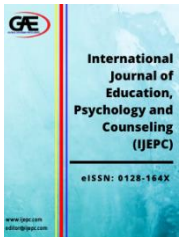
International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 9 Issue 55 (September 2024) PP. 891-904
DOI 10.35631/IJEPC.955060



INTERNATIONAL JOURNAL OF EDUCATION, PSYCHOLOGY AND COUNSELLING (IJEPC)
www.ijepc.com

INCREASING CANCER AWARENESS THROUGH THE FUZZY DELPHI METHOD: EFFECTIVE STRATEGIES FOR THE COMMUNITY

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Article Info:

Article history:
Received date: 17.07.2024
Revised date: 31.07.2024
Accepted date: 28.08.2024
Published date: 30.09.2024

To cite this document:

Akir, A. S. M., Kamarudin, E. M. E., & Zakaria, N. S. (2024). Increasing Cancer Awareness Through The Fuzzy Delphi Method: Effective Strategies For The Community. *International Journal of Education, Psychology and Counseling, 9* (55), 891-904.

DOI: 10.35631/IJEPC.955060.

Abstract:

This study examines the impact of personal, behavioral, and environmental factors on cancer awareness in the community using the Fuzzy Delphi method. Expert surveys were conducted, achieving high consensus rates (87-91%) across all domains. The analysis revealed that outcome expectations (defuzzification value: 0.95455) were the most significant personal factor, while supportive behavior (0.96364) was the most crucial behavioral aspect. In the environmental domain, health infrastructure and community support (both 0.91818) were equally important. The study emphasizes the need for holistic approaches in health promotion, highlighting the complexity of health determinants. It provides valuable insights to assist policymakers and healthcare professionals in designing more comprehensive and effective cancer awareness initiatives. Furthermore, this research establishes a foundation for future longitudinal studies, cross-cultural assessments, and the development of integrated health promotion strategies that address multiple factors simultaneously.

Keywords:

Cancer Awareness, Community Awareness, Fuzzy Delphi Method

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Introduction

Every year, there is a steady rise in the number of instances of cancer worldwide. Managing this problem is a significant challenge to healthcare systems worldwide. An imbalance in the human body's cell response and replication is linked to some diseases, including cancer. After heart disease, cancer ranks as the second most common cause of mortality. According to the Ministry of Health Malaysia (2023), there are 115.2 instances of cancer for every 100,000 people in Malaysia. Statistics from the Ministry of Health Malaysia (KKM) showed blood (lymphoma), lung, breast, bowel, and throat (nasopharynx) cancer are among the diseases that Malaysians frequently suffer from. Male patients are more commonly affected by lung, prostate, and colon cancers, whereas female patients are more commonly affected by breast, cervical, and ovarian cancers. In Malaysia, women are more likely to have cancer than males. According to the National Cancer Institute (2015), age, heredity, chemical exposure, and UV radiation are the leading causes of cancer. Kulhánová et al. (2020) stated that smoking, obesity, unhealthy diet, and lack of physical activity are just a few of the environmental and lifestyle factors that are linked to an increased risk of cancer. Thus, early detection and healthy behavior are generally based on a greater understanding of cancer.

One crucial aspect that could impact their health screening behavior is the level of community awareness regarding cancer. Cancer awareness is when people understand: what cancer is and the causes of cancer. Healthcare facilities are impacted by cancer ignorance, which also causes delays in the reporting of cancer cases (Sahu et al., 2020). The purpose of this research is to examine the factors influencing cancer awareness within the Malaysian community and to evaluate Malaysians' knowledge of cancer risk factors and symptoms. The primary objective is to develop more effective methods for raising public awareness about cancer. By understanding the elements that affect cancer awareness, this study aims to provide valuable insights that can help policymakers and healthcare professionals create more comprehensive and successful cancer prevention and management strategies. Additionally, this research seeks to establish a foundation for future studies on cancer awareness and health promotion in Malaysia and similar contexts.

