

# Disparities in A1C Levels Between Hispanic and Non-Hispanic White Adults With Diabetes

## A meta-analysis

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**OBJECTIVE** — Hispanics have higher rates of diabetes and diabetes-related complications than do non-Hispanic whites. A meta-analysis was conducted to estimate the difference between the mean values of A1C for these two groups.

**RESEARCH DESIGN AND METHODS** — We executed a PubMed search of articles published from 1993 through July 2007. Data sources included PubMed, Web of Science, Cumulative Index to Nursing and Allied Health, the Cochrane Library, Combined Health Information Database, and Education Resources Information Center. Data on sample size, age, sex, A1C, geographical location, and study design were extracted. Cross-sectional data and baseline data from clinical trials and cohort studies for Hispanics and non-Hispanic whites with diabetes were included. Studies were excluded if they included individuals <18 years of age or patients with pre-diabetes or gestational diabetes.

**RESULTS** — A total of 495 studies were reviewed, of which 73 contained data on A1C for Hispanics and non-Hispanic whites, and 11 met the inclusion criteria. Meta-analysis revealed a statistically significant mean difference ( $P < 0.0001$ ) of  $-0.46$  (95% CI  $-0.63$  to  $-0.33$ ), correlating to an  $\sim 0.5\%$  higher A1C for Hispanics. Grouping studies by design (cross-sectional or cohort), method of data collection for A1C (chart review or blood sampling), and care type (managed or nonmanaged) yielded similar results.

**CONCLUSIONS** — In this meta-analysis, A1C was  $\sim 0.5\%$  higher in Hispanic patients with diabetes than in non-Hispanic patients. Understanding the reasons for this disparity should be a focus for future research.

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**E**thnic minorities in the U.S. are disproportionately affected by diabetes (1). For adults  $\geq 18$  years of age, the age-adjusted prevalence of diagnosed di-

abetes is 10.5% for Hispanic or Latino individuals compared with 6.8% for non-Hispanic whites (1). The Hispanic population is the fastest growing minority

group in the U.S., and Hispanics have a higher lifetime risk of diabetes than do non-Hispanic whites (2,3). Diabetes has a major adverse impact on life years and quality-adjusted life years in all U.S. sub-populations, with an even greater impact among minority individuals including Hispanics (3). Specifically, Hispanics have higher rates of many diabetes complications such as retinopathy, neuropathy, and lower leg amputations than do non-Hispanic whites (4–9).

Improvements in glycemic control have been shown to prevent microvascular complications, and large trials have demonstrated the need for glucose control among patients with diabetes (10,11). Literature reviews have suggested that A1C is higher among minority populations than among nonminority populations, and a previous meta-analysis confirmed higher levels of A1C among African Americans than among non-Hispanic whites (12,13). Factors that may underlie lack of A1C control include language barriers, inadequate access to care, lack of insurance coverage, low socioeconomic status, quality-of-care factors, self-care behaviors, and biological differences (14,15). Variance in A1C between populations may be due to poor control and/or biological differences across ethnic groups.

Although a number of studies varying in size and design have shown ethnic differences in glycemic control between Hispanics and non-Hispanic whites, to date there has not been a systematic analysis of these data. We reviewed the literature (1993–July 2007) for studies in which comparisons between these populations were made and conducted a meta-analysis using standardized statistical methods. This time period was selected because the A1C measurement, a marker of attachment of glucose to the erythrocyte over the previous 3 months, became more standardized over the past 10–15 years. Hispanic refers to populations who trace their origin to Spain or a Spanish-speaking country. We used this criterion

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**Abbreviations:** MeSH, Medical Subject Heading.

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for defining Hispanic populations in this article and restricted our focus to such populations residing in the U.S.

## RESEARCH DESIGN AND METHODS

### Identification of studies

We conducted a MEDLINE search in PubMed, using Medical Subject Heading (MeSH) terms and restricted the search to entries from 1993 through July 2007. We used the search terms “Diabetes Mellitus” (MeSH) or “Diabetes Mellitus, type 2” (MeSH) and “Hemoglobin A, Glycosylated” (MeSH) and “Hispanic Americans” (MeSH) or “Mexican Americans” (MeSH). The MeSH term “Hispanic Americans” when exploded includes Hispanic Americans, Spanish Americans, Cuban Americans, Hispanics, Latinos, and Puerto Ricans. We applied the limits “All Adult,  $\geq 18$  years of age,” and “English language.” We initially retrieved 1,271 abstracts and evaluated them for applicability to the project. Publications accepted had to include patients with di-

