

ORIGINAL ARTICLE

Development, Validation and Translation of The Benzene Exposure Knowledge, Attitude, And Practice (BEKAP) Questionnaire

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ABSTRACT

Introduction: Benzene, a hazardous air pollutant, may harm children's respiratory and developmental systems. This study aims to create, validate, and translate the Benzene Exposure Knowledge, Attitude and Practice (BEKAP) questionnaire for parents of primary school children. **Methods:** The study comprises of two phases. Phase I: Item development and validation. Phase II: Item translation into Malay through cultural and linguistic adaptations, following the International Society for Pharmacoeconomics and Outcome Research (ISPOR) standards. A panel of four experts and 33 parents assessed BEKAP's validity, with Microsoft Excel used for the content validity index (CVI) and face validity index (FVI) analysis. **Results:** Phase I: BEKAP (Version 1.0) consisted of 63 items across three domains—knowledge, attitude, and practice regarding benzene exposure. Only the knowledge domain achieved S-CVI values exceeding the acceptable threshold of 0.8, with S-CVI/UA at 0.88 and S-CVI/Ave at 0.97. Thirty-two items were revised for clarity, and 12 were removed due to redundancy. Phase II: A total of 51 items was prepared for translation. I-FVI exceeded the 0.83 cut-off, leading to revisions for seven items to enhance clarity. The final BEKAP (Version 3.0) - Malay version retained 51 items, ensuring consistency while improving the clarity and relevance. **Conclusion:** Creating, validating, and translating the questionnaire is a thorough, iterative process. Involving content experts and respondents is crucial for ensuring its validity. Subsequent steps include a pilot study and psychometric analysis to determine the suitability of the Malay-version BEKAP for parents of primary school children in Johor, Malaysia.

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Children are particularly vulnerable due to their higher inhalation rates per body weight, developing physiology and increased exposure to environmental pollutants (3,4).

INTRODUCTION

Benzene, the colourless and highly flammable liquid with a sweet smell, is a well-known environmental pollutant primarily originating from anthropogenic sources such as vehicular emissions, industrial processes and tobacco smoke (1,2). The World Health Organization (WHO) identifies benzene exposure as a global concern. Classified as a Group 1 human carcinogen by the International Agency for Research on Cancer (IARC), benzene is produced annually in substantial quantities exceeding 1000 metric tons (3). Chronic exposure to benzene is associated with various adverse health effects, particularly haematological disorders, immunotoxicity, and an increased risk of leukaemia.

In Malaysia, particularly in Johor, rapid urbanization and industrial expansion have contributed to elevated benzene levels in the ambient air (5,6). Despite global and local efforts to regulate benzene emissions, there remains a significant gap in public awareness and preventive measures, particularly among parents responsible for minimizing their children's exposure to this hazardous compound. While numerous studies have investigated the environmental and health impacts of benzene exposure (2), limited research has focused on understanding parental knowledge, attitudes, and practices (KAP) regarding benzene exposure. This gap underscores the need for a validated instrument to assess these aspects effectively and facilitate targeted public health interventions.

The novelty of this study lies in the development, validation, and translation of the Benzene Exposure Knowledge, Attitude and Practice (BEKAP) questionnaire, a comprehensive tool designed to measure parental KAP regarding benzene exposure. Unlike previous studies that primarily focused on exposure assessment and health outcomes, this study provides a behavioural and perceptual factor in understanding exposure risks. The BEKAP questionnaire is expected to serve as an essential tool for public health initiatives, supporting the design of targeted educational programs and risk reduction strategies.

Existing studies on benzene exposure predominantly focus on environmental monitoring and epidemiological outcomes, providing limited insights into behavioural and educational aspects that are necessary for effective public health interventions. The BEKAP questionnaire addresses this limitation by capturing parental perceptions and preventive behaviours, enabling the development of tailored educational initiatives and policy-driven programs. By equipping policymakers and health practitioners with relevant data, this study contributes to a more comprehensive approach to mitigating benzene exposure risks.

This study aims to develop, validate and translate the BEKAP questionnaire to ensure its cultural and linguistic relevance in the Malaysian context. By employing a structured and rigorous methodology, the research ensures that the questionnaire is scientifically robust and applicable for future large-scale assessments and interventions. This study is part of a broader research project titled 'Evaluating the Impact of Ambient Air Benzene Exposure on Primary School Children's Health in Johor'.

METHODS

Two main phases were involved (Fig. 1): i) Phase I: questionnaire development and validation; and ii) Phase II: questionnaire translation. During Phase I, our focus was on crafting a comprehensive instrument specifically designed to assess aspects related to benzene exposure. This process, spanning from June 2022 to February 2023, utilized various methods to ensure that the tool was both thorough and relevant. We conducted extensive literature reviews and engaged with experts to gain deep insights, further ensuring the content's validity and its pertinence to benzene exposure.

