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# Extended parallel process model (EPPM) in evaluating lung Cancer risk perception among older smokers



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## Abstract

**Background:** There is a lack of scientific literature on the application of fear appeals theories to evaluate lung cancer risk perception among smokers. The aim of the present study is to apply the Extended Parallel Process Model (EPPM) to discover the perception of the smokers about their lifetime risk of developing lung cancer (perceived susceptibility), their perception of lung cancer survival (perceived severity), response efficacy, self-efficacy, and readiness to quit.

**Methods:** In this cross-sectional study, 215 eligible smokers (aged 45 years and over who have smoked at least 1 pack per day in the last 5 years) were recruited. The data collection tool was designed using validate self-report questionnaires and it was contained items on the perceived risk of a smoker contracting lung cancer and perceived lung cancer survival rate. It also had questions to measure the main constructs of the EPPM and Readiness to quit ("Low\_Readiness", and "High\_Readiness"). To test how the data support conceptual EPPM to data, Generalized Structural Equation Modeling (GSEM) was used.

**Results:** Findings showed a significant relationship between Perceived\_Susceptibility and Perceived\_Response Efficacy; ( $B = 1.16$ ,  $P < 0.001$ ); between Perceived\_Susceptibility and Perceived\_Self Efficacy, ( $B = -0.93$ ,  $P < 0.001$ ), Perceived\_Severity, and Perceived\_Response Efficacy ( $B = 1.07$ ,  $P < 0.001$ ). There was also a significant relationship between Perceived\_Threat and Perceived\_Response Efficacy; between Perceived\_Threat and Perceived\_Self Efficacy. The relationship between High\_Readiness and Perceived\_Self Efficacy, and between High\_Readiness and Perceived\_Severity also were significant. However, the relationships between High\_Readiness and Perceived\_Threat were not significant ( $P > 0.05$ ).

**Conclusion:** Perceived\_threat and Perceived\_efficacy were important for smokers with low readiness to quit, while Perceived\_efficacy was most important for smokers with high readiness to quit. These findings could be used in promoting lung cancer awareness and designing smoking cessation programs based on smokers' stages of change.

**Keywords:** Risk perception, Lung cancer, Conceptual model, Smoking, High readiness, Older smoker

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## Background

Recent estimates show that almost one-third of the world population smokes [1]. Smoking imposes a significant economic burden on the health system and society as a whole [2]. Besides, the largest proportion of cancer death is related to lung cancer [2]. According to the results of a review article by Moosazadeh et al., one-fifth of Iranian men and around 2–3% of women smoke on an everyday basis and this pattern even increases significantly after the age of 30 [3]. It is estimated that 55% of lung cancer deaths in women and over 70% of lung cancer deaths in men are due to smoking [1].

The second most common cancer in both men and women is lung cancer which is one of the deadliest cancer types around the world [4]. There have been advances in lung cancer treatment in the past decades; however, the 5-year survival rate (2009–2015) remains very low at only 19.4% [5]. Lung cancer is the leading cause of cancer death globally [6]. Active cigarette smoking is the main cause of lung cancer [7, 8]. People who smoke cigarettes are 15 to 30 times more likely to develop lung cancer or die from lung cancer [9]. Medical research has confirmed that smoking leads to lung cancer [7] and tobacco use is the leading cause of lung cancer [1]. Inconsistent with tobacco control, numerous activities performed at the local, national, and international levels are emphasizing behavior change by using health communication strategies and behavior change theories [10]. Effective risk communication depends on presenting general risk factors and preventive information, and also on factors that are specific to the individual [10]. Behavior models such as the Health Belief Model and Self-Regulation Model, have been used to investigate how smokers perceive the risk of lung cancer [11]. There are also studies such as the study conducted by Chen et al. that postulates emotion-based (or parallel processing) theories that discuss pathways shaping risk perceptions [12].

### Extended parallel process model

One of the fear appeal theories is the Extended Parallel Process Model (EPPM), which incorporates effective processes (i.e., fear) in risk communication [13]. This study is designed to apply EPPM in evaluating the risk of acceptance in the context of personalized risk communication and effects of the intervention on intention to quit among smokers [13]. Kim Witte explains what leads to danger control versus fear control [13]. Then, she identified the underlying mechanisms occurring in each process [11]. Prior cancer-related studies have examined the EPPM in relation to smoking cessation [14, 15], mammography [16], and skin cancer screening [17].

