Research Article

Cancer Epidemiology, Biomarkers & Prevention

Trends in Colon and Rectal Cancer Incidence in Australia from 1982 to 2014: Analysis of Data on Over 375,000 Cases

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Abstract

Background: Colorectal cancer is the third most commonly diagnosed cancer in Australia. Emerging evidence from several countries suggests increasing incidence in people aged <50 years.

Methods: We assessed colon and rectal cancer incidence trends in people aged 20+ in Australia from 1982 to 2014. We used data on 375,008 incident cases (248,162 colon and 126,846 rectal). We quantified the annual percentage change (APC) in rates by age group using Joinpoint regression.

Results: For people aged <50 years, colon cancer rates increased from the mid-2000s, with the increase in APCs ranging from 1.7% to 9.3% per annum (depending on specific age group); rectal cancer rates increased from the early 1990s, with APCs ranging from 0.9% to 7.1% per annum. For people aged 50 to 69 years, colon and rectal cancer rates decreased from the mid-1990s, with the decrease in APCs in specific age groups ranging from 0.8% to 4.8% per annum (except for colon cancer in those ages 65 to 69 years, where similar rate decreases were observed from 2007). An overall reduction in older persons (>70 years) was estimated at 1.9% to 4.9% per annum for colon cancer from 2010 onward and 1.1% to 1.8% per annum in rectal cancer from the early 2000s onward.

Conclusions: Colon and rectal cancer incidence has increased in people aged <50 years in Australia over the last two decades. However, colon and rectal cancer rates decreased in people aged 50+, likely due to *de facto* and organized bowel cancer screening.

Impact: Further research is needed to examine the cause of the increase and to quantify the impact of future trends on the cost-effectiveness of population-based screening for those <50 years.

Introduction

In Australia, colorectal cancer was the third most commonly diagnosed cancer in 2017 overall, with estimated all-age incidence rates of 67.3 per 100,000 in males and 49.4 per 100,000 in females (1, 2). Emergent evidence has suggested that incidence of colorectal cancer in people under 50 years of age ("early onset colorectal cancer") is rising in high-income countries (3–6), including Australia (7–10), with varying survival outcomes depending on the stage of disease at diagnosis (11, 12). A small proportion of early onset colorectal cancer is likely associated with hereditary syndromes, which increase risk at younger ages, such as Lynch syndrome and familial adenomatous polyposis (FAP), but these account for only approximately 3% and well below 1% of the total number of new colorectal cancer cases, respectively (13, 14).

Modifiable lifestyle factors have been linked to colorectal cancer in epidemiologic analyses (15, 16). Excess body fatness and physical inactivity, smoking, red and processed meat consumption, and ionizing radiation have all been associated with increased colorectal cancer risk (15, 17–19). Conversely, dietary fiber, calcium supplements, dairy products, whole grains, and regular aspirin use have been associated with reduced colorectal cancer risk (15, 20). Risk factors for colon and rectal cancer are generally similar, with some key exceptions, such as physical activity, which has been found to significantly reduce colon but not rectal cancer (15, 21). At-risk levels of these behaviors have reportedly increased at the same time as the observed increases in early onset colorectal cancer, and these phenomena could be linked (3, 5, 8).

Screening can lead to reduced cancer incidence, as well as mortality, through the early detection of both cancer and precancerous conditions (22). The Australian National Bowel Cancer Screening Program (NBCSP) is currently at an advanced stage of a phased implementation process. By 2020, all those ages 50 to 74 years will be invited to participate biennially in screening, with current biennial participation rate of approximately 41% (23). In this context, the aim of the current study was to perform a detailed,

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comprehensive, and up-to-date analysis of temporal trends in colon and rectal incidence in Australia by age, period, and cohort from 1982 to 2014.

Materials and Methods

Data sources

We included new cases diagnosed with cancer of the colon (C18), or rectosigmoid and rectum (C19–C20), between 1982 and 2014 in the analysis. Australian incident cancer data have been classified as high quality and are reported regionally before being collated at a national level (24). The colorectal cancer data were extracted from the Australian Cancer Incidence and Mortality books (http://www.aihw.gov.au/acim-books/), grouped by cancer type, year of diagnosis, 5-year age group, and sex. Corresponding national population figures by calendar year, 5-year age group, and sex were also obtained (25). We restricted the analyses to those aged 20 years or over, given small case numbers in people under 20 years. As the incidence trends were similar for men and women (not shown), analyses were combined, as in other studies (3). Colon cancer (C18) cases were separated from cancers of the rectosigmoid (C19) and rectum (C20), which were grouped together as rectal cancer for analysis.

