Check for updates

Current status of colorectal cancer screening in Mexico: a literature review

Diego I. Álvarez-López[1], Angélica Hernández-Guerrero[2], Francisco Freyria-Sutcliffe[3], Juan M. Hernández-Aguilar[4], and Nancy Reynoso-Noverón[5,6]

[1]Program for Master's in Public Health, Instituto Nacional de Salud Pública, Cuernavaca, Mor.; [2]Endoscopy Department, Instituto Nacional del Cáncer, Mexico City; [3]General Direction, Fundación Fomento de Desarrollo Teresa de Jesús, I.A.P (FUTEJE), Mexico City; [4]Social Programs Department, Fundación Fomento de Desarrollo Teresa de Jesús, I.A.P (FUTEJE), Mexico City; [5]Research Department, Instituto Nacional del Cáncer, Mexico City; [6]Medicine School, UNAM, Mexico City. Mexico

Abstract

Colorectal cancer (CRC) is a public health problem worldwide. The disease burden of CRC in Mexico is one of the highest among countries in Latin America and the Caribbean. The highest mortality rates are observed in the north of Mexico, where most of the population lives in urban areas. The Mexican health system is fragmented, which has made it difficult to implement a national CRC screening program despite the strong evidence supporting the efficacy of early detection tests. Prevention programs have focused on screening for cervical, breast, and childhood cancer. Some low-and middle-income countries have conducted programs with high participation and follow-up that could be replicated in our country. It is necessary to place CRC on the political agenda to reduce its disease burden.

Keywords: Early detection. Colorectal cancer. Mexico. Literature review.

Estado actual del tamizaje de cáncer colorrectal en México: revisión de la literatura

Resumen

El cáncer colorrectal (CCR) es un problema de salud pública en todo el mundo. La carga de la enfermedad del CCR en México es una de las más altas entre los países de América Latina y el Caribe. Las tasas de mortalidad más altas se observan en el norte de México, donde la mayoría de la población vive en áreas urbanas. El sistema de salud mexicano está fragmentado, lo que ha dificultado la implementación de un programa nacional de detección del CCR a pesar de la sólida evidencia que respalda la eficacia de las pruebas de detección temprana. Los programas de prevención se han centrado en la detección del cáncer cervical, de mama y de la infancia. Algunos países de ingresos bajos y medios han llevado a cabo programas con una alta participación y seguimiento que podrían replicarse en nuestro país. Es necesario incluir el CCR en la agenda política para reducir su carga de enfermedad.

Palabras clave: Detección temprana. Cáncer colorrectal. México. Revisión de la literatura.

Introduction

In the 21st century, colorectal cancer (CRC) emerged as a global public health concern due to its rising incidence, closely linked to factors like increased life expectancy and risky lifestyles such as sedentary behavior, alcohol consumption, smoking, and high red meat intake[1]. About 95% of CRC cases stem from adenomatous polyps, prevalent in roughly 40% of individuals aged over 50, with a 5-18-year transformation period into malignancy, offering a window for secondary prevention programs[1,2]. However, in Latin America, particularly low- and middle-income countries (LMICs), CRC screening initiatives are scarce[3]. According to The Global Cancer Observatory (GLOBOCAN), CRC was the leading cause of cancer death in Mexico in 2022; yet, the country lacks an effective screening program[4]. As a result of the high burden of CRC in Mexico, some valuable CRC screening initiatives have been implemented by tertiary hospitals (National Cancer Institute and Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán)[5] and national researchers in the last decade[6,7]. This review outlines prevalent CRC early detection tests and the current screening landscape in Mexico, alongside challenges and potential solutions applicable to similar contexts worldwide.

