

Understanding Diabetes and the Role of Psychology in Its Prevention and Treatment

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Diabetes is a common, chronic, and costly condition that currently affects millions of individuals in the United States and worldwide with even greater numbers at high risk for developing the disease. Dramatic increases in diagnosed diabetes are projected for the decades to come meaning that most people will be affected by diabetes; either personally or through a family member. This article introduces the special issue of the *American Psychologist* focused on diabetes by providing an overview of the scope of diabetes and the importance of psychologists for improving disease management and quality of life. This includes an overview of the contributions of the behavioral and social sciences toward improved diabetes prevention and treatment. Finally, the article will point to opportunities for psychologists to close the gaps in the research, develop practice competencies, and increase training opportunities to meet the challenges of diabetes today and in the future.

Keywords: diabetes, treatment, prevention, biopsychosocial model, health psychology

Diabetes is a common, chronic, and costly condition that currently affects millions of individuals in the United States and worldwide with even greater numbers at high risk for developing the disease. Although genetic, biological, and environmental factors play a role in the risk for and progression of diabetes, behavioral, cognitive, and psychosocial management are crucial to prevention and improved health outcomes. In many ways, diabetes is a model disease for the importance of a biopsychosocial approach to health care (Engel, 1977; Young-Hyman & Peyrot, 2012). This article introduces the special issue of the *American Psychologist* focused on diabetes. The goal of this article is to provide psychologists with a basic understanding of diabetes and its prevention and treatment, as well as the behavioral and psychosocial aspects of managing the disease. This article highlights the importance of psychological expertise

in the delivery of evidence-based diabetes lifestyle and disease management interventions in addition to the delivery of mental health treatment for individuals with diabetes. The article also identifies research opportunities for advancing diabetes prevention and care and discusses the training needs for the next generation of psychologists.

The Scope of Diabetes

Diabetes affects an estimated 29.1 million people, or 9.3% of the United States population. Another 86 million Americans have prediabetes, which puts them at increased risk for developing diabetes (Centers for Disease Control and Prevention [CDC], 2014). Individuals with diabetes have a 50% higher risk of early death and double the medical costs compared to those without diabetes (CDC, 2014). In the United States, the annual cost of diabetes is estimated at \$245 billion dollars, with \$176 billion related to direct medical costs and \$69 billion related to indirect costs such as disability, work loss, and premature death (American Diabetes Association [ADA], 2013; CDC, 2014). Further, the individual and societal costs of diabetes are predicted to rise significantly over the next few decades. Boyle, Thompson, Gregg, Barker, and Williamson (2010) estimated that as many as one in three people in the United States will have diabetes by the year 2050. Internationally the prevalence of diabetes is also considerable, with the rates doubling over the past 3 decades (Chen, Magliano, & Zimmet, 2012). Estimates suggest that by the year 2030, 439 million (7.7%) of the global adult population will have diabetes (Shaw, Sicree, & Zimmet, 2010).

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What Is Diabetes?

Glucose, largely supplied by our food intake, is the main source of energy for the cells in the body. In normal metabolic processing, the pancreas detects glucose in the bloodstream and releases the correct amount of insulin, which is a hormone that is essential in facilitating the transport of the glucose from the blood stream into cells. Diabetes is characterized by a disruption in this system that results in high levels of glucose circulating in the blood, caused by impairment in the body's ability to produce or efficiently use insulin, or impairment in both systems. Improving glycemic control through medication and lifestyle behaviors is one of the central goals in diabetes treatment. In routine clinical care there are two primary methods to measure glycemic control. The first is the use of the hemoglobin A1C blood test which measures average blood glucose over the previous 3-month period. Although treatment targets need to be individualized, the goal for many adults with diabetes is achieving an A1C at or below 7%, or less than 7.5% for pediatric populations (ADA, 2015). The second common method for monitoring glucose control is daily self-monitoring of blood glucose using a finger stick to obtain a small amount of blood used with a home blood glucose meter. Self-monitoring of blood glucose allows individuals to tailor their treatment and lifestyle decisions based on their blood glucose values and assess, in near real-time, whether glycemic targets are being achieved. For more detailed information about measuring glycemic control, see the Gonder-Frederick, Shepard, Grabman, & Ritterband (2016) article. Also, the ADA annually publishes updated guidelines for assessment and treatment. These guidelines also

include many recommendations for the psychosocial and behavioral disease management support. Psychologists who plan to work with individuals with diabetes should be familiar with the latest guidelines <http://professional.diabetes.org/ResourcesForProfessionals.aspx?cid=84160&loc=rp-slabnav>.

