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# A Comparative Study on Colorectal Neoplasia Detection Rates in Average-Risk Individuals Under 50 Years of Age

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*Article*

# A Comparative Study on Colorectal Neoplasia Detection Rates in Average-Risk Individuals Under 50 Years of Age

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**Abstract**

**Background/Objectives:** Colonoscopy, as the modality of choice for Colorectal cancer (CRC) screening, has a well-documented impact on decreasing CRC incidence. Although starting CRC screening at the age of 50 for average-risk individuals is widely recommended, several studies suggest the need for an earlier onset. **Methods:** Study of 353 average-risk individuals aged 40-54 years old who underwent colonoscopy investigation. Out of the study population, 3 age groups (40-44, 45-49, and 50-54 years old) were formed. Adenoma detection rate (ADR), polyp detection rate (PDR), sessile serrated lesions detection rate (SDR), and rate of advanced colorectal neoplasia (ACRN) and colorectal cancer (CRC) were compared between the groups. **Results:** Comparing age groups 40-44 vs. 50-54 years old we found a statistically significant difference in terms of PDR and ADR (p-value= 0.038 and 0.045 respectively). On the contrary, no statistically significant difference was found between the age groups 45-49 and 50-54 years old, in terms of PDR, ADR, SDR, and CRC detection rate (p-value= 0.063 for PDR, 0.2 for ADR, 0.3 for SDR, >0.9 for CRC). ACRN rates were comparable between the age groups 45-49 and 50-54 years old. As for patients' gender, males 50-54 had increased ADR and PDR in comparison with groups 40-44 and 45-49. In contrast, females bared no statistically significant difference in terms of ADR and PDR in all groups. **Conclusions:** Age group 45-49, sharing comparable detection rates with group 50-54, could also be considered for colorectal cancer screening.

**Keywords:** adenoma; polyp; neoplasia; colorectal; cancer

## 1. Introduction

Colorectal cancer (CRC) ranks third in incidence, having the second highest mortality among all cancer sites [1]. Its incidence and mortality rate vary in different world regions with higher ones noted in Europe, Australia, and North America, and lower in West Africa and South Asia [2–6]. This variability may stem from differences in the prevalence of risk factors (smoking, obesity, unhealthy diet) [7] but is mainly attributed to the establishment of CRC screening programs throughout the world [8] which has led to a decrease in overall CRC incidence and mortality [9,10].

In recent years there has been a variety of studies that show an increasing trend in CRC incidence and mortality in individuals younger than 50 years of age [11,12]. Accordingly, several studies have investigated the most appropriate age for CRC screening onset [13–15]. In most of these studies, the primary endpoint was the proportion of participants under 50 years of age who presented with neoplasia in a screening colonoscopy. In the study of Kolb et al. (2021)[12] the rate of neoplasia in the

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age group of 45-49 was 17.8%, somewhat lower compared to the respective percentage in the age group of 50-59 (24.8%, p = 0.04). On the other hand, the rates of advanced neoplasia in both age groups bared statistical similarity (3.6% in the age group 45-49 years old vs. 4.2% in the age group 50-59 years old). In another study by Butterly et al. (2021)[16] those younger than 50 presented with neoplasia in general at a rate of 17.5% and more specifically advanced neoplasia at a rate of 3.7%. These observations suggest that an earlier onset of CRC screening could lead to a further reduction of CRC prevalence [12].

Therefore, similar studies in different countries around the world, are needed in order to draw firm conclusions about the most appropriate age for commencement of screening. Accordingly, the US Multi-Society Task Force (USMSTF) [17] in the recently published recommendations ended up with a suggestion for CRC screening colonoscopy starting at the age of 45, which has been considered both safe [18] and cost-effective [17]. However, no pertinent guidelines regarding the earlier commencement of screening colonoscopy have yet been published by European gastroenterology societies.

The aim of this study is to determine the rate of colorectal neoplasia in a sample of average-risk for CRC European-Greek population under 50 years of age and compare it against a group of individuals aged 50-54 undergoing colonoscopy at the same period with a view to examine the possible need for application of earlier onset of screening colonoscopy, in a European country like Greece, in accordance with the more recent, updated USMSTF guidelines [17].

## 2. Results

A total of 583 consecutive individuals 40-54 years old were offered a colonoscopy investigation in our department during an 18-month period, out of which 230 individuals met the exclusion criteria. The remaining population consisted of 353 persons, 34 between the ages of 40 and 44 years old, 114 between the ages of 45 and 49 years old, and 205 between 50 and 54 years old (Figure 1).