Materials and methods

The objective of this narrative review is to evaluate CRC screening strategies in LMICs and discuss the importance of implementing a nationwide screening program in Mexico. A search was conducted in different literature databases and official websites of international health research organizations. Regarding national and international CRC epidemiology, we extracted the latest data provided by the International Agency for Research on Cancer. Using the interactive platform provided by the Global Cancer Observatory, we compared incidence, age-standardized incidence rate, deaths, and age-standardized mortality rate regarding CRC across the six World Health Organization (WHO) regions. To assess the current recommendations concerning CRC screening for average-risk adults, we explored three updated guidelines published in the United States (American Cancer Society in 2018, US Preventive Task Force in 2021, and National Comprehensive Cancer Network in 2022). To evaluate the experiences of LMICs regarding CRC screening programs, we conducted a search between April and June 2023 in MEDLINE, Latin American and Caribbean Health Sciences Literature

and Google Scholar. We conducted our search and selection of articles to be included according to the international Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. We used the keywords "CRC screening", "low- and middle-income countries", "fecal occult blood test", "fecal immunochemical test (FIT)", and "results". We included original observational studies, written in English or Spanish, of CRC screening programs implemented in any LMIC (as defined by the World Bank in 2022) that assessed for, at least the participation rate, positivity rate, and sensitivity of the screening method used. We excluded studies that were written in any other language and those with full texts unavailable.

Results

CRC epidemiology worldwide

CRC is the third most common cancer worldwide, with nearly 2 million new cases annually, causing 935,000 deaths in 2020 (second leading cause of cancer-related deaths). Both incidence and mortality rates are significantly higher in men[4,8]. While the risk rises after age 50, there is been an uptick in incidence among younger individuals in the 21st century[9,10]. The "Westernization of lifestyle," particularly Western diets, has driven these trends[11]. The global burden of CRC is projected to increase by 60% by 2030 due to the transition from low-to-medium HDI nations (Table 1)[2].

CRC epidemiology in Mexico

In Mexico, CRC ranks third in cancer incidence and first in cancer mortality. According to the International Agency for Research on Cancer (IARC), in 2022, Mexico ranked second and third among Latin American and Caribbean countries in CRC incidence and mortality, respectively, with over 16,000 new cases and 8,200 deaths. Men aged 50 and older have the highest incidence (50.7/100,000) and mortality (27.0/100,000)[1,4]. In addition, there is been an increase in CRC cases among those under 50[12]. Various individual and environmental factors contribute to this rise. From 1998 to 2018, the age-adjusted mortality rate rose from 3.6 to 5.5/100,000, especially in men[13]. Sociocultural differences across regions impact disease burden, with higher mortality rates observed in urban areas, particularly in northern Mexico[13], where behaviors such as processed meat consumption[14], excessive alcohol use[15], and obesity prevail[16], all contributing to CRC risk[17].

Table 1. Epidemiology of colorectal cancer by WHO regions

WHO Region	New cases			Age-standardized incidence rate*			Deaths			Age-standardized mortality rate*		
	Men	Women	Total	Men	Women	World	Men	Women	Total	Men	Women	World
Western Pacific (WPRO)	464 483	353 577	818 060	30.6	20.5	25.3	223 433	172 615	396 048	14.3	9.0	11.5
Europe (EURO)	300 443	254 126	554 569	36.0	23.3	28.8	141 801	121 513	263 314	15.6	9.3	12.0
Americas (PAHO)	162 356	153 162	315 518	23.3	18.5	20.7	69 081	64 341	133 422	9.4	7.0	8.1
South-East Asia (SEARO)	83 942	57 986	141 928	8.5	5.5	7.0	47 876	32 208	80 084	4.9	3.1	4.0
Eastern Mediterranean (EMRO)	28 269	22 134	50 403	10.2	7.9	9.0	15 702	12 273	27 975	5.8	4.5	5.1
Africa (AFRO)	26 243	24 453	50 696	9.5	7.5	8.4	17 634	16 498	34 132	6.7	5.2	5.8

Source: Compiled by the authors based on data from the Global Cancer Observatory, 2020. *per 100,000 population.