Phase II, encompassing the translation and validation of the developed instrument, was dedicated to verifying its suitability and precision. This phase, carried out at the Johor Bahru District Health Office from March to June 2023, highlighted the importance of linguistic accuracy and cultural appropriateness, considering the diverse respondents. These included public health physicians, Master of Public Health (MPH), Doctoral of

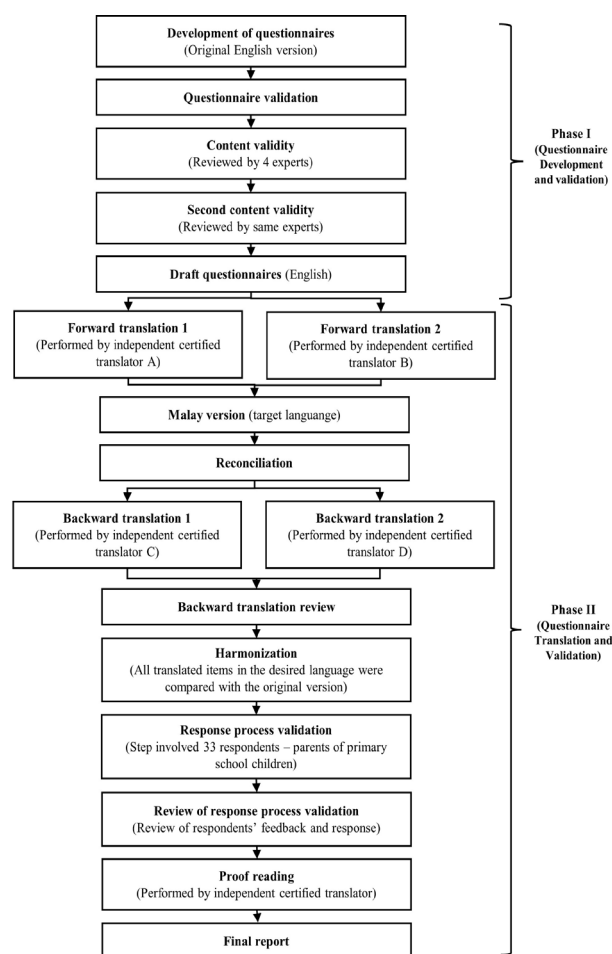


Fig. 1 Process flow of questionnaire development, translation, and validation.

Public Health (DrPH) scholar doctors, and laypersons, all contributing to a comprehensive understanding of the context. The details of both phases will be discussed in this section.

The study has obtained ethical clearance from the Medical Research Ethics Committee of Universiti Malaysia Sabah (UMS), with the approval number JKetika 1/23 (14), as well as from the Medical Research and Ethics Committee of the Ministry of Health Malaysia, with the approval number NMRR ID-23-00807-HRP (IIR). The study conducted follows the principles outlined in the Declaration of Helsinki.

Phase I: questionnaire development and validation

1.0 Item generation

We aim to develop the Benzene Exposure Knowledge, Attitude, and Practice Questionnaire (BEKAP), which was meticulously crafted through a comprehensive approach. The questionnaire's foundation stemmed from an exhaustive review of the existing literature to identify the published questionnaire and personal consultations with field experts. Utilizing selected keywords such as 'benzene,' 'benzene exposure,' 'volatile organic compounds,' 'air pollution,' 'health knowledge, attitudes, practice,' 'parental perception,'

‘parental practices,’ ‘health belief model,’ and ‘child health,’ we conducted searches on various databases including Google Scholar, Scopus, and PubMed.

Questions relevant to benzene exposure were adapted from identified literature and were aligned with guidelines and updates from authoritative bodies such as the World Health Organization (WHO), Centres for Disease Control and Prevention (CDC), and the Environmental Protection Agency (EPA). The questionnaire comprises three domains, each drawing questions from the Knowledge, Attitude, and Practice (KAP) components.

In the Knowledge section, parents were assessed on their general knowledge of benzene, sources of exposure, risk factors, nutrition, and prevention methods. The Chicago Lead Knowledge Test-Malay Version (mCLKT) (7), an originally validated tool, served as a model with explicit modifications to measure parental knowledge on benzene exposure. The permission to use and adapt the questionnaire was obtained from the developer.

For the Attitude domain, 28 items were formulated based on the Health Belief Model (HBM) concepts (8,9). Meanwhile, the Practice section focused on ten items related to preventive measures during pregnancy and a child’s early life regarding benzene exposure. The maximum scores for Knowledge, Attitude, and Practice were 25, 140, and 20, respectively, while the minimum scores were 0 for all domains. Table I displays the domains, number of items, theories covered and response options in the questionnaire.

