

**EFFECT OF AN INTERVENTION STUDY TO IMPROVE EARLY-STAGE COLORECTAL  
CANCER SCREENING AMONG ZAGAZIG UNIVERSITY EMPLOYEES: A QUASI-  
EXPERIMENTAL DESIGN.**

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**Abstract**

**Background:** Colorectal cancer (CRC) is the third most prevalent cancer worldwide. The adoption of colon cancer screening is strongly influenced by public awareness that ailment colon cancer screening is closely related to Egyptian sustainable development goals for 2030.

**Purpose:** This study aimed to evaluate the effect of an intervention study to improve early-stage colorectal cancer screening among Zagazig University employees.

**Patient and methods:** A quasi-experimental design was utilized and carried out at Zagazig University included 11 faculty members and two administrative buildings. A total of 118 employees were chosen by a systematic random sampling technique from the study settings. A self-administered questionnaire in four parts was utilized to assess employees' knowledge concerning colorectal cancer incidence, colorectal cancer risk factors, symptoms, and screening methods. Additionally, the questionnaire evaluated employees' attitudes and practices related to colorectal cancer and identified barriers related to colorectal cancer screening.

**Results:** The intervention program led to a significant improvement ( $p \leq 0.001$ ) of patients who underwent colorectal cancer tests. Furthermore, the overall knowledge level was initially unsatisfactory among the studied employees and improved to an impressive level post-intervention. Moreover, a remarkable increase in

colorectal cancer preventive behaviors within the study population was observed post-intervention compared with pre-intervention. Similarly, the overall positive attitude increased post-intervention compared to that pre-intervention. The post-intervention percentages revealed a decrease in various factors contributing to reluctance to undergo colonoscopy, with several factors showing highly significant differences.

**Conclusion:** The intervention study yielded positive outcomes, effectively improving early-stage CRC screening. It is recommended that Zagazig University employees initiate and sustain educational campaigns aimed at raising awareness about colorectal cancer.

**Keywords:** Colorectal cancer, Employees, Intervention study, Screening, Zagazig University.

## Introduction

Colorectal cancer (CRC) is the third most common cancer and the second leading cause of cancer death worldwide.<sup>1</sup> In Egypt, CRC is the 7<sup>th</sup> most common malignant tumor in Egypt, representing 4% of the total diagnosed cancers and 53% of gastrointestinal tract (GIT) cancers.<sup>2</sup> Similarly, the major cause of death from CRC in developing countries is poor awareness of its manifestations, late diagnosis, and limited accessibility to screening tests.<sup>3</sup> On the other hand, the risk of developing colorectal cancer is increased by a change in dietary patterns, referred to as the westernization of lifestyle. This means increased consumption of animal fats, processed meats, refined grains or sweets; a low supply of dietary fibers, fruits, and vegetables; and low physical activity. The occurrence of overweight or obesity is often the result of such a lifestyle.<sup>4</sup>

Early detection represents a crucial linchpin in public health strategies across all contexts, particularly in high-risk populations. Notably, effective screening methods for colorectal cancer (CRC) are currently available. It exhibits proven efficacy in diminishing both CRC incidence, morbidity, and mortality from invasive cancer in the early diagnosis of adenomatous polyps.<sup>5</sup> Screening tools such as fecal immunochemical tests (FITs), barium enemas, and screening colonoscopies have all played roles in this endeavor. Nonetheless, the journey toward effective screening encounters several hurdles.<sup>6</sup> Mitigating the onset of colorectal cancer (CRC) is highly important and involves both primary prevention through health education and secondary prevention through early diagnosis and swift intervention.<sup>4</sup>

Moreover 90% of pa can be effectively treated when diagnosed early, emphasizing the importance of early detection and treatment in CRC management. Early detection leads to improved prognoses and treatment outcomes.<sup>7</sup> Cancer awareness improves treatment prospects and quality of life. Nurses play a crucial role in healthcare by providing curative services and championing preventive efforts.<sup>8</sup> Community health nursing plays a crucial role in colorectal cancer prevention and includes education, coordination, screening test administration, follow-up procedures, and palliative care. However, insufficient knowledge or lack of guidance can hinder their fulfillment. Nurses require substantial clinical acumen and experience to effectively execute these roles.<sup>6,9</sup>

The intervention study at Zagazig University aimed to improve early-stage colorectal cancer screening practices, aligning with the United Nations (UN) Sustainable Development Goals (SDGs) 2030 for public health and sustainable development. By targeting early-stage CRC detection, this study effectively addresses SDG 3, which focuses on ensuring healthy lives and well-being and seeks to reduce premature mortality from noncommunicable diseases, including cancer.<sup>1</sup> The study's success in promoting CRC screening also underscores the collaborative and partnership-driven approach advocated by SDG 17. The close collaboration

between academic institutions, employees, and health professionals emphasizes academia and research's role in positive health behaviors.

### **Research Hypotheses**

**H1.** The percentage of early-stage colorectal cancer screenings among Zagazig University employees will be improved post the nursing intervention.

**H2.** Nurses' knowledge, practices and attitudes regarding colorectal cancer screening will improve after nursing intervention.

