RESEARCH ARTICLE

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Evaluating the Effectiveness of a Modified Colorectal Cancer Screening Program in Almaty, Kazakhstan

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Abstract

Objective: This study aimed to evaluate the effectiveness of a modified colorectal cancer (CRC) screening program, incorporating culturally tailored strategies to increase screening uptake and compliance, in Almaty, Kazakhstan. **Methods:** A cross-sectional study was conducted in Almaty between 2019-2022, involving 5370 participants aged 50-70 from diverse settings. Participants were assigned to the main (modified method) and comparison (standard method) groups based on the parity of their ID number digits. Variables of interest included demographics, somatic comorbidities, disability degree, and CRC screening results. The modified screening emphasized healthcare prioritization, optimized nursing resources, enhanced accessibility, and preparedness for the second screening stage. **Results:** In the study 2702 patients in the main group (modified method), and 2668 patients in the comparison group (standard method). Comorbidity data showed that the majority of participants in both groups had between 1-10 comorbidities, with an average of 8.2 in the main group and 8.1 in the comparison group. Screening response rates at stage I were higher in the main group, with 82.6% of subjects undergoing screening, compared to 78.9% in the comparison group (χ^2=12.12, p=0.001). The response rates were higher among females in both groups, and no significant differences were found across age groups. At stage II, the response rate was again higher in the main group (56.2%) than in the comparison group (47.2%) (χ^2=4.217, p=0.040), with no significant differences noted in relation to sex or age. However, the main group showed a higher response rate at stage I among respondents with 6-10 comorbidities (87.1% vs 82.5%, χ^2 =7.820, p=0.009). **Conclusion:** The study demonstrates that the modified program significantly outperformed the traditional one, achieving higher response rates at both the initial and subsequent stages of screening. These findings emphasize the value of revisiting and refining current CRC screening methods to maximize early detection rates.

Keywords: Colorectal cancer- screening program- Kazakhstan- health accessibility- health services

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Introduction

Colorectal cancer is one of the primary areas to employ screening programs aimed at identifying risk factors and detecting the early stages of the disease due to its high prevalence and the availability of screening technologies (Issa and Noureddine, 2017; Loomans-Kropp and Umar, 2019).

In Kazakhstan, malignant neoplasms of colorectal localization have been increased in recent years (Zhylkaidarova et al., 2021). Worldwide, many countries implement colorectal cancer screening programs with varying population coverage and diagnostic measures (Schreuders et al., 2015). Colorectal screening was implemented in Kazakhstan since the second half of 2012 (Zhylkaidarova et al., 2021). However, in 2020, due to the COVID-19 pandemic, the program was unable to fully conduct its screening activities.

Since the adoption of the national screening program in Kazakhstan in 2012, global practices have undergone several changes (Navarro et al., 2017). These developments underscore the importance of revisiting and updating national screening strategies to keep pace with international standards and emerging evidence.

Undoubtedly, from a population perspective, organized programs are superior to opportunistic screening. However, no country can offer organized colonoscopy for the entire population (Bevan and Rutter, 2018).

Depending on the country, the process of organizational changes in colorectal cancer screening has its specific features (Anhang Price et al., 2010).

The stages of changes not only include referrals for

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screening, specific patient groups, visit planning, and types of screening tests but also important organizational features that may facilitate cancer screening (Yano, 2008).

Assessing the cancer screening process within or between organizations is a crucial step for the development and implementation of effective organizational solutions. Research aimed at developing and applying indicators that describe organizational factors affecting screening stages can be beneficial for healthcare organizations striving to improve screening. Organizational strategies for improving screening should ideally be directed towards the effectiveness of the current process, including patient participation in screening, ensuring patient monitoring with abnormal results, and regular rescreening of patients with normal results (Yabroff, 2008).

Several potential barriers, such as limited public awareness, low compliance rates, and potential systemic issues in medical institutions, have contributed to the unsatisfactory effectiveness of screening programs (Issa and Noureddine, 2017). In response to this situation, a modified screening program was introduced in the Almaty region. This modification aims to address the identified issues, with a particular focus on increasing public awareness and screening accessibility.

The aim of this study is to assess the effectiveness of the modified colorectal cancer screening program by examining early detection rates, the proportion of diagnoses at advanced stages, and compliance rates within the target population. The outcome of this research will provide valuable insights into the efficacy of the implemented modifications and potentially inform future improvements to the program.

