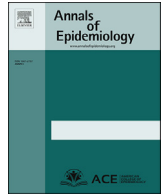




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Temporal trends in age at ischemic stroke onset by ethnicity

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ABSTRACT

Purpose: To explore temporal trends in age at first-ever ischemic stroke onset in a bi-ethnic, population-based study.**Methods:** Cases of first-ever ischemic stroke ($n = 3252$) were identified in the Brain Attack Surveillance in Corpus Christi Project (2000–2012). Demographics and risk factors were abstracted from medical records. Trends in age at stroke onset were assessed overall and by ethnicity (Mexican American [MA] and non-Hispanic white [NHW]) using generalized additive models. Differences by ethnicity were tested by including an interaction term between time and ethnicity. Models were run unadjusted and adjusted for age of the population at risk for stroke.**Results:** Mean age at first-ever ischemic stroke significantly decreased from an average of 71.7 years in 2000 to an average of 69.3 years in 2012 ($p = .0043$). Ethnicity significantly modified the temporal trends ($p < .001$) with declines greater in NHWs than in MAs; mean age was estimated to decrease from 74.8 to 71.3 over the 13 years for NHWs, whereas for MAs, mean age was estimated to decrease from 68.9 to 66.9 after adjusting for ethnic-specific average age of the population at risk.**Conclusions:** Average age at first-ever stroke onset declined over time in this community. Efforts should be made to prevent stroke by controlling risk factors before and during midlife.

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Introduction

Stroke is the leading cause of adult disability and the fifth leading cause of death in the United States (U.S.) [1]. In recent decades, the incidence rate for stroke has declined [2, 3]. However, several studies have reported that this decline is not present in those younger than 65 years [3, 4]. Moreover, modest yet significant increases in stroke incidence in the population younger than 55 years have been reported in both the United States and Europe [5, 6]. It is possible that these trends in incidence will translate into a lower average age at stroke onset.

Lower average age at stroke onset would have considerable public health implications. As stroke mortality has decreased dramatically over time [7], especially in those younger than 65 years [4], strokes in younger persons carry the potential for greater years of disability and lifetime cost [8]. Furthermore, stroke

survivors often face a loss of income, and loss of earnings for individuals who experience stroke at younger ages is expected to be greater [9].

Although age at stroke onset is an important outcome from a public health perspective, data on contemporary U.S. trends in age at stroke onset are limited. One study from the Greater Cincinnati/Northern Kentucky Stroke Study found that mean age at stroke significantly decreased from 71.2 to 69.2 years over a 12-year period from 1993 to 2005 in both blacks and whites [5]. Similar data for other populations and race-ethnic groups, including Hispanic Americans, are not available.

There are several reasons why understanding temporal trends in age at stroke in Hispanic Americans is important. People of Hispanic origin are now the nation's largest ethnic minority and they are currently youthful, with a median age of 27.3 years, suggesting stroke will take on increasing importance as this population ages [10]. Mexican Americans (MAs) are the largest subgroup of Hispanic Americans. Previous research has revealed that stroke incidence is higher, particularly at younger ages, and the outcome is worse in MAs compared with non-Hispanic whites (NHWs) [3, 11]. In addition, stroke incidence has remained stable over time in MAs

Disclosures: None.

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45–59 years of age, in contrast to the declining incidence seen in older MAs [3].

The aim of this study was to describe temporal trends in age at ischemic stroke onset overall and by ethnicity using data from a large population-based stroke study conducted in a bi-ethnic community. We hypothesized that age at stroke onset has decreased over time and that MAs have experienced greater declines compared with NHWs.

Methods

Patients and setting

The Brain Attack Surveillance in Corpus Christi (BASIC) Project is a population-based stroke surveillance study in Nueces County, Texas. The BASIC Project methods have been previously published [12]. The population of Nueces County was 361,350 in 2016, of which 63.4% were MAs [13]. The community has been stable over time with fewer than 6% of the county residents in 2010 moving to another county in 2011, lower than the average for the state of Texas [14]. Corpus Christi, the major city in Nueces County, is more than 150 miles away from referral centers in San Antonio and Houston, and adjacent counties are sparsely populated. Thus, medical care in Nueces County is highly self-contained. There are two health systems with seven acute-care community hospitals and all of them have computed tomography and magnetic resonance imaging.

