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REVIEW

Social determinants of colorectal cancer risk, stage, and survival: a systematic review

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Abstract

Background Several social determinants of health have been examined in relation to colorectal cancer incidence, stage at diagnosis, and survival including income, education, neighborhood disadvantage, immigration status, social support, and social network. Colorectal cancer incidence rates are positively associated with income and other measures of socioeconomic status. In contrast, low socioeconomic status tends to be associated with poorer survival.

Methods The present review is based upon bibliographic searches in PubMed and CINAHL and relevant search terms. Articles published in English from 1970 through April 1, 2019 were identified using the following MeSH search terms and Boolean algebra commands: colorectal cancer AND (incidence OR stage OR mortality) AND (social determinants OR neighborhood disadvantage OR racial discrimination OR immigration OR social support).

Results This review indicates that poverty, lack of education, immigration status, lack of social support, and social isolation play important roles in colorectal cancer stage at diagnosis and survival.

Conclusions To address social determinants of colorectal cancer, effective interventions are needed that account for the social contexts in which patients live.

Keywords African Americans · Education · Colorectal cancer · Immigration · Poverty · Social support

Socioeconomic factors such as lack of education, poverty, and income inequality are key social determinants of health. Low-income people are at increased risk of an array of adverse health outcomes and more likely to die prematurely. Social determinants of health that have been examined in relation to colorectal cancer incidence, stage at diagnosis, and survival include income, education, neighborhood disadvantage, immigration status, social support, and social network [1–5]. Several studies have found that socioeconomic factors influence risk of colorectal cancer. Most studies have shown that low income is associated with increased risk of poorer survival [6–8]. Disparities in colorectal cancer survival have been observed by socioeconomic status, race, education, and census-tract-level poverty.

This review provides an overview of these disparities, followed by a systematic review of published studies on the relation between neighborhood disadvantage, immigration status, social support, and social network and colorectal cancer incidence, stage at diagnosis, and survival. The published studies were from developed countries.

Background

Van Loon et al. [1] examined the relation between socioeconomic status and colon cancer risk in a prospective study in The Netherlands. Male, white collar workers had a higher colon cancer risk than blue collar workers (relative risk [RR] = 1.42, 95% confidence interval [CI] 0.95, 2.11). There were no clear associations between indicators of socioeconomic status and colon cancer risk in women.

Shaw et al. [9] examined the relation between socioeconomic position and colorectal cancer mortality in New Zealand. For females, differences in colorectal cancer

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mortality by income and education increased over time. Poor females had a 40% higher colorectal cancer mortality than rich females in 1996–1999, compared with no difference in 1981–1984 (p for trend = 0.04). In men, increases in inequality were seen by income but not education.

Using data from the SEER cancer registries-Medicare linked database, Du et al. [6] examined the relation between socioeconomic status and survival among elderly patients with colon cancer. Patients who lived in the lowest socioeconomic status communities had 19% higher all-cause mortality compared with patients who lived in communities with the highest socioeconomic status (hazard ratio [HR] = 1.19, 95% CI 1.13, 1.26, $p < 0.001$ for trend). The risk of dying was reduced only slightly after controlling for race/ethnicity (HR = 1.17, 95% CI 1.10, 1.24).

Egeberg et al. [7] examined the relation between socioeconomic status and incidence and survival from colon and rectal cancer in a population-based study in Denmark in 1994–2003. Higher incidences of colon and rectal cancer were associated with greater social disadvantage, predominantly among men. Short- and long-term relative survival from both colon and rectal cancer decreased with poorer education, disposable income, and cohabiting status.

Using data from the National Program of Cancer Registries Patterns of Care Study, Byers et al. [8] examined the relation between socioeconomic status and colorectal cancer survival. In contrast to other studies, only a weak association was observed between socioeconomic status and mortality after a diagnosis of colorectal cancer (HR = 1.10, 95% CI 0.98, 1.23). Low socioeconomic status was a much stronger predictor of mortality among individuals < 65 years (HR = 1.38) and among individuals from racial/ethnic minority groups.

Kelsall et al. [10] examined the relation between socioeconomic status and colorectal cancer mortality among participants in the Melbourne Collaborative Cohort Study. The hazard ratios of dying from all causes and from colorectal cancer associated with living in the least disadvantaged areas compared with the most disadvantaged areas were 0.73 (95% CI 0.53, 1.00, p for trend = 0.06) and 0.80 (95% CI 0.57, 1.12, p for trend = 0.22), respectively. Using data from the New Jersey State Cancer Registry between 1986 and 1999, Niu et al. [11] examined colorectal cancer survival disparities by race/ethnicity and socioeconomic status. Compared to those residing in the wealthiest areas, colorectal cancer patients residing in areas of high poverty had increased risks of cancer death. African American colorectal cancer patients had higher death rates than non-Hispanic whites did ($p < 0.01$). After adjustment for poverty level, the higher risk of death among African American patients was attenuated.

