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Original article

Cost-Utility Analysis of Colorectal Cancer Screening Starting at Age 45 Compared to Age 50 in Colombia

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Abstract

Background: Colorectal cancer (CRC) is among the four cancers with the highest incidence and mortality in Colombia. CRC screening is currently recommended in national guidelines starting at age 50. The American Cancer Society has suggested beginning screening at age 45. **Objectives:** To estimate the cost-utility ratio of initiating CRC screening at age 45 compared to age 50 in Colombia. **Methods:** A Markov model simulating the natural history of CRC was used to compare the initiation of screening at ages 45 and 50. The cost-utility analysis incorporated costs and utilized Colombia's per capita gross domestic product (GDP) threshold (COP 21,500,000). **Results:** Starting colonoscopy screening at age 45 was 0.33% less costly, yielded a gain of 3.49 quality-adjusted life years (QALYs), and reduced mortality by 37% compared to initiating at age 50 (costs: COP 92,364,407 vs. COP 92,669,231; QALYs: 19.40 vs. 15.91; and mortality proportion: 3.4% vs. 5.4%, respectively). **Conclusion:** Based on the Markov model analysis and the assumptions made, initiating CRC screening at age 45 was cost-effective. Costs were lower, more QALYs were gained, and the incremental cost-effectiveness ratio was below Colombia's GDP threshold. A budget impact analysis is recommended to support the implementation of policies in Colombia.

Keywords

Colon cancer, screening, cost-effectiveness, quality-adjusted life years.

INTRODUCTION

Colorectal cancer (CRC) is the third leading cause of cancer-related deaths in Colombia, following breast and prostate cancer, contributing significantly to morbidity, mortality, and high public health costs worldwide[1–3]. Approximately 80% of CRC cases are preceded by adenomatous polyps, considered precancerous lesions. When removed, these polyps significantly reduce CRC incidence[1,4,5]. Adenomas are histologically classified into tubular (87%), tubulovillous (8%), and villous (5%) types, with the latter having a higher potential for malignancy over a prolonged latency period of 10 to 15 years. Age is a known risk factor for their development[5–8].

The mortality rate from CRC in Colombia is 7.4%, and this figure has increased in recent years[1]. In 2021, 7,579 new cases were reported, with a five-year prevalence of 18,654 cases (equivalent to 36.6 cases per 100,000 inhabitants)[2]. Early-stage interventions can significantly alter cancer incidence[9–12]. According to Colombian legislation, CRC is recognized as a public health concern and a national priority. Early and integrated prevention of risk factors, along with effective, timely, and continuous detection, improves quality of life, reduces economic impact,

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and enhances social outcomes for patients (Article 5, Law 1384 of 2010)[13–16]. CRC screening is a recommended intervention outlined in local guidelines and endorsed by scientific cancer societies worldwide. Colonoscopy is the gold standard for CRC detection, offering the highest sensitivity and specificity as both a diagnostic and therapeutic tool for identifying adenomas. Colombian guidelines recommend negative-screening colonoscopies be repeated every 10 years, starting at age 50 and continuing until age 75[17]. For cases with positive adenoma findings, follow-up intervals depend on polyp size and histological characteristics. However, colonoscopy has certain disadvantages: it is invasive, requires bowel preparation, carries a risk of complications, and may be costly or have limited availability for large-scale implementation[18].

In Latin America, CRC screening is recommended starting at age 50[18–20]. The 2013 Colombian Clinical Practice Guideline (CPG) for colon and rectal cancer from the Ministry of Health and Social Protection, along with the 2015 CPG for colorectal cancer detection by the Colombian Association of Gastroenterology and the Colombian Association of Coloproctology, establish that CRC screening should begin at age 50 (a favorable recommendation with moderate-quality evidence) as a best practice. The choice of screening test should be individualized based on medical judgment. Colonoscopy is recommended as the first option, but fecal occult blood tests (FOBT), including the fecal immunochemical test (FIT) and the guaiac-based FOBT (g-FOBT), are acceptable alternatives[17]. When comparing colonoscopy to g-FOBT/FIT, colonoscopy demonstrated higher CRC detection rates (relative risk [RR]: 5.91, confidence interval [CI]: 70); however, compliance rates were higher with g-FOBT/FIT (RR: 0.57, 95% CI: 0.42–0.78)[17,18].

