Cardiovascular Disease Mortality in Hispanics and Non-Hispanic Whites

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Despite a worse cardiovascular disease (CVD) risk profile, Hispanics have lower CVD mortality than non-Hispanic Whites in studies based on death certificates. This study examined 310 deaths that occurred between 1984 and 1998 among 1,862 Hispanic and non-Hispanic White participants in the San Luis Valley Diabetes Study, using medical records to classify cause of death. Among persons without diabetes, the age-adjusted all-cause mortality rate was 6.1/1,000 person-years in non-Hispanic Whites and 7.4/1,000 person-years in Hispanics. Among persons with diabetes, it was 24.3/1,000 person-years in non-Hispanic Whites and 21.9/1,000 person-years in Hispanics. Among nondiabetics, the age-adjusted CVD mortality rate was 2.5/1,000 person-years in non-Hispanic Whites and 1.6/1,000 person-years in Hispanics. Among diabetics, it was 12.9/1,000 person-years in non-Hispanic Whites and 8.8/1,000 person-years in Hispanics. Among nondiabetics, the adjusted hazard ratio for CVD death in Hispanics compared with non-Hispanic Whites was 0.65 (95% confidence interval (CI): 0.34, 1.23). The hazard ratio for coronary heart disease death was 0.95 (95% CI: 0.35, 2.59). Among diabetics, the hazard ratio for CVD death, after adjustment for conventional and diabetes risk factors, was 0.44 (95% CI: 0.26, 0.74), and for coronary heart disease death it was 0.43 (95% CI: 0.21, 0.91). A statistically significant decreased risk of CVD death was observed only in male Hispanics with diabetes. Competing mortality or factors that interact with diabetes may explain these differences.

cardiovascular diseases; diabetes mellitus; Hispanic Americans; mortality; risk factors

Abbreviations: CI, confidence interval; HDL, high density lipoprotein; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; LDL, low density lipoprotein.

It has been reported that Hispanics have a higher prevalence of cardiovascular disease risk factors than non-Hispanic Whites, including type 2 diabetes (1–3), obesity (4, 5), lipid abnormalities (5), and lower levels of physical activity (4). Several studies have reported lower cardiovascular disease and coronary heart disease mortality in Hispanics compared with non-Hispanic Whites (6–11). Less nonfatal coronary heart disease in Hispanics versus Whites has also been reported (12, 13), especially among men and persons with type 2 diabetes. However, similar or higher cardiovascular disease mortality has been reported as well (14–16), and the Corpus Christi Heart Project reported a higher incidence of hospitalized myocardial infarction (17) and greater case fatality after acute myocardial infarction (18) in Mexican Americans compared with non-Hispanic Whites. Thus, there is uncertainty about the actual disease pattern in these groups.

To date, most studies comparing cardiovascular disease mortality in Hispanics and non-Hispanic Whites have relied on death certificates for classification of cause of death (6–8, 19), and some ascertained ethnicity from the death certificate (6, 8, 14). In comparison with autopsy or medical records, death certificates may contain more misclassification, especially for older persons and out-of-hospital deaths (20–23).
In a review of New Mexico death certificates, nonspecific causes of death were more commonly assigned to Hispanics than to non-Hispanic Whites (24). Ethnicity coding errors on death certificates may be more likely for Hispanic decedents than for non-Hispanic White decedents (25). If any form of misclassification varies by ethnicity, ethnic comparisons of cause-specific mortality based on death certificates may be biased.
This study reports on cardiovascular disease and coronary heart disease mortality during 15 years of follow-up in a well-characterized cohort of 1,862 Hispanic and non-Hispanic White participants in the San Luis Valley Diabetes Study. We hypothesized that cardiovascular disease mortality would be similar in the two ethnic groups. To avoid bias, we had medical records reviewed and coded by a committee that was masked with regard to ethnicity for determination of cause of death.

**MATERIALS AND METHODS**

**Population**

The San Luis Valley Diabetes Study is a population-based cohort study designed to determine the prevalence and incidence of type 2 diabetes and its complications among Hispanic and non-Hispanic White adults. The rural population of the San Luis Valley in southern Colorado is approximately 44 percent Hispanic (26), and the primary economic activities in the area are agriculture, service, and tourism.