Kim et al. [12] analyzed data from the Nurses' Health Study to examine the relation between neighborhood socioeconomic status and risk of colon and rectal cancer in women. Neighborhood socioeconomic status was not associated with colon cancer among all women. However, among women with college or greater education, higher neighborhood socioeconomic status was inversely related to colon cancer (p for trend = 0.01). Path analysis suggested medication by red meat intakes and body mass index. Higher neighborhood socioeconomic status was inversely related to rectal cancer among all women (p for trend = 0.08).

In an analysis of data from the National Institutes of Health-American Association of Retired People Diet and Health Study, Doubeni et al. [13] examined the contribution of behavioral risk factors and obesity to socioeconomic differences in colorectal cancer incidence. Health behaviors (physical inactivity, unhealthy diet, smoking) and body mass index combined explained approximately 36.2% (95% CI 28.0% to 51.2%) of the association of neighborhood socioeconomic status with risk of colorectal cancer. Residents of low socioeconomic status neighborhoods had a higher risk of colorectal cancer [14].

Using data from the California Cancer Registry from 1998 to 2002, Steinbrecher et al. [15] examined the relation between a census-tract-level socioeconomic index and colorectal cancer incidence and mortality. Overall colorectal cancer incidence and socioeconomic status did not show a clear association. In Hispanics, socioeconomic status was positively associated with colorectal cancer incidence (socioeconomic status quartile 5 vs. quartile 1: incidence rate ratio [IRR] = 1.54, 95% Ci 1.39, 1.69). For whites (IRR = 0.80, 95% CI 0.77, 0.83) and African Americans (IRR = 0.83, 95% CI 0.70, 0.97), inverse associations with socioeconomic status were observed. Mortality rates declined with increasing socioeconomic status in whites. In Hispanics, colorectal cancer mortality rates significantly increased with socioeconomic status.

Saldana-Ruiz et al. [16] examined trends in colorectal cancer mortality in the United States according to socioeconomic status. Prior to 1980, there was a stable gradient in colorectal cancer mortality, with people living in higher socioeconomic status counties having a higher risk than people living in lower socioeconomic status counties. Beginning in 1980, this gradient began to narrow and then reversed as people living in higher socioeconomic status counties experienced greater reductions in colorectal cancer mortality than those living in lower socioeconomic status counties.

In a retrospective cohort study of patients diagnosed with colorectal cancer in Georgia between 2000 and 2007, Hines et al. [4] examined the relation between census tract-level socioeconomic status and mortality. Lower-middle- and low-socioeconomic status patients had an increased risk of death (lower-middle: HR = 1.16, 95% CI 1.10, 1.22; low: HR = 1.24, 95% CI 1.16, 1.32).

Enewold et al. [17] examined the relation between county-level socioeconomic status and colorectal cancer mortality in the United States from 1990 to 2007. Among non-Hispanic whites, non-Hispanic black women, and non-Hispanic Asian

and Pacific Islander men, colorectal cancer mortality rates were significantly lower in the poorest counties than the richest counties during 1990–1992. By 2003–2007, colorectal cancer mortality rates were significantly higher in the poorest than the richest counties among all sex-race/ethnicity groups.

Using data from the Florida Cancer Data System registry and US Census data, Tannenbaum et al. [18] examined the relation between socioeconomic status and colorectal cancer mortality. Among 18–49 and 50–64 age groups, there was a higher mortality risk among the lowest socioeconomic status compared to highest socioeconomic status. Married patients had a lower mortality risk than those who were divorced/separated or widowed.

Using data from the Vitamins and Lifestyle Study, Hastert et al. [19] examined the relationship between a block group socioeconomic status index and colorectal cancer incidence. Compared with the highest socioeconomic status areas, living in the lowest socioeconomic status areas was associated with higher colorectal cancer incidence (hazard ratio [HR] = 1.52, 95% CI 1.11, 2.09).

In analysis of registry data for individuals with colon cancer from Ontario, Canada and California between 1996 and 2000 and followed to 2010, Gorey et al. [20] examined associations with census tract-based socioeconomic status. High poverty neighborhoods were oversampled. Significant inverse associations of poverty (RR = 0.79) were observed with survival in California but not in Ontario.

Beckmann et al. [21] examined the relation between socioeconomic status and colorectal cancer mortality in 2003–2008 using data from the South Australia Central Cancer Registry. Patients from the most socioeconomically advantaged areas had significantly better outcomes than those from the least advantaged areas (HR = 0.75, 95% CI 0.62, 0.91).

