ORIGINAL ARTICLE

Declining Bowel Cancer Incidence and Mortality in Germany

An Analysis of Time Trends in the First Ten Years After the Introduction of Screening Colonoscopy

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SUMMARY

Background: In October 2002, screening colonoscopy from age 55 onward was introduced as part of the German national statutory cancer screening program. Screening colonoscopy is intended to lower both the mortality and the incidence of bowel cancer by enabling the detection and removal of precursor lesions.

Method: The authors studied trends in bowel cancer incidence and mortality in Germany from 2003 to 2012 on the basis of data from the epidemiological cancer registries and from cause-of-death statistics.

Results: Over the period of investigation, the age-standardized incidence of bowel cancer (with the European population as a standard) fell from 66.1 to 57.0 cases per 100 000 persons per year (−13.8%) in men and from 42.6 to 36.5 per 100 000 persons per year (−14.3%) in women. In parallel with these changes, the age-standardized mortality from bowel cancer fell by 20.8% in men and by 26.5% in women. In the age groups 55–64, 65–74, and 75–84 years, the cumulative risk of receiving a diagnosis of bowel cancer fell by 17–26%; in persons under age 55, this risk fell by only 3% in men, but increased by 14% in women. Long-term data from the cancer registry in the German federal state of Saarland revealed that the incidence of bowel cancer, but not its mortality, had risen over the decades preceding the study; it was only during the period of investigation that the trend reversed itself.

Conclusion: Within 10 years of the introduction of screening colonoscopy in Germany, the incidence of bowel cancer in persons over age 55 fell by 17–26%, after having risen steadily over the preceding decades.

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Bowel cancer is one of the most frequently diagnosed cancers. Worldwide, every year about 1.4 million people develop bowel cancer and in approximately 700 000 people the disease is fatal (1). In international comparisons, Germany is among the countries with high incidence of bowel cancer: The estimated total numbers of new cases and deaths in 2010 were about 62 000 and 26 000, respectively (2).

Screening colonoscopy was added to the German national statutory cancer screening program in October 2002. Ever since then, men and women aged 55 years and older have been offered the opportunity to undergo screening colonoscopy for bowel cancer. Patients having the examination done before age 65 are eligible for a second screening colonoscopy after 10 years. Screening colonoscopy data are compiled in a nationwide registry hosted by the Central Research Institute of Ambulatory Health Care in Germany.

In contrast to other types of screening examinations suitable for diagnosing cancer at an early stage, screening colonoscopy can reliably detect precursors of cancer, such as colorectal adenoma, which can usually be removed during the screening procedure. Thus, screening colonoscopy does not only contribute to early detection of bowel cancer but also to its prevention. According to recent estimates based on data from the German national screening colonoscopy registry, adenomas were detected and removed in approximately 1 in 5 million participants during the first 10 years of the screening program, translating into approximately 180 000 bowel cancer cases estimated to have been prevented in the long run (3). With bowel cancer in most cases developing very slowly over many years (4), the full effect of this preventive measure will only be seen in the longer term (5). The aim of this study was to evaluate whether or not and to what extent bowel cancer incidence and mortality have already declined in the affected age groups in the first 10 years after the introduction of screening colonoscopy in Germany.

Methods

We present trends in the incidence and mortality of bowel cancer (ICD-10 items: C18–C21) in Germany between 2003 and 2012. Incidence rates are derived

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Age-standardized
bowel cancer inci-
dence and mortality
in Germany between
2003 and 2012
(standard: European
population)

FIGURE 1

from extrapolations of the Association of Population-based Cancer Registries in Germany (GEKID, Gesellschaft der Epidemiologischen Krebsregister in Deutschland) based on data from the Epidemiologic Cancer Registries (6). Mortality rates are based on the official cause-of-death statistics. Apart from age-standardized rates (standard: European Standard Population) across all age groups, specific incidence and mortality trends are also presented for the age groups <55, 55–64, 65–74, and 75–84 years. Cumulative risk of disease and risk of mortality, being particularly illustrative measures of age-specific incidence and mortality, were calculated within the age ranges and their percentage changes between 2003 and 2012 were determined. Based on the age-specific incidence and mortality rates, the cumulative disease and mortality risks quantify the probability to develop or die of bowel cancer within the age range.

