Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Psychosocial determinants of colorectal screening intention among the Persian Older adults using Parallel extended process model (EPPM)

Ameneh moghadar
Alborz University of medical Sciences
Leili salehi
leilisalehi88@gmail.com

Alborz University of medical Sciences
Abbas Moghimbeigi
Alborz University of medical Sciences
Zahed Rezaei
Hamadan University of Medical Sciences,Iran

Research Article

Keywords: Awareness, colorectal cancer, older adults, parallel extended process model, screening

Posted Date: November 4th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10399530/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background and objective:

Colorectal cancer (CRC) is recognized as one of the most common cancers in Iran and worldwide, with high mortality rate especially among older adults. Screening strategies, especially Fecal Occult Blood Testing (FOBT) followed by colonoscopy, have been proven to significantly reduce CRC mortality. However, despite their proven effectiveness, screening uptake remains low. The present study aimed to determine the factors influencing the colorectal cancer screening intention among the older adults considering Parallel Extended Process Model (EPPM).

Method

In this cross-sectional study, 355 participants aged 60 or older who attended the urban health centers in Gorgan, Iran, in 2023 were selected using multistage systematic random sampling. Data were collected using pervious validated questionnaires developed based on the EPPM (susceptibility, severity, self-efficacy, response efficacy, fear, defensive mechanism, intention) and knowledge. Validity and reliability of the study tools assessed in the present study before data collection.

Results

The mean age (SD) was 68.38 ± 6.12 years. The educational level of most participants was less than a high school diploma. In addition, 43% reported having an adequate financial status. A small sample proportion had a family history of colorectal cancer although only 7% had previously undergone colonoscopy. Higher level of knowledge was directly and significantly associated with perceived susceptibility, perceived severity, perceived self-efficacy, and perceived response efficacy. ($P < 0.05$). Analyzing efficacy pathway indicated that self-efficacy was the most influential factor enhancing participants' intention to undergo colorectal cancer screening ($P < 0.05$). However, perceived susceptibility exerted the greatest effect on screening intention in the threat pathway ($P < 0.05$).

Conclusion

Older adults with higher self-efficacy demonstrated stronger intentions to undergo colorectal cancer screening. Therefore, interventions based EPPM enhance individuals' confidence in their ability to perform CRC screening. Furthermore, perceived severity leads to higher intention to perform CRC screening in older adults. Emphasized risk perception is another factor that should be considered in interventional procedure. Certainly, theory driven interventions may enhance participation in CRC screening among older adults.

Introduction

Globally, colorectal cancer (CRC) is the third most common cancer in men and the second most frequent cause of cancer-related death in women, imposing a considerable burden on public health systems [1]. Given its substantial disease burden and the possibility of detecting precancerous or early-stage lesions, CRC is regarded as an ideal candidate for screening programs [2]. The incidence of CRC has steadily increased in Iran during recent years, highlighting the need for effective screening strategies [3]. Evidence reveals that screening through fecal occult blood test (FOBT) and colonoscopy can reduce CRC incidence and mortality through the early detection and precancerous lesions removal. Consequently, international guidelines recommended regular screening for individuals aged 50 years and older [6]. Given that CRC incidence markedly enhances with age, population ageing has become an important public health concern. Similar to many countries, Iran is experiencing a rapid demographic transition toward an older population [7].

Despite the effectiveness of CRC screening, participation rates remain unsatisfactory in many countries, especially in low- and middle-income settings. Previous studies indicated that demographic characteristics alone cannot adequately explain individuals' participation in screening programs, and psychosocial factors play a critical role in shaping health-related decision-making and preventive behaviors [8]. Thus, identifying the psychological mechanisms underlying screening intention is essential for designing effective educational and behavioral interventions.

One of the theoretical frameworks widely applied to explain preventive health behaviors is the Extended Parallel Process Model (EPPM), originally proposed by Witte [10]. The EPPM suggests that individuals' responses to health messages depend on two simultaneous cognitive appraisals: perceived threat and perceived efficacy. Perceived threat consists of perceived susceptibility and perceived severity, whereas perceived efficacy includes self-efficacy and response efficacy. According to this model, individuals first evaluate the seriousness of a health threat and their personal vulnerability to it. They then assess whether the recommended preventive action is effective and whether they are capable of performing that behavior successfully [9, 10].

Based on the EPPM, individuals may follow one of two response paths after exposure to a fear-arousing health message. When perceived efficacy exceeds perceived threat, individuals take a preventive action against the danger or threat, focusing on adopting adaptive behaviors to reduce the health risk. In contrast, if perceived threat outweighs perceived efficacy, individuals enter a fear control process characterized by defensive reactions such as denial, avoidance, or message rejection rather than engagement in preventive behaviors [10]. Since CRC screening messages frequently emphasize both the seriousness of the disease and the benefits of early detection, the EPPM provides an appropriate theoretical framework for understanding the formation of screening intentions among older adults.

Several studies applied the EPPM to examine cancer-related preventive behaviors including CRC screening [9, 11] although important knowledge gaps remain. First, most early studies focused on general adult populations rather than older adults, despite the higher incidence of CRC in later life.

Second, although the Iranian population is ageing rapidly, limited evidence is available regarding the relative contribution of EPPM constructs to CRC screening intention among Iranian older adults. Third, only a limited number of studies have simultaneously examined EPPM constructs and health literacy within a Structural Equation Modeling (SEM) framework to explain CRC screening intention. Addressing these research gaps could provide a more comprehensive understanding of the psychosocial mechanisms underlying screening behavior and inform the development of evidence-based, theory-driven interventions.

Accordingly, the present study was designed to investigate the psychosocial determinants of CRC screening intention among Iranian older adults by applying the EPPM within an SEM framework. More specifically, this study sought to examine both the direct and indirect relationships among health literacy, perceived susceptibility, perceived severity, self-efficacy, response efficacy, and CRC screening intention within a unified conceptual model (Fig. 1).

Method

Study design and setting

This cross-sectional study was conducted on the older adults referred to the urban healthcare centers in Gorgan, Iran in 2023. The study was designed to recognize the psychosocial factors of CRC screening intension based on the EPPM. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Sample size and sampling

The required sample size was calculated using the following formula:

$$n_0 = \frac{z^2 (p)(1-p)}{(r)^2}$$

The sample size was estimated based on the correlation coefficient reported by Emadi Azam et al. [12]. Assuming a correlation coefficient of r = 0.29, a 95% confidence level, and the desired statistical power, the minimum required sample size was calculated to be 316 participants. Regarding 10% attrition, the final sample size was increased to 355 participants.