Ellis et al. [22] analyzed data from the California Cancer Registry between 2000 and 2013 to estimate colorectal cancer-specific survival for each racial/ethnic group. A composite index of neighborhood socioeconomic status was derived using US Census or American Community Survey data on education, occupation, employment, household income, poverty, and rent and house values. Colorectal cancer-specific mortality among African American men with colorectal cancer was 36% higher than among non-Hispanic white men (HR = 1.36, 95% CI 1.30, 1.43). About 16% of this disparity was explained by differences in marital status. Colorectal cancer-specific mortality among African American women with colorectal cancer was 34% higher than among non-Hispanic white men (HR = 1.34, 95% CI 1.28, 1.41). About 13% of this disparity was explained by differences in marital status. Smaller contributions were made by differences in neighborhood socioeconomic status (5% to 6%).

In a population-based case-control study in Montreal, Canada, Nicolau et al. [23] examined socioeconomic position over the life course among men. Disadvantaged socioeconomic position in childhood increased the risk of colon and rectal cancer, suggesting that early childhood may be a critical period for exposures associated with socioeconomic position.

Other studies have examined the relation between socioeconomic status and colorectal cancer stage at diagnosis. Schwartz et al. [3] examined whether racial differences in colorectal cancer stage at diagnosis are explained by differences in socioeconomic status. A socioeconomic status variable was calculated for each case using aggregate US Census data for education, poverty status, and occupation specific to each case's census block group. Socioeconomic status was an independent predictor of colorectal cancer stage at diagnosis, with cases from the highest socioeconomic status block group more likely to present with local stage disease than those from the lowest socioeconomic status group. Using SEER-Medicare data for 1992–1996, and followed through 1999, Gomez et al. [24] examined the joint effects of sociodemographic factors, stage, and census-based socioeconomic status on colorectal cancer survival. Colorectal cancer mortality rates were higher among African American males than their white counterparts (RR = 1.34, 95% CI 1.26, 1.42). Stage and socioeconomic status accounted for about half of the higher rate among African Americans relative to whites. In a nationwide study in Denmark from 1996 to 2004, Frederiksen et al. [25] examined the relation between socioeconomic status and stage at diagnosis. Among elderly rectal cancer patients, higher socioeconomic status was associated with a reduced risk of being diagnosed with late stage cancer was observed. Among younger rectal cancer patient, a reduced risk was seen in those having more education. No social gradient was observed for colon cancer. Greenlee and Howe [26] examined the relationship between county-level poverty and late-stage colorectal cancer using data from the North American Association of Central Cancer Registries from 1997 to 2001. Higher county poverty was associated with increased late stage disease (OR = 1.4, 95% CI 1.3, 1.5).

Methods

The present review relies upon bibliographic searches in PubMed and CINAHL and relevant search terms. Articles published in English from 1970 through April 1, 2019 were identified using the following MeSH search terms and the following Boolean algebra commands: colorectal cancer AND (incidence OR stage OR mortality) AND (social determinants OR neighborhood disadvantage OR racial discrimination OR immigration OR social support). The searches were not limited to words appearing in the title of an article nor to studies in a particular country or geographic region of the world. The references of review articles were also examined. Information obtained from

bibliographic searches (title and topic of article, information in abstract, study design, and key words) was used to determine whether to retain each article identified in this way. Studies were eligible for inclusion if they were written in English and examined social determinants of colorectal cancer risk, stage, and survival.

A total of 979 articles were identified in the bibliographic searches. Of these, 30 met the study criteria (Fig. 1). A variety of study designs were identified including case-control studies, cohort studies, and population-based studies of cancer registry data.

Results

Neighborhood disadvantage and colorectal cancer

Using SEER cancer registry-Medicare linked data, Haas et al. [2] examined the relation between neighborhood disadvantage and colorectal cancer stage at diagnosis (Table 1). Area of residence was categorized into four groups: low segregation/high income (potentially the most advantaged), high segregation/high income, low segregation/low income, and high segregation/low income (possibly the most disadvantaged. For colorectal cancer, the Black/white disparity was largest in low-segregation/low-income areas and smallest in the most segregated areas.

Zhou et al. [27] examined the relation between racial bias in mortgage lending and colorectal cancer mortality using data from the Wisconsin Cancer Reporting System. For all-cause mortality, racial bias in mortgage lending was significantly associated with a greater hazard rate among blacks [HR = 1.37; 95% CI, 1.06–1.76] and among black women (HR = 1.53; 95% CI, 1.06–2.21), but not black men in sex-specific models.

In an analysis of mortality and census data for all Belgian residents, Hagedoom et al. [28] examined the relation between a deprivation index and colorectal cancer mortality. Neighborhood socioeconomic position was measured using the deprivation index. Women living in highly deprived neighborhoods had a significantly higher mortality from colorectal cancer. Among males, colorectal cancer was not significantly associated with neighborhood deprivation.