Materials and Methods

Study Design

The research employs a cross-sectional study design, which was selected for its aptness in capturing a snapshot of the colorectal cancer screening process during a specific timeframe. The primary advantage of this design for our purposes is its capacity to assess the prevalence of outcomes in relation to exposures (in this case, the modified screening program) at a single point in time. This aligns with the study's aim of evaluating the effectiveness of the modified colorectal cancer screening program over a set period. The study was conducted from 2019 to 2022 at the Almaty Regional Multidisciplinary Clinic and Primary Health Care (PHC) facilities in Almaty, Republic of Kazakhstan.

Participants

The participants in the study were individuals aged 50 to 70 years old, belonging to both sexes, and living in both urban and rural areas. They were selected from the target population across various districts. To create two groups for comparison, the participants' identification numbers were used. The participants were divided into two groups based on the even and odd sums of the digits in their identification numbers. One group was called the main group, and the other group was the comparison group. The study included a total of 5370 participants, with 2702 individuals in the main group and 2668 individuals in the comparison group. Participants were assigned to the main (modified method) and comparison (standard method) groups based on the parity of their ID number digits.

Variables

Key variables evaluated in the study include demographics (gender, age, and place of residence), somatic comorbidities, degree of disability, and results from colorectal cancer screening. These variables were chosen as they have potential influence on the screening program's effectiveness. Diagnostic criteria were employed for assessing somatic comorbidities and disability degrees.

Data Sources/Measurement

Data collection was done using the Committee of Medical Statistic (CMS) database, which provided an efficient means for obtaining data on the somatic status and screening results of the participants. The comparability of assessment methods across the groups was maintained since the same sources and measures were applied.

Bias

Potential biases, such as selection bias, were minimized by adopting a random selection of participants from various districts and blind group assignment.

Study Size

The study size of 5370 participants was determined to be statistically significant for evaluating the outcomes of the screening program.

Quantitative Variables

The handling of quantitative variables in the analysis was addressed using frequency and grouping strategies. The groupings were selected based on demographic characteristics, comorbidity counts, and disability degrees to evaluate the impact of these factors on the screening program.

Program Modifications

A significant aspect of the study involved implementing modifications to the existing colorectal cancer screening program. Prioritization of the healthcare system's activities was the first step in the program's modification. This included determining which actions within the system could have the most significant impact on ensuring a swift and effective response to colorectal cancer. The goal was to optimize the use of available resources to increase the speed of early detection and treatment.

Changes were also made in the use of nursing service resources. This strategy involved enlisting nurses to actively participate in the screening program, relying on their expertise in patient care. Nurses played a critical role in patient education, planning and conducting screenings, and providing necessary subsequent care. Improving the accessibility of colorectal cancer screening for patients was achieved by simplifying the examination process, ensuring convenient examination locations, and offering flexible scheduling options. In addition, efforts were

made to eliminate potential barriers to screening, such as transportation, language, or literacy problems.

An essential part of the program's modification was the implementation of an active preparation for the second stage of screening. This involved careful monitoring of patients to ensure they transitioned to the second stage of screening when necessary, which potentially increased the likelihood of early cancer detection.

Ethical issues

The study was approved by the Local Ethics Committee of the S.D. Asfendiyarov Kazakh National Medical University, Almaty, Republic of Kazakhstan (protocol of the Local Ethics Commission No. 8 (120) of 28.09.2019).

Statistical Methods

The results extracted from the CMS database were grouped by characteristics (textual, numerical), entered into a specially created database, sorted, and absolute and relative (frequency) indicators were determined. Missing data were addressed by excluding these cases from the final analysis, ensuring the integrity of the results. The data were analyzed using SPSS 20.0 (SPSS Inc., Chicago, IL, United States), where Student's t-test was used for comparing quantitative characteristics and Pearson χ^2 criterion for frequency indicators. A statistical significance level of $P<0.05$ was chosen to reject the null hypothesis.

Results

A total of 5370 participants were involved in the study, of which 2702 patients were in the main group (modified method), and 2668 patients were in the comparative group (standard method).

The majority of the participants were female (57.9% in the main group, and 58.6% in the comparison group). The mean age was 61.3 ±7,9 years in the main group and 60.9±7,6 years in the comparison group. In terms of residential areas, the main group comprised 64.2% urban and 35.8% rural participants, while the comparison group included 62.5% urban and 37.5% rural residents (Table 1). Table 2 shows the distribution of somatic comorbidities and degrees of disability within the main and comparison groups.

In the main group, only 3.4% of participants had no comorbidities, while 35.2% had 1-5 comorbidities, 49.3% had 6-10 comorbidities, and 12.1% had more than 10 comorbidities. The average number of comorbidities in this group was 8.2±0.2.

