Colon Cancer Survival in California from 2004-2011 by Stage at Diagnosis, Sex, Race/Ethnicity, and Socioeconomic Status

Samee A. Hameed[a,b], Isabelle S. Kusters, PhD MPH[c,d], Mashfee Khan, MD[b], Melissa Matz, PhD[a]

[a] London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK; [2] University of Texas Medical Branch, 301 University Blvd. Galveston, TX 77550, USA; [3] Department of Clinical, Health, and Applied Sciences, University of Houston-Clear Lake, 2700 Bay Area Blvd. Houston, TX 77058, USA; [4] Center for Medical Ethics and Health Policy, Baylor College of Medicine, 1 Baylor Plaza, Houston, TX 77030, USA

Corresponding Author:

Samee A. Hameed

2207 Gleneagles Drive, League City, TX 77573

samee.hameed94@gmail.com

sahameed@utmb.edu

samee.hameed1@student.lshtm.ac.uk

Word Counts

Abstract: 249

Manuscript: 3200

Highlights: 47

Abstract:

Background:

Disparities in cancer survival exist between groups. This study aims to examine these disparities between stage-, sex-, race/ethnicity-, and socioeconomic-specific colon cancer net survival in California for adults diagnosed between 2004 and 2011.

Methods:

We estimated age-standardized net survival using the Pohar Perme estimator for colon cancer by stage at diagnosis (localized, regional, and distant), sex, race/ethnicity (Non-Hispanic White, Non-Hispanic Black, and Hispanic), and socioeconomic status (SES). Data from the Surveillance, Epidemiology, and End Results database on adults diagnosed with malignant colon cancer during 2004-2011 in California were included (n=78,285). County-level SES was approximated quintile grouping usng the Federal Poverty Level.

Results:

Five-year survival for all included adults was 66.0% (95% CI: 65.6%-66.4%). The difference between Non-Hispanic White (White) adults and Non-Hispanic Black (Black) adults was 9.3%, and between White adults and Hispanic adults was 3.4%. A higher proportion of Black (24.5%) and Hispanic (21.4%) adults were diagnosed with distant disease compared to White adults (19.4%). Differences in sex-specific survival were minimal, with only differences in Hispanic men (62.0% [60.5%-63.4%]) and women (65.9% [64.4%-67.3%]). SES differences were largest between the lowest quintile 63.0% (62.3%-65.2%) and the highest quintile 67.8% (66.8%-68.8%). SES-, stage-, and race/ethnicity-stratified analysis demonstrated improving trends for White adults with localized and regional disease, and Hispanic adults with regional disease.

Conclusion:

Colon cancer survival in California is lower for Black and Hispanic adults than White adults in all three categories: stage, sex, and SES. Suggesting the need for improved health policy for Hispanic and Black adults.

Keywords: Colonic Neoplasms; Race; Socioeconomic Factors; Social Class; Survival Analysis

Total Pages: 23

Total Tables: 5

Total Figures: 2

Total Supporting Tables: 1

Total Supporting Figures: 1

1. INTRODUCTION:

Excluding skin cancers, colon cancer ranks third in the United States in annual incidence for both men and women.[1] Since 1996, the United States Preventative Services Taskforce (USPSTF) has recommended colon cancer screening for those aged 50 to 75 years.[2,3] These screening guidelines have led to the earlier detection of tumors, which are often early stage and easier to treat.[4,5] Thus, the guidelines have helped improve survival since the mid-1990s.[6-8]

However, this improvement in survival has been noted to be unequal between different population groups. In the United States from 2004-2009, the absolute difference in five-year survival between Blacks and Whites was 8.8%, with Whites having higher survival. In California, for the same time period, a similar difference in five-year survival (9.5%) was also observed between these two groups. Distributions of stage at diagnosis were also unequal, with many Blacks being diagnosed at a later stage, compared to Whites.[9,10]

Health insurance plays a crucial role in providing patients with access to regular screening opportunities and a more usual source of care.[11,12] In 2006-2011, approximately 17.1% of the U.S. population and 20.3% of Californians were uninsured.[13] Those of lower socioeconomic status (SES) are more commonly uninsured, lack usual sources of care, and have worse health outcomes.[14,15] Additionally, Blacks are more often uninsured than Whites, resulting in differences in access to screening and a usual source of care.[16] Therefore, it is important to consider the SES-specific survival for these groups, to help delineate potential explanations for the observed differences.

Currently, there is a lack of evidence in the literature on the impact of stage, sex, race/ethnicity, and SES collectively – especially using differences in five-year

survival outcomes – for colon cancer. The aim of this paper is to evaluate the age-standardized, stage-, sex-, race-, and SES-specific net survival of patients diagnosed with colon cancer in California between 2004-2011. The goal of this research is to influence policy as a way to improve survival outcomes between groups that have worse outcomes.

2. MATERIALS AND METHODS:

2.1 DATA SOURCES:

Data was obtained from the Surveillance, Epidemiology, and End Results (SEER) database, using SEER*Stat Software 8.3.6.1. From the SEER 18 November 2018 submission, we selected colon cancer patients in California diagnosed during 2004-2011.[17] The definition of colon cancer used for this study was defined by the International Classification of Diseases for Oncology codes C180-C189;C260.[18] Data on 78,285 incident colon cancers in California for men and women aged 15-99 years were available. All primary, malignant colon cancers that were microscopically confirmed were included. Additionally, patients who had a previous malignancy but were diagnosed with a primary colon cancer during the years 2004-2011 were also included in the analysis. However, if a patient had two primary colon cancers in that time, only the first was included in the analysis. Patients who had missing follow-up details, invalid years of death or diagnosis, or other missing data were excluded. Additionally, all included patients had a full five years of follow-up data until December 31, 2016.

