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Review Article

A Roadmap to Developing a Population-Based Colorectal Cancer Screening Program in Oman

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Abstract

Colorectal cancer (CRC) is a major public health problem worldwide, as it is the third most common disease and the second leading cause of cancer-related fatalities. In recent years, Oman, like many other countries, has seen an epidemiological shift from communicable diseases to noncommunicable diseases, including colorectal cancer, necessitating comprehensive planning to address the root cause of the problem as well as a comprehensive screening program to detect diseases at an early stage and thus improve health outcomes. Colorectal cancer is the second most frequent cancer in Oman, with the highest mortality rate, inflicting considerable public health and economic consequences; nevertheless, there is no population-based CRC screening programme in place to minimise the disease's incidence, mortality, and severe health outcomes. This review highlights the epidemiology of colorectal cancer in Oman, the Wilson and Junger criteria, operational readiness, and recommendations for implementing a population-based colorectal cancer screening program.

Keywords:
colorectal cancer; population-based screening program; Oman

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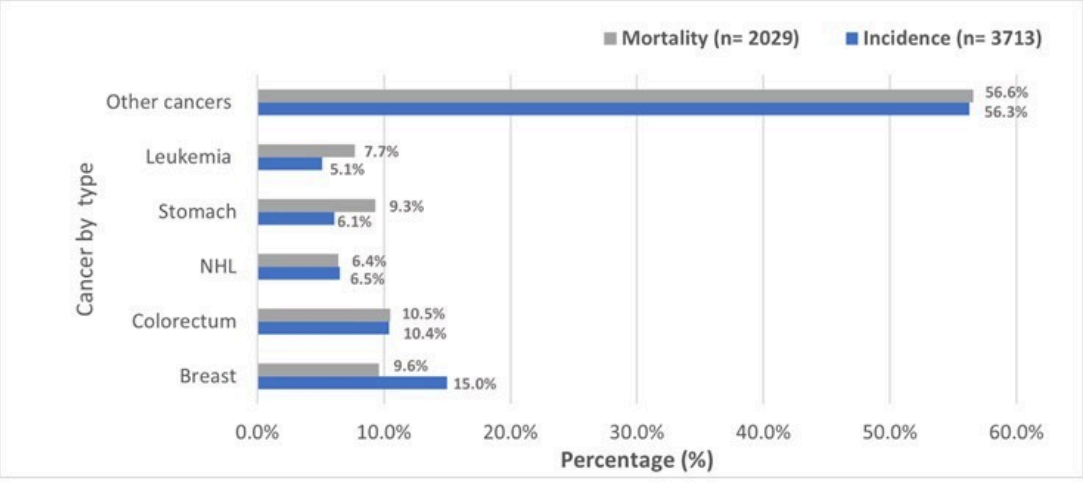
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Introduction

Colorectal cancer (CRC) is a worldwide public health problem, with incidence and fatality rates increasing over time [1], [2]. In 2020, CRC ranked the third most common cancer in the world, trailing only breast and lung cancer, with 1.93 million new cases [3]. Nearly one million people died from CRC in 2020, just second only to lung cancer [4]. The health and economic impact of colorectal cancer are variable across nations, with the highest incidence and mortality rate seen in high-income countries [5]. The annual burden of colorectal cancer is expected to rise to 3.2 million new cases and 1.6 million deaths by 2040 [1]. The incidence of colorectal cancer rises with age, most likely due to a buildup of risks for specific cancers that increase with age [1], [6]. Several lifestyle variables are associated with the development of colorectal cancer, including excessive alcohol intake, sedentary behaviour, obesity, smoking, high intake of processed meat, and low intake of fruits and vegetables [1], [7]. Between 30 and 50% of cancers can be prevented by avoiding risk factors and implementing evidence-based prevention strategies [6]. These strategies include adopting a healthy lifestyle as well as early detection, effective treatment, and care for cancer patients [1], [7].

In Oman, CRC is the second most frequent cancer and has the highest mortality rate, imposing a significant public health and economic burden on the country [8]. Many countries have realised the substantial public health impact of establishing an efficient colorectal cancer screening program, which can considerably reduce the incidence and mortality of colorectal cancer [1]. However, Oman has yet to implement a population-based screening program for CRC. This review aims to highlight the current epidemiology of colorectal cancer in Oman, the operational readiness, and a suggested roadmap to develop a CRC screening program in Oman.



