

# RACIAL/ETHNIC DIFFERENCES IN BYSTANDER CPR IN LOS ANGELES, CALIFORNIA

**Background:** Bystander CPR (BCPR) has been demonstrated to improve rates of return of spontaneous circulation, survival to hospital admission, and quality of life in survivors. While previous studies have shown that African Americans are less likely to receive BCPR than Caucasians even after adjusting for variables such as socioeconomic status, BCPR rates in Latinos have not been reported.

**Objective:** To describe BCPR rates in an urban African American and Latino population as compared to Caucasians.

**Methods:** A retrospective analysis of the Cardiac Arrest Resuscitation Evaluation in Los Angeles (CARE-LA) database combined with the California Death Statistical Master File (CDSMF). The combined database included location, race/ethnicity/ethnic background, witnessed status, socioeconomic status, and other variables that have previously been associated with differing rates of BCPR.

**Results:** There were 814 individuals included in the final study group (53% Caucasian, 28% African American, 19% Latino). African Americans and Latinos were younger than the Caucasians, had more events in the home and had a bystander CPR rate of 13% compared to 24% for the Caucasians (OR=0.47 (95%CI: 0.30–0.74) for African Americans and OR=0.48 (95%CI:0.28–0.80) for the Latinos). Bystander CPR was found to be an independent predictor of survival to hospital discharge and, after adjustment, Latino ethnicity was associated with lower rates of bystander CPR (OR 0.45 (95%CI:0.22–0.92)).

**Conclusion:** After adjusting for other variables, Latinos in Los Angeles receive bystander CPR at approximately half the rate of Caucasians. (*Ethn Dis.* 2009;19:401–406)

**Key Words:** CPR, Epidemiology, Resuscitation, Cardiac Arrest

---

From the Department of Emergency Medicine, Keck/USC School of Medicine, Los Angeles, CA (PB, ME, CM, SOH); and the Department of Preventive Medicine Keck/USC School of Medicine, Los Angeles, CA (SOH).

Address correspondence and reprint requests to Sean O. Henderson, MD; Department of Emergency Medicine; LA-

Peter C. Benson, MD; Marc Eckstein, MD; Christian D. McClung, MD, M.Phil(Cantab); Sean O. Henderson, MD

## INTRODUCTION

Between 400,000 to 450,000 people die from sudden cardiac arrest each year in the United States.<sup>1</sup> The incidence of EMS-treated sudden cardiac arrest is estimated to be approximately 50 per 100,000 person-years with a survival of 8.4%.<sup>2</sup> To improve the dismal survival associated with cardiac arrest, the concept of the chain of survival has evolved and one of the early links of this chain is early bystander CPR (BCPR). Most observational studies have associated BCPR with an increased survival from out-of-hospital cardiac arrest (OOHCA), making it an important subject for cardiac arrest research. Herlitz et al demonstrated that lay-person BCPR improved survival to hospital discharge, although less effectively than professional BCPR.<sup>3</sup> Previous research focusing on ethnic or racial disparities has demonstrated that African Americans are less likely to receive BCPR<sup>4–6</sup> but no studies have examined the likelihood that Hispanic/Latinos will receive BCPR. In Los Angeles, California, the Hispanic/Latino population is very large, representing nearly one half of the city's total inhabitants. Furthermore, much of this population is recently immigrated from Mexico or Central America and does not use English as their first language.

In this study, we used a large existing database of OOHCA data previously collected in Los Angeles, California to examine the rate of BCPR in separate ethnicities. We hypothesized that the Latino population would be at-risk for lower rates of BCPR, as they were less likely to have been exposed to

the education and public health efforts directed at US residents. Furthermore, socioeconomic disparities would also likely result in lower BCPR rates.

## METHODS

### Study Design

This study was a secondary analysis of data collected for the CARE-LA study which has been described previously.<sup>7</sup> Briefly, the study was a prospective investigation of OOHCA in Los Angeles County during 12 consecutive months from 2000 to 2001. Data was collected by a full-time study coordinator and included all confirmed cases of nontraumatic OOHCA in patients aged >17 years. The endpoint of interest was survival to hospital discharge neurologically intact. As we were primarily interested in lay-person BCPR, cases of OOHCA occurring in the presence of EMS, in clinics, in dialysis units, jail or the workplace were excluded for the current study cohort.