To conduct a stage-specific survival estimate, the SEER Summary Stage 2000 was used. Colon cancer cases were categorized into three general stages: "Localized", "Regional", and "Distant",[19] enabling a more robust subgroup analysis.

Race/ethnicity was also included and classified into three groups: "Non-Hispanic White" (White), "Non-Hispanic Black" (Black), and "Hispanic (all races)" (Hispanic).

To estimate population-level SES, United States Census Small Area Income Poverty Estimates Program (SAIPE) data were used to determine the total percentage of people living below the Federal Poverty Level (FPL) in 2011 in each county.[20] Based on the SAIPE model methodology, a single year estimate was used, to avoid using averages of averages for counties less than 65,000 people.[21] The 58 counties in California were then grouped into five quintiles based on their poverty estimates, with Q1 representing the lowest SES, or largest percentage of individuals under the FPL, and Q5 representing the highest SES, or the smallest percentage of people under the FPL.

2.2 STATISTICAL METHODS:

We estimated net survival using the Pohar Perme estimator for all patients diagnosed in California between 2004-2011. One-, two-, three-, four- and five-year survival was estimated by sex, race/ethnicity, stage at diagnosis, and SES. Net survival was used because it reflects the probability that a cancer patient will survive their cancer up to a given point after diagnosis while correcting for competing causes of death, or the background mortality.[22] To further control for differences in background all-cause mortality for the different groups, SES/geography/race-specific life tables included in the SEER*Stat software were used. We estimated survival for the 15-44, 45-54, 55-64, 65-75, and 75+ year age groups. Age-standardization was performed using the International Cancer Survival Standard 1 (ICSS1) weights, and pooled estimates were reported after standardization.[23] Lastly, a cohort approach was used to estimate net survival as all patients included in the analysis had a full five years of follow up.[24]

3. RESULTS:

A total of 78,285 new diagnoses of colon cancer occurred in California during 2004-2011. Of all adults included in the analyses, 63.2% (N=49,451) were White, 8.2% (N=6,445) were Black, and 16.0% (N=12,509) were Hispanic (Table 1). White adults had the highest percentage of localized disease (40.8%) and the lowest percentage of distant disease (19.4%). Black adults were found to have the lowest percentage of localized (37.4%) and regional (34.9%) disease. Black adults also had the highest percentage distant stage tumors (24.5%). The highest percentage of regional disease was seen in Hispanic adults (38.3%). The largest difference between stage proportions was seen for distant stage disease between White and Black adults, with an absolute difference of 5.1%.

Stage	All Races	Non-Hispanic White	Non-Hispanic Black	Hispanic
Localized (%)	31,044 (39.7)	20,154 (40.8)	2,410 (37.4)	4,688 (37.5)
Regional (%)	29,269 (37.4)	18,397 (37.2)	2,250 (34.9)	4,797 (38.3)
Distant (%)	15,740 (20.1)	9,580 (19.4)	1,579 (24.5)	2,676 (21.4)
Total Patients	78,285*	49,451*	6,445*	12,509*

Table 1

Number of patients diagnosed with colon cancer in California during the years 2004-2011 and distribution based on SEER Stage and race/ethnicity.

* Cumulative totals of the different stages will not be equivalent to the row titled "Total Patients", as some patients are not diagnosed with a stageable disease and are therefore not included in the different stages but are still included in other analyses for survival.

One-, three-, and five-year survival for all adults diagnosed with colon cancer in the state of California was 84.2% (95% CI: 83.9%-84.5%), 72.1% (71.7%-72.5%), and 66.0% (65.6%-66.4%), respectively (Figure 1). Black adults had the lowest survival, among the races/ethnicities included in this analysis, with a five-year