In 2018, the American College of Gastroenterology (ACG), the American Society for Gastrointestinal Endoscopy (ASGE), and the American Cancer Society published CRC screening guidelines recommending screening start at age 45. This was based on the rising incidence of CRC over the past two decades, which increased from 1.3% to 2.3% among individuals under 55 years of age[21]. Screening at age 45 could prevent 277,000 CRC cases and 203,000 deaths by 2030[22]. In 2019, a study conducted by Stanford University, the University of California, and the University of Pittsburgh reported that CRC screening at age 45 in a cohort of 1,000 individuals prevented four CRC cases, two CRC-related deaths, and gained 14 quality-adjusted life years (QALYs). However, earlier screening required 758 additional colonoscopies, thereby increasing costs[23]. A Colombian study documented adenoma findings in one out of every five screening colonoscopies in individuals aged 45 to 50 years (18.5% prevalence), supporting the justification for CRC screening starting at age 45[24].

Early CRC screening has economic implications for society[12]. In Europe, the economic burden of CRC is estimated at EUR 13 billion[25], while in the United States, the cost of diagnosing and treating CRC is approximately USD 100,000[26]. In Colombia, the economic burden of CRC and the cost of screening starting at age 45 remain unknown. U.S. recommendations are not directly applicable to Colombia due to differences in CRC diagnosis and treatment costs. Therefore, to evaluate and decide on the implementation of CRC screening in Colombia, cost-utility and cost-effectiveness studies using local monetary values are warranted[27].

The aim of this study was to assess whether initiating CRC screening at age 45 in Colombia is cost-effective compared to the threshold established by the World Health Organization (WHO) based on the gross domestic product (GDP). Additionally, the study evaluated its impact on mortality, QALYs, and costs.

METHODOLOGY

A microeconomic evaluation was conducted to analyze the cost-effectiveness[27] of initiating CRC screening at age 45 compared to age 50 from the perspective of a third-party payer. Costs and mortality were compared, expected outcomes for each age group were estimated using simulated mathematical modeling, and the incremental cost-utility ratio (ICUR) was calculated[28–30]. Screening was considered cost-effective when the ICUR was below the per capita GDP threshold, as defined by the Colombian Institute for Health Technology Assessment (IETS in Spanish) and the World Health Organization (WHO)[30]. A Markov model (**Figure 1**) was designed to compare three screening strategies: annual FIT-based FOBT, annual guaiac-based FOBT, and colonoscopy every 10 years. A positive FOBT result was followed by a colonoscopy.

A systematic literature review was performed using various MeSH terms in the Cochrane Library, Medline, SciELO, and Google Scholar databases. There were no language restrictions, and gray literature was included.

A 31-year time horizon was defined, starting screening at age 45 and continuing to age 76, the life expectancy in Colombia according to the National Administrative Department of Statistics (DANE in Spanish). The evaluation was conducted from the perspective of Colombia's General System of Social Security in Health (SGSSS in Spanish), incorporating the value of all direct resources associated with the use of the technology and the perceived health benefits directly experienced by patients. A