Joinpoint analysis

Annual incidence rates from 1982 to 2014 were estimated for 11 age groups (20–29, 30–39, 40–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85+) for colon cancer, and 9 age groups (20–29, 30–39, 40–49, 50–59, 60–69, 70–74, 75–79, 80–84, 85+) for rectal cancer, with age groupings by subtype determined by the case numbers and similarity of trends (Supplementary Tables S1 and S2). Joinpoint regression analysis (26, 27), a commonly used technique to discern temporal trends in cancer incidence, was used to identify the points of change in direction and estimate the magnitude of change in rates. The Joinpoint analysis estimates annual percentage change (APC) by assessing observed data and fitting a series of joined straight lines to determine the APC over each period. To quantify the linear trends, an APC is computed for each change in direction in rates for an age group over time. The changes are then tested for statistical significance.

Age-period-cohort modeling

Birth cohort models were fitted using an age-period-cohort analysis tool (28). Age-period-cohort modeling (29) describes relationships between observed incidence rates and age at diagnosis, calendar period of diagnosis, and birth cohort of cancer cases. Input data were stratified into six 5-year time periods (1985–1989, 1990–1994, 1995–1999, 2000–2004, 2005–2009, and 2010–2014) and fourteen 5-year age groups. Twenty birth cohorts were generated, starting from the 1900 birth cohort (representing people born from 1898 to 1902) up to the 1990 birth cohort (1988 to 1992). Cohort effects were presented as incidence rate ratios (IRR), calculated by comparing the incidence rate for a given birth cohort with that of a chosen referent cohort. The 1943–1947 birth cohort was used as the default reference cohort for both colon and rectal cancers. In addition, we estimated local drifts which illustrate the trends of birth cohort effects.

Results

There were 375,008 colorectal cancer cases diagnosed between 1982 and 2014 in Australians over 20 years of age, including 248,162 colon and 126,846 rectal cancer cases. Approximately 7% (17,859 cases) and 9% (11,457 cases) of colon and rectal cancer cases, respectively, were in people under 50 years of age. The results of the Joinpoint regression are shown in Table 1 and Figs. 1 (for colon cancer) and 2 (for rectal cancer).

Table 1. APC in colon and rectal cancer incidence rates by age and tumor location, Australia, 1982–2014

		Trend 1		Trend 2		Trend 3		Trend 4	
	N	Year	APC (95% CI)[a]	Year	APC (95% CI)	Year	APC (95% CI)	Year	APC (95% CI)
Colon									
20–29	1,496	1982–2004	2.0 (0.7, 3.3)[a]	2004–2014	9.3 (6.4,12.3)[a]				
30–39	3,860	1982–1995	−3 (−4, −2)[a]	1995–1999	6.9 (−4.7, 20)	1999–2006	−1.3 (−4.5, 2)	2006–2014	6.5 (4.6, 8.5)[a]
40–49	12,504	1982–2003	−1.9 (−2.3, −1.5)[a]	2003–2014	1.7 (0.7, 2.6)[a]				
50–54	13,273	1982–1991	0.7 (−1.1, 2.4)	1991–1998	−4 (−6.8, −1.2)[a]	1998–2014	−0.8 (−1.4, −0.1)[a]		
55–59	20,088	1982–1996	1.3 (0.5, 2)[a]	1996–2004	−4.8 (−6.6, −3)[a]	2004–2007	4.8 (−10.3, 22.3)	2007–2014	−3.4 (−5.1, −1.7)[a]
60–64	27,816	1982–1992	1.4 (0.8, 2)[a]	1992–2000	0 (−0.9, 1)	2000–2014	−2.4 (−2.7, −2.1)[a]		
65–69	35,353	1982–2007	0.9 (0.6, 1.2)[a]	2007–2014	−4.9 (−6.5, −3.3)[a]				
70–74	39,305	1982–1993	0.7 (0.2, 1.2)[a]	1993–2000	2.1 (1, 3.1)[a]	2000–2010	−0.3 (−0.8, 0.2)	2010–2014	−4.9 (−6.8, −3)[a]
75–79	38,395	1982–2009	0.8 (0.7, 0.9)[a]	2009–2014	−1.9 (−3.4, −0.4)[a]				
80–84	30,530	1982–2011	0.7 (0.5, 0.8)[a]	2011–2014	−2.3 (−6.2, 1.8)				
85+	25,543	1982–2014	0.2 (0.1, 0.4)[a]						
Rectum									
20–29	489	1982–1993	−1.3 (−4.8, 2.3)	1993–2014	7.1 (6.1, 8)[a]				
30–39	2,374	1982–2014	2.6 (2.2, 3)[a]						
40–49	8,593	1982–1990	−1.8 (−3.9, 0.4)	1990–2014	0.9 (0.6, 1.2)[a]				
50–59	22,946	1982–1994	1.3 (0.6, 1.9)[a]	1994–2003	−1.3 (−2.4, −0.2)[a]	2003–2007	3.0 (−2.2, 8.4)	2007–2014	−3.7 (−4.9, −2.5)[a]
60–69	36,185	1982–1989	0.7 (−0.5, 1.9)	1989–1994	4.0 (1.3, 6.7)[a]	1994–2007	−0.4 (−0.8, 0)	2007–2014	−3.6 (−4.4, −2.7)[a]
70–74	19,176	1982–2000	1.4 (1.0, 1.8)[a]	2000–2011	−1.1 (−2, −0.3)[a]	2011–2014	−5.8 (−11.3, 0.1)		
75–79	16,760	1982–2001	1.3 (0.9, 1.7)[a]	2001–2014	−1.8 (−2.4, −1.1)[a]				
80–84	11,690	1982–2002	0.7 (0.2, 1.3)[a]	2002–2014	−1.8 (−2.7, −0.9)[a]				
85+	8,633	1982–2014	−0.8 (−1, −0.5)[a]						