survival of 58.0% (56.5%-59.5%). Hispanic adults had higher survival than Black adults with a five-year survival of 63.9% (62.8%-64.9%). The highest survival was observed in White adults with a five-year survival of 67.3% (66.7%-67.8%). The same pattern in five-year survival between the different races/ethnicities is also seen in one-year and three-year survival, with Black adults having the least favorable outcomes and White adults having the most favorable. The absolute differences in five-year survival between White and Black adults, and White and Hispanic adults were 9.3% and 3.4%, respectively.
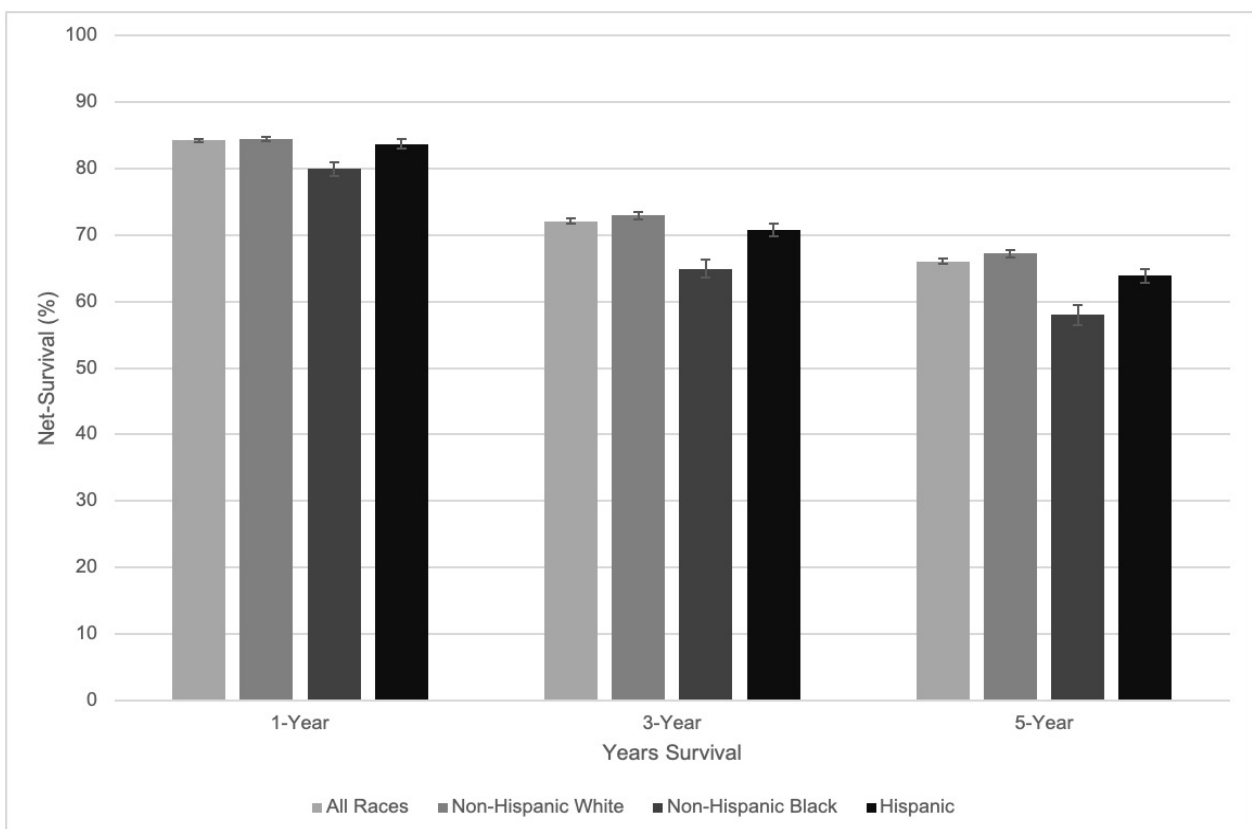

Figure 1

Age-standardized one-, three-, and five-year net survival for patients diagnosed with colon cancer in California during the years 2004-2011 by race/ethnicity. 95% confidence intervals are reported on the figure.

When examining survival differences between men and women, very little difference was found (Table 2). Differences in survival for White men and women, and Black men and women ranged between 0.3% and 1.1% with overlapping Confidence Intervals for each estimate. However, for Hispanic adults, the difference between men and women ranged from 2.1% to 3.9%, with non-overlapping Confidence Intervals for each survival estimate. The gap between one-, three-, and five-year survival for Hispanic men and women widened as time since diagnosis increased. Additionally, stage distribution for Hispanic males and females had similar proportions (Supplemental Table 1).

	Men								Women							
	All Races		Non-Hispanic White		Non-Hispanic Black		Hispanic		All Races		Non-Hispanic White		Non-Hispanic Black		Hispanic	
Years	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI
1	83.8	83.4-84.2	84.2	83.7-84.7	79.4	77.8-80.9	82.7	81.7-83.7	84.6	84.2-85.0	84.7	84.2-85.1	80.5	79.0-81.8	84.8	83.8-85.8
3	71.7	71.1-72.2	72.7	72.0-73.3	64.6	62.6-66.6	69.2	67.9-70.4	72.5	72.0-73.0	73.0	72.4-73.7	65.2	63.4-67.0	72.5	71.2-73.8
5	65.3	64.7-65.9	66.7	65.9-67.5	57.7	55.5-59.9	62.0	60.5-63.4	66.7	66.1-67.3	67.7	67.0-68.5	58.1	56.0-60.1	65.9	64.4-67.3

Table 2

Age-standardized one-, three-, and five-year net survival for patients diagnosed with colon cancer in California during the years 2004-2011 separated by race/ethnicity and sex.

	All Races		Non-Hispanic White		Non-Hispanic Black		Hispanic	
Stage	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI
Localized	90.5	90.0-91.1	91.2	90.5-91.9	86.6	84.2-88.6	88.7	87.1-90.0
Regional	71.1	70.4-71.8	72.3	71.4-73.1	63.4	60.7-65.9	68.6	67.0-70.2
Distant	14.2	13.6-14.8	14.9	14.1-15.6	10.3	8.7-11.9	14.3	12.9-15.8

Table 3

Five-year age-standardized net survival for patients diagnosed with colon cancer in California during the years 2004-2011 by SEER stage and race/ethnicity.

Five-year net survival estimates for the different stages show that White

adults had the highest survival among the races/ethnicities at each stage at

diagnosis (Table 3). The absolute difference between Hispanic and White adults was

larger for localized (2.5%) and regional stages (3.7%), than for distant stage (0.6%).

However, the difference between White and Black adults was substantially wider for

regional (8.9%) stage than for localized (4.6%) and distant stages (4.6%). Widening

of the stage-stratified survival gaps between White adults and the other

races/ethnicities were primarily observed when examining regional stage disease,

with smaller gaps in survival noted for localized and distant disease.