abetes and contain comparative data for both Hispanics (of any area) and non-Hispanic whites. We rejected abstracts that included patients with gestational diabetes or pre-diabetes. However, we accepted studies that included both type 1 and type 2 diabetes. We collected additional references from bibliographies of reviews, original research articles, and other articles of interest. Web of Science, Cumulative Index to Nursing and Allied Health, the Cochrane Library, Combined Health Information Database, and Education Resources Information Center were databases that we also searched. A total of 495 abstracts were applicable to the project.

A variety of study designs were found (Table 1). If the SD of the A1C was not reported or could not be obtained from the authors, we did not include the study in the meta-analysis. We accepted author-reported data only if we were assured by written communication that the information was obtained from the original computerized dataset. If a study was an intervention trial, it was excluded because

of potential selection bias in patient recruitment. If there was more than one publication from the same database, we accepted the most recent data file that was published.

### Data extraction

Two investigators (J.K.K. and R.A.B.) independently reviewed each study for the following data: 1) sample size ( $N$ ), 2) mean and SD of participants' age, 3) number of men and women, 4) A1C mean and SD, 5) geographic location of the research, and 6) study design. Figure 1 shows a flow diagram of the literature review. Eleven studies (16–26) contained glycemia-related data for Hispanics and non-Hispanic whites including A1C mean value and SD (Table 1). For three of the studies (15,17,18) included in this meta-analysis, the authors personally provided A1C data or SDs.

### Statistical analysis

A primary meta-analysis was conducted on the 11 studies (16–26). Six individual meta-analyses were conducted on subsets including study type (cohort and cross-sectional studies), method of data collection (chart review and blood sampling), and care type (managed or nonmanaged). Baseline data are summarized in Table 1 for the 11 studies that met the inclusion criteria. Individual meta-analyses were conducted on the subsets to judge the sensitivity of the results and justify the conclusions of the primary analysis. In addition to the meta-analyses performed in the subsets, two additional analyses were done to further examine the effect of age or BMI on A1C differences between Hispanics and non-Hispanic whites. Without patient-level data, the summary meta-analysis could not be adjusted for possible confounding effects of age and BMI. The first of these two additional meta-analyses was done on the subset of studies in which there were no differences in age between the two groups. The second analysis was done on the subset of studies in which there was no difference in BMI between the two groups (Table 1). A mean difference in A1C was calculated between Hispanics and non-Hispanic whites. For each study, a 95% CI was calculated.

Homogeneity of the effect sizes across studies was first assessed using a  $\chi^2$  test to determine whether a fixed- or random-effects approach should be implemented. A fixed-effects approach treats the set of