A multistage sampling method was employed. In the first stage, urban primary healthcare centers in Gorgan were considered as sampling clusters. The required sample from each center was allocated proportionally according to the population covered by that center. In the second stage, a list of eligible older adults was obtained from each healthcare center, and participants were selected using systematic random sampling until the required sample size for each center was achieved.

Eligibility criteria

The inclusion criteria were age over 60 years, a cognitive performance score above the established threshold on the Mini-Mental State Examination (MMSE) [13], and having an active health record at one of the primary healthcare centers. Furthermore, economic status was evaluated using an asset-based index developed by Ferguson et al. [14, 15], which has been widely utilized in previous international research examining the association between socioeconomic status and health outcomes in developing countries [16].

Anthropometric measurements were performed at the health centers. Participants' body weight was measured using a calibrated SECA scale with a precision of 0.01 kg, while participants wore light clothing. Height was recorded in centimeters using a wall-mounted stadiometer. Body mass index (BMI) was subsequently calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Individuals with a BMI exceeding 30 kg/m^2 were excluded from the study.

Study tool

A multi-section questionnaire was used to collect the required data. The first section comprised demographic characteristics including age, gender, financial status, and educational level. The second section consisted of EPPM constructs [17] including the perceived susceptibility (4-item), perceived severity (4-item), perceived self-efficacy (3item), perceived response efficacy (4-item), fear (6-item), defensive mechanisms (4-item), and screening intention (3-item). In the present study content validity of the instrument was assessed by a panel of experts, and its reliability was evaluated using Cronbach's alpha coefficient. The obtained alpha values were 0.75 for perceived susceptibility, 0.71 for perceived severity, 0.77 for perceived self-efficacy, 0.72 for perceived response efficacy, 0.79 for fear, and 0.74 for defensive mechanisms and screening intention.

The third section of the instrument comprised of the Knowledge of CRC questionnaire with 20 true/ false items [18]. This questionnaire assessed participants' knowledge across four domains including definition of CRC, risk factors, screening and prevention strategies, and signs and symptoms of the disease.

Content validity was established for this section through evaluation by an expert panel. To assess reliability, a test-retest method was employed with a 10-day interval between administrations. The obtained intraclass correlation coefficient was 0.69 ($p < 0.001$), indicating acceptable stability of the instrument over time.

Study analysis

Before analysis, the data normality was examined using the Kolmogorov-Smirnov (K-S) test, which confirmed that all variables followed normal distribution ($P > 0.05$). Between-group comparison of

knowledge score were performed using independent samples t- test and one-way analysis of variance (ANOVA), as appropriate. Correlation between the study variables assessed using Pearson's correlation coefficient. Structural equation modeling (SEM) was employed to evaluate the predictive relationships between screening intention and knowledge, as well as EPPM constructs.

Descriptive statistics (Mean, frequency, percentage, and standard deviation) were calculated for all study variables. All statistical analyses were conducted using SPSS software (version 26), with a significance level set at $P < 0.05$. For SEM, path coefficients with t-values greater than 1.96 were considered statistically significant. Model fit was evaluated using multiple indices, including $\chi^2/df < 3$, RMR, SRMR, GFI, NFI, NNFI, IFI, CFI, and RMSEA. Path analysis was performed using LISREL software (version 8.8).

Results

Demographic characteristics

The present study comprised 355 older adults. The mean age of the participants was 68.34 ± 6.12 years. Most of them had educational levels below a high school diploma, and 43.7% reported having a moderate economic status. Approximately 8.2% had a family history of CRC and 7% had previously undergone screening tests such as Fecal Occult Blood Test (FOBT).

Between-group comparison of knowledge

Significant differences in CRC screening knowledge scores were observed across various demographic and clinical characteristics. Specifically, knowledge scores differed significantly based on gender, educational attainment, and economic status, as well as among individuals with a family history of CRC and those with prior screening experience (Table 1).

Table 1
Demographic characteristics and Mean (SD) of knowledge Between-groups

Statistics Variable	**Frequency**		**Knowledge**		**P**
	Frequency	Precent	Mean	SD	.99
Age	117	33	27.09	2.47	
60–64	105	29.6	26.89	2.89	
65–69	74	20.8	27.01	2.21	
70–74	36	10.1	26.69	1.93	
75–79	18	5.1	27	2.72	
> 80	5	1.4	27.60	3.05	
Mean ± SD	68.34 ± 6.12		27.04 ± 2.22		
Age					
Female	184	51.8	26.7	2.23	.033
Male	171	48.2	27.27	2.63	
Education					
illiterate	25	7	23.12	1.48	< 0.001
6 years	84	24.62	23.12	.48	
12 years	189	53.2			
college	57				
Economic status					
Very poor	29	8.2	23.12	1.37	< 0.001
Poor	88	24.8	24.62	0	
acceptable	155	43.7	26.50	.502	
good	78	22	28	.489	
Very good	5	1.4	30.28	1.48	
Physician visits					
Never	30	8.5	26.47	2.83	.194
Every 2–3 years	75	21.1	27.09	2.53	

Statistics Variable	Frequency		Knowledge		P
Every year	55	15.5	27.13	2.41	
Every 6 months	65	18.3	27.27	2.51	
Every 3 months	63	17.7	27.51	2.42	
Every month	67	18.9	26.57	2.49	
family history of colorectal cancer					
Yes	29	8.2	26.95	2.55	< 0.01
No	281	79.2	25.97	1.66	
I don’t know	45	12.12	27.79	2.53	
history of screening tests					
Yes	39	10.98	26.71	2.40	< 0.01
No	316	89	29.13	3.47	

As presented in Table 1, the findings indicated that higher economic status was associated with increased knowledge scores. Similarly, participants with higher levels of educational attainment demonstrated significantly greater knowledge regarding CRC screening compared to those with lower education levels.

Correlation between the study variables

Pearson correlation analysis revealed a positive and significant association between screening intension and the study variables. The correlation coefficients ranged from 0.02 to 0.855, indicating varying strengths of association across the examined constructs (Table 2).