In an analysis of US Cancer Statistics Registry data from 40 states, Mobley et al. [29] examined the relation between a social isolation index of residential segregation and stage at colorectal cancer diagnosis. The social isolation index of residential segregation was defined for racial and ethnic groups. Living in a highly segregated African American community was associated with a lower risk of late-stage diagnosis, while the opposite was true for people living in highly-segregated Asian communities.

Danos et al. [30] examined the relation between a neighborhood concentrated disadvantage index and colorectal cancer incidence using data from the Louisiana Tumor Registry and the US Census. Colorectal cancer risk was higher for African Americans than whites (risk ratio [RR] = 1.28, 95% CI 1.22, 1.33). A one standard deviation increase in neighborhood concentrated disadvantage index was associated with a 14% increase in risk for whites (RR = 1.14, 95% CI 1.10, 1.18) and 5% increase for African Americans (RR = 1.05, 95% CI 1.02, 1.09).

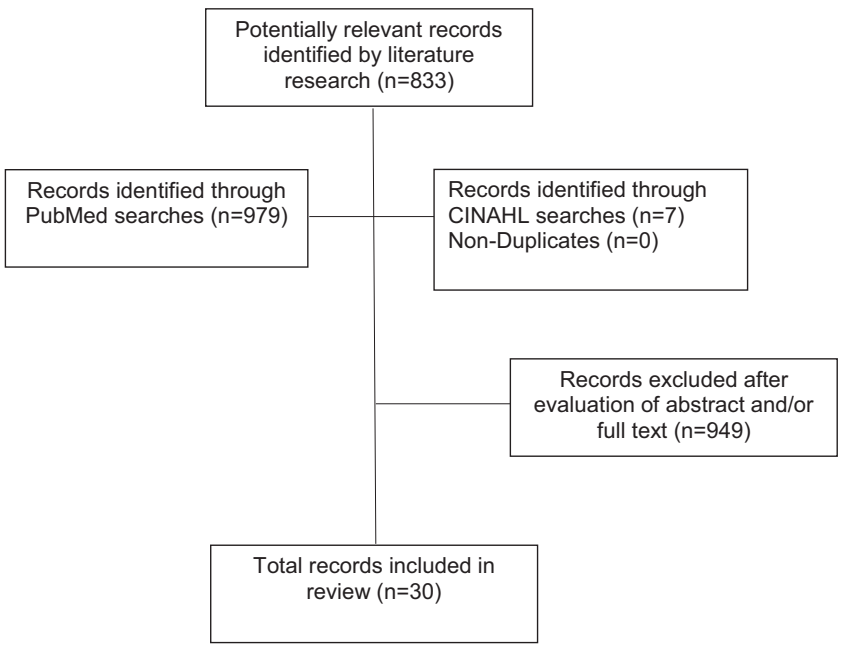

Fig. 1 Flowchart of record selection process

Table 1 Studies of neighborhood disadvantage and colorectal cancer risk, stage, and survival

Author	Design	Outcomes	Sample size	Results
Haas et al. 2008	Analysis of SEER-Medicare data, between 1992 and 2002	Colorectal cancer stage at diagnosis	91,497 individuals with colorectal cancer+	Area of residence was categorized into 4 groups: low segregation/high income (potentially the most advantaged), high segregation/high income, low segregation/low income, and high segregation/low income (possibly the most disadvantaged. For colorectal cancer, the Black/white disparity was largest in low-segregation/low-income areas and smallest in the most segregated areas.
Zhou et al. 2017	Analysis of data from the Wisconsin Cancer Reporting System	Colorectal cancer mortality		For all-cause mortality, racial bias in mortgage lending was significantly associated with a greater hazard rate among blacks [HR = 1.37; 95% CI, 1.06–1.76] and among black women (HR = 1.53; 95% CI, 1.06–2.21), but not black men in sex-specific models.
Hagedoom et al. 2017	Analysis of mortality and census data for all Belgian residents, for 2001–2011	Colorectal cancer mortality		Neighborhood socioeconomic position was measured using a deprivation index. Women living in highly deprived neighborhoods had a significantly higher mortality from colorectal cancer. Male colorectal cancer was not significantly associated with neighborhood deprivation.
Mobley et al. 2017	Analysis of US Cancer Statistics Registry data from 40 states, during 2004–2009	Stage at colorectal cancer diagnosis	Over 500,000 colorectal cancer cases	The isolation index of residential segregation was defined for racial and ethnic groups. Living in a highly segregated African American community was associated with a lower risk of late-stage diagnosis, while the opposite was true for people living in highly-segregated Asian communities.
Danos et al. 2018	Analysis of data from the Louisiana Tumor Registry, between 2008 and 2012, and US Census	Colorectal cancer incidence	10,198 cases of colorectal cancer	Colorectal cancer risk was higher for African Americans than whites (risk ratio [RR] = 1.28, 95% CI 1.22, 1.33). A one standard deviation increase in neighborhood concentrated disadvantage index was associated with a 14% increase in risk for whites (RR = 1.14, 95% CI 1.10, 1.18) and 5% increase for African Americans (RR = 1.05, 95% CI 1.02, 1.09).