[a]The APC is significantly different from zero at alpha = 0.05. Statistically significant positive APCs are in gray boxes, and statistically significant negative APCs are in black boxes.

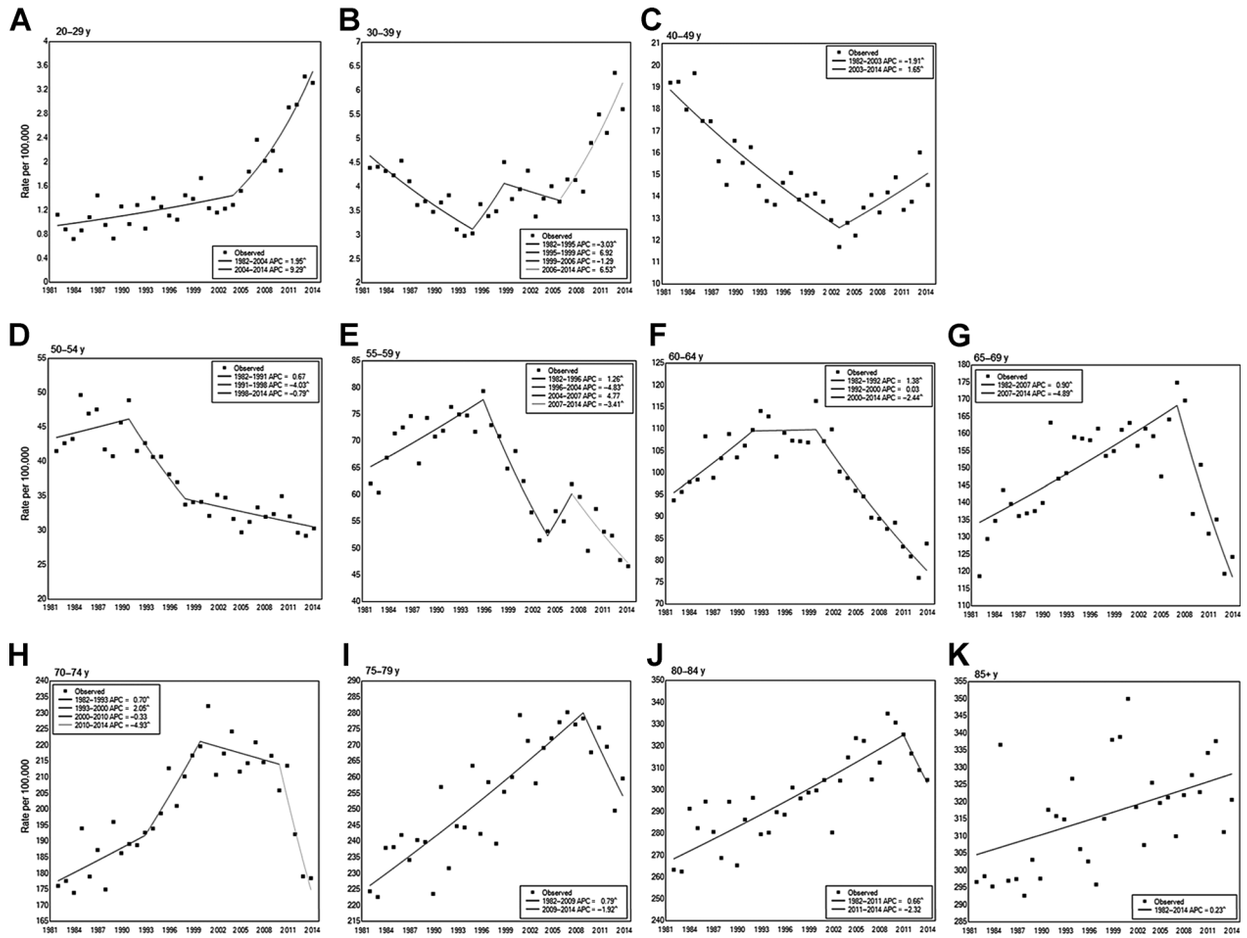

Figure 1.