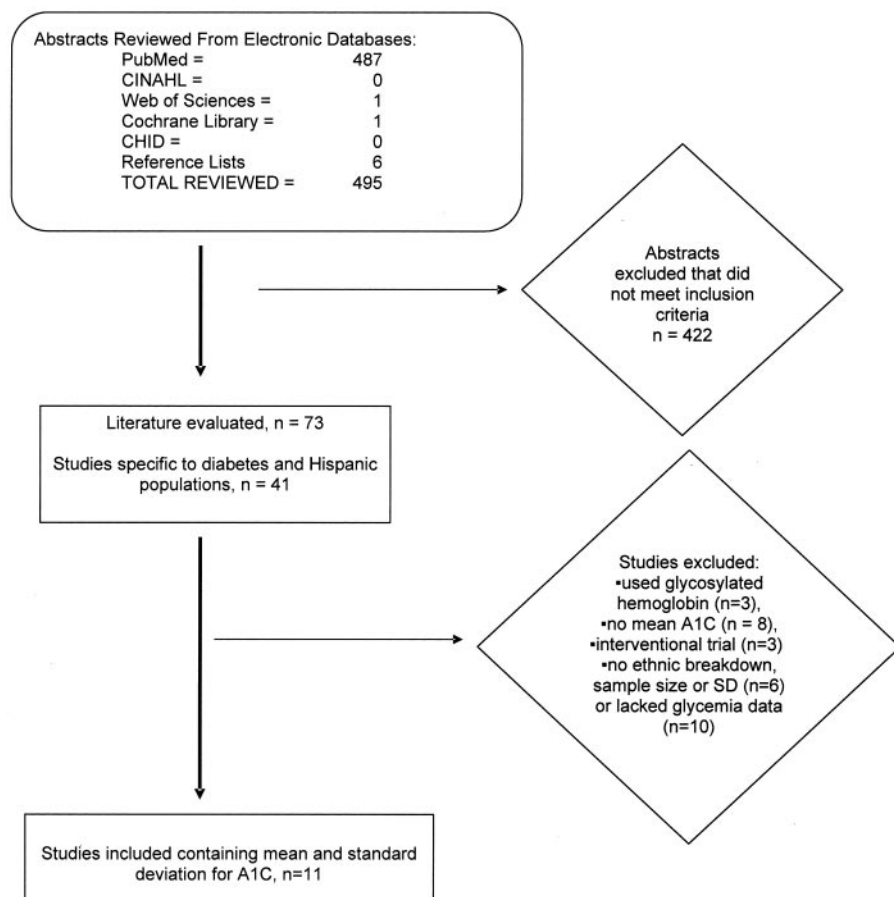
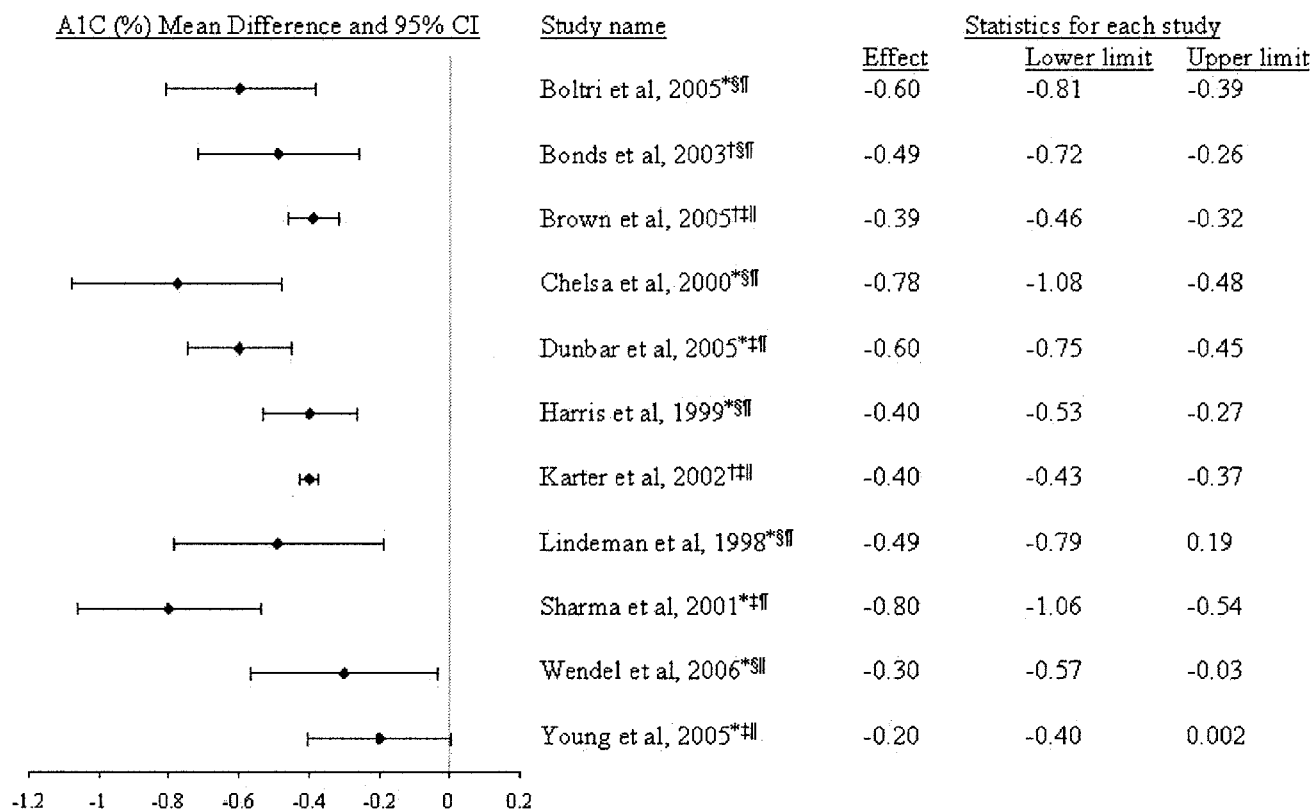


Figure 1—Flow diagram of systematic review of literature.