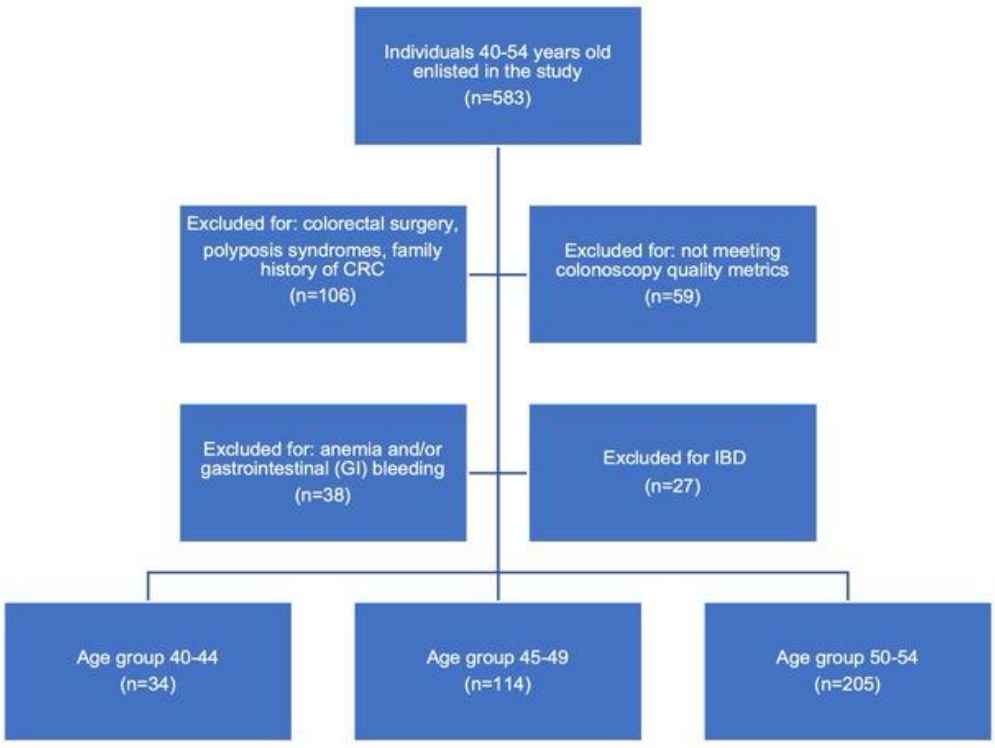


**Figure 1.** Study Population. CRC, Colorectal Cancer.

Overall ADR was estimated as 8.82%, 19.30%, and 25.37% in the age groups 40-44, 45-49, and 50-54 respectively (Table 1).

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**Table 1.** Detection rates in all age groups.

| | Overall | Age Groups | | | p-value |
|---|---|---|---|---|---|
| | n=353 | 40-44 years n=34 | 45-49 years n=114 | 50-54 years n=205 | |
| | n (%) | n (%) | n (%) | n (%) | |
| PDR | 143(40.51%) | 9 (26.47%) | 40 (35.09%) | 94 (45.85%) | 0.037[1] |
| ADR | 77 (21.81%) | 3 (8.82%) | 22 (19.30%) | 52 (25.37%) | 0.071[1] |
| SDR | 24 (6.80%) | 0 (0.00%) | 8 (7.02%) | 16 (7.80%) | 0.3[2] |
| CRC | 5 (1.42%) | 0 (0.00%) | 2 (1.75%) | 3 (1.46%) | >0.9[2] |
| ACRN | 37 (10.48%) | 3 (8.82%) | 12 (10.53%) | 22 (10.73%) | >0.9[2] |

[1]Pearson's Chi-squared test; [2]Fisher's exact test; ADR, adenoma detection rate; PDR, polyp detection rate; SDR, sessile serrated lesions detection rate; ACRN, advanced colorectal neoplasia and CRC, colorectal cancer.

The group 50-54 was found to have an increased ADR compared with group 40-44 (OR 0.285; 95% CI, 0.083, 0.974; p-value=0.045) whereas the group 45-49 bared no statistically significant difference in terms of ADR in comparison to group 50-54 (OR 0.704; 95% CI, 0.400, 1.236; p-value= 0.2) (Table 2).