The San Luis Valley Diabetes Study identified all 20- to 74-year-old residents of two counties with a previous diagnosis of diabetes and selected a stratified random sample of persons without a history of diabetes. Detailed information on the study methods has been reported elsewhere (1). Briefly, a complete household enumeration was completed in the two study counties at the beginning of the study (1984), and there was a 95 percent response rate. Persons with diabetes were identified from retrospective and ongoing reviews of medical records at area medical practices, referrals from health care providers, community outreach, and San Luis Valley Diabetes Study clinic visit oral glucose tolerance tests. Control subjects were selected by drawing a stratified random sample of all enumerated individuals who were Hispanic or non-Hispanic White. Stratification criteria included age, ethnicity, gender, and county of residence and were based on the distribution of these factors in the diabetic sample.

The baseline visit was completed between 1984 and 1992. The response rate was 81 percent among diabetic participants and 68 percent among control participants. After providing written informed consent, participants completed a clinic visit that included laboratory measurements, standardized physical examinations, and administration of questionnaires in English or Spanish. All protocols were approved by the University of Colorado Health Sciences Center Multiple Institutional Review Board.

**Measurement and definition of variables**

Hispanic ethnicity was defined by self-report based on the 1980 US Census question “Are you of Hispanic origin or descent?” (26). Diabetes status was determined using a 2-hour, 75-g glucose tolerance test after a fast of at least 10 hours and was based on the 1985 World Health Organization criteria for diabetes (27). Participants who reported using oral hypoglycemic medication or insulin were classified as diabetic regardless of their test result. Twenty-eight persons with type 1 diabetes were excluded from this analysis. Hypertension was defined as a resting systolic blood pres-
sure ≥140 mmHg or a diastolic blood pressure ≥90 mmHg (28) or current use of antihypertensive medication. A history of cardiovascular disease was defined as a positive self-report of previous myocardial infarction and/or cerebrovascular accident at the baseline visit or at any follow-up study visit or during a surveillance telephone interview. A positive family history of cardiovascular disease was defined as a myocardial infarction or cerebrovascular accident in a first-degree relative at any age.

Glycosylated hemoglobin was measured by means of a commercial microcolumn method (Quik-Set; Isolab, Windsor, Ontario, Canada) and a filter paper method, with calibration across methods (29). Retinopathy was classified using stereo fundus photographs of three fields (I, II, IV), through dilated pupils, that were graded by the University of Wisconsin Fundus Photograph Reading Center. Persons with no retinopathy (codes 10–12) and persons with background retinopathy (codes 15–40) were grouped together, as