Source: Global Cancer Observatory (9)

Figure 1. Estimated number of new cancer cases and death cases in Oman for both sexes and all ages in 2020

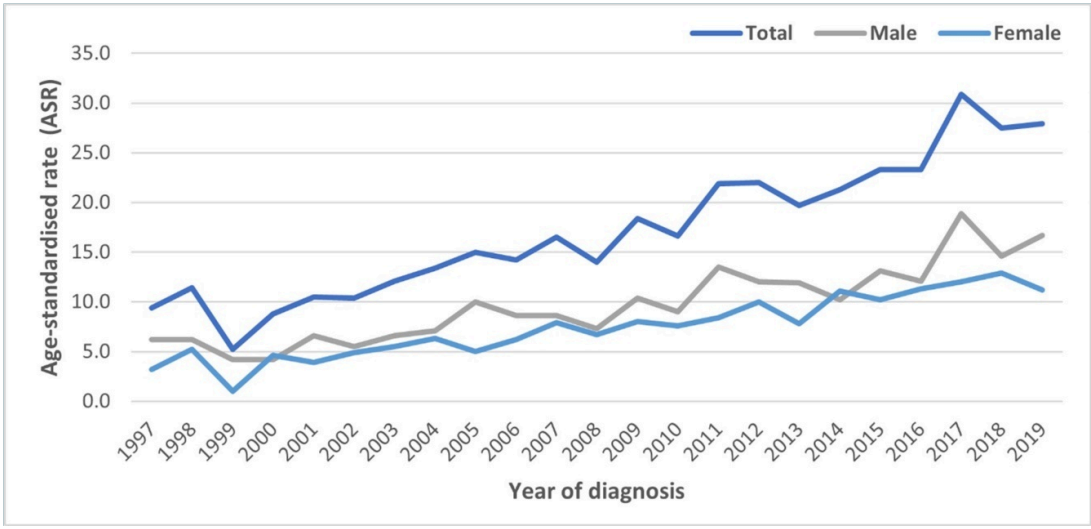


Figure 2. Age-standardised rate (ASR) of colorectal cancer (CRC) in Oman from 1997 to 2019

Epidemiology of colorectal cancer in Oman

Incidence and mortality

According to the Global Cancer Observatory, 2020, the total incidence of cancer in Oman for both sexes and all ages was 3713, with 2232 males and 1481 females [9]. Among both sexes, colorectal cancer was the second most common cancer (10.4%), after only breast cancer (15.0%), Figure 1[9]. It was the most common cause of cancer in males (12.9%), followed by prostate (8.5%) and stomach (7.8%) cancer, and the third most common cause of cancer in females (6.5%), following only breast (37.7%) and thyroid (9.1%) cancer [9]. A total of 2029 cancer deaths, of which 1351 were male and 678 were female, were estimated in 2020 in Oman, with CRC being the leading cause of death (10.5%), followed by breast cancer (9.6%) and stomach cancer (9.3%), Figure 1[9]. CRC is the first leading cause of death in males (11.9%), followed by stomach cancer (10.9%), and the second leading cause of death in females (7.7%), only after breast cancer (28.8%).

Figure 2 illustrates the age-standardised rate (ASR) of colorectal cancer in Oman between 1997 and 2019. As has been clearly demonstrated, the trend of colorectal cancer has steadily increased with time, with males' ASR being higher than females' ASR. Although the incidence of CRC is low compared to the regional level [4], [8], it steadily rises with time [5], which will be reflected in adverse health and economic consequences.

Age distribution of colorectal cancer

The majority of colorectal cancers in Oman are detected in adults over the age of 50 (65.3%), with males having a larger proportion than females, as shown in Figure 3[8]. Before the age of 40, both sexes have a comparable age distribution of CRC cases; however, the discrepancy widens as one gets older.