**Table 2.** Odds Ratios ADR between age groups.

| Gender | Age Group | OR[1] | SE[1] | 95% CI[1] | p-value |
|---|---|---|---|---|---|
| Overall | 40-44 vs 50-54 | 0.285 | 0.625 | 0.083,0.974 | 0.045 |
| | 45-49 vs 50-54 | 0.704 | 0.287 | 0.400, 1.236 | 0.2 |
| Males | 40-44 vs 50-54 | 0.086 | 1.04 | 0.011, 0.668 | 0.019 |
| | 45-49 vs 50-54 | 0.378 | 0.461 | 0.153, 0.937 | 0.035 |
| Females | 40-44 vs 50-54 | 1.230 | 0.830 | 0.2414, 6.263 | 0.803 |
| | 45-49 vs 50-54 | 1.456 | 0.404 | 0.660, 3.212 | 0.352 |

[1]OR, Odds Ratio; SE, Standard Error; CI, Confidence Interval.

As far as gender is concerned, male individuals in group 50-54 had increased ADR compared with both group 40-44 (OR 0.086; 95% CI, 0.011, 0.668; p-value=0.019) and group 45-49 (OR 0.378; 95% CI, 0.153, 0.937; p-value=0.035) (34.58% vs. 16.67% vs. 4.35% ADR in males of age groups 50-54, 45-49 and 40-44 respectively (Tables 2 and 3).

**Table 3.** ADR and PDR in age groups (Males).

| | Overall | Age Groups | | | |
|---|---|---|---|---|---|
| | n=172 | 40-44 years n=23 | 45-49 years n=42 | 50-54 years n=107 | p-value[1] |
| | n (%) | n (%) | n (%) | n (%) | |
| PDR | 83 (48.26%) | 6 (26.09%) | 15 (35.71%) | 62 (57.94%) | 0.004 |
| ADR | 45 (26.16%) | 1 (4.35%) | 7 (16.67%) | 37 (34.58%) | 0.003 |

Pearson's Chi-squared test; PDR, polyp detection rate; ADR, adenoma detection rate.

No statistically significant difference was observed in all age groups for female patients (Table 4).

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**Table 4.** ADR and PDR in age groups (Females).

| | Overall | Age Groups | | | |
|---|---|---|---|---|---|
| | | 40-44 years | 45-49 years | 50-54 years | |
| | n=181 | n=11 | n=72 | n=98 | **p-value**[1] |
| | n (%) | n (%) | n (%) | n (%) | |
| PDR | 60 (33.15%) | 3 (27.27%) | 25 (34.72%) | 32 (32.65%) | >0.9 |
| ADR | 32 (17.68%) | 2 (18.18%) | 15 (20.83%) | 15 (15.31%) | 0.7 |

[1]Fisher's exact test; PDR, polyp detection rate; ADR, adenoma detection rate.

In terms of ACRN, the rates estimated for the age groups 40-44, 45-49, and 50-54 were 8.82%, 10.53%, and 10.73% respectively (Table 1). No statistically significant difference was found when comparing the rates of ACRN in the age groups (p-value > 0.9) (Table 1).

As for PDR, rates of 26.47%, 35.09%, and 45.85% were estimated in the age groups 40-44, 45-49, and 50-54 respectively and as a result, a statistically significant difference between them was found (p-value= 0.037) (Table 1). Individuals in the age group 50-54 bared an increased PDR in comparison with age group 40-44 (OR 0.425; 95% CI, 0.189, 0.958; p-value=0.038) (Table 5) while, when compared with age group 45-49, no statistically significant difference in PDR was found (OR 0.638; 95% CI, 0.397, 1.026; p-value=0.063) (Table 5). Taking gender into consideration, males 50-54 had increased PDR compared with males 40-44 (OR 0.256; 95% CI, 0.093, 0.704; p-value=0.008) and males 45-49 (OR 0.403; 95% CI, 0.192, 0.846; p-value=0.016) (57.94% vs. 35.71% vs. 26.09% PDR in males of age groups 50-54, 45-49 and 40-44 respectively)(Tables 3 and 5).

No statistically significant difference was found in all age groups for women (40-44 vs 50-54 and 45-49 vs 50-54 with p-value 0.718 and 0.778 respectively) (Table 4)(Table 5).