The proposed model of the study postulates that when an individual is conferred with a fear-arousing message,

two cognitive appraisal processes will begin: (a) threat appraisal and (b) efficacy appraisal. In the threat appraisal, the individual examines two characteristics of the perceived threat which are severity and susceptibility. Severity appraisals entail finding out how much harm can be caused by the threat (e.g., ‘Lung Cancer can kill me.’), while susceptibility appraisal is about the estimation of possibility of the threat is affecting the individual (e.g., ‘Because I am a smoker, I will develop lung cancer in my lifetime.’). If the perceived threat is considered to be, low, it is unlikely that the individual will process the message any further. However, if the perceived threat is high, the individual will enter the efficacy appraisal phase.

In response, the efficacy of the individual determines how much the recommended behavior is effective in avoiding the threat. (‘Quitting smoking can lower my chance of developing lung cancer.’). In self-efficacy, the individuals evaluate their capability to achieve the recommended behavior (‘I think I am capable to stop smoking.’). When both threat and efficacy appraisals are high, the individual will enter a cognitive process with the goal of controlling the danger, and therefore, they will engage in adaptive behavior (e.g., taking steps to quit smoking). However, If threat appraisals are high but efficacy is low, the individual will start a cognitive process to control the fear rather than the danger itself. This process will lead to dysfunctional reactions such as defensive avoidance (e.g., ‘I will not think about that!’) [18].

### Lung cancer risk perception

One of the factors that affect decision-making based on the risk perception, is an individual’s frame of reference developed over a lifetime [19, 20]. Other researchers have used the EPPM in relation to various cancerous diseases such as breast cancer [21–24], skin cancer [25, 26], and colorectal cancer [18, 27, 28].

For instance, findings of the study conducted by Birmingham et al. provided support of the utility of Extended Parallel Process Model to motivate colorectal cancer screening in persons at increased risk [18]. Results of the literature review identified that there is no study (if any) to determine the effectiveness of EPPM to evaluate the risk perception of lung cancer among smokers. Therefore this study aimed to apply EPPM in evaluating the perception of the smokers about their lifetime chance of developing lung cancer and their perception about lung cancer survival.

## Methods

### Participants and procedure

This project is a cross-sectional study with a survey as a collection tool and a sample size of 215 individuals between April 2019–July 2019 in Tabriz, Iran. Participants

were smokers age 45 or older who had smoked at least 1 pack per day (or more) in the past 5 years. Interviewers read the questions to the participants and their responses were collected by the interviewers. The survey questions were adapted from validated surveys (English) to determine the effectiveness of the EPPM model in evaluating smokers' perception of lung cancer risk [18, 29–31]. This process was performed after the forward-backward translation of the survey and checking for their reliability and validity, and cultural adaptation of the questionnaire. The final survey (Farsi) was distributed among eligible participants in locations such as parks, bus stations, retirement houses, senior health organizations, Clinic of pulmonary disease in Imam Reza hospital, and Razi hospital in Tabriz city. Iran's National Elite Foundation, Center For International Science and Technology Cooperation (CISTC) approved the initial proposal of this cross-sectional study. All methods were carried out in accordance with relevant guidelines and regulations of Tabriz University of Medical Sciences. The Institutional Review Board (IRB) of this university approved the study and granted the IRB code (IR.TBZMED.REC.1397.955).

#### Study size

A sample size of 138 achieves 95% power to detect a correlation of 0.3 between the main outcomes of the study including lung cancer risk perception and self-efficacy (as found in Birmingham et al., 2015) using a two-sided hypothesis test with a significance level of 0.05. Taking into account, the design effect of the sampling procedure equals 1.5, the final sample size increased to 207 cases [32–34]. Finally, a sample size of 215 participants were recruited for this study.

In the factor analysis, a sample must include at least five subjects per item [35]. Considering a total number of 28 items, a sample size of 140 was required which our sample size of 215 fulfills the minimum requires sample size.

#### EPPM theoretical constructs

- A) Perceived self-efficacy: There are 4 questions designed to measure this variable and are measured in three categories of “yes”, “no”, and “maybe”. These questions are: 1) *I feel that I have little control over the smoking associate risk on my health.* 2) *If I get complications from lung cancer, there is not much that I can do about it.* 3) *My own efforts can help control my risk of developing lung cancer complications.* 4) *If I make good efforts to control lung cancer, I am less likely to get serious complications.*
- B) Perceived response-efficacy: There are 2 questions to measure this variable which are in three

categories of “yes”, “no”, and “maybe” and are asking about the effect of smoking cessation on the likelihood of contracting lung cancer and survival of lung cancer. These questions are: 1) *If I quit smoking, I am less likely to develop lung cancer.* 2) *If I get lung cancer in my lifetime, quitting smoking is effective to prevent complications.*