Table 2:Correlation association between intention and studied variables

variable	Know	suscep	sever	SE	RE	fear	DM	intension
know	1							
suscep	.444**	1						
sever	.446**		1					
SE	.264**	.658**	.761**	1				
RE	.197**	.610**	.666**	.708**	1			
fear	.598**	.722**	.682**	.577**	.619**	1		
DM	.0.84**	.102**	.020**	.105**	.722**	.5656**	1	
Intension	.271**	.709**	.855**	.734**	.830**	.556**	.059**	1

Know: Knowledge; Suscep: Susceptibility; Sev: Severity; RE: Response efficacy; DM: defense mechanism

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Model Fit Indices

The model fit indices indicated an acceptable overall model fit, demonstrating that the relationships among the variables were consistent with the conceptual framework (Table 3).

Table 3. Model fit indices

index	**df /χ2**	**RMSEA**	**CFI**	**IFI**	**NNFI**	**NFI**	**GFI**	**SRMR:**	**RMR**
Optimal	< 3	0.08<	> 0.9	> 0.9	> 0.9	> 0.9	> 0.9	→0	→
Reported value	2.48	0.05	0.97	0.93	0.90	0.93	0.91	0.18	0.12

SEM results

The results of SEM revealed that knowledge exerted a positive and significant impact on four constructs of perceived sensitivity, perceived severity, self-efficacy, and response efficacy. Higher levels of CRC-related knowledge were associated with greater perceived risk and severity of the disease, higher confidence in one's ability to undergo screening and stronger beliefs regarding the effectiveness of screening procedures. (Fig. 2)

Additionally, within the threat appraisal pathway, perceived severity exerted the strongest standardized effect on screening intention (β = 0.57), indicating that higher belief about the seriousness of CRC was associated with greater intention to undergo screening. Similarly, within the efficacy appraisal pathway,

perceived self-efficacy demonstrated a significant positive effect (β = 0.44), suggesting that greater confidence in one's ability to perform screening was associated with higher screening intention (Fig. 3). As a result, the findings of the present study supported the hypotheses derived from the EPPM in predicting the intention to undergo CRC screening among Iranian older adults. Furthermore, the results underscored the significance of both threat and efficacy appraisal pathways in this population (Fig. 3).

Discussion

The present study aimed to identify factors influencing the intention to undergo CRC screening among older adults using the EPPM. The findings demonstrated that the EPPM provides a good theoretical framework for predicting the psychosocial determinants of CRC screening intention among Iranian older adults. Specifically, knowledge can influence the older adults' screening intention through the mediating roles of perceived susceptibility, perceived severity, self-efficacy, and response efficacy. This underscores the critical and indirect role of knowledge in shaping screening decisions among older adults. Furthermore, the findings highlight the necessity of incorporating fear-based and threat-oriented models in the design and implementation of CRC prevention interventions.

The results of the present study indicated no significant difference in CRC-related knowledge across different age groups, which is not in line with the study results of García-García et al. [19], who found that the older adults aged over 65 years exhibited lower health literacy regarding CRC compared to those under 65 years of age. In the same vein, Baccolin et al. (2022) in a systematic review, demonstrated that the prevalence of low health literacy varied considerably across populations, ranging from 1.6% – 99.5%, depending on the assessment tool utilized [20].

These discrepancies between the findings of the present study and those of previous research may be attributed to several factors including differences in demographic characteristics, sampling locations, educational levels of participants, healthcare system structures, motivation of healthcare providers to educate patients, or different assessment tools employed. Given that the participants in the present study were recruited from those receiving routine care at the participating health centers, this finding underscores the importance of patient education and health literacy promotion within this specific healthcare setting.

The present study demonstrated significant differences in CRC-related knowledge based on economic status, corroborating earlier findings that older adults with higher income levels exhibit greater awareness of CRC [21]. It seems that individuals with greater financial resources encounter fewer barriers to acquiring health-related knowledge, thereby facilitating better understanding and awareness of CRC screening.

The results of the present study indicated a significant relationship between educational level and CRC screening awareness, which is consistent with the study results of Xu et al. [22]. Obviously, higher levels of education enhance individuals' tendency to seek out health-related information and improve their awareness of preventive health measures. Given that factors such as limited access to knowledge and

financial constraints may hinder this process [22], scholars argue that individuals with lower educational backgrounds should be prioritized in targeted interventions [23, 24].

In this study, the small proportion of participants reporting a family history of CRC (8.2%) was lower than those the rates reported in previous research [25]. This finding underscores the need to prioritize these individuals in screening initiatives, given their elevated risk for the disease [25]. Implementing population-based screening programs, especially among high-risk groups, facilitates the early detection of precancerous lesions and colorectal tumorous, thereby creating an opportunity for timely intervention before cancer progression occurs [26].

Furthermore, consistent with the study results of Maheri et al., only about 10% of participants in the present study had a history of undergoing CRC screening [27]. This proportion is notably lower than that reported in a study conducted in Iran [28]. However, Hafezi Bakhtiari et al. reported a higher proportion of individuals with a history of screening [29].

The lower screening rates observed in both the present study and that of Maheri et al. may be attributed to differences in demographic characteristics, particularly educational attainment. In In both studies, the the majority of participants had low levels of education, whereas the study by Rahimi et al. included participants with higher educational backgrounds. Given the positive association between educational level and health knowledge, the lower screening rates observed in these populations is somewhat justifiable.

The results of this study align with the results of previous research conducted in Iran, which has consistently reported low rates of CRC screening. In the present study, individuals with a history of screening demonstrated significantly higher levels of knowledge compared to those who had never undergone screening. In the same vein, some studies [30–32] indicated that having adequate health knowledge is associated with higher rates of CRC screening.

Furthermore, Pearson correlation analysis indicated a significant and direct association between CRC screening intention and the study variables. Among the examined constructs, perceived severity showed the strongest positive and significant association with intention to undergo CRC screening, followed by perceived self-efficacy, which also exerted a substantial influence. These findings are consistent with those of Faryabi et al. (2024), who demonstrated that perceived severity and self-efficacy were the primary predictors of intention to participate in breast cancer screening [33].

Similarly, a study conducted in China investigating the determinants of breast cancer screening intention among urban women reported a significant association between perceived severity and the decision to undergo screening [34]. Also, Lee et al. reported a positive relationship between higher perceived risk and willingness to undergo CRC screening among male at risk [35]. Additionally, people are more likely to take the initiative to engage in screening programs when they understand the seriousness and risks of a disease well. This underscores the crucial importance of emphasizing disease risks, potential harms, and the benefits of early detection in health promotion interventions.