In addition, age-standardized incidence and mortality rates (standard: European Standard Population) for the German Federal State of Saarland are presented for the 40-year period from 1972 to 2012 to provide a background of long-term bowel cancer incidence and mortality trends; thus, the corresponding time trends since the introduction of screening colonoscopy can be assessed within this context (7). While the majority of epidemiological cancer registries in Germany were only established in the last 10 to 20 years, the Saarland Cancer Registry provides sufficiently complete cancer

registry data over this long period of time. For the presentation of the Saarland incidence and mortality rates, the averages for each period of three consecutive calendar years were calculated and presented to reduce the impact of random fluctuations.

Because of the large differences in bowel cancer incidence between men and women, all epidemiological indicators are presented separately for each gender.

Results

Incidence and mortality changes between 2003 and 2012

Figure 1 shows the development of age-standardized bowel cancer incidence and mortality rates in Germany between 2003 and 2012. During the entire period, the mortality rates were a little more than 60% below the corresponding incidence rates. Both incidence and mortality are much higher in men compared with the corresponding rates in women. Between 2003 and 2012, substantial decreases not only in mortality but also in incidence were noted. Among men, the age-standardized incidence declined from 66.1 to 57.0 per 100 000 (–13.8%), among women from 42.6 to 36.5 per 100 000 (–14.3%). Age-standardized mortality decreased in men by 20.8% and in women by 26.5%. While the decline in mortality was slightly more pronounced during the first 5 years of the study period, an acceleration over the last years was noted for the decrease in incidence observed since 2004. Owing to

FIGURE 2

Age-standardized bowel cancer incidence and mortality in the Federal State of Saarland, Germany, between 2003 and 2012 (standard: European population)

demographic trends, the total number of new cases of bowel cancer declined only marginally from approximately 63 000 to about 61 500.

Long-term trends

While a downward trend in age-standardized bowel cancer mortality can be traced back for about 30 years, age-standardized incidence only started to decline during the last 10 years, as illustrated by the long-term trends derived from the data of the Saarland Cancer Registry (Figure 2). Prior to this, bowel cancer incidence rates increased over several decades; only after the millennium, this trend reversed.

Age-specific trends

Across Germany, major differences in the development of the incidence rates of the various age groups were observed between 2003 and 2012 (Table). While the cumulative risk of disease in the age ranges 55–64, 65–74 and 75–84 decreased by 17 to 20% in men and 21 to 26% in women, only a minor reduction of 3% was observed in the age group up to 55 years in men. In women of the same age group, the cumulative risk of disease even increased by 14%. However, because the risk of disease prior to age 55 is comparably low, the cumulative risk of disease over the age range from 0–84 years declined both in men (from 7.76% to 6.39%) and in women (from 4.66% to 3.73%) substantially (by 18% and 20%, respectively).

The cumulative risks of deaths showed a slightly more pronounced decline. Here, significant decreases of 18% in men and 23% in women were observed in the age groups below 55, too. In the age group 55–64, 65–74 and 75–84, however, these declines were markedly stronger with 23 to 28% in men and 25 to 30% in women.

Discussion

The expected benefits of screening colonoscopy are complex. Not only is it supposed to help detect existing bowel cancer earlier, but it is meant to prevent bowel cancer from developing in the first place by identifying and removing colorectal adenomas. The aim of this study was to evaluate whether in the first 10 years after the introduction of screening colonoscopy in Germany there was already a noticeable decline in bowel cancer incidence and mortality rates. We found a decrease in age-standardized incidence by approximately 14% and in age-standardized mortality by more than 20% between 2003 and 2012. The cumulative risks of disease declined in the age groups 55–64, 65–74 and 75–84 years by 17–20% in men and 21–26% in women. Long-term data from the Saarland Cancer Registry indicate that this decrease in incidence represents a trend reversal following decades of increase. In contrast, no comparable downward trend was identified for the incidence rates in the age groups below 55 years to which screening colonoscopy was not offered.