Although there are other forms of diabetes (e.g., gestational diabetes), the two main types of diabetes are Type 1 diabetes (T1D) and Type 2 diabetes (T2D). T1D is an autoimmune disease characterized by a failure to produce insulin and accounts for about 5–10% of the diagnosed cases of diabetes in the United States (CDC, 2014). T2D accounts for 90–95% of the cases of diabetes (CDC, 2014) and is generally characterized by a resistance to insulin signaling (i.e., the body cannot efficiently use the insulin the body produces), which can lead to subsequent impairments in insulin production.

T1D was previously referred to as juvenile diabetes and insulin-dependent diabetes mellitus. Although the diagnosis of T1D is most commonly made in childhood, it can also be diagnosed in adulthood, and the majority of individuals living with T1D are adults. Further, individuals with T2D may require insulin as the disease progresses so the distinction of insulin dependence is not a true discriminator of type of diabetes. The prevalence of T1D has increased in the last decade (Dabelea et al., 2014), but the cause for that increase remains uncertain. Some estimates suggest that by 2050, the number of youth with T1D will triple (Imperatore et al., 2012). Although T1D has historically been viewed as a disease that occurs primarily in Whites, emerging data are clear that increases are also seen in minority racial and ethnic groups, although the highest prevalence continues to be seen in non-Hispanic Whites (Dabelea et al., 2014). Although the absolute numbers of individuals affected are relatively small, health disparities exist such that African American, Hispanic, American Indian, and Asian/Pacific Islander youth have poorer glycemic control than non-Hispanic Whites (Petitti et al., 2009). Also, unlike T2D, there is currently no known way to prevent the onset of T1D.

The risk for developing T2D is associated with increasing age, obesity, a sedentary lifestyle, family history of diabetes, personal history of gestational diabetes, impaired glucose metabolism, and race or ethnicity (CDC, 2014). Racial and ethnic minority populations such as African Americans, Hispanics, some Asians, American Indians, and Native Hawaiians or other Pacific Islanders are at considerably higher risk for developing T2D and its complications as compared to non-Hispanic Whites (CDC, 2014, Dabelea et al., 2014). Although the acute health risks are often less severe in people with T2D than in those with T1D, the long-term complications of poorly managed T2D are significant. The existing and increasing numbers of individuals with T2D make improvements in prevention and treatment a public

health imperative. Also, as with T1D, there are multifaceted behavioral, psychosocial and environmental factors that play an important role in the prevention and treatment of T2D.

While it is not realistic to perfectly control blood glucose at all times, good diabetes management is largely a task of reducing the amount of time spent with very high blood glucose while preventing blood glucose from falling too low. Over time, consistently elevated blood glucose (hyperglycemia) can cause serious health complications such as heart disease, stroke, kidney failure, blindness, nerve damage (e.g., neuropathy), and nontraumatic lower limb amputation (CDC, 2014). Severe cases of hyperglycemia can result in coma or death. However, hypoglycemia (very low blood glucose) is also a concern and can result from taking too much insulin or other diabetes medications, skipping a meal, intense exercise, or illness. Untreated hypoglycemia can lead to seizures, loss of consciousness, and even death. A recent study in older adults found that hospitalizations for hypoglycemia now exceed those for hyperglycemia (Lipska et al., 2014).

Treatment and Prevention Trials

Large multicenter trials have demonstrated that improved glycemic control and modification of cardiovascular risk factors in individuals with both T1D and T2D reduce the risk for future diabetes complications (The Diabetes Control and Complications Trial Research Group, 1993; U.K. Prospective Diabetes Study Group, 1998). In Look AHEAD, a large clinical trial focused on individuals with T2D, an intensive behavioral lifestyle intervention did not reduce cardiovascular events but did result in decreased sleep apnea, reductions in the need for diabetes medications, and improved physical mobility and quality of life (Foster et al., 2009; Foy et al., 2011; Espeland et al., 2014; Williamson et al., 2009). Improved glycemic control is partly related to advances in medical treatment, but optimal outcomes are also directly tied to an individual's ability to engage in consistent self-management behaviors. This requires the involvement of the individual and their family over the course of the disease, engaging in a multitude of disease management behaviors, and the ability to address concurrent or associated psychosocial challenges. As Wilson (2015) noted, there is strong evidence for the "ripple effects" of behavioral interventions in more broadly improving physical, psychological, and social outcomes over the life course. As such, psychological science and practice has much to offer in the prevention and treatment of diabetes. Multiple trials have demonstrated the benefits of behavioral and psychological approaches to diabetes self-management including, but not limited to, problem solving therapy, cognitive-behavioral therapy, motivational interviewing, patient empowerment, family based