The current study used the existing CARE-LA database as well as the 2000 and 2001 versions of the California Death Statistical Master File (CDSMF)

---

*We hypothesized that the Latino population would be at-risk for lower rates of BCPR, as they were less likely to have been exposed to the education and public health efforts directed at US residents.*

---

---

C+USC Medical Center; 1200 N. State Street Room 1011; Los Angeles, CA 90033; 213-226-6667; 213-226-8044 (fax); sohender@hsc.usc.edu

to obtain data about race, ethnicity and country of origin by matching for names and date of birth.

Latinos, for the purpose of this study, were those individuals who were classified as being of Latino origin on the 2000 or 2001 CDSMF. In those cases where an individual was categorized as "African American" (Fields 43–45), they were coded as African American regardless of Latino origin. (US Census Bureau, 2000 Census of Population, Public Law 94-171 Redistricting Data File. <http://factfinder.census.gov>.)

From the original database, we submitted those with complete address information to TeleAtlas, a service that gave us the Census Tract Codes for each address. There were 574 unique census tract codes within this batch of 1307 addresses. We entered one representative address per census tract code into the geocoding website to obtain the following fields of data: median family income %, tract population, tract minority %, 2005 estimated median family income, owner-occupied units, % below poverty, # of households, American Indian population, Asian/HI/Pacific Islander population, African American population, Latino population, White population, and other/more than 2 race/ethnicities population. Out of the 574 unique census tract codes, we were unable to obtain geocode information for 34. Due to the fact that some census tract codes had more than one address, we generated a final database containing only those subjects with complete address information and with available geocoding variables.

Statistical analysis was performed using STATA 8.0 software (College Station, Tex.). Proportional differences are reported using two-sample test of proportions without correction for multiple testing. Univariate and multivariate logistical regression analysis were reported separately with corresponding odds ratio and 95% confidence intervals. Known confounding variables are included in the multivariate model regardless of statistical significance, and included age, sex, loca-

tion of the cardiac arrest (home vs public), witnessed cardiac arrest (yes/no), and socioeconomic status (5 levels, 1=highest, 5=lowest).

Racial differences are studied using dummy variables with "White" race/ethnicity as the baseline for comparison because of the frequency of observation. Subjects with "other" racial classification are included in the analysis to determine the likely estimate of effect modification for each variable. Subjects classified as "other" for race/ethnicity are not included in demographic comparisons since this group is heterogeneous and findings cannot be generalized. However, the "other" race/ethnicity group is included in the multivariate model to control for potential confounding. Socioeconomic variables are not those of the individual patient but rather the socioeconomic estimate of the surrounding area where the cardiac arrest occurred. The main outcome of this study is the rate of bystander CPR (BCPR) and therefore the socioeconomic status of the responder is more important than the collapsed patient.

## RESULTS

After combining the original CARE-LA database with the California Master Death Statistical File, 1646 individuals were available for further analysis. We were unable to determine the location of the cardiac arrest event in 399 individuals due to missing or unabstractable EMS ambulance call reports. Of the remaining 1207 subjects, 910 had their event at home or in a public setting.

Table 1 details the demographic information on 814 of these individuals. Fifty three percent were Caucasian, 28% African American and 19% Latino. Latino and African American cardiac arrest victims were younger (mean age of 59.6 years and 64.7 years, respectively) than the Caucasians and had a higher percentage of events at home (86% for

Latinos and 90% for African Americans) when compared to the Caucasians (79%). For both the African American and Latino populations, BCPR was performed in 13% of the cardiac arrests compared to 24% in Caucasians. While return of spontaneous circulation (ROSC) was slightly lower in African Americans, overall survival and CPC score was similar in all three ethnicities studied. Survival to hospital discharge among Latinos was 5%, African Americans 3%, and Caucasians 6%. None of the Latinos had good neurological outcome while only 2% of Caucasians had a good neurological outcome. Latino and African American patients were significantly more likely to collapse in the lower/lowest socioeconomic areas (lowest SES: Latinos 29%, African Americans 46%, Caucasians 10%).