**Table 5.** Odds Ratios PDR between age groups.

| Gender | Age Group | OR[1] | SE[1] | 95% CI[1] | p-value |
|---|---|---|---|---|---|
| Overall | 40-44 vs 50-54 | 0.425 | 0.413 | 0.189, 0.958 | 0.038 |
| | 45-49 vs 50-54 | 0.638 | 0.241 | 0.397, 1.026 | 0.063 |
| Males | 40-44 vs 50-54 | 0.256 | 0.514 | 0.093, 0.704 | 0.008 |
| | 45-49 vs 50-54 | 0.403 | 0.377 | 0.192, 0.846 | 0.016 |
| Females | 40-44 vs 50-54 | 0.773 | 0.710 | 0.192, 3.113 | 0.718 |
| | 45-49 vs 50-54 | 1.097 | 0.328 | 0.577, 2.087 | 0.778 |

[1]OR,Odds Ratio; SE, Standard Error; CI,Confidence Interval; PDR, Polyp detection rate.

Regarding SDR, no sessile serrated lesion was found in the group 40-44 years old. The SDR estimated in age groups 45-49 and 50-54 were 7.02% and 7.80% respectively and no statistically significant difference was observed between the two age groups (p-value= 0.3) (Table 1). With regards to CRC, no cancer was detected in the age group 40-44, whereas no statistically significant difference was found between age groups 45-49 and 50-54 years old (p-value >0.9) (Table 1).

## 3. Discussion

Colonoscopy with polypectomy [8,34], is the gold standard modality for CRC prevention. The optimal age to commence CRC screening seems to be in the spotlight of several studies, in recent years, affecting the latest statements of gastroenterology societies, especially in the USA [8,17]. However, European societies are yet to decide how to address this matter.

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In the present study, we attempted to estimate and compare ADR, ACRN, PDR, SDR, and CRC rates between age groups 40-44, 45-49 and 50-54 in a sample of European Greek population.

Overall ADR and overall PDR bared a statistically significant difference between age groups 40-44 vs. 50-54, whereas no statistically significant difference was observed between the age groups 45-49 and 50-54. Gender affected the detection rates with males of group 50-54 found to have increased rates of polyp and adenoma detection compared with males of age groups 40-44 and 45-49, whereas female individuals bared no statistically significant difference in polyp and adenoma detection between the age groups. Of note, ADR and PDR in females were increased in age group 45-49 compared with the age group 50-54, although this was not statistically significant.

We also calculated SDR and CRC detection rates for our groups with no statistically significant differences being noted between age groups 45-49 and 50-54 years old.

ACRN in different age groups was also an endpoint of our study. We especially focused on these polyps as their presence could lead to different screening intervals [27]. Thus, in terms of ACRN, the percentages were estimated and found statistically comparable.

Our study outcomes add up to the results of other recent studies investigating neoplasia detection rates in individuals younger than 50 years old [35]. In a study by Ladbaum et al. (2022) [35] ADR as well as detection rate for advanced adenoma, were comparable between the age groups 45-49 (34.3% and 6.3% respectively) and 50-54 (38.2% and 5.8% respectively) which was also the case in our study. Another study by Trivedi et al. (2022) [32] addressing this matter, detected percentages of neoplasia in age groups 45-49 and 50-54 consistent with these in our study (32% vs. 35.09% neoplasia in our study in the age group 45-49 and 37.72% vs 45.85% neoplasia in our study in the age group 50-54). The percentages of ACRN as a sum of advanced premalignant lesions (APL) and CRC [32] were also similar (7.5% APL+0.58% CRC vs. 10.53% ACRN in our study in the age group 45-49 and 9.48% APL+0.32% CRC vs. 10.73% ACRN in our study in the age group 50-54).

Concerning Greek population two studies from the same team have been published so far [36,37]. In both studies, the rate of adenomas (10.6% and 10.4%), advanced adenomas (AA) (8.5% and 4.5%), and CRC (2.1% and 1.5%) were estimated in average-risk individuals aged 30-49 years old [36,37]. Even though in both these studies, the study groups were different than those of our study (30-49 age groups vs. 45-49 age group), higher rates of adenoma (19.30%) and ACRN (10.53%) were found in our study with similar rates of CRC.

An important outcome of our study is also the relatively higher rates of ACRN observed, especially in the age group 45-49 years old, in comparison with other recent studies. While in our study the rate of ACRN in the age group 45-49 is 10.53%, other studies estimated this rate at 3.6% [12], 3.7% [16], 6.3% [35] and 7.5%+0.58% [32]. A possible explanation is the difference in the definition of ACRN between the aforementioned studies and the inclusion or not of CRC and advanced SSL in it.

