

# Effect of Race and Socioeconomic Status in the Treatment of Appendicitis in Patients With Equal Health Care Access

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**Background:** Lower socioeconomic and minority racial/ethnic status have been linked to delays in surgical care and thus higher appendiceal perforation rates.

**Hypothesis:** Equal access to health care eliminates the previously reported socioeconomic and racial/ethnic disparities in rates of appendiceal perforation.

**Design:** Retrospective cohort study using discharge abstract data and US census data.

**Setting:** Twelve regional Kaiser Permanente hospitals in southern California.

**Patients:** A total of 16 156 patients treated for appendicitis. Patients were divided into low, medium, and high groups based on annual household income and educational level, as well as racial/ethnic status (white, black, Hispanic, and Asian).

**Main Outcome Measures:** Appendiceal perforation (AP) rate and length of hospitalization (LOH).

**Results:** The adjusted odds ratio for AP was lower in Hispanics and similar in blacks and Asians compared with whites. The odds ratio for AP was similar in high- and medium-income families compared with low-income families. The odds ratio for AP was higher in patients with high educational levels and similar in those with medium educational levels compared with low educational levels. The adjusted LOH was longer in blacks, shorter in Hispanics, and similar in Asians compared with whites. The LOH was similar in high- and medium-income families compared with low-income families. The LOH was higher in patients with medium educational levels and similar in those with high educational levels compared with low educational levels.

**Conclusions:** Lower socioeconomic background and minority race/ethnicity did not correlate with higher AP rates or a clinically longer LOH in patients with equal access to care. Based on these findings, we believe that equal health care access leads to equivalent outcomes in all patients with appendicitis.

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**S**URGICAL EMERGENCIES MAY reflect the effectiveness of readily available access to care because delays in the treatment of such emergencies often lead to worse outcomes. Acute appendicitis has a fairly consistent time-dependent history of progression, and any

## See Invited Critique at end of article

delay in diagnosis or treatment increases the risk of perforation. Appendiceal perforation (AP) is associated with increased morbidity and length of hospitalization (LOH). Because delay in care is a major determinant of rupture, AP rates have been used as a marker for access to surgical care. Previous studies have shown that racial/ethnic minorities have in-

creased AP rates compared with whites.<sup>1-5</sup> Furthermore, patients with no insurance or public insurance also have increased AP rates compared with patients with private insurance.<sup>1-7</sup> These findings suggest that race/ethnicity as well as lower socioeconomic status are associated with impaired access to surgical care.

The status of health care coverage in the United States continues to be an area of debate. With increasing health care expense and the increasing number of uninsured Americans, many people believe that the current health care system in the country needs reform.<sup>8-10</sup> Some suggest that a universal coverage choice as practiced by all other developed countries is needed. Others propose a government-sponsored program for the uninsured to provide health care coverage to all Americans. The effect of such a system in the United States is not known, especially with respect to access-

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ing elective and emergency care. The purpose of this study was to determine whether the previously documented racial/ethnic and socioeconomic disparities in outcomes of appendicitis are eliminated in a health care system with equal access to medical care.

## METHODS

Following approval by the institutional review board, the Southern California Kaiser Permanente Discharge Abstract Database was reviewed to identify patients (aged  $\geq 18$  years) with a diagnosis of appendicitis (*International Classification of Diseases, Ninth Revision* codes 540.0, 540.1, and 540.9<sup>11</sup>) between January 1, 1998, and December 31, 2007.