Further, Mohammadi and Mohammadnabizadeh [36] indicated that higher self-efficacy leads to increased participation in CRC screening. This finding is fully consistent with the theoretical assumptions of the EPPM, which states that individuals will intend to engage in preventive behavior when they possess both an adequate understanding of disease-related risk and seriousness, as well as the confidence in their ability to perform the recommended behavior.

Self-efficacy is widely recognized as one of the strongest predictors of intention in health-related behaviors [37]. Accordingly, it is essential to consider whether other psychosocial factors may mediate individuals' motivation to participate in effective CRC screening programs [27]. Based on the results of the present study, an increase in self-efficacy was associated with a higher intention to undergo CRC screening, which is consistent with the study results of Mohammadi and Mohammadnabizadeh [36], who reported a standardized significant effect of self-efficacy ($\beta = 0.44$) on CRC intention among university employees. In the present study, the impact of self-efficacy was also 0.44, which indicates the key role of self-efficacy in the adoption of preventive behaviors across different populations.

Likewise, Qin et al. [38] identified self-efficacy as the strongest predictor of engaging in preventive cancer screening behaviors. In contrast, another study demonstrated no association between self- efficacy and intention to undergo CRC screening test [38]. This discrepancy may be related to differences in demographic characteristics and study settings. For instance, Gholian-Aval conducted their study in a relatively small city with its own cultural context (Nishsbour), while the present study was conducted in one of the largest and most modern cities in Iran (Gorgan). Furthermore, Douma et al. [40] illustrated that self-efficacy has consistently been identified as a key predictor of both intention and actual behavior.

Older adults often encounter multiple barriers to CRC screening including physical limitations, dependence on family members, fear of colonoscopy, anxiety about the outcomes, and transportation difficulties. Thus, even if they understand the risk of the disease, they are less likely to form an intention to undergo screening unless they feel capable of completing the screening process. This finding is also consistent with the central concept of the EPPM, which states that in threatening situations, self-efficacy perceptions determine whether an individual engages in risk-control or fear-control responses.

However, regarding actual screening behavior, there appears to be some controversy. Some studies pointed to a gap between screening intention and actual behavior [39]. Despite the direct effects of intention on behavior, this discrepancy can be attributed to barriers impeding the translation of intention into action. Further research is needed to elucidate the factors that moderate this intention-behavior gap.

Perceived response efficacy emerged as the third most influential factor affecting the intention to undergo CRC intention screening. Incorporating response efficacy into screening programs is considered essential, as it can reinforce both the motivation to undergo screening and actual screening behavior [41]. This result underscores the importance of effectiveness of screening interventions to individuals. Participants with higher perceived response efficacy were more likely to recognize the benefits of CRC screening and demonstrated stronger intentions to participate. However, low response efficacy has been linked to persistent reluctance to engage in screening [42].

Self-efficacy, as individuals' belief in their ability to successfully perform a behavior in a specific circumstance with known outcomes, should be considered within the broader context of environmental barriers.

Furthermore, fatalistic beliefs, wherein individuals perceive cancer diagnosis as a matter of fate or beyond personal control, or believe that death is inevitable following a cancer diagnosis, may undermine screening motivation [43]. This highlights the importance of emphasizing the power of screening tests in early cancer detection and the high possibility of avoiding cancer-related death. Also, health interventions should address misconceptions and false beliefs.

In health promotion and disease prevention, especially regarding cancer preventive behaviors, intention is widely recognized as the most powerful predictor of whether an individual will engage in a specific health-related behavior [44]. Based on the results of the present study, perceived susceptibility, perceived severity, self-efficacy, and response efficacy each demonstrated a positive and direct relationship with intention to undergo CRC screening. Additionally, knowledge was found to influence intention indirectly, mediated through its effects on perceived susceptibility, perceived severity, self-efficacy, and response efficacy, which is fully consistent with the assumptions of the EPPM.

Booger et al. concluded that individuals with a higher perception of cancer-related risk and greater health literacy about diagnostic methods and their effective role in cancer prevention, are more likely to participate in screening programs [11]. Further, other evidence demonstrated that socio-demographic factors, socio-economic status, and psychosocial components are associated with CRC screening [45–47]. Notably, psychosocial variables can be altered through behavioral interventions designed to enhance CRC screening uptake [48].

Within the threat appraisal pathway, perceived severity exerted the strongest influence on the intention to undergo CRC screening, highlighting the importance of emphasizing this construct when designing health messages. This finding is consistent with the results of Feng et al. [49], who also demonstrated a positive relationship between perceived risk and willingness to undergo screening among women at risk for cancer. It can be concluded that when individuals have a higher perception of cancer severity and possess greater health literacy regarding diagnostic methods and their effective role in cancer prevention, they are more likely to participate in screening tests.

The present study also indicated a direct relationship between fear and defense mechanisms and the intention to undergo CRC screening, supporting the hypotheses of the EPPM in this regard. Booger et al. [11] reported that a decrease in engagement with defense mechanisms is associated with increased participation in CRC screening programs.

Collectively, Consistent with the results of other studies [50], the present study found a significant and direct relationship between perceived severity and the intention to undergo screening. Within the efficacy pathway, self-efficacy exerted the strongest influence on screening intention ($P < 0.05$), thereby supporting the theoretical framework of EEM. Similarly, Dahr emphasized that the acceptance of risk

messages depends on an individual's knowledge, values, and beliefs [51], aligning with the results of the present study.

To the best of our knowledge, the present study is the first to employ EPPM as theoretical framework to identify factors influencing the intention to undergo CRC screening. The utilization of a validated theoretical model offers a strong basis to study psychosocial elements and provide appropriate guidance for designing valuable intervention. However, the present study has several limitations that should be acknowledged.

1. 1. This study exclusively focused on urban older adults enrolled in healthcare centers, which may limit the generalizability of the results to the other older adult populations in Iran (rural older adults or other older people who don't routinely use healthcare services)
2. 2. Additionally, the cross-sectional nature of the study restricts the ability to infer causal relationships. Future interventional studies are recommended to more accurately identify and validate the predictors outlined by the model.
3. 3. Another limitation of this study is the use of intention to undergo CRC screening as the outcome variable, rather than actual screening behavior.
4. 4. Some potential variables affecting the intention to undergo colorectal screening in the older adults such as social support, insurance coverage, physician recommendation, and easy access to screening service centers, were not included in the model, which could be another notable limitation.