Moreover, we also estimated a high rate of sessile serrated polyps in both age groups 45-49 and 50-54 (7.02% and 7.80% respectively). Those rates are in close proximity but somewhat higher than the ones estimated by Butterly et al. (2021) (5.9% and 6.1% in the age groups 45-49 and 50-54 respectively) [16] and also higher than the ones presented by Desai et al. (2021) (SDR: 2%) [33]. The heterogeneity in SSL definition could be a possible explanation of the aforementioned observed differences.

This study presents various strengths, including the fact that it is daily-practice oriented, that strictly defined average-risk groups were formed and compared in the study and that the colonoscopies were performed by multiple experienced endoscopists. To our knowledge, this is one of the few European studies in general that attempted to estimate ADR, PDR, SDR, ACRN, and CRC rates in narrowly defined age groups under 50 (40-44 and 45-49) and to compare them with relevant data of individuals over the age of 50 years (50-54), who are already candidates for screening for CRC. Thus, our results add to the ongoing discussion about the most appropriate age to commence screening colonoscopy in the European population.

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Among the limitations of our study were that it was a single center with a relatively small study population under 50 years old willing to undertake colonoscopy and simultaneously fulfilling our inclusion criteria. The fact that CRC screening program in Greece is opportunistic may have resulted in a study population mainly comprised of self-referred Greek individuals that could be characterized by an increased healthcare seeking behavior (HSB). This probable selection bias due to the absence of an established CRC screening program, has led to age groups with numerically unequal populations and unbalanced in terms of gender. Consequently, this may have brought about the gender-related alterations observed in the comparisons of detection rates (ADR and PDR) between the age groups.

## 4. Materials and Methods

### *4.1. Study Design*

This is an observational study of individuals between 40- and 54-years old, who underwent colonoscopy in a single tertiary center [Department of Gastroenterology of the 417 Army Equity Fund Hospital (NIMTS)], between November 2023 and November 2024.

### *4.2. Participants*

Patients aged 40-54 years, with average risk for CRC, who underwent colonoscopy investigation were included in the study. Patients with average risk for CRC were defined as those without inflammatory bowel disease (IBD), polyposis syndromes, and family history of CRC [19]. Other exclusion criteria were a history of colorectal surgery, clinical symptoms [12] highly associated with CRC and anemia or gastrointestinal (GI) bleeding [17].

According to age, patients were stratified into three groups, a 40-44 years-old group, a 45–49-years-old group and a 50-54 years-old group. Groups 40-44 and 45-49 were the study groups, while group 50-54 which already has an established indication for CRC screening was used as the control group.

Reasons to withdraw patients from the study inability to intubate caecum, inadequate bowel preparation (Boston Bowel Preparation Scale (BBPS) <6 or/and any colon segment with BBPS<2), and a new diagnosis of polyposis syndrome or IBD.

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Scientific Review Committee of Army Share Fund Hospital.

### *4.3. Colonoscopy Procedure*

Colonoscopies were performed by 4 experienced (>5000 colonoscopies) endoscopists using high-resolution colonoscopes. Participants received a split-dose polyethylene glycol (PEG) preparation regimen when the colonoscopy was scheduled for the morning, or a PEG-based preparation on the same day when an afternoon colonoscopy was planned, in agreement with the latest ESGE recommendations on pre-endoscopy bowel preparation [20]. During the procedure minimal to moderate sedation was administered, using a combination of midazolam and fentanyl while hyoscine butyl bromide was also used as required [21,22]. Examination of the right colon with a second forward view (SFV) was a prerequisite for all the participants [23]. Quality indicators for colonoscopy were monitored. The BBPS [24] was used to assess the quality of bowel preparation. Adequate preparation was defined as a total score $\geqslant$6 and with no colon segment characterized by a score of less than 2 [25]. Cecal intubation rate [24] and withdrawal time of the colonoscope were also documented.

Throughout the procedure, the presence and number of neoplasias were documented. Paris classification [26] was used to describe the morphology of the lesions found during colonoscopy. The size of polyps was estimated against an open biopsy forcep [27] (7mm) or a snare [27]. Accordingly, polyps were classified in terms of size into 3 groups: diminutive polyps, small ones, and

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intermediate/large ones with sizes ⩽ 5 mm, 6-9 mm, and ⩾ 10 mm respectively. [28,29] Narrow Band Imaging (NBI) was used for optical diagnosis.