- C) Perceived susceptibility: There are 3 questions designed to measure this variable. Two of these questions are on the scale of “0” to “10” and one question was about the perceived risk of developing lung cancer in comparison to the individuals of the same age and sex category. These three questions are: 1) *If you continue to smoke, what is your chance of developing lung cancer? Please choose a number from “0” to “10”, with “0” as having zero chance of developing lung cancer and “10” as having a definite chance of lung cancer.* 2) *If you continue smoking, what do you think about your risk of developing lung cancer compared to other people of the same age and sex. Answer choices are 1: “less chance”, 2: “more chance”, and 3: “equal chance”.* 3) *Because I am a smoker, I am more likely to develop lung cancer compared to other people of the same age and sex. Answer choices are “yes”, “no”, and “maybe”.*
- D) Perceived severity: Two questions are designed to measure this variable. One of these questions is on the scale of “0” to “10” and the second question is asking about perceived lung cancer survival in comparison to the individuals of the same age and sex category. These questions are: 1) *If you continue to smoke and develop lung cancer, what is your chance of being alive after 5 years? Please choose a number from “0” to “10”, with “0” as having zero chance of surviving the lung cancer and “10” as having a definite chance of surviving the lung cancer (definite survival).* 2) *Because I am a smoker, I am more likely to have serious lung cancer complications compare to other people of the same age and sex. Answer choices are “yes”, “no”, and “maybe”.*
- E) Perceived fear/threat: There are 2 questions that measure the fear and worry of the participants of developing lung cancer and lung cancer survival. These 2 questions are: 1) *Because I am a smoker, I am very concerned to develop lung cancer.* 2) *Because I am a smoker, I am very concerned to have serious lung cancer complications.*

#### Measures

Levels of cigarette consumption, such as the number of cigarettes smoked per day, the number of days smoked per month, and the amount of lifetime cigarette use has

been used differently by researchers around the world to define smoking status [36]. The risk of lung cancer drops substantially (39.1%) among those who were heavy smokers in the past and who had a history of quitting compared to current smokers, and this lower risk was detectable within 5 years of quitting [37]. Therefore, in our study, smokers are defined as individuals who smoked at least 1 pack per day in the past 5 years. The definition of “heavy smoker” is varied in the literature. However, based on most definitions smoking more than 1 pack per day is considered “heavy smoking” [38]. We recruited heavy smokers to obtain more understanding of their perception about the effects of smoking on lung cancer; considering the fact that smoking is the major preventable risk factor for lung cancer advertised in public health education programs for smoking cessation. Most of the diagnosed cases of lung cancer are 65 or older and only a very small number of people are diagnosed with lung cancer younger than the age of 45 [39]. This means the chance of developing lung cancer under the age of 45 is very small [40]. Therefore, in this study the age 45 and over, has been chosen as age inclusion criteria.

In this process, the data collection tool was designed using validated questionnaires both in Persian and English language, and it was contained questions on the perception of getting lung cancer and its survival, and questions based on the constructs in the EPPM model. Highly experienced lung cancer and health education experts (10 individuals) reviewed the final Persian version of the questionnaire and confirmed its content and face validity in quantitative and qualitative manners. Their comments were later reviewed by the research team and the necessary modifications were applied [31].

### Background characteristics

Demographic characteristics of the participants have been measured with the checklist designed from the validated surveys found in the literature, with cultural adaptation. These variables include Sex, Ethnicity (Fars, Azeri, Other), Marital status (Engaged, Single, Married, Divorced), Age (years), Education (Middle school, High School, Diploma, Associate degree, Master, Doctorate), Occupation (Farmer, Teacher, Driver, Worker, Office Employee, etc) and Income (<IRR 500,000, IRR 500,00-IRR1000,000, up to >IRR4,000,000). Three variables, 1.Education 2.Occupation 3.Income were used to create a new variable “SES.score” (Score for Socio-Economic Status). In this process, first, each of the variables Education, Occupation, and Income was transformed on a scale of 1–6. For instance, variables “Occupation”, the “Office employee” and “Receptionist” were given the same score, and “University faculty” and “Teacher” were also given the same score (value, here). Finally, a

combination of these scores for three variables (Education, Occupation, and Income) was used to create a variable of SES and then the “SES.level” was categorized on the scale of 1–3 (Low, Medium, and High).

There were two groups of constructs in the Structural Equation Modelling (SEM) [1]: EPPM constructs (Perceived self-efficacy, Perceived response-efficacy, Perceived susceptibility, Perceived severity, Perceived fear/threat), and [2] Main outcome measures (Readiness to quit, High\_Readiness and Low\_Readiness). An initial conceptual framework was developed for this study based on the original EPPM model explained by Kim Witte and another model is discussed in the article by Birmingham et al. [18]. This model and the relationship between the constructs have been shown in Fig. 1:

Two constructs of the EPPM (Perceived susceptibility, and Perceived severity) have been used as the measure for lung cancer risk perception. Lung cancer risk perception was first measured in two separate categories. The first category measures “Perceived susceptibility” and is on a scale of “0” to “10”. The next variable is measuring “Perceived severity” and is also on a scale of “0” to “10” [12]. Based on the conceptual model and our measures of the construct, we add “Perceived\_Susceptibility” latent variable with three indicators, and “Perceived\_Self Efficacy” latent variable with two indicators. Details of these indicators are in Fig. 1.