Table 2 details the crude/unadjusted odds ratio for BCPR for each variable and then the adjusted odds ratio controlling for age (continuous), sex, location, and SES. The unadjusted odds ratio for receiving BCPR in Los Angeles for Latinos and African Americans was 0.48 (95% CI:0.28–0.80) and 0.47 (95%CI:0.30–0.74) respectively when compared to Caucasians. We also found a significant trend toward decreasing BCPR with decreasing socioeconomic status. When race/ethnicity, age, sex and socioeconomic status were adjusted for, the Latino population still had an OR of BCPR of 0.46 (95% CI:0.23–0.92) when compared to Caucasians. The odds ratio and confidence interval changed among African American subjects after multivariate adjustments with an OR to 0.67 (95%CI:0.38–1.16).

Overall, BCPR doubled the chance of survival to discharge from the hospital after a cardiac arrest (OR=2.06; 95% CI:1.04–4.07).

## DISCUSSION

Bystander CPR has been described as the second link in the chain of

**Table 1. Demographics of study cohort derived from the CARE-LA database**

	Latino (n=154) n (%)	African-Am (n=225) n (%)	Caucasian (n=435) n (%)
Age mean (SD)	59.6 (18.1)*	64.7 (16.8)*	69.9 (15.5)
Sex n (%)			
Male	109 (71)	138 (61)*	302 (69)
Female	54 (29)	87 (39)	133 (31)
Location n (%)			
Home	133 (86)*	202 (90)*	342 (79)
Public	21 (14)	23 (10)	93 (21)
Initial Rhythm n (%)			
Asystole	62 (40)	94 (42)	169 (39)
VF	52 (34)	55 (24)	131 (30)
PEA	33 (21)	61 (27)	93 (21)
Agonal	6 (4)	15 (7)	38 (9)
VT	1 (1)	0 (0)	4 (1)
Witnessed n (%)			
Yes	61 (40)	81 (36)*	210 (48)
No	93 (60)	144 (64)	225 (52)
Bystander CPR n (%)			
Yes	20 (13)*	29 (13)*	104 (24)
No	134 (87)	196 (87)	331 (76)
ROSC n (%)			
Yes	10 (6)	10 (4)*	38 (9)
No	138 (90)	210 (93)	376 (86)
ROSC w/o ROSV	6 (4)	5 (2)	21 (5)
SES of Arrest Location n (%)			
Highest=1	5 (5)*	9 (5)*	105 (30)
2	19 (19)*	19 (10)*	105 (30)
3	22 (22)	32 (16)	66 (19)
4	24 (24)*	45 (23)*	39 (11)
Lowest=5	28 (29)*	91 (46)*	34 (10)
Outcome n (%)			
Field death	10 (7)	11 (5)	40 (9)
ER death	118 (79)	185 (84)*	311 (73)
ICU death	15 (10)	16 (7)	51 (12)
D/C-home	0 (0)	2 (1)	9 (2)
D/C-other	7 (5)	5 (2)	15 (4)
Cerebral performance category n (%)			
Normal	0 (0)	2 (1)	7 (2)
Moderate disability	2 (1)	2 (1)	6 (1)
Severe disability	1 (1)	2 (1)	4 (1)
Coma	4 (3)	0 (0)	4 (1)
Death	142 (95)	212 (97)	402 (95)

\*  $P < .05$  compared to the Caucasian population.

Other race/ethnicity not listed in this table ( $n=72$ ).

Inclusion criteria: location=public and home, aged >18 years.

Exclusion criteria: EMS witnessed.

ROSC=return of spontaneous circulation, ROSV=return of spontaneous ventilation, SES=socioeconomic status, VF=ventricular fibrillation, PEA – pulseless electrical activity, VT=ventricular tachycardia.

survival for sudden cardiac death. Multiple reports, such as this one, document the value of BCPR but simultaneously highlight the fact that it is performed

with infrequency. A recent article reported on a series of cardiac arrests in Michigan where the majority of cardiac arrests (54.1%) were witnessed by

bystanders that were trained in CPR.<sup>8</sup> Of those subjects trained in CPR, only one third provided BCPR when witnessing the event. With such a low