Southern California Kaiser Permanente consists of 12 medical centers and provides comprehensive medical care to more than 3½ million members. All physicians on staff at these medical centers belong to the Southern California Permanente Medical Group and practice exclusively at Kaiser Permanente facilities. All members have equal access to any of the Kaiser Permanente clinics, emergency departments, or medical centers. Study outcomes were AP rate and LOH. Independent variables included age, sex, race/ethnic group, annual median household income, and educational level. Racial/ethnic information was obtained from the Permanente Discharge Abstract Database, and patients were categorized as white, black, Hispanic, Asian, Native American, other, multiracial, or unknown. White patients served as the reference group in the multivariate analysis. Patients in the other, multiracial, unknown, or Native American categories were excluded from this study. Median household income was based on the patient's zip code of residence and extracted from the US Census Bureau database.<sup>9</sup> Patients were separated into 3 groups based on annual median household income: low (<\$40 000), medium (\$40 000-\$65 000), or high (>\$65 000). Patients in the low-income group were used as the reference group in the multivariate analysis. Household educational level was also based on the patient's zip code of residence and extracted from the US Census Bureau database. Patients were separated into 3 groups based on the percentage of households with a high school diploma or higher degree: low (<50%), medium (50%-75%), or high (>75%). Patients in the low educational level group were used as the reference group in the multivariate analysis. Patients residing in zip codes outside of California or zip codes with no census data were excluded.

Data from the Southern California Kaiser Permanente Discharge Abstract Database were exported to SAS version 9.13 (SAS Institute, Inc, Cary, North Carolina) statistical software for subsequent analysis. Statistical significance was determined using Wilcoxon rank sum test,  $\chi^2$  analysis, and multivariate linear and logistic regression.  $P < .01$  was considered statistically significant.

## RESULTS

A total of 17 386 patients were initially identified with the appropriate *International Classification of Diseases, Ninth Revision* code.<sup>11</sup> The following patients were excluded: no sex stated ( $n=2$ ); race categorized as unknown, other, multiple, or Native American ( $n=834$ ); resided outside of California ( $n=85$ ); and no census data on zip code available ( $n=309$ ); thus, 16 156 patients were included in the analysis.

The mean (SD) age was 40.9 (15.9) years (median, 38.0; range, 18.0-99.0) and 54.5% of the patients were male. Overall LOH was 5.1 (3.1) days for AP and 1.8 (1.7)

**Table 1. Unadjusted Analysis of AP Rate With Respect to Sex, Age, Race, Household Income, and Household Educational Level**

Characteristic	AP Rate, %	P Value <sup>a</sup>
Sex		
Female (n=7390)	27	.005
Male (n=8806)	29	
Age, y		
18-39 (n=9438)	19	<.001
40-65 (n=5877)	34	
>65 (n=1197)	51	
Race		
White (n=6477)	32	.002
Black (n=1107)	29	
Hispanic (n=7312)	24	
Asian (n=1300)	28	
Annual median household income, \$		
Low, <40 000 (n=4299)	25	<.001
Medium, 40 000-65 000 (n=6606)	28	
High, >65 000 (n=5291)	29	
Household educational level		
Low, <50% (n=2915)	23	.29
Medium, 50%-75% (n=4805)	27	
High, >75% (n=8476)	30	

Abbreviation: AP, appendiceal perforation.

<sup>a</sup>  $P < .01$  was considered significant.

days for nonperforated appendicitis ( $P < .001$ ). The unadjusted analysis of AP rate with respect to sex and age is summarized in **Table 1**. Women had a lower AP rate (27% vs 29%;  $P = .005$ ). Older patients (>65 years) had a higher AP rate ( $P < .001$ ). Multivariate analysis confirmed that the AP rate was lower in women. The adjusted odds ratio (OR) (95% confidence interval [CI]) for AP was higher for patients older than 65 years (OR, 4.14; 95% CI, 3.68-4.66) and for patients between 40 and 65 years (OR, 2.01; 95% CI, 1.92-2.23) compared with patients between 18 and 39 years (**Table 2**). The unadjusted analysis of LOH with respect to sex and age is summarized in **Table 3**. Sex did not affect LOH. Patients older than 65 years and those between 40 and 65 years had a longer LOH. Multivariate linear regression confirmed these findings (**Table 4**).