Stage of diagnosis of colorectal cancer in Oman

Figure 4 illustrates the stage of colorectal cancer at diagnosis in 2017, 2018, and 2019 [8]. The stage of colorectal cancer has shifted over time, with a smaller proportion of cancers being detected at an early stage and a greater proportion at a late stage, increasing the overall health and economic cost. In 2019, only 5% of cancers were identified in stage one, while over half were detected at stage 3 or stage 4. The possible underlying cause of the late diagnosis could be ascribed to a lack of knowledge of CRC symptoms along with a suboptimal healthcare system capable of detecting colorectal cancer at an early stage.

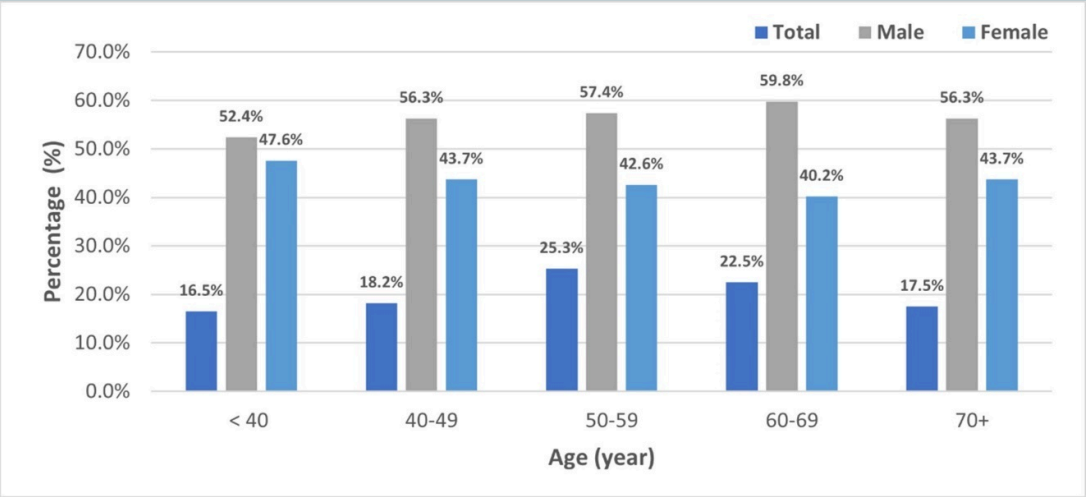


Figure 3. Percentage of colorectal cancer (CRC) by age in Oman from 1997 to 2019 (n= 2448)

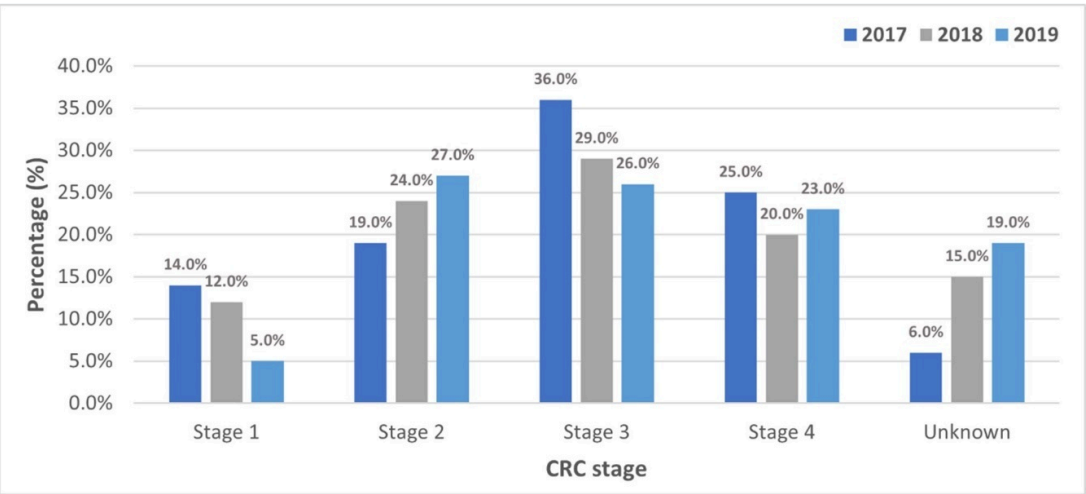


Figure 4. Stages of colorectal cancer (CRC) in Oman in 2017 (n=233), 2018 (n-227), and 2019 (n= 234)

Projected change in CRC incidence and mortality in Oman

The incidence and mortality rate of colorectal cancer are expected to rise over time in Oman, as shown in Figure 5. The total number of cases is anticipated to rise from 385 in 2020 to 824 by 2040, with male incidence being threefold higher than female incidence. Similarly, the predicted number of deaths is expected to rise from 213 in 2020 to 463 in 2040 [5].