| TABLE 2. Cause-specific crude mortality rates per 1,000 person-years,* by diabetes status, gender, and ethnicity (n = 1,862), San Luis Valley Diabetes Study, 1984–1998 |
|---------------------------------|------------------|------------------|------------------|------------------|
| Cause of death† (ICD-9-CM code(s)) | Rate/1,000 person-years | 95% CI‡ | No. | Rate/1,000 person-years | 95% CI | No. | Rate/1,000 person-years | 95% CI | No. | Rate/1,000 person-years | 95% CI | No. |
|---------------------------------|------------------|------------------|------------------|------------------|
| Cardiovascular disease (390–459) | 3.9 | 2.2, 6.3 | 16 | 4.4 | 2.3, 7.5 | 13 | 2.6 | 1.4, 4.4 | 13 | 0.5 | 0.07, 2.0 | 2 |
| Coronary heart disease (410–414) | 1.7 | 7 | 2.4 | 7 | 0.4 | 2 | 0 |
| Cerebrovascular accident (431–436) | 0.7 | 3 | 1.0 | 3 | 0.8 | 4 | 0.3 | 1 |
| Cardiac arrest (427.5) | 0.7 | 3 | 0.3 | 1 | 0.2 | 1 | 0 |
| Other coronary heart disease (429–429.9) | 0.2 | 1 | 0 | 0 | 0 |
| All other cardiovascular disease codes | 0.5 | 2 | 0.7 | 2 | 1.2 | 6 | 0.3 | 1 |
| Diabetes mellitus (250–250.9) | 0 | 0 | 0 | 0 | 0 |
| Cancer (140–208 and 230–239) | 2.7 | 1.3, 4.8 | 11 | 5.0 | 2.6, 8.3 | 15 | 1.2 | 0.4, 2.6 | 6 | 1.6 | 0.6, 3.6 | 6 |
| Other causes (all other ICD-9-CM codes) | 3.6 | 2.0, 6.0 | 15 | 6.4 | 3.8, 10.0 | 19 | 2.8 | 1.5, 4.7 | 14 | 2.2 | 0.9, 4.3 | 8 |
| Sudden death (798–798.9) | 0 | 0.3 | 1 | 0 | 0.5 | 2 |
| Ill-defined/unknown causes (799–799.9) | 0.5 | 2 | 0.7 | 2 | 0.2 | 1 | 0 |
| Infections (001–139) | 0.5 | 2 | 0.3 | 1 | 0.4 | 2 | 0 |
| Trauma (all E codes)§ | 0.7 | 3 | 1.7 | 5 | 0.6 | 3 | 0 |
| Alcohol-related causes (303 and 571)¶ | 0 | 1.0 | 3 | 0.2 | 1 | 0 |
| Dementia (290) | 0.5 | 2 | 0.3 | 1 | 0 | 0.3 | 1 |
| Other ICD-9-CM codes | 1.5 | 6 | 2.0 | 6 | 1.4 | 7 | 1.4 | 5 |
| Total no. of deaths | 42 | 47 | 33 | 16 |
| Total person-years of follow-up | 4,121 | 2,977 | 5,053 | 3,681 |
| All-cause mortality/1,000 person-years | 10.2 | 7.3, 13.8 | 15.8 | 11.6, 21.0 | 6.5 | 4.5, 9.2 | 4.4 | 2.5, 7.1 |

Table continues
were persons with preproliferative retinopathy (code 50) and proliferative retinopathy (codes 60–80). Microalbuminuria was classified as being in the ≥90th percentile of the range of spot urine albumin values among normoglycemic participants in the San Luis Valley Diabetes Study. Physical activity was classified as vigorous, moderately vigorous, or sedentary based on self-report.

Cause of death was coded using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) (30) for underlying cause of death. Cardiovascular disease included ICD-9-CM codes 390–459.9 (all diseases of the heart and vascular system), and coronary heart disease included codes 410–414.9 (acute, subacute, and chronic ischemic heart disease).
Follow-up and review of medical records

Participants’ vital status was ascertained from the baseline visit through the end of 1998 via telephone surveillance, obituary monitoring, and searches of the Colorado Department of Public Health and Environment death certificate database. Vital status was determined for 98 percent of the participants, and 316 of 1,862 participants (17 percent) were identified as deceased. Autopsy reports were requested for cases with an autopsy reported on the death certificate (7.5 percent of cases), and coroner’s reports were requested for cases indicating coroner notification (15 percent of cases). Medical records were obtained for 310 of the 316 decedents (98 percent) and were reviewed by a committee of three physicians. The following types of records were reviewed: terminal inpatient and emergency room records; records from the month preceding death for nursing home deaths; and outpatient medical records and hospital discharge summaries for the 3 months preceding death for deaths that occurred outside of an institution.

The distributions of place of death and amount and type of medical record data were similar for the two ethnic groups. The review committee was masked as to ethnicity. Consensus agreement of the committee after record review was used to assign cause of death, and committee-assigned ICD-9-CM codes were used for analyses. The San Luis Valley Diabetes Study mortality protocol included standardized criteria for the validation of cardiovascular disease death that were adapted from the World Health Organization’s MONICA [Monitoring of Trends and Determinants in Cardiovascular Disease] Project (31). In cases of possible coronary heart disease, the following items were reviewed (if available): 1) autopsy information, 2) history of chest pain, 3) cardiac enzyme data collected within 72 hours of the onset of chest pain, 4) electrocardiograms, and 5) additional medical record data, including a past history of coronary heart disease and medications used.