The unadjusted analysis of AP rate with respect to race/ethnicity, household income, and household educational level is summarized in Table 1. Whites had the highest AP rate and Hispanics had the lowest AP rate. Patients from the low-income group had the lowest AP rate, whereas household educational level did not affect the AP rate. The adjusted analysis of AP rate with respect to race/ethnicity, household income, and household educational level is summarized in Table 2. The adjusted OR for AP was similar in blacks (OR, 1.00; 95% CI, 0.86-1.16) and Asians (OR, 0.87; 95% CI, 0.76-1.00) compared with whites. Hispanics (OR, 0.89; 95% CI, 0.82-0.97) had a lower adjusted OR compared with whites. The adjusted OR for AP was similar in patients from high- (OR, 0.95; 95% CI, 0.85-1.07) and medium-income (OR, 1.02; 95% CI, 0.92-1.12) families compared with low-income families. The adjusted OR for AP was higher in patients with high (OR, 1.20; 95% CI, 1.05-1.36) and similar in patients with medium (OR, 1.15; 95% CI, 1.03-

**Table 2. Multivariate Analysis of Appendiceal Perforation Rate Adjusting for Sex, Age, Race, Household Income, and Household Educational Level**

Characteristic	Adjusted OR (95% CI)	P Value <sup>a</sup>
Sex		
Female (n=7390)	1.00 [Reference]	...
Male (n=8806)	1.16 (1.08-1.25)	<.001
Age, y		
18-39 (n=8531)	1.00 [Reference]	...
40-65 (n=3982)	2.01 (1.92-2.23)	<.001
>65 (n=1510)	4.14 (3.68-4.66)	<.001
Race		
White (n=6477)	1.00 [Reference]	...
Black (n=1107)	1.00 (0.86-1.16)	.99
Hispanic (n=7312)	0.89 (0.82-0.97)	.01
Asian (n=1300)	0.87 (0.76-1.00)	.05
Annual median household income, \$		
Low, <40 000 (n=4299)	1.00 [Reference]	...
Medium, 40 000-65 000 (n=6606)	1.02 (0.92-1.12)	.68
High, >65 000 (n=5291)	0.95 (0.85-1.07)	.41
Household educational level		
Low, <50% (n=2915)	1.00 [Reference]	...
Medium, 50%-75% (n=4805)	1.15 (1.03-1.29)	.02
High, >75% (n=8476)	1.20 (1.05-1.36)	.007

Abbreviations: CI, confidence interval; OR, odds ratio.  
<sup>a</sup>P<.01 was considered significant.

1.29) household educational levels compared with patients with low household educational levels.

The unadjusted analysis of LOH with respect to race/ethnicity, household income, and household educational level is summarized in Table 3. The mean (SD) LOH was longest in blacks (3.5 [3.3] days) and shortest in Hispanics (2.4 [2.3] days). Length of hospitalization was shortest in patients from low-income households: high (2.8 [2.7] days), medium (2.7 [2.6] days), and low (2.5 [2.5] days) ( $P < .001$ ). Length of hospitalization was also shortest in patients with low household educational levels: high (2.8 [2.7] days), medium (2.7 [2.6] days), and low (2.4 [2.3] days) ( $P < .001$ ). The adjusted analysis of LOH with respect to race/ethnicity, household income, and household educational level is summarized in Table 4. The adjusted LOH was longer in blacks compared with whites ( $P < .001$ ). The adjusted LOH was lower in Hispanics compared with whites ( $P < .001$ ). Household income levels did not affect adjusted LOH. Finally, patients with medium household educational levels had a longer LOH compared with patients with low household educational levels ( $P = .01$ ).