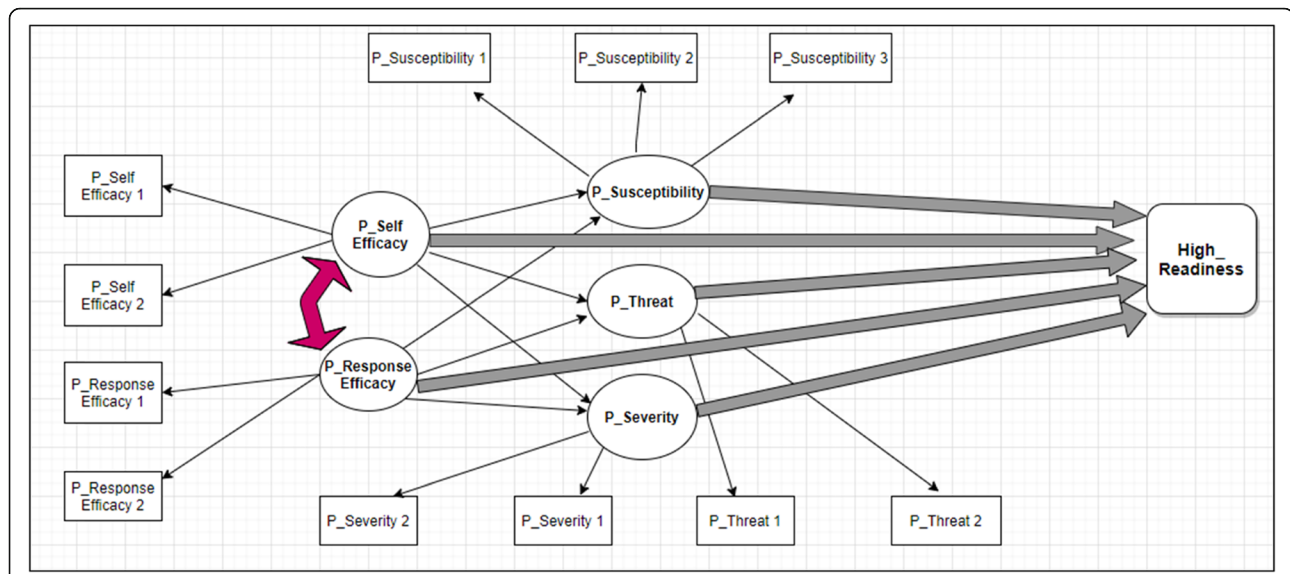
### Main outcome: low and high readiness to quit

When individuals are in the protection motivation process of the EPPM, they have high readiness to quit and when they are in the defensive motivation of the model, they have “low readiness” to quit. Readiness to quit was defined as early and later stages of change, consecutively. The questions that are designed to measure the stages of change are listed below:

### Are you seriously considering quitting smoking within the next 6 months?

1. *Are you planning to quit in the next 30 days?*
2. *If yes, are you currently in the status of quitting smoking?*
3. *If yes, how long have you been in the quitting smoking status?*
4. *What were your reasons for quitting smoking in the past? (Open-ended question)*

The concept of “stage of change” has been widely accepted in the literature and it has commonly been used for behavioral modification in areas such as smoking cessation, dieting, regular exercise, and seatbelt use [41]. Individuals progress through a series of stages in smoking cessation: recognizing the need to change,



**Fig. 1** Initial Conceptual Model. (\*P: Perceived)

contemplating a change, making a change, and finally sustaining the new behavior [42] (Precontemplation, contemplation, preparation, action, and maintenance). The first 3 questions are designed in the categories of “yes”, “no”. For the 4th question, the answer choices are 1) 1 week, 2) 1 week to 1 month, 3) 1 month to 2 months, 4) More than 3 months, and the last question is open-ended. It is possible to determine the stage of change of participants by these questions. The responses to these 3 questions are transformed into new categories to determine the final stage of change of the participants. Individuals who were identified in the stages of “Precontemplation” and “contemplation” was labeled as individuals with “Low\_Readiness” and individuals who were in the stage of “preparation”, “action”, and “maintenance” were labeled as “High\_Readiness”.