Immigration status and colorectal cancer

Using data from Statistics Canada, Newman and Spengler [31] examined the relation between immigration status and colorectal cancer mortality (Table 2). The rates of death from colorectal cancer tended to be lower among immigrant groups (British, Italian, German, Dutch, Polish, and Soviet) than for the Canadian-born.

Grulich et al. [32] examined the relation between immigration from East and West African and the Caribbean and colorectal cancer mortality in England and Wales. In Caribbean immigrants, colorectal cancer mortality was significantly low (RR = 0.5, 95% CI 0.5, 0.6) compared with the England and Wales-born population.

In a population-based study in New South Wales, Australia, McCredie et al. [33] examined the relation between immigration from Asia and colorectal cancer mortality. Asian-born patients had a lower risk of dying from colorectal cancer than Australia-born patients. The initial lower risk from colorectal cancer later converged toward the Australian-born level.

McCredie et al. [34] examined the relation between immigration from the British Isles and southern Europe in a population-based study in New South Wales. Migrants from the British Isles and southern Europe had a significantly lower risk of dying from colorectal cancer than Australia-born patients. There was a clear gradient of increasing risk with duration of stay in Australia.

Using data from the SEER cancer registry and US Census, Blesch et al. [35] examined the relation between immigration from India and colon cancer incidence. Asian Indians born in the US had a higher risk of developing colon cancer than their counterparts born in India but the difference was not statistically significant. Compared with whites, Asian Indians in the US had a statistically significant lower risk of developing colon cancer.

Table 2 Studies of immigration status and colorectal cancer risk, stage, and survival

Author	Design	Outcomes	Sample	Results
Newman and Spengler 1984	Analysis of data from Statistics Canada	Colorectal cancer mortality		The rates of death from colorectal cancer tended to be lower among immigrant groups (British, Italian, German, Dutch, Polish, and Soviet) than for the Canadian-born.
Grulich et al. 1992		Colorectal cancer mortality	Immigrants from East and West Africa and the Caribbean to England and Wales	In Caribbean immigrants, colorectal cancer mortality was significantly low (RR = 0.5, 95% CI 0.5, 0.6) compared with the England and Wales-born population.
McCredie et al. 1999a	Population-based study in New South Wales, Australia	Colorectal cancer mortality	11,000 deaths from colorectal cancer	Asian-born patients had a lower risk of dying from colorectal cancer than Australia-born patients. The initial lower risk from colorectal cancer later converged toward the Australian-born level.
McCredie et al. 1999b	Population-based study in New South Wales, Australia, 1975–1995	Colorectal cancer mortality	21,457 deaths from colorectal cancer	Migrants from the British Isles and southern Europe had a significantly lower risk of dying from colorectal cancer than Australia-born patients. There was a clear gradient of increasing risk with duration of stay in Australia.
Blesch et al. 1999	Analysis of SEER cancer registry data and US Census data for 1988–1991	Colon cancer incidence	US-born whites and Asian Indians, and immigrant Asian immigrants	Asian Indians born in the US had a higher risk of developing colon cancer than their counterparts born in India but the difference was not statistically significant. Compared with whites, Asian Indians in the US had a statistically significant lower risk of developing colon cancer.
Hemminki et al. 2002	Analysis of data from the Swedish Family-Cancer Database	Colorectal cancer incidence	613,000 immigrants to Sweden	For colorectal cancer, male standardized incidence ratios (SIRs) for Norwegians, Estonians, and Frenchmen were increased, as were female SIRs for Danes and Austrians. The only decreases were for Finnish and all Asian men and women.
Choe et al. 2005	Analysis of SEER cancer registry data between 1973 and 1998	Stage at diagnosis and all-cause mortality	17,302 Asian and Pacific Islander patients with colorectal cancer	Foreign-born Asian and Pacific Islander patients were more likely to present later, and they had a higher risk for death (HR = 1.29, 95% CI 1.23, 1.36).
Lee et al. 2007	Analysis of SEER data (US) and IARC data (South Korea)	Colorectal cancer incidence		Colorectal cancer risk was higher among Korean American men than their Korean counterparts.
Nasseri and Moulton 2011	Analysis of Advanced Vital Statistics System data from Los Angeles County and Orange County, California from 1997 through 2004	Colorectal cancer mortality	First and second generation migrants from selected Middle Eastern countries and US-born non-Hispanic whites	First and second generation immigrants had higher odds for colorectal cancer.
Mousavi et al. 2012	Analysis of data from the Swedish Family-Cancer Database, from 1958 to 2008	Colorectal cancer incidence	Migrants and Swedish-born individuals at risk of colorectal cancer	Non-Swedish-born individuals were classified into “high-risk” countries when their risk was increased and into “low-risk” when their risk was decreased. An increasing trend in colorectal cancer incidence was observed in low-risk men and high-risk women.