The age-specific colon cancer incidence rates and APC from 1982 to 2014 for people aged (**A**) 20–29 years, (**B**) 30–39 years, (**C**) 40–49 years, (**D**) 50–54 years, (**E**) 55–59 years, (**F**) 60–64 years, (**G**) 65–69 years, (**H**) 70–74 years, (**I**) 75–79 years, (**J**) 80–84 years, and (**K**) 85+ years.

Under 50 years of age

For those aged 20 to 29 years, colon cancer incidence increased by 2% per annum between 1982 and 2004 and then by 9.3% per annum from 2004 to 2014. A similar trend was observed for those aged 30 to 39 years, but the increase started approximately a decade later (6.9% per annum from 1995 to 1999 and 6.5% per annum from 2006 to 2014). In those aged 40 to 49 years, the increase was 1.7% per annum from 2003 to 2014.

For those aged 20 to 29 years, rectal cancer incidence increased by 7.1% per annum from 1993 to 2014. An increasing trend was observed for those aged 30 to 39 years over the entire period (2.6% per annum from 1982 to 2014). In those aged 40 to 49 years, the increase was 0.9% per annum from 1990 to 2014.

Fifty years and over

In those aged 50 and over, colon cancer incidence increased in early periods and then fell. For people aged 50 to 64 years, colon cancer rates have been decreasing since the mid-1990s (by between 0.8% and 4.8% per annum), and for those aged 65 to 69 years, rates have been decreasing since 2007 by 4.9% per annum. For those aged 70 to 79 years, the APC decreased from 2009–2010 to 2014 by 1.9% to 4.9% per annum. The exception was for those aged 85 years and older in whom an increase of 0.2% per annum was observed over the entire 33-year period.

For people in their 50s and 60s, rectal cancer has been decreasing since the mid-90s (most recently by 3.6% to 3.7% per annum from 2007 to 2014). For people in their 70s, rates decreased from the early 2000s. In contrast to colon cancer, rectal cancer incidence decreased in those aged 85 and over at a rate of 0.8% per annum over the entire 33-year period.

IRRs and local drift

Table 2 and Fig. 3 show the IRRs by birth cohort for colon and rectal cancers for the period of 1985 to 2014. Compared with the 1943–1947 birth reference cohort, the IRRs for colon cancer were marginally higher for birth cohorts from the late 1880s to the early 1940s, and the IRRs were slightly lower for cohorts from the late 1940s to the early 1970s. The 1973–1977 birth cohort was notable for its increase in IRR which continued to later cohorts reaching 3.03 [confidence interval (CI), 2.37–3.88] for the youngest cohort (1988–1992). Similarly, the IRRs for rectal cancer were marginally higher for the earlier birth cohorts in comparison with

Table 2. IRRs for colon and rectal cancers, by birth cohort

Colon cancer, 1985–2014		Rectal cancer, 1985–2014	
Cohort	**IRR (95% CI)**	**Cohort**	**IRR (95% CI)**
1898–1902	1.06 (1–1.13)	1898–1902	1.26 (1.13–1.4)
1903–1907	1.08 (1.03–1.13)	1903–1907	1.12 (1.04–1.2)
1908–1912	1.06 (1.03–1.1)	1908–1912	1.08 (1.02–1.14)
1913–1917	1.09 (1.05–1.12)	1913–1917	1.05 (1–1.1)
1918–1922	1.09 (1.06–1.13)	1918–1922	1.06 (1.02–1.1)
1923–1927	1.17 (1.13–1.2)	1923–1927	1.07 (1.04–1.11)
1928–1932	1.21 (1.18–1.25)	1928–1932	1.08 (1.04–1.12)
1933–1937	1.21 (1.18–1.24)	1933–1937	1.09 (1.05–1.12)
1938–1942	1.17 (1.14–1.2)	1938–1942	1.09 (1.05–1.12)
1943–1947	1 (1–1)	1943–1947	1 (1–1)
1948–1952	0.93 (0.9–0.96)	1948–1952	1.02 (0.99–1.06)
1953–1957	0.86 (0.83–0.9)	1953–1957	1.02 (0.97–1.06)
1958–1962	0.84 (0.8–0.88)	1958–1962	1.06 (1–1.12)
1963–1967	0.91 (0.86–0.96)	1963–1967	1.24 (1.16–1.34)
1968–1972	0.96 (0.89–1.04)	1968–1972	1.43 (1.29–1.58)
1973–1977	1.15 (1.04–1.28)	1973–1977	1.83 (1.59–2.09)
1978–1982	1.55 (1.35–1.77)	1978–1982	2.43 (2.01–2.95)
1983–1987	2.34 (1.98–2.77)	1983–1987	4.42 (3.36–5.82)
1988–1992	3.03 (2.37–3.88)	1988–1992	3.95 (2.32–6.73)

the reference cohort but increased in magnitude for cohorts from the mid-1960s reaching the highest IRR of 4.42 (CI, 3.36–5.82) for the 1983–1987 cohort.