Screening tests for CRC

CRC screening utilizes various tests, each with distinct pros and cons, categorized as fecal blood detection, endoscopic examination, and radiographic visualization[18]. Only guaiac-based fecal occult blood test (gFOBT) and sigmoidoscopy have proven to reduce CRC incidence and mortality in clinical trials[19]. Among fecal blood tests, gFOBT and FIT are commonly used, with FIT offering higher sensitivity and consistency. FIT's advantages include requiring only one stool sample, no dietary restrictions, and higher patient participation rates[20-25]. Colonoscopy, though invasive, is the gold standard due to its sensitivity, but it's costly and requires preparation and sedation. Computed tomography colonography, minimally invasive, provides similar detection rates to colonoscopy but may uncover extracolonic findings with uncertain benefits (Table 2)[26,27].

Mexican health system

The Mexican health system is characterized by fragmentation between public and private sectors, including multiple social security institutions and programs catering to the uninsured[28]. This fragmentation compromises service quality and continuity of care for non-communicable diseases like cancer. Persistent differences among health institutions in prevention, diagnosis, and treatment processes contribute to inequities in early detection and survival rates for cancer patients.

In recent years, significant reforms have reshaped the Mexican health system. Notably, the dissolution of Seguro Popular and the establishment of INSABI in 2020 aimed to provide free health services and medication to the uninsured[29,30]. However, these responsibilities have now shifted to IMSS-BIENESTAR[31].

The introduction of the MAS-BIENESTAR model, rooted in Primary Health Care principles, marks another significant development. Among its five intervention axes, the emphasis on disease prevention stands out, focusing on specific protection and early detection. While the model acknowledges the importance of early cancer screening, its current focus is primarily on cervical, breast, and prostate cancer[32], potentially overlooking other cancer types.

Table 2. Characteristics of the tests currently used for colorectal cancer screening

Screening tests	Recommended interval[17-19]	Sensibility (%)[24]	Specificity (%)[24]	CRC deaths averted[a,18]	Strengths	Limitations
Fecal blood detection						
High-sensitivity gFOBT	Annual	61.5-79.4	92.5	23	At-home test / Relatively low cost / Available within the National Health System / No bowel preparation or sedation required	Diet and medication restrictions / Multiple samples required / False-positive rate higher than other tests (FIT)
FIT[b]	Annual	62.3-83.3	96.4	25	At-home test / No diet and medication restrictions / Single stool sample / No bowel preparation or sedation required	Not widely available within the National Health System / Health personnel are unaware of the utility of the test
Mt-sDNA	Every 1-3 years	84.0-97.0	89.8	24-27	At-home test / No bowel preparation or sedation required	Insufficient evidence of performance / False-positive rate higher than other tests (FIT) / More expensive than other stool-based tests
Endoscopic examination						
Colonoscopy	Every 10 years	93.1-99.5	86	27	Gold standard / Combined screening and treatment procedure	Bowel preparation and sedation required / Specialized personnel required / Risk of perforation and hemorrhage / Most expensive test
Flexible sigmoidoscopy[c]	Every 5 years	93.1-99.5	87	23	No sedation or hospitalization needed	Examination of the proximal colon is excluded / Uncomfortable and painful
Radiographic visualization						
Computed tomography colonography	Every 5 years	75.6-92.4	88	26	Extracolonic findings (it is unclear if this represents a benefit for patients)	Radiation exposure / Bowel preparation required

[a]Per 1000 people screened; [b]Cut-off point at 100 ng/mL; [c]Taking the depth of insertion as reference (distal colon); CRC: colorectal cancer; gFOBT: guaiac-based fecal occult blood test; FIT: fecal immunochemical test; MT-sDNA: multitarget stool DNA.

CRC screening in Mexico

The Specific Action Program for Cancer Prevention and Control 2021-2024 aims to boost nationwide early cancer detection. However, its focus primarily on cervical, breast, and childhood cancer sidelines CRC[33]. While validated CRC screening tests are recognized, proposed actions prioritize other cancers. Institutional support, notably the National Cancer Institute's free CRC screening program since 2017, has been pivotal. This program offers FIT screening to individuals aged 45-76 years, with participation rates reaching 91.0% and colonoscopy completion rates among positive tests at 77.7%[5,6]. However, opportunistic CRC screening prevails in Mexico, with patients actively seeking available tests. The Mexican clinical practice guideline for CRC screening, last updated in 2009, recommends fecal occult blood testing (gFOBT or FIT) for low-risk individuals[34]. However, national comparative studies between these tests are lacking. Studies have indicated FIT's efficacy, with positive predictive values, especially with a cut-off point of 100 ng/mL, showing higher accuracy[7,35].