Table 2 (continued)

Author	Design	Outcomes	Sample	Results
Barclay et al. 2014	Analysis of data on colorectal cancer stage at diagnosis and survival in a single tertiary care center in Australia	Stage at colorectal cancer diagnosis and survival	557 patients with colorectal cancer	Using Australian Census data, four socioeconomic indices were assigned by residential postal code. No significant relation was found between an individual's country of birth and presenting with a later stage.
Ladabaum et al. 2014	Analysis of data from the California Cancer Registry for US-born and foreign-born Asian subgroups, from 1990 to 2004	Colorectal cancer incidence	16,159 Asians and 153,805 non-Hispanic whites	Colorectal cancer incidence was lowest among foreign-born South Asians and highest among foreign-born Japanese. Women in all Asian subgroups except Japanese, and men in all Asian subgroups except Japanese and US-born Chinese, had lower colorectal cancer incidence than non-Hispanic whites. Amon Chinese men and Filipino women and men, colorectal cancer incidence was lower among foreign-born than US-born persons. The opposite was observed for Japanese women and men.
Tao et al. 2014	Analysis of data from the California Cancer Registry for US-born and foreign-born Hispanics, from 1988 through 2010	Colorectal cancer mortality	33,146 Hispanic individuals	Hispanics residing in lower socioeconomic status neighborhoods had a higher rate of overall and colorectal cancer-specific mortality than those residing in high socioeconomic status neighborhoods. The socioeconomic status associations were observed only among US-born Hispanics.
Feletto and Sitas 2015	Analysis of cancer incidence and mortality data for New South Wales, Australia residents, for 2004–2008	Colon cancer incidence		Colon cancer incidence was lower in non-Australian born men than in Australian-born men. The highest colon cancer rates were in western, English-speaking regions.
McDonald et al. 2017	Analysis of data from Statistics Canada that links Census information with administrative data on cancer and mortality, between 1991 and 2003	Colorectal cancer diagnosis	Individuals diagnosed with colorectal cancer	Recent immigrants to Canada were significantly less likely than non-immigrant Canadians to be diagnosed with colorectal cancer (OR = 0.477, p value = 0.000). This gap declined with additional years in Canada for immigrant men.
Paszat et al. 2017	Exposure-control matched design, between 1991 and 2008	Colorectal cancer incidence	401,635 non-Canadian born individuals and 2,008,175 matched controls	Among female immigrants, the HR for colorectal cancer was 0.63 (95% CI 0.59, 0.67) during the first 10 years, and 0.66 (95% CI 0.59, 0.74) thereafter. Among male immigrants, the HR for colorectal cancer was 0.55 (95% CI 0.52, 0.59) during the first 10 years, and 0.63 (95% CI 0.57, 0.71) thereafter.
Shuldiner et al. 2018	Retrospective cohort study in Ontario, Canada, from 2004 to 2014	Colorectal cancer incidence	Canadian-born and non-Canadian born individuals	Canadian immigrants born in South Asia had the lowest colorectal cancer incidence compared to long-term residents. Increased length of stay was associated with higher risk of colorectal cancer.

Table 2 (continued)

Author	Design	Outcomes	Sample	Results
Kaucher et al. 2018	Analysis of data from two cohorts in Germany, including ethnic Germans who had immigrated from the Russian federation and other countries of the former Soviet Union	Colorectal cancer incidence, mortality, and stage at diagnosis	32,972 and 59,390 individuals at risk of colorectal cancer	Compared to the general German population, ethnic resettlers had lower incidence and mortality from colorectal cancer.

Using data from the Swedish Family-Cancer Database, Hemminki et al. [36] examined the relation between immigration and colorectal cancer incidence. For colorectal cancer, male standardized incidence ratios (SIRs) for Norwegians, Estonians, and Frenchmen were increased, as were female SIRs for Danes and Austrians. The only decreases in SIRs were for Finnish and all Asian men and women.

Using SEER cancer registry data, Choe et al. [37] examined the relation between immigration and colorectal cancer stage at diagnosis and all-cause mortality among Asians and Pacific Islanders. Foreign-born Asian and Pacific Islander patients were more likely to present later, and they had a higher risk for death (HR = 1.29, 95% CI 1.23, 1.36). In an analysis of SEER data (United States) and International Agency for Research on Cancer data (South Korea), Lee et al. [38] found that colorectal cancer incidence was higher among Korean American men than their Korean counterparts.

