The Impact of Diabetes on Cognitive Functioning among African American Diabetics

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Abstract

Diabetes is a rapidly growing problem among African Americans. Most of the extant research has focused on the physiological effects of diabetes. In this article, we focus on the impact of diabetes on cognitive functioning. The literature indicates that diabetes contributes to deficits in memory, attention span, and processing speed. Diabetics are at higher risk of dementia than individuals in the general population. However, there is evidence that these cognitive deficits can be avoided altogether or minimized to the extent that diabetic patients maintain tight glycemic control. We discuss cognitive intervention strategies that diabetics can utilize to improve their glycemic control.

Diabetes has a tremendous impact on the African American community. Overall, 10 percent of African American adults suffer from diabetes; for those over the age of 55 the figure rises to 25%. On the whole, African Americans are 1.6 times more likely to become diabetic than non-Latino whites (American Diabetes Association, 2008).

Type II diabetes is particularly prevalent among African Americans, partly due to genetics (Koshiyama, Hamamoto, Honjo, Wada, & Ikeda, 2006; Lindquist, Gower, & Goran, 2000) and lifestyle factors, such as obesity and inactivity (Diabetes Prevention Program Research Group, 2006). In addition to being more likely to suffer from diabetes, African American diabetics are more likely to suffer from diabetes-related complications than Causcasians (Two Feathers et al., 2005). However, racial differences in mortality and disability disappear when African American diabetics maintain the same level of glycemic control as Caucasians (Nyenwe, & Dagogo-Jack, 2007).

Media and healthcare professionals have typically emphasized the physical effects of diabetes, including strokes and cardio-vascular disease. However, there has been little emphasis on the impact of diabetes on cognitive processes, even though studies have increasingly indicated that diabetes affects cognitive as well as physiological functioning (Cukierman, Gerstein, & Williamson, 2005). Research indicates that diabetics experience cognitive decline at twice the rate of nondiabetics (McCall, 2005). The goal of this paper is to focus on the cognitive functioning of Type II diabetics. We will describe the nature of Type II diabetes, the ways in which it might affect cognitive processes, and what can be done to prevent or minimize diabetes-related cognitive decline (Black & Scogin, 1998).

Nature of Type 2 Diabetes

There are two types of diabetes: Type 1 and Type 2. Type 1 is due to an autoimmune deficiency and only affects five percent of the total population of diabetics. Ninety-five percent of diabetics suffer from Type 2 diabetes (Black, 2001), which is heavily related to lifestyle factors, such as obesity, diet, and exercise. Most people know of the untoward physiological effects associated with Type 2 diabetes but are unaware of the pathogenesis of these diabetes-related complications. The linkage between diabetes and complications such as heart disease, blindness, and end-stage-renal disease is largely due to the deleterious effects of excess sugar on the vascular system. The excess sugar destroys the inner lining of blood vessels, making them rigid and inflexible. As a result, blood flow is

impeded (Ritter, Chowienczyk, & Mann, 2000) resulting in damage to major organs, such as the heart or kidneys. Most importantly for the purposes of this article, diabetes impedes blood flow to the brain (Bentsen Larsen & Lassin, 1975; Fowler, 2008; Mather,Verma & Anderson, 2001; Ritter et al., 2000) which in turn affects cognitive performance. There is also evidence that diabetes has a direct impact on the brain through the accumulation of end products that damage nerve cells (Jankowiak, 2004; Abbatecola et al., 2006; Saczynski et al., 2008).

To make matters worse, diabetes is often accompanied by other medical conditions with adverse affects on blood flow and ultimately cognition: hypertension, dislipidemia, and abdominal obesity (Howard et al., 1998).

Cardiovascular Complications and Cognition

Diabetes is linked to a phenomenon labeled metabolic syndrome, a list of physiological characteristics (i.e., abdominal obesity, hypertension, and dislipidemia) linked to heart disease. Metabolic syndrome is thought to stem from cellular insensitivity to insulin, the very characteristic key to Type II diabetes. In fact, metabolic syndrome is sometimes referred to as Insulin Resistance Syndrome (Howard et al., 1998). Extant research indicates that all of the physiological characteristics that accompany diabetes and metabolic syndrome have an adverse effect on cognition.