Knowledge and attitude towards colorectal cancer in Oman

Several factors may raise the risk of colorectal cancer, including alcohol intake, smoking, red and processed meat, obesity, and family history of the disease [10]. There is a paucity of public health awareness of colorectal cancer and its risk factors in Oman, necessitating a concerted effort to raise public perception and knowledge about this public health problem. A study was conducted to investigate the knowledge of risk factors, symptoms, and the time needed to explore the medical care for stomach cancer and colorectal cancer (CRC) among Omani participants attending 28 local health centres (LHCs) in the governorate of Muscat, Oman [11]. The most recognised risk factors were excessive alcohol consumption and smoking. Risk factors for CRC were most recognised by young participants, highly educated participants, and married participants [11]. One in every two respondents would have a colonoscopy if the doctors recommended it; the primary reasons for refusal were embarrassment, lack of trust in the doctors, and religious or cultural beliefs [11]. Another study of people attending

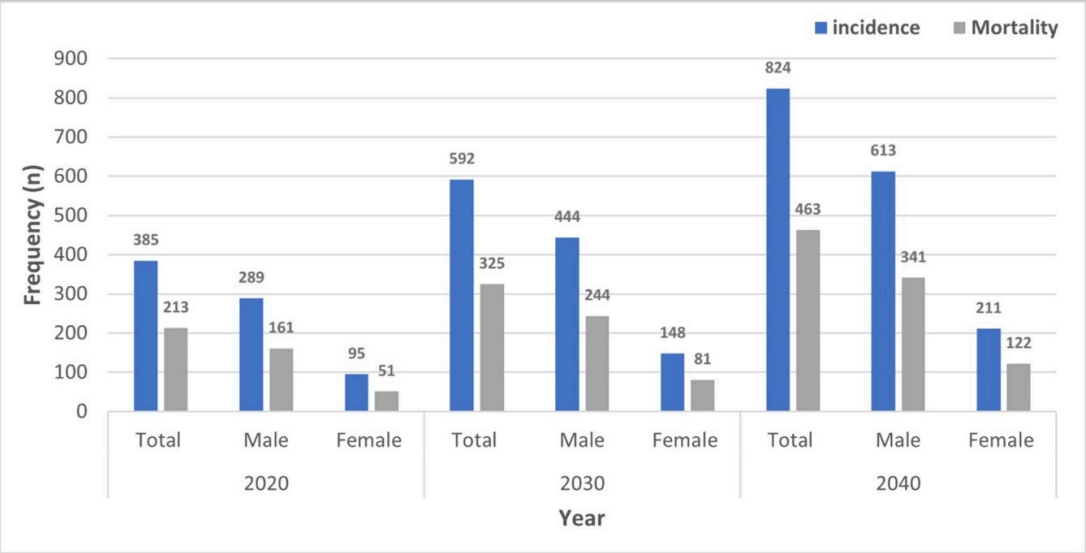


Figure 5. Projection of colorectal cancer cases in Oman 2030 and 2040

Sultan Qaboos University Hospital (SQUH) found that three out of every four participants had never heard of colorectal cancer screening; however, over two-thirds (70.6%) said they would do it if it was recommended [12]. Males were more aware of CRC screening than females. The most prevalent barriers were embarrassment at the prospect of a colonoscopy, the absence of CRC symptoms, and fear of being diagnosed with CRC [12].

Health system in Oman

Oman spent around 2.6% of its GDP (11% of the budget) on health care, rising by 12.9% annually [13]. Only two hospitals (SQUH and Royal Hospital) have a cancer care services unit. The government funds and operates 80% of hospitals, and population growth is putting additional pressure on this public health care system. In 2014, the government commenced a long-term plan for the healthcare sector entitled Health Vision 2050, which envisions large-scale investment in the healthcare sector to create a well-organized, equitable, efficient, and responsive health system [13]; however, this will need more investment in infrastructure and human resources to meet this vision.