TABLE

Age-specific changes in the cumulative risk of disease and mortality for colorectal cancer in German men and women between 2003 and 2012

Gender	Age (years)	Cumulative risk of disease (%)		Change (%)	Cumulative risk of mortality (%)		Change (%)
		2003	2012		2003	2012	
Men	< 55	0.55	0.53	-3	0.17	0.14	-18
	55-64	1.57	1.30	-17	0.52	0.40	-23
	65-74	2.39	1.95	-19	1.31	0.94	-28
	75-84	3.25	2.61	-20	2.70	2.12	-24
	0-84	7.76	6.39	-18	4.64	3.57	-23
Women	< 55	0.45	0.51	+14	0.13	0.10	-23
	55-64	0.99	0.75	-24	0.28	0.21	-25
	65-74	1.40	1.03	-26	0.71	0.50	-30
	75-84	1.82	1.44	-21	1.83	1.30	-29
	0-84	4.66	3.73	-20	2.94	2.10	-29

Comparison with other data from epidemiological and randomized studies

These results are in line with projections based on data from the German national screening colonoscopy registry, indicating that screening colonoscopy is likely to deliver a substantial preventive effect in the long run (3, 5). According to these projections, the initial apparent increase in incidence caused by the detection of not yet clinically evident bowel cancer during screening colonoscopy will be more than offset in the following years by the number of cancer cases prevented as the result of the detection and removal of adenomas. The average number of bowel cancer cases newly detected between 2003 and 2012 during screening colonoscopy was approximately 4000 per year (3), representing about 6 to 7% of the total number of annually diagnosed new cases. However, as the number of cancer cases detected during screening colonoscopy was relatively constant, it can be assumed that it had only a minor impact on the incidence trends observed between 2003 and 2012.

The strongest effect in the first 10 years of the screening program is to be expected in the age groups 55-64 and 65-74 years; this is in line with our results. However, in the long run even stronger effects can be anticipated in the age group 75 years and over (5). Overall, the projections indicate that the downward trend in incidence is set to continue and accelerate over the next years.

The more pronounced decline in incidence among women compared with men in the age groups 55-64 and 65-74 years is in line with the higher screening colonoscopy participation rates of women in these age groups. This very noticeable decline by 24% and 26 %, respectively, is in stark contrast to the increase in incidence by 14% in the age groups below 55 years to

which screening colonoscopy was not offered.

This extent of decline in bowel cancer incidence in the age groups 55 years and over is, initially, surprising given the overall only moderate participation rates in the bowel cancer screening program. According to estimates, only about 20 to 25% of the eligible population chose to undergo screening colonoscopy (3). The decrease in incidence by 17 to 26% in the age groups 55 years and over is of similar size and could only be fully explained by the effect of screening colonoscopy if bowel cancer screening was capable of achieving an almost complete reduction in incidence within in a few years.

Data from randomized studies regarding the time course and extent of the decline in incidence following the introduction of screening colonoscopy are not yet available. Randomized studies on flexible sigmoidoscopy screening only showed a reduction in cumulative incidence five or more years after randomization because of the apparent initial increase in incidence resulting from the detection of not yet clinically evident bowel cancer. After 10 or more years of follow-up, the per-protocol analysis of persons who underwent screening sigmoidoscopy showed a decline in the incidence of cancer of the rectum and distal colon, i.e. within the reach of sigmoidoscopy, by 40 to 50% (8, 9). Epidemiological observational studies found a comparable or even greater decline in total bowel cancer incidence after colonoscopy by approximately 70% (10). In a recent study from Germany, the risk of bowel cancer was found reduced by approximately 90% within 10 years after screening colonoscopy (11).

However, even an effect of this size could not fully explain the decline in incidence rates observed in Germany, given the moderate participation rates in the screening colonoscopy program. Further possible

reasons for the pronounced reduction in incidence include the increased number of colonoscopies performed for other indications, e.g. as part of a diagnostic workup. In the relevant age groups, these are performed twice as often as screening colonoscopies (12) and a comparable effect can be assumed as the result of the detection and removal of adenomas. In a representative survey conducted in 2010, 58% of the female and male respondents in Germany aged over 55 years reported that they already underwent colonoscopy once before (13). This percentage is almost twice as high as the prevalences reported in a population-based study for the years 2003 and 2004 (14).

Potential role of other factors

Needless to say that there are other factors which may have contributed to the decline in bowel cancer incidence since 2003. Examples include, apart from the increased use of acetylsalicylic acid, the decline in smoking, an established risk factor for bowel cancer (15); however, while smoking rates fell especially among men, the incidence of bowel cancer in men showed a less marked reduction (16).