**H3.** Barriers to CRC screening among Zagazig University employees will be reduced after nursing intervention.

### **Materials and Methods**

A quasi-experimental design (pre-intervention, intervention, post-intervention) was utilized in the present study and conducted across various faculties, including the Faculty of Nursing and Commerce. Additionally, the survey encompassed the College of Medicine, Pharmacy, Veterinary, Agriculture, Education, Physical Education, Productive Adequacy, and Law. Moreover, the study considered two administrative buildings situated within Zagazig University.

The sample initially comprised 304 employees, and a subgroup of 118 employees was identified for the subsequent stage of the study. Utilizing two sampling techniques, in the initial stage, a systematic random sampling technique was employed. The total number of employees was 1400 and a random allocation process was subsequently used to select every 20th employee, resulting in a sample size of 304 employees. In the second stage, through statistical analysis, a high-risk group consisting of 118 colorectal cancer (CRC) employees was identified and included in the intervention program of the study.

### **Tools for data collection**

The assessment phase: The study used a self-developed focus group interview guide in initial stage to collect data of two integral parts: part (1) to gather sociodemographic information about the employees' variables, such as age, gender, education, occupation, and monthly income art, as well as part (2) risk factors for colorectal cancer checklist adapted by Aleksandrova et al for assessment of risk factors associated with colorectal cancer.<sup>10</sup> The checklist included a range of crucial data points, including but not limited to family history of colorectal cancer or adenoma, personal history of colorectal cancer or adenoma, history of inflammatory bowel disease, personal history of hereditary syndromes, dietary habits, smoking status, obesity, and other relevant factors. A cohort of 304 employees was meticulously selected from the study settings. The age range spanned from 24 to 66 years, with 48.4% of the participants being females. The assessment of their risk of developing colorectal cancer was conducted using the formula detailed.

Risk score=  $0.5 \times \text{Age} + 3 \times \text{gender (male: 1; female: 0)} - 2.7 \times \text{education (elementary school: 1; illiteracy: 0)} + 1.1 \times \text{education (high school: 1; illiteracy: 0)} + 0.7 \times \text{education (college or above: 1; illiteracy: 0)} + 3.0 \times \text{employment (yes: 1; no: 0)} - 7.4 \times \text{personal business (yes: 1; no: 0)} + 5 \times \text{professionals (es: 1; no: 0)} + 4 \times \text{other occupations (yes: 1; no: 0)} + 7.4 \times \text{diarrhea (yes: 1; no: 0)} + 14.0 \times \text{constipation (yes: 1; no: 0)} + 16.5 \times \text{colon mucosa (yes: 1; no: 0)} + 7.7 \times \text{gallbladder disease (yes: 1; no: 0)} + 2.1 \times \text{stressful life event (yes: 1; no: 0)} + 9.5 \times \text{family history of CRC (yes: 1; no: 0)} + 36.8 \times \text{positive fecal immunochemical test result (yes: 1; no: 0)} + 5.4 \times \text{fecal immunochemical test not performed (yes: 1; no: 0)}$ . The calculated risk scores ranged between 21.8 and 105.4, with an average score of 46.4. A subgroup of 118 individuals with the highest cumulative

scores was thoughtfully selected for the subsequent intervention phase. This selection process was vital for meeting the required sample size in accordance with the study's stipulations.

A score of less than 40% was considered to indicate a low social class, 40% to less than 70% was considered a middle class, and a score of 70% or more a high social class.

The implementation and evaluation phase: It was performed utilizing self-administered questionnaire that involved 4-parts. Part (a) it was adapted by Alshammari et al.<sup>11</sup> to assess the knowledge of employees regarding CRC.<sup>11</sup> This tool consists of 37 questions, knowledge about disease (5-items about parts of colon, functions, types, definition of colorectal cancer, prevalence of colon cancer). CRC risk factors (16-items about family history, smoking status, exercise status, age, stress, obesity, dietary habits, and chronic diseases). Clinical manifestation (11-items about changes in bowel habits, bleeding in the stool, anemia, weight loss, and fatigue). Screening process (5-items about fecal occult blood test results, tumor marker levels, CBC results, CT results, and colonoscopy results). A correct response was given one, and an incorrect response was zero. It was summed, and the total was divided by the number of items, producing a mean score and a percentage score. A score of 50% or more was considered satisfactory, whereas less than 50% was considered unsatisfactory.

Part (b) It was composed of five statements to assess the level of participant attitudes about CRC.<sup>12</sup> the responses on the Likert scale were strongly agree, agree, uncertain, strongly disagree, and disagree, were scored as 5, 4, 3, 2, and 1, respectively. The scores of the items were summed, and the total was divided by the number of items, bearing a mean score and percentage score for positive attitude if it was 60% or more and negative if it was less than 60%. Part (c) It was composed of questionnaires that served to assess the participants' actual practices in relation to the prevention of colorectal cancer.<sup>11</sup> The items "not done" and "done" were scored as "0" and "1", respectively. The items "not applicable" were not scored and were discounted from the total. The scores of the items were summed, and the total was divided by the number of items, giving a mean score and a percentage score. The practice was considered adequate if the percentage score was 60% or more and inadequate if it was less than 60%. Part (d) It was 13-questions that adapted to investigate the barriers participants may encounter in relation to colorectal cancer screening.<sup>9,13</sup> It was delved into factors that might impede proactive screening efforts. Some of the barriers probed included lack of prior consideration, absence of medical advice from a doctor, no symptoms or discomfort experienced, fear of potential colorectal cancer diagnosis, and time constraints. the answers on the Likert scale were agree, neutral, strongly disagree, and disagree, were scored as 5, 4, 3, 2, and 1, respectively. The scores of the items were summed, and the total was divided by the number of items.