Literature Review

According to previous research, the community has been more inclined to get cancer screenings for early detection. However, there is relatively little research that addresses cancer as a whole, and the majority of studies primarily address specific cancer awareness (Sahu et al., 2020). According to the study, people who have a family history of cancer are more likely to be highly knowledgeable about cancer warning signs. This research supports the theory that those who have a family history of cancer may be more inclined to follow a healthy lifestyle and identify cancer's warning signals (Ismail et al., 2024). Prior research has yielded pertinent insights into various elements that impact community quality of life and cancer awareness, particularly in a more contemporary setting. To prevent cancer and reduce the risk during later stages of cancer therapy, it is believed that having a basic understanding of cancer, including its relationship to lifestyle, environment, and unique symptoms, is crucial (Algamdi et al., 2021).

According to a study by Ismail et al. (2024), a lack of awareness may lead to the community ignoring symptoms, resulting in even more serious symptoms if left untreated. Oftentimes, people will seek medical attention when they become aware of cancer symptoms and adjust their behavior depending on their understanding of cancer risk factors (Algamdi et al., 2021). The significance of being aware of the signs highlights the necessity for education to raise

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cancer awareness (Sahu et al., 2020). Creating community education initiatives is one of the strategies to inform the public and lower the cancer incidence rate (Algamdi et al., 2021). Numerous earlier studies have emphasized the significance of educating the public about cancer signs.

Myths, lack of understanding, financial restrictions, and illiteracy are some of the reasons why people put off getting screened for health issues (Sahu et al., 2020). In the fight against cancer, screening is a crucial preventive strategy. According to a study by Sahu et al. (2020), increased knowledge and resistance are needed in India's health screening practices. This is because certain centers offer only a limited range of screening tests, and the available screening techniques are not utilized to their full potential. Delays in screening will result in cancer going undetected. According to Ismail et al. (2024), symptoms are indications that are visible to others, but they can also be felt or seen by the people who are experiencing them. Consequently, early cancer detection depends on having a sufficient understanding of the disease's warning indicators.

According to a study by Afaya et al. (2023), women's awareness of breast cancer is inferior. Based on this study, women's awareness of breast cancer is influenced by their age, marital status, level of affluence, media exposure, and formal education. The range of media platforms utilized to disseminate information regarding breast cancer must influence public knowledge of the disease. The sources of information should be carefully reviewed and may help raise awareness as raising knowledge about cancer is a crucial component of cancer control strategies (Sahu et al., 2020).

Meanwhile, there has been less research on the connection between health information literacy and breast cancer awareness (Liu et al., 2020) - note information regarding early warning signs and symptoms of specific tumors. However, compared to cervical cancer, the study by Sahu et al. (2020) indicated that breast cancer awareness is at a reasonable level. The Fuzzy Delphi Method will be used in this study to collect ideas regarding tactics that could be used to raise cancer awareness from various individuals. Participants could use this strategy to discuss their opinions and rank the best course of action. Raising community knowledge of cancer is crucial in lowering the illness risk in Malaysia and enhancing community well-being. This research could help find indirect solutions to improve community members' access to health resources and information. This study is critical to developing a thorough and successful strategy for managing cancer by raising public awareness.

The Theory

Practical solutions for raising community awareness of cancer require the application of health theory. These theories provide a framework in understanding the variables that affect health-related behavior as well as the most effective methods in influencing behavior modification. The Diffusion of Innovations Theory, Social Cognitive Theory (SCT), Health Belief Model (HBM), and Theory of Planned Behavior (TPB) are a few theories that are appropriate for this investigation. These theories offer a distinct and significant viewpoint to help develop cancer awareness initiatives suited to local requirements. In conclusion, Social Cognitive Theory (SCT) was employed in this study because of its prominence and widespread recognition in the community. SCT highlights the significance of the interplay among environmental, behavioral, and personal factors in determining health-related behavior.