#### COMMENT

Acute appendicitis is a time-sensitive condition. Once appendicitis develops, any delay in treatment increases the risk of perforation and its associated morbidity and longer LOH. Thus, any barriers to seeking or obtaining medical care for patients with appendicitis will lead to higher AP rates. For this reason, AP rates have been used as a marker for access to surgical care. Previous studies have shown that racial/ethnic minorities and patients with public insurance have higher AP rates, reflecting decreased access to care compared with whites and patients with private insurance.<sup>1-7</sup> Given the timeline outlined in *Healthy People*

**Table 3. Unadjusted Analysis of LOH With Respect to Sex, Age, Race, Household Income, and Household Educational Level**

Characteristic	LOH, Mean (SD), d	P Value <sup>a</sup>
Sex		
Female (n=7390)	2.7 (2.5)	.18
Male (n=8806)	2.7 (2.7)	
Age, y		
18-39 (n=8531)	2.1 (2.1)	<.001
40-65 (n=3982)	3.0 (2.8)	
>65 (n=1510)	4.6 (3.4)	
Race		
White (n=6477)	2.9 (2.8)	<.001
Black (n=1107)	3.5 (3.3)	
Hispanic (n=7312)	2.4 (2.3)	
Asian (n=1300)	2.7 (2.5)	
Annual median household income, \$		
Low, <40 000 (n=4299)	2.5 (2.5)	<.001
Medium, 40 000-65 000 (n=6606)	2.7 (2.6)	
High, >65 000 (n=5291)	2.8 (2.7)	
Household educational level		
Low, <50% (n=2915)	2.4 (2.3)	<.001
Medium, 50%-75% (n=4805)	2.7 (2.6)	
High, >75% (n=8476)	2.8 (2.7)	

Abbreviation: LOH, length of hospitalization.  
<sup>a</sup>P<.01 was considered significant.

2010<sup>12</sup> to eliminate health disparities in the United States as well as the current debate on health care reform, the present study addressed a number of important topics related to surgical care access in the current US health care system. The purpose of this study was to highlight whether racial/ethnic and socioeconomic disparities in appendicitis outcomes persist in a health care system with equal access to care. Currently, Kaiser Permanente is the health care provider that most resembles a single payer/provider system. This study focused on southern California, where Kaiser Permanente provides care to more than 1% of the US population. All members have equal access to any of the Kaiser Permanente clinics, emergency departments, or medical centers. Being part of this system gave us the unique opportunity to determine AP rates based on racial/ethnic background, household income, and educational level while controlling for health care access.

For this study, it was assumed that acute appendicitis develops and progresses at the same rate in all individuals. Any delay in surgical care resulting in higher AP rates can be due to a number of factors. First, the patient must report pain. Next, the patient must recognize the urgency of the condition relative to other illnesses and seek medical attention. For this step, patients must have readily available access to health care. Finally, the correct diagnosis must be made and the treatment must be appropriate and prompt. For this study, we mainly focused on these 3 steps as causes for treatment delay leading to a higher AP rate since previous studies have shown that there is little or no delay between correct diagnosis and appendectomy.<sup>13,14</sup> We will address cultural and socioeconomic differences as well as potential areas in which changes in health care policy may decrease the delay in treatment.

The first step in potential delay in care involves the patient's ability to report pain. It is for this reason that young children have a higher AP rate.<sup>2,13,15</sup> This study also showed that elderly patients had a higher risk of AP; the rate in patients older than 65 years was 51%, which was more than twice that of patients between 18 and 39 years. As with the very young group, elderly patients may also have difficulty communicating their symptoms, thus delaying treatment. Furthermore, elderly patients may not have readily available family members or others to bring them to medical care. Whatever the etiology for this finding, it is uncertain whether there are any racial/ethnic, cultural, or socioeconomic differences that would affect this factor, leading to a lower AP rate in elderly patients. It is also unlikely that any change in health care policy would decrease this delay in care.