### **The study protocol**

The study was initiated by the issuance of an official letter from the Faculty of Nursing at Zagazig University that succinctly outlined the objectives and purpose of the study to establish a formal and authorized connection between the researchers and the relevant authorities. These steps fortified the researchers' authenticity and provided an added layer of confirmation during the study. Literature review and theoretical familiarization. In the preparatory phase, an extensive review of relevant historical and contemporary literature was conducted to present the exploration of theoretical concepts across various facets of the study. The sources encompassed books, articles in periodicals or magazines, and online resources. The review aimed to foster a deep understanding of the research problem and to facilitate the development of precise study tools.

The validity of the tools was assessed by a panel of 5-experts from the college of Nursing and Medicine to a meticulous evaluation of the tools' content. The modifications were implemented for content's relevance and the clarity of sentence structures. The tools' reliability was systematically evaluated using both test-retest reliability and internal consistency measures. The Cronbach's alpha coefficients were 0.75, 0.90, 0.90 for knowledge, attitude, and practice consecutively. Involving 10% of the study participants (30 employees), the pilot study was implemented to ensure that the survey instruments were clear and comprehensible. Notably, the required modifications were developed, and the pilot study sample were subsequently excluded from the study sample.

The researchers initiated the data collection process and program implementation. A structured schedule was meticulously prepared in collaboration with the deans, directors of each faculty member, and administrative building directors. Once the schedule was established, the researchers sought the employees' consent to participate. Subsequently, individual interviews were conducted with each employee. The introduction involved acquainting participants with the researchers, followed by a succinct discussion about the study's purpose and nature. Participants were assured that the collected information would remain strictly confidential and solely utilized for research purposes. The pretest questionnaire required approximately 20-25 minutes to complete. The intervention was executed through a series of three theoretical sessions and two practical sessions within each faculty member and each administrative building. In total, there were 39 theoretical sessions and 26 practical sessions.

These sessions, lasting between 30 and 45 minutes, included interactive discussions. The posttest was administered promptly after each session and was facilitated by a PowerPoint presentation and a real case video related to colorectal cancer. Additionally, a booklet was distributed to the participants as a reference. Following the program's completion, the researchers distributed posttest questionnaires. The data collection process was extended over a period of two months, commencing in mid-September 2022 and ending in mid-March 2023, signifying the initiation of the study's second stage. Additionally, meticulous planning, execution, and data collection efforts were carried out in two distinct phases, illustrating a comprehensive approach aimed at assessing the risk group and ensuring the effective implementation of the program.

Data entry and statistical analysis were conducted utilizing the SPSS 20.0 statistical software package. For the comparison of quantitative continuous data, either Student's t test or the Mann-Whitney test was used as appropriate. Categorical variables were assessed through the chi-square test. Spearman rank correlation was used to explore relationships among quantitative and ranked variables. To identify independent predictors of undergoing a screening test for CRC, multiple logistic regression analysis was performed and statistically significant at  $p < 0.05$ .

## Results

**Table 1** shows that 56.8% of the participants were male, 66.1% were 40+ years old, and their ages ranged from 25-66 years. Furthermore, 83.9% were married and 66.9% of the participants were associated with university-level education. Moreover, 53.4% of them reported sufficient income.

**Table 2** demonstrates the substantial improvements across all knowledge domains following the program implementation. Notably, the overall level of knowledge among the study participants was initially unsatisfactory, with none of them meeting the pre-intervention criteria compared to remarkably 99.2% post-intervention. Furthermore, the collective positive attitude toward CRC preventive practices was quite limited

in the pre-intervention phase, compared to positively shifted to 85.6% post-intervention. The notably significant p value strongly emphasizes the intervention's effectiveness in driving a substantial shift in preventive practices among the study participants.

**Table 3** highlights a significant improvement in the percentage of CRC tests performed following the program's implementation. Initially 3.4% of the study participants underwent the fecal occult blood test during the pre-intervention phase compared to 64.4% during the post-intervention. About 4.2% completed occult blood test compared with 60.2% post-intervention. Of those who underwent the blood imaging test, 13 individuals had abnormal blood test results, and the difference was statistically significant ( $p < 0.001$ ). However, only 0.8% of participants agreed to undergo colonoscopy, whereas 18.6% opted for colonoscopy post intervention.

**Table 4** presents a comprehensive analysis of the reasons cited by employees for not undergoing colonoscopy before and after the intervention. The percentage of participants citing time constraints decreased from 60.2% (preprogram) to 44.9% (post program), with a significant p value of 0.02. The post-programme percentages indicated a decrease in various reasons for not undergoing colonoscopy, with several factors demonstrating highly significant differences ( $p < 0.001$ ) except not thinking about colonoscopy and fear of the process postintervention.

**Table 5** indicates that attitude scores vary based on demographic attributes. Some factors, particularly residence, income, university education, and chronic disease status, exhibited statistically significant differences with  $p < 0.05$ .