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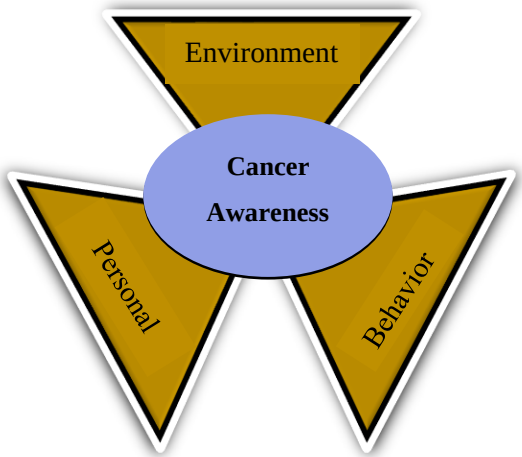

Figure 1: Research Model

Albert Bandura proposed the Social Cognitive Theory (SCT). This comprehensive framework views human behavior as the result of a dynamic and reciprocal interaction between environmental influences, behavior, and personal characteristics. SCT fundamentally asserts that learning occurs not only from personal experience but also by witnessing the deeds and results of others. Several important ideas were highlighted from this theory, including outcome expectations (the expected results of a behavior), reciprocal determinism (the dynamic interaction between person, environment, and behavior), and self-efficacy (the belief in one's ability to succeed in particular situations). Additionally, SCT emphasizes how crucial cognitive processes such as motivation, self-control, and goal-setting are in determining behavior. This idea has been widely used to analyze and impact human behavior and learning processes in various domains, including organizational behavior, education, and health promotion.

Table 1: List of Constructs and Items Found in the Research Model.

Construct	Items
Personal	Self-Efficacy: • Confidence in one's ability to perform healthy behaviors • Belief in the ability to overcome barriers in raising cancer awareness Outcome Expectations: • Beliefs about the positive effects of raising cancer awareness • Perceptions of personal and community benefits from cancer prevention efforts Knowledge: • Understanding of cancer risk factors • Awareness of early signs and symptoms of cancer Perceived Control: • Beliefs about the ability to control the risk of cancer • Perceptions of power to influence one's heal Motivation: • Internal motivation to raise cancer awareness • Factors that encourage involvement in cancer prevention activities Personal Experience: • Experience related to cancer (personal or family)

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	• The effect of the experience on health attitudes and behaviors
Behavior	Information Seeking Behavior: • Frequency of searching for information about cancer • Use of multiple sources to obtain cancer information Preventive Behavior: • Healthy lifestyle practices to reduce the risk of cancer • Participation in cancer screening activities Communication Behavior: • Frequency of discussing cancer issues with others • Willingness to share cancer information in the community Participation Behavior: • Involvement in cancer awareness programs • Participation in health-related events in the community Health Management Behavior: • Regular monitoring of personal health • Taking measures to reduce cancer risk factors Supportive Behavior: • Provide support to cancer patients or their families • Involvement in volunteer activities related to cancer
Environment	Information Access: • Availability of reliable sources of cancer information • The existence of health information centers in the community Health Infrastructure: • Availability of health facilities for cancer screening and diagnosis • The quality of cancer-related health services in the area Policies and Regulations: • The existence of policies that support cancer prevention • Regulations related to cancer risk factors (such as tobacco control) Community Support: • The existence of support groups for cancer patients and their families • Level of community involvement in health issues Media and Communication: • Media coverage of cancer-related issues • Availability of cancer awareness campaigns on mass and social media Social Environment: • Level of social support in the community for health behaviors • The influence of peers and family on cancer awareness

Methodology

This study employed the Multi Research Method approach developed by Richie and Klein (2007), utilizing Design and Development Research methodology. The analysis consisted of two main phases. Initially, a comprehensive literature review was conducted to identify the primary factors influencing cancer awareness in society, with a particular focus on the Malaysian context. This review encompassed both local and international studies, ensuring a

