes impact health outcomes (36,37). The same technology was used in a randomized controlled trial of patients at-risk for cardiovascular disease and type 2 diabetes mellitus (n=149), in which both a control and intervention group received exercise instruction, while the intervention group was
also provided with smartphones equipped with a mHealth application and pedometers (38,39). The intervention group showed small, but significant, decreases in hemoglobin A1c (HbA1c) at 24 and 52 weeks, while the active control group showed more transient HbA1c decreases at 24 weeks (39). No significant differences were observed between groups at 24 or 52 weeks (39).

Studies are needed to examine the efficacy of wearable devices in improving physical activity and weight management among persons with impaired glucose tolerance or impaired fasting glucose who are at-risk of diabetes and cardiovascular disease. To clarify the efficacy of wearable devices for increasing physical activity among persons with pre-diabetes, studies with a randomized controlled trial design are needed that have adequate sample sizes and study periods.

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Footnote

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References


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