**Table 6** highlights the presence of statistically significant positive correlations between knowledge scores and attitude scores and between knowledge scores and the number of tests conducted ( $r=0.632$  and  $r=0.600$ , respectively). Furthermore, a statistically significant positive correlation was observed between attitude scores and the number of tests ( $r=0.570$ ).

**Table 7** illuminates the outcomes of the best-fitting multiple linear regression model used to predict employees' knowledge scores. The variables included in the model (intervention and urban residence), their coefficients, standardized coefficients, t test results, p values, and 95% confidence intervals for the coefficients are highlighted. The employees' attitude score was also included. Chronic disease and knowledge scores were found to be statistically independent positive predictors of employee attitudes.

**Table 8** presents the most appropriate linear regression model for employees' agreement to undergo the endoscopy test. The attitude score was a statistically independent positive predictor of employees' agreement with the endoscopy test. The regression model accounts for 40% of the variation in employees' agreement to undergo the endoscopy test, as indicated by the R-squared value.

**Table 1:** Demographic characteristics of employees in the study sample (n=118)

Demographic characteristics	Frequency	Percent
<b>Age:</b>		
▪ <40	40	33.9
▪ 40+	78	66.1
Range	25-66	
Mean±SD	43.8±9.2	
Median	45.0	

<b>Gender:</b>		
▪ Male	67	56.8
▪ Female	51	43.2
<b>Residence:</b>		
▪ Rural	67	56.8
▪ Urban	51	43.2
<b>Income:</b>		
▪ Insufficient	53	44.9
▪ Sufficient	63	53.4
▪ Saving	2	1.7
<b>University education:</b>		
▪ No	39	33.1
▪ Yes	79	66.9
<b>Marital status:</b>		
▪ Married	99	83.9
▪ Single	9	7.6
▪ Divorced	4	3.4
▪ Widow	6	5.1

**Table 2:** Colorectal cancer knowledge attitudes and practices among employees in the study sample before and after the intervention (n=118)

Knowledge, Attitude, and practice	Time				X <sup>2</sup> test	p value
	Pre (n=118)		Post (n=118)			
	No.	%	No.	%		
<b>Satisfactory knowledge (50%+) of:</b>						
▪ Colon anatomy	3	2.5	113	95.8	205.14	<0.001*
▪ Colon physiology	2	1.7	97	82.2	157.04	<0.001*
▪ Colon diseases	2	1.7	113	95.8	208.97	<0.001*
▪ Colorectal cancer (CRC)	1	0.8	104	88.1	182.02	<0.001*
▪ CRC risk factors	1	0.8	117	99.2	228.07	<0.001*
▪ CRC symptoms/signs	1	0.8	114	96.6	216.56	<0.001*
▪ CRC diagnosis	2	1.7	117	99.2	224.17	<0.001*
<b>Total knowledge:</b>						
▪ Satisfactory	0	0.0	117	99.2		<0.001*
▪ Unsatisfactory	11	100.0	1	0.8	232.03	
<b>Attitudes toward CRC preventive practices:</b>						
▪ Positive	14	11.9	101	85.6		<0.001*
▪ Negative	104	88.1	17	14.4	128.37	
<b>Practices toward CRC prevention</b>						

▪ Satisfactory	3	2.5	115	97.5	212.61	<0.001*
▪ Unsatisfactory	115	97.5	3	2.5		
(*) Statistically significant at $p < 0.05$ highly statistically significant $< 0.001$ .						

**Table 3:** Tests performed by employees in the study sample before and after the intervention (n=118)

Tests performed	Time				X <sup>2</sup> test	p value
	Pre (n=118)		Post (n=118)			
	No.	%	No.	%		
<b>Fecal Occult Blood test: @</b>						
▪ Not done	114	96.6	42	35.6	98.03	<0.001*
▪ Done	4	3.4	76	64.4		
<b>Blood picture: @@</b>						
▪ Not done	113	95.8	47	39.8	84.54	<0.001*
▪ Done	5	4.2	71	60.2		
<b>Tests done:</b>						
▪ 1	115	97.5	47	39.8	91.03	<0.001*
▪ 2+	3	2.5	71	60.2		
<b>No. of tests performed:</b>						
▪ Range	0-2		0-3		98.61	<0.001*
▪ Mean±SD	0.1±0.4		1.4±1.1			
▪ Median	0.0		2.0			
<b>Agree to have colonoscopy:</b>						
▪ No	117	99.2	96	81.4	21.24	<0.001*
▪ Yes	1	0.8	22	18.6		
(*) Statistically significant at $p < 0.05$ (@)6 had positive occult blood test results (@@)13 had abnormal blood picture						

**Table 4:** Reasons for not performing colonoscopy as reported by employees in the study sample before and after the intervention (n=118)

Reasons for No colonoscopy	Time				X <sup>2</sup> test	p value
	Pre (n=118)		Post (n=118)			
	No.	%	No.	%		
▪ Not thinking about it	73	61.9	65	55.1	1.12	0.29
▪ Not advised by doctor	71	60.2	43	36.4	13.30	<0.001*
▪ No symptoms	67	56.8	39	33.1	13.43	<0.001*
▪ Fear of diagnosis	73	61.9	39	33.1	19.64	<0.001*
▪ No time	71	60.2	53	44.9	5.51	0.02*
▪ Fear of process	72	61.0	60	50.8	2.48	0.12
▪ Associated pain	71	60.2	32	27.1	26.20	<0.001*