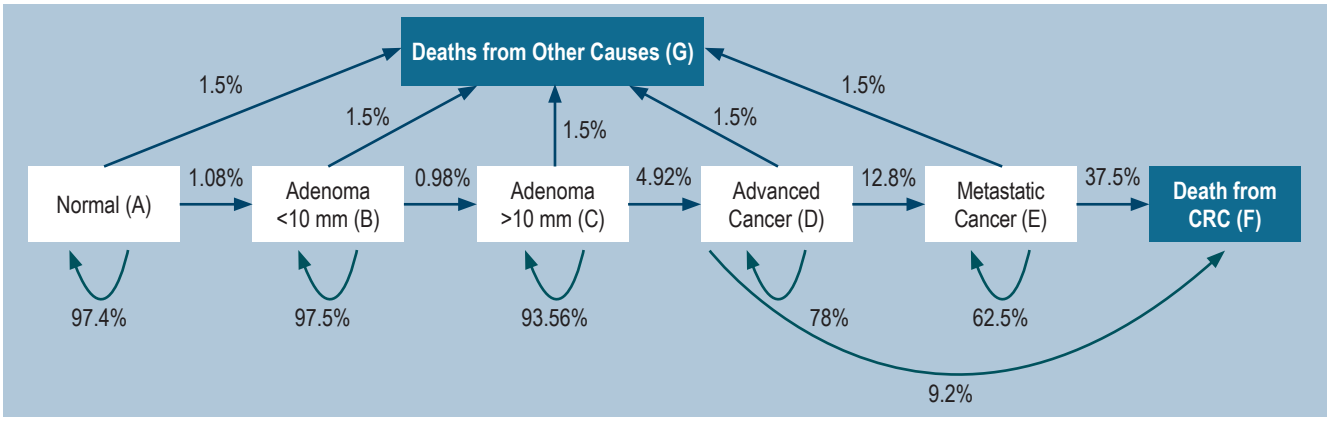


Figure 1. Markov Model Simulating the Natural History of CRC, Including Five Successive Health Transition Stages. Developed by the authors based on information from: López-Kostner F, and colleagues. Rev Med Chil. 2018;146(6):685–692[31]; Gupta S, and colleagues. Gastroenterology. 2020;158(4):1154[33]; Vatn MH, and colleagues. Cancer. 1982;49(4):819–25[34]; Williams AR, and colleagues. Gut. 1982;23(10):835–42[35]; Clark JC, and colleagues. Int J Cancer. 1985;36(2):179–86[36]; Arminski TC, and colleagues. Dis Colon Rectum. 1964;7:249–61[37]; Rickert RR, and colleagues. Cancer. 1979;43(5):1847–57[38].

5% annual discount rate, recommended by the IETS, was applied to costs and health effectiveness outcomes. The primary outcomes were the proportion of CRC-related mortality in both groups and quality-adjusted life years (QALYs).

To estimate costs, the Medication Price Information System (SISMED in Spanish) database was consulted to determine weighted averages and reported unit quantities. Micro-costing was conducted, and monetary valuation was calculated using the official fee manual of Colombia's mandatory traffic accident insurance (SOAT in Spanish). Direct costs for each stage were considered, including procedural costs and treatment costs for complications (**Tables 1–5**).

Based on published literature, frequencies for findings from screening colonoscopy were constructed, including probabilities for the health states proposed in the model for the disease at ages 45 and 50. Frequencies of findings

Table 1. Screening in Normal State (A)

Resource	Quantity	Usage Rate	Unit Cost	Source	Total Cost
General practitioner	1	100%	COP 35,100	SOAT 2020	COP 35,100
Specialist physician (family, internal or gastroenterologist)	1	100%	COP 41,300	SOAT 2020	COP 41,300
Fecal occult blood (guaiac-bases)	1	100%	COP 7,300	SOAT 2020	COP 7,300
Fecal occult blood (immunohistochemical)	1	100%	COP 17,490	Dr, Roselli Study	COP 17,490
Colonoscopy	1	100%	COP 213,040	SOAT 2020	COP 213,040

Author's own research.

Table 2. Adenoma Less Than 10 mm (B)

Resource	Quantity	Usage Rate	Unit Cost	Source	Total Cost
Specialist consultation	1	100%	COP 41,300	SOAT 2020	$ 41,300
Colonoscopy every 3, 5, and 10 years	1	100%	COP 213,040	SOAT 2020	$ 213,040

Author's own research.

Table 3. Adenoma Greater Than 10 mm (C)

Resource	Quantity	Usage Rate	Unit Cost	Source	Total Cost
Specialist consultation	3	100%	COP 41,300	SOAT 2020	COP 123,900
Colonoscopy follow-up	1	100%	COP 213,040	SOAT 2020	COP 213,040
Polypectomy (endoscopic resection of large bowel lesion)	1	100%	COP 2,446,700	SOAT 2020	COP 2,446,700

Author's own research.

in screening colonoscopy for patients aged 45 and 50 were obtained from a Chilean study (population similar to Colombia's) on a multicenter CRC screening program[31], a Colombian study on adenoma prevalence in individuals aged 45–50[24], and Korea's national cancer screening program[32] (**Table 6**).

Model Assumptions

- Screening begins at ages 45 and 50 and ends at age 76 or upon death.
- There is a probability that, after undergoing the procedure, the patient remains in the same stage they were in initially.
- Colonoscopies meet quality standards, preventing the occurrence of interval cancers within the model.
- Health stages are successive and non-reversible unless intervention with polypectomy or surgery occurs.
- The two absorbing states are death from CRC (F) and death from other causes (G).
- Colonoscopy follow-ups are conducted in the first, third, fifth, seventh, and tenth years based on the type of adenoma documented, following international guidelines on digestive endoscopy and cancer[33].