**Table 2. Crude and adjusted logistic regression analysis of bystander CPR**

	<i>n</i> (%)	Crude-OR	95% CI	Adjusted OR	95% CI
Race/ethnicity ( <i>n</i> =886)					
White	435 (49.1)	1.00	--	1.00	--
African American	154 (17.4)	0.47	0.30, 0.74	0.67	0.38, 1.16
Latino	225 (25.4)	0.48	0.28, 0.80	0.46	0.23, 0.92
Other	72 (8.1)	0.70	0.37, 1.33	1.01	0.49, 2.08
Gender ( <i>n</i> =899)					
Male	600 (66.7)	1.00	--	1.00	--
Female	299 (33.3)	0.74	0.51, 1.07	0.98	0.63, 1.53
SES ( <i>n</i> =710)					
Highest	126 (17.8)	1.00	--	1.00	--
2 ( <i>n</i> =157)	157 (22.1)	1.66	0.96, 2.87	1.80	1.02, 3.15
3 ( <i>n</i> =132)	132 (18.6)	0.62	0.32, 1.18	0.69	0.35, 1.36
4 ( <i>n</i> =125)	125 (17.6)	0.70	0.37, 1.33	0.80	0.40, 1.61
5 ( <i>n</i> =169)	169 (23.8)	0.55	0.29, 1.02	0.68	0.35, 1.36
Trend		0.80	0.70, 0.91	0.86	0.73, 1.00
Witnessed ( <i>n</i> =899)					
No	499 (55.5)	1.00	--	1.00	--
Yes	400 (44.5)	3.19	2.24, 4.54	3.25	2.13, 4.97
Location ( <i>n</i> =899)					
Home	741 (82.4)	1.00	--	1.00	--
Public	158 (17.6)	2.99	2.04, 4.38	1.71	1.07, 2.72
Age, years ( <i>n</i> =899)					
<50	158 (17.6)	1.00	--	1.00	--
50-79	510 (56.6)	1.18	0.75, 1.86	1.00	0.58, 1.74
>80	231 (25.7)	0.79	0.46, 1.36	0.61	0.32, 1.17
Trend		0.99	0.99, 1.00	0.98	0.97, 1.00

95% CI, confidence interval; OR, odds ratio; SES, socioeconomic status. Adjusted odds ratio *n*=701 due to missing data. Adjusted for sex, SES, witnessed, location, and age.

efficiency rate, small educational deficits will be exaggerated in a community such as the Los Angeles Latinos.

Hispanic/Latinos in our cohort were only half as likely to receive BCPR than Caucasians. To our knowledge, this is the first time this disparity has been identified in a Latino population and the reasons for it are unclear. Previous research of CPR has demonstrated that BCPR is more likely to be performed based on a number of different factors, including the sex of the patient, location of collapse, whether or not it was witnessed, racial, and socioeconomic factors of the victim and/or the neighborhood in which it occurs.<sup>5,6,9-11</sup>

A previous study of attitudes and willingness among Australian residents of Queensland demonstrated that fear of disease, visible blood and perceived danger were factors decreasing the

likelihood that they would perform BCPR.<sup>9</sup> However, they were more likely to provide BCPR if they knew the victim, felt the victim would die without CPR, or believed they themselves possessed the necessary skills to perform it. In addition, males, those in a marital or *de facto* relationships, smokers, organ donors, those with recent training in CPR and those who could perceive no barriers were more likely to perform BCPR. However, this study was a telephone-based survey and no information about race/ethnicity of the respondents was provided.

A Swedish review of primarily Caucasian bystander attitudes described feelings of ambivalence, a fear of doing more harm than good, concerned about vomitus in the victim's mouth, repugnance when confronted by death, and a fear of contracting a disease, most

notably HIV, as barriers against performing CPR.<sup>10</sup>

A study from Chicago looked at the subject of racial differences in cardiac arrest and survival between Whites and African Americans. African Americans were significantly less likely to receive BCPR, have a witnessed cardiac arrest, a "favorable" initial rhythm (that is, a non-asystolic rhythm potentially amenable to medical therapy) or survive to hospital admission. Those who did survive to hospital admission were half as likely to survive the hospitalization.<sup>5</sup> When compared to this study, African Americans in Los Angeles received BCPR at a lower rate (13% vs 18% in the Chicago study).

Brookoff et al reviewed more than 1,000 cases of cardiac arrest retrospectively and found that African Americans were less than one half as likely as

---

*Latinos were less likely to receive BCPR when compared to Caucasians, a disparity which persisted despite adjustment for a number of socioeconomic indicators.*

---

Whites to receive BCPR. This difference held true even when the cardiac arrest was witnessed, and whether or not it occurred at home or in a public place.<sup>6</sup> Their conclusion was that the differences they observed might be due to a differential rate of training in CPR and called for special efforts to strengthen this link of the chain of survival among the underserved.