▪ Financial	73	61.9	31	26.3	30.33	<0.001*
▪ Lack of knowledge	72	61.0	17	14.4	54.57	<0.001*
▪ Lack of access	70	59.3	12	10.2	62.87	<0.001*
▪ Hazards of colonoscopy	70	59.3	18	15.3	49.00	<0.001*
▪ No encouragement	70	59.3	37	31.4	18.62	<0.001*
▪ Have no risk factors	64	54.2	18	15.3	39.55	<0.001*
(*) Statistically significant at $p < 0.05$						

**Table 5:** Relationships between employees' post-intervention attitudes and their characteristics (n=118)

Demographic Characteristics	Attitude score		U-test	p value
	Mean±SD	Median		
<b>Age:</b>				
▪ <40	87.5±15.0	90.00	2.49	0.11
▪ 40+	79.2±25.3	80.00		
<b>Gender:</b>				
▪ Male	82.1±22.8	90.00	0.03	0.87
▪ Female	82.0±22.6	80.00		
<b>Residence:</b>				
▪ Rural	78.5±22.4	80.00	9.06	0.003*
▪ Urban	86.7±22.3	100.00		
<b>Income:</b>				
▪ Insufficient	85.5±23.7	100.00	8.82	0.01*
▪ Sufficient	79.0±21.8	80.00		
▪ Saving	85.0±7.1	85.00		
<b>University education:</b>				
▪ No	76.9±24.7	80.00	5.81	0.02*
▪ Yes	84.6±21.2	90.00		
<b>Married:</b>				
▪ No	82.1±23.7	80.00	0.01	0.91
▪ Yes	82.0±22.5	90.00		
<b>Have chronic diseases:</b>				
▪ No	76.2±24.5	80.00	15.93	<0.001*
▪ Yes	90.0±17.0	100.00		
<i>U-test: Mann-Whitney test</i>			<i>(*) Statistically significant</i>	
<i>at <math>p &lt; 0.05</math></i>				

**Table 6:** Correlations between employees' knowledge, attitude scores and their characteristics (n=118)

Variables	Spearman's rank correlation coefficient	
	Knowledge scores	Attitude scores

Attitude	.632**	1.000
<b>Characteristics:</b>		
▪ Age	.012	-.024
▪ Education	.046	.005
▪ Income	-.027	-.083
▪ No. of tests	.600**	.570**
(*) Statistically significant at $p<0.05$		

**Table 7:** Best-fitting multiple linear regression model for employees’ knowledge and attitudes scores (n=118)

Variables	Unstandardized Coefficients		Standardized Coefficients	t test	p value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
<b>*Knowledge score</b>							
▪ Constant	-88.71	2.11		41.995	<0.001	-92.87	-84.55
▪ Intervention	91.14	0.99	0.99	92.439	<0.001	89.20	93.09
▪ Urban residence	1.80	1.00	0.02	1.811	0.071	-0.16	3.76
<b>**Attitude score</b>							
▪ Constant	45.66	2.31		19.803	0.000	41.12	50.21
▪ Chronic diseases	7.17	2.73	0.13	2.624	0.009	1.79	12.55
▪ Knowledge score	0.35	0.03	0.61	11.863	<0.001	0.29	0.40
* <i>r-square</i> =0.97				* <i>Model ANOVA: F</i> =4274.13, $p<0.001$			
** <i>r-square</i> =0.39				** <i>Model ANOVA: F</i> =74.05, $p<0.001$			
<i>Variables entered and excluded: age, gender, education, marital status, income, chronic diseases</i>							

**Table 8:** Best-fitting multiple logistic regression model for agreement upon colonoscopy (n=118)

Variables	Wald	Df	P	OR	95.0% CI for OR	
					Upper	Lower
▪ Constant	20.841	1	<0.001	0.00		
▪ Attitude score	17.113	1	<0.001	1.12	1.06	1.18
<i>Nagelkerke R Square: 0.40 Hosmer and Lemeshow Test: p=0.163 Omnibus Tests of Model Coefficients: p&lt;0.001</i>						

## Discussion

On a global scale, colorectal cancer is the third most significant contributor to cancer-related mortality in men and is the second most common cancer-related mortality in women. Remarkably, the incidence of CRC is experiencing an upward trajectory among younger individuals across various regions worldwide, including the Middle East. This paradigm shift in disease occurrence and epidemiological patterns has been notably evident in the Arab world. The profound impact of Western lifestyles on the Arab population has spurred a concerning

increase in CRC incidence, particularly among younger age brackets.<sup>14</sup> This transformative landscape of disease presentation and prevalence is strikingly observable in Egypt, where the incidence of colorectal cancer is progressively surging. Regrettably, the available knowledge and awareness regarding CRC screening practices and preventive measures often lag behind the increasing health challenges posed by this concerning trend.