Conclusion

Based on the findings of the present study, it is recommended that health education interventions incorporate several key components to enhance colorectal cancer screening uptake among older adults. These include: (1) providing practical training on how to perform the fecal immunochemical test (FIT), (2) increasing self-efficacy through hands-on training and step-by-step demonstration of the screening process, (3) utilizing successful peer models (peer modeling) to encourage screening behavior, (4) reducing fear of colonoscopy through educational videos that familiarize individuals with the procedure, (5) emphasizing the curability of cancer when detected at an early stage, and (6) training primary care physicians to strengthen their recommendations and advocacy for screening.

Abbreviations

BMI: Body mass index; EPPM: the extended Parallel Process Model; FOBT: Fecal occult blood test; MMDE: Mini mental state examination; BMI: Body Mass index; SECA: Medical Measurement System and scale

Declarations

Acknowledgements

We sincerely thank all the older adults who participated in this study for their valuable time and contribution.

Authors' contributions

AMGH: Collected the data of the study.

LS: Supervised the study and wrote the manuscript

AGH: Analyzed the data

ZR: Helped in data analysis and wrote the manuscript

Funding

This research received no external funding.

Availability of data and materials

Not applicable (this manuscript does not report data generation or analysis).

Ethics approval and consent to participate

The authors confirm that all procedures in this study were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants after providing a clear explanation of the study objectives and procedures. The study protocol was approved by the Ethics Committee of Alborz University of Medical Sciences (approval number: IR.ABZUMS.REC.1401.153).

Consent for publication

Not applicable.

Competing interests

The authors declared no conflict of interest.

References

1. Xi Y, Xu P. Global colorectal cancer burden in 2020 and projections to 2040. Translational Oncol. 2021;14(10):101174. https://doi.org/10.1016/j.tranon. 2021.101174.
2. Olfatifar M, Rafiei F, Sadeghi A, Ataei E, Habibi MA, Pezeshi Modarres M. Ghalavand Z,Houri HR. Assessing the Colorectal Cancer Landscape: A Comprehensive Exploration of Future Trends in 216 Countries and Territories from 2021 to 2040. J Epidemiol Glob Health. 2025;15(5). https://doi.org/10.1007/s44197-025-00348-3.

3. Gholamiveis R, Heydarpour F, Moradinazar M. Colorectal cancer trends in Iran: An age-periodcohort analysis of incidence and mortality and trends in key risk factors. Cancer Treat Res Commun. 2026;47:1–10. https://doi.org/10.1016/j.ctarc.2026.101234.
4. Blom J, Saraste D, Törnberg S, Jonsson H. Routine Fecal Occult Blood Screening and Colorectal Cancer Mortality in Sweden. JAMA Netw Open. 2024;7(2):e240516. https://doi.org/10.1001/jamanetworkopen.
5. Tanaka K, Sobue T, Zha L, Kitamura T, Sawada N, Iwasaki M, Inoue M, Yamaji T, Tsugane SH. Effectiveness of Screening Using Fecal Occult Blood Testing and Colonoscopy on the Risk of Colorectal Cancer: The Japan Public Health Center-based Prospective Study. J Epidemiol. 2023;33(2):91–100. https://doi.org/10.2188/jea. JE20210057. [Abstract].
6. Gupta S. Screening for Colorectal Cancer. Hematol Oncol Clin North Am. 2022;36(3):393–414. 10.1016/j.hoc.2022.02.001.
7. Aghaei N, Sadeghi R, Koosheshi M, Zeinab HE. A 100-year Projection of Population Aging in Iran through the Decomposition of Population Momentum. Salmand: Iranian Journal of Ageing. 2026; 20 (4):500-513URL: http://salmandj.uswr.ac.ir/article-1-2948en.html
8. Dsouza JP, Broucke SVd. DOST: A consolidated health behavior model that maps factors influencing cancer screening uptake. Archive of Public Health.2025; 83:70(2025). https://doi.org/10.1186/s13690-025-01517-3
9. Birmingham WC, Hung M, Boonyasiriwat W, Kohlmann W, Walters ST, Burt RW, Stroup AM, Edwards SL, Schwartz MD, Lowery JT, Hill DA, Wiggins CL, Higginbotham JC, Tang P, Hon SD, Franklin JD, Vernon S, Kinney AY. Effectiveness of the extended parallel process model in promoting colorectal cancer screening. Psychooncology. 2015;24(10):1265–78. https://doi.org/10.1002/pon.3899.
10. Zafarramazanian F, Kazempour V, Riahi Madvar, Rezae M, Alizadeh M. pplications of the Extended Parallel Process Model in health promotion: A systematic review. J Nurs Rep Clin Pract. 2026;4(2):102–9. https://doi.org/10.32598/JNRCP.2503.1261.
11. Boogar IR, Talepasand S, Norouzi H, Mozafari S, Hosseini SJ. The Prediction of colorectal cancer screening based on the extended parallel process model: moderating the role of health literacy and cancer-related empowerment. Int J Cancer Manage. 2018; 11(6).
12. Emadi Azam M, Bashirian S, Karimi Shahanjarini A, Barati M. Factors Associated with Intention to Perform Fecal Occult Blood Test among Medical Professionals: An Application of the Protection Motivation Theory. Govaresh. 2019;24:147–54.
13. Maduro PA, Carvalho LPDC, Maduro LAR, Rodrigues ABDC, Rocha ASL, Matos LRRS, Nascimento MM, Bavaresco Gambassi B, Schwingel PA. Accuracy of the MiniMental State Examination and Montreal Cognitive Assessment in Detecting Cognitive Impairment in Older Adults: A Comparative Study Adjusted for Educational Level. Neuroscience. 2025;6(3):86. https://doi.org/10.3390/neurosci6030086.
14. Salehi L, Eftekhar H, Mohammad K, Tavafian SS, Jazayery A, Montazeri A. Consumption of fruit and vegetables among elderly people: a cross-sectional study from Iran. Nutr J. 2010;9:2. 10.1186/1475-

2891-9-2.