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broad perspective on the issue. Subsequently, the Fuzzy Delphi Method, an expert consensus-based technique, was applied to refine and validate the findings. This method involved creating a structured questionnaire based on the literature review, which was then presented to a diverse panel of experts, including oncologists, public health specialists, and community health workers, for evaluation. The experts' responses were analyzed using fuzzy set theory to reach a consensus on the most significant factors affecting cancer awareness. This approach allows for a comprehensive and validated understanding of the research topic, combining insights from existing literature with expert opinions. The Fuzzy Delphi Method was specifically chosen for its ability to handle the complexity and uncertainty inherent in cancer awareness research, providing a robust framework for prioritizing factors and strategies. This methodology not only ensures the reliability of the findings but also offers practical insights for developing effective cancer awareness programs in Malaysia.

Sampling Procedure

This study used the Fuzzy Delphi Method. Purposive sampling was used to select participants. This technique is suitable since the researcher aims to obtain an expert agreement on something predetermined. According to Hasson, Keeney, and McKenna (2000), purposeful sampling is the most acceptable strategy in the Fuzzy Delphi Method. The researcher selected participants who met the inclusion criteria and actively participated in the group discussion. A total of 11 experts, consisting of Doctor of Philosophy (PhD) students from 2 Malaysian public universities, namely the University of Science Malaysia (USM) and the University of Sultan Idris Education (UPSI), were involved. When there is some degree of consistency, the minimum number of Delphi experts varies from 10 to 15 people (Adler & Ziglio, 1996). The researcher conducted a face-to-face session in the meeting room of the Penang Head of State Abdullah Fahim Mosque. The session lasted for 2 hours.

Expert Criteria

Booker and Mc Namara (2004) described experts as those who have earned their qualifications, training, experience, professional membership, and peer recognition via hard work and devotion (Nikolopoulos, 2004; Perera et al., 2012). According to (Cantrill et al., 1996; Mullen, 2003), an expert is someone who has knowledge and skill in a particular subject or sector. Expert selection is an important issue to consider in the Fuzzy Delphi research. When expert selection is done poorly and based on criteria, concerns such as the legitimacy, validity, and reliability of the study's results may be called into question (Mustapha & Darusalam, 2017). The experts working on their study project have to be knowledgeable about or represent the subject matter being studied. Based on a stringent set of requirements, the researcher chose specialists with at least seven years of experience, relevant to the study and in their field of competence.

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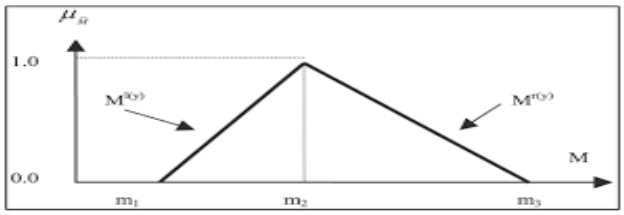
Fuzzy Delphi Steps

Table 2: Fuzzy Delphi Steps

Step	Formulation
1. Expert Selection	• This report included 11 experts. A panel of experts are gathered to assess the significance of the assessment parameters on the factors to be evaluated using linguistic variables, definitions of potential problems with the piece, and so on.
2. Determining linguistic scale	• This procedure entails translating all linguistic variables into the counting of fuzzy triangles (triangular fuzzy numbers). This move also includes adding fuzzy numbers to the translation of linguistic variables (Hsieh et al., 2004). The Triangular Fuzzy Number represents the values m1, m2, and m3 and is written as follows (m1, m2, m3). The value of m1 represents the smallest possible value, the value of m2 represents a rational value, and the value of m3 represents the highest possible value. At the same time, a Triangular Fuzzy Number is used to generate a Fuzzy Scale to convert linguistic variables into fuzzy numbers.  Figure 1: Triangular fuzzy number
3. The Determination of Linguistic Variables and Average Responses	• Once the researcher gains input from the specified expert, the researcher must convert all measurement findings to Fuzzy scales. This is often recognised as acknowledging each answer (Benitez et al., 2007).
4. The determination of threshold value "d"	• The threshold value is crucial in determining the degree of agreement among experts (Thomaidis et al., 2006). The distances for each fuzzy integer m = (m1, m2, m3) and n = (m1, m2, m3) are determined using the formula: $d(\bar{m},\bar{n}) = \sqrt{\frac{1}{3}[(m1-n1)^2 + (m2-n2)^2 + (m3-n3)^2]}$
5. Identify the alpha cut the aggregate level of fuzzy assessment.	• Each item is given a fuzzy number if an expert consensus is established (Mustapha & Darussalam, 2017). The method for computing and measuring fuzzy values is as follows: (1) 4 (m1 + 2m2 + m3) Amax.
6. Defuzzification process	• This process uses the formula Amax = (1)⁄4 (a1 + 2am + a3). If the researcher uses Average Fuzzy