The next step involves the ability of patients to recognize the urgency of their condition. This step could be affected by socioeconomic status or educational level. With regard to socioeconomic status, theoretically, patients of low-income families may not choose to miss work and lose wages in order to seek medical attention. Furthermore, patients of lower income levels may delay seeking care for fear of economic ruin due to medical bills. Previous studies have shown that children and adults residing in lower-income zip codes have a higher AP rate.<sup>1,4,6</sup> Conversely, our study showed that equal access to care eliminated this socioeconomic disparity. The adjusted OR for AP was similar in medium- and high-income families compared with low-income families. Educational level had little effect on AP rate. Patients with the highest educational level actually had the highest AP rate. Again, it is unlikely that any racial/ethnic or cultural differences exist that would affect this factor, as confirmed by the AP rates across all racial/ethnic groups in our study. There may be a delay due to economic differences because patients from low-income households may choose to not miss work, resulting in a delay in care; however, this theory was not supported by the findings of this study. Finally, changes in health care policy may be able to decrease this delay in care. Patients with easy access to care may be more apt to seek care even if they are uncertain about the urgency of their condition. A previous study in a region with a well-developed primary care network showed no socioeconomic difference in the AP rate, presumably due to the readily available access to care.<sup>16</sup> Furthermore, our study showed that in a system with equal access to care, the previously shown socioeconomic disparities in appendicitis outcomes are eliminated.

The third step to possibly delay surgical care is the ability to access health care. Potential delays in this step may involve multiple factors, including geographic barriers as well as readily available access to professional medical care. It has been shown that geographic barriers are associated with increased AP rate despite universal health care.<sup>17</sup> In that Canadian study, poor access to and delay of treatment were related to the distance and extreme weather limiting transportation to health care. Although this reason for delay is important, it is unlikely that changes in health care policy will lessen this problem. The area in which health care policy may

**Table 4. Multivariate Analysis of Length of Hospitalization Adjusted for Sex, Age, Race, per Capita Income, and Household Educational Level**

Characteristic	Adjusted PE (95% CI)	P Value <sup>a</sup>
Sex		
Female (n=7390)	1.00 [Reference]	...
Male (n=8806)	0.12 (0.00 to 0.04)	.20
Age, y		
18-39 (n=8531)	1.00 [Reference]	...
40-65 (n=3982)	0.84 (0.76 to 0.92)	<.001
>65 (n=1510)	2.41 (2.27 to 2.55)	<.001
Race		
White (n=6477)	1.00 [Reference]	...
Black (n=1107)	0.70 (0.54 to 0.86)	<.001
Hispanic (n=7312)	-0.16 (-0.26 to -0.07)	<.001
Asian (n=1300)	-0.17 (-.32 to -0.02)	.02
Annual median household income, \$		
Low, <40 000 (n=4299)	1.00 [Reference]	...
Medium, 40 000-65 000 (n=6606)	0.10 (-0.01 to 0.20)	.06
High, >65 000 (n=5291)	0.01 (-0.11 to 0.14)	.85
Household educational level		
Low, <50% (n=2915)	1.00 [Reference]	...
Medium, 50%-75% (n=4805)	0.18 (0.00 to 0.05)	.005
High, >75% (n=8476)	0.08 (-0.05 to 0.22)	.23

Abbreviations: CI, confidence interval; PE, parameter estimate.

<sup>a</sup> P<.01 was considered significant.

affect disparities in care is avoidance of unnecessary delay in seeing health care providers due to lack of insurance or fear of consequences due to immigration status. Studies<sup>1-7,18-23</sup> continue to demonstrate these racial/ethnic disparities in health care not only with respect to appendicitis outcomes but also in an array of other clinical arenas. Our study, on the other hand, showed that equal access to care eliminated racial/ethnic and socioeconomic disparities in the AP rate. The AP rate was similar across all racial/ethnic groups and all levels of household income.

We also looked at the relationship between race/ethnicity and socioeconomic status with respect to LOH. We wanted to see whether there were any cultural, economic, or educational level differences that affected patients being discharged from the hospital. We found that black patients had a longer LOH—more than a half a day longer than whites, Hispanics, and Asians. We also found that LOH was similar across all income levels. We assume that all postadmission factors were similar in all patients, namely, time to diagnosis and operation; thus, this finding of longer LOH in blacks may be due to a cultural difference and therefore unlikely to be affected by changes in health care policy. Rather, local changes to improve discharge planning may be required to minimize the LOH in all patients.