15. Ferguson BD, Tandon A, Gakidou E, Murray CJ. Estimating permanent income using indicator variables. Health systems performance assessment: debates, methods and empiricism Geneva: World Health Organization. 2003:747 – 60.
16. Chatterji S, Kowal P, Mathers C, Naidoo N, Verdes E, Smith JP, et al. The health of aging populations in China and India. Health Aff. 2008;27(4):1052–63.
17. Kebede N, Kasaye MD, Muche A, Tsega Y. Application of the extended parallel process model to assess the predictors of physical exercise in preventing non-communicable diseases among civil servants in Ethiopia, a mixed-method study. BMC Public Health. 2026;26:402. https://doi.org/10.1186/s12889-025-26097-3.
18. Mitsutake S, Shibata A, Ishii K, Miyawaki R, Oka K. Associations of ehealth literacy with obtaining knowledge about colorectal cancer among internet users accessing a reputable cancer website: Internet-based survey study. Int J Environ Res Public Health. 2020;17(9):3302. https://doi.org/10.3390/ijerph17093302.
19. García-García D, Pérez-Rivas FJ. Health literacy and its sociodemographic predictors: A cross-sectional study of a population in Madrid (Spain). Int J Environ Res Public Health. 2022;19(18):11815. https://doi.org/10.3390/ijerph191811815.
20. Baccolini V, Isonne C, Salerno C, Giffi M, Migliara G, Mazzalai E, Turatto F, Sinopoli A, Rosso A, De Vito C, Marzuillo C. Villari P.The association between adherence to cancer screening programs and health literacy: A systematic review and meta-analysis. Prev Med. 2022;155:106927. https://10.1016/j.ypmed.2021.106927.
21. Iskander OA, Jareebi MA, Daak LI, Areeshi RA, Aljudayba RM, Akoor FA, Abutaleb YB, Mobarki OA, Ageeli AI, Alibrahim AM, Alfaifi MJ, Borik WS, Othman JA, Halimah JA, Alyahyawi K. Determinants of Colorectal Cancer: Risk Factors, Knowledge, and Diagnosis in a Cross-Sectional Study of Saudi Adults. Cancer Control. 2025;32:10732748251405927. https;// doi.org/10.1177/10732748251405927.
22. Xu HF, Gu XF, Wang XH, Wang WJ, Du LB, Duan SX, Liu Y, Zhang X, Zhao YQ, Ma L, Liu YY, Huang JX, Cao J, Fan YP, Li L, Feng CY, Lian XM, Du JC, Zhang JG, Yu YQ, Qiao YL, China Working Group on Colorectal Cancer Survey. Knowledge and awareness of colorectal cancer risk factors, screening, and associated factors in advanced colorectal cancer patients: a multicenter cross-sectional study in China. Ann Transl Med. 2022;10(6):354. https://doi.org/10.21037/atm-22-1019.
23. Wong FMF. Factors Associated with Knowledge, Attitudes, and Practice towards Colorectal Cancer and Its Screening among People Aged 50–75 Years. Int J Environ Res Public Health. 2021;18(8):4100. https://doi.org/10.3390/ijerph18084100.
24. Torosian T, Abrami EA, Massoumi RL, Harutyunyan NM, Dallakyan G, Hovhannisyan H, Hovhannisyan M, Dawes AJ, Aboulian A, Shekherdimian S. Assessing Knowledge and Perceptions of Colorectal Cancer Screening in Armenia. J Surg Res. 2021;257:616–24. https://doi.org/10.1016/j.jss.2020.08.038.

25. Maria-Alexia P, Cristina R, Andreea-Ramona T, Octavian A, Viorica R. Familial colorectal cancer: risk factors, screening strategies and personalized medicine.Cancer Genetics.2026; 302–303(2026):166–175. https://doi.org/10.1016/j.cancergen.2026.02.008
26. Brück CC, Mwangi LW, Wifferen Fv, Hsu L, Thomas M, Peters U. Risk-based screening for early detection of colorectal cancer. Overv Best Pract Res Clin Gastroenterol. 2026;80:102014. https://doi.org/10.1016/j.bpg.2025.102014.
27. Maheri M, Rezapour B, Didarloo A. Predictors of colorectal cancer screening intention based on the integrated theory of planned behavior among the average-risk individuals. BMC Public Health. 2022;22(1):1800. https://doi.org/10.1186/s12889-022-14191-9.
28. Rahimi F, Rezayatmand R, Najafi E, Ravankhah Z, Tabesh E, Adibi P. Pattern of Participation in Colorectal Cancer Screening from a Population-Based Screening Program in Iran. Arch Iran Med. 2024;27(8):407–13. https://doi.org/10.34172/aim.31072.
29. Hafezi Bakhtiari M, Ahmadinia H, Rezaeian M, Ghaseminasab-Parizi M, Nasirzadeh M. Evaluation of Fecal Immunochemical Test (FIT) Screening and Its Determinants: A Descriptive Study Based on the Extended Parallel Process Model, 2025. Journal of Occupational Health and Epidemiology. 2026;15(1):40 – 7. URL: http://johe.rums.ac.ir/article-1-1055-en.html
30. McQueen A, Vernon SW, Rothman AJ, Norman GJ, Myers RE, Tilley BC. Examining the role of perceived susceptibility on colorectal cancer screening intention and behavior. Ann Behav Med. 2010;40(2):205–17.
31. Kobayashi LC, Wardle J, von Wagner C. Limited health literacy is a barrier to colorectal cancer screening in England: evidence from the English Longitudinal Study of Ageing. Prev Med. 2014;61:100–5.
32. Sentell TL, Tsoh JY, Davis T, Davis J, Braun KL. Low health literacy and cancer screening among Chinese Americans in California: a cross-sectional analysis. BMJ open. 2015;5(1):e006104.
33. Faryabi R, Jafarnezhad A, Daneshi S. Predictors of the Intention to Perform Preventive Behaviors Against the Occurrence of Breast Cancer. JCHR. 2024;13(1):109118. hhttps://doi.org/10.18502/jchr.v13i13.15713.
34. Zhang M, Wei W, Li Q, Chen X, Zhang M, Zuo D, et al. Determinants of intention to participate in breast cancer screening among urban Chinese women: an application of the protection motivation theory. Int J Environ Res Public Health. 2021;18(21):11093.
35. Lee J, Keil M, Lee JS, Baird A, Choi HY. Gender Effects on the Impact of Colorectal Cancer Risk Calculators on Screening Intentions: Experimental Study.JMIR Formative Research. 2023;7(2023):926–30. https://doi.org/10.2196/37553
36. Mohammadi M, Mohammadnabizadeh S. Investigating predictive factors of participation in colorectal cancer screening based on the Preventive Health Model (PHM) and health literacy. BMC Prim Care. 2026;27(1):83. https://doi.org/10.1186/s12875-026-03203-x.
37. Warner LM, Schwarzer R. Self-efficacy and health. Handbook of concepts in health, health behavior and environmental health. Singapore: Springer Nature Singapore; 2024. pp. 1–26.