approaches, and technology-assisted behavioral approaches (Hill-Briggs, Fitzpatrick, Schumann, & Golden, 2014; Winkley, Ismail, Landau, & Eisler, 2006), many of which will be reviewed more thoroughly in other articles in this special edition (such as, de Groot, Golden, & Wagner, 2016; Gonzalez, Tanenbaum, & Commissariat, 2016; Venditti, 2016; West, Coulon, Monroe, & Wilson, 2016; and Hilliard, Powell, & Anderson, 2016).

The Diabetes Prevention Program (DPP), a landmark multicenter randomized controlled trial in individuals at high risk for T2D, demonstrated that a behavioral lifestyle intervention focused on a modest weight loss of 7% resulted in a 58% reduction in the incidence of diabetes and the oral diabetes medication, metformin, reduced risk for diabetes by 31% (Knowler et al., 2002). Ten years after entering the study, the incidence of diabetes for the participants in the lifestyle arm remained reduced by 34% and those in the metformin arm by 18% (Knowler et al., 2009). The data from the 10 year follow-up of DPP also demonstrated that the lifestyle intervention was cost-effective and metformin was marginally cost-saving compared to placebo treatment (Diabetes Prevention Program Research Group, 2012). These results demonstrate the significant, lasting, and cost-effective value of an intensive and well-designed behavioral lifestyle intervention for diabetes prevention. Multiple translational trials have also demonstrated that behavioral lifestyle interventions based on the DPP, but delivered in community settings such as the YMCA (Ackermann, Finch, Brizendine, Zhou, & Marrero, 2008) or through community health workers (Katula et al., 2013), are effective at achieving similar weight losses as those seen in original DPP study (Ali, Echouffo-Tcheugui, & Williamson, 2012). Psychologists are at the forefront or key contributors to many of these trials, and psychological expertise will be needed to ensure that innovative adaptations of the interventions are delivered in efficient but evidence-based ways in future dissemination and implementation efforts (Vendetti, 2016).

These advances in the treatment and prevention of diabetes combined with many new technologies to more precisely monitor blood glucose and deliver insulin are considerable. However, translating these advances to real-world outcomes remains a challenge. Recent findings demonstrate that many people with diabetes in the United States do not meet the recommended goals for optimal control of diabetes and related risk factors. For example, using data from the Type I Diabetes Exchange, Wood and colleagues (2013) found that only 21% of their clinic registry patients who were 13–20 years old met the ADA A1C (average level of blood sugar [glucose] over the previous 3 months) target of <7.5% and their sample had a mean A1C of 8.8%. In patients with T2D, between 33 and 49% do not meet targets for glycemic control, blood pressure, or cholesterol, and only 14% meet targets for all three measures (Ali et al., 2013). These data highlight the need for advances in care,

including a focus on behavioral and psychosocial approaches to improve disease management.

Maintaining good glycemic control requires individuals to consistently engage in multiple disease management behaviors, which can be burdensome for the individual with diabetes and their loved ones. Self-management often requires regular self-monitoring of blood glucose values, adherence to a medication regimen, sustained changes in diet and physical activity, preventive self-management (e.g., foot and eye exams), and other behavioral strategies for maintaining healthy mood and quality of life (ADA, 2015). All of these self-management behaviors are influenced by the type of diabetes, duration of illness, and presence of physical and psychological comorbidities, as well as differing requirements for treatment and support across the life span. As such, psychologists play an important role, not only in delivering this behavioral care, but also in developing new approaches to improve prevention and treatment that are tailored to an individual's developmental stage, social support networks, and capacity for self-management.

Living With Diabetes

The next section of the article will provide more specifics about what is involved in treatment and prevention of the disease and illustrate some of the biopsychosocial issues that are related to good care for each of the two types of diabetes.