Nasseri and Moulton [39] analyzed data from the Advanced Vital Statistics System from Los Angeles County and Orange County, California to examine the relation between immigration from selected Middle Eastern countries and colorectal cancer mortality. First and second generation immigrants had higher odds for dying from colorectal cancer.

Using data from the Swedish Family-Cancer Database, Mousavi et al. [40] examined the relation between immigration and colorectal cancer incidence. Non-Swedish-born individuals were classified into "high-risk" countries when their risk was increased and into "low-risk" when their risk was decreased. An increasing trend in colorectal cancer incidence was observed in low-risk men and high-risk women.

Barclay et al. [41] analyzed data on colorectal cancer stage at diagnosis and survival in a single tertiary care center in Australia. Using Australian Census data, four socioeconomic indices were assigned by residential postal code. No significant associations were observed.

Ladabaum et al. [42] analyzed colorectal cancer data from the California Cancer Registry for US-born and foreign-born Asian subgroups. Colorectal cancer incidence was lowest among foreign-born South Asians and highest among foreign-born Japanese. Women in all Asian subgroups except Japanese, and men in all Asian subgroups except Japanese and US-born Chinese, had lower colorectal cancer incidence than non-Hispanic whites. Among Chinese men and Filipino women and men, colorectal cancer incidence was lower among foreign-born than US-born persons. The opposite was observed for Japanese women and men.

Tao et al. [43] analyzed colorectal cancer mortality data from the California Cancer Registry for US-born and foreign-born Hispanics. Hispanics residing in lower socioeconomic status neighborhoods had a higher rate of overall and colorectal cancer-specific mortality than those residing in high socioeconomic status neighborhoods. The socioeconomic status associations were observed only among US-born Hispanics.Feletto and Sitas [44] examined the relation between immigration and colon cancer incidence using data for New South Wales, Australia. Colon cancer incidence was lower in non-Australian born men than in Australian-born men. The highest colon cancer rates were in western, English-speaking regions.

McDonald et al. [5] analyzed data from Statistics Canada that links Census information with administrative data on cancer and mortality. Recent immigrants to Canada were significantly less likely than non-immigrant Canadians to be diagnosed with colorectal cancer (OR = 0.477, p value = 0.000). This gap declined with additional years in Canada for immigrant men.

Paszat et al. [45] examined the relation between immigration status and colorectal cancer incidence in a exposure-control matched design study in Canada. Among female immigrants, the HR for colorectal cancer was 0.63 (95% CI 0.59, 0.67) during the first 10 years, and 0.66 (95% CI 0.59, 0.74) thereafter. Among male immigrants, the HR for colorectal cancer was 0.55 (95% CI 0.52, 0.59) during the first 10 years, and 0.63 (95% CI 0.57, 0.71) thereafter.

In a retrospective cohort study in Ontario, Canada, Shuldiner et al. [46] examined the relation between immigration and colorectal cancer incidence. Canadian immigrants born in South Asia had the lowest colorectal cancer incidence compared to long-term residents. Increased length of stay was associated with higher risk of colorectal cancer.

Kaucher et al. [47] examined colorectal cancer incidence, mortality, and stage data from two cohorts in Germany, including ethnic Germans who had immigrated from the Russian federation and other countries of the former Soviet Union. Compared to the general German population, ethnic resettlers had lower incidence and mortality from colorectal cancer.

Social support and colorectal cancer

In a cohort study of colorectal cancer patients in Denmark, Villingshoj et al. [48] examined the relation between having a cohabitation partner and colorectal cancer survival, as summarized in Table 3. A significantly higher mortality was observed among patients who had lost their partner compared to patients cohabitating with the same partner as before surgery for colorectal cancer (rate ratio = 1.4, 95% CI 1.1, 1.8). In a cohort study in Copenhagen, Denmark, Bergelt et al. [49] found no significant associations between high social network scores and colorectal cancer incidence.

Using SEER cancer registry data, Wang et al. [50] examined the relation between marital status and stage at colorectal cancer diagnosis and death from cancer. Married patients were more likely to be diagnosed at an earlier stage compared with single and separated/divorced patients. Married patients had a significantly lower risk of death from cancer (for men: HR = 0.86, 95% CI 0.82, 0.90; for women: HR = 0.87, 95% CI 0.83, 0.91). In a similar analysis of SEER cancer registry data, Aizer et al. [51] found that married patients were more likely to be diagnosed at an earlier stage compared with single and separated/divorced patients. Married patients had a significantly lower risk of death from cancer.

