Translating Hemoglobin A1c Scores across an Ethnically Diverse Population: Is the Language Consistent across All Races?

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ABSTRACT

Hemoglobin A1c testing is an accepted measure of how well the blood glucose level has been controlled in the recent past (six to eight weeks) among individuals with diabetes. The purpose of this study was to evaluate the relationship between hemoglobin A1c (HbA1c) and blood glucose in an ethnically diverse population in a clinical setting. A cross-sectional research design was employed to explore associations between these two diabetes control measures in a sample of African American, White and Hispanic patients receiving diabetes treatment and follow-up in an outpatient clinic in Tallahassee, Florida. Data collection included a questionnaire, medical examinations, and lab results. Although we found a significant association between the glucose level and the HbA1c levels, the A1c value did not predict the mean glucose value as closely as previously found in less diverse groups. These findings suggest there is need for further study of these two variables among minority groups.

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Background

Type 2 diabetes mellitus is a chronic disease that progresses through a spectrum of impaired glucose tolerance until fasting hyperglycemia (an abnormally high blood sugar level) appears as the liver production of glucose declines. A high quality of life is possible for individuals with this disease, but long-term care to stave off complications and effectively manage the disease is necessary. The landmark Diabetes Control and Complications trial (DCCT, 1993) corroborated the *glucose hypothesis* (that there is a correlation between diabetic complications and hyperglycemia) and also established the hemoglobin A1C test as the gold standard tool to gauge blood glucose control in persons with diabetes for more than a quarter of a century (Delameter, 2010). In the DCCT, subjects were randomized into a conventional therapy group or an intensive treatment group. The latter maintained a lower blood glucose level during the trial. As a result, the intensive treatment group exhibited a significant reduction in prevalence of retinopathy, renal disease and diabetic neuropathy (DCCT, 1993).

Although the hemoglobin A1c test is broadly accepted as the standard for assessing blood sugar control in patients with diabetes, test results can be impacted by a number of conditions independent of blood glucose. Among these are renal failure, anemia, certain drugs and hemoglobin variants. Among variant hemoglobins known to distort the relationship between HbA1c and mean blood glucose are hemoglobin S and C (Frank et al., 2000). Hemoglobin variants are much more prevalent among certain ethnic groups. Previous studies have underscored discrepancies in the hemoglobin A1c of minorities when compared to non-Hispanic whites. In a meta-analysis describing disparities in Hemoglobin A1c levels between African Americans and non-Hispanic whites, a hemoglobin A1c difference of approximately 0.65% was found among African Americans (Kirk, 2006). A similar meta-analysis comparing A1c between Hispanics and non-Hispanic whites discovered an A1c approximately 0.5% higher among Hispanics (Kirk, 2008). Moreover, prior studies relating Hemoglobin A1C and mean blood glucose have only included a limited number of minority participants. In the DCCT, 96.5% of the study participants were white, while 2% were Black and 1.5 % 'other'. In the Nathan (2005) study, whites comprised 83.2% of subjects in the study translating the A1c assay into estimated average glucose values.

Other researchers have pointed out the difficulties with the HbA1c indicator in minority populations. In addition to biological factors, quality of care and socioeconomic status were also suggested factors driving the differences in HbA1c control (Karter, 2002). Lack of access to health care and a reduced frequency in obtaining preventive services were also associated to the A1c disparities within

minority groups (Rhee, 2005). Nevertheless, the HbA1c test continues to serve as the most reliable measurement of glycemic control, and large scale trials have established the need for glycemic control to temper diabetic complications (DCCT, 1993).

Approximately 7.6% of Leon County residents were diagnosed with type 2 diabetes mellitus in 2007 (CDC, 2007). Non-Hispanic Blacks were 1.5 times more likely to be diagnosed. Non-Hispanic Blacks were 6 times more likely than other ethnic groups to receive 10 or more A1c test in a 12-month period, suggesting their diabetes is not controlled.

Methods

Data Collection Methods

This study evaluated the relationship between hemoglobin A1c and blood glucose in an ethnically diverse group in a clinical setting. For this purpose, we assessed serial blood glucose monitoring data and compared this to hemoglobin A1c values among diabetic patients in an outpatient diabetes clinic in Leon County, Florida. Blood sugar meter data, downloaded electronically and stored in the Electronic Medical Record (EMR) were used to provide the glucose level indicator. Each patient was assigned a confidential code number and from each of their records several measures were collected, including: (1) Date range; (2) Mean blood glucose [MBG]; (3) Frequency of MBG recordings within given date range; (4) Meter make and model; (5) Hemoglobin A1c value; (6) Recorded date of A1c value; and (7) Standard reference range.

Mean blood glucose and Hemoglobin A1c values were examined to determine its variability when compared to the standard established in previous studies. Information was based on two different records from the EMR database, at two distinct points within a year to ensure consistency in our results.