Transition Probabilities

The proposed model defines the transition probabilities for each stage, as presented in the transition probability matrix, which reflects the natural history of CRC.

The literature indicates that a patient undergoing a screening colonoscopy with normal results has a 97% probability of remaining in this normal stage for one year and a 1% probability of progressing to an adenoma smaller than 10 mm[31,32,34–38]. A person with an adenoma smaller than 10 mm has a 97% probability of remaining in the same stage for one year and a 1% probability of progressing to an adenoma larger than 10 mm[35,37,38]. A patient with an adenoma larger than 10 mm has a 5% probability of progressing to advanced regional cancer within one year and a 94% probability of remaining in the same stage[34,36–38]. A patient with advanced regional cancer identified during a screening colonoscopy has a 77% probability of remaining in this stage for one year, a 13% probability of progressing to metastatic cancer, and a 9% probability of progressing to death from CRC within one year[39]. A patient diagnosed with metastatic CRC during screening has a 62% probability of surviving for one year and a 37% probability of progressing to death within that time[39] (**Table 7**).

Using the parameters described above (**Table 8**), a transition matrix was constructed for a cohort of 1,000 patients. This included 31 cycles for patients starting screening at age 45 and 26 cycles for those starting at age 50 (**Tables 9** and **10**).

Utility Calculation

Quality-adjusted life years (QALYs) were used as the utility outcome. To calculate the quality of life for each stage, the EuroQol (EQ-5D-5L) scale was applied to patients undergoing CRC screening. A value of 1 was assigned to normal quality of life (stages A and B), 0.74 to patients undergoing interventions such as polypectomies, surgeries, hospitalizations, chemotherapy, or radiotherapy (stages C, D, and E), and 0 to patients who died (stages F and G)[40].

The cost-utility ratio (C/U) and incremental cost-utility ratio (ICUR) were calculated for the two screening strategies. Life years gained were adjusted according to the effectiveness of the two screening approaches: 0.82 for screening starting at age 45 and 0.75 for screening from ages 50 to 76 (**Tables 9** and **10**).

Table 4. Treatment of Advanced Regional Colorectal Cancer (D)

Resource	Quantity	Usage Rate	Unit Cost	Source	Costo total
Oncologist consultation	6	100%	COP 41,300	SOAT 2020	COP 247,800
Radiotherapist consultation	2	100%	COP 41,300	SOAT 2020	COP 82,600
Gastroenterologist/Coloproctologist	4	100%	COP 41,300	SOAT 2020	COP 165,200
Hemogram	6	100%	COP 24,300	SOAT 2020	COP 145,800
Liver profile	6	100%	COP 394,400	SOAT 2020	COP 2,366,400
Renal function (urea)	6	100%	COP 11,700	SOAT 2020	COP 70,200
Renal function (creatinine)	6	100%	COP 1,400	SOAT 2020	COP 8,400
LDH	6	100%	COP 17,300	SOAT 2020	COP 103,800
Abdomen and pelvis CT	3	100%	COP 670,900	SOAT 2020	COP 2,012,700
Chest X-ray	1	100%	COP 70,200	SOAT 2020	COP 70,200
Chest CT	1	100%	COP 509,700	SOAT 2020	COP 509,700
Two-dimensional M-mode echocardiogram	1	100%	COP 422,500	SOAT 2020	COP 422,500
Renal ultrasound	1	100%	COP 137,800	SOAT 2020	COP 137,800
Radiotherapy	1	100%	COP 868,400	SOAT 2020	COP 868,400
Polychemotherapy (full protocol cycle) with any protocol schedule	1	100%	COP 557,100	SOAT 2020	COP 557,100
Surgical Management (D)					
- Colectomy	1	100%	COP 2,889,700	SOAT 2020	COP 2,889,700
- Colostomy/Ileostomy; includes cecostomy, transversostomy, colostomy, sigmoidostomy	1	100%	COP 1,596,700	SOAT 2020	COP 1,596,700
- Retroperitoneal/pelvic lymphadenectomy	1	100%	COP 2,611,500	SOAT 2020	COP 2,611,500
Hospitalization and Treatment Complications (D)					
- Emergency consultations	258	100%	COP 63,244	SOAT 2020	COP 16,316,952
- Hospitalization, number of days due to treatment or treatment complications (third level). Shared room, 3 beds)	15	100%	COP 268,300	SOAT 2020	COP 4,024,500
- Intermediate care hospitalization, number of days (second and third level)	3,1	100%	COP 779,500	SOAT 2020	COP 2,416,450
- Intensive care hospitalization, number of days (second and third level)	5,6	100%	COP 1,454,500	SOAT 2020	COP 8,145,200
Palliative Care (D)					
- Palliative care consultation	6	100%	COP 41,300	SOAT 2020	COP 247,800
- Medications	6	100%	COP 2,294,145	María Ximena León and colleagues	COP 13,764,870
- Sympathetic block by region (e.g., hypogastric, celiac plexus)	1	100%	COP 2,446,700	SOAT 2020	COP 2,446,700