In the comparison group, 3.1% of participants had no comorbidities, 35.6% had 1-5 comorbidities, 50.2% had 6-10 comorbidities, and 11.1% had more than 10 comorbidities. The average number of comorbidities was 8.1±0.3. Regarding disability, in the main group, 2.7% were in disability groups I-II, and 3.4% were in disability group III. In the comparison group, 2.6% were in disability groups I-II, and 3.3% were in disability group III.

Table 3 presents the level of response to colorectal cancer (CRC) screening at stage I, as well as the influence of age and sex characteristics on the response, comparing the main group (modified program) and the comparison group (standard method).

Table 1. General Characteristics of Study Participants

Indicator	Group of screening participants	
	Main group (n,%)	Comparison group (n,%)
Gender		
Male	1215 (45%)	1192 (45%)
Female	1487 (55%)	1476 (55%)
Residence		
Urban	1612 (60%)	1546 (58%)
Rural	1090 (40%)	1122 (42%)
Age		
50 years old	258 (10%)	272 (10%)
52 years old	255 (9%)	250 (9%)
54 years old	237 (9%)	228 (9%)
56 years old	233 (9%)	230 (9%)
58 years old	254 (9%)	246 (9%)
60 years old	279 (10%)	272 (10%)
62 years old	264 (10%)	261 (10%)
64 years old	255 (9%)	249 (9%)
66 years old	241 (9%)	243 (9%)
68 years old	223 (8%)	219 (8%)
70 years old	203 (8%)	198 (7%)
Total	2702 (100%)	2668 (100%)

Overall, in the main group, 82.6% of the contingent subjects underwent screening, while in the comparison group, 78.9% passed the screening. The difference in response rates between the two groups was statistically significant ($\chi^2 = 12.12$, $p = 0.001$), indicating a higher level of response in the main group. When considering the response by sex, in both the main and comparison groups, females had higher response rates compared to males. However, the difference in response rates between males and females was more pronounced in the main group ($\chi^2 = 24.81$, $p = 0.001$). This suggests that the modified program may have had a greater impact on improving the response among males.

Regarding age characteristics, the response rates varied across different age groups in both the main and

Table 2. Distribution by the Presence of Somatic Comorbidities and Disability

Indicator	Main group (n,%)	Comparison group (n,%)
Comorbidities		
No comorbidities	93 (3.4)	82 (3.1)
1-5 comorbidities	952 (35.2)	949 (35.6)
6-10 comorbidities	1331 (49.3)	1340 (50.2)
More than 10 comorbidities	326 (12.1)	297 (11.1)
Average number of comorbidities	8.2±0.2	8.1±0.3
Disability		
Disability I-II groups	73 (2.7)	70 (2.6)
Disability III group	92 (3.4)	90 (3.3)

Table 3. The Level of Response to Screening and the Influence of Age and Sex Characteristics on the Response to CRC Screening at Stage I

Categories	Main group			Comparison group			χ2	p
	Subject to	Passed	%	Subject to	Passed	%		
All contingent	2702	2233	82.6	2668	2105	78.9	12.12	0,001*
Males	1215	983	80.9	1192	862	72.3	24.81	0,001*
Females	1487	1250	84.1	1476	1243	84.2	0.013	0.91
50 years old	258	205	79.5	272	218	80.1	0.039	0.844
52 years old	255	202	79.2	250	201	80.4	0.11	0.741
54 years old	237	191	80.6	228	179	78.5	0.31	0.578
56 years old	233	187	80.3	230	180	78.3	0.281	0.597
58 years old	254	201	79.1	246	191	77.6	0.164	0.686
60 years old	279	224	80.3	272	203	74.6	2.525	0.113
62 years old	264	225	85.2	261	201	77	5.79	0,017*
64 years old	255	218	85.5	249	198	79.5	3.118	0.078
66 years old	241	209	86.7	243	195	80.2	3.677	0.056
68 years old	223	194	87	219	177	80.8	3.123	0.078
70 years old	203	177	87.2	198	162	81.8	2.215	0.137

* p<0.05

comparison groups. However, there were no significant differences in response rates between the two groups within each age category. Table 4 presents the influence of age and sex characteristics on the response to CRC screening at stage II, comparing the main group (modified method) and the comparison group (standard method).

In the overall contingent, the response rate at stage II screening was 56.2% in the main group, compared to 47.2% in the comparison group. The difference in response rates between the two groups was statistically significant ($\chi^2 = 4.217$, $p = 0.040$), indicating a higher level of response in the main group.