In our study, we found that the lower rates of BCPR seen in the African Americans were less significant after adjustment for age, sex and socioeconomic status. This observation is similar to that reported by Feero et al where low income was associated with cardiac arrest instead of racial associations.<sup>11</sup> On the other hand, we observed that Latino patients had outcomes similar to the African Americans in Brookhoff's study.<sup>6</sup> Latinos were less likely to receive BCPR when compared to Caucasians, a disparity which persisted despite adjustment for a number of socioeconomic indicators. However, unlike Brookhoff's study, we found no difference in BCPR rates when we limited our analysis to only public locations (Latino OR 1.01 [95%CI: 0.26–3.90]; African American OR 1.28 [95% CI 0.34–4.84]). Even though the majority of the cardiac arrest cases studied here occurred in the home where the potential caregiver would have been expected to be acquainted with the victim, the rate of BCPR was dramatically low when compared to the Caucasian population. It is also noteworthy that the differences in BCPR rates were not reflected in survival to

hospital discharge. The high rates of asystole and PEA suggest long ischemia times and may explain these high mortality rates.

Fourteen percent of the United States is Hispanic/Latino and this group is particularly vulnerable to healthcare disparities due to a variety of cultural and linguistic differences that make it challenging to adapt to the US healthcare system, particularly for the recently immigrated. The number of Latinos recently surpassed the African American population, and is expected to comprise 25% of the total US population by 2050.<sup>12</sup> The Hispanic/Latino population is extremely heterogeneous; even the term "Hispanic" is confusing, as it refers to anyone with ancestry in Cuba, the Dominican Republic, Puerto Rico, Spain, Mexico, South or Central America, while "Latino" implies origins in Latin America, which is generally accepted to refer to those with ancestry in Mexico, Central or South America. The 2000 Census of the United States elected to use the term Hispanic/Latino, although the socioeconomic characteristics of a Spanish American who has been in the United States for many generations more closely approximates a European American than that of a recent Mexican American immigrant, leading to difficulty in assessing healthcare disparities.

According to the 2000 census, the city of Los Angeles has a population of 3,694,820 inhabitants, of whom 46.5% are classified as Hispanic/Latino, of which 63.5% are Mexican, 13.9% are Central American, 2% are South American, 1% are Spanish American, and 18% are not specified. In the area of Los Angeles with the highest density of Hispanic/Latinos, nearly 70% of the population does not have a high school education, more than 50% are foreign born, and nearly 90% speak a language other than English (mostly Spanish) at home, and 37% are living below the poverty level.<sup>12,13</sup> When studying Hispanic/Latinos, it is therefore imperative

to understand the specific demographics of the population to assess for generalizability to Hispanic/Latino populations elsewhere in the United States.

Our study demonstrated a significantly decreased rate of BCPR in the Latino and African American population in Los Angeles. After adjustment for age, sex and socioeconomic factors, the BCPR rate among African Americans more closely resembled that of Caucasians while the difference persisted in the Latino community. We were unable to measure the effects of education and language on BCPR. While we know that twice as many African Americans complete high school when compared to Latinos in Los Angeles County, the effect of language is more difficult to assess.<sup>13</sup> We also had a fairly significant decrease in cohort size due to incomplete cardiac arrest location data from the original CARE-LA study, which was not designed to capture this data.

It should be noted that survival for all groups was very low, however the purpose of this study was to examine patterns of BCPR among different ethnic groups; our data points to a significant and persistently lower BCPR rate among Latinos, especially when the cardiac arrest occurred in the home. Like the African Americans reported by Becker et al 12 years ago, race was an independent predictor of BCPR for Latinos in Los Angeles but not for African Americans. The push to target the African American population a decade ago appears to have succeeded and may provide a guide on how to proceed among other disadvantaged populations.

### Limitations

This is a secondary analysis of data collected to determine rates of intact neurologic survival from OOHCA. The study was not primarily designed and/or powered to investigate racial differences in these events. Therefore, this study offers hypothesis-generating conclu-

sions. It is possible that some patients received BCPR that was not recorded on the paramedic run-sheets which could potentially misclassify subjects; however, the occurrence of this would diminish the strength of the results. There is no indication that paramedics were biased in their recording with any particular group.

