BMC Cancer

RESEARCH Open Access

Hybrid multi-criteria decision-making model for assessing perceived significance of 23 potentially modifiable cancer risk factors among senior nursing officers

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Abstract

Background Potentially modifiable cancer risk factors have been increasingly recognized among the Chinese population. In this study, we aimed to investigate the perceived significance of these risk factors among senior nursing officers, who play a crucial role in providing healthcare services. We also sought to determine senior nursing officers' performance in reducing these risk factors.

Methods A questionnaire survey regarding 23 potentially modifiable cancer risk factors was conducted in November 2023 with 58 senior nursing officers at Taizhou Hospital in Zhejiang Province, China. The consistent fuzzy preference relation method and importance–performance analysis were used to determine the attribute weights and performance levels.

Results The senior nursing officers considered diabetes, ultraviolet radiation exposure, $PM_{2.5}$ exposure, excess body weight, physical inactivity, alcohol consumption and secondhand smoking significant. However, performance in reducing secondhand smoking, physical inactivity, excess body weight, $PM_{2.5}$ exposure, and ultraviolet radiation exposure required improvement.

Conclusions The proposed hybrid multiple-criteria decision-making model enhances our understanding of the perceived significance of 23 modifiable cancer risk factors and performance in reducing them, which could facilitate improvements in health education efforts.

Keywords Nursing, Cancer prevention, China, Education

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Background

Cancer prevention has long been a prominent field within the research community, as it involves the examination of lifestyle choices, genetic predispositions, and environmental factors that contribute to the development of various types of cancer [1, 2]. Chen et al. published a comprehensive risk assessment focused on the Chinese population and utilized cancer death data from 31 provinces in China [3]; they successfully identified 23 potentially modifiable risk factors for cancer, including those related to lifestyle and the surrounding environment. Among the numerous approaches and strategies used for cancer prevention, health education has consistently demonstrated effectiveness, as supported by a wealth of evidence [4–6]. Health education plays a crucial role in integrated care [7, 8] and is essential for both healthy individuals and cancer survivors [9, 10]. Nurses, at the forefront of patient care, play a critical role in delivering health education to patients and the general public. However, while nurses' knowledge of cancer risk factors is essential for effective education, their personal perceptions may not always translate into self-care practices [11]. Nevertheless, nurses' perceptions can significantly influence the knowledge and attitudes of patients and the general public regarding cancer prevention. Therefore, ensuring that nurses possess adequate knowledge and training in cancer prevention is crucial for maximizing the effectiveness of health education initiatives and ultimately improving cancer prevention outcomes [12].

Despite the crucial role of nurses and senior nursing officers (SNOs) in promoting cancer prevention, research exploring their knowledge and understanding of modifiable cancer risk factors remains limited. In the Chinese healthcare system, SNOs are responsible for the management of clinical care, teaching, scientific research, and continuing medical education in the departments to which they belong. They bear the primary responsibility for ensuring nursing quality and safety management and continuous improvement of the department. Typically, each department has only one SNO. While SNOs do not directly deliver patient health education, their knowledge and perceptions of cancer risk factors play an important role in shaping hospitals' overall cancer prevention efforts. In this study, we address a critical gap in the literature by investigating SNOs' current understanding regarding 23 potentially modifiable cancer risk factors identified by Chen et al. [3]. Specifically, we aim to (1) determine the perceived significance (i.e., weight) of each dimension and criterion related to these risk factors and (2) evaluate SNOs' cancer prevention performance by assessing their efforts to reduce these risk factors. Unlike Chen et al. [3], who presented a list of 23 risk factors, we employ a multi-criteria decision-making (MCDM) model utilizing a consistent fuzzy preference relation (CFPR) method and importance–performance analysis (IPA) to provide a more comprehensive understanding of SNOs' knowledge and practices related to cancer prevention.

Methods

Study design

We aimed to create an MCDM model for hospital implementation. A questionnaire was designed based on Chen et al. [3]. Dimensions and criteria for perceived significance were developed using the CFPR method (see supplementary material for English version). The intended application of this model is to evaluate the perceived significance of the 23 cancer risk factors among SNOs and improve future health education.

Participants

The participants were 58 conveniently sampled SNOs from Zhejiang Taizhou Hospital.