Figure 4 shows the local drift (net age-specific APC) of colon and rectal cancer incidence rates. For colon cancer, there was an increase in incidence for ages up to 40 years and for ages over 70 years. The average APC over the whole period for colon cancer incidence for all age groups combined was 0.12% (statistically significant). For rectal cancer, there was an increase in incidence for ages up to approximately 45 years and a decrease in incidence for ages older than 45 years, with an average APC over the whole period of 0.9% (statistically significant) for all age groups combined. These age-period-cohort findings highlight the period and cohort effects and are consistent with those of the Joinpoint analysis.

Discussion

Our analysis of incidence trends over time suggests that for people under 50 years of age, the incidence of colon cancer has been increasing since the mid-2000s. Rates of rectal cancer have

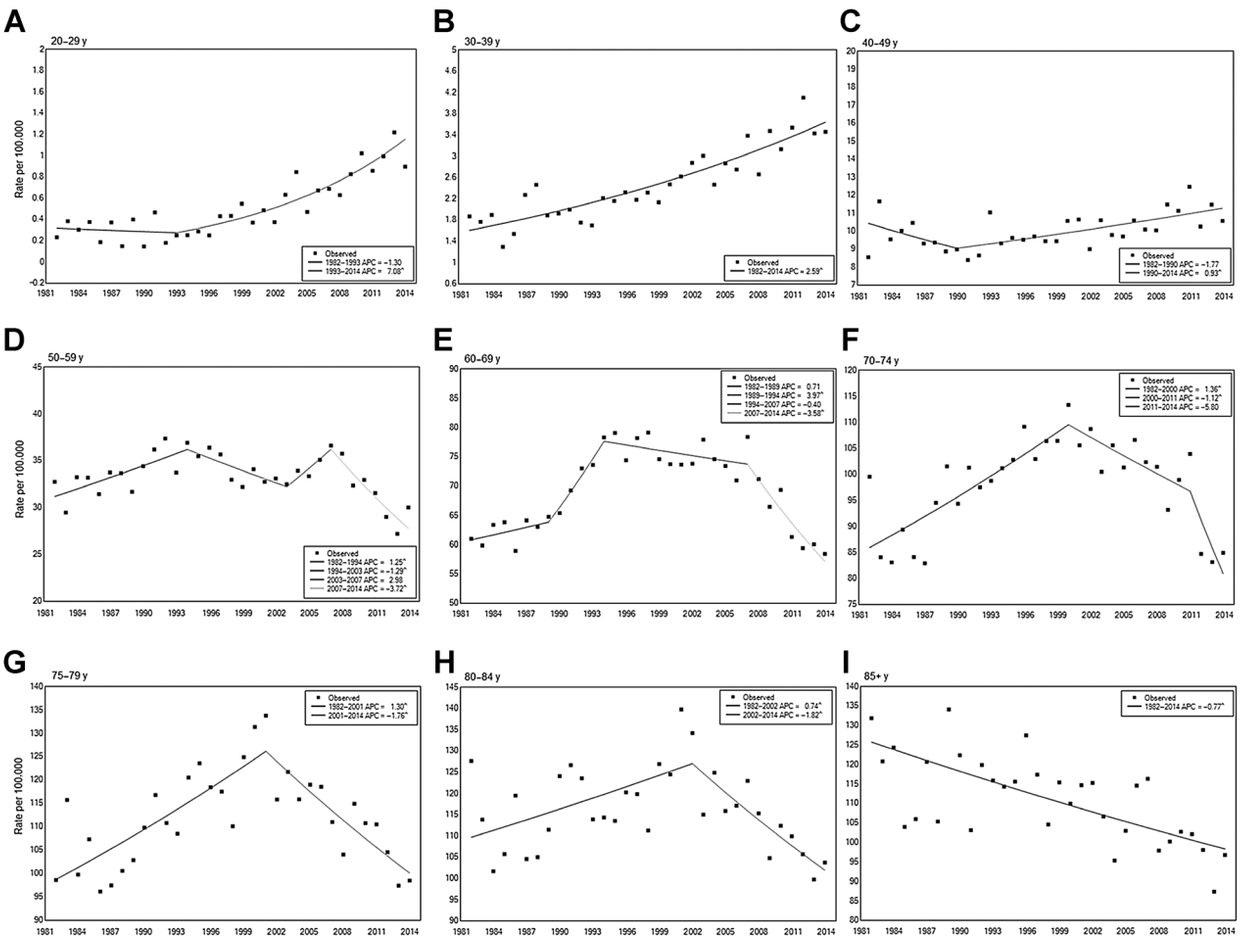

Figure 2.
The age-specific rectal cancer incidence rates and APC from 1982 to 2014 for people aged (**A**) 20–29 years, (**B**) 30–39 years, (**C**) 40–49 years, (**D**) 50–59 years, (**E**) 60–69 years, (**F**) 70–74 years, (**G**) 75–79 years, (**H**) 80–84 years, and (**I**) 85+ years.