LDH: Lactate Dehydrogenase; Rx: X-Ray; SOAT: Mandatory Traffic Accident Insurance; CT: Computed Tomography. Author's own research.

Table 5. Metastatic Colorectal Cancer (E)

Resource	Quantity	Usage Rate	Unit Cost	Source	Costo total
Oncologist consultation	6	100%	COP 41,300	SOAT 2020	COP 247,800
Radiotherapist consultation	2	100%	COP 41,300	SOAT 2020	COP 82,600
Gastroenterologist consultation	1	100%	COP 41,300	SOAT 2020	COP 41,300
Hemogram	6	100%	COP 24,300	SOAT 2020	COP 145,800
Liver profile	6	100%	COP 394,400	SOAT 2020	COP 2,366,400
Renal function (urea)	6	100%	COP 11,700	SOAT 2020	COP 70,200
Renal function (creatinine)	6	100%	COP 1,400	SOAT 2020	COP 8,400
LDH	6	100%	COP 17,300	SOAT 2020	COP 103,800
Abdomen and pelvis CT	3	100%	COP 670,900	SOAT 2020	COP 2,012,700
Chest X-ray	1	100%	COP 70,200	SOAT 2020	COP 70,200
Chest CT	1	100%	COP 509,700	SOAT 2020	COP 509,700
Two-dimensional M-mode echocardiogram	1	100%	COP 422,500	SOAT 2020	COP 422,500
Renal ultrasound	1	100%	COP 137,800	SOAT 2020	COP 137,800
Radiotherapy	1	100%	COP 868,400	SOAT 2020	COP 868,400
Polychemotherapy (full protocol cycle) with any protocol schedule	1	100%	COP 557,100	SOAT 2020	COP 557,100
Surgical Management (E)					
- Colectomy	1	100%	COP 2,889,700	SOAT 2020	COP 2,889,700
- Colostomy/Ileostomy; includes cecostomy, transversostomy, colostomy, sigmoidostomy	1	100%	COP 1,596,700	SOAT 2020	COP 1,596,700
- Retroperitoneal/pelvic lymphadenectomy	1	100%	COP 2,611,500	SOAT 2020	COP 2,611,500
Palliative Care (E)					
- Palliative care consultation	12	100%	COP 41,300	SOAT 2020	COP 495,600
- Medications	12	100%	COP 2,294,145	María Ximena León and colleagues	COP 27,529,740
- Sympathetic block by region (including hypogastric, ganglion impar, celiac plexus, and splanchnic nerve in cases of hepatic metastasis)	2	100%	COP 2,446,700	SOAT 2020	COP 4,893,400
Complications from Treatment or Disease (E)					
- Emergency consultations	258	100%	COP 63,244	SOAT 2020	COP 16,316,952
- Hospitalization, number of days due to treatment or treatment complications (third level). Shared room, 3 beds)	15	100%	COP 268,300	SOAT 2020	COP 4,024,500
- Intermediate care hospitalization, number of days (second and third level)	3,1	100%	COP 779,500	SOAT 2020	COP 2,416,450
- Intensive care hospitalization, number of days (second and third level)	5,6	100%	COP 1,454,500	SOAT 2020	COP 8,145,200

LDH: Lactate Dehydrogenase; Rx: X-Ray; SOAT: Mandatory Traffic Accident Insurance; CT: Computed Tomography. Author's own research.