### Statistical analysis

Statistical analyses were performed using MPlus (7.4) [43] and SPSS [17] (SPSS Inc., Chicago, IL, USA). To test the fitness of the measurement model and to fit the conceptual EPPM to data, generalized Structural Equation Modeling was used [43]. To investigate the fitness, the goodness of fit indices were calculated. Values smaller than 0.08 for Root Mean Square Error of Approximation (RMSEA), the normed chi2 (chi2 divided by the degrees of freedom) < 5, and values greater than 0.90 for Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) confirmed the fitness of model [35]. We used a 6 step process in the modeling: model specification based on conceptual theoretic model, model identification, model estimation utilizing maximum likelihood method, model testing utilizing the goodness of fit indices and

significance of the parameters, model modification utilizing modification indices, and finally model validation.

## Results

### Recruitment

Approximately 500 individuals were approached to assess their eligibility to be part of this study. From this number, 260 were eligible to enter the study. Some participants didn’t consent after explaining the study goals. This was more common among female participants and their concern about their privacy. Finally, a total number of 215 participants were recruited in this study which 192 (89.7%) were current smokers and 188 (89.1%) had smoked 1 pack per day in the past 5 years (or more than 5 years) but they were in the quitting status at the time of the participation.

### Participants profile

The number of male participants was 185 (86.0%) of 215 participants. Nearly a quarter of the participants ( $n = 55$ ; 25.6%) were from low SES levels, more than half of them belonged to the middle SES levels ( $n = 124$ ; 57.7%) and only 36 individuals (16.7%) had a high SES level. The majority of the participants ( $n = 188$ ; 87.4%) were married or engaged. About 20% of the respondents were in the age category of 51–55 and nearly half of the respondents were above age 55 (46.6%). For more information about the demographic characteristics of the participants, please refer to Table 1.

### Smoking history and quitting intention

Years of smoked among participants had a minimum-maximum of 1–68 years with a mean of 30.8 (SD = 13.1).

**Table 1** Demographic characteristics and SES level of participants

	Frequency	Valid Percent (%)
<i>SES Level</i>		
Low	55	25.6
Medium	124	57.7
High	36	16.7
<i>Marital Status</i>		
Single	8	3.7
Married-Engaged	188	87.4
Divorced	7	3.3
Widow	12	5.6
<i>Age</i>		
45–50 years	72	33.5
51–55 years	43	20.0
56–60 years	38	17.7
61–65 years	29	13.5
66–70 years	10	4.7
71–75 years	14	6.5
> 75 years	9	4.2
<i>Education</i>		
Illiterate	21	9.8
End of Elementary school	51	23.7
End of Middle school	46	21.4
End of High school	42	19.5
End of Associate degree	37	17.2
End of Bachelor's degree	15	7.0
End of Master's degree	1	0.5
Ph.d. and more	2	0.9
<i>Occupation</i>		
Farmer	12	5.6
Factory worker	9	4.2
Receptionist	1	0.5
Teacher	5	2.3
University faculty	3	1.4
Driver	49	22.8
Office employee	81	37.7
Home keeper	21	9.8
Other	34	15.8
<i>Recruitment Location</i>		
Parks	45	20.9
Bus stations	29	13.4
Retirement houses	24	11.1
Senior organizations	18	8.3
Imam Reza hospital	25	11.6
Razi hospital	50	23.2
Other	24	11.1

Most of the participants (199) had a smoking history of 1–2 packs per day and only 16 of them smoked 2–4 packs per day. Participants with quitting attempts in the past identified their reasons to quit as 1) Diagnosis of chronic disease (e.g. heart), 2) Maintaining overall health, 3) Respecting family members or non-smokers, 4) Cigarettes' bad smell and 5) Reducing financial burden of cigarettes. This group also believed that their past quitting failures were caused by 1) Lack of motivation and entertainment, 2) Financial, work, and family problems, 3) Influence of smoker friends/partner and 4) Stress and anxiety. Participants' readiness to quit is measured as having low and high readiness to quit. Of 215 participants, 147 individuals (68.37%) were in the group of Low\_Readiness and 68 of them (31.62%) were in the group of High\_Readiness.