In the context of the present study, the research hypotheses were subjected to rigorous examination, yielding compelling and noteworthy outcomes. The affirmation of the first research hypothesis, which stated that the implementation of an educational intervention would result in an enhanced percentage of CRC screenings among Zagazig university employees, is substantiated by robust evidence. The analysis revealed a statistically significant enhancement in colorectal cancer screening practices among employees after the intervention, spanning multiple screening methods ( $p < 0.001$ ). Specifically, the results revealed substantial transformations within individual screening categories:

**Fecal Occult Blood Test:** A striking and transformative increase in the number of employees participating in colorectal cancer screening was observed following the educational intervention. Remarkably, the prevalence of screening has approached almost two-thirds of the population. This significant surge underscores the concrete effect of the intervention, a notion further strengthened by the identification of individuals from the minority group who exhibited positive results in occult blood tests. **Colonoscopy:** Post-intervention, a remarkable surge in the willingness of employees to undergo colonoscopy was evident. This heightened willingness, marked by a significant increase in the proportion of employees consenting to the procedure, highlights a noteworthy shift in attitude toward this screening method.

**Blood Picture:** This study revealed a substantial increase in the number of individuals opting for blood picture screening following the educational intervention. With slightly more than three-fifths of the employees participating and less than one-fifth exhibiting abnormal blood analysis results, the intervention's success was evident in the favorable screening outcomes observed. This positive transformation in screening practices can be directly attributed to the effectiveness of the educational intervention. Notably, a statistically significant relationship was established between employees' total knowledge of satisfaction and their positive attitudes postintervention ( $p < 0.001$ ). These findings are like those of the very recent research conducted by Hasirci and Şahin, where the occult blood test emerged as a prominent CRC screening method.<sup>15</sup> Moreover, an earlier systematic review by Vuik et al. emphasized the effectiveness of colon capsule colonoscopy for CRC screening, aligning with the current findings.<sup>16</sup>

The positive impact of educational interventions on cancer screening intentions is corroborated by Maheri et al. whose study documented an increase in cancer screening intentions following similar interventions.<sup>17</sup> An earlier study carried out by Khani Jaihooni et al. further affirmed the influence of educational interventions rooted in the theory of planned behavior on cancer screening intention.<sup>18</sup> Furthermore, the study aligns with the observations presented by Wolf et al. concerning the effectiveness of endoscopic ultrasound in identifying tumors and evaluating lymph nodes in diverse organs, including the colon.<sup>19</sup> By incorporating these results alongside comparative analyses from previous literature, the study undeniably highlights the capacity of educational interventions to profoundly influence attitudes, understanding, and behaviors linked to colorectal cancer screening. This emphasizes the crucial significance of nursing interventions in cultivating favorable transformations in employees' viewpoints and conducting cancer screening. Ultimately, this contributes to the

overarching objective of advancing early detection and proactive health practices among employees.

Enhancing Knowledge through Intervention: The results of this study successfully validated the second research hypothesis by suggesting that implementing an educational intervention led to a substantial improvement in employees' knowledge about CRC screening. Prior to the intervention, the overall level of satisfactory knowledge among participants was notably deficient. Only a minority of patients demonstrated a clear understanding of colon anatomy, physiology, colon diseases, CRC risk factors, and associated symptoms/signs. This knowledge gap prevalent among healthcare professionals can be attributed to curriculum gaps in community-based health education and the absence of effective educational initiatives or workshops targeting employees. The scarcity of information dissemination through public media campaigns has further contributed to this lack of awareness. This observation echoes the findings of previous studies, such as those of Aga et al. in Saudi Arabia, which noted limited knowledge about CRC epidemiology and risk factors.<sup>20</sup> However, following the intervention, a profound transformation occurred in various domains: colon anatomy, physiology, colon diseases, CRC risk factors, symptoms/signs, and diagnosis. These improvements were highly statistically significant ( $p < 0.001$ ), and participants exhibited notable improvements in their postintervention satisfactory knowledge scores.

This positive influence of nursing education on knowledge enhancement is mirrored in several similar scattered studies, such as that of Wang et al. who reported that a multimedia client education intervention improved self-care knowledge and skills in colorectal cancer patients.<sup>21</sup> Additionally, El-Sayed et al. supported the effectiveness of nurse-led interventions in increasing awareness of colorectal cancer.<sup>22</sup> Similarly, Briant et al. and Mosli et al. reported comparable outcomes, showing that educational interventions effectively increased participants' awareness of colorectal cancer screening.<sup>23,24</sup> Furthermore, the association between higher education levels and improved awareness aligns with Gede et al.<sup>25</sup> The increase in perceived self-efficacy scores after the intervention aligns with the findings of Toleutayeva et al. who suggested that educational interventions can enhance self-efficacy for cancer screening.<sup>26</sup> The strategic utilization of the Health Belief Model (HBM) as the framework for educational intervention further substantiates these positive outcomes. These study results underscore the effectiveness of targeted educational interventions in enhancing employees' knowledge of CRC screening. All these previous findings emphasize the effectiveness of the pivotal role of well-designed educational interventions in enhancing knowledge related to CRC.