CRC screening in regions with similar contexts to Mexico

In LMIC, implementing population-based CRC screening programs faces challenges, but recent evidence suggests feasibility and cost-effectiveness. Nearly all European Union member states have CRC screening programs, with Bulgaria and Romania being exceptions. Pilot studies in these nations using FIT showed varying participation rates and CRC detection rates[36-38]. Other LMICs in Europe, like Serbia, have seen success with organized CRC screening programs, boasting high participation rates and FIT's positive predictive value[39].

In Southeast Asia, low participation rates in screening programs hinder efforts to reduce CRC mortality[40]. Malaysia and Thailand lack formal national strategies but have conducted local pilot screening programs using FIT, reporting moderate to high participation rates, especially among women and rural residents, with CRC detection rates up to 0.3%[41-43].

A study in Thailand assessed the cost-effectiveness of CRC screening tests, finding that annual FIT screening could prevent a significant percentage of CRC cases compared to colonoscopy, which is significantly more expensive[44]. In Sub-Saharan Africa, evidence on population-level CRC screening is limited, but a study

in Nigeria showed high FIT participation rates, particularly among older individuals and those with higher socioeconomic status[45,46]. In Latin America, Chile has a well-established national program for early CRC detection, but its high-income status presents challenges for replication across the region's diverse socioeconomic contexts (Table 3).

Discussion

The implementation of population-based CRC screening programs remains a pending issue in most Latin American countries, including Mexico. While the burden of CRC has historically been higher in high-income countries, they have reduced CRC mortality in recent years through several early detection strategies[9]. Both financial and human resources are determining factors for the creation and development of cancer prevention programs. Unfortunately, such resources are usually limited in LMIC.

Despite being one of the most commonly diagnosed cancers every year, there are no official figures on health-care costs associated with CRC in Mexico. This lack of knowledge hampers the estimation of potential savings that the system could achieve if a national program for CRC early detection were implemented. Based on reports from other countries, CRC screening is cost-effective regardless of the test used[47].

The presence of multiple risk factors for CRC among a significant percentage of the Mexican population warrants a transition from opportunistic screening to an organized approach. According to the IARC, organized screening programs should have six key characteristics: an explicit policy with specified age ranges, methods, and intervals; a defined target population; a team responsible for implementation; a health team for decisions and care; a quality-assurance infrastructure; and a method for identifying cancer occurrence in the target population[48].

In addition, although clinical practice guidelines serve as valuable tools for health-care providers' decision-making, their usefulness diminishes when not regularly updated. Recent evidence has shown the effectiveness of population-based FIT in reducing CRC mortality; thus, it is appropriate to recommend it with greater emphasis, even prioritizing it over gFOBT. On the other hand, it is necessary to incorporate tools that facilitate the prediction of CRC in asymptomatic populations through risk stratification. In Asia, for example, the Asia-Pacific Colorectal Screening (APCS) score

Table 3. Experiences of other low-and middle-income countries with colorectal cancer screening programs

Authors	Location and study period	Target population	Screening test	Participation rate (%)	Positivity rate (%)	Follow-up with colonoscopy after a positive result (%)	CRC cases per 1000 people screened
Bărbulescu et al.[36]	Romania Oct 2019-Sep 2022	Patients over 18 years registered with the practice in charge of the screening	gFOBT FIT	52.8	15.8	50.0	0.0
Tsvetanova Dimova et al.[38]	Bulgaria 2013	Average-risk asymptomatic individuals, aged ≥ 45 years	FIT	78.8	8.5	75.0	6
Banković-Lazarević et al.[39]	Serbia 2013-2014	Individuals aged between 50 and 74 years	FIT	62.5	5.9	42.1	2.1
Abu Hassan et al.[41]	Kedah, Malaysia 2013	Asymptomatic participants aged ≥ 50 years, not on anticoagulant therapy	FIT	94.7	9.6	68.1	1.3
Khuhaprema et al.[42]	Lampang, Thailand Apr 2011-Nov 2012	Individuals aged 50 to 65 years, with no personal history of colorectal cancer	FIT	62.9	1.1	71.8	0.3
Abdullah et al.[43]	Selangor, Kuala LumpurMalaysia Jul 2017-Jan 2019	Participants of The Malaysian Cohort study recruited between 2006 and 2012	FIT	79.6	13.1	52.7	3.0
Alatise et al.[45]	Osun, Kwara, Lagos, Nigeria Jan-Apr 2021	Average-risk asymptomatic individuals, aged 45-75 years	FIT	90.5	20.5	66.0	1.4