Polyps were removed using the recommended polypectomy techniques [28,29]. Sessile or flat polyps up to 9 mm were resected with the cold snare technique while sessile/flat polyps ⩾10mm as well as pedunculated polyps were resected using hot snare polypectomy techniques. Biopsy forceps (cold) were only used for diminutive polyps up to 3mm when the application of a snare was technically not feasible. [28] All polyps retrieved were sent for histopathological evaluation. Thus, resected lesions were classified histologically as hyperplastic [30], sessile serrated lesions (SSL) [30] with or without dysplasia, adenomas with low-grade dysplasia (LGD) [31], adenomas with high-grade dysplasia (HGD) [31], CRC, or non-conclusive when none of the criteria for the aforementioned categories were met, as in the case of inflammatory pseudopolyps, normal colonic mucosa, unretrievable resected polyps, etc.

### *4.4. Outcomes*

The primary outcomes of the study were the adenoma detection rate (ADR) and the rate of advanced colorectal neoplasia (ACRN) as defined by Trivedi et al. (2022) (adenoma with size ⩾10 mm, adenomas baring HGD, villous adenomas, SSL with size ⩾10 mm, or SSLs with any size baring dysplasia, traditional serrated adenomas (TCA and CRC) [32]. The ADR and ACRN were estimated in each group and compared for any probable statistically significant difference between them.

Secondary outcomes were the polyp detection rate (PDR), the SSL detection rate (SDR) [33], and the CRC rate in the aforementioned age groups [24].

### *4.5. Statistical Analysis*

The statistical analysis was performed using R package at version 4.3.1. All statistical tests were two-sided at 0.05 significance level.

Descriptive statistical analysis was performed to provide an overview of all variables of interest overall and by age group. Continuous variables were summarized using descriptive statistical measures (mean, median, standard deviation, minimum and maximum), while for categorical variables the number and percentage of subjects in each category were provided. The association between age groups in detection rates (ADR, PDR, SDR, CRC, ACRN) was assessed using Pearson's Chi-squared test or Fisher's exact test as appropriate. Subgroup analysis based on gender was also performed for the ADR and PDR.

Logistic regression models were applied with dependent variable the ADR and PDR using as independent variable the age group in order to estimate the ADR or PDR difference between age groups. Additional logistic regression models were applied using as dependent variables the ADR or PDR including the interaction of age group and gender in order to estimate the ADR or PDR difference between age groups by gender. Results were expressed as Odds Ratios followed by corresponding 95% Confidence Intervals.

## 5. Conclusions

In conclusion, no statistically significant difference was demonstrated in our study between the age group 45-49 and 50-54 years old in terms of overall ADR, PDR, SDR, ACRN, and CRC detection rate. Consequently, it seems that, the age group 45-49 could also be considered for screening colonoscopy for CRC. This conclusion is in accordance with the findings of studies in other countries as well as with the recommendations of USMSTF. To further support our findings, studies with larger population samples are needed, which will investigate not only the incidence of CRC but also the cost-effectiveness and safety of this approach.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## References