Oman has a population-based cancer registry that tracks and reports the trend of various cancers over time. There is no population-based CRC screening program; instead, opportunistic screening with a faecal occult blood test (gFOBT) is performed upon request. The gFOBT is also performed as part of an elderly care program that targets individuals aged 60 and older, with those who have a positive result referred for additional diagnostic procedures (colonoscopy). The referral pathway for positive gFOBT is significantly inefficient, with individuals having to wait for specialist evaluations and other diagnostic procedures for prolonged periods of time, potentially delaying early diagnosis and treatment. Even though CRC is considered a public health issue in Oman, there is no agreed-upon strategy in place to establish and implement a population-based screening program in the near future.

Wilson and Jungner Criteria

The goal of cancer screening is to identify individuals in an apparently healthy population who are at risk for health problems, allowing for early treatment or intervention and potentially improving outcomes. It reduces the incidence, mortality, and severity of illness by detecting diseases early in a person's life when more treatment options are available. Wilson and Junger proposed ten principles for determining if cancer screening is a suitable course of action for improving public health [14]. Before launching a population-based screening program, policymakers should assess the Wilson and Jungner criteria to ensure that all practicable, cost-effective preventative interventions have been applied [14].

In Oman, colorectal cancer is the second most common cancer in both sexes, the most common in men, with the greatest fatality rate also among men, making it a major and escalating public health

Table 1. Comparison of different non-invasive colorectal cancer screening tests

	Faecal occult blood test	Faecal immunochemical test	Stool DNA test
Description	A stool sample collection kit that is used to check for blood in the stool	A stool sample collection kit that is used to check for blood in the stool	A stool sample collection kit used to check for abnormal DNA that may have emerged from malignant precancerous cells.
Interval	Every 1-2 years	Every 1-2 years	Every 1-3 years
Number of samples required	Three separate samples	A single stool sample	A single stool sample
Preparation	Dietary restriction	No dietary restriction	No dietary restriction
Sensitivity	CRC=50%	CRC=79%, Advanced adenoma=24%	CRC=92%, Advanced adenoma=42%
Specificity	98%	94%	87%

problem. The natural history and latency period of the disease are well recognised. CRC pathogenesis is characterised by a gradual progression from benign adenomas to malignant adenocarcinomas, which can take up to ten years [15]. Up to 90% of deaths can be avoided if the disease is detected early [15]. The target population for screening is different across nations [15]; however, it can be easily identified at primary health care levels in Oman.

There are effective non-invasive CRC screening tests that can detect the disease at an early stage and, hence, improve the outcome. These include the faecal immunochemical test, the faecal occult blood test (gFOBT), and the stool DNA test, Table 1[15]. The faecal occult blood test (gFOBT) is used in primary care as part of geriatric care and is extremely specific; nevertheless, it requires dietary restrictions. The FIT test, on the other hand, is highly sensitive and specific and doesn't require diet restriction; however, it is not available in Oman. The three tests are straightforward, acceptable, and affordable. There is an agreed-upon plan of action for investigating participants who have positive screening tests, which includes diagnostic testing, treatment, and follow-up care, all of which are available at selected secondary and tertiary health care facilities in Oman.

There is adequate infrastructure in Oman for a comprehensive cancer screening program, including financial resources, health human resources, information technology, buildings, equipment, and test technologies. The health system has a clear diagnostic and treatment pathway for those with abnormal gFOBT results. The population-based screening program is considered clinically, socially, and ethically acceptable. The benefits and harms of screening programs are well-established globally [14]; however, there should be a robust quality assurance system in place to ensure the program runs effectively and meets performance standards. Despite the adequacy of infrastructure, Oman has yet to establish a comprehensive population-based cancer screening program that achieves the intended public health goals.

Table 2Summarize the Wilson and Jungner criteria for launching a CRC screening program in Oman.

Operational readiness to develop a CRC screening program in Oman.

Implementing a population-based colorectal screening program requires a comprehensive strategy that includes a clinical governance framework, leadership, coordination, and management [14]. This framework should cover aspects such as clinical guidelines, monitoring performance, local service delivery, financing and payment systems, access to personal data, and quality assurance systems. Leadership, coordination, and management are crucial for the successful implementation of the program.