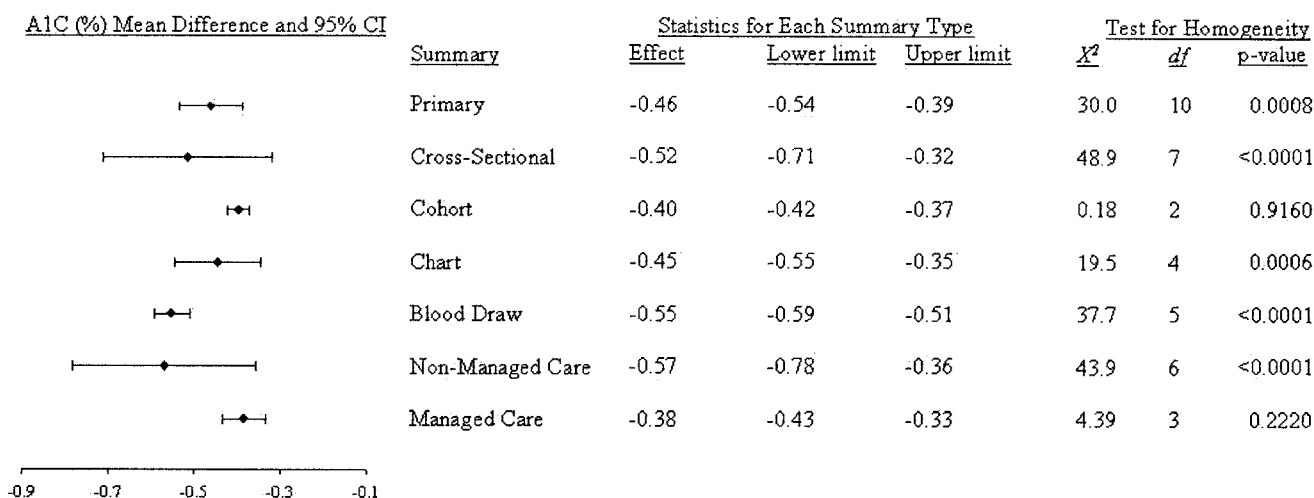
**Figure 2**—Mean A1C (%) differences between Hispanics and non-Hispanic whites. \*Cross-sectional study; †prospective cohort study; ‡data obtained from chart review; §A1C sample from study-initiated blood draw; ¶managed care; ||nonmanaged care.

studies as homogeneous and considers them representative of all potential studies of interest, whereas the random-effects approach treats the studies as heterogeneous and considers them to be a sample from a population of comparable studies. The homogeneity test results indicated the use of random-effects models in five of the seven meta-analyses. As the more conservative approach to meta-analyses, ran-

dom-effects models were used in all seven cases. All tests of effect were two sided, and  $P < 0.05$  was considered to be statistically significant.

**RESULTS**— Differences existed in the age of participants across studies, but most included patients  $>50$  of age (Table 1). Four studies designated the popula-

tion as Hispanic, three as Mexican American, and two as Latino. Four studies were done in a managed care setting; five used chart review, and six used blood sampling to obtain A1C data (Table 1). BMI and age were reported for 10 of the 11 studies. Statistical comparison of mean age between non-Hispanic whites and Hispanics showed no difference in five of the studies. The same comparison for BMI