CRC: colorectal cancer; gFOBT: guaiac-based fecal occult blood test; FIT: fecal immunochemical test.

effectively identifies Asian populations at high risk for advanced colorectal neoplasia[49]. Local studies are required to test the validity of similar scores in the Mexican population.

Health education is another core element that should be integrated into any prevention strategy. Mexican studies have indicated a significant proportion of the population rejecting stool blood tests (specifically FIT) due to disinterest, low-risk perception, and fear, among other factors[50]. Similar findings have been reported in other LMICs, highlighting the inadequate training of primary health personnel on topics related to CRC[51].

Conclusions

Given the prevalent epidemiological and sociocultural context in Mexico, it is imperative to consider the development and implementation of a national CRC screening program. Specifically, evidence from high-income countries indicates that the widespread use of tests such as FIT contributes to reducing CRC mortality. Moreover, experiences in other LMICs, along with cost-effectiveness analyses, suggest that the development of such strategies is feasible and can be adequately accepted by the population. However, the reconstruction of the country's health system raises more questions than answers and health priorities

seem to be not entirely clear. It is crucial to redirect attention toward diseases with increasing morbidity and mortality rates, which also impose a considerable economic burden on the health system. Unlike other types of cancer, CRC presents a unique opportunity for early detection and subsequent treatment. Considering these factors, genuine political commitment from health authorities could be the missing piece to improve the current status of CRC in Mexico.

Acknowledgments

Funding

Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that no patient data appear in this article. Furthermore, they have acknowledged and followed the recommendations as per the SAGER guidelines depending on the type and nature of the study.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Use of artificial intelligence for generating text. The authors declare that they have not used any type of generative artificial intelligence for the writing of this manuscript or for the creation of images, graphics, tables, or their corresponding captions.