We evaluated the demographic variables and rate of BCPR among the individuals where geocoding was unavailable ( $n=189$ ). There were no statistically significant differences in receiving BCPR, survival, age, and sex. However, the proportion of Latino patients was higher (30% vs 14%) where geocoding was unavailable. The patients missing geocoding were included in the univariate analysis of ethnicity and similar disparities were observed. Therefore, we do not feel that the omission of these patients from the multivariate analysis introduced a bias of our results.

### Conclusion

Future studies of racial differences in OOHCA would benefit from a prospective study designed to investigate these effects. Such research would require a multicenter study to allow for sufficient data collection of minority populations. It would be beneficial to know both the race of the victim and the witnesses/responders with an opportunity to determine their specific barriers to delivering BCPR. Furthermore,

direct demographic information (ie, education, income, prior CPR training) about both victims and responders may further elucidate additional differences that might explain why BCPR rates vary. However, our experience in Los Angeles suggests that there are racial differences in BCPR rates that cannot be explained by sex, age or socioeconomic factors.

### REFERENCES

- Zheng Z, Croft JB, Giles WH, Mensah GA. Sudden cardiac death in the United States, 1989 to 1998. *Circulation*. 2001;104:2158-2163.
- Rea T, Eisenberg M, Sinibaldi G, White R. Incidence of EMS-treated out-of-hospital cardiac arrest in the United States. *Resuscitation*. 2004;63:17S-24S.
- Herlitz J, Svensson L, Holmberg S, Angquist K, Young M. Efficacy of bystander CPR: Intervention by lay people and by health care professionals. *Resuscitation*. 2005;66:291S-295S.
- Cowie MR, Fahrenbruch CE, Cobb LA, Hallstrom AP. Out-of-hospital cardiac arrest: Racial differences in outcome in Seattle. *Am J Pub Health*. 1993;83:955-959.
- Becker LB, Han BH, Meyer PM, Wright FA, Rhodes KV, Smith DW, Barrett J. Racial differences in the incidence of cardiac arrest and subsequent survival. *NEJM*. 1993;329:600-606.
- Brookoff D, Kellermann AL, Hackman BB, Somes GB, Dobbins P. Do Blacks get bystander cardiopulmonary resuscitation as often as Whites? *Ann Emerg Med*. 1994;24:1147-1150.
- Eckstein M, Stratton S, Chan L. Cardiac Arrest Resuscitation Evaluation in Los Angeles: CARE-LA. *Ann Emerg Med*. 2005;45(5):504S-509S.
- Swor R, Khan I, Domeier R, Honeycutt L, Chu K, Compton S. CPR training and CPR performance: do CPR-trained bystanders perform CPR? *Acad Emerg Med*. 2006;13:596-601.
- Johnston TC, Clark MJ, Dingle GA, Fitzgerald G. Factors influencing Queenslanders' willingness to perform bystander cardiopulmonary resuscitation. *Resuscitation*. 2003;56(1):67-75.
- Axelsson Asa. Bystander cardiopulmonary resuscitation: would they do it again? *J Cardiovasc Nurs*. 2001;1691:15-20.
- Feero S, Hedges JR, Stevens P. Demographics of cardiac arrest: association with residence in a low-income area. *Acad Emerg Med*. 1995;2:74-76.
- Maldonado-Young M. *Hispanic Health Information Outreach: Recommendations for NLM Strategy and Tactics*. Available at : <http://nlnm.gov/evaluation/tools/hispanicoutreach.pdf>. Last accessed August 4, 2009.
- US Census Bureau; *Table 16. Educational Attainment of People 18 Years and Over, by Age, Sex, Race, and Hispanic Origin, for the 15 Largest Metropolitan Areas: March 1999*. September 2000. Available at <http://www.census.gov/population/socdemo/education/p20-528/tab16.txt>. Last accessed August 4, 2009.

### AUTHOR CONTRIBUTIONS

*Design concept of study:* Benson, Eckstein, Henderson  
*Acquisition of data:* Benson, Eckstein, Henderson  
*Data analysis and interpretation:* Benson, Eckstein, McClung, Henderson  
*Manuscript draft:* Benson, Eckstein, McClung, Henderson  
*Statistical expertise:* Benson, McClung  
*Acquisition of funding:* Benson, Eckstein  
*Administrative, technical, or material assistance:* Eckstein, Henderson  
*Supervision:* Henderson