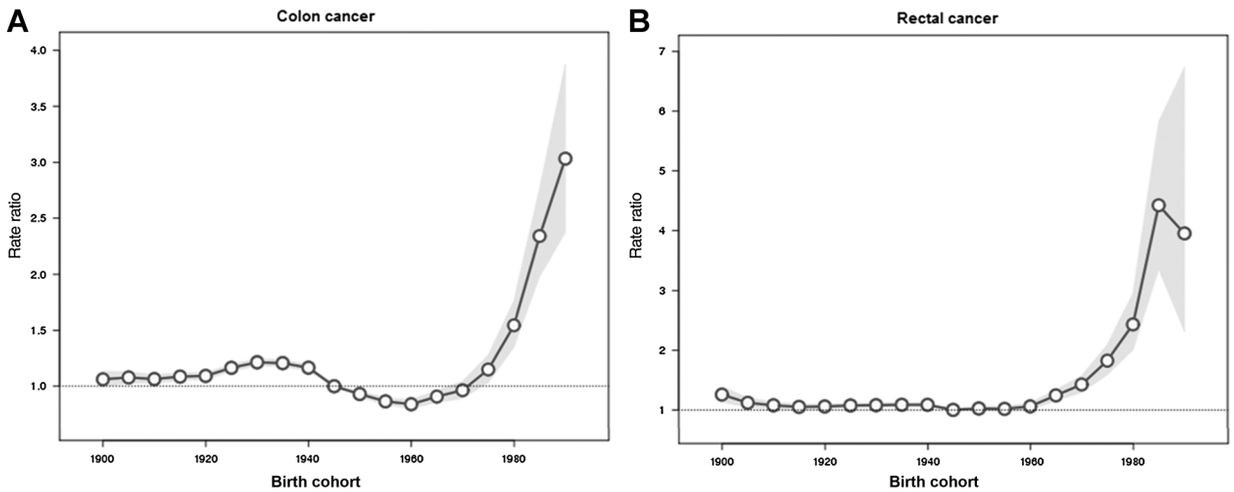

Figure 3.
The IRRs by birth cohort for (**A**) colon and (**B**) rectal cancers.

been increasing since the early 1990s in those aged 20 to 29 and 40 to 49 and since the early 1980s for those aged 30 to 39 years. For people aged 50 to 69 years, colon and rectal cancer rates decreased from the mid-1990s. An overall reduction in older persons (>70 years) was also seen for colon cancer from 2010 onward and in rectal cancer from the early 2000s onward.

These changes over time can be explained by cohort effects. We found that colon cancer incidence has increased for cohorts born in the late 1970s onward, with the incidence of colon cancer being 3 times higher for those born from 1988 to 1992 compared with those born in 1943 to 1947. Rectal cancer has been increasing in cohorts born from the 1960s onward, with a 4-fold increase in incidence experienced by the youngest birth cohorts examined, who were born in the late 1980s to early 1990s. These findings suggest that the changing rates over time are largely attributable to changing exposures in successive generations.

Our findings are consistent with previous work in Australia (8–10) but provide a greater level of detail over a longer time period, with information on specific trends in colon and rectal cancer, with the inclusion of over 375,000 cases in our analysis. A previous study analyzed incidence rates from 1990, 1995, 2000, 2005, and 2010 and found that colorectal cancer incidence was increasing for those under 40 years of age but was stable or declining in those ages 40 to 59 years (9). An analysis of Australian women from the early 1980s identified an excess of colon cancer in those ages 35 to 60 years, hypothesized to be associated with hormonal effects or other unidentified factors (7). This was also found in a later analysis, where the incidence rates for Australian women ages 18 to 39 years appeared to increase by 1.4% per annum over the period of 1982 to 2007, but this increase was not observed for men (–0.4% per annum; ref. 8). On the other hand, two studies in New South Wales and Victoria in the 2000s found