In a cohort study in Japan, Ikeda et al. [52] examined the relation between social support and colorectal cancer incidence and mortality. The HRs and 95% CIs for colorectal cancer incidence and mortality in the highest social support group vs. lowest social support group were 1.48 (1.06, 2.05) and 3.07 (1.65, 5.69) in men, respectively. Social support was not associated with colorectal cancer outcomes in women.

Using data from the Nurses' Health Study, Sarma et al. [53] examined the relation between social isolation and all-cause mortality and colorectal cancer-specific mortality. Women who were socially integrated before diagnosis had a reduced risk of all-cause mortality (HR = 0.65, 95% CI 0.46, 0.92) and colorectal cancer mortality (HR = 0.63, 95% CI 0.38, 1.06) compared with women who were socially isolated.

Table 3 Studies of social support and colorectal cancer risk, stage, and survival

Author	Design	Outcomes	Sample	Results
Villingshoj et al. 2006	Cohort study of colorectal cancer patients in Denmark	Colorectal cancer survival	770 colorectal cancer patients	A significantly higher mortality was observed among patients who had lost their partner compared to patients cohabitating with the same partner as before surgery for colorectal cancer (rate ratio = 1.4, 95% CI 1.1, 1.8).
Bergelt 2009	Cohort study in Copenhagen, Denmark	Colorectal cancer incidence	8548 individuals at risk for colorectal cancer	No significant associations were observed between high social network scores and colorectal cancer.
Wang et al. 2011	Analysis of SEER cancer registry data, between 1992 and 2006	Stage at colorectal cancer diagnosis and death from cancer	127,753 patients with colon cancer	Married patients were more likely to be diagnosed at an earlier stage compared with single and separated/divorced patients. Married patients had a significantly lower risk of death from cancer (for men: HR = 0.86, 95% CI 0.82, 0.90; for women: HR = 0.87, 95% CI 0.83, 0.91).
Aizer et al. 2013	Analysis of SEER cancer registry data from 2004 to 2008	Stage at colorectal cancer diagnosis and death from cancer	Individuals with colorectal cancer	Married patients were more likely to be diagnosed at an earlier stage compared with single and separated/divorced patients. Married patients had a significantly lower risk of death from cancer.
Ikeda et al. 2013	Cohort study in Japan	Colorectal cancer incidence and mortality	44,152 Japanese men and women	The HRs and 95% CIs for colorectal cancer incidence and mortality in the highest social support group vs. lowest social support group were 1.48 (1.06, 2.05) and 3.07 (1.65, 5.69) in men, respectively. Social support was not associated with colorectal cancer outcomes in women.
Sarma et al. 2018	Analysis of data from the Nurses' Health Study	All-cause mortality and colorectal cancer-specific mortality	896 women diagnosed with colorectal cancer	Women who were socially integrated before diagnosis had a reduced risk of all-cause mortality (HR = 0.65, 95% CI 0.46, 0.92) and colorectal cancer mortality (HR = 0.63, 95% CI 0.38, 1.06) compared with women who were socially isolated.
Yang et al. 2019	Analysis of data for colon cancer patients included in a medical center cancer registry in Taiwan	Colorectal cancer-specific survival	925 patients with colon cancer	Married patients had better 5-year disease-specific survival compared with unmarried patients (69.1% vs. 55.9%, $p < 0.001$).

In an analysis of data for colon cancer patients included in a medical center cancer registry in Taiwan, Yang et al. [54] examined the relation between marital status and colorectal cancer-specific survival. Married patients had better 5-year disease-specific survival compared with unmarried patients (69.1% vs. 55.9%, $p < 0.001$).

Discussion

The results of this review indicate that poverty, lack of education, immigration status, lack of social support, and social isolation play key roles in colorectal cancer survival. Although colorectal cancer incidence rates tend to be lower among immigrants, the healthy immigrant effect diminishes with each generation. Studies indicate that country of origin is associated with colorectal cancer survival. The later stage at diagnosis among immigrants is likely due to lower colorectal cancer screening rates and population differences in diet and physical activity.

A variety of factors may account for the inverse association between social support and advanced stage at colorectal cancer diagnosis. Patients may be influenced by their relatives or friends to undergo colorectal cancer screening. In addition, people who are married are more likely to have health insurance and a higher household income. Married persons may have greater access to colorectal cancer screening.

A number of studies have found an association between neighborhood disadvantage and higher colorectal cancer stage at diagnosis and mortality. Social stressors associated with neighborhood disadvantage and low socioeconomic status may increase the risk of colorectal cancer incidence and mortality through a number of pathways.

Conclusions

To address these social determinants of colorectal cancer, effective interventions are needed that account for the social and environmental contexts in which patients live [55]. Access to health care among immigrant populations is of concern. Also of concern is health communication about the benefits of early detection and treatment of colorectal cancer among patients who are unmarried or socially isolated.

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