**Figure 3**—Summary of mean A1C (%) differences between Hispanics and non-Hispanic whites.

**Table 1—Characteristics of studies among Hispanics and non-Hispanic whites\***

Study	Non-Hispanic whites				Hispanic				Site	Study design
	n	Age (years)*	BMI (kg/m <sup>2</sup> )†	A1C (%)	n	Age (years)*	BMI (kg/m <sup>2</sup> )†	A1C (%)		
Boltri et al., 2005 (16)	157	59 ± 1.7	32.8 ± 9.8	7.6 ± 2.5	202	56.5 ± 1.6	31.0 ± 5.16	8.2 ± 4.2	1999–2000 NHANES national sample	Cross-sectional
Bonds et al., 2003 (17)*‡	144	62 ± 8	30.8 ± 6	7.4 ± 1.8	156	61.4 ± 9.1	30.7 ± 5.7	7.9 ± 2.1	IRAS cohort in CO and TX	Prospective cohort
Brown et al., 2005 (18)*‡	2,787	61 ± 13	31.6 ± 7.3	7.8 ± 1.7	1,207	60.9 ± 12.7	30.9 ± 6.8	8.2 ± 1.9	TRIAD study of diabetes in managed care (MI, NJ, PA, TX, CA, HI, and IN)	Prospective cohort
Chesla et al., 2000 (19)†	116	48.4 ± 8.9	31.0 ± 7.2	8.2 ± 1.6	76	51.7 ± 7.7	31.8 ± 5.3	9.0 ± 2.1	11 private and public health facilities in CA	Cross-sectional
Dunbar et al., 2005 (20)	599	51 ± 1.9	31.4 ± 7.6	8.7 ± 2.2	257	46 ± 1.9	29.5 ± 5.5	9.3 ± 2.9	Urban outpatient diabetes clinic in GA	Cross-sectional
Harris et al., 1999 (21)	486	≥20	NA	7.6 ± 1.9	399	≥20	NA	8.0 ± 2.0	NHANES III	Cross-sectional
Karter et al., 2002 (22)‡	40,025	61 ± 13	30.0 ± 6.6	8.4 ± 1.8	6,279	56.7 ± 12.3	30.3 ± 6.1	8.8 ± 2.0	Northern CA Kaiser	Prospective cohort
Lindeman et al., 1998 (23)*†	70	72.9 ± 5.5	27.7 ± 4.0	8.4 ± 2.5	118	74.1 ± 5.6	27.8 ± 4.7	8.9 ± 2.9	Permanent patients Medicare recipients from Health Care Financing Authority in NM	Cross-sectional
Sharma and Pavlik, 2001 (24)*†	111	63.2 ± 12.7	31.4 ± 8.1	9.4 ± 2.9	132	60.6 ± 13	30.6 ± 6.3	10.2 ± 2.1	Community clinic patients in TX	Retrospective chart review
Wendel et al. 2006 (26)*†	226	65.5 ± 9.4	32.3 ± 6.2	7.9 ± 1.4	72	64.9 ± 10.1	30.9 ± 5.7	8.2 ± 1.6	3 Veterans Affairs Medical Centers in Southwest	Cross-sectional
Young et al., 2005 (25)†	2,197	60.9 ± 12.3	31.9 ± 7.5	7.8 ± 1.6	98	55.5 ± 11.9	31.1 ± 7.8	8.0 ± 1.8	9 primary care clinics in western WA	Cross-sectional

Data are means ± SD. \*t test for differences in age (NS). †t test for differences in BMI (NS). ‡A1C provided by the author via written communication. IRAS, Insulin Resistance Atherosclerosis Study; NA, not available; NHANES, National Health and Nutrition Examination Survey; TRIAD, Translating Research into Action for Diabetes.



resulted in no difference between the groups in six of the studies. Two separate additional meta-analyses were performed including only these five and six studies, respectively.

One of the 11 studies indicated significantly higher A1C levels in Hispanics than in non-Hispanic whites (Fig. 2). Each meta-analysis resulted in statistically significant differences in A1C levels between Hispanics and non-Hispanic whites. The summary mean A1C (%) difference size was  $-0.46$  (95% CI  $-0.54$  to  $-0.39$ ), which indicated that non-Hispanic whites had A1C values that were  $\sim 0.5\%$  below those of Hispanics (Fig. 3). The mean differences were similar regardless of study design. The estimated mean difference for cross-sectional studies was  $-0.52$  ( $-0.71$  to  $0.32$ ) and for prospective cohort studies was  $-0.40$  ( $-0.42$  to  $-0.37$ ). Similarly, when studies were divided into two groups according to data collection type, the mean A1C (percent) differences were consistent with the results from the summary analysis. Studies in which the A1C values were collected from chart reviews had a mean difference of  $-0.45$  ( $-0.55$  to  $-0.35$ ), and studies in which the values were obtained from baseline blood sampling had a mean difference of  $-0.55$  ( $-0.59$  to  $-0.51$ ). For managed care studies the mean difference was  $-0.38$  ( $0.43$  to  $-0.33$ ), and for non-managed care it was  $-0.57$  ( $-0.78$  to  $-0.36$ ). The supporting analysis, including only studies in which there was no difference in age, had a mean difference of  $-0.48$  ( $-0.63$  to  $-0.33$ ). Likewise, the analysis including only studies in which there was no difference in BMI had a mean difference of  $-0.50$  ( $-0.70$  to  $-0.30$ ). Both results support the primary meta-analysis and indicate that despite differences in age or BMI between non-Hispanic whites and Hispanics in some studies included in this analysis, the differences in A1C are persistent.