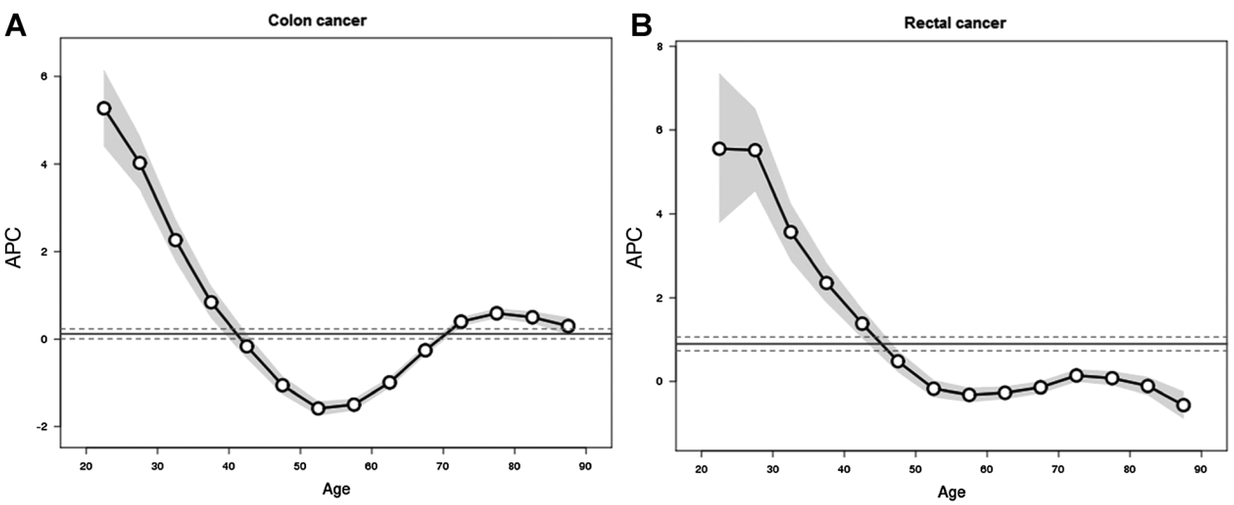

Figure 4.
The age-specific APC (local drift) for (**A**) colon and (**B**) rectal cancers.

that there was no significant increase in the incidence rate of early onset colorectal cancer overall, but both noted an increased absolute number of rectal cancer cases in younger people (30, 31). By using national, longitudinal data from 1982 to 2014, our analysis was able to better assess the temporal trends across the whole population and illustrate a definitive rise in the incidence of early onset colorectal cancer, for both colon and rectal cancer. Trends were not analyzed separately for males and females as incidence was similar in the two groups.

A global analysis of temporal trends in colorectal cancer suggested declining incidence and mortality over time for Australians of all ages (32). However, when analyses are stratified into age groups, Australia and countries with similar overall colorectal cancer trends have shown evidence of increasing incidence of early onset colorectal cancer (3–6). Most recently, Siegel and colleagues analyzed U.S. data from 1974 to 2013 and found an increase in both colon and rectal cancer incidence for people aged under 50 years (3). When compared with our findings, the U.S. and Australian trends by age were broadly similar, but with variations in the timing of changes in rates. In general terms, the U.S. findings also suggest a birth cohort effect. Studies from other developed countries have reported conflicting patterns in early onset colorectal cancer incidence with some suggestion of increasing incidence in younger people (4, 5, 33, 34). Data from low- and middle-income countries point toward rising incidence in early onset colorectal cancer as an emerging issue as they progress through periods of transition (32).

Risk factor exposure

A rise in chronic disease prevalence in Australia has been at least partially attributed to lifestyle exposures (35). The results of the age-period-cohort modeling identified substantial cohort effects illustrating a change in rates in successive age groups in successive time periods; this is often associated with a change in exposure affecting an entire birth cohort. The prevalence of key colorectal cancer risk factors has shifted in recent decades in Australia and in other high-income countries (36, 37). Overweight and obesity prevalence has increased in Australia, and this increase is projected to continue to 2025 (37, 38). Childhood obesity has also increased over 2.5-fold from 1985 to 2012 (39). Although many indicators of alcohol consumption have decreased recently, more individuals are undertaking risky drinking behaviors (40). Risky behaviors and rising obesity could contribute to increased colorectal cancer risk and, if started at an early age, could be partially driving the rise in early onset colorectal cancer.

Other exposures have also been associated with increased colorectal cancer risk. The available data suggest that red meat consumption has dropped since the 1970s but remains over 100 g per day (41). Data on processed meat consumption showed that in 2011–2012, adult Australians consumed over 11 g of processed meats daily (42). These data suggest that red and processed meat consumption may contribute to the burden of colorectal cancer. Smoking, linked to increased colorectal cancer risk (19), has been decreasing for Australian men and women from the mid-1980s (43). Considering the declining prevalence, the age delay in uptake, and the lag time between smoking and colorectal cancer risk, it could be hypothesized that declining smoking rates have contributed to the decreasing incidence in older age groups rather than having an effect on the increasing rates in people under 50 years (9). Also, it has been suggested that colorectal cancer risk may be related to repeated antibiotic exposure which can cause a lasting change in colonic bacterial diversity (44).

There are also key lifestyle factors that may reduce colorectal cancer risk. Regular moderate to vigorous physical activity has been associated with decreased colorectal cancer risk, particularly for colon cancer (21), but in 2011–2012, only 53% of the population met the guideline daily physical activity recommendations (45). In addition, daily aspirin intake appears to reduce colorectal cancer risk after a latency period of approximately 10 years (20). New Australian clinical practice guidelines for colorectal cancer recommend daily aspirin use for all people ages 50 to 70 years at average colorectal cancer risk (46).