As the county SES quintile increased, indicating reduced percentage under

the FPL, the one-, three-, and five-year survival also increased (Table 4). A steady

increase in survival was observed for one-, three- and five-year survival. The

absolute differences between the Q1 and Q5 for one-, three-, and five-year survival

were 4.7%, 4.9%, and 4.8%, respectively.

	Q1		Q2		Q3		Q4		Q5	
Years	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI
1	81.5	81.7-83.6	83.1	82.6-83.6	84.2	83.6-84.7	85.2	84.5-85.8	86.2	85.6-86.8
3	69.3	68.9-71.5	70.9	70.3-71.5	72.0	71.3-72.8	73.4	72.5-74.3	74.2	73.3-75.0
5	63.0	62.3-65.2	64.9	64.1-65.6	66.3	65.4-67.1	67.4	66.3-68.3	67.8	66.8-68.8

Table 4

Age-standardized one-, three-, and five-year net survival of colon cancer patients diagnosed
in California in the years 2004-2011 by SES Quintile.

Five-year net-survival estimates for county poverty groupings and stage

(Table 5) show a similar trend as the overall SES analysis. However, the absolute

differences between Q5 and Q1 were the largest for regional stage survival (5.8%).
The survival differences between Q5 and Q1 for localized and distant stages were
smaller (4% and 1.3%, respectively). Distant stage survival was minimally impacted
by SES, with small differences and overlapping Confidence Intervals between Q5
and Q1.

	Q1		Q2		Q3		Q4		Q5	
Stage	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI
Localized	**88.2**	86.0-90.0	**90.5**	89.5-91.5	**90.6**	89.4-91.6	**90.0**	88.6-91.2	**92.2**	90.9-93.3
Regional	**67.5**	65.2-69.8	**70.0**	68.8-71.1	**71.0**	69.6-72.3	**73.2**	71.6-74.8	**73.3**	71.7-74.8
Distant	**12.9**	11.0-14.9	**13.7**	12.7-14.7	**14.7**	13.5-15.9	**15.0**	13.5-16.5	**14.2**	12.9-15.7

Table 5

Five-year age-standardized net survival of colon cancer patients diagnosed in California in the
years 2004-2011 by SES Quintile and SEER Stage.

Five-year age-standardized stage- and race-specific net survival increased
with increasing SES for White adults diagnosed with localized or regional tumors,
and for Hispanic adults with regional tumors (Figure 2). White adults had the highest
survival for both localized (93.2% [91.7%-94.5%]) and regional (73.4% [71.5%-
75.2%]) tumors, with the highest survival seen in Q5. Hispanic adults had the highest
five-year survival for distant disease (16.9% [13.0%-21.2%]), with the highest
survival seen in Q4. Black adults had the lowest survival in each quintile for all three
stages and among the included races/ethnicities. Additionally, no appreciable trend
can be ascertained for improvements in survival among Black adults as the county
SES increases. Five-year survival for Black adults in each quintile had overlapping
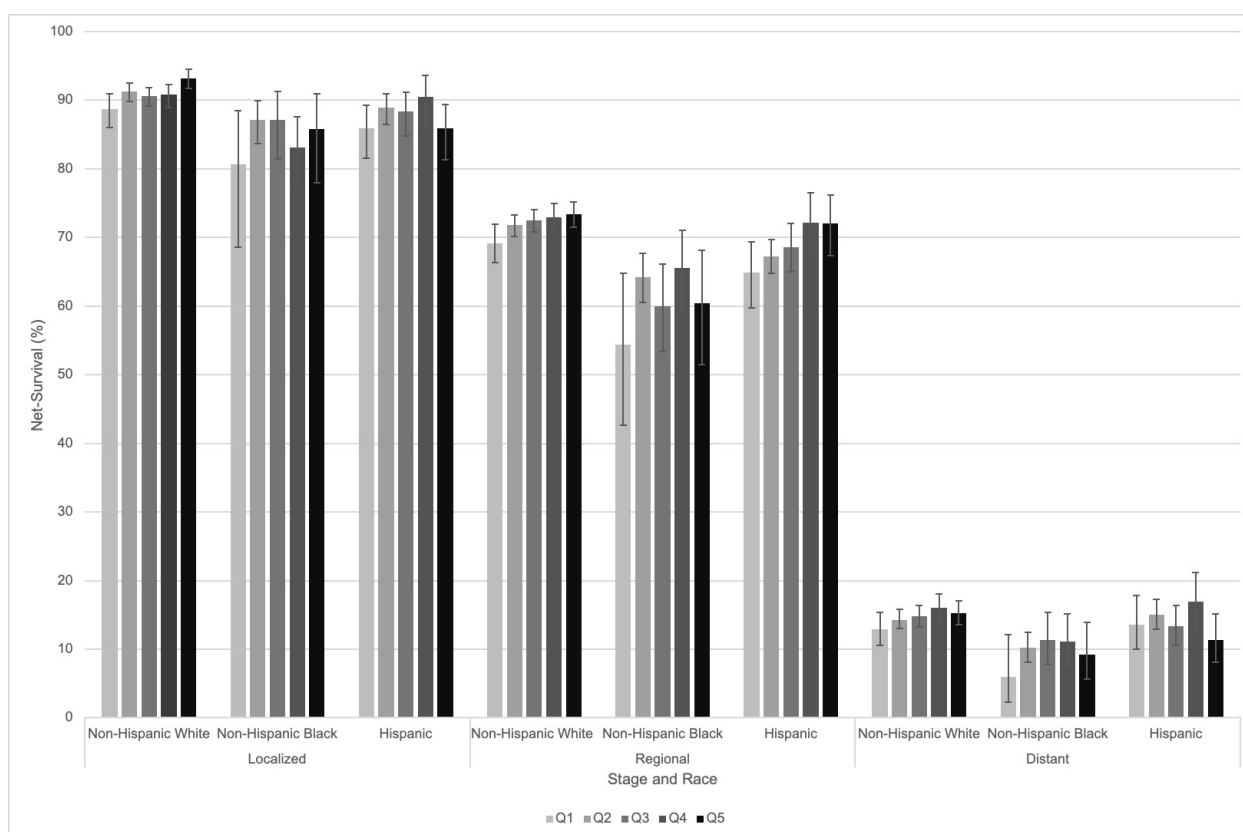Confidence Intervals, suggesting less of a possible difference.