When considering the response by sex, there was a higher response rate among females in both the main and comparison groups, although the difference was not statistically significant ($\chi^2 = 1.610$, $p > 0.05$).

Regarding age characteristics, there were no significant differences in response rates between the main and comparison groups within each age category. Table 5 presents the influence of the health status of respondents on the response to CRC screening, comparing the main group (modified method) and the comparison group (standard method). The analysis includes the frequency of comorbidities and the presence of disability.

At stage I, there were no significant differences in response rates based on the number of comorbidities or disability status between the main and comparison groups. The response rates were relatively high across all categories, ranging from 76.4% to 87.1%. Similarly, at stage II, there were no significant differences in response rates based on the health status of respondents. However, it is important to note that at stage I, in the category of

Table 4. The Influence of Age and Sex Characteristics on the Response to CRC Screening at Stage II.

Categories	Main group			Comparison group			χ^2	p
	Subject to	Passed	%	Subject to	Passed	%		
All contingent	308	173	56.2	299	141	47.2	4.217	0.040*
Males	145	75	51.7	139	56	40.3	4.190	0.042*
Females	163	98	60.1	160	85	53.1	1.610	>0.05
50 years old	24	12	50.0	25	12	48.0	0.020	>0.1
52 years old	23	12	52.2	26	11	42.3	0.477	>0.1
54 years old	25	14	56.0	23	12	52.2	0.071	>0.1
56 years old	27	14	51.9	25	12	48.0	0.077	>0.1
58 years old	33	18	54.5	30	15	50.0	0.130	>0.1
60 years old	35	20	57.1	32	15	46.9	0.706	>0.1
62 years old	34	20	58.8	35	16	45.7	1.188	>0.1
64 years old	30	19	63.3	29	13	44.8	2.035	>0.1
66 years old	29	17	58.6	27	12	44.4	1.125	>0.1
68 years old	25	14	56.0	25	12	48.0	0.321	>0.1
70 years old	23	13	56.5	22	11	50.0	0.192	>0.1

* p<0.05

Table 5. The Influence of the Health Status of Respondents on the Response to CRC Screening

Categories	Main group			Comparison group			χ^2	p
	Subject to	Passed	%	Subject to	Passed	%		
I stage								
No comorbidities	593	481	81.1	567	466	82.2	0.223	>0.1
1-5 comorbidities	852	662	77.7	869	664	76.4	0.405	>0.1
6-10 comorbidities	931	811	87.1	935	771	82.5	7.82	0.009*
More than 10 comorbidities	326	279	85.6	297	254	85.5	0.001	>0.1
Disability I-II groups	73	49	67.1	70	44	62.9	0.286	>0.1
Disability III group	92	86	93.5	90	79	87.8	1.746	> 0.05
II stage								
No comorbidity	57	29	50.9	60	29	48.3	0.076	>0.1
1-5 comorbidities	84	49	58.3	79	35	44.3	3.208	> 0.05
6-10 comorbidities	108	66	61.1	103	51	49.5	2.87	> 0.05
More than 10 comorbidities	59	29	49.2	57	26	45.6	0.146	>0.1
Disability I-II groups	6	5	83.3	5	2	40.0	-	-
Disability III group	11	7	63.6	11	5	45.5	0.733	>0.1

* $p<0.05$

respondents with 6-10 comorbidities, the main group had a higher response rate (87.1%) compared to the comparison group (82.5%), and this difference was statistically significant ($\chi^2 = 7.820$, $p = 0.009$). This suggests that the modified program may have had a positive effect on improving the response in this specific subgroup of respondents with a moderate number of comorbidities. At stage II, there were no significant differences in response rates between the main and comparison groups within any of the comorbidity or disability categories.

Discussion

Screening for colorectal cancer, as a primary method for early detection, is extensively practiced worldwide, particularly through public health initiatives (Ferlizza et al., 2021; Kadakuntla et al., 2021). Despite the advanced development and extensive practice of these screenings, there remain numerous challenges that decrease the effectiveness of these programs. These issues contribute to the substantial frequency of late-stage cancer detection or delayed discovery of precancerous colorectal conditions. One primary challenge is the insufficient response rate from the target screening population (Hampton et al., 2021). This issue is especially prevalent in healthcare systems that lack experience and sufficient organizational capabilities (Goyal et al., 2020; Podda et al., 2021).

In Kazakhstan, there's a robust implementation of colorectal cancer (CRC) screenings and its resultant positive outcomes are notable. However, the rate of late detection of malignant neoplasms in this region remains higher than in many developed countries (Lin et al., 2021).