Regarding the selection of the most suitable linear regression model for employees' knowledge scores, the results of the present study revealed that the intervention and urban residence were statistically independent positive predictors of employees' knowledge scores. This finding underscores the effectiveness of the intervention in enhancing participants' knowledge about colorectal cancer. It also highlights the contribution of highly educated individuals who reside in urban areas to this increase in knowledge. A similar study conducted at Eastern Kentucky University by Catlett found a significant increase in mean knowledge scores from pre- to posttests ( $p < 0.007$ ), aligning with the outcomes of this project.<sup>27</sup> This finding reinforces the idea that educational programs can effectively raise awareness about CRC and its screening recommendations, ultimately influencing individuals' intentions to undergo screening. The evaluation of the program underscores its value in addressing the community's informational needs. Additionally, Mohamed et al. reported significant improvements in the mean knowledge scores and CRC screening rates for most study subjects after implementing a similar program.<sup>28</sup> Conversely, a study conducted by Sindhu et al. among the urban population

of Klang Valley in Malaysia revealed poor awareness of CRC. This disparity in awareness could be attributed to cultural differences.<sup>29</sup>

**Improvement of Attitudes through Intervention:** The outcomes of this study robustly confirmed the second research hypothesis, shedding light on the transformative impact of educational intervention on employees' attitudes toward CRC screening. Prior to the intervention, a minority of participants demonstrated positive attitudes toward CRC, while the majority held less favorable perspectives. This initial disposition can be attributed to the well-established connection between knowledge and attitude. Individuals who possess greater knowledge about CRC and its screening protocols tend to exhibit more positive attitudes. Moreover, higher educational levels and the presence of chronic diseases emerged as indicators of favorable attitudes, aligning with insights from prior research. These findings agreed with those of the study conducted by Colón-López et al. which assessed knowledge, attitudes, and beliefs about CRC screening in Puerto Rico.<sup>30</sup> Their research emphasized the need for educational initiatives to improve knowledge and attitudes surrounding CRC screening, coupled with enhanced client-provider communication to facilitate informed recommendations. Huang et al. also underscored the barriers and facilitators influencing CRC screening uptake among cancer survivors.<sup>13</sup> Their study demonstrated that factors such as physician recommendations, higher household income, family history, and perceived need significantly impacted the likelihood of undergoing screening. Strong predictors of screening uptake included physician recommendations and a higher level of CRC symptom knowledge.

Effectively, the educational intervention orchestrated a shift in employees' attitudes toward CRC screening from less favorable to more positive. This profound shift emphasizes the pivotal role of knowledge dissemination and targeted education in nurturing positive attitudes. These attitudes, in turn, contribute to increased participation in CRC screening programs. By effectively altering attitudes through education, this study underscores the potential for structured interventions to significantly influence individuals' perspectives and decisions related to CRC screening. Ultimately, the findings highlight the synergy between knowledge enhancement and the cultivation of favorable attitudes, paving the way for heightened engagement in crucial healthcare practices. Furthermore, the results of this study revealed statistically significant differences, particularly in terms of residence, income, university education, the presence of chronic diseases, and attitudes. From the researcher's perspective, this can be attributed to the fact that participants with higher levels of education, urban residence, and chronic diseases tended to exhibit more positive attitudes. This observation aligns with a study by Wang et al. in China, which showed that a positive cancer preventive attitude was associated with higher education.<sup>21</sup> Additionally, the place of residence, income, and educational level had significant impacts on the participants' attitude scores ( $p < 0.05$ ), as reported by Erkal in Turkey.<sup>31</sup>

Regarding the selection of the most suitable linear regression model for employee attitude scores, the study's findings indicated that knowledge scores and the presence of chronic diseases were statistically independent positive predictors of employee attitude scores. This finding suggested that individuals with greater knowledge tend to exhibit more positive attitudes. A similar observation was made in a study conducted in Saudi Arabia by Althobaiti and Jradi, who found that a positive attitude toward CRC screening was an independent predictor of higher knowledge levels.<sup>32</sup> In China, Liu et al. concluded that the colorectal cancer screening model based on chronic disease management effectively improved the screening participation rate.<sup>33</sup> This aligns with the findings of the present study, which showed that the presence of chronic disease is positively associated with

a more favorable attitude toward CRC screening.

**Improvement of practices through Intervention:** The outcome of this study robustly confirmed the second research hypothesis regarding CRC practices. The study's findings revealed that a minority of employees exhibited comprehensive knowledge about CRC practices, while a larger proportion were familiar with CRC prevention practices. This observation resonates with the findings of Al-Thafar et al. who conducted a study in Saudi Arabia in which 26.2% of their participants believed that CRC was not preventable, 50.4% were uncertain, and 23.4% acknowledged the potential for CRC prevention.<sup>34</sup> Notably, most participants in that study regarded exercise and a healthy diet as the primary strategies for CRC prevention. These parallels underscore the common thread in public understanding regarding CRC prevention across different regions.