Mapping the full screening pathway in a country's health system helps describe the process from target population identification to diagnosis and treatment. Regular training of personnel is essential for maintaining their skills. Health information systems are critical for the success of cancer screening

Table 2. Wilson and Jungner criteria for establishing a colorectal cancer (CRC) screening program in Oman.

Criteria	Evidence
1. The condition should be an important health problem.	Second most common cancer among both sexes in Oman [9].
	Second highest mortality among all cancers in both sexes in Oman [9].
	The trend is increasing with time [5].
2. The natural history of the condition, including its development from latent to declared disease, should be adequately understood.	Yes [15,16]
3. There should be a recognizable latent or early asymptomatic stage.	Many CRCs are preceded by an asymptomatic interval.
	Polyps typically grow slowly, allowing for early identification and CRC prevention [16], [17]
4. There should be an accepted treatment for patients with recognized disease.	There is well-recognised, evidence-based treatment for CRC[1].
	Consensus guidelines for CRC treatment exist.
5. Facilities for diagnosis and treatment should be available.	All diagnostic and treatment options are available at selected health care facilities in Oman.
6. There should be a suitable test or examination.	Different non-invasive screening tools exist.
	In Oman, the gFOBT is available at primary healthcare centres.
7. The test should be acceptable to the population.	Non-invasive screening tests are simple and acceptable for individuals.
8. There should be an agreed policy on whom to treat as patients.	The treatment pathway is well established for positive screening test cases.
9. The cost of case finding (including diagnosis) should be economically balanced in relation to possible expenditures on medical care.	Literature shows that screening is cost-effective, improve mortality and morbidity [14].
10. Case finding should be a continuing process and not a "once and for all" project.	USPSTF and others recommend strategies for screening, such as annual FIT, or every 10-year colonoscopy[18].

programs, connecting screening procedures, and quality assurance. They rely on various sources, such as hospitals, laboratory services, and death certificates [14].

Adequate funding is essential for screening programs, as intermittent and uncertain funding can hinder cost-effectiveness. Health system capacity should be considered when planning screening programs, as reallocating resources can negatively impact other healthcare areas and lower the quality of care for people with symptomatic conditions. Information and communication should be unbiased and easy to understand so people can make an informed decision about whether to participate or not in the screening program. Overall, Oman now has a window of opportunity to establish a population-based colorectal screening program that can improve health and economic impact in a dramatic fashion.