The linkage between cognition and metabolic syndrome is of special interest because African Americans are significantly more likely to suffer from metabolic syndrome than Caucasians (Lamonte, Ainsworth, & Durstine, 2005). For example, Lamonte and colleagues (2005) found that 29.5 percent of African American women suffered from metabolic syndrome as compared to 8.9 percent of Caucasian women.

The component of metabolic syndrome that has received the most attention with respect to African Americans is hypertension. A number of studies have shown that hypertension has a deleterious effect on cognitive performance (Ford, Giles, & Dietz, 2002; Hassing, et al., 2004) and on the brain (Burns et al., 2005; Kumari, Brunner, & Fuhrer, 2000). For example, Elias and colleagues (1997) found that hypertension and diabetes interact in producing a decline in tests of cognitive functioning, including abstract reasoning, memory, and verbal fluency. More recently, Hassing et al. (2004) tracked Mini-Mental-Status-Exam performance (a screening task for dementia that also measures cognitive functions such as memory and attention control) among very old individuals in three groups: 1) those free of both hypertension and diabetes; 2) those with either hypertension or diabetes, and 3) those who had both. The results indicated that diabetes resulted in larger cognitive declines than hypertension, but the worst cognitive performers were individuals with both hypertension and diabetes.

Another aspect of the metabolic syndrome that disproportionately affects African American female diabetics is abdominal obesity, one of the primary markers for insulin resistance. Older adults with abdominal obesity have a 74% increased risk of dementia relative to individuals without abdominal obesity (Taylor & MacQueen, 2007), possibly due to accompanying neuronal degradation. In fact, animal models have shown a linkage between excess adiposity and impairment in hippocampal functioning. The hippocampus is the part of the brain responsible for memory formation. To explain further, abdominal obesity is associated with the secretion of excess cortisol (Roland et al., 2000) which has a deleterious effect on the hippocampus (Jacobson, & Sapolsky, 1991). In fact, one recent study indicated that diabetics with abdominal obesity have greater cognitive decline than individuals with diabetes alone (Elias, Elias, Sullivan, Wolf, & D'Agostino, 2005).

Thus, individuals who suffer from hypertension and/or abdominal obesity in addition to diabetes are particularly vulnerable to premature cognitive decline due to neurological damage. That is, abdominal obesity might lead to the shrinkage of a major part of the brain (i.e., the hippocampus) and cardiovascular complications

result in neurological damage due to restricted blood flow to the brain (Fowler, 2008).

Another component of metabolic syndrome that disproportionately affects African Americans is hyperglycemia or high levels of glucose in the bloodstream. Research indicates that long bouts of hyperglycemia ultimately have a deleterious effect on the brain independent of the effects on the vascular system (Abbatecola et al., 2006).

However, even diabetics who have fairly good glycemic control might experience transitory changes in cognitive functioning as glucose levels fluctuate before and after meals.

Most studies indicate that acute changes in cognition occur when blood sugar levels exceed 200 mg/dl (Yaffe, et al., 2004). Sommerfield, Deary and Frier (2004) examined the extent to which acute periods of hyperglycemia affect mood and cognitive functioning, using a hyperinsulinemic glucose clamp to control glucose levels. They divided participants into two groups: euglycemic (optimal glucose control) and hyperglycemic. Hyperglycemia affected working memory (the ability to store and mentally manipulate information) along with other cognitive processes; thus, the Sommerfield et al. study indicates that high blood sugar for even relatively brief periods of time has an adverse effect on cognition. Because transitory spikes occur regularly for many diabetics, these findings have important implications for a diabetic's ability to engage in tasks that require cognitive resources such as driving or comprehending complex information.

The effects of diabetes on cognitive functioning are wide-ranging. Diabetes adversely affects memory performance, attentional control and problem-solving ability (Cukierman et al., 2005) and increases one's risk for dementia (Cukierman et al., 2005). Ironically, to maintain good glycemic control must one utilize a number of cognitive resources (Black & Scogin, 1998).

Thus, diabetics with poor glycemic control over a number of years may be in a Catch 22 situation.