Figure 2

Five-year age-standardized survival for patients diagnosed with colon cancer in California in the years 2004-2011, by race/ethnicity, SEER stage, and SES quintile.

4. DISCUSSION AND CONCLUSION:

4.1 DISCUSSION:

The aim of this study was to evaluate the age-standardized, stage-specific, sex-specific, race/ethnicity-specific, and SES-specific net survival of patients diagnosed with colon cancer in California between 2004-2011. This population-based study is the most current analysis of net survival for the state that also examines the stage-, sex-, race/ethnicity-, and SES-specific net survival in a single analysis. Five-year survival for the state of California as a whole was 66.0%, and survival was unequal across the different variables examined.

Sex was demonstrated to have the smallest differences in net survival with relatively similar survival outcomes among men and women. White and Black adults had similar survival after stratifying by sex, indicating that there is unlikely a difference in how these two groups access care and receive treatment for colon cancer. This result is in line with other findings in the literature showing that men and women have similar outcomes in both White and Black populations.[9] However, in the Hispanic population, there was a larger difference between men and women. Regular follow-up care and screening are essential to improving outcomes in colon cancer survival. However, screening practices may not explain this difference, as similar distributions of tumor stage at diagnosis are found in both Hispanic men and women, indicating that a reason outside of stage at diagnosis is causing this difference. Regular follow-up care could be a possible explanation for the observed differences, as Hispanic women have been noted to have a higher odds of attending more than one physician visit when compared to Hispanic men.[25] This disparity in follow-up care could explain the difference in net survival between men and women in the Hispanic population, compared to the other races/ethnicities.

Potential differences in follow-up care availability and practices can also be appreciated when observing the gaps in stage-specific survival stratified by race/ethnicity. In this analysis, survival was lower for Black and Hispanic adults than for White adults; however, there were larger gaps for regional disease than for localized and distant disease. Interestingly, this also corresponds with the treatment strategies for each stage. Localized disease is typically managed with surgery and less frequently necessitates intensive follow-up and adjuvant treatment. However, regional disease requires more supervised care, specifically the need for adjuvant chemotherapy after tumor resection, which demands more frequent follow-up.[26]

Compared to regional disease, distant disease has a lower likelihood of potential remission, even with consistent follow-up treatment. Moreover, in one analysis detailing insurance status and colon cancer survival, as survival time increased for distant disease the differences in survival between insured and uninsured decreased. However, the opposite trend was observed in localized and regionally diagnosed disease, with a steeper increase in difference observed in regional stage disease.[27] When coupled with the findings from our analysis, and the fact that insured patients are more readily able to access care than uninsured patients, it would seem that regional disease survival is most dependent on one's ability to readily access care and follow-up. Therefore, those who have historically been noted to have less access to care would consequently have worse outcomes in that disease category than others. This trend is further emphasized by the difference in five-year survival for the different stages of diagnosis stratified by SES quintile, as the survival difference between Q1 and Q5 is largest for regional stage disease. Thus, when counties are poorer overall, there is less access to care and follow-up treatment, which negatively impacts survival. When taken together, these analyses indicate that access to healthcare and follow-up treatment play a more important role in regionally diagnosed disease than other stages.

Although follow-up is a key part of any cancer treatment protocol, screening and early diagnosis also play an important role in predicting patient survival.[4] Specifically for colon cancer, treatment options vary between the different stages and the treatment has improved over time for early-stage disease.[26,28,29] In our study, the effect of screening on survival can be appreciated when looking at stage-specific analyses. Five-year survival decreases substantially when comparing localized disease to advanced disease. This could be attributed to lead-time bias, and an

improvement in survival solely due to the disease being diagnosed earlier. However, the more effective treatment options for earlier diagnosed colon cancer might also play a role in improving survival. Because of the difference in treatment, shifting the burden of disease from later stage tumors to localized tumors could be an effective way for improving survival among colon cancer patients. This can be observed in one study, where patients who were screened for colon cancer using colonoscopy had significantly better five-year survival and significantly earlier stage distribution than their non-screened counterparts.[30]

Additionally, race/ethnicity seems to play a role in this screening gap as well. Black and Hispanic adults have a higher percentage of later stage disease compared to White adults. This could offer a possible explanation for the gap in survival among these groups compared to White adults. Lack of screening in the Black population has been shown to contribute partially to the disparity seen between Black and White adults.[31] Furthermore, Black and Hispanic adults have been found to have lower rates of screening than other races/ethnicities, due to a combination of many different factors (e.g. cultural, SES, insurance coverage, immigration status, health literacy, etc.).[32] In 2009, the Center for Disease Control attempted to remedy this by funding the Colorectal Cancer Control Program (CRCCP), which provides colon cancer screening and treatment for patients who typically would not be able to afford it, as well as community awareness and provider education.[33] However, the CRCCP-funded colon cancer screening and treatment is not available in all states and has only been implemented in one portion of the California health system.[33] In 2009, the California Department of Public Health created the California Colon Cancer Control Program (C4P) in order to increase awareness of colon cancer screening. However, the C4P did not include funding for patients who would not qualify for Medicaid

coverage, but for whom private health insurance is too costly.[34] Further analysis of how California compares to other states that did expand funding for screening and treatment through the CRCCP could be useful for determining future policy directions for the California Department of Public Health, and whether increases in funding for colon cancer screening and treatment would be helpful in improving survival.