Analyses

Descriptive statistics were computed using the Statistical Analysis System, version 6.12 (SAS Institute, Inc., Cary, North Carolina). Mortality rates were calculated using PEPI software, version 2 (32), with the 2000 US Census population age distribution used for direct age adjustment. Hazard ratios, controlling for confounding factors, were calculated using Cox proportional hazards regression (Statistical Analysis System, PROC PHREG). Persons with type 2 diabetes were oversampled in the study design, so stratified analyses were performed on two groups: participants with normal or impaired glucose tolerance and participants with type 2 diabetes at the baseline visit. Triglyceride values were log-transformed for the analyses.

RESULTS

Of the 1,862 persons in the population studied, 51 percent were non-Hispanic White, and 28 percent had type 2 diabetes. Table 1 summarizes baseline characteristics of the cohort. Hispanics in both groups were more likely to have a lower income and less education than non-Hispanic Whites. Other ethnic differences in cardiovascular disease risk factors varied by diabetes status. Among nondiabetic persons, Hispanics were more likely to be current smokers and to consume more alcohol, and they had higher triglyceride levels and lower high density lipoprotein (HDL) cholesterol levels. Among diabetics, Hispanics were younger and were more likely than non-Hispanic Whites to be female, to have higher low density lipoprotein (LDL) cholesterol, HDL cholesterol, and triglyceride levels, to have microalbuminuria, and to be treated with insulin. The higher HDL cholesterol levels in Hispanics were related to a high proportion of female Hispanics among persons with diabetes.

After a total of 15 years (mean = 11.4 years) and 21,197 person-years of follow-up, crude cumulative all-cause mortality was 15 percent in non-Hispanic Whites, 18 percent in Hispanics, 10 percent in nondiabetics, and 33 percent in diabetics. The mean age at death among nondiabetics was 71 years in non-Hispanic Whites and 69 years in Hispanics; among diabetics, it was 70 years in non-Hispanic Whites and 69 years in Hispanics (for both age contrasts, p > 0.05).

Figure 1 presents age-adjusted rates of all-cause, cardiovascular disease, and coronary heart disease mortality among non-Hispanic White and Hispanic participants by diabetes status. Table 2 presents cause-specific mortality rates by ethnicity, gender, and diabetes status.

Figure 2 presents age-adjusted rate ratios for all-cause, cardiovascular disease, and coronary heart disease mortality in Hispanics compared with non-Hispanic Whites. Among males with type 2 diabetes, the cardiovascular disease and coronary heart disease mortality rate ratios were significantly lower in Hispanics. There were no significant ethnic differences in rate ratios among diabetic females and nondiabetic males and females.

Cox proportional hazards regression, adjusted for age and gender, was used to test the hazard ratios associated with individual cardiovascular disease and coronary heart disease mortality risk factors among nondiabetic and diabetic subjects (data not shown). The risk of cardiovascular disease and coronary heart disease death associated with worse conventional cardiovascular risk factors varied by diabetes status. For example, elevated LDL cholesterol levels, lower HDL cholesterol levels, and physical inactivity were associated with increased cardiovascular disease and coronary heart disease mortality only among nondiabetic subjects. Among diabetic subjects, the hazard ratios indicated that factors related to diabetes, such as longer duration of diabetes, and the presence of retinopathy and microalbuminuria were associated with increased cardiovascular disease and coronary heart disease mortality.

Table 3 presents hazard ratios and 95 percent confidence intervals for all-cause, cardiovascular disease, and coronary heart disease mortality in Hispanics compared with non-Hispanic Whites, by diabetes status. There were no significant ethnic differences in all-cause mortality. Among nondiabetics, the Hispanic/non-Hispanic White hazard ratio for cardiovascular disease mortality was 0.65 (95 percent confidence interval (CI): 0.34, 1.23) after adjustment for multiple risk factors, with little change from the age- and gender-
adjusted value of 0.69. This suggests a nonsignificant reduced risk among Hispanics compared with non-Hispanic Whites. There was no ethnic difference in the risk of coronary heart disease mortality among nondiabetics.