Table 6. Frequencies of Findings from Screening Colonoscopy in Patients Aged 45 and 50[31–33]

Health States	Patients Aged 45	Patients Aged 50
Normal (A)	81.50%	73.20%
Adenoma <10 mm (B)	13.95%	19.30%
Adenoma >10 mm (C)	4.55%	6.30%
Regional cancer (D)	0.00%	1.10%
Metastatic cancer (E)	0.00%	0.00%
Death from CRC (F)	0.00%	0.00%
Death from other causes (G)	0.00%	0.00%

Adapted from: López-Kostner F, and colleagues. Rev Med Chil. 2018;146(6):685–692[31]; Shim JI, and colleagues. Cancer Res Treat. 2010;42(4):191–8[32]; Gupta S, and colleagues. Gastroenterology. 2020;158(4):1154[33].

Table 7. Transition Probability Matrix

Health States	Normal (A)	Adenoma <10 mm (B)	Adenoma >10 mm (C)	Advanced Cancer (D)	Metastatic Cancer (E)	Death from CRC (F)	Death from Other Causes (G)	References
Normal (A)	97.40%	1.08%	0.00%	0.00%	0.00%	0.00%	1.51%	(31-36)
Adenoma <10 mm (B)	0.00%	97.50%	0.98%	0.00%	0.00%	0.00%	1.51%	(33,35,36)
Adenoma >10 mm (C)	0.00%	0.00%	93.56%	4.92%	0.00%	0.00%	1.51%	(31,35,36)
Advanced Cancer (D)	0.00%	0.00%	0.00%	76.82%	12.61%	9.06%	1.51%	(37)
Metastatic Cancer (E)	0.00%	0.00%	0.00%	0.00%	61.55%	36.93%	1.51%	(37)
Death from CRC (F)	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	(38)
Death from Other Causes (G)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	(38)

Adapted from: López-Kostner F, and colleagues. Rev Med Chil. 2018;146(6):685–692[31]; Gupta S, and colleagues. Gastroenterology. 2020;158(4):1154[33]; Vatn MH, and colleagues. Cancer. 1982;49(4):819–25[34]; Williams AR, and colleagues. Gut. 1982;23(10):835–42[35]; Clark JC, and colleagues. Int J Cancer. 1985;36(2):179–86[36]; Arminski TC, and colleagues. Dis Colon Rectum. 1964;7:249–61[37]; Rickert RR, and colleagues. Cancer. 1979;43(5):1847–57[38].

RESULTS

Incremental Cost-Utility Ratio

The CRC screening strategy for Colombian adults starting at age 45 was 0.329% less expensive compared to screening starting at age 50 (COP 92,364,407 versus COP 92,669,231). Screening at age 45 yielded 19.40 QALYs, compared to 15.91 QALYs for screening at age 50, resulting in a gain of 3.49 QALYs with earlier screening.

The incremental cost-utility ratio (ICUR) was COP 87,243 per QALY for screening at age 45, making it more effective by gaining more QALYs and less costly. This positions it as a dominant strategy over screening at age 50 (**Table 11**).

Table 8. Parameter Calculation and Ranges for the Transition Matrix

Model Parameters	Minimum	Maximum	Base Case Value
Normal	31.50%	73.10%	97.40%
Adenoma <10 mm	19.70%	22.90%	97.50%
Adenoma >10 mm	43.00%	63.00%	93.56%
Advanced cancer	0.10%	1.30%	76.82%
Metastatic cancer	0.00%	1.30%	61.55%
Death from CRC	0.00%	7.40%	100.00%
Death from other causes	0.00%	34.30%	100.00%

Author's own research.

Mortality was 3.4% for screening starting at age 45, compared to 5.4% for screening at age 50. This represents a 37% reduction in mortality with earlier screening at age 45.

Validation Model and Sensitivity Analysis

To assess the influence of parameter uncertainty on the final outcome of the mathematical model, a deterministic sensitivity analysis was performed using probabilities ranging from 0 to 1. Monte Carlo simulations (1,000 iterations) were conducted in Visual Basic Excel, varying parameter values randomly according to statistical probability distributions. Seed variables were input based on the frequency table of screening findings for CRC in patients aged 45 and 50, and a probability matrix was constructed with the number of individuals transitioning through each stage, guided by the previously described transition probabilities. This iterative process continued until cycle 31 for patients starting screening at age 45 and cycle 26 for those starting at age 50, representing the point when the patient reaches 76 years of age or dies.