Potentially modifiable cancer risk factors

Chen et al. provided a comprehensive systematic analysis of the site-specific cancer burden in 31 Chinese provinces, focusing on 23 potentially modifiable risk factors [3]. According to their findings, the implementation of preventive measures could prevent over one million annual cancer-related deaths. They focused on five dimensions: behavioral factors (C_1), dietary factors (C_2), metabolic factors (C_3), environmental factors (C_4), and infectious agents (C_5) (Table 1). Detailed descriptions can be found elsewhere [3]. This analysis considers the influence of both personal and environmental factors on cancer risk.

CFPR method

The analytic hierarchy process (AHP) is a widely employed decision model used to determine the weights of criteria, indicating their relative significance. To conduct pairwise comparisons for n criteria in the AHP, n(n-1)/2 comparisons must be made [13]. However, inconsistencies have been identified in the pairwise comparisons made using the AHP [13, 14]. The CFPR method was developed to address this issue and reduce the time required for comparison. The CFPR method requires significantly fewer pairwise comparisons than the AHP, only n-1 [15]. This method allows decision makers to express their preferences for a set of attributes or alternatives while avoiding the need to check for inconsistency in the decision-making process [16]. CFPR and the AHP provide similar results; however, as the number of criteria increases, the traditional AHP may encounter problems with questionnaire consistency [17]. Considering the number of items in our questionnaire, CFPR was the preferable method. CFPR has been applied in various fields, including human resources [18] and hazard

Table 1 Modifiable cancer risk factors based on Chen et al. [3]

	Risk factors
C_1 Behavioral factors	C_{11} Smoking
	C_{12} Secondhand smoking
	C_{13} Alcohol drinking
	C_{14} Physical inactivity
C_2 Dietary factors	C_{21} Low fruit intake
	C_{22} Low vegetable intake
	C_{23} Low dietary fiber consumption
	C_{24} Low dietary calcium consumption
	C_{25} Red meat consumption
	C_{26} Processed meat consumption
	C_{27} Salt-preserved vegetable consumption
C_3 Metabolic factors	C_{31} Excess body weight
	C_{32} Diabetes
C_4 Environmental factors	C_{41} $PM_{2.5}$
	C_{42} Ultraviolet radiation
C_5 Infectious agents	C_{51} Helicobacter pylori
	C_{52} Hepatitis B virus
	C_{53} Hepatitis C virus
	C_{54} Human immunodeficiency virus
	C_{55} Human papillomavirus
	C_{56} Epstein–Barr virus
	C_{57} Clonorchis sinensis
	C_{58} Human herpes virus type 8

Note The risk factors were derived from Chen et al.'s [3] study

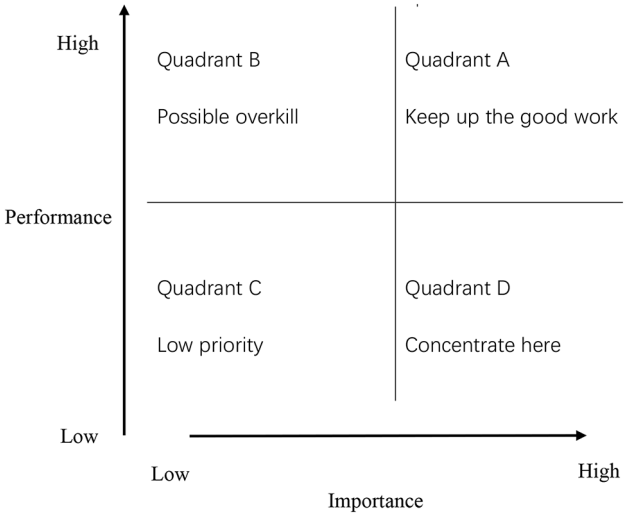

Fig. 1 Importance–performance analysis for the four-quadrant chart

assessment [19]. We calculated the confidence level of weights based on the following formula:

$$\frac{1}{n}\sum_{i=1}^{n}\frac{|w_i^{58}-w_i^{58-1}|}{w_i^{58}}\times 100\%$$

IPA method

The IPA method, introduced in 1977 in the business field [20] (Fig. 1), is commonly utilized in the assessment of service quality [21] and identification of key factors within fields such as marketing [22, 23]. IPA is also widely employed in healthcare settings to assess service quality [24] and job satisfaction [25]. The IPA method is structured and rigorous; its use across disciplines also indicates its adaptability and robustness. Compared to other qualitative methods, IPA is simple and useful, and it clearly shows the items that need the most improvement [26]. As for the procedures, participants are tasked with ranking attributes based on their levels of importance and performance. These rankings are subsequently mapped onto a two-dimensional plane, where the intersection point represents the average value of importance and performance. The plane is divided into four quadrants. In our study, Quadrant A consisted of criteria that trainee nurses perceived as important with good performance, suggesting the need for continued improvement in these areas. Quadrant B consisted of criteria that trainee nurses perceived as unimportant with good performance, indicating the need to maintain the current state. Quadrant C encompassed criteria perceived as unimportant with poor performance, highlighting the need for future improvement. Finally, Quadrant D included criteria perceived as important with poor performance, emphasizing the need for dedicated attention and improvement.

Data collection

The participants completed a questionnaire in November 2023, which comprised three sections: (1) assessing the relative significance of the 23 criteria, (2) self-assessment of performance in reducing cancer risk factors, and (3) demographic information. The participant characteristics are presented in Table 2.

Results

Perceived significance

Table 3 presents the perceived significance of 23 cancer risk factors. Among the dimensions considered, infectious agents (C_5) was the most important, with an average weight level of 0.240, followed by behavioral factors (C_1) and metabolic factors (C_3). Environmental factors (C_4) was the least influential dimension. Diabetes (C_{32}) had the highest average global weight of 0.142, whereas low fruit intake (C_{21}) had the lowest average global weight of 0.015.

Performance in reducing cancer risk factors among SNOs

Table 4 and Fig. 2 presented the outcomes of the IPA for the performance of reducing cancer risk factors. Quadrant A encompassed risk factors such as

Table 2 Senior nursing officers' characteristics

	n (%)
Gender	
Men	0
Women	58 (100)
Education	
Bachelor's degree	52 (89.7)
Master's degree	6 (10.3)
Age (years)	
≤ 40	32 (55.2)
≥ 41	26 (44.8)
Professional title	
Nursing director	18 (31.0)
Deputy nursing director	33 (57.0)
Assistant nursing director	1 (1.7)
Reserve officer	6 (10.3)
Nursing management experience (years)	
< 5	22 (37.9)
5–9	14 (24.2)
≥ 10	22 (37.9)

alcohol consumption (C_{13}) and diabetes (C_{32}). Quadrant B included risk factors such as smoking (C_{11}), Hepatitis B virus (C_{52}), Hepatitis C virus (C_{53}), human immunodeficiency virus (C_{54}), human papillomavirus (C_{55}), Epstein–Barr virus (C_{56}), Clonorchis sinensis (C_{57}), and Human herpes virus type 8 (C_{58}). Quadrant C comprised risk factors such as low fruit intake (C_{21}), low vegetable intake (C_{22}), low dietary fiber consumption (C_{23}), low dietary calcium consumption (C_{24}), red meat consumption (C_{25}), processed meat consumption (C_{26}), salt-preserved vegetable consumption (C_{27}), and Helicobacter pylori (C_{51}). Quadrant D encompassed risk factors such as secondhand smoke (C_{12}), physical inactivity (C_{14}), excess body weight (C_{31}), $PM_{2.5}$ exposure (C_{41}), and ultraviolet radiation (C_{42}).

Discussion

The results indicated that diabetes, ultraviolet radiation exposure, $PM_{2.5}$ exposure, excess body weight, physical inactivity, alcohol consumption and secondhand smoking were considered significant by the participants. Moreover, secondhand smoking, physical inactivity, excess body weight, $PM_{2.5}$ exposure, and ultraviolet radiation required the most caution among participants.