Among persons with type 2 diabetes, the age- and gender-adjusted risks of cardiovascular disease and coronary heart disease mortality were lower in Hispanics than in non-Hispanic Whites, a finding that persisted after adjustment for multiple risk factors, including diabetes-related factors (hazard ratios were 0.44 (95 percent CI: 0.26, 0.74) for cardiovascular disease and 0.43 (95 percent CI: 0.21, 0.91) for coronary heart disease). The risks of cardiovascular disease and coronary heart disease death in Hispanics compared with non-Hispanic Whites were tested separately for male and female diabetics (data not shown). For persons of both genders, the hazard ratios indicated a decreased risk of cardiovascular disease and coronary heart disease death in Hispanic participants; however, with the exception of cardiovascular disease in men, the 95 percent confidence intervals included 1.00. Among men, adjusted hazard ratios were 0.33 (95 percent CI: 0.16, 0.69) for cardiovascular disease and 0.46 (95 percent CI: 0.19, 1.11) for coronary heart disease; among women, adjusted hazard ratios were 0.58 (95 percent CI: 0.31, 1.10) for cardiovascular disease and 0.45 (95 percent CI: 0.16, 1.28) for coronary heart disease.

**DISCUSSION**

This study compared risks of cardiovascular disease and coronary heart disease death in 1,862 Hispanics and non-Hispanic Whites during an average of 11.4 years of follow-up based on a review of medical records to ascertain cause of death. Among participants with type 2 diabetes at the baseline visit, risks of cardiovascular disease and coronary heart disease death were significantly lower for Hispanics than for non-Hispanic Whites, particularly in men. Among nondiabetic persons, there was no significant ethnic difference in the risk of cardiovascular disease or coronary heart disease death, though the point estimate for the hazard ratio comparing the two groups suggested a similar pattern for cardiovascular disease.

To our knowledge, this is the first report of decreased cardiovascular disease mortality in Hispanics compared with non-Hispanic Whites based on a review of medical records and the first time a study included a representative group of persons with type 2 diabetes. These findings are consistent with some observations of decreased cardiovascular disease and coronary heart disease mortality in Hispanics versus non-Hispanic Whites.
non-Hispanic Whites based on death certificates (6–11); however, they differ from those of other studies that reported higher coronary heart disease mortality in Hispanics versus non-Hispanic Whites (14, 16, 18). Previous studies did not report risk differences stratified by diabetes status and usually were not able to adjust for relevant risk factors as was done here. Earlier San Luis Valley Diabetes Study reports noted that coronary heart disease incidence (13) and prevalence (33) in Hispanics compared with non-Hispanic Whites was lower only among persons with type 2 diabetes, which is consistent with these mortality results. Other differences in study design could also at least partly account for varying results in the literature on coronary heart disease mortality in Hispanics versus non-Hispanic Whites. For example, the Corpus Christi Heart Project used community-based surveillance for ascertainment of coronary heart disease mortality, relied on US Census population data for denominator values, and determined ethnicity from death certificates in its report on coronary heart disease mortality (14). Project investigators reported coronary heart disease mortality rates for Mexican Americans that were equal to or higher than those for non-Hispanic Whites. Heterogeneity among Hispanic populations could affect both the ascertainment of cardiovascular disease and risk for cardiovascular disease. For example, immigration patterns, disparities in access to health care, and rural versus urban residence vary regionally in the United States. There is clearly a need for further research on the risks of cardiovascular disease and coronary heart disease mortality in Hispanics compared with non-Hispanic Whites.

Because cause of death was determined through medical record review by a committee that was masked with regard to ethnicity, the San Luis Valley Diabetes Study avoided many of the biases that may result from relying on death certificates to ascertain cause of death. Potential sources of bias that may occur in longitudinal studies were also addressed. Loss to follow-up was low and was similar in both ethnic groups (approximately 2 percent), and medical records were equally available. A comparison of causes of death in the two ethnic groups (table 2) suggests that Hispanics in this study were not more likely to be assigned nonspecific or unknown causes of death, which differs from the case in a New Mexico report based on death certificates alone (24).

One possible explanation for the lower cardiovascular disease mortality observed among Hispanic men with diabetes in the San Luis Valley Diabetes Study is competing mortality. Mortality rates specific to diabetes, cancer, and alcohol-related causes were higher in Hispanic diabetic men than in non-Hispanic White diabetic men (table 2), though the numbers of deaths in these categories were small. Additional longitudinal follow-up of a larger number of deaths may allow better estimates of rates of mortality due to these causes and indicate whether competing risk from these causes accounts for the deficit of cardiovascular disease deaths among Hispanic men.