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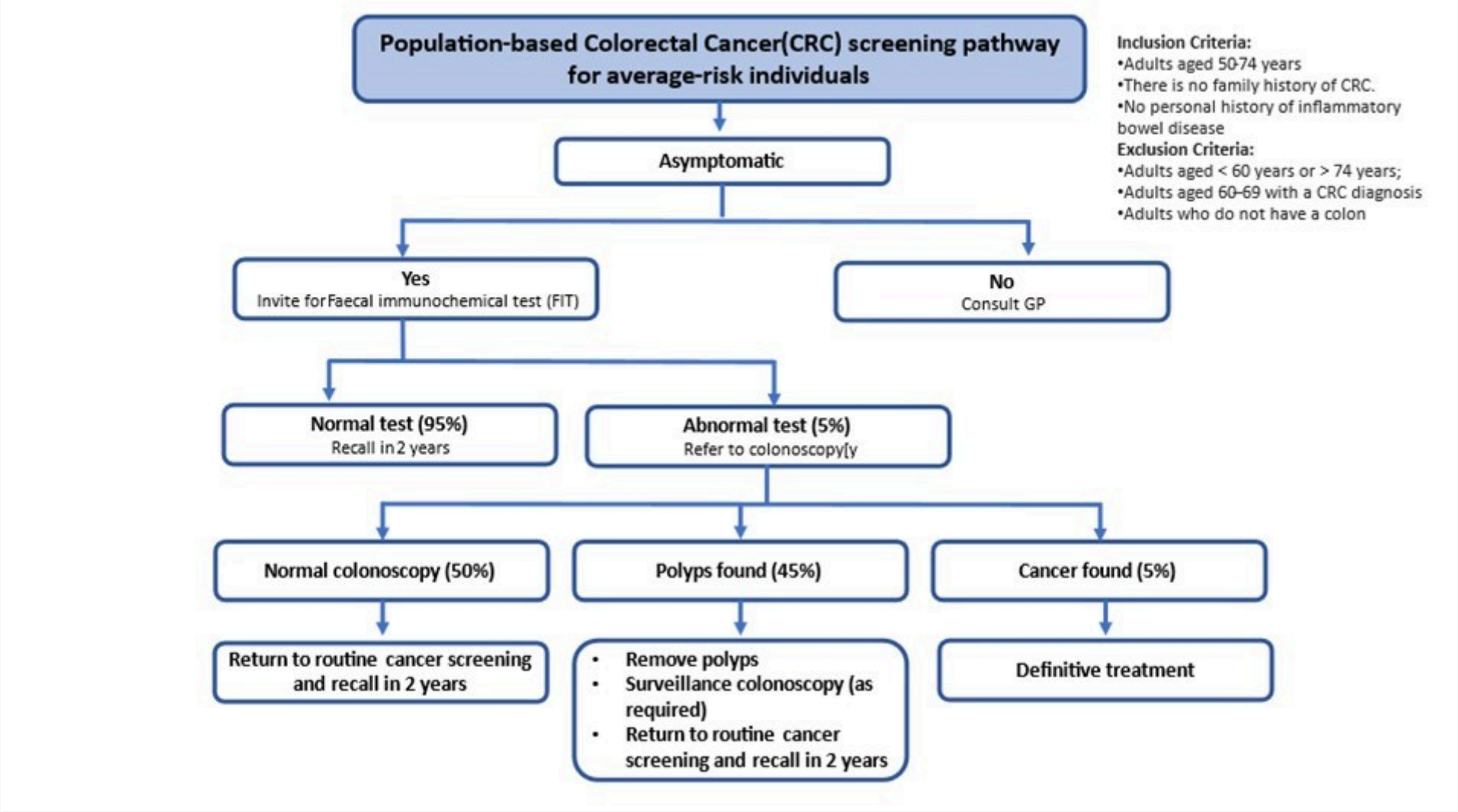


Figure 6. Provisional pathway of a population-based colorectal cancer screening pathway for average-risk individuals in Oman

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To develop an effective population-based colorectal screening program, there should be extensive planning. Table 3 summarises the strategies through which a CRC program can be developed in Oman, which are based on countries' experience in developing and implementing CRC program[14], [19].

Table 3. Strategies for developing colorectal cancer screening program141920

Before planning	**Review current literature and guidelines.**
	Review the disease incidence, mortality, survival, and cost.
	Assess the benefit and harm of implementing the CRC screening program.
	Assess the political will and responsibilities.
Comprehensive planning	Establish a coordination office for the CRC screening program.
	Planning infrastructure and building capacity.
	Collaboration between screening and treatment processes
	Develop an efficient monitoring system to capture screening cases.
	Develop quality assurance (QA), including key performance indicators (KPI), auditing, and monitoring.
Preparation	Scientific and ethical review of the feasibility protocol.
	Develop communication strategies.
	Clearance of data protection and confidentiality issues.
Piloting	Select one/few pilot regions.
	Budget of the pilot program.
	Ensure financial commitment.
	Supervision and coaching of screening staff.
	International partnerships with established programs.
	Testing and legal framework.
Scaling up from pilot to service screening (Usually in a phased manner)	Define the key stakeholders for the program, their roles, and responsibilities.
	Setting up infrastructure for coordinating screening program.
	Identify barriers and facilitators.
	Monitoring and evaluation plan.
	Multidisciplinary case management with collaboration between screening and treatment systems.
	Special training and reference centre.
	Develop an information system.
	Advocacy for the program.
Running a full scall program	Supervision of all steps of the screening program.

Table 3 (continued)

Before planning	**Review current literature and guidelines.**
	Ability to exclude bad performers.
	Testing ground for new technology.
	Monitoring and evaluation of the program including benefit and harm.
Sustainability	Ensure adequate, continuous financial support for the program.
	Accurate and accessible communication of screening program
	Maintain population confidence

Proposal for developing population-based CRC screening program in Oman

The provision of a population-based colorectal cancer screening program in Oman aims to detect pre-cancerous adenomas in the intestinal lining in "average risk" individuals, making it a preventative health strategy that reduces treatment burden on individuals and the health system. The program will provide free screening to eligible people on a two-year cycle, with primary healthcare facilities determining eligible individuals in their catchment areas.

