

Numbers Don't Lie, but Do They Tell the Whole Story?

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Newly appointed Secretary of the U.S. Department of Health and Human Services, Kathleen Sebelius, recently reaffirmed that reducing social disparities in diabetes is a national priority (1). Lower educational attainment has been strongly linked to higher diabetes prevalence and worse diabetes control. In California, for example, diabetes is much more common among those with a 9th grade education or less (14%) compared with those with a college degree or higher (5%). Nationally, very large disparities in diabetes-related mortality also exist across education levels, with rates three- to fivefold higher among those with less than a high school degree versus a college degree. Educational disparities in both diabetes control (as measured by A1C) and mortality have widened over the last 20 years (2). Similarly, many racial and ethnic minority groups have higher diabetes prevalence and worse diabetes control. African Americans are much more likely than non-Hispanic white to have diabetes and to experience worse glycemic control, even in populations with similar access to care (3). Insofar as African Americans are less likely than non-Hispanic white to have received the benefits of higher education, understanding whether lower educational attainment is an explanatory factor for racial and ethnic disparities in diabetes is critical for practitioners and policy makers in public health and clinical medicine.

It is in that spirit that Osborn et al. (4) have asked the question, "Can an assessment of performance strongly related to educational attainment (numeracy) help explain observed racial disparities in disease control, in a disease (diabetes) whose

management demands a certain facility with numbers?" Prior research in a sample of ethnically diverse, low-income, public hospital patients has shown that limited literacy, a frequent co-traveler with low numeracy, partially mediates the relationship between educational attainment and glycemic control (5), but the effects of limited literacy on disparities were not reported. A study of older, insured individuals demonstrated that limited literacy partially mediates both educational and racial disparities in self-rated health (6). Cavanaugh et al. (7), studying the same sample of patients described in the current study by Osborn et al., suggest that lower diabetes-related numeracy may be associated with worse glycemic control, an effect more pronounced among patients using insulin.

The current study (4) utilizes structural equation modeling to evaluate diabetes-related numeracy as an explanatory pathway in black-white differences in A1C. Their main findings were that African Americans had worse glycemic control than non-Hispanic white; that there was a disproportionate burden of lower diabetes-related numeracy scores among African Americans; and that inclusion of diabetes-related numeracy scores in the "path" between race and A1C reduced the effects of race on glycemic control, thereby fulfilling requirements to describe diabetes-related numeracy as a mediator of racial disparities in A1C (8). They also found that diabetes-related numeracy had effects on A1C that were more robust than measures of health-related literacy and general numeracy skills.

While we believe the recent studies from this research group provide much-

needed evidence that numeracy matters in diabetes care, we advise readers unfamiliar with structural equation modeling techniques to use caution in interpreting the finding that diabetes-related numeracy is a mediator of black-white disparities. To begin with, diabetes-related numeracy only partially mediated the relationship between race and glycemic control, reducing the magnitude of this relationship by ~25%. This suggests that diabetes-related numeracy is, at most, a partial mediator. Moreover, the authors' final model (that included the pathway of race → diabetes-related numeracy → A1C) accounted for no more of the variation in A1C than the initial model that did not include diabetes-related numeracy. This suggests that diabetes-related numeracy, like most determinants of glycemic control, is not very potent. Insofar as structural equation modeling was used to analyze cross-sectional data, usual concerns regarding causation and residual confounding hold. Specifically, it is possible that exposure to higher A1C among African Americans for other reasons leads to lower performance on a diabetes-related numeracy assessment. Recent studies suggest that prolonged hyperglycemia affects cognitive and problem-solving capacities like those needed to score well on a diabetes numeracy test (9). This would suggest a path that is more circular than linear. Lower diabetes-related numeracy in African Americans could be a marker for unmeasured confounders, such as lack of access to diabetes education, or more general forms of social disenfranchisement associated with lack of access to healthy foods or unsafe neighborhoods that prevent physical activity.

Rather than interpreting the current findings to mean that numeracy is a "magic bullet" in the quest to understand (and the necessity to intervene on) social disparities in diabetes, we believe this work advances the broader conceptualization of the more holistic construct of "functional health literacy" as an important target for efforts in public health and clinical medicine. Specifically, by demonstrating the predictive validity of diabetes-related numeracy, this research integrates numeracy as one of five key, interrelated components of functional

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health literacy (10), along with reading and writing (print literacy) and speaking and listening (oral literacy) (11–13). That diabetes-related numeracy in this sample appears to be more robust than literacy in its association with A1C reinforces the notion that functional health literacy reflects not only the current “capacities” of an individual but also the nature of the disease and the demands that its treatment places on the individual, the communication capacities of the clinicians in imparting self-management skills, and the extent to which health systems and the broader community support self-management skill building (10). Diabetes self-management places significant demands on patients (14), requiring expertise in problem detection, organizing information around functional relationships, and problem-solving strategies, each of which requires varying degrees of numeracy. Future research should examine which aspects of diabetes self-management are most affected by lower numeracy, and whether improving numeracy improves A1C by improving self-management or by increasing patient participation in treatment intensification decisions. How effectively diabetes educators, nutritionists, pharmacists, primary care physicians, and endocrinologists impart self-management skills, as well as how best to improve their teaching skills (including skills that require numeracy) across racial and cultural lines, should now be the focus of rigorous research. In addition, health systems must support innovative self-management support programs accessible to populations with limited literacy and numeracy (15). Future research should assess clinician and health system performance, not only patient performance.

Finally, insofar as the current study could lead to an increase in the extent to which numeracy is assessed for both clinical care and research in diabetes, we would be remiss in not expressing concerns regarding some unintended consequences of this research and questioning the “consequential validity” of numeracy assessment as it relates to black-white health disparities and the perpetuation of stereotype-laden and unidimensional explanations for these disparities. Diabetes disparities cannot be adequately explained, or even conceptualized, by examining individual characteristics alone. Rather, they are produced and perpetuated by multilevel forces operating at the individual, family, health system, community, and public policy levels that mu-

tually reinforce each other to produce injustice and perpetuate disparities (16). Consequential validity, a term developed by experts in educational psychology (17) refers to the social consequences of testing and performance measurement. It acknowledges that the social consequences of testing may be either positive, such as improved educational policies and increased resources based on comparisons of student performance, or negative, especially when associated with bias in scoring, unfairness in test use, or errors in interpretation of results and attribution. With this in mind, we believe that low numeracy is but one of many markers for educational disparities and societal disenfranchisement, albeit one that clinicians and health systems have a direct and compelling responsibility to help overcome. But from the public health perspective, we must also interpret the findings of this research as additional motivation to reverse the unfair social policies that drive diabetes disparities.

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