Type I Diabetes

T1D is a serious chronic disease that requires daily attention to a complex disease management regimen including focus on the type, quantity, and timing of food intake and physical activity, as well as frequent checks of blood glucose and administration of insulin. Because failure to regulate blood glucose levels can have serious short- and long-term consequences, individuals with T1D, or their caregiver, must check their blood glucose frequently; often 6–10 times a day (ADA, 2015). Checking blood glucose involves sticking the finger with a needle to draw a small amount of blood to place on a strip for analysis by a portable blood glucose monitoring device. It can also include the use of a continuous glucose monitoring (CGM) device that is connected to the body through an electrode under the skin and measures glucose in the fluid in the tissues. The CGM samples glucose levels frequently, offering real-time data to help patients, caregivers, and their health care team understand glucose trends in response to behavior or time of day, as well as track trends over time. These measured glucose values often require some action on the part of the individual or caregiver, such as administration of insulin through injection or a wearable insulin pump providing continuous subcutaneous insulin infusion, or eating to bring blood

glucose values into an acceptable range. These disease management behaviors must be tailored to be appropriate for individuals differing needs across the life span.

The diagnosis of T1D in a child and the subsequent treatment demands, on top of the normal stress of life and child rearing, can strain family functioning (Smaldone & Ritholz, 2011; Niedel, Traynor, McKee, & Grey, 2013) and increase the risk of depression and anxiety symptoms in the parents (Patton, Dolan, Smith, Thomas, & Powers, 2011). Managing diabetes in young children is particularly challenging. Small insulin doses are harder to calculate and young children are more at risk for hypoglycemic episodes, particularly at night (for more detail about the potential neurocognitive consequences of hypoglycemia see Ryan, van Duinkerken, & Rosano, 2016). It is not uncommon for parents and their child to have impaired sleep due to nighttime blood glucose checks or awakenings in response to a CGM alarm (Streisand & Monaghan, 2014). Normal developmental issues create additional challenges for disease management (Streisand & Monaghan, 2014). For example, young children have a more limited ability to understand and communicate changes in their physical symptoms and have more unpredictable patterns of eating and activity. Administration of insulin, which is largely based on predicted food consumption, can be problematic if the child refuses to eat or does not eat the predicted amount of food. Unlike older youth or adults, young children are less likely to have bouts of planned physical activity such as participation in sports or going for a run. Their play is often characterized by more spontaneous activity of variable duration, which can make appropriate insulin dosing more challenging. This complex medical regimen, along with fear about mistakes or oversights, can also present challenges in obtaining childcare, because the demands for health management are then shifted to daycare providers or babysitters. Psychologists with competencies in pediatric care and/or family therapy can help families develop improved problem solving, communication, and behavioral management skills as a means to improve quality of life for the child and family and to optimize disease management.

Adolescence and young adulthood can be a time when youth with diabetes experience deteriorating glycemic control and withdrawal from regular health care (Wood et al., 2013). Many of the unique issues that account for this deterioration in disease management are related to the normal pubertal, social, emotional, and cognitive changes that occur in this phase of life. The transition from childhood into young adulthood involves increasing autonomy, which requires a shift in responsibility for disease management activities. Understandably, this shift in responsibility can be problematic when the relationship between the parent/s and adolescent is strained, there is poor communication or conflict, and either or both parties are over or under involved in this transition of disease management responsibilities (An-

derson, 2004). Adolescents are increasingly influenced by their peers, can have concerns about fitting in and possible stigma associated with their diabetes, and may be experimenting with substance use, all of which can influence adherence to the diabetes management regimen (Chiang, Kirkman, Laffel, & Peters, 2014). Many of these same issues continue into young adulthood and are compounded by the expected social, financial and health care changes that occur when leaving home to live independently.

Due to considerable advances in treatment over the past few decades, many individuals with T1D are living longer, closing the gap in life expectancy between those with T1D and the rest of the U.S. population (Miller, Secrest, Sharma, Songer, & Orchard, 2012). Although this is a tremendous achievement, it is a relatively recent development and there is a need for focused research to improve our understanding about how the psychosocial and treatment barriers and facilitators change as one ages. Adults with T1D must balance the disease management demands in the context of their employment and/or building and caring for a family. As individuals age, the diabetes medical regime and maintenance of quality of life can become more challenging as individuals incorporate the management and treatment of new diabetes or age-related comorbidities such as cardiovascular disease, cognitive impairment, musculoskeletal disorders, vision and hearing loss, end stage renal disease, and painful neuropathies. There may also be a need for changes to, or additional support for, managing the medical regimen as there are changes in living situations (e.g., nursing facilities). Individualization in care might also require an upward adjustment to the glycemic control targets to reduce the risk of hypoglycemia associated with very tight control, although this must be balanced against concerns that very high blood glucose levels would also be detrimental (ADA, 2015).