Figure 6 illustrates the provisional overview of a pathway for a population-based colorectal cancer screening program in Oman. The inclusion criteria for "average-risk individuals" are males and females aged 60 to 69, with a plan to expand it to 50 to 74 years, with no personal history of colorectal adenomatous polyps or CRC or inflammatory bowel disease, and no family history of colorectal cancer. The exclusion criteria are individuals aged less than 60 years or older than 74 years; individuals aged 60 to 69 with a bowel cancer diagnosis; and individuals who do not have a colon. Individuals who do not meet the eligibility criteria but are concerned about colorectal cancer should consult their GP. Moderate- and high-risk individuals are not included in the population-based screening program and thus should have a different pathway determined by their GP.

Participants will be invited via the health system to participate, and they will collect the faecal immuno-chemical test from their local health center and complete the test at home. Participants with normal results will be notified, and they will be advised to retake the test in two years. Those with abnormal results will be contacted for further assessment by their GP before being referred to secondary care for further evaluation. To guarantee timely evaluation and management of screening program patients, a distinct referral pathway should be established.

For a population-based colorectal cancer screening program to be effective, there should be a well-established quality assurance system to ensure that the program is working efficiently and effectively. Each step in the screening process should be monitored and assessed on a regular basis using a set of standards to verify the efficacy of the CRC screening program.

Conclusion

Colorectal cancer is a major public health problem in Oman, with its incidence ranking second among all cancers in 2020, exerting a considerable burden on both individuals and healthcare facilities, making it a national health priority. Despite the availability of effective colorectal cancer screening tests that detect the disease at an early stage, reducing mortality and morbidity, Oman has no explicit strategy to implement a cancer screening program on a national scale. The general public's knowledge of colorectal cancer risk factors, as well as the availability of screening, is insufficient, making early detection and diagnosis of CRC patients challenging. Recent years have seen an epidemiological shift from communicable disease to noncommunicable disease, including colorectal cancer, in Oman which requires comprehensive planning to tackle the root cause of the problem as well as a comprehensive screening program that detects the disease at an early stage and thus improves the health outcome.

Several recommendations can be made. First, introduce a population-based colorectal cancer screening program in Oman that targets the average risk population aged 60–69 years old, with a future goal to broaden eligibility criteria to individuals aged 50–74 years old. Leadership and accountability are

critical for running a successful and cost-effective screening program, where a team at the national or regional level, as well as leadership at service delivery, are required. Operational policies should clarify important personnel's duties for accountability at all system levels. Third, introduce the FIT test as a method for screening as it is highly sensitive and specific compared to the currently used gFOBT. Furthermore, it doesn't need any dietary restrictions. Fourth, create a national, standardised referral pathway for individuals with abnormal FIT tests to guarantee a consistent approach across all health care systems. Sixth, increase health-care capacity (both personnel and equipment) to accommodate the growing demand for diagnostic colonoscopy and ensure that the program operates as intended. Seventh, increase public awareness at the individual, health care professional, and societal levels about colorectal cancer and the proper channel for accessing screening services. Finally, implement quality assurance of the population-based colorectal cancer screening program in Oman by identifying targets to be met and ongoing monitoring of key indicators utilising appropriate data collected within a program. The program can be piloted at a select set of health care facilities with the objective of further developing the program before implementing it on a national scale. A special emphasis should be placed on ensuring the program's long-term viability by ensuring financial support for the program.

Oman can mitigate the long-term burden of colorectal cancer by implementing WHO's comprehensive strategy, including awareness-raising, prevention, early detection, health system strengthening, capacity building, research, and collaboration. Given the public health implications in Oman, more research, including health technology assessments, is needed to better understand the enablers and hurdles to establishing population-based cancer screening programmes and the best method for executing them on a national scale.

Disclaimer

Competing interest

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Authors' contributions

Dr. Salma AlKalbani conceived and designed this review and wrote and edited the final manuscript. Dr. Alan Smith provided feedback on the manuscript.

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