The participants' perceptions indicated that infectious agents were considered the most important dimension. This finding is consistent that of Chen et al. [3], who found that the proportion of cancer deaths attributable to infectious agents was the highest across all age groups in women. As all participants in our study were women, it is understandable that they were concerned about infectious agents. The second most important dimension identified by the participants was behavioral factors,

Table 3 Perceived significance of cancer risk factors

	Local weight	Ranking	Criteria	Local weight	Ranking	Global weight	Ranking
C_1	0.224	2	C_{11}	0.209	4	0.047	9
			C_{12}	0.251	3	0.056	7
			C_{13}	0.264	2	0.059	6
			C_{14}	0.277	1	0.062	5
C_2	0.180	4	C_{21}	0.068	7	0.015	23
			C_{22}	0.134	4	0.030	15
			C_{23}	0.133	5	0.030	16
			C_{24}	0.120	6	0.027	20
			C_{25}	0.150	3	0.034	12
			C_{26}	0.185	2	0.042	11
			C_{27}	0.211	1	0.047	8
C_3	0.190	3	C_{31}	0.365	2	0.082	4
			C_{32}	0.635	1	0.142	1
C_4	0.167	5	C_{41}	0.410	2	0.092	3
			C_{42}	0.590	1	0.132	2
C_5	0.240	1	C_{51}	0.204	1	0.046	10
			C_{52}	0.100	7	0.023	21
			C_{53}	0.098	8	0.022	22
			C_{54}	0.131	4	0.029	17
			C_{55}	0.128	6	0.029	19
			C_{56}	0.129	5	0.029	18
			C_{57}	0.136	3	0.030	14
			C_{58}	0.146	2	0.033	13

Note: The confidence level of weights is $\frac{1}{n}\sum_{i=1}^{n}\frac{|w_i^{58}-w_i^{58-1}|}{w_i^{58}} \times 100\% = 0.3\%$ <5%, i.e., significance confidence is 99.7%

Table 4 Performance results for reducing cancer risk factors

Criteria	Risk factor	Importance	Performance	Quadrant
C_{11}	Smoking	0.209	4.759	B
C_{12}	Secondhand smoking	0.251	3.759	D
C_{13}	Alcohol drinking	0.264	4.362	A
C_{14}	Physical inactivity	0.277	3.172	D
C_{21}	Low fruit intake	0.068	3.690	C
C_{22}	Low vegetable intake	0.134	3.983	C
C_{23}	Low dietary fiber consumption	0.133	3.810	C
C_{24}	Low dietary calcium consumption	0.120	3.345	C
C_{25}	Red meat consumption	0.150	3.310	C
C_{26}	Processed meat consumption	0.185	3.517	C
C_{27}	Salt-preserved vegetable consumption	0.211	3.672	C
C_{31}	Excess body weight	0.365	3.621	D
C_{32}	Diabetes	0.635	4.397	A
C_{41}	$PM_{2.5}$	0.410	3.672	D
C_{42}	Ultraviolet radiation	0.590	3.672	D
C_{51}	Helicobacter pylori	0.204	3.741	C
C_{52}	Hepatitis B virus	0.100	4.466	B
C_{53}	Hepatitis C virus	0.098	4.535	B
C_{54}	Human immunodeficiency virus	0.131	4.655	B
C_{55}	Human papillomavirus	0.128	4.310	B
C_{56}	Epstein–Barr virus	0.129	4.397	B
C_{57}	Clonorchis sinensis	0.136	4.466	B
C_{58}	Human herpes virus type 8	0.146	4.362	B