38. Qin W, Hamler TC, Miller DB. Self-efficacy and importance of participation reasons as predictors for prostate cancer screening intention in African American men. Ethn Health. 2022;27(2):316–28. https://doi.org/10.1080/13557858.2020.1724269.
39. Gholian-Aval M, Behrouzi B, Jamali J. Predicting the Determinants of Colorectal Cancer Screening Behaviors Using Protection Motivation Theory: A Cross-Sectional Partial Least Squares Structural Equation Modeling Analysis. Health Sci Rep. 2025;8(10):e71295. https://doi.org/10.1002/hsr2.71295.
40. Douma LN, Uiters E, Verweij MF, Timmermans DRM. Autonomous and Informed Decision-Making: The Case of Colorectal Cancer Screening. PLoS ONE. 2020;15(5):e0233308. 10.1371/journal.pone.0233308.
41. Romli R, Mohamad EMW, Abd Rahman R, Chew KT, Mohd Hashim S, Mohammed NA, Translation. Cross-Cultural Adaptation, and Validation of the Malay Version of the Protection Motivation Theory Scale Questionnaire for Pap smear Screening. Int J Environ Res Public Health. 2022;19(11):6858. https:/doi.org/10.3390/ijerph19116858.
42. Gillibrand S, Gibson H, Howells K, Urwin S, Davies JC, Crosbie EJ, Sanders C. Exploring the barriers to cervical screening and perspectives on new self-sampling methods amongst under-served groups. BMC Health Serv Res. 2025;25(1):79. https://doi.org/10.1186/s12913-024-12098-2.
43. Ngien A, Shaohai Jiang SH. Online cancer information seeking and colorectal cancer screening in China: Considering threat and coping appraisals, and cancer fatalism. Prev Med Rep. 2024;24:102824. https://doi.org/10.1016/j.pmedr. 2024.102824.
44. Daskalakis C, DiCarlo M,Hegarty S, Gudur A,Vernon SW, Myers RE. Predictors of overall and test-specific colorectal Cancer screening adherence. Prev Med. 2020;13:106022. https://doi.org/10.1016/j.ypmed.2020.106022.
45. Ghanayem A, Elewa M, Abu Dawood H, OwaisTA, Ghanayem R, et al. Public awareness of colorectal cancer symptoms and risk factors, and exploring screening barriers across nine countries: A multi-national cross-sectional study. PLOS Global Public Health. 2026;6(3):e0005986. https://doi.org/10.1371/journal.pgph.0005986.
46. Ramazani AA, Norozi E, AmirabadiZadeh H, Ehteshampour AR, Salehiniya H. Predictors of Colorectal Cancer Screening Participation in Southern Khorasan (Iran). J Gastrointest Cancer. 2021;52:187–91. https://doi.org/10.1007/s12029-020-00379-y.
47. Moons L, Mariman A, Vermeir P, Colemont L, Clays E, Van Vlierberghe H, Vogelaers D. Sociodemographic factors and strategies in colorectal cancer screening: a narrative review and practical recommendations. Acta Clin Belg. 2020;75(1):33–41. https://doi.org/10.1080/17843286.2018.1563736.
48. Lemmo D, Martino ML, Vallone F, Donizzetti AR, Freda MF, Palumbo F, Lorenzo E, D'Argenzio A, Caso D. Clinical and psychosocial constructs for breast, cervical, and colorectal cancer screening participation: A systematic review. Int J Clin Health Psychol. 2023;23(2):100354. https://doi.org/10.1016/j.ijchp.2022.

49. Feng GC, Lin Z, Ou W, Su X, Yan Q. A Model-Based Meta-Analysis of Willingness to Participate in Cancer Screening. Int J Environ Res Public Health. 2021;18(5):2580. https://doi.org/10.3390/ijerph18052580.
50. Huang J, Choi P, Pang TW, Chen X, Wang J, Ding H, Jin Y, Zheng ZJ,Wong MCS. Factors associated with participation in colorectal cancer screening: A population-based study of 7200 individuals. Eur J Cancer Care. 2021;30(2):e13369. https://doi.org/10.1111/ecc. 13369.
51. Dhar T, Bornstein L, Lizarralde G, Nazimuddin GSM. Risk perception—a lens for understanding adaptive behaviour in the age of climate change? Narratives from the Global South. Int J Disaster Risk Reduct. 2023;95(103886):1–16. https://doi.org/10.1016/j.ijdrr.2023.103886.