Once data for each screening group were collected, scenarios were created using QALY impact as the variable to observe the distribution of incremental utility data and incremental costs relative to the per capita GDP, given the absence of explicit thresholds in Colombia. Cost adjustments were calculated at 12%, and quality adjustments were based on the EQ-5D-5L scale, assigning a value of 0.617 for the stages of adenoma larger than 10 mm, advanced cancer, and metastatic cancer, following the EuroQol (EQ-5D-5L) results[41].

The sensitivity analysis revealed that colonoscopy screening for adults aged 45 generated 20.35 QALYs, compared to 19.85 QALYs for those aged 50. Additionally, with a 12% cost adjustment (applying the extreme discount rate), screening starting at age 45 was found to be less expensive than starting at age 50 (COP 48,284,262 versus COP 49,935,820) (**Table 12**).

Ethical Aspects and Limitations

This study addresses a societal need by examining a public health issue, providing results that benefit the entire population by evaluating and analyzing screening strategies and their cost-effectiveness. While the study adheres to the research guidelines of Colombia's IETS and follows economic evaluation methodology processes, it is a review study that relies on secondary sources. Therefore, its results must be interpreted cautiously and within the methodological framework to avoid conclusions or judgments that exceed the reproducibility of the findings.

To compare costs and benefits between two age groups (45 years and older versus 50 years and older), comprehensive data for all stages in both groups are necessary. A key limitation is the scarcity of studies reporting screening findings in patients over 45, as screening colonoscopy for individuals under 50 is not yet a recommended practice in Colombia.

Table 9. Cohort Transition Matrix for Screening Starting at Age 45

Health State (Age in Years)	Normal (A)	Adenoma <10 mm (B)	Adenoma >10 mm (C)	Cancer (D)	Metastatic Cancer (E)	Death from CRC (F)	Death from Other Causes (G)
Quality Adjustment	1	1	0.74	0.74	0.74	0	0
45	1000	0	0	0	0	0	0
46	815	140	46	0	0	0	0
47	794	145	44	2	0	0	15
48	773	150	43	4	0	0	30
49	753	154	41	5	1	1	45
50	734	159	40	6	1	1	59
51	715	163	39	7	1	2	73
52	696	166	38	7	2	3	87
53	678	170	37	7	2	5	101
54	660	173	37	7	2	6	115
55	643	176	36	7	2	7	128
56	627	178	35	8	2	9	141
57	610	181	35	8	2	10	154
58	594	183	34	7	2	12	166
59	579	185	34	7	2	14	179
60	564	186	34	7	2	15	191
61	549	188	33	7	2	17	203
62	535	189	33	7	2	18	215
63	521	190	33	7	2	20	227
64	508	191	33	7	2	21	238
65	494	192	32	7	2	23	249
66	482	192	32	7	2	24	260
67	469	193	32	7	2	26	271
68	457	193	32	7	2	27	282
69	445	193	32	7	2	29	292
70	434	193	31	7	2	30	302
71	422	193	31	7	2	32	312
72	411	193	31	7	2	33	322
73	401	192	31	7	2	35	332
74	390	192	31	7	2	36	342
75	380	191	31	7	2	38	351
76	370	191	31	7	2	39	360

Adapted from: Gupta S, and colleagues. Gastroenterology. 2020;158(4):1154[33]; Vatn MH, and colleagues. Cancer. 1982;49(4):819–25[34]; Williams AR, and colleagues. Gut. 1982;23(10):835–42[35]; Clark JC, and colleagues. Int J Cancer. 1985;36(2):179–86[36]; Arminski TC, and colleagues. Dis Colon Rectum. 1964;7:249–61[37]; Rickert RR, and colleagues. Cancer. 1979;43(5):1847–57[38].

Table 10. Cohort Transition Matrix for Screening Starting at Age 50

Health State (Age in Years)	Normal (A)	Adenoma <10 mm (B)	Adenoma >10 mm (C)	Cancer (D)	Metastatic Cancer (E)	Death from CRC (F)	Death from Other Causes (G)
Quality Adjustment	1	1	0.74	0.74	0.74	0	0
50	1000	0	0	0	0	0	0
51	732	193	63	11	0	0	0
52	713	197	61	12	2	1	15
53	694	199	59	12	2	3	30
54	676	202	57	12	3	5	45
55	659	204	56	12	3	7	59
56	642	206	54	12	4	9	73
57	625	208	53	12	4	12	87
58	609	210	51	12	4	14	101
59	593	211	50	12	4	17	114
60	578	212	49	11	4	19	127
61	563	213	48	11	4	21	140
62	548	214	47	11	4	24	153
63	534	214	46	11	4	26	165
64	520	215	45	10	4	29	177
65	507	215	44	10	4	31	189
66	493	215	44	10	3	33	201
67	481	215	43	10	3	35	213
68	468	215	42	10	3	37	224
69	456	215	42	10	3	39	235
70	444	214	41	9	3	42	246
71	433	214	41	9	3	44	257
72	421	213	40	9	3	46	268
73	410	212	40	9	3	48	278
74	400	212	39	9	3	50	288
75	389	211	39	9	3	51	298
76	379	210	38	9	3	53	308