### Results of structural equation modeling for EPPM constructs

The bivariate associations among EPPM concepts are not relevant, also because these concepts are seen as theoretically distinct concepts. Theoretically, some correlation is expected but the EPPM is based on the assumption that its concepts are independently associated with intention/readiness. We fit a model with all demographic variables that have a path to "High Readiness", but since there was no significant relationship between the demographic variable and "High Readiness", therefore, in the next step we removed these variables from the model for model parsimony. The strongest associations with readiness are expected for efficacy perceptions over and beyond threat perceptions. The full model fitted the data well after some modifications;  $\chi^2(60) = 64.67$ ,  $P = 0.317$ ,  $> 0.05$ ,  $\chi^2/df = 1.08 < 5$ ,  $TLI = 0.954 > 0.9$ ,  $CFI = 0.964$ ,  $> 0.9$ ,  $RMSEA = 0.019 < .08$ , (90% CI = (0.001 to 0.047)). In fact, the model exactly fits the original EPPM conceptual model which is introduced in the introduction section. In addition, all the relationships between the items and the scales were significant ( $P < 0.05$ ). This applied to all the scales: Perceived\_Susceptibility, Perceived\_Severity, Perceived\_Self Efficacy, Perceived\_Response Efficacy, and Perceived\_Threat. For more information please refer to Table 2.

Findings showed a significant relationship between the Perceived\_Susceptibility and P\_Response Efficacy; between P\_Susceptibility and P\_Self Efficacy, P\_Severity, and P\_Response Efficacy; between P\_Severity and P\_Self Efficacy. There was also a significant relationship between P\_Threat and P\_Response Efficacy; between P\_Threat and P\_Self Efficacy. The relationship between High\_Readiness and P\_Self Efficacy, between High\_Readiness and P\_Severity; High\_Readiness and P\_Response Efficacy also was significant. The relationship between P\_Response Efficacy and P\_Self Efficacy also was

**Table 2** EPPM STANDARDIZED MODEL PARAMETERS

	B (SE)	P-Value
<b><sup>a</sup>P_Susceptibility BY</b>		
P_Susceptibility1	26.010 (SE: 3.295)	< 0.000
P_Susceptibility2	3.285 (SE: 1.541)	0.033
P_Susceptibility3	33.869 (SE: 5.373)	0.000
<b>P_Self Efficacy BY</b>		
P_Self Efficacy1	18.725 (SE: 5.468)	0.001
P_Self Efficacy 2	19.095 (SE: 4.696)	< 0.001
<b>P_Response Efficacy BY</b>		
P_Response Efficacy 1	30.343 (SE: 4.198)	< 0.001
P_Response Efficacy 2	21.076 (SE: 4.113)	< 0.001
<b>P_SEVerity BY</b>		
P_Severity1	0.760 (SE: 0.213)	< 0.001
P_Severity2	28.205 (SE:3.623)	< 0.001
<b>P_Threat BY</b>		
P_Threat 1	35.349 (SE: 8.800)	< 0.001
P_Threat 2	22.136 (SE: 5.721)	< 0.001
<b>P_SUSceptibility ON</b>		
P_Response Efficacy	1.167 (SE: 0.150)	< 0.001
P_Self Efficacy	-0.935 (SE: 0.170)	< 0.001
<b>P_Severity ON</b>		
P_Response Efficacy	1.076 (SE: 0.097)	< 0.001
P_Self Efficacy	-0.783 (SE: 0.107)	< 0.001
<b>P_Threat ON</b>		
P_Response Efficacy	0.858 (SE: 0.146)	< 0.001
P_Self Efficacy	-0.484 (SE: 0.106)	< 0.001
<b>HIGH_Readiness ON</b>		
P_Threat	-0.243 (SE: 0.321)	0.451
P_Self Efficacy	-22.228 (SE: 3.973)	0.000
P_Susceptibility	0.509 (SE: 0.501)	0.310
P_Severity	-28.240 (SE: 3.655)	< 0.001
P_Response Efficacy	30.343 (SE: 4.198)	< 0.001
<b>P_Response Efficacy WITH</b>		
P_Self Efficacy	0.458 (SE: 0.101)	< 0.001

<sup>a</sup>P Perceived

significant (All  $P < 0.05$ ). However, the relationships between High\_Readiness and P\_Threat; and High\_Readiness and P\_Susceptibility were not significant (Both  $P > 0.05$ ). For more information, please refer to Fig. 2.