Our study is limited for a number of reasons. Our data come from a discharge database, and the *International Classification of Diseases, Ninth Revision*<sup>11</sup> coding of each diagnosis and procedure was not independently validated. Thus, we cannot obtain negative appendectomy rates from this database and cannot determine the duration of symptoms prior to admission. We also based income status and educational level on the patient's zip code of residence. Although this is commonly used in health care research, there is always a bias risk of using

aggregate data instead of individual-level measurements. However, previous studies<sup>24</sup> have shown that aggregate statistics from a census block group is a useful proxy for individual-level measures. The racial/ethnic diversity in this study may not reflect the population in most other areas of the country. However, the racial/ethnic demographics seen in this study closely resembles those of Los Angeles County and California as a whole.<sup>25</sup> Our study population was also located in an area where patients were not too far from medical care. Our study group was limited to adults. Previous studies<sup>2-5</sup> have shown both racial/ethnic and socioeconomic disparities in the AP rates in children. However, we chose not to include children because we believe that reasons for delays in care in the pediatric population may be significantly different from delays in adults. Thus, by including children, we might have compared 2 very different patient populations in the same analysis. Furthermore, a separate study including only children is nearly complete. Another potential limitation is the income level breakdown. The low-income group (<\$40 000) was approximated by doubling the poverty threshold level.<sup>26,27</sup> We chose the middle-income group (\$40 000-\$65 000) based on the annual median household income of Los Angeles County (\$53 494) and California (\$59 928). The final income levels were then determined by creating roughly 3 equal groups of patients. However, the lowest socioeconomic level (unemployed, uninsured, or publicly insured patients) was not specifically addressed in this study because all Kaiser Permanente members have health insurance and the majority of the members are employed. However, this last limitation is also unique to this study since the purpose for our review was to determine whether previously demonstrated socioeconomic disparities in AP rates are eliminated when all patients have equal access to care. In addition, we are currently reviewing outcomes of appendicitis at a large county hospital to gain a better understanding of this lowest socioeconomic level group.

Overall, the findings of this study demonstrated that lower socioeconomic background and minority racial/ethnic status did not correlate with higher AP rates in patients with equal access to health care. Income and educational levels had no effect on LOH, whereas minority racial/ethnic status did not consistently correlate with longer LOH. Length of hospitalization was longest in black patients and shortest in Hispanic patients. This finding may be due to a cultural difference and may not be influenced by changes in health care policy. These data suggest that the previously reported socioeconomic and racial/ethnic disparities in appendicitis outcomes are preventable in a health care system with equal access. Finally, this report should be useful to health care policymakers in their work to close the existing racial/ethnic and socioeconomic health disparity gap.

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## INVITED CRITIQUE

# Health Care Reform and Access

## Will It Work?

The article by Lee and colleagues hypothesizes that universal health insurance coverage for their patient population eliminates racial and socioeconomic disparities in access to care. In the current debate on health care reform, this is an important topic since the findings in this article might be extrapolated to suggest that universal coverage of the US population may have significant, demonstrable health care and cost benefits. One must be careful, however, in taking the conclusions of this article too far; further research, which the authors are conducting, is needed. The annual median household incomes examined may not be separated enough to determine any real differences in the defined groups because people at the income levels chosen may face similar problems with loss of income from time off their jobs, as addressed in the article. In southern California where the cost of living is one of the highest in the United States, the income levels may not adequately reflect differences in a family's access to outside resources when coping with a sick family member. The study is limited in that it deals only with adults and it is not clear whether the same findings will be noted in chil-

dren. In addition, it is not clear whether the Kaiser Permanente patient population base in southern California can be extrapolated to be used as a surrogate for the entire US population. Recognition of these limitations, however, does not minimize the potential importance of this article. If further study substantiates the findings, this will add evidence that universal coverage and health care reform are not only beneficial for society but may also be associated with health care cost savings by dealing with illness early in its course rather than later when it has become more difficult, complex, and costly to treat.

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