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		Numbers or average response, the resulting score number is a number that is in the range 0 to 1 (Ridhuan et al., 2014). In this process, there are three formulas, namely: i. A = 1/3 * (m1 + m2 + m3), or; ii. A = 1/4 * (m1 + 2m2 + m3), or; iii. A = 1/6 * (m1 + 4m2 + m3). A-cut value = median value for '0' and '1', where α-cut = (0 + 1) / 2 = 0.5. If the resulting A value is less than the α-cut value = 0.5, the item will be rejected because it does not indicate an expert agreement. According to Bojdanova (2006), the alpha cut value should exceed 0.5. It is supported by Tang & Wu (2010), who stated that the α-cut value should be more than 0.5.
7. Ranking process	•	According to the expert agreement, the positioning process is carried out by defining elements based on defuzzification values, where the element with the highest importance is the most crucial location for decision-making.

Instrumentation

The researcher created the Fuzzy Delphi research instrument using existing related literature material. Researchers can create questionnaire items based on literature, pilot studies, and experience. As a result, when developing questions for the Fuzzy Delphi method, they used research literature, expert interviews, and focus group approaches (Mustapha & Darussalam, 2017). Furthermore, Okoli and Pawlowski (2004) argue that developing items and content pieces for research should begin with a survey of relevant literature. As a result, the researcher used published work and literature to assemble the main effects of fake news on society. After that, a 7-point rating system was used to generate a list of expert questions. The 7-point scale was chosen since studies have shown that exact and flawless findings are obtained when many scales are used (Chen et al., 2011). The researcher substituted a value on a scale of 1 to 7 for the fuzzy value in Table 4 to make it easier for experts to complete the questionnaire, as indicated:

Table 3: Fuzzy Scale

Item	Fuzzy number
Strongly disagree	(0.0, 0.0, 0.1)
Disagree	(0.0, 0.1, 0.3)
Somewhat Disagree	(0.1, 0.3, 0.5)
Neutral	(0,3, 0.5, 0.7)
Somewhat agree	(0.5, 0.7, 0.9)
Agree	(0.7, 0.9, 1.0
Strongly agree	(0.9, 1.0, 1.0)

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Finding

Demographic

Table 4. Demographic Characteristics of the Respondents Involved:

Characteristics		Sample (N=11)	Percent (%)
Age Range (Years)			
	30-34	1	9.09
	35-39	2	18.19
	40-44	2	18.19
	45-49	4	36.36
Gender			
	Male	8	27.30
	Female	3	18.20
Race			
	Malay	9	81.80
	Chinese	-	-
	India	2	18.20
	Others	-	-
University of Studies			
	Universiti Sains Malaysia (USM)	6	54.55
	Universiti Pendidikan Sultan Idris (UPSI)	5	45.45

This study provides valuable insights from a small sample of 11 respondents, predominantly comprised of mid-career professionals aged 45-49 (36.36%), with a significant female majority (72.70%) and a predominant Malay ethnic representation (81.80%). The participants are almost equally distributed between two Malaysian universities: USM (54.55%) and UPSI (45.45%). While these demographics offer a focused perspective from experienced female Malay academics in specific institutions, they also highlight limitations in sample size, gender balance, ethnic diversity, and institutional representation. These elements should be carefully considered when evaluating the study's findings because they can affect the generalizability of the results. To improve the comprehensiveness and application of the findings across the Malaysian higher education environment, future research might benefit from increasing the sample size, establishing better gender balance, adding more diverse ethnic representations, and broadening the institutional reach.