Adapted from: Gupta S, and colleagues. Gastroenterology. 2020;158(4):1154[33]; Vatn MH, and colleagues. Cancer. 1982;49(4):819–25[34]; Williams AR, and colleagues. Gut. 1982;23(10):835–42[35]; Clark JC, and colleagues. Int J Cancer. 1985;36(2):179–86[36]; Arminski TC, and colleagues. Dis Colon Rectum. 1964;7:249–61[37]; Rickert RR, and colleagues. Cancer. 1979;43(5):1847–57[38].

Table 11. Cost-Effectiveness Ratio (C/E), Incremental Cost-Utility Ratio (ICUR), and Adjustment of Quality-Adjusted Life Years (QALYs) Gained for Effectiveness

Screening Strategy	Costs	Incremental Cost (45–50)	QALYs Gained	Incremental Effectiveness	C/E	ICUR (ICER)
CRC screening at 45 years	COP 171,175,412	COP -	24,012	0	COP 7,128,864	0
CRC screening at 50 years	COP 163,104,893	$8,070,519	21,64	2,37	COP 7,537,656	COP 3,401,086
Quality-Adjusted	**Costs**	**Incremental Cost (45–50)**	**QALYs Gained**	**Incremental Effectiveness**	**C/E**	**ICUR (ICER)**
CRC screening at 45 years	COP 11,093,632	COP -	19,40	0	COP 571,713	0
CRC screening at 50 years	COP 9,249,970	COP 1,843,662	15,91	3,494	COP 581,384	COP 527,672

Author's own research.

Table 12. Quality-Adjusted Life Years and Discounted Cost by Strategy

Strategy	QALYs	12% Cost Discount
CRC screening at 45 years	20.35	COP 48.284.262
CRC screening at 50 years	19.85	COP 49.935.820

QALYs: Quality-Adjusted Life Years. Author's own research.

DISCUSSION

This study arises from the need to evaluate the cost-effectiveness and cost-utility of initiating CRC screening at age 45, as recommended by the American Cancer Society, due to the increasing incidence of CRC in individuals under 50 in Colombia. On one hand, this decision has several implications for the healthcare system, such as increasing the demand for screening colonoscopies among a larger number of asymptomatic individuals, which will lead to higher resource consumption. On the other hand, the goal of screening is to diagnose precancerous lesions early, allowing for timely intervention and altering the natural history of a high-cost disease like CRC, ultimately contributing to resource savings.

The earlier screening begins, the larger the number of individuals to be screened, based on the population pyramid, and the higher the likelihood of not finding disease in these patients. To reduce this uncertainty, national studies are needed to estimate the prevalence of adenomas and CRC in individuals under 50.

Another issue to consider is that CRC screening in Colombia is opportunity-based. Consequently, there is a population of individuals over 50 who lack access to screening. It could be argued that a greater benefit might be achieved by including more patients from the 50+ age group rather than expanding the screening age range[42–45]. Healthcare organizations and government entities should prioritize cancer screening as part of their agenda, as its cost-effectiveness is well-documented. This prioritization could positively impact future healthcare cost distribution by mitigating the economic burden of advanced-stage CRC.

CONCLUSIONS

In a screening scenario based on the assumptions established in this study, initiating CRC screening at age 45 was shown to dominate the strategy of screening individuals over 50 in Colombia. This suggests that beginning CRC detection studies in this population yields greater benefits and lower overall costs, making it a cost-effective strategy.

The cost difference between the two strategies was 0.329%. Screening at age 45 resulted in higher utility measured in quality-adjusted life years (QALYs) and reduced mortality by 2% compared to starting screening at age 50.

A budget impact analysis (BIA) is required to support the decision to implement a national public health policy for universal CRC screening at age 45.

Conflict of Interest and Funding Statement

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