## Discussion

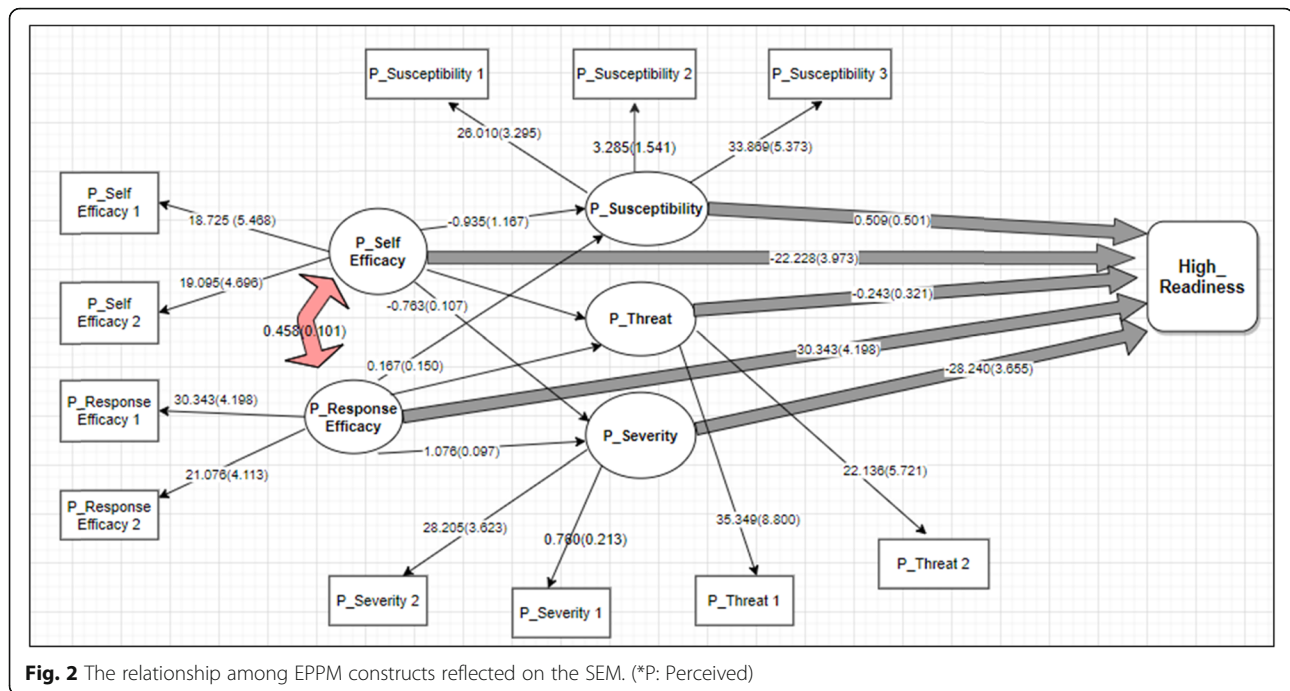
The present study examines the EPPM in which an additive relationship exists between perceived severity and susceptibility (i.e., threat) and between perceived response and self-efficacy to quit (i.e., efficacy) to determine the model's predictive validity regarding the

model's effectiveness on readiness to quit smoking and lung cancer risk perception. Risk communication is about creating and promoting awareness of cancer-related health risks. The EPPM contains both of these components and has been effectively used in various health topics in the past [44] but has not been examined in the context of lung cancer risk perception and intention to quit. Although the relationship between risk perception and health behavior, in general, has extensively been researched; the association between lung cancer risk perception and readiness to quit is unclear [45].

Studies have suggested causal relationships between lung cancer risk perception and cigarette-smoking behaviors in different directions (positive, negative, and not significant) [46, 47]. Moreover, instead of causality relations, some studies have simply reported a positive correlation between lung cancer risk perception and smoking behaviors [48, 49], whereas other studies have reported different associations [50, 51]. Perceived lung cancer risk influences people to take action to lower their risk of getting lung cancer [52]. Intention to quit smoking has been chosen as a behavior change that can reduce smoker's chance to contract lung cancer [53]. Stopping smoking at any age could lead to decreasing the risk of lung cancer [7]. The results of a study conducted by Ziebarth show that smokers who self-report that they do not plan to quit, are significantly more likely to underestimate their lifetime risk of developing lung cancer [54, 55].

## Perceived susceptibility

This study showed a significant relationship between Perceived\_Susceptibility and both Perceived\_Response Efficacy, and PerceivedSelf Efficacy. The significant relationship between Perceived\_Susceptibility and Perceived\_Response Efficacy indicated that individuals who view themselves at higher risk of developing lung cancer, also believe that quitting smoking can lower this risk (Perceived\_Response Efficacy). Moreover, the majority of the participants viewed themselves as capable of quitting smoking (Perceived\_Response Efficacy). Most of the participants (199) smoked 1–2 packs per day and only 16 of them smoked 2–4 packs per day (heavy smokers). It is discussed by many researchers that heavy smokers are more likely to underestimate their true risk of developing lung cancer [55, 56]. Therefore, we can assume that most of our participants (non-heavy smokers) had a higher perception of their lung cancer risk. However, we can't make any assumptions about their intention to quit and their quitting process which is similar to the finding of the study conducted by Poggiolini et al., that even self-efficacy has desirable effects, but that might also



serve as a justification to continue smoking instead of stopping smoking [57].