The Relationship between Cognitive Deficits and Glycemic Control

Achieving optimal glycemic control is difficult because the diabetic has to manually perform tasks normally performed automatically by the pancreas in healthy individuals. To achieve the appropriate balance between blood insulin levels and glucose levels, the diabetic person needs to keep a running tally of caloric intake and the nutritional values of the food ingested and the amount of medication in the bloodstream. If the diabetic person does not ingest enough food to balance the amount of insulin in the blood, she or he runs the risk of hypoglycemia (e.g., low blood sugar) which can lead to a coma or even death (Hunt, Arar, & Larme, 1998; Black, 2001). If the diabetic person takes in too much or the wrong kinds of food, she or he runs the risk of hyperglycemia, which can eventually lead to a number of physical and cognitive complications (Hunt et al., 1998).

The diabetic person must also remember to perform actions, such as monitoring glucose levels and taking medications at a given time, which is referred to as prospective memory. It is not unusual for diabetics to have as many as two or three comorbid conditions, each requiring a different medical regimen (Two Feathers et al., 2005). African American diabetics may have particularly complex regimens due to their higher likelihood of diabetes-related complications (Jackson, Newton, Ostfield, & Schneider, 1988). African American diabetics may also experience cognitive decline at a faster rate than Caucasians because African American diabetics have more diabetes-related health problems (Black, 2001).

What can be done?

Because the likelihood of diabetes increases with age (Saczynski et al., 2008) and accelerates age-related cognitive decline,

Black and Scogin (1998) recommend an intervention focusing on the cognitive abilities (i.e., prospective memory, improving comprehension, and problem-solving). The aforementioned cognitive abilities have been shown to be related to diabetes management.

Improving Comprehension

For decades, cognitive aging researchers have lamented the poor communication between older patients and healthcare professionals (Kane, Solomon, Beck, Keeler & Kane, 1981). Although older adults actually need extra time because of changes in processing speed and sensory acuity, healthcare professionals often spend less time with the elderly and often use jargon to describe complex medical procedures, leaving the older patient somewhat confused about specifics of their medical regimen (Robinson, White, & Houchins, 2006).

These problems are often compounded for older African American diabetics who frequently have had less opportunity to pursue higher education than their Caucasian counterparts and therefore have lower levels of health literacy (Nurss et al., 1997). One study reported that less than half of the African Americans diabetics at urban healthcare facilities fully understood their medical regimen (Nurss et al., 1997).

These communication barriers can be especially problematic for diabetics, who have complex regimens and need to thoroughly understand their medical regimen to achieve optimal glycemic control. Schorling and Saunders (2000) found that one-fourth of rural African Americans thought they had “sugar” but not diabetes and that these patients had higher glucose levels than individuals who understood they had diabetes, possibily because they were less informed about the seriousness of their disease and the necessity of following a strict medical regimen.

Morrow and colleagues (Leirer, Morrow, Pariente, & Sheikh, 1983; Leirer, Morrow, Tanke, & Pariente, 1991; Mcdonald-Miszczak, Maris, Fitzgibbon, & Ritchie, 2004; Morrow, Winer, Young, Steinley, Deer, & Murray, 2005; Park, Morrell, Frieske & Kincaid, 1992; Park, Willis, Morrow, Diehl, & Gaines, 1994) have developed strategies to make medical information more accessible among a wide range of patients. These strategies include using a list format, explicit language, following a medication-taking schema, and intermixing text and graphics.

In one study, Morrow et al. (2005) designed two groups of healthcare packets for older adults who were largely poor and African American: a standard packet and a patient-centered packet designed to be easy for older adults to comprehend. The patient-centered packet used large print, was written at a 7th grade level and was organized according to older adults' medication-taking schema. Information was stated explicitly, and icons were used to reinforce the text. These researchers found that information in the patient-centered condition was better remembered and comprehended. Additional research has shown that culturally competent healthcare professionals have much better success in communicating with older African American patients and, as might be expected, compliance rates are higher (Anderson-Loftin, Barnett, Sullivan, Summers-Bunn, Tavakoli, 2002).

Although the first step in achieving good glycemic control is comprehending the diabetic regimen, the next step involves executing the regimen. Individuals with diabetes have to remember to perform a number of self-care procedures throughout the day. That is, they have to engage in a process that cognitive psychologists refer to as prospective memory, remembering to perform activities in the future.