**Barriers to Colonoscopy and Implications:** The outcome of this study robustly confirmed the third research hypothesis within the parameters of this study; the post-program percentages revealed a decline in various reasons for abstaining from colonoscopy. Several factors exhibited highly significant differences postintervention ( $p < 0.001$ ), except for "not thinking about it" and "fear of the process". The most substantial obstacles hindering individuals from undergoing colonoscopy were identified as lack of consideration, fear of diagnosis, and financial constraints. These challenges were succeeded by limited knowledge, the absence of doctor advice, time limitations, and fears regarding the procedure. These findings mirror those of Al-Naggar et al. whose research emphasized the significance of pain-related fears and embarrassment as notable barriers to CRC screening.<sup>12</sup> This congruence underscores the universal nature of these hindrances across diverse cultural and geographical settings. Furthermore, these findings align with Hatamian et al. comprehensive inquiry into barriers to and facilitators of colorectal cancer screening in Asia.<sup>9</sup> Their analysis of 36 articles revealed common impediments, such as lack of knowledge, fear of outcomes, aversion to screening procedures, anxiety about pain, limited awareness, high expenses, and absence of gastrointestinal symptoms. Conversely, pivotal facilitators encompassed understanding, awareness of CRC screening, perceived risk and seriousness, family cancer history, and physician endorsements.

Similarly, in Puerto Rico, Colón-López et al. studied barriers such as insufficient awareness of CRC, unfamiliarity with screening tests and their preparations, feelings of embarrassment, low perceptions of screening benefits, fatalistic beliefs, transportation difficulties (especially in rural areas), time constraints, and financial burdens.<sup>30</sup> After participants were informed about the advantages of CRC screening, their acknowledgment of its benefits expanded. Notably, the study revealed a scarcity of provider recommendations for CRC screening, further underscoring the significance of healthcare provider involvement. For Puerto Rican participants who did not adhere to CRC screening, misconceptions about CRC, screening tests, and procedures emerged as substantial deterrents. The combination of limited knowledge levels, unfavorable attitudes toward screening, and a lack of provider recommendations emphasized the intricacies of promoting CRC screening. These findings accentuate the urgent need for educational initiatives to augment awareness and attitudes about CRC screening. Moreover, enhancing communication between patients and providers is pivotal in seizing opportunities to suggest and endorse CRC screening. Collectively, these insights underscore the need for comprehensive endeavors to address barriers and facilitate informed decision-making in the context of CRC screening.

In terms of identifying the most suitable linear regression model for agreement upon undergoing colonoscopy, the study's results revealed that the attitude score was a statistically independent positive predictor of

agreement to have a colonoscopy. This can be attributed to the fact that individuals with a more positive attitude are more likely to participate in screening practices, including colonoscopy. These findings align with the findings of Douma et al. who noted that the public's positive attitude toward CRC screening is linked to their overall positive attitude toward preventive health screening, their perception of the seriousness of cancer, their belief in the importance of health, and their trust in the government regarding national screening programs.<sup>35</sup> This study provides valuable insights into the intricate relationships among knowledge, attitudes, and practices related to CRC screening. The noteworthy positive correlations observed between knowledge scores and attitudes and between the frequency of tests performed underscore the interdependent nature of these factors. As individuals' familiarity with CRC screening increased, their attitudes became more positive, leading to a greater willingness to undergo tests. This comprehensive perspective underscores the effectiveness of nursing interventions and suggests that knowledge and attitudes play pivotal roles in shaping health-related behaviors. In a similar context, Alghamdi et al. also concluded that knowledge and attitude scores are associated with the practice of colorectal cancer screening tests.<sup>36</sup> Finally, the intervention program had a statistically significant impact on knowledge, attitudes, and screening practices and ultimately led to improved participation in the early detection of colorectal cancer. These findings align with the results reported by Kim et al. who similarly found that interventions had a significant effect on raising awareness regarding colorectal screening, including blood and stool tests.<sup>37</sup>

**Conclusion:** The implementation of the intervention program yielded statistically significant improvements in CRC testing rates; a substantial increase in knowledge levels; a notable transformation of CRC preventive behaviors within the study population from the minority preprogram to the majority post-program; and a remarkable shift toward positive attitudes regarding CRC preventive practices. The study's results recommended that an intervention program should focus on disseminating accurate information about CRC, its risk factors, symptoms, and available screening methods. Collaborations with academic institutions, healthcare providers, and public health agencies could help effectively disseminate this knowledge. Given the significant increase in the percentage of CRC tests conducted postintervention, regular CRC screening programs should be established and promoted within the university community. These programs should include various screening methods, and efforts should be made to ensure easy access to these tests for employees. A study could be conducted on a large-ample population and replicate the experimental and control group designs.

**Abbreviations:** UNs, united nations; Cs, complete blood counts; CRC, colorectal cancer; CT, computed tomography; FIT, fecal immunochemical tests, HBM, health belief model; SDGs, sustainable development goals.

#### **Declarations**

**Funding:** This was a self-supporting study by the authors.

**Consent for publication:** In this study, there was no applicable material.

**Conflicts of interest:** There were no conflicts of interest associated with the current study.

**Availability of data:** Upon appropriate request, the author will make the data sets assembled and interpreted during this study available.

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**Author Contributions:** All authors completed a significant involvement to the work stated, whether that is in the conception, study design, implementation, gaining of data, analysis, and interpretation, or in all these extents; acquired in drafting, revising, or critically reviewing the manuscript; presented final approval of the article to be published; have approved on the journal to which the article has been submitted; and correspond to be accountable for all parts of the work.

**Ethical Considerations:** It is obtained from the research ethical committee, Faculty of Nursing's Zagazig University as well as from university's colleges with the reference number of ID/ZU.Nurs.REC (Date: 27/01/2023). Each study participant provided a written informed consent, and assured their anonymity and confidentiality were kept or preserved.

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