Type II Diabetes

Prediabetes. Being overweight or obese is a significant and potentially modifiable risk factor for prediabetes and the development of T2D. The prevalence of overweight and obesity has steadily increased over the past few decades and, today, 31.8% of 2- to 19-year-olds and 68.5% of adults are either overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014). Some recent data suggest the rates of obesity may be leveling off in some age groups (Ogden et al., 2014); however, this good news must be tempered by the large number of individuals affected by excess weight. Unless there is a downward trend in obesity, the outlook for the personal and societal costs of T2D will remain considerable.

Over one third of U.S. adults aged 20 years or older have prediabetes, which is characterized by having an A1C or a fasting glucose level that is higher than the cutoff for normal

but has not reached the threshold for a diagnosis of T2D (ADA, 2015). The risk for prediabetes increases with age, and half of all Americans aged 65 years and older meet the criteria for prediabetes (CDC, 2014). Although not all people with prediabetes will eventually get a diagnosis of T2D; without intervention, up to 30% of people with prediabetes will develop T2D within 5 years (CDC, 2014). Further, because the duration of diabetes is strongly related to the development of micro- and macrovascular complications (ADA, 2015), the prevention or delay of a T2D diagnosis is an important public health goal.

As noted, the primary evidenced-based approaches to prevent or delay a diagnosis of T2D include a modest 5–10% weight loss as a result of a behavioral weight loss program (focused on reduced calories and increases in physical activity) or use of the medication metformin (Knowler et al., 2002). Although identifying prediabetes is a crucial first step to initiating appropriate prevention efforts, according to the CDC (2014), nine out of 10 people with prediabetes are not aware that they have the condition. This gap in care may be due to more limited referral and reimbursement options for behavioral weight loss delivered by providers with behavioral training or, despite the evidence to the contrary, a lack of confidence on the part of the patient and/or health care provider that behavioral weight loss works (Steeves, Liu, Willis, Lee, & Smith, 2014). There are also barriers to the routine prescription of metformin for individuals with prediabetes. The lack of an FDA-approved indication for metformin to treat prediabetes and the lack of profit for marketing a generic drug may be some key limiting factors. It is also possible that many patients and providers are reluctant to start a lifelong medication when conversion to T2D is not a certainty. Developing approaches to encourage providers and health care systems to offer lifestyle behavior change (or metformin) to the most at risk individuals, such as those with a history of gestational diabetes or those who are very obese (ADA, 2015), may trim the gap between the evidence and practice.

Treatment and preventing complications. Historically, T2D was a disease experienced by individuals in middle age or older and, although most cases of T2D are still diagnosed in adults, the data from SEARCH, a national multicenter prospective observational study, indicate that between 2001 and 2009 there was an overall increase in prevalence of T2D in youth by 30.5% (Dabelea et al., 2014). These same investigators found that the health disparities data in youth mirror the data in adults, with the highest burden of disease seen in racial and ethnic minority groups. Estimates suggest that by the year 2050 there will be a fourfold increase in the number of youth with T2D (Imperatore et al., 2012).

Data from a recent large-scale, multicenter clinical trial, Treatment Options for Type II Diabetes in Adolescents and Youth (TODAY), suggest that T2D in youth may actually be more aggressive and difficult to treat than diabetes in

adults (TODAY Study Group, 2012). Also, in the SEARCH study, over a quarter of the youth in their large multiethnic national sample had poor glycemic control ($A1C \geq 9.5\%$) and the rates of poor control were higher in racial and ethnic minority youth (Petitti et al., 2009). These factors, combined with the longer duration of the disease, mean that youth with T2D are likely to suffer health problems for a much greater portion of their lives and may also die at a younger age than their parents (Alberti et al., 2004; Linder, Fradkin, & Rodgers, 2013). This alarming situation points to the need to develop and test new approaches to prevent T2D, as well as more effective approaches to treat the disease in this high risk age group.

Some people with T2D can control their diabetes, at least initially, by losing weight, improving their diet, and engaging in physical activity (ADA, 2015). Although these lifestyle changes can produce good results and have minimal side effects, initiating and maintaining these changes over time is a challenge for many people. An environment that supports a sedentary lifestyle and provides easy access to energy dense and highly palatable foods only compounds the challenges to making sustainable lifestyle changes. Oral medications for glucose and risk factor control (e.g., high blood pressure and cholesterol) and the addition of insulin administration, if necessary, are also an important part of T2D treatment. Problems with appropriate intensification of the treatment regimen by the health care team and/or appropriate adherence to the medications on the part of the individual with diabetes limit the effectiveness of these medications to optimally manage T2D.