Hypothesis

We hypothesized that there would be a significant positive relationship between the glucose level and the hemoglobin A1c level of patients with type 2 diabetes. We focused on this variability between the hemoglobin A1c and mean blood glucose because it can lead to treatment errors and poor patient compliance and adherence to prescribed regimens of diet, exercise, and drug therapy.

Participants

The selection criteria for the study participants included: (1) Diagnosis of type 2 diabetes mellitus; (2) Continuous care at the clinic for a minimum of three years; (3) Serum creatinine of 1.4 or below; (4) Verification of non-gravid status for females of childbearing age; and (5) Absence of severe co-morbidity that would be expected to impact hemoglobin A1c. Patients who met these criteria were identified by the clinic physician using an electronic medical record (EMR) database. The final study sample was composed by 28 participants: 38.5% African American, 60% White and 1.5 % other patients. This research was approved by the Institutional Review Board at Florida Agricultural and Mechanical University [FAMU].

Data Analysis

Data were selected between April 2008 and December 2008. A total of 48 patient records were selected from the North Florida Regional Thyroid Center. All analyses were conducted with SPSS 11. Bivariate analyses focused on the association between HbA1c and mean glucose levels, and Pearson correlations were obtained for the variables of interest. Multivariate analyses consisted of a linear regression test used to compare the two variables and describe their association.

Results

The final study sample consisted of 28 patients after the selected criterion was applied. The records were retrieved from March 2006 to July 2008, with the majority of records (75%) from the year 2008. Most of the patients used AccuChek (76%), whereas the others used OneTouch (20%) and Bayer Ascenia (3.3%). Although the majority of the sample population was white (60%), there were non-Hispanic blacks (38%) and other races (2%) as well.

As hypothesized, there was a significant relationship between the glucose level and the A1c level of type 2 diabetes patients. As the data in Table 1 show, there was a statistically significant, positive association found between the variables of mean glucose level and HbA1c ($p = .01$).

Bivariate Analyses

The actual average glucose for this sample was 174.96 (Figure 1). This mean corresponds to an estimated A1c level of approximately 7.0. However, the actual average A1c level for this sample was 8.07 (Figure 2). We found that the A1c value did not predict the mean glucose value as closely as in less diverse samples.

Multivariate Analyses

To explore the relationship between the mean glucose and the average HbA1C levels further, a linear regression was used to compare the two variables (Figure 3). The line represents the normal relationship between HbA1c levels and mean glucose levels. The circular points provide a graphic depiction of how distant from the norm (depicted by the line of best fit) the levels of our sample were.

Table 1. Correlation between Average Glucose and the Average A1c Score

Correlations

		Average Mean	Average A1c Score
Average Mean	Pearson Correlation	1.000	.489**
	Sig. (2-tailed)		.010
	N	28.000	27
Average A1c Score	Pearson Correlation	.489**	1.000
	Sig. (2-tailed)	.010	
	N	27	28.000

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 1. Average Glucose Level among Study Participants