In addition, the effects of the known bowel cancer risk and preventive factors are mostly not very large; consequently, massive risk factor changes in the population would be required to explain a decline in bowel cancer incidence of the size observed. This lacks plausibility. In addition, some factors developed in a way that one would rather expect an increase in bowel cancer incidence, especially in the age groups 55 years and over. Examples include the rise in the risk factors overweight and obesity and the decline in the use of postmenopausal hormone replacement therapy which is associated with a decreased risk of bowel cancer (17).

The mostly parallel development of incidence and mortality rates suggests that the decrease in mortality is largely caused by the decline in incidence. However, the reduction in mortality was more pronounced than the decrease in incidence. On the one hand, the additional effect of colonoscopy to detect existing cancer in an early stage where the chances of healing are substantially better may have played a role. This is supported by the finding of a sharp increase in the percentage of bowel cancer lesions observed during the years after the introduction of screening colonoscopy (18). On the other hand, treatment advances have had a major impact (19, 20) which may explain the pronounced decline in mortality in the absence of a decrease in incidence in the age groups under 55 years.

Limitations

Besides the lack of reliable nationwide incidence data for the time before 2003, the main limitation of our study is that it was not possible to perform direct analyses of incidence and mortality among participants and non-participants in the screening colonoscopy program, due to the data protection legal framework. It would have been highly desirable if, along with the introduction of screening colonoscopy, the prerequisites

for a systematic evaluation of process and outcome quality had been established, as it is rightly asked for by, for example, the European Guidelines for Quality Assurance in Colorectal Cancer Screening and Diagnosis (21) and the National Cancer Plan (22) as a general requirement for any screening program. The establishment of the German national screening colonoscopy registry was a step in the right direction, but is not sufficient for a comprehensive evaluation of the screening program. Direct estimation of the effect of screening colonoscopy on bowel cancer incidence and mortality is impeded by the inability to link the screening colonoscopy registry data with data from the epidemiological cancer registries, mainly due to data protection regulations. Without the opportunity to combine these data, we can only draw indirect conclusions in our incidence analysis about the possible contribution of screening colonoscopy to the reduction in bowel cancer incidence.

Conclusion

Despite these limitations, the epidemiological patterns we have identified clearly suggest that screening colonoscopy makes a major contribution to the prevention of bowel cancer in Germany. The patterns of selective decline in bowel cancer incidence in the age groups for which screening colonoscopy is recommended or offered, correspond very well to related observations in the United States where large-scale bowel cancer screening with flexible sigmoidoscopy or colonoscopy was already undertaken in the 1980s and 1990s (23–25). Based on the long ranging screening colonoscopy experience in the US and the projections mentioned above (5), it can be expected that the incidence and mortality of bowel cancer in Germany will continue to substantially decline over the next years. With increased screening colonoscopy participation rates, this trend could be even stronger. Experiences made in other screening programs indicate that higher participation rates can best be achieved with an organized screening offering with targeted invitations to eligible persons. Therefore, the National Cancer Plan requests that bowel cancer screening is advanced to an organized screening program. In addition, it should be ensured in Germany too that the legitimate interest of the population in optimum, evidence-based and quality-assured screening programs is not impeded by inappropriately restrictive data protection regulations.

Conflict of interest statement

The authors declare that no conflict of interest exists.

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KEY MESSAGES

- Between 2003 and 2012, about 20–30% of the eligible persons participated in the screening colonoscopy program.
- Between 2003 and 2012, the age-standardized bowel cancer incidence in Germany declined by 13.8% in men and 14.3% in women. The age-standardized bowel cancer mortality decreased by 20.8% in men und 26.5% in women.
- The sharp decline in incidence was selectively observed in the age groups 55 years and over. Prior to this, incidence rates had increased over several decades; only during the study period, this trend reversed.
- The patterns observed indicate that screening colonoscopy has contributed largely to the reduction of bowel cancer incidence and mortality in Germany.
- Based on the longer screening colonoscopy experience in the United States and recent projections, it can be expected that the downward trend in incidence and mortality of bowel cancer in Germany will continue and accelerate over the next years.

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