References

1. Hossain MS, Karuniawati H, Jairoun AA, Urbi Z, Ooi J, John A, et al. Colorectal cancer: a review of carcinogenesis, global epidemiology, current challenges, risk factors, preventive and treatment strategies. Cancers (Basel). 2022;14:1732.
2. Sawicki T, Ruszkowska M, Danielewicz A, Niedźwiedzka E, Arłukowicz T, Przybyłowicz KE. A review of colorectal cancer in terms of epidemiology, risk factors, development, symptoms and diagnosis. Cancers (Basel). 2021;13:2025.
3. Pan American Health Organization. Expert Consultation on Colorectal Cancer Screening in Latin America and the Caribbean: Pan American Health Organization; c2016. Available from: https://iris.paho.org/bitstream/handle/10665.2/28552/PAHONMH16003-eng.pdf [Last accessed on 2023 Mar 29].
4. Ferlay J, Ervik M, Lam F, Laversanne M, Colombet M, Mery L, et al. Global Cancer Observatory: Cancer Today; 2023. Available from: https://gco.iarc.who.int/today [Last accessed on 2023 Mar 29].
5. Secretaría de Salud. Instituto Nacional de Cancerología Aplica Programa de Detección Gratuita de Cáncer Colorrectal; c2023. Available from: https://www.gob.mx/salud/prensa/87-instituto-nacional-de-cancerologia-aplica-programa-de-deteccion-gratuita-de-cancer-colorrectal?idiom=es [Last accessed on 2023 Apr 27].
6. Manzano-Robleda MD, Espinosa-Tamez P, Potter MB, Lajous M, Van Loon K, Zhang L, et al. Fecal immunologic test results and diagnostic colonoscopy in a Mexican population at average risk for colorectal cancer. Cancer Prev Res (Phila). 2020;13:959-66.
7. Remes-Troche JM, Hinojosa-Garza G, Espinosa-Tamez P, Meixueiro-Daza A, Grube-Pagola P, Van Loon K, et al. Faecal immunochemical test-based colorectal cancer screening in Mexico: an initial experience. Fam Pract. 2020;37:321-4.
8. Douaiher J, Ravipati A, Grams B, Chowdhury S, Alatise O, Are C. Colorectal cancer-global burden, trends, and geographical variations. J Surg Oncol. 2017;115:619-30.
9. Siegel RL, Wagle NS, Cercek A, Smith RA, Jemal A. Colorectal cancer statistics, 2023. CA Cancer J Clin. 2023;73:233-54.
10. Sifaki-Pistolla D, Poimenaki V, Fotopoulou I, Saloustros E, Mavroudis D, Vamvakas L, et al. Significant rise of colorectal cancer incidence in younger adults and strong determinants: 30 years longitudinal differences between under and over 50s. Cancers (Basel). 2022;14:4799.
11. Garcia-Larsen V, Morton V, Norat T, Moreira A, Potts JF, Reeves T, et al. Dietary patterns derived from principal component analysis (PCA) and risk of colorectal cancer: a systematic review and meta-analysis. Eur J Clin Nutr. 2019;73:366-86.
12. Burbano-Luna DF, Manrique MA, Chávez-García MÁ, Pérez-Corona T, Hernández-Velázquez NN, Escandón-Espinoza YM, et al. Epidemiología del cáncer colorrectal en menores de 50 años en el Hospital Juárez de México. Endoscopia. 2016;28:160-5.
13. Espinosa-Tamez P, Suazo-Zepeda E, Sánchez-Blas H, Meneses-Medina M, Huitzil-Meléndez FD, Van Loon K, et al. National and state-level colorectal cancer mortality trends in Mexico, 1998-2018. Salud Publica Mex. 2021;64:5-13.
14. Gaona-Pineda EB, Martínez-Tapia B, Arango-Angarita A, Valenzuela-Bravo D, Gómez-Acosta LM, Shamah-Levy T, et al. Consumo de grupos de alimentos y factores sociodemográficos en población Mexicana. Salud Publica Mex. 2018;60:272-82.
15. Rivera-Rivera L, Séris-Martínez M, Reynales-Shigematsu LM, Villalobos A, Jaen-Cortés CI, Natera-Rey G. Factores asociados con el consumo excesivo de alcohol: encuesta nacional de salud y nutrición 2020 sobre covid-19. Salud Publica Mex. 2021;63:789-98.
16. Barquera S, Hernández-Barrera L, Trejo-Valdivia B, Shamah T, Campos-Nonato I, Rivera-Dommarco J. Obesidad en México, prevalencia y tendencias en adultos. Ensanut 2018-19. Salud Publica Mex. 2020;62:682-92.
17. Brenner H, Kloor M, Pox CP. Colorectal cancer. Lancet. 2014;383:1490-502.
18. Issa IA, Noureddine M. Colorectal cancer screening: an updated review of the available options. World J Gastroenterol. 2017;23:5086-96.
19. Helsingen LM, Kalager M. Colorectal cancer screening-approach, evidence, and future directions. NEJM Evid. 2022;1(1):1-13.
20. Wolf AM, Fontham ET, Church TR, Flowers CR, Guerra CE, LaMonte SJ, et al. Colorectal cancer screening for average-risk adults: 2018 guideline update from the American cancer society. CA Cancer J Clin. 2018;68:250-81.
21. US Preventive Services Task Force, Davidson KW, Barry MJ, Mangione CM, Cabana M, Caughey AB, et al. Screening for colorectal cancer: US preventive services task force recommendation statement. JAMA. 2021;325:1965-77.
22. National Comprehensive Cancer Network. Colorectal Cancer Screening; 2022. Available from: https://www.nccn.org/professionals/physician_gls/pdf/colorectal_screening.pdf [Last accessed on 2023 Apr 05].
23. Shaukat A, Kahi CJ, Burke CA, Rabeneck L, Sauer BG, Rex DK. ACG clinical guidelines: colorectal cancer screening 2021. Am J Gastroenterol. 2021;116:458-79.
24. Huang Y, Li Q, Ge W, Cai S, Zhang S, Zheng S. Predictive power of quantitative and qualitative fecal immunochemical tests for hemoglobin in population screening for colorectal neoplasm. Eur J Cancer Prev. 2014;23:27-34.
25. Cole SR, Young GP. Effect of dietary restriction on participation in faecal occult blood test screening for colorectal cancer. Med J Aust. 2001;175:195-8.
26. Johnson CD, Chen MH, Toledano AY, Heiken JP, Dachman A, Kuo MD, et al. Accuracy of CT colonography for detection of large adenomas and cancers. N Engl J Med. 2008;359:1207-17.