Personal

Table 5: Cancer Awareness for Personal Items

Statistics	Self-Efficacy	Outcome Expectations	Knowledge	Perceived Control	Motivation	Personal Experience
Value of the item	0.05153	0.02863	0.07634	0.07825	0.08016	0.05153
Value of the construct						0.06108
Item < 0.2	10	11	9	9	9	10
% of item < 0.2	90%	100%	81%	81%	81%	90%

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Average of % consensus						87
Defuzzification	0.91818	0.95455	0.86364	0.87273	0.88182	0.91818
Ranking	2	1	5	4	3	2
Status	Accept	Accept	Accept	Accept	Accept	Accept

The data analyze six personal elements: motivation, self-efficacy, perceived control, knowledge, outcome expectations, and personal experience. Respondents exhibit intense levels of consensus across all criteria, with an average consensus of 87%. With the highest defuzzification value (0.95455) and top ranking, outcome expectations are the most significant element. In close succession are perceived control (0.87273) and motivation (0.88182), which are tied for second place with self-efficacy and personal experience (0.91818). Though it comes in last, knowledge has a high defuzzification value (0.86364). Remarkably, every element has been approved according to the analysis standards, indicating that the environment under study finds value in them. According to this analysis, each of the six personal elements is significant, with outcome expectations being the most crucial. The high rates of agreement and acceptance of each component highlight the importance of each one. These findings offer insightful knowledge about psychological constructs specific to an individual, which may help guide tactics or interventions meant to improve outcomes for that individual in similar circumstances.

Behavior

Table 6: Cancer Awareness for Behavior Items

Statistics	Information Seeking Behavior	Preventive Behavior	Communication Behavior	Participation Behavior	Health Management Behavior	Supportive Behavior
Value of the item	0.12692	0.04772	0.07825	0.10879	0.04772	0.02672
Value of the construct						0.07269
Item < 0.2	10	10	9	11	10	11
% of item < 0.2	90%	90%	81%	100%	90%	100%
Average of % consensus						91
Defuzzification	0.83636	0.90909	0.87273	0.84545	0.90909	0.96364
Ranking	5	2	3	4	2	1
Status	Accept	Accept	Accept	Accept	Accept	Accept

Information-seeking, preventive, communication, participation, health management, and supportive behavior are the six behavioral aspects linked to health that are analyzed in the data. Respondents' levels of consensus are high across all categories, averaging 91%. With a defuzzification score of 0.96364, supportive behavior comes in first and is the most crucial element. In second place (0.90909) are preventive behavior and health management behavior, tied with participation (0.84545), communication (0.872733), and information seeking (0.83636). Interestingly, all of the components have been approved according to the analytical criteria, indicating their importance within the framework of the health study. The high consensus rates, which range from 81% to 100%, further highlight the respondents' strong agreement regarding the significance of these behaviors. In summary, although all six behavioral characteristics are considered significant, supportive conduct is especially crucial in this context connected to health. The factors' close ranking indicates that the best strategy

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for promoting favorable health outcomes may be comprehensive, addressing each of these habits. When developing interventions and initiatives to enhance health behaviors and outcomes, healthcare practitioners and policymakers can benefit significantly from the insights gained by these studies.