Family history and hereditary factors

Family history and hereditary factors can promote the development of colorectal cancer at an earlier age, forming a group of higher risk individuals compared with the general population (47). Without regular endoscopic surveillance or prophylactic surgery, the majority of FAP patients develop colorectal cancer by 50 years of age. People at higher risk should be under closer surveillance which would lead to higher ascertainment of colorectal cancer in those under 50 years of age, and evidence exists to support screening for high-risk population groups, regardless of age, in a more systematic manner. Risk-based triaging continues to gain momentum as a way of reducing early-onset colorectal cancer incidence, colorectal cancer burden, and managing high-risk patients effectively (48). It was not possible from our data to segment analyses and discern the proportion of people with a family history or a hereditary predisposition that may have contributed to the increased colorectal cancer incidence at younger ages. If identified as being at higher risk and monitored closely, those more likely to be diagnosed with early onset colorectal cancer may be identified and undergo preventive interventions before developing cancer.

Impact of screening

In contrast to the increasing rates in younger people, the patterns showed a previous increase in incidence of colon and rectal cancers, which appears to have been reversed in recent decades for most age groups over 50. This is likely due to opportunistic screening from the early 2000s and organized screening of people ages 50 to 74 years since 2006 as the NBCSP has been rolling out. The NBCSP in Australia has been implemented in a staged process (Supplementary Table S3). We saw recent decreases in rates of colon and rectal cancer in people over 50 which could represent the delayed effects of NBCSP-related screening in older age groups. However, no such reversal of the increasing trend has been observed for colon cancer in older people (85+ years). Improvements related to any screening initiative (population wide or opportunistic) would be more apparent after full roll out of the program is complete in 2020 and by stage shifts in colorectal cancers; however, stage-specific data are not available at a national population level for analysis.

People under 50 years of age are not included in the target age range for the NBCSP under the current guidelines and as a result are not directly affected by organized screening practices. Recently, we re-evaluated the recommended age range for screening, and it was concluded that extending screening to those 45 to 49 years of age, while potentially being cost-effective, had a less favorable benefits-to-harms ratio (49). Thus, the NBCSP at present we believe remains best targeted at people ages 50 to 74 years

(46, 49). If early onset colorectal cancer incidence rises, this has the potential to modify the balance of benefits to harms of screening in younger people, and the current target age group may need to be reconsidered. Until such time, encouraging NBCSP participation in the targeted population and improved management of individuals of any age at higher risk of colorectal cancer should be the focus of any cancer control initiatives. For the general population at low-to-average colorectal cancer risk, a focus on risk factor reduction would be more useful and effective in addressing the colorectal cancer burden. Further research to disentangle the etiologic factors that may underlie increasing incidence in people under 50, as well as ongoing epidemiologic analyses, would be informative.

Strengths and limitations

This study has a number of strengths. Birth cohort analyses provide a more robust assessment of trends that may be associated with changing prevalence of risk factors. The analyses are able to isolate changes by cohort often associated with modifications to long-term habits or long-term exposures whereby different generations are exposed to different risk. We aimed to provide a contemporary analysis of variations of colon and rectal cancer incidence differences in Australia to enable the distinction of age-related differences that have not been previously apparent. However, important study limitations should be highlighted. Population-level data limit our ability to make inferences relating to differences in subgroups such as high-risk populations or by colorectal cancer subtypes. National aggregate trends on risk factor prevalence are available, but these cannot be directly correlated to changing incidence rates, and these associations can only be inferred. Finally, information relating to underlying genetic risk factors and stage at presentation is not available from national databases and cannot be assessed.

Conclusion

The incidence of both colon and rectal cancers appears to be increasing in people under 50 years of age in Australia. It is possible that some of the observed increase in early onset colorectal cancer is attributable to lifestyle changes in the population over time. By contrast, rates are decreasing in people in their 50s, 60s, and 70s, potentially due to the role of opportunistic screening and surveillance, and more recently the introduction of an organized national screening program in people ages 50 to 74 years. These findings underpin the rationale for the implementation of primary prevention approaches to colorectal cancer. If rates in young people continue to increase, a reassessment of the role of bowel cancer screening in younger age groups will be warranted.

Disclosure of Potential Conflicts of Interest

K. Canfell is co-PI of an unrelated investigator-initiated trial of cervical screening in Australia ("Compass") conducted by the Victorian Cytology Service, which has received a funding contribution from Roche Molecular Systems and Ventana Inc., USA. No potential conflicts of interest were disclosed by the other authors.

Authors' Contributions

Conception and design: E. Feletto, X.Q. Yu, M.A. Jenkins, F.A. Macrae, S.E. Mahady, K. Canfell
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