Figures

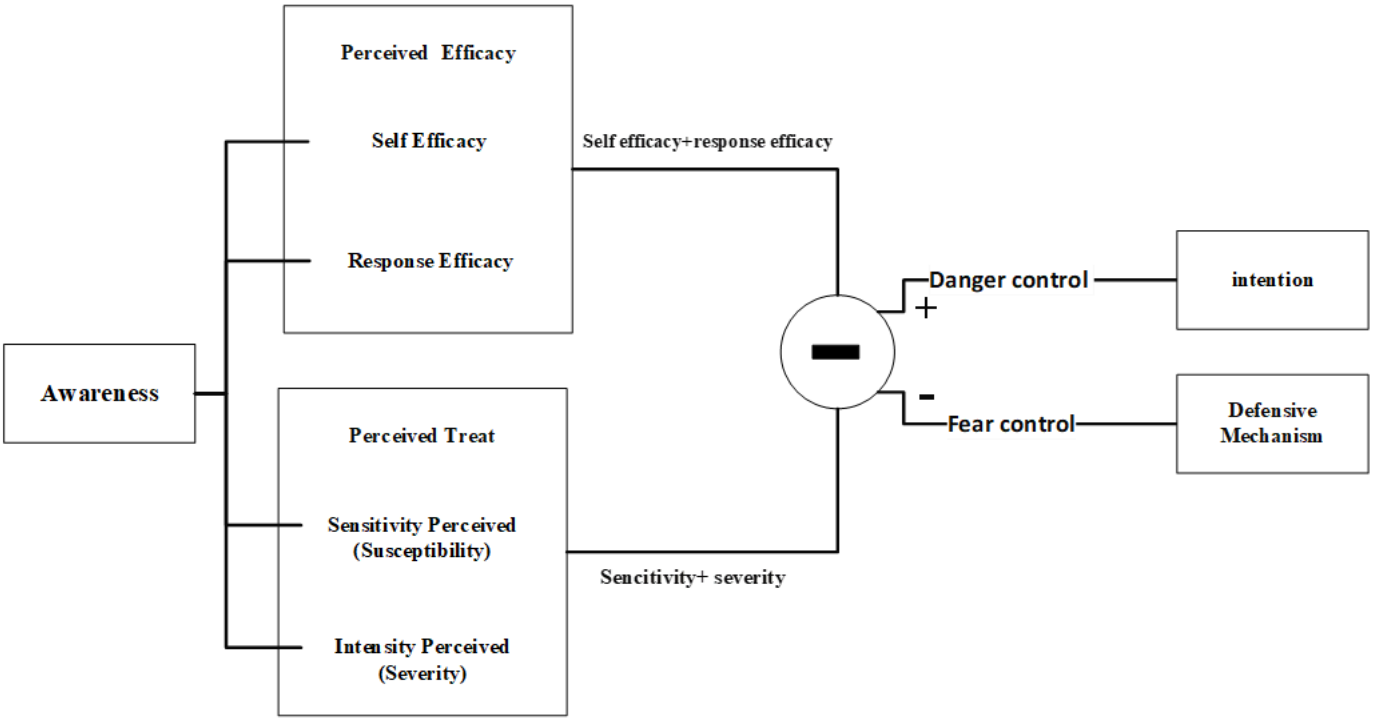
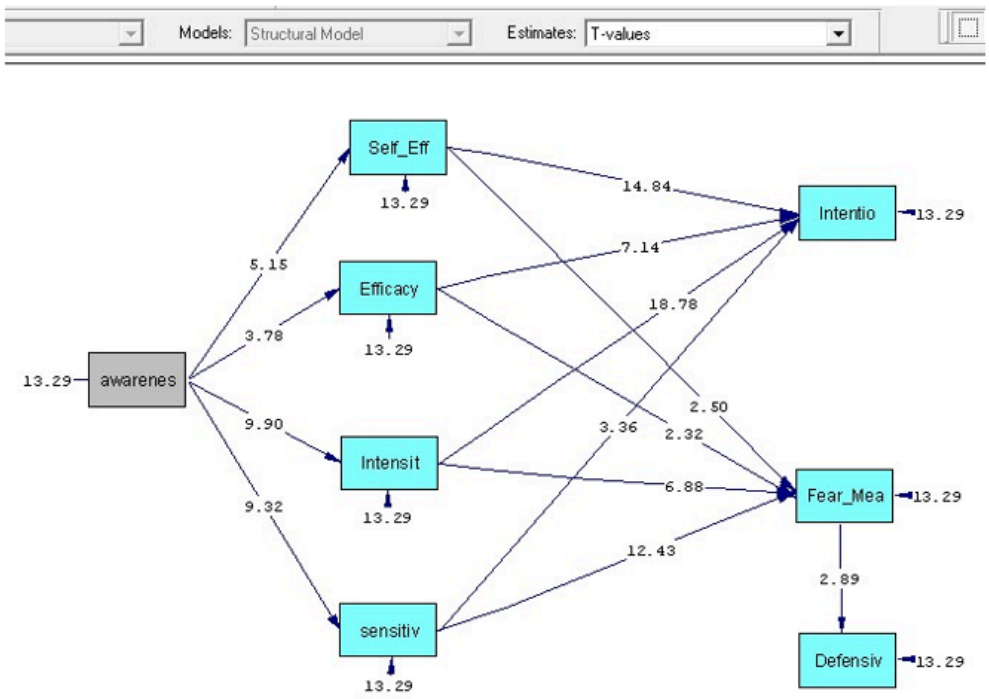


Figure 1

Conceptual Model

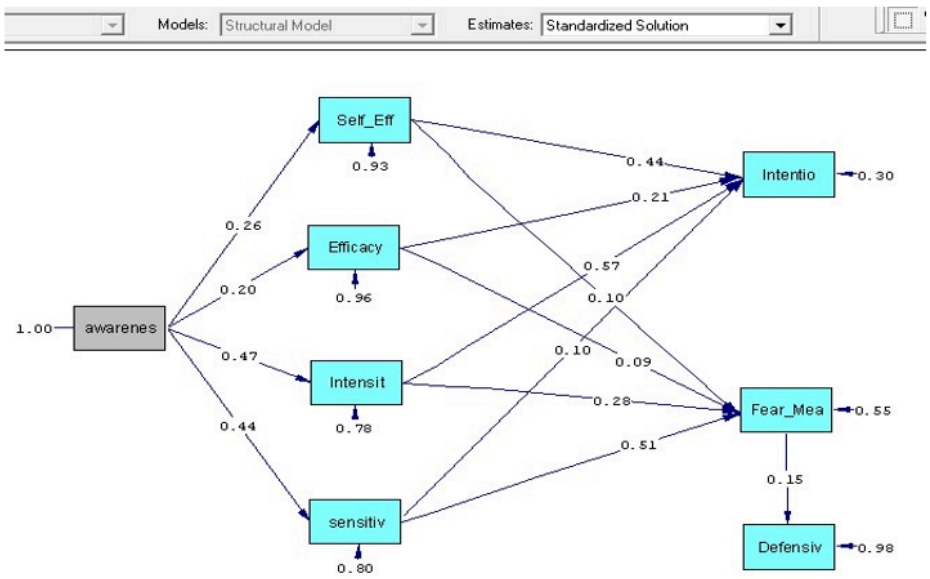


sesitiv = susceptibility;intendit= perceived severity; Efficacy = response efficacy; Self_Eff = Self -efficacy.

intentio = Intention; Fear_Mea= Fear;defensiv = defense mechanism

Figure 2

Path analysis of the study variable based on t value



sesitiv = susceptibility;intendit= perceived severity; Efficacy = response efficacy; Self_Eff = Self -efficacy.

intentio = Intention; Fear_Mea= Fear;defensiv = defense mechanism

Figure 3

Path analysis of the study variable based on β standard