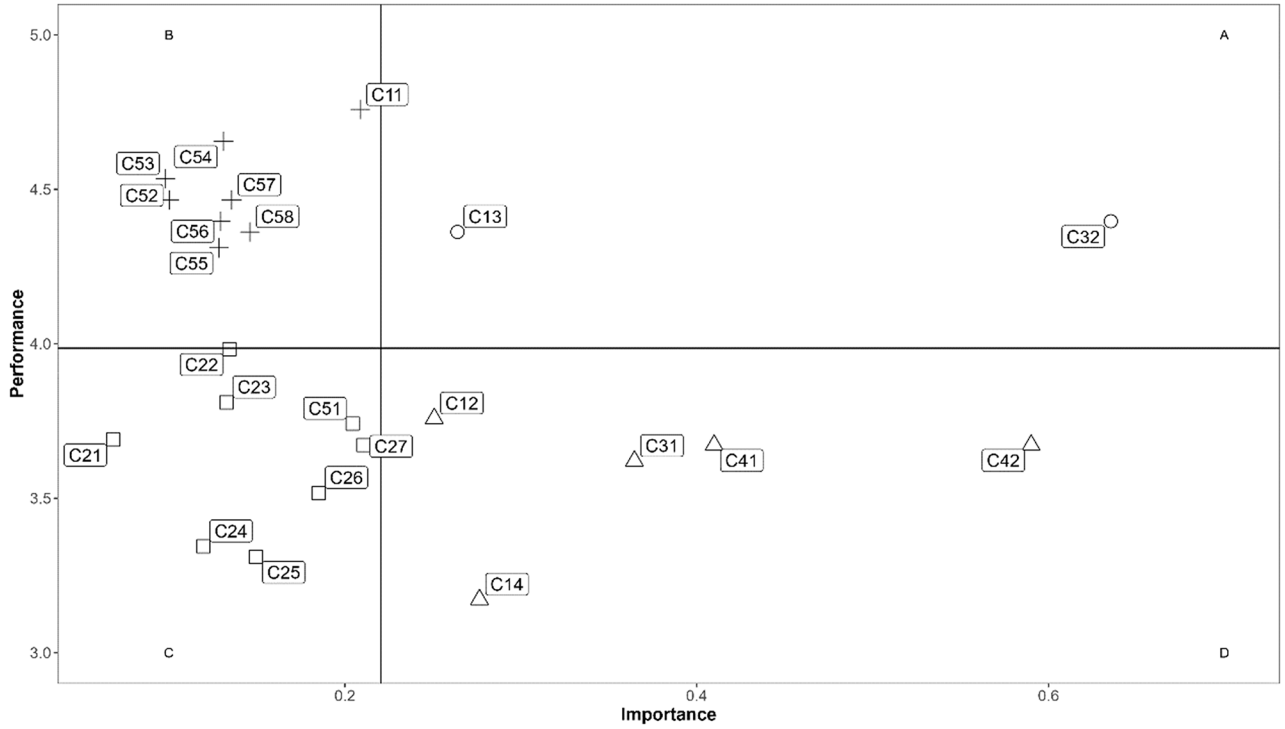

Fig. 2 Quadrant diagram analysis of performance for reducing cancer risk factors

including smoking, alcohol consumption, and physical inactivity. These three factors are among the four target behaviors recommended by the World Health Organization for reducing the prevalence of non-communicable diseases [27]. Furthermore, the participants identified secondhand smoking, alcohol consumption, physical inactivity, excess body weight, diabetes, $PM_{2.5}$ exposure, and ultraviolet radiation as significant. Previous studies have demonstrated that healthcare workers with healthy behaviors may be better at promoting health behaviors than those without [28, 29]. Therefore, an awareness of these potentially modifiable cancer risk factors is important.

Moreover, our findings indicated that, despite awareness of cancer risk factors, the participants failed to take appropriate actions in some areas, consistent with the findings of a previous study [30]. Our study highlighted the need for decisive improvements in addressing risk factors such as secondhand smoking, physical inactivity, excess body weight, $PM_{2.5}$ exposure, and ultraviolet radiation. The global prevalence of overweight and obesity among nurses has been identified as a significant concern [31]. Moreover, environmental risk factors, such as $PM_{2.5}$ exposure and ultraviolet radiation, for which individuals can employ tools such as air purifiers and sun-proof creams, respectively, should be addressed. Furthermore, the effect of secondhand smoking on global mortality rates is considerable, with a significant proportion of deaths occurring among women (47%) and children (28%) [32].

Strengths and limitations

We used a hybrid MCDM model that employed CFPR and IPA to assess SNOs' perceptions. This model offers a novel approach to understanding the relative importance of and performance related to cancer risk factors, providing a framework for future research and development of targeted interventions. While we focused on SNOs' perspectives, the identified significant risk factors that require appropriate actions and the model itself can inform the development of tailored health education materials and training programs for nurses and other healthcare professionals, thereby improving the overall effectiveness of cancer prevention strategies. The strengths of this study include its extensive examination of cancer risk factors among Chinese participants, allowing for better application of the findings to a broader Chinese context. Moreover, this study emphasized the importance of knowledge training and sharing sessions specifically aimed at nurses. This finding is important for paving the way for health education.