1. Sung H, Ferlay J, Siegel RL, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin*. 2021;71(3):209-249. doi:10.3322/caac.21660
2. Ferlay J, Soerjomataram I, Dikshit R, et al. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer*. 2015;136(5):E359-E386. doi:10.1002/ijc.29210
3. Douaiher J, Ravipati A, Grams B, Chowdhury S, Alatise O, Are C. Colorectal cancer-global burden, trends, and geographical variations. *J Surg Oncol*. 2017;115(5):619-630. doi:10.1002/jso.24578
4. Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global cancer statistics, 2012. *CA Cancer J Clin*. 2015;65(2):87-108. doi:10.3322/caac.21262
5. Torre LA, Siegel RL, Ward EM, Jemal A. Global Cancer Incidence and Mortality Rates and Trends--An Update. *Cancer Epidemiol Biomarkers Prev*. 2016;25(1):16-27. doi:10.1158/1055-9965.EPI-15-0578
6. Arnold M, Sierra MS, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global patterns and trends in colorectal cancer incidence and mortality. *Gut*. 2017;66(4):683-691. doi:10.1136/gutjnl-2015-310912
7. Center MM, Jemal A, Smith RA, Ward E. Worldwide variations in colorectal cancer. *CA Cancer J Clin*. 2009;59(6):366-378. doi:10.3322/caac.20038
8. Shaukat A, Kahi CJ, Burke CA, Rabeneck L, Sauer BG, Rex DK. ACG Clinical Guidelines: Colorectal Cancer Screening 2021. *Am J Gastroenterol*. 2021;116(3):458-479. doi:10.14309/ajg.0000000000001122
9. Brown JJ, Asumeng CK, Greenwald D, et al. Decreased colorectal cancer incidence and mortality in a diverse urban population with increased colonoscopy screening. *BMC Public Health*. 2021;21(1):1280. Published 2021 Jun 30. doi:10.1186/s12889-021-11330-6
10. Siegel RL, Miller KD, Goding Sauer A, et al. Colorectal cancer statistics, 2020. *CA Cancer J Clin*. 2020;70(3):145-164. doi:10.3322/caac.21601
11. Ng OH, Lunevicius R, Arthur JD. Rising incidence of colorectal cancer in individuals younger than 50 years and increasing mortality from rectosigmoid cancer in England. *Colorectal Dis*. 2021;23(10):2637-2646. doi:10.1111/codi.15819
12. Kolb JM, Hu J, DeSanto K, et al. Early-Age Onset Colorectal Neoplasia in Average-Risk Individuals Undergoing Screening Colonoscopy: A Systematic Review and Meta-Analysis. *Gastroenterology*. 2021;161(4):1145-1155.e12. doi:10.1053/j.gastro.2021.06.006
13. Meester RGS, Peterse EFP, Knudsen AB, et al. Optimizing colorectal cancer screening by race and sex: Microsimulation analysis II to inform the American Cancer Society colorectal cancer screening guideline. *Cancer*. 2018;124(14):2974-2985. doi:10.1002/cncr.31542
14. Peterse EFP, Meester RGS, Siegel RL, et al. The impact of the rising colorectal cancer incidence in young adults on the optimal age to start screening: Microsimulation analysis I to inform the American Cancer Society colorectal cancer screening guideline. *Cancer*. 2018;124(14):2964-2973. doi:10.1002/cncr.31543
15. Wolf AMD, Fontham ETH, Church TR, et al. Colorectal cancer screening for average-risk adults: 2018 guideline update from the American Cancer Society. *CA Cancer J Clin*. 2018;68(4):250-281. doi:10.3322/caac.21457
16. Butterly LF, Siegel RL, Fedewa S, Robinson CM, Jemal A, Anderson JC. Colonoscopy Outcomes in Average-Risk Screening Equivalent Young Adults: Data From the New Hampshire Colonoscopy Registry. *Am J Gastroenterol*. 2021;116(1):171-179. doi:10.14309/ajg.0000000000000820