Subjects are eligible for BASIC if they are aged 45 years and older, have had a stroke not as a result of head trauma, and reside in Nueces County for at least 6 months per year. Only MA and NHW cases were included in the current study due to low numbers of individuals with other race-ethnicities. The University of Michigan Institutional Review Board and the Institutional Review Boards of both Nueces County hospital systems approved the BASIC project.

Case ascertainment

Procedures to identify stroke cases in the BASIC project include active and passive surveillance [3, 12]. Trained abstractors review emergency room and admission logs daily to identify stroke patients using validated screening terms. In addition, hospital wards and intensive care units are examined for in-house strokes or those not ascertained through the screening logs. The active surveillance is supplemented by monthly review of hospital passive listings of International Classification of Disease discharge codes for stroke. Minor changes to the case ascertainment procedures during this project have been previously reported [3].

Cases are validated by stroke fellowship trained physicians using source documentation, blinded to ethnicity. Stroke diagnosis is based on published international clinical criteria [15] that require onset of a focal neurologic deficit specifically attributable to a cerebrovascular distribution that persists for greater than 24 hours and not explainable by a nonvascular etiology. Computed tomography and magnetic resonance imaging assists in determining the stroke type. Only validated cases of incident (no documented history of stroke/TIA in medical record) ischemic stroke between January 1, 2000, and June 30, 2012, were included.

Data collection

Age at onset was abstracted from the medical record. Time in years since 2000 (primary exposure) was based on date of first presentation to the hospital. Demographics and risk factors were also collected from the medical record. Risk factors represent documented history (present vs. absent) of a given risk factor in the medical record and included atrial fibrillation, coronary artery

disease, excessive alcohol, diabetes, high cholesterol, hypertension, and ever smoker. Race-ethnicity in the medical record agrees highly with self-reported race-ethnicity in this community ($\kappa = 0.94$) [12]. Initial stroke severity was assessed by the National Institute of Health Stroke Scale (NIHSS), which was abstracted from the medical record or calculated using a published algorithm [16]. Data from the 2000 and 2010 U.S. Census, and from 2001–2009 and 2011–2012 intercensal estimates, were used to estimate yearly average age of the population at risk for stroke overall and by ethnicity. Yearly estimates were calculated by first multiplying yearly population counts in each 5-year age interval by the median age of the interval. Products were then summed and divided by the yearly population counts to determine yearly average age in the population.

Statistical analysis

Descriptive statistics were calculated overall and by ethnicity. Mean change of each variable (demographics and risk factors) over time was evaluated by fitting a linear regression model with robust standard errors. To display changes over time in a more intuitive way, the characteristics (age, sex, race-ethnicity, NIHSS) and prevalence of risk factors (atrial fibrillation, coronary artery disease, excessive alcohol, diabetes, high cholesterol, hypertension, ever smoker) were also calculated for the early (2000–2002) and late (2010–2012) periods. Temporal trends in age at stroke were investigated using generalized additive models with time in years since 2000 modeled through a smoothing spline [17]. The crude model included only time. To explore effect modification of temporal trends in age at stroke by ethnicity, ethnicity and the interaction term between ethnicity and time were included in a second model. To adjust for changes in the age of the population at risk, yearly average ages overall and by ethnicity were included in the previous two models, respectively. Other potential confounders were not included in the models as our goal was to describe overall trends in age at stroke onset over time. In sensitivity analyses, we re-ran the model excluding the year 2009 as mean age in this year was abnormally high compared with other years.

Post hoc analysis

Because there has been an increased use of imaging over time, it is possible that in the more recent period, a greater number of mild strokes in younger people are being detected that would have been missed in the earlier study period [18]. For this reason, a post hoc analysis was conducted to describe temporal trends in stroke severity by age group to investigate increases in the use of imaging over time. A generalized additive model was used to look at stroke severity over time by age group with stroke severity modeled as natural logarithm of NIHSS plus one.

Results

There were 3496 first-ever ischemic strokes ascertained between January 1, 2000, and June 30, 2012; 244 were excluded as they were not NHW or MA. Tables 1 and 2 include demographic characteristics, as well as risk factor prevalences, and their mean changes during the study period by ethnicity. For MAs, median age at stroke onset was 67.0 years (IQR: 57.0–78.0) and for NHWs, it was 75.0 years (IQR: 63.0–83.0). Fifty-three percent of MAs had diabetes, and the estimated mean change in prevalence of diabetes was 6.5% over the 13 years. Twenty-five percent of NHWs had diabetes, and the estimated mean change in prevalence was 7.9% over the 13-year study period. In both ethnic groups, prevalence of uninsured, hypertension, and high cholesterol increased

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