However, some limitations must be noted. First, as a retest was not performed, trends or changes in the perceived significance and performance related to reducing cancer risk factors could not be discerned. Therefore, future research could focus on the trends of the perceived significance and performance using longitudinal design together with retest. Second, while the use of CFPR overcomes certain shortcomings of the AHP and enhances its practical value, the approach is still based on an independent relationship among attributes. However, from the clinical viewpoint, there may exist interdependencies among these attributes. Third, we did not distinguish cancer risk factors by types or sites; only general risk factors were considered. However, it is difficult to conduct such studies owing to the limitation of valid findings. Fourth, we acknowledge that the findings of this study, based on a sample of 58 SNOs from a single hospital in Zhejiang, may not be directly generalizable to other places or settings, which indicated that interventions and strategies need to be tailored in different settings. However, this study serves as an exploratory investigation into the knowledge and perceptions of SNOs within this specific context. Understanding these aspects is important for informing strategies to improve the effectiveness of cancer prevention efforts at the hospital level. Fifth, the sample size is larger compared to previous studies using the same methods [25, 33], which may therefore only slightly bias our results; future research with larger samples and diverse settings is needed to validate and generalize our findings. Nevertheless, this study offers insights into the knowledge and perceptions of SNOs regarding cancer prevention, which can contribute to a more comprehensive understanding of the factors that influence cancer prevention efforts within healthcare systems. Sixth, as this study was based on convenience sampling, research based on multi-center data is needed to validate our findings. Seventh, findings of our study cannot be used for drawing causal inference as this is only an observational study [34]. Eighth, we could not compare the perceived significance and performance among SNOs from different departments, especially between those from the oncology department and those from non-oncology departments, because the participants' information is anonymous. Finally, we acknowledge that the use of voluntary participation for SNO selection could have introduced selection bias. Those who chose to participate may indeed have been more engaged in and enthusiastic about professional development, and more interested in such research, than those who did not volunteer. This self-selection could have skewed the representativeness of our sample toward individuals who are more proactive and possibly more proficient in their roles.

Conclusion

This study contributes valuable insights to the field of cancer prevention by examining the perceived significance of 23 modifiable cancer risk factors and performance related to reducing them among SNOs in a Chinese hospital. Our findings highlight the importance of knowledge training and sharing sessions in enhancing SNOs' understanding of these risk factors, particularly those need to be improved, such as secondhand smoking, physical inactivity, excess body weight, $PM_{2.5}$ exposure, and ultraviolet radiation. This information is crucial for informing future health education interventions aimed at improving cancer prevention awareness and practices within healthcare settings.

Abbreviations

AHP	analytic hierarchy process
CFPR	consistent fuzzy preference relation
IPA	importance–performance analysis
MCDM	multi-criteria decision-making
SNO	senior nursing officer

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12885-024-13078-9.

Supplementary Material 1

Acknowledgements

We would like to thank Dr. Yen-Ching Chuang for his contribution to this study.

Author contributions

Conceptualization: ZLJ, WW, C-WC, YW, Y-PY, T-HT. Data curation: ZLJ, WW, C-WC, YW, Y-PY, T-HT. Formal analysis: ZLJ, WW, C-WC, YW, Y-PY, T-HT. Methodology: ZLJ, WW, C-WC, YW, Y-PY, T-HT. Project administration: Y-PY, T-HT. Resources: WW, Y-PY, T-HT. Software: ZLJ, YW. Supervision: Y-PY, T-HT. Visualization: ZLJ, WW, C-WC, YW, Y-PY, T-HT. Writing – original draft: ZLJ, YW Writing – review & editing: ZLJ, WW, C-WC, YW, Y-PY, T-HT.

Funding

This study received no financial support from public or private sources.

Data availability

All data are included in the study.

Declarations

Ethics approval and consent to participate

This survey was exempted from written informed consent and was approved by the Ethics Committee of Taizhou Hospital of Zhejiang Province (No. K202107139). All procedures were carried out according to the standards of our ethics committee and adhered to the tenets of the Declaration of Helsinki. Participants' personal information was fully anonymized.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 30 April 2024 / Accepted: 18 October 2024
Published online: 30 October 2024

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