 doi:10.20944/preprints202510.0268.v1




17. Patel SG, May FP, Anderson JC, et al. Updates on Age to Start and Stop Colorectal Cancer Screening: Recommendations From the U.S. Multi-Society Task Force on Colorectal Cancer [published correction appears in Gastroenterology. 2022 Jul;163(1):339]. *Gastroenterology*. 2022;162(1):285-299. doi:10.1053/j.gastro.2021.10.007
18. Kothari ST, Huang RJ, Shaukat A, et al. ASGE review of adverse events in colonoscopy. *Gastrointest Endosc*. 2019;90(6):863-876.e33. doi:10.1016/j.gie.2019.07.033
19. van Leerdam ME, Roos VH, van Hooft JE, et al. Endoscopic management of Lynch syndrome and of familial risk of colorectal cancer: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. *Endoscopy*. 2019;51(11):1082-1093. doi:10.1055/a-1016-4977
20. Hassan C, East J, Radaelli F, et al. Bowel preparation for colonoscopy: European Society of Gastrointestinal Endoscopy (ESGE) Guideline - Update 2019. *Endoscopy*. 2019;51(8):775-794. doi:10.1055/a-0959-0505
21. American Association for Study of Liver Diseases; American College of Gastroenterology; American Gastroenterological Association Institute; Multisociety sedation curriculum for gastrointestinal endoscopy. *Gastrointest Endosc*. 2012;76(1):e1-e25. doi:10.1016/j.gie.2012.03.001
22. ASGE Standards of Practice Committee, Early DS, Lightdale JR, et al. Guidelines for sedation and anesthesia in GI endoscopy. *Gastrointest Endosc*. 2018;87(2):327-337. doi:10.1016/j.gie.2017.07.018
23. Kamal F, Khan MA, Lee-Smith W, et al. Second exam of right colon improves adenoma detection rate: Systematic review and meta-analysis of randomized controlled trials. *Endosc Int Open*. 2022;10(10):E1391-E1398. Published 2022 Oct 17. doi:10.1055/a-1896-4499
24. Kaminski MF, Thomas-Gibson S, Bugajski M, et al. Performance measures for lower gastrointestinal endoscopy: a European Society of Gastrointestinal Endoscopy (ESGE) Quality Improvement Initiative. *Endoscopy*. 2017;49(4):378-397. doi:10.1055/s-0043-103411
25. Clark BT, Protiva P, Nagar A, et al. Quantification of Adequate Bowel Preparation for Screening or Surveillance Colonoscopy in Men. *Gastroenterology*. 2016;150(2):396-e15. doi:10.1053/j.gastro.2015.09.041
26. Endoscopic Classification Review Group. Update on the paris classification of superficial neoplastic lesions in the digestive tract. *Endoscopy*. 2005;37(6):570-578. doi:10.1055/s-2005-861352
27. Hassan C, Antonelli G, Dumonceau JM, et al. Post-polypectomy colonoscopy surveillance: European Society of Gastrointestinal Endoscopy (ESGE) Guideline - Update 2020. *Endoscopy*. 2020;52(8):687-700. doi:10.1055/a-1185-3109
28. Ferlitsch M, Moss A, Hassan C, et al. Colorectal polypectomy and endoscopic mucosal resection (EMR): European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline. *Endoscopy*. 2017;49(3):270-297. doi:10.1055/s-0043-102569
29. Kaltenbach T, Anderson JC, Burke CA, et al. Endoscopic Removal of Colorectal Lesions: Recommendations by the US Multi-Society Task Force on Colorectal Cancer. *Am J Gastroenterol*. 2020;115(3):435-464. doi:10.14309/ajg.0000000000000555
30. Pai RK, Bettington M, Srivastava A, Rosty C. An update on the morphology and molecular pathology of serrated colorectal polyps and associated carcinomas. *Mod Pathol*. 2019;32(10):1390-1415. doi:10.1038/s41379-019-0280-2
31. Rubio CA, Nesi G, Messerini L, et al. The Vienna classification applied to colorectal adenomas. *J Gastroenterol Hepatol*. 2006;21(11):1697-1703. doi:10.1111/j.1440-1746.2006.04258.x
32. Trivedi PD, Mohapatra A, Morris MK, et al. Prevalence and Predictors of Young-Onset Colorectal Neoplasia: Insights From a Nationally Representative Colonoscopy Registry. *Gastroenterology*. 2022;162(4):1136-1146.e5. doi:10.1053/j.gastro.2021.12.285
33. Desai M, Anderson JC, Kaminski M, et al. Sessile serrated lesion detection rates during average risk screening colonoscopy: A systematic review and meta-analysis of the published literature. *Endosc Int Open*. 2021;9(4):E610-E620. doi:10.1055/a-1352-4095
34. Rex DK, Boland CR, Dominitz JA, et al. Colorectal Cancer Screening: Recommendations for Physicians and Patients from the U.S. Multi-Society Task Force on Colorectal Cancer. *Am J Gastroenterol*. 2017;112(7):1016-1030. doi:10.1038/ajg.2017.174
35. Ladabaum U, Shepard J, Mannalithara A. Adenoma and Sessile Serrated Lesion Detection Rates at Screening Colonoscopy for Ages 45-49 Years vs Older Ages Since the Introduction of New Colorectal

 doi:10.20944/preprints202510.0268.v1



Cancer Screening Guidelines. *Clin Gastroenterol Hepatol*. 2022;20(12):2895-2904.e4. doi:10.1016/j.cgh.2022.04.037

36. Panteris V, Vasilakis N, Demonakou M, et al. Alarming endoscopic data in young and older asymptomatic people: Results of an open access, unlimited age colonoscopic screening for colorectal cancer. *Mol Clin Oncol*. 2020;12(2):179-185. doi:10.3892/mco.2019.1967
37. Panteris V, Karantanos P, Vasilakis N, et al. New considerations for colorectal cancer screening based on the demographic profile of colorectal cancer in a Greek population. *Mol Clin Oncol*. 2022;16(3):57. doi:10.3892/mco.2022.2490