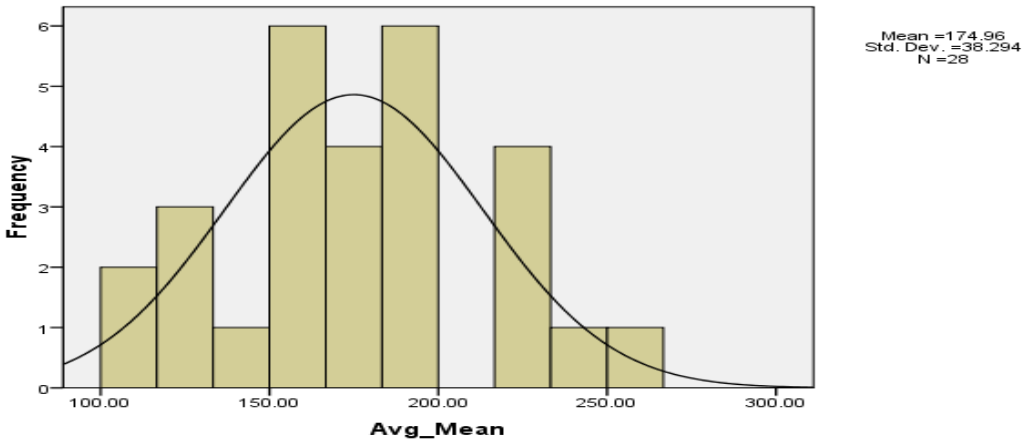


Figure 2. Average Hemoglobin A1c Level among Study Participants

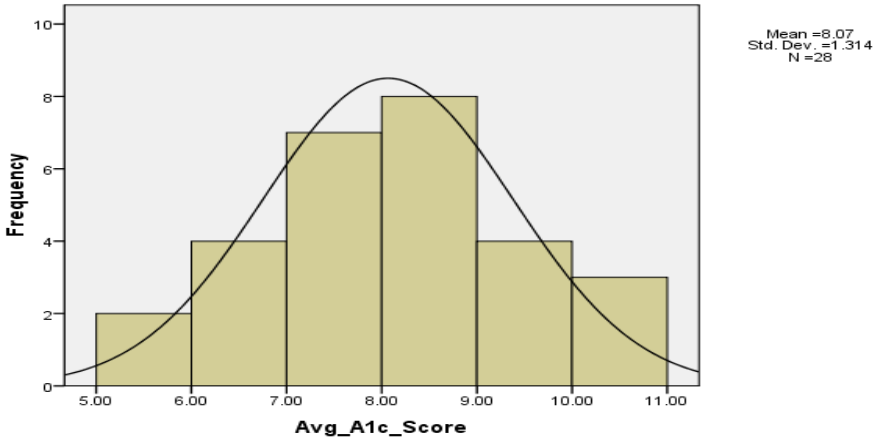
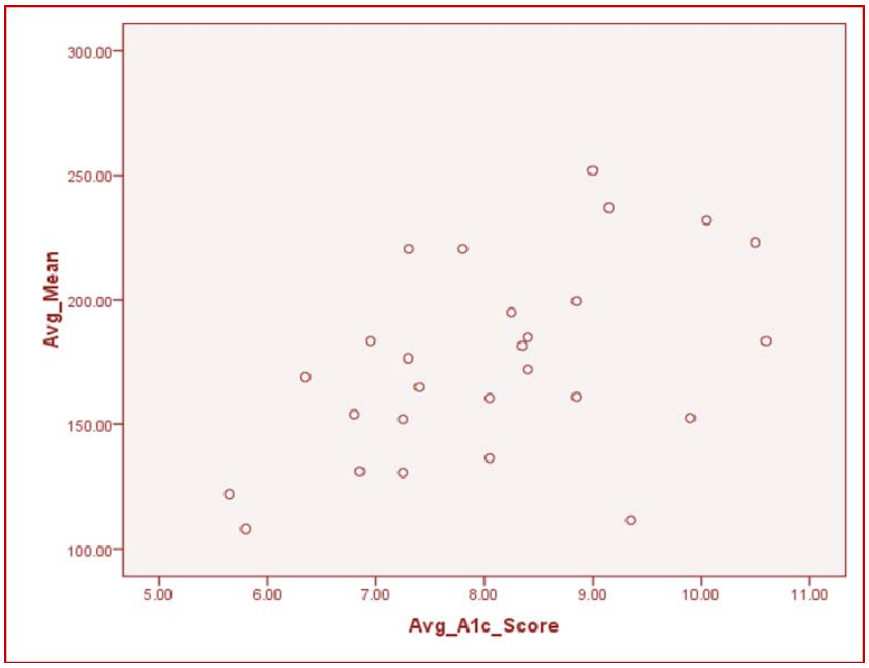


Figure 3. Linear Regression between Mean Glucose Level and Hemoglobin A1c Level



Our hypothesis was that there would be a statistically significant, positive association between mean glucose level and HbA1c. Although our null hypothesis was rejected, the central theme of this study was not just the positive association but that such an association was not as strong in an ethnically diverse population.

Discussion

The aim of this study was to evaluate the relationship between Hemoglobin A1c and blood glucose in an ethnically diverse group in a clinical setting. The average blood glucose and HbA1c data were compared among diabetes patients at the North Florida Regional Thyroid Center. As hypothesized, we found that the relationship between HbA1c and the mean blood glucose may vary more widely in an ethnically diverse population. This variability may lead to treatment errors and poor compliance. The study consisted 38.5% of African Americans, 60% of Whites, and 1.5% of other ethnicities with type 2 diabetes mellitus.

Our study was guided by the landmark Diabetes Control and Complication Trial (DCCT), published in 1993, which assisted in validating the glucose hypothesis. Whereas there was a correlation trend between A1c and mean glucose in our ethnically diverse sample, the strength of the association did not appear as strong as in a non-ethnically diverse sample (Nathan et al, 2005; DCCT, 1993). Our findings are consonant with those by Kirk et al. (2006, 2008), and reflect an imperative of diabetes inequity research regarding the continued evaluation of standards. Therefore, our findings suggest that the assumption that standards such as HbA1c will act congruently across populations should be reexamined.

The present study has notable limitations. Principally, this study was limited by the small sample size. In addition, not having identical systems to record patient data such as Accuchek was another limitation. Further, the recorded data we obtained did not contain demographic data (such as gender, date of birth, or age). Finally, we were unable to compare those individuals who were cared for by a specialist to those who were not.

Despite these limitations, this study underscores the need for additional exploration for possible variability in standard A1c scores. Future studies that focus on the equitable utility of the standards with a larger sample, as well as on cofounding variables such as SES, number of self testing per year, poor compliance, physician-patient relationship and age can have significant implications for self-management and treatment regiments, especially for minority populations.

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