### Perceived severity

There was also a significant relationship between Perceived\_Severity and both Perceived\_Response Efficacy, and Perceived\_Self Efficacy. The relationship between Perceived\_Severity and Perceived\_Response Efficacy indicated that individuals who think they will have low lung cancer survival, also positively believed that quitting smoking can improve this outcome. In addition, when the perceived severity is high, it has a positive effect on perceived self-efficacy. This means that even if they are aware of the long-term consequences of smoking, they also view themselves as capable of quitting smoking. Such results give us valuable information about the likelihood of our population participating in smoking cessation programs. We may presume that they might have never had any chance to participate in such educational programs. Self-efficacy is usually associated with self-control and self-regulation, which is extremely critical in adapting the target behavior [18]. Smokers who are not in the status to quit smoking (low readiness to quit) are considerably more inclined to underestimate this mortality risk [54] which is similar to our results that there was a significant correlation between Perceived\_Severity and Perceived\_Self Efficacy. Another explanation for this finding is based on the cognitive dissonance theory [58]. Because it is not easy to quit smoking, most smokers (in our population, people with low readiness to quit) decide to change their beliefs rather than their behaviors.

In this status, they underestimate the health risks of smoking and they focus more on positive aspects of smoking (e.g., increasing concentration).

### Perceived threat

The next significant relationship was between Perceived\_Threat and both Perceived\_Response Efficacy and Perceived\_Self Efficacy. When both threat and efficacy appraisals are high, the individual will enter a cognitive process to control the danger rather than the fear. In this stage, people are more likely to engage in adaptive behavior which is taking actual steps such as quitting smoking [59, 60]. Therefore, we could suggest that educational programs for smoking cessation in a similar population could be more focused on increasing the Perceived\_Threat of the disease. This also could be explained by cognitive dissonance theory. Smokers who feel distressed by knowing the long-term health risks of smoking and also are capable of taking actual steps to quit, in fact, are lowering their dissonance by changing their behavior [58].

### High readiness

However, the relationships between the High\_Readiness with two EPPM theoretical variables (Perceived\_Threat, and Perceived\_Susceptibility) were not significant. Wong and Cappella have concluded in their study that Perceived\_Threat is more important for smokers with Low\_Readiness, whereas efficacy is most important among smokers with High\_Readiness [14]. This is also in line with our results that there was no significant association



between Perceived\_Threat and intention to quit among smokers with High\_Readiness. It could be explained that smokers' high readiness to quit is not necessarily related to their higher Perceived\_Threat or Perceived\_Susceptibility of lung cancer. In other words, their high intention to quit is not an indicator that they view themselves at a higher risk of developing lung cancer. Based on our final results, it may be they are more inclined to quit, because of other factors such as other chronic diseases (e.g. heart disease, diabetes, Chronic Obstructive Pulmonary Disease, etc.), respecting family members or partner's request to quit, cigarette's bad smell, and reducing the financial burden of smoking.

The limitations of this study must be acknowledged. Recruiting female smokers was challenging because this topic is sensitive among female participants in Iranian culture. Another limitation was the unbalanced sample size in the subgroups which may make the statistical tests underpowered and therefore, the results of the study could be nonsignificant. The lack of a control group to compare the perceived risk between smokers and non-smokers, gathering responses through a self-report system, and the cross-sectional nature of this study could be other limitations of the present study. Finally, their consistent findings in the literature about the relationship between lung cancer risk perception and smoking behaviors (e.g., readiness to quit) could impact interpretation of our results. Designing future longitudinal studies to further investigate this association in our population is suggested.

## Conclusion

Both threat and efficacy were important for smokers with low readiness to quit, whereas efficacy was most important among smokers with high readiness to quit. Our findings provided practical support for the utility of the Extended Parallel Process Model in designing effective educational programs to promote lung cancer awareness. The study findings could be extremely helpful in developing public health interventions to quit smoking based on smokers' stage of change and readiness to quit.

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## Authors' contributions

FZ: Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing - Original draft preparation, Writing - review and editing, Visualization, Project administration, Funding acquisition. HA: Conceptualization, Methodology, Writing - review, and editing. MAJ:

Conceptualization, Methodology, Software, Validation, Formal analysis, Resources, Data curation, Writing - Original draft preparation, Writing - review and editing, Visualization, Supervision. The author(s) read and approved the final manuscript.

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## Availability of data and materials

The datasets used and analyzed for this current study are available from the first author and/or the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

Institutional Review Board (IRB) of Tabriz University of Medical Sciences approved the study and granted the IRB code (IR.TBZMED.REC.1397.955). The first page of the survey included the consent statement. Informed consent was obtained from all the participants involved in the study. Informed consent from the Legally authorized representatives/legal guardian of illiterate participants was also involved in this study. All methods were carried out in accordance with relevant guidelines and regulations of Tabriz University of Medical Sciences.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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