**CONCLUSIONS**— This meta-analysis shows that, in general, A1C is higher in Hispanics than in non-Hispanic whites with an overall mean A1C difference of  $0.5\%$ . The consistency of the findings is notable. This meta-analysis combined 11 studies to evaluate the overall mean difference. For the studies that were excluded but that reported A1C above target thresholds (i.e.,  $>7\%$ ), glycemic control was worse among Hispanics than among non-Hispanic whites (27–32). The strengths of this analysis are its

inclusion of a variety of study designs, the ability to examine A1C differences by study type, data collection methods, and care type, and the use of previously unpublished data (15,17,18).

The reasons for the disparity in A1C found in this meta-analysis are not well established in the literature. Hispanic patients with diabetes have been reported to have a higher prevalence of cardiovascular disease risk factors than non-Hispanic whites (4–6). Differences in biology, access to care, insurance status, and adherence to diabetes treatment regimens (medication, nutrition, behavior, and others) are all plausible explanations of the disparity. Beliefs about diabetes common among Hispanics may also result in behaviors that limit diabetes self-management (33–35). A recent comparison of 2004 Behavioral Risk Factor Surveillance System data for Hispanics and non-Hispanic whites indicates that Hispanics have lower quality of diabetes care (36).

A limitation to the analysis is publication bias. However, we performed numerous searches on this topic and contacted multiple investigators to retrieve unpublished data on A1C means and SDs. The heterogeneity of the studies adds to the limitations of the analysis in that individuals classified as Hispanic have a variety of places of origin. In some studies, Hispanics (20) were likely to be recent migrants from Mexico and Central America, whereas others (17) included Spanish-speaking populations who have been in the U.S. for a considerable length of time. Nevertheless, results are probably generalizable to Hispanic and non-Hispanic white adult patients with type 2 diabetes because the data included a broad range of patient ages, geographic settings, and study types. Another limitation to this meta-analysis is that despite the comprehensive review of abstracts, the potential for omission exists if an abstract initially reviewed through our search process did not specifically address racial disparities.

The results of this meta-analysis, however, depend in part on the accuracy, standardization, and reliability of the A1C measurement across studies. A recent evaluation of ethnic differences in A1C among patients in the Diabetes Prevention Program with impaired glucose tolerance indicated that hemoglobin glycation or red cell survival may differ among ethnic groups (37). Additionally,

the relationship between A1C and complications related to medical costs has been investigated using a computer-simulated model in individuals with type 2 diabetes developed by the National Institutes of Health (38). Using this model, Hispanics had the highest predicted complication rates and the highest predicted costs for eye disease, renal disease, and neuropathy/lower extremity amputation.

Although the studies included in our analysis used a variety of designs, a consistency in the degree of disparity of glycemic control was found regardless of study type. Multiple separate meta-analyses were conducted across study types (prospective cohort, cross-sectional, or retrospective chart review). Additional meta-analyses were also performed according to whether A1C data were collected by blood sampling or obtained post hoc from medical chart review and by sex, with all resulting in the same outcome. Hispanics with diabetes have an  $\sim 0.5\%$  higher A1C across studies. Of note is the fact that a  $1\%$  reduction in A1C has been correlated with an estimated  $21\%$  reduction in vascular complications (39). For this meta-analysis, an estimated reduction would correspond to about a  $10.5\%$  decreased risk. The reported findings are significant because ethnic disparities in glycemic control may be directly related to vascular outcomes.

Future researchers should focus not only on discovering the source of disparities in glycemic control that exist between minority populations and non-Hispanic whites but also on reducing these disparities—specifically, how much of these disparities is due to biological differences, types of lifestyles, health care access and utilization, or socioeconomic factors. Although an overall  $0.5\%$  difference in A1C among studies between Hispanics and non-Hispanic whites was found, the largest difference in A1C was among the nonmanaged care group of studies. These data suggest that Hispanic patients with diabetes in nonmanaged care settings are different with regard to A1C values. Potential fragmented care, access to care, and quality of care should be further evaluated in this population.

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