In the SES-specific analyses higher socioeconomic quintiles demonstrated improved survival. However, when examining survival by SES, race/ethnicity, and stage, improved survival with improved SES was only noted among White adults for local and regional disease and Hispanic adults for regional disease. This seems to indicate that White adults are the most affected by changes in county-level SES. Although Hispanic adults do see a positive trend with increased survival among those from higher quintiles and regionally diagnosed disease, a similar trend is not observed elsewhere. This finding among Hispanic adults could be similar to what was previously discussed regarding the sensitivity of regional disease to changes in access to care and follow-up – mediated in this analysis by improvements in county-level SES. However, what is striking is that this improvement is not appreciable in Black adults. One potential explanation is that Black adults are treated differently than White adults by healthcare workers and might receive different levels of care, regardless of SES.[35-37]

Assuming access to care is the reason for gaps in survival, improving SES should have correlated with improved access to care, and subsequently improved survival regardless of race/ethnicity. This was appreciated in a few of the analyses, but not all. One reason could be that the variable chosen for SES was not sensitive enough to capture the changes in access to care that are typically seen with increasing wealth. To further investigate this, analyses were also conducted with

counties ranked by quintiles using percent uninsured in each county; again, no appreciable trend was found for Black adults (Supplemental Figure 1). The lack of trend in both of these analyses among the Black population indicate that the reason for the observed differences in survival between Black and White adults might not be due to differences in access to care, but instead are more suggestive of unequal treatment and implicit bias as the reason for the survival gap.[35-37] This phenomenon has also been well documented in the literature and has been shown to be pervasive throughout the American healthcare system, even outside of cancer care.[38,39] Based on the results of this study, both the unequal treatment of different races/ethnicities and lack of access to care could be reasons why Black and Hispanic adults have worse survival than White adults. Given the improvement in survival among Hispanic adults as SES increased for regional disease, Hispanic adults may be less affected by factors such as implicit bias and unequal care than Black adults, and because of that, see the improvements in survival expected if access to care was the reason for the gap. However, since there is no trend in the other Hispanic-specific and Black-specific analyses stratified by SES, it is likely that another factor is at play, notably bias within the healthcare system.

Combatting this bias within the health system is one of the important steps towards equalizing health outcomes between different races and ethnicities. Much of the research in this field has been geared towards identifying which specific factors contribute to the underlying bias in the health system between different races and ethnicities. Communication, medical mistrust, delays in treatment initiation and follow-up, racial microaggressions, and lack of shared decision making between provider and patient seemed to be factors that mediate the differences in experience in the health system between different races.[40-42] Mitigating these factors through

targeted interventions would be the next step. In a habit-breaking intervention described by Devine et al., those who received the intervention had increased awareness about discrimination and their own biases, subsequently they were less prone to implicit bias than the control group.43 Additionally, research is currently being done on health promotion campaigns in social media to reduce the stigma associated with HIV testing and viral suppression in young black and LatinX men who have sex with men and transgender women who have sex with men in order to improve HIV outcomes mediated by improving communication and shared decision making.44 These interventions are promising ways to help start reducing the systemic problems associated with implicit bias within the health care system, and work such as this is imperative to continue.

Some limitations of this study stem from the level of data analyzed. Both SES and insurance coverage were measured at the population level, so identifying the unique SES and insurance status of each individual within the county was not possible. Although this is a weakness of population-level data, the other variables we examined (i.e. race/ethnicity, sex, and stage) used individual case data from the population registry, providing a comprehensive description of the disparities present between different groups in our sample.

4.2 CONCLUSION:

Overall, this study uncovers important trends in gaps in colon cancer survival due to sex, stage, race/ethnicity, and SES in California from 2004-2011. It also provides age-standardized estimates that can be used to compare different states. Future studies should examine populations in other states with smaller gaps in survival, to understand the impact of these variables on survival. Policy development, funding allocation, and programmatic development and

implementation should also be examined, with the aim of uncovering and sharing

best practices. Working towards these goals can help to reduce disparities in colon

cancer survival for all groups across the United States.

5. ACKNOWLEDGEMENTS:

6. REFERENCES:

1.   American Cancer Society. American Cancer Society: Cancer Facts and Figures 2019. https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/annual-cancer-facts-and-figures/2019/cancer-facts-and-figures-2019.pdf. Published 2019. Accessed August 28, 2020.

2.   Bibbins-Domingo K, Grossman DC, Curry SJ, et al. Screening for colorectal cancer: US preventive services task force recommendation statement. JAMA - J Am Med Assoc. 2016;315(23):2564-2575. doi:10.1001/jama.2016.5989

3.   Woolf SH. Archived: Colorectal Cancer: Screening, 1996 | United States Preventive Services Taskforce. USPSTF. https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/colorectal-cancer-screening-1996. Published 1996. Accessed October 20, 2020.