27. Knudsen AB, Zauber AG, Rutter CM, Naber SK, Doria-Rose VP, Pabiniak C, et al. Estimation of benefits, burden, and harms of colorectal cancer screening strategies: modeling study for the US preventive services task force. JAMA. 2016;315:2595.

28. Gómez-Dantés O, Sesma S, Becerril VM, Knaul FM, Arreola H, Frenk J. Sistema de salud en México. Salud Publica Mex. 2011;53:s220-32.

29. Cámara de Diputados LXV Legislatura. Publica DOF Decreto que Crea el Insabi y Desaparece el Seguro Popular; c2019. Available from: https://www5.diputados.gob.mx/index.php/esl/comunicacion/agencia-de-noticias/2019/noviembre/29/3808-publica-dof-decreto-que-crea-el-insabi-y-desaparece-el-seguro-popular [Last accessed on 2023 Apr 20].

30. Gobierno de México. INSABI: Misión y Visión; c2020. Available from: https://www.gob.mx/insabi/documentos/mision-y-vision-insabi?idiom=es [Last accessed on 2023 Apr 20].

31. Secretaría de Gobernación. DECRETO Por el Que se Crea el Organismo Público Descentralizado Denominado Servicios de Salud del Instituto Mexicano del Seguro Social Para el Bienestar (IMSS-BIENESTAR); c2022. Available from: https://www.dof.gob.mx/nota_detalle.php?codigo=5663064&fecha=31/08/2022#gsc.tab=0 [Last accessed on 2023 Apr 20].

32. Secretaría de Gobernación. ACUERDO Por el Que se Emite el Modelo de Atención a la Salud Para el Bienestar (MAS-BIENESTAR); c2022. Available from: https://www.dof.gob.mx/nota_detalle.php?codigo=5669707&fecha=25/10/2022#gsc.tab=0 [Last accesed 2023 Apr 26].

33. Secretaría de Salud. Programa de Acción Específico de Prevención y Control del Cáncer 2021-2024. Secretaría de Salud; c2021. Available from: https://www.gob.mx/cms/uploads/attachment/file/706943/pae_can_cf.pdf [Last accessed on 2023 Apr 26].

34. Secretaría de Salud. Guía de Práctica Clínica "Detección Oportuna y Diagnóstico de Cáncer de Colon y Recto no Hereditario en Adultos en Primero, Segundo y Tercer Nivel de Atención; c2009. Available from: https://www.cenetec-difusion.com/cmgpc/imss-145-08/er.pdf [Last accessed on 2023 Apr 28].

35. Gálvez-Ríos S, Sobrino-Cossío S, Siu A, Chaurand M, Abdo-Francis M, López-Colombo A, et al. Resultados de la prueba inmunoquímica fecal en un programa de escrutinio para cáncer colorrectal en México. Cir Cir. 2020;88:4475.

36. Bărbulescu LN, Mogoantă SS, Bărbulescu LF, Kamal C, Popa DL, Popa RT. A pilot colorectal cancer study using fecal occult blood tests and colonoscopy to identify the weaknesses of the romanian public healthcare system before implementing national screening. Int J Environ Res Public Health. 2023;20:2531.