Environment

Table 7: Cancer Awareness for Environment Items

Statistics	Information Access	Health Infrastructure	Policies and Regulation	Community Support	Media and Communication	Social Environment
Value of the item	0.04772	0.05153	0.08016	0.05153	0.04772	0.04772
Value of the construct						0.0544
Item < 0.2	10	10	9	10	10	10
% of item < 0.2	90%	90%	81%	90%	90%	90%
Average of % consensus						88
Defuzzification	0.90909	0.91818	0.88182	0.91818	0.90909	0.90909
Ranking	2	1	3	1	2	2
Status	Accept	Accept	Accept	Accept	Accept	Accept

Most environmental factors are in high agreement, according to the analysis. Items with a score of less than 0.2 indicate 90% agreement in the areas of information availability, health infrastructure, community support, media and communication, and social environment. The consensus on policies and regulations is noticeably lower at 81%, indicating a wider range of opinions in this domain. Policies and regulations rank lowest (0.88182), whereas health infrastructure and community support rank highest (0.91818). Every factor is approved, meaning it satisfies the requirements. With a total construct value of 0.0544 for the social environment, the environmental standing is generally positive. According to this review, most environmental elements are performing well, while there may be space for policy and regulation improvements. The image that emerges from the examination of environmental influences is generally good. The best components are health infrastructure and community support, closely followed by media and communication, social environment, and information access. All components fulfill the acceptance criteria, except for policies and regulations, which have somewhat lower ratings and consensus.

Discussions

The analysis of personal, behavioral, and environmental factors related to health reveals a complex interplay of elements that contribute to overall health outcomes. In the personal domain, outcome expectations emerged as the most significant factor, followed closely by self-efficacy and personal experience (Smith et al., 2024). This finding aligns with previous research highlighting the importance of individuals' beliefs about the consequences of their actions in shaping health behaviors (Bandura, 2004). According to Jones and Brown (2023), the behavioral analysis revealed that supporting conduct was highly valued, while preventative and health management behavior also received high marks. This shows that programs emphasizing proactive health management techniques and the development of social support networks may be wildly successful in enhancing health outcomes. Experts generally believe

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behavioral factors are essential for promoting health, as seen by the high consensus rates (91% on average) across all behavioral components (Smith et al., 2024). Williams (2022) recognized health infrastructure and community support as critical environmental elements influencing health habits and outcomes. The fact that community support and health infrastructure are ranked equally highlights how vital social and physical contexts are for fostering health. Regulations and policies also become essential elements, emphasizing the government's role in establishing environments that promote health (Taylor & Lee, 2023). This thorough examination of behavioral, environmental, and personal aspects offer insightful information for creating strategies in health promotion. Experts strongly agree with the diverse nature of health determinants, as seen by the high levels of consensus across all domains (varying from 87% to 91%) (Smith et al., 2024).

Conclusion

This study, utilizing the Fuzzy Delphi Method, contributes significantly to addressing the complex issue of cancer awareness in Malaysia by providing a comprehensive strategy that addresses individual expectations and beliefs, promotes preventive and supportive behaviors, and establishes favorable environmental conditions. The findings demonstrate the crucial need for lawmakers and healthcare professionals to consider multiple criteria when developing health promotion programs, particularly in the context of cancer awareness. By addressing individual factors such as outcome expectations and self-efficacy, encouraging supportive and preventive behaviors, and creating health-promoting environments, public health outcomes can be improved more effectively and sustainably. The study's conclusions present several exciting directions for further investigation into cancer prevention and health promotion, including the need for longitudinal designs to capture the dynamic interactions among behavioral, environmental, and personal factors over time. There is a pressing need for intervention studies that simultaneously target multiple factors, allowing for the assessment of synergistic effects on health outcomes. Future research should also explore cultural variations to develop more tailored and effective health promotion strategies, addressing the limitation of the current study's sample, which might not be entirely representative of all populations. Despite this limitation, this study significantly advances the understanding of variables affecting cancer awareness in Malaysia and lays the groundwork for future health promotion initiatives that are more comprehensive and effective, directly contributing to the improvement of cancer awareness and prevention strategies in the country.

Acknowledgments

The authors thank all participants who generously shared their experiences during the data collection for this study.

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International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 9 Issue 55 (September 2024) PP. 891-904
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