4.   Tong L, Ahn C, Symanski E, Lai D, Du XL. Relative impact of earlier diagnosis and improved treatment on survival for colorectal cancer: A US database study among elderly patients. Cancer Epidemiol. 2014;38(6):733-740. doi:10.1016/j.canep.2014.10.004

5.   Gross CP, Andersen MS, Krumholz HM, McAvay GJ, Proctor D, Tinetti ME. Relation between medicare screening reimbursement and stage at diagnosis for older patients with colon cancer. J Am Med Assoc. 2006;296(23):2815-2822. doi:10.1001/jama.296.23.2815

6.   Allemani C, Matsuda T, Di Carlo V, et al. Global surveillance of trends in cancer survival 2000–14 (CONCORD-3): analysis of individual records for 37 513 025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries. Lancet. 2018;391(10125):1023-1075. doi:10.1016/S0140-6736(17)33326-3

7.   Allemani C, Weir HK, Carreira H, et al. Global surveillance of cancer survival 1995-2009: Analysis of individual data for 25 676 887 patients from 279 population-based registries in 67 countries (CONCORD-2). Lancet. 2015;385(9972):977-1010. doi:10.1016/S0140-6736(14)62038-9

8.   Coleman MP, Quaresma M, Berrino F, et al. Cancer survival in five continents: a worldwide population-based study (CONCORD). Lancet Oncol. 2008;9(8):730-756. doi:10.1016/S1470-2045(08)70179-7

9.   White A, Joseph D, Rim SH, Johnson CJ, Coleman MP, Allemani C. Colon cancer survival in the United States by race and stage (2001-2009): Findings from the CONCORD-2 study. Cancer. 2017;123(Suppl 24):5014-5036. doi:10.1002/cncr.31076

10.   Chien C, Morimoto LM, Tom J, Li CI. Differences in colorectal carcinoma stage and survival by race and ethnicity. Cancer. 2005;104(3):629-639. doi:10.1002/cncr.21204

11. Echeverria S, Carrasquillo O. The roles of citizenship status, acculturation, and health insurance in breast and cervical cancer screening among immigrant women. Med Care. 2006;44:788-792.

12. Mandelblatt JS, Gold K, O'Malley AS, et al. Breast and cervix cancer screening among multiethnic women: Role of age, health, and source of care. Prev Med (Baltim). 1999;28(4):418-425. doi:10.1006/pmed.1998.0446

13. Bureau UC. Small Area Health Insurance Estimates (SAHIE) Program. https://www.census.gov/programs-surveys/sahie.html. Accessed August 28, 2020.

14. Abdel-Rahman O. Outcomes of non-metastatic colon cancer patients in relationship to socioeconomic status: an analysis of SEER census tract-level socioeconomic database. Int J Clin Oncol. 2019;24(12):1582-1587. doi:10.1007/s10147-019-01497-9

15. Adler NE, Newman K. Socioeconomic disparities in health: Pathways and policies. Health Aff. 2002;21(2):60-76. doi:10.1377/hlthaff.21.2.60

16. Sohn H. Racial and Ethnic Disparities in Health Insurance Coverage: Dynamics of Gaining and Losing Coverage Over the Life-Course. Popul Res Policy Rev. 2017;36(2):181-201. doi:10.1007/s11113-016-9416-y

17. Surveillance, Epidemiology, and End Results (SEER) Program. SEER*Stat Database Incid 18 Regs Res Data + Hurric Katrina Impacted Louisiana Cases, Novemb 2018 Submiss (1975-2016 varying)-Linked to Cty Attrib US, 1969-2017 Counties. 2019.

18. Fritz A, Percy C, Jack A, et al. ICD-O International Classification of Diseases for Oncology First Revision.; 2013. www.who.int. Accessed November 8, 2020.

19. Nci, Seer. Digestive and Hepatobiliary Systems Summary Stage Manual 2018; Digestive and Hepatobiliary Systems Summary Stage Manual 2018.; 2018.

20. Bureau UC. Small Area Income and Poverty Estimates (SAIPE) Program. https://www.census.gov/programs-surveys/saipe.html. Accessed August 28, 2020.

21. 2010 - 2018 County-Level Estimation Details. Census Bureau. https://www.census.gov/programs-surveys/saipe/technical-documentation/methodology/counties-states/county-level.html. Published December 11, 2019. Accessed October 20, 2020.

22. Perme MP, Stare J, Estève J. On Estimation in Relative Survival. Biometrics. 2012;68(1):113-120. doi:10.1111/j.1541-0420.2011.01640.x

23. Corazziari I, Quinn M, Capocaccia R. Standard cancer patient population for age standardising survival ratios. Eur J Cancer. 2004;40(15):2307-2316. doi:10.1016/j.ejca.2004.07.002

24. Cutler SJ, Ederer F. Maximum utilization of the life table method in analyzing survival. J Chronic Dis. 1958;8(6):699-712. doi:10.1016/0021-9681(58)90126-7

25. Downer B, Al Snih S, Chou L-N, Kuo Y-F, Markides KS, Ottenbacher KJ. Differences in hospitalizations, emergency room admissions, and outpatient visits among Mexican-American Medicare beneficiaries. BMC Geriatr. 2019;19(1):136. doi:10.1186/s12877-019-1160-9

26. National Comprehensive Cancer Network. Colon Cancer (Version 4.2020. https://www.nccn.org/professionals/physician_gls/pdf/colon.pdf. Published 2020. Accessed August 13, 2020.