Role of Psychologists in Diabetes Care: Now and in the Future

The scope of diabetes and the multiple factors that go into successful management of the disease make it clear that a biopsychosocial approach to diabetes management is crucial for achieving improved individual and population health outcomes. Despite a robust research literature, there remain many areas where psychological science and improved evidenced-based practice are still needed. This section highlights some of the practice needs and research gaps that psychologists are uniquely poised to address. Many of the subsequent articles in this special issue will cover these topics in greater breadth and depth. The intent in this article is not to provide a comprehensive review of each area, or even all areas of potential research and practice focus, but to serve as a broad overview related to the need for psychological expertise applied to diabetes now and in the future.

Lifestyle Changes

Eating a healthy diet, engaging in regular physical activity, and losing a modest amount of weight, if indicated, are

cornerstones of good glycemic control and mitigation of long-term consequences. The fact that self-management behaviors have a meaningful impact on disease outcomes is a cause for optimism, but also some caution. Optimism is warranted because these are modifiable behaviors, there are evidence-based behavioral interventions to assist individuals in making these changes, and there are relatively few, if any, side effects to these interventions.

The cautionary note is related to several factors. First, although the “tide” in reimbursement may be changing, the current health care system offers less than optimal reimbursement for these behavioral and psychosocial services. Second, there is a dearth of psychologists who are trained to interact with the medical team and deliver lifestyle interventions tailored for varying needs based on type of diabetes and other developmental, cultural and social factors (Johnson, 2013; de Groot & Fisher, 2011). Third, although there are multiple efficacious behavioral interventions, these are often not a routine part of care. We must find ways to translate evidence-based approaches into real-world populations and settings. This includes the development of more efficient models of care delivery that extend the reach of these interventions while maintaining their efficacy. Fourth, many of the behavioral lifestyle changes are difficult to initiate and even more difficult to sustain over time. For example, even under the most tightly controlled intervention delivery conditions, there is wide variability in response to treatment and varying degrees of maintenance of weight loss (Field, Camargo, & Ogino, 2013). Behavioral phenotyping research is needed to improve our understanding of individual differences in the ability to initiate and maintain behavior change. Such research will contribute to a better match between individuals and treatments as well as identify novel targets for the development of more robust interventions at the individual and environmental levels. Finally, psychologists need to focus on translating the findings from basic behavioral and social science research into new treatment approaches. For example, there are interesting data on the role of executive function, memory, and reward pathways in eating behavior (Hall, Hammond, & Rahmandad, 2014) and other data regarding the relationship between affective responses and exercise behavior (Williams, Dunsiger, Jennings, & Marcus, 2012) that might be used to develop new or enhanced approaches to weight management. Despite the promise of these findings for developing new treatment approaches, there is a limited pool of researchers engaged in addressing this important gap in the translational research continuum (Czajkowski, 2011).

Adherence

Adherence to clinical practice guidelines and self-management behaviors is another cornerstone of diabetes

management. Yet, adherence to diabetes self-management activities and medication are less than optimal (Nicolucci et al., 2013). At the patient level, poor adherence can be influenced by less modifiable factors such as income level and expensive medication copays (Brown & Bussell, 2011). However, there are other factors that contribute to nonadherence that are either modifiable or might be addressed through more tailored approaches. Some of the common reasons for poor adherence are related to complexity of the regimen, patient misunderstandings of the regimen, attitudes or beliefs about medications, forgetfulness, and difficulty understanding the long-term risk (Stirratt et al., 2015). Adherence at the level of health care delivery is another important gap that behavioral solutions could address. For example, many people at risk are not screened for diabetes, and if they are found to have prediabetes they often receive little evidenced-based follow-up or referral care (Karve & Hayward, 2010). Also, treatment intensification (e.g., adding new medications) to improve diabetes or risk-factor control is often suboptimal (Schmittiel et al., 2008). Despite the potential for behavior modification at the patient and provider levels, the existing findings on approaches to improve medication adherence have been underwhelming and point to the need to identify more effective and feasible interventions to promote adherence (Nieuwlaet et al., 2014).