Prospective Memory and Keeping Track of Information

Leading cognitive aging researchers have argued that one of the best ways to improve prospective memory among older adults is

through the use of environmental support (Craik & Jennings, 1992). Environmental support refers to using cues in the environment as reminders for tasks. Cognitive researchers have designed interventions focused on integrating to-be-remembered information with cues in the environment. One of the first individuals to suggest this technique was Hussey (1991), who labeled the technique tailoring and cueing. Specifically, Hussey encouraged people to arrange their medication regimen around routinely occurring events, For example, a patient might take her pills when watching her favorite television show. Based on the cognition literature, if the patient repeatedly takes her medication at the same time that an event occurs in the environment, the act of taking her medication and the event should eventually become yoked together in long-term-memory, a retrieval cue. Insel and Cole (2005) implemented Hussey's tailoring and cueing strategy and found it to be effective.

Another promising approach that diabetes educators have explored is the use of cognitive orthotics (Black, 2008), which involves using technology to provide cognitive assistance to people with memory impairments or complex medical regimens. For example, one fairly simple and inexpensive intervention involving telemedicine is teleMinders, through which diabetics receive a phone call to remind them to take their medication. Fulmer et al. (1999) found that medication compliance was above 80% with a telephone call but below 50% without one.

Because prospective memory is so important in managing diabetes, nurses, diabetes educators and other health professionals should consider incorporating strategies to improve prospective memory into their training sessions, especially when working with older adults. A number of studies have shown that memory intervention vastly improves medical compliance among older adults (Park, Morrell, Frieske, & Kincaid 1992); however very few of these studies have involved a large percentage of African American participants. More research needs to be conducted to determine if these types of interventions would improve medication compliance among African American older adults.

Problem Solving

Another cognitive process required to properly manage diabetes is problem-solving ability, which has been shown to be a significant predictor of glycemic control (Glasgow, Mullan, Fisher, Toobert, & Skaff, 2007). However, one of the most difficult aspects of diabetes education is teaching patients to do this. Older adults in particular have difficulty with problem solving due to age-related declines in working memory and executive processes—the ability to plan, problem-solve and strategize, (Rhodes & Kelley, 2005). Several diabetes educators have opted to anticipate the problems older diabetics will face and provide them with ready-made solutions. Glasgow and colleagues (1992) found that this method improved glycemic control, although a disadvantage of this approach is that it is impossible for healthcare professionals to anticipate all situations that might arise.

Alternatively, there has been an emphasis on teaching diabetics how to solve problems on their own. For example, D'Zurilla and Nezu (2006) developed a problem-solving therapeutic intervention based on the following five steps: 1) gather information about the problem, clearly separating fact from fiction; 2) identify factors associated with the problem; 3) set realistic problem solving goals; 4) select the best solution; and 5) modify the solution if necessary. Glasgow and colleagues (2007) along with Hill-Briggs and colleagues (2006) modified D'Zurilla and Nezu's problem-solving steps to specifically apply to diabetics. This Diabetic Problem-Solving Inventory has been shown to predict the number of complications associated with diabetes (Glasgow et al., 2007). Hills-Briggs and colleagues (2006) examined its validity on a group of 64 African American diabetics and found it to accurately predicted glycemic control (Hill-Briggs et al., 2007). Although Hills-Briggs and colleagues (2006) have examined the validity of the Diabetic Problem Solving Inventory in predicting glycemic control among African Americans; heretofore, (to our knowledge) no published studies have examined the effectiveness of problem-solving training with a largely African American population. This type of research

needs to be conducted because there are studies that indicate that problem-solving training is effective in improving glycemic control among Caucasian diabetics (Grey & Berry, 2004).

Conclusion

Finding ways to improve compliance among diabetics is imperative. Diabetes affects all major organs in the body, including the brain, increasing the diabetic's risk of developing cognitive impairments. With regard to diabetes, a number of studies have demonstrated the best way to prevent cognitive impairment is through tight control of the disease (Abbatecola et al., 2006). This is especially crucial for African Americans as they disproportionately suffer from both diabetes and its physiological and cognitive consequences.

Older African Americans, in particular, disproportionately bear the burdens associated with diabetes. Although there are a number of barriers that interfere with older diabetics' ability to achieve tight control (e.g., economic), one often overlooked barrier revolves around cognition. Specifically, as one grows older, it becomes more difficult to engage in the prospective memory and problem-solving tasks necessary to maintain optimal glycemic control. Interventions have been designed to aid older diabetics and have been shown to be effective (e.g., Glasgow et al., 2007; Fulmer et al., 1999). However, more research needs to be conducted examining the effectiveness of cognitive interventions and designing new and better programs to help older African American diabetics maintain glycemic control.

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