37. Eurostat. GDP Per Capita, Consumption Per Capita and Price Level Indices; c2022. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=gdp_per_capita,_consumption_per_capita_and_price_level_indices [Last accessed on 2023 Jun 16].

38. Tsvetanova Dimova R, Dimitrova Dimitrova D, Angelova Levterova B, Stoyanov Dimov R, Atanasova Semerdjieva M, Frantova Tarnovska M, et al. Feasibility of immunochemical faecal occult blood testing for colorectal cancer screening in Bulgaria. J BUON. 2015;20:413-20.

39. Bankovic-Lazarevic D, Krivokapic Z, Barisic G, Jovanovic V, Ilic D, Veljkovic M. Organized colorectal cancer screening in Serbia-the first round within 2013-2014. Vojnosanit Pregl. 2016;73:360-7.

40. Sano Y, Byeon JS, Li XB, Wong MC, Chiu HM, Rerknimitr R, et al. Colorectal cancer screening of the general population in East Asia. Dig Endosc. 2016;28:243-9.

41. Abu Hassan MR, Leong TW, Andu DF, Hat H, Mustapha NR. Evaluation of a colorectal carcinoma screening program in Kota Setar and Kuala Muda Districts, Malaysia. Asian Pac J Cancer Prev. 2016;17:569-73.

42. Khuhaprema T, Sangrajrang S, Lalitwongsa S, Chokvanitphong V, Raunroadroong T, Ratanachu-ek T, et al. Organised colorectal cancer screening in Lampang Province, Thailand: preliminary results from a pilot implementation programme. BMJ Open. 2014;4:e003671.

43. Abdullah N, Abd Jalal N, Ismail N, Kamaruddin MA, Abd Mutalib NS, Alias MR, et al. Colorectal screening using the immunochemical faecal occult blood test kit among the Malaysian cohort participants. Cancer Epidemiol. 2020;65:101656.

44. Phisalprapa P, Supakankunti S, Chaiyakunapruk N. Cost-effectiveness and budget impact analyses of colorectal cancer screenings in a low-and middle-income country: example from Thailand. J Med Econ. 2019;22:1351-61.

45. Alatise OI, Dare AJ, Akinyemi PA, Abdulkareem FB, Olatoke SA, Knapp GC, et al. Colorectal cancer screening with fecal immunochemical testing: a community-based, cross-sectional study in average-risk individuals in Nigeria. Lancet Glob Health. 2022;10:e1012-22.

46. Lussiez A, Dualeh SH, Dally CK, Opoku BK, Raghavendran K, Aitpillah F, et al. Colorectal cancer screening in Ghana: physicians' practices and perceived barriers. World J Surg. 2021;45:390-403.

47. Lansdorp-Vogelaar I, Knudsen AB, Brenner H. Cost-effectiveness of colorectal cancer screening. Epidemiol Rev. 2011;33:88-100.

48. International Agency for Research on Cancer. Cervix Cancer Screening; 2005. Available from: https://publications.iarc.fr/book-and-report-series/iarc-handbooks-of-cancer-prevention/cervix-cancer-screening-2005 [Last accessed on 2023 Apr 27].

49. Li W, Zhang L, Hao J, Wu Y, Lu D, Zhao H, et al. Validity of APCS score as a risk prediction score for advanced colorectal neoplasia in Chinese asymptomatic subjects: a prospective colonoscopy study. Medicine (Baltimore). 2016;95:e5123.

50. Unger-Saldaña K, Saldaña-Tellez M, Potter MB, Van Loon K, Allen-Leigh B, Lajous M. Barriers and facilitators for colorectal cancer screening in a low-income urban community in Mexico City. Implement Sci Commun. 2020;1:64.

51. Moussallem M, Jreij M, Yeretzian JS, Asmar MK, Bou-Orm IR. Colorectal cancer screening knowledge and uptake in Lebanon: a national survey. Rev Épidémiol Santé Publique. 2022;70:67-73.