An area for future study is possible genetic factors that protect against cardiovascular disease in Hispanic men with diabetes. Hispanics have been noted to have less carotid wall thickness and plaque than non-Hispanic Whites (34), which is probably an indication of less atherosclerosis. To explain the cardiovascular disease mortality patterns observed in the San Luis Valley Diabetes Study, genetic factors would have to differ by gender and diabetes. Factors such as the hepatic

### Table 3. Hazard ratios for all-cause, cardiovascular disease, and coronary heart disease death in Hispanics compared with non-Hispanic Whites (n = 1,862), San Luis Valley Diabetes Study, 1984–1998

<table>
<thead>
<tr>
<th>Model and type of mortality</th>
<th>Participants without diabetes (n = 1,338)</th>
<th>Participants with type 2 diabetes (n = 524)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hazard ratio 95% confidence interval</td>
<td>Hazard ratio 95% confidence interval</td>
</tr>
<tr>
<td>Adjusted for age and gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All causes</td>
<td>1.14 0.81, 1.59</td>
<td>0.85 0.62, 1.16</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>0.69 0.37, 1.28</td>
<td>0.58 0.37, 0.91</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>0.94 0.35, 2.54</td>
<td>0.56 0.30, 1.08</td>
</tr>
<tr>
<td>Model 1*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All causes</td>
<td>0.98 0.70, 1.36</td>
<td>0.89 0.66, 1.21</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>0.65 0.34, 1.23</td>
<td>0.55 0.35, 0.87</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>0.95 0.35, 2.59</td>
<td>0.55 0.28, 1.05</td>
</tr>
<tr>
<td>Model 2† (diabetic subjects only)</td>
<td>0.44 0.26, 0.74</td>
<td>0.43 0.21, 0.91</td>
</tr>
</tbody>
</table>

* Model 1 included conventional risk factors for cardiovascular disease/coronary heart disease: age, gender, body mass index, low density lipoprotein cholesterol, high density lipoprotein cholesterol, triglycerides, current smoking, hypertension, past history of cardiovascular disease, and vigorous physical activity (23 nondiabetic participants were missing data on one or more variables and 57 diabetic participants were missing data on one or more variables).

† Model 2 included conventional and significant diabetes-related risk factors: age, gender, current smoking, hypertension, duration of diabetes, glycohemoglobin, and microalbuminuria (140 participants were missing data on one or more variables).
lipase gene C(-514)T (35), which regulates HDL and LDL subfractions, and the lipoprotein lipase LpL D9N allele (36), which is important in triglyceride catabolism, are known to differ between Hispanics and non-Hispanic Whites and could plausibly interact with type 2 diabetes and gender to reduce the risk of cardiovascular disease. Other cardiovascular disease risk factors, such as the promoter polymorphism T(-107)C of the PONI gene (37), which affects the expression of the antioxidant paraoxonase and hyperhomocysteinemia (38), could differ by Hispanic ethnicity. These possibilities require further study.

Certain limitations should be considered when interpreting our results. Medical record data were less likely to be available for deaths that occurred outside of an institution, though there was no ethnic difference in the distribution of place of death. Small numbers of cardiovascular disease and coronary heart disease deaths in nondiabetic participants limited the study’s power to detect a significant ethnic difference. We estimated that 136 additional cardiovascular disease deaths and a total of 55,844 person-years of follow-up (compared with the current 21,197 person-years) would have been needed to detect, as significant, the ethnic difference in cardiovascular disease death seen in the nondiabetic group. Finally, residual confounding not accounted for in the analyses could partly explain lower cardiovascular disease mortality in Hispanic men.

Although this study found lower cardiovascular disease mortality in Hispanic men with diabetes, cardiovascular disease was still the leading cause of death in all participants with type 2 diabetes. Investigations into ethnic differences in mortality and the underlying biologic pathways for cardiovascular disease and coronary heart disease have the potential to contribute important knowledge about prevention of significant morbidity and mortality.

ACKNOWLEDGMENTS

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