Technology

There are two key areas where the application of technology to diabetes prevention and treatment show promise. First, are the advances in technologies that are directly related to monitoring blood glucose or delivering insulin such as blood glucose monitors, insulin pumps, and CGMs. These tools allow increasingly more precise and individualized treatment and, if used properly and consistently, can lead to much tighter glucose control (ADA, 2015). Although advanced technologies such as CGM and insulin pumps may not be ideal for everyone, the current rates of use seem to suggest that there are barriers to widespread implementation that need to be addressed. For example, data from the Type I Diabetes Exchange clinic registry found that only 9% of their sample used the CGM (Wong et al., 2014) and 50% used the insulin pump (Nambam, Hirsch, Danne, & Schatz, 2015). Psychologists can assist in identifying the human and psychosocial factors that impair or improve an individual's ability to maximize the use of these tools. These factors can be used to develop more effective behavioral or psychosocial interventions to overcome barriers, such as becoming overwhelmed by the volume of information or concerns about stigma from peers or coworkers when wearing the insulin pump or CGM.

A second area that shows promise for research and practice includes information and communication technologies such as the Internet, mobile devices, and the increased

capacity for video conferencing. A recent systematic review found that Internet-delivered diabetes education and support resulted in improved glycemic control as compared to usual care (Pereira, Phillips, Johnson, & Vorderstrasse, 2015). These non-face-to-face communication modalities offer exciting opportunities for expanded delivery of diabetes self-management education, behavior change, and support services. They also potentially offer new pathways to more efficiently and cost-effectively deliver behavioral interventions. Further, methods such as geolocation and wearable accelerometer devices can provide real-time data to support behavior change (Patel, Asch, & Volpp, 2015). These technologies can potentially provide flexibility in the pace and timing of the intervention delivery and remove barriers to face-to-face treatment such as travel and scheduling. Despite this promise, there are many unanswered questions and considerable room for innovation to address issues such as waning attention and engagement over time, understanding under what circumstances and for whom technology matches or surpasses face-to-face approaches, and keeping up with rapid technology development (Nilsen, Riley, & Heetderks, 2013; Pereira, Phillips, Johnson, & Vorderstrasse, 2015).

Tailoring Psychosocial and Behavioral Interventions

Psychosocial interventions improve glucose control and other health and behavioral outcomes (Harkness et al., 2010), but opportunities remain to develop more targeted and robust interventions. Although there is consistent agreement that tailored approaches to care are more responsive to patient needs and improve treatment outcomes (Noar, Benac, & Harris, 2007), there are knowledge gaps in practice about when tailoring is needed and how to optimize the factors on which to tailor to enhance efficacy or improve engagement of higher risk populations. There are too many promising avenues for tailoring to fully cover in this article, but a few are highlighted as illustrative examples.

Tailoring to address cultural values and beliefs is one of the most common areas on which this research literature focuses. For example, the DPP lifestyle intervention was equally effective in racial and ethnic minority participants, which made up 45% of the sample (Knowler et al., 2002), but subsequent translational trials have not had as much success consistently engaging these groups in their research to test adaptations of DPP in real-world settings (Ali et al., 2012). Although there are many economic and societal reasons that may explain these disparities, differences in cultural norms and values may influence the acceptability of some of the current evidence-based interventions. For example, interventions must account for different cultural beliefs about body size and shape, perceptions about exer-

cise, and practices around food type, preparation, and intake.

Another area where tailored approaches might be fruitful is health literacy. Health literacy is “the degree to which individuals have the capacity to obtain, process, and understand the basic health information and services they need to make appropriate health decisions” (U.S. Department of Health and Human Services, 2010, p. 1). Almost nine out of 10 adults in the United States have some difficulty understanding and using routine health information (U.S. Department of Health and Human Services, 2010), such as prescription label instructions or information about risk for future disease or deteriorations in functioning. There is a growing body of research that suggests that low health literacy is related to poorer health outcomes (Al Sayah, Majumdar, Williams, Robertson, & Johnson, 2012; Bailey et al., 2014). In diabetes prevention and treatment, low health literacy may limit several areas of important disease management, such as a person’s ability to understand information about the risk of diabetes and its complications or the ability to effectively manage numbers to count calories or carbohydrates, or make appropriate adjustments in insulin dose. Improving an individual’s health literacy is a complicated but potentially important goal but, at a minimum, health communication and intervention delivery should be adjusted to account for the level of literacy and tested to see if it improves outcomes.