27. Pulte D, Jansen L, Brenner H. Disparities in Colon Cancer Survival by Insurance Type. Dis Colon Rectum. 2018;61(5):538-546. doi:10.1097/DCR.0000000000001068

28. Tong L, Ahn C, Symanski E, Lai D, Du XL. Effects of newly developed chemotherapy regimens, comorbidities, chemotherapy-related toxicities on the changing patterns of the leading causes of death in elderly patients with colorectal cancer. Ann Oncol. 2014;25(6):1234-1242. doi:10.1093/annonc/mdu131

29. Abrams TA, Brightly R, Mao J, et al. Patterns of adjuvant chemotherapy use in a population-based cohort of patients with resected Stage II or III colon cancer. J Clin Oncol. 2011;29(24):3255-3262. doi:10.1200/JCO.2011.35.0058

30. Wiegering A, Ackermann S, Riegel J, et al. Improved survival of patients with colon cancer detected by screening colonoscopy. doi:10.1007/s00384-015-2501-6

31. Lansdorp-Vogelaar I, Kuntz KM, Knudsen AB, Van Ballegooijen M, Zauber AG, Jemal A. Contribution of screening and survival differences to racial disparities in colorectal cancer rates. Cancer Epidemiol Biomarkers Prev. 2012;21(5):728-736. doi:10.1158/1055-9965.EPI-12-0023

32. White A, Thompson TD, White MC, et al. Cancer Screening Test Use — United States, 2015. MMWR Morb Mortal Wkly Rep. 2017;66(8):201-206. doi:10.15585/mmwr.mm6608a1

33. CDC. About the CRCCP. https://www.cdc.gov/cancer/crccp/about.htm. Accessed August 28, 2020.

34. California Department of Public Health. California Colon Cancer Program. https://www.cdph.ca.gov/Programs/CCDPHP/DCDIC/CDCB/Pages/ColonCancerProgram.aspx. Published March 10, 2020. Accessed August 28, 2020.

35. Tait RC, Chibnall JT, Raymond Tait note C. Racial/Ethnic Disparities in the Assessment and Treatment of Pain Psychosocial Perspectives. 2014;69(2):131-141. doi:10.1037/a0035204

36. Potosky AL, Harlan LC, Kaplan RS, Johnson KA, Lynch CF. Age, Sex, and Racial Differences in the Use of Standard Adjuvant Therapy for Colorectal Cancer. J Clin Oncol. 2002;20(5):1192-1202. doi:10.1200/jco.2002.20.5.1192

37. White A, Liu CC, Xia R, et al. Racial disparities and treatment trends in a large cohort of elderly African Americans and Caucasians with colorectal cancer,

1991 to 2002. Cancer. 2008;113(12):3400-3409. doi:10.1002/cncr.23924

38. Hall WJ, Chapman M V., Lee KM, et al. Implicit racial/ethnic bias among health care professionals and its influence on health care outcomes: A systematic review. Am J Public Health. 2015;105(12):e60-e76. doi:10.2105/AJPH.2015.302903

39. Fiscella K, Sanders MR. Racial and Ethnic Disparities in the Quality of Health Care. Annu Rev Public Health. 2016;37(1):375-394. doi:10.1146/annurev-publhealth-032315-021439

40. Acree, M. E., McNulty, M., Blocker, O., Schneider, J., & Williams, H. 'Herukhuti' S. (2020). Shared decision-making around anal cancer screening among black bisexual and gay men in the USA. *Culture, Health and Sexuality*, *22*(2), 201–216. https://doi.org/10.1080/13691058.2019.1581897

41. Black, K. Z., Lightfoot, A. F., Schaal, J. C., Mouw, M. S., Yongue, C., Samuel, C. A., Faustin, Y. F., Ackert, K. L., Akins, B., Baker, S. L., Foley, K., Hilton, A. R., Mann-Jackson, L., Robertson, L. B., Shin, J. Y., Yonas, M., & Eng, E. (2018). 'It's like you don't have a roadmap really': using an antiracism framework to analyze patients' encounters in the cancer system. *Ethnicity & Health*, 1–21. https://doi.org/10.1080/13557858.2018.1557114

42. Hamoda, R. E., McPherson, L. J., Lipford, K., Jacob Arriola, K., Plantinga, L., Gander, J. C., Hartmann, E., Mulloy, L., Zayas, C. F., Lee, K. N., Pastan, S. O., & Patzer, R. E. (2020). Association of sociocultural factors with initiation of the kidney transplant evaluation process. *American Journal of Transplantation*, *20*(1), 190–203. https://doi.org/10.1111/ajt.15526

43. Devine, P. G., Forscher, P. S., Austin, A. J., & Cox, W. T. L. (2012). Long-term reduction in implicit race bias: A prejudice habit-breaking intervention. *Journal of Experimental Social Psychology*, *48*(6), 1267–1278. https://doi.org/10.1016/j.jesp.2012.06.003

44. Muessig, K. E., Golinkoff, J. M., Hightow-Weidman, L. B., Rochelle, A. E., Mulawa, M. I., Hirshfield, S., Rosengren, A. L., Aryal, S., Buckner, N., Wilson, M. S., Watson, D. L., Houang, S., & Bauermeister, J. A. (2020). Increasing HIV Testing and Viral Suppression via Stigma Reduction in a Social Networking Mobile Health Intervention Among Black and Latinx Young Men and Transgender Women Who Have Sex With Men (HealthMpowerment): Protocol for a Randomized Controlled Trial. *JMIR Research Protocols*, *9*(12), e24043. https://doi.org/10.2196/24043