The first stage of the established two-stage program displays the best outcomes regarding the relative frequency of response and screenings. This success is likely due to its non-invasive nature and perceived safety by the participants (Ebner and Kisiel, 2020). The second stage involves a smaller participant group and conducts more complex medical studies that are ethically unacceptable to some individuals (Forbes et al., 2021). The healthcare system must exert substantial effort to achieve a high examination level, which includes preparing patients with somatic diseases and engaging in psychological support (Insamran and Sangrajrang, 2020).

Our research analyzed the results of implementing several modifications to CRC screenings in Kazakhstan's Almaty region. These adjustments do not alter the screening program's structure or schedule, but supplement the primary approach with strategies to enhance response rates.

Targeted efforts were made for specific respondent groups those with chronic somatic diseases and males. The differences were identified based on factors such as gender, age, and comorbidity frequency. The findings favored the introduced alterations in the screening program. Specifically, we observed an increase in response rate for the first stage of screening for the general cohort, males, and individuals aged 62 years. The second stage also showed a response rate increase for the whole cohort and male participants.

Considering the concurrent pathology led to an increased response at stage I only for one of the chosen categories (with the number of comorbid diseases between 6 and 10). The impact of having more than 10 diseases and disabilities on response rates wasn't determined, nor were any significant effects at the second screening stage. These findings may be due to the relatively small number of patients who progress to stage II. In summary, our data substantiates the influence of various factors on the response to colorectal cancer screening and suggests that these factors can potentially be managed through systematic organizational strategies.

Our results align with other studies that have demonstrated the significance of tailored interventions in enhancing screening response rates (Lee et al., 2014). Specifically targeting groups, such as males or

those with multiple comorbidities, was based on prior research showing their lower participation rates in cancer screenings (Davis et al., 2012). Tailored interventions, such as specialized educational materials or targeted outreach, might have played a pivotal role in achieving the observed improvements.

Given the positive outcomes observed in this research, healthcare policymakers could consider adopting such tailored approaches in broader screening initiatives, ensuring higher early detection rates and consequently better patient outcomes. To further the progress in this domain, future studies can explore the integration of digital tools or telemedicine in enhancing participation rates, especially in the second, more invasive stage of screenings.

In conclusions, in an effort to improve early detection of colorectal cancer (CRC), this study sought to compare the effectiveness of an unmodified screening program with a modified version. We found that the modified program significantly outperformed the traditional one, achieving higher response rates at both the initial and subsequent stages of screening. Interestingly, while the modified approach was particularly effective among females, the traditional screening showed a slightly enhanced response among males. A notable observation was that individuals with 6-10 comorbidities responded significantly better during the first stage when under the modified program, pointing to potential tailored strategies for this group. These findings emphasize the value of revisiting and refining current CRC screening methods to maximize early detection rates. Moving forward, it would be invaluable to dissect the underlying reasons for these observed differences and tailor interventions to specific populations for even better outcomes in CRC screening initiatives.

Limitations

Our use of a cross-sectional study design offers a snapshot of the situation during the research period. While it provides valuable insights, it doesn't allow for monitoring changes over time or establishing causal relationships as would be possible in a longitudinal study. Our focus on the Almaty region of Kazakhstan limits the generalizability of our results. While the findings are insightful for this specific region, they may not necessarily be representative of other areas with different demographic, socioeconomic, or cultural characteristics. While the Committee of Medical Statistic (CMS) database is comprehensive, like any database, there might be instances of missing or inaccurately recorded data which can influence the results.

Author Contribution Statement

Conceptualisation: Raushan Zholmurzayeva and Dinara Ospanova, data curation: Raushan Zholmurzayeva and Dinara Ospanova; formal analysis: Auyeskhan Dzhumabekov; investigation: Raushan Zholmurzayeva, Nailya Talkimbayeva, Akmaral Aytmanbetova and Neilya Ussebayeva; methodology: Yoshihiro Noso, Ildar Fakhradiyev and Tagabay Zhorayev; project administration: Dinara Ospanova; validation: Auyeskhan Dzhumabekov; visualisation: Nailya Talkimbayeva; writing – original draft, and writing– review & editing: Raushan Zholmurzayeva, Dinara Ospanova, Yoshihiro Noso and Ildar Fakhradiyev.

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Ethical Declaration

The study was approved by the Local Ethics Committee of the S.D. Asfendiyarov Kazakh National Medical University, Almaty, Republic of Kazakhstan (protocol of the Local Ethics Commission No. 59 (110) dated 28.09.2019).

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Conflicts of interest

The authors declare no conflict of interest.

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