Mental Health Comorbidities

Psychologists have an important role to play in identifying and effectively treating the mental health and psychosocial challenges that many people with diabetes experience. For example, individuals with diabetes are at increased risk for depression and diabetes distress, and both are linked to decrements in self-management, quality of life, and diabetes-related outcomes (Holt et al., 2014; Fisher, Gonzalez, & Polonsky, 2014). Meta-analytic data suggest that combined treatment of depression and diabetes self-management results in improvement in both depression and diabetes outcomes whereas treatment of the depression alone alleviates depression but does not usually result in much improvement in diabetes outcomes (van der Feltz-Cornelis et al., 2010). Also, individuals with serious mental illness such as schizophrenia and bipolar disorder are at increased risk for obesity and diabetes, partially due to the medications used to treat those conditions (Fiedorowicz, Palagummi, Forman-Hoffman, Miller, & Haynes, 2008). This increased risk is combined with poor access to primary care services, which results in underdetection and treatment of diabetes in an already vulnerable population (Fiedorowicz et al., 2008).

Given the high rates of diabetes and the projections for increases in the future, psychologists operating within med-

ical settings and in specialty or community mental health practice will encounter individuals with comorbid diabetes. In addition to understanding the influence of these mental health conditions on disease management, it is important for psychologists to consider how the demands of diabetes management may be relevant to the treatment of the presenting psychosocial or mental health condition.

Training and Work Force Needs

To address the chronic health needs posed by diabetes and its physical and psychosocial sequelae, we need to train a psychological workforce that is competent in the biopsychosocial model and able to integrate the delivery of psychological services into health care settings and practice (Johnson, 2013, and Johnson & Marrero, 2016). With the growing demands of diabetes prevention and care, the integration of psychological services into primary care and into community prevention efforts will be particularly important for timely and efficient prevention and health care delivery. Treatment guidelines for adults and pediatric populations (ADA, 2015) make clear recommendations that good diabetes care includes psychosocial screening and intervention, or referral to specialty mental health practitioners when warranted; yet this type of care is not a routine part of most practices (de Wit, Pulgaron, Pattino-Fernandez, & Delamater, 2014; Ducat, Philipson, & Anderson, 2014). This is partly due to a shortage of practitioners and researchers to meet the practice and research needs in diabetes (de Groot & Fisher, 2011). Graduate schools must do more to recruit and train psychologists interested in applying their skills to improve the health of the growing number of individuals in the United States with chronic medical conditions, including diabetes. Professional societies and health care systems also have an important role in advocating for and supporting the integration of psychologists into routine diabetes care (de Groot & Fisher, 2011; Johnson, 2013).

Shortages seen in practitioners also exist in the research workforce. There is a need to train and support researchers focused on behavioral or psychosocial aspects of diabetes (de Groot & Fisher, 2011) who can also work in interdisciplinary teams and across the translational continuum (Czajkowski, 2011; Hunter, 2011). More basic behavioral science is needed to identify individual differences in treatment response and the behavioral, psychological, or social mechanisms that contribute to successful initiation and maintenance of behavior change. There is also a need for research focused on “bench to bedside” translation to take the existing basic behavioral and social science findings and use those data to inform the development and testing of novel interventions to address the range of behavioral and psychosocial needs (Czajkowski et al., 2015). Finally, we need researchers who understand the broader ecological context, as well as dissemination and implementation sci-

ence, to move from efficacy research to test behaviorally- and economically sustainable adaptations and implementation strategies that will enable the delivery of needed psychosocial care in various settings, populations, and age groups.

Conclusion and Future Directions

Diabetes is a common condition with significant implications for quality of life, as well as mental health and physical complications. Although there have been a number of advances in prevention and treatment, many individuals with diabetes experience less than optimal glycemic control and have or are at risk for complications. Also, given the number of individuals at risk for or currently living with diabetes, as well as the predictions for dramatic increases in these numbers in the decades to come, there is a public health imperative to improve prevention and treatment approaches, as well as ensure that existing evidenced-based interventions are implemented in real-world practice setting and populations. The emphasis on translating the evidence to practice is particularly needed for vulnerable and high-risk populations. Clearly, understanding the biological underpinnings of obesity and diabetes is one aspect of improving prevention and treatment options. However, the behavioral, social, cultural, economic, and environmental factors that contribute to diabetes are equally important to understand to more effectively address the burdens and demands of the disease on individuals, families and society. There is a need for more psychologists with diabetes training to meet the growing care needs. Psychologists also have an important role to play in the research needed to optimize care today and into the future.

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