Table I. KAP questionnaire on benzene exposure among primary school children

Do- mains	No. of Items	Measurements	Response choices
Knowl- edge	25	general knowledge, source and route of benzene exposure, method of prevention, risk of exposure in food intake	Yes/No/I don’t know. 1= correct answer 0= wrong/ I don’t know
Attitude	28 (8 reverse scored items)	attitudes towards benzene exposure based on health belief model	1= Strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree
Practice	10 (7 reverse scored items)	practice during pregnancy and child’s early childhood to limit benzene exposure.	1= never, 2= seldom, 3= sometimes, 4= usually, 5= always

2.0 Content validation (English version)

To ensure a comprehensive content validation process, forms were developed with a four-point response scale (1: not relevant; 2: somewhat relevant; 3: quite relevant;

4: highly relevant) (10). Domain definitions were provided to aid experts in grading each item based on its relevance to the measured concept/construct and the clarity of wording. Five experts in environmental health, toxicology, and nutrition, each with over 15 years of experience, were engaged for content validation through a non-face-to-face approach. Two rounds of expert reviews were conducted via email, resulting in an 80% response rate. The systematic follow-up enhanced the response rates and saved time, highlighting the efficacy of this non-face-to-face approach.

Experts independently scored each item based on relevance, providing verbal or written feedback for improvement. All feedback was considered in refining the domain and its items. After each review, the content analysis gauged expert agreement, and a content validity index (CVI) was calculated for each item. Two forms of CVI, I-CVI (for individual items) and S-CVI (for the entire scale), were computed. The relevance rating was recoded before CVI calculation (1 for relevance scale of 3 or 4, and 0 for a scale of 1 or 2). The acceptable cut-off score for CVI with four experts was set at 1 (11,12), while the recommended values for S-CVI/UA and S-CVI/Ave were 0.8 and 0.9 or higher, respectively (13).

Phase II: questionnaire translation and validation

The translation process involved 10 steps, as detailed by the International Society for Pharmacoeconomics and Outcome Research (ISPOR) (14). This comprehensive approach spans multiple stages, meticulously designed to uphold the integrity and relevance of the instrument for the targeted population.

1. Preparation stage: After meticulous content validation by experts, the draft questionnaire underwent a rigorous translation process. Collaborating with a bilingual researcher and a trained linguist was crucial for an accurate, fluent, and appropriate translation (14).
2. Forward translation: Two qualified multilingual translators created two Malay versions, considering cultural nuances, medical terminology, and casual conversations.
3. Reconciliation: The best forward translation was selected through a committee consensus in a meeting, chaired by the author and attended by a Public Health Physician, MPH and DrPH scholars without prior knowledge of the translation.
4. Backward translation: Malay versions were translated back into English by two qualified translators, blind to both the original and back-translated questionnaires.
5. Backward translation review: A meeting without prior knowledge of the previous translation identified and resolved the inconsistencies in the reconciled translation.
6. Harmonization: The comparison of all translated items with the source version ensured agreement on the sentence structure, terminology, and overall meaning (14).

7. Response process validation: Face validity assessed 33 volunteers, and their feedback was analysed to compute a validity index. The calculated FVI of at least 0.80 was taken as the acceptable FVI value (15).

8. Review of response process validation: Collaborative decisions by the authors ensured that the alterations preserved the original conceptual meaning.

9. Proofreading: An experienced proofreader with over ten years of experience in Education, Applied Linguistics, and Science conducted a final check for minor errors.

10. Final report: The summary of the entire translation process, methodologies, adaptations, and proofreading feedback, provide insights for future researchers, and serve as reference for refinements in subsequent translations.

RESULT

Phase I: questionnaire development and validation

1.0 Questionnaire development

A total of 63 questions pertaining to benzene exposure was identified, constructed, and included in the questionnaire. The literature search revealed that benzene exposure in children is frequently linked to the practices (16,17) as well as the knowledge level (18,19), and the perception of parents (20,21). BEKAP Version 1.0 was produced at the end of this step.

2.0 Content validation (English version)

The results of the first round validation showed that out of the 63 items in BEKAP (Version 1.0) show that all of them had an I-CVI value of 1, except for 3 items from the knowledge domain (K2,K11,K23) (Supplementary Table I) which had an I-CVI of 0.8, 10 items from the attitude domain (A10,A11,A13-A16,A19,A20,A22,A28) (Supplementary Table II) and 5 items from the knowledge domain (P2,P6-P9) (Supplementary Table III), where both domains had a range of I-CVI between 0.3-0.8. Only the knowledge domain had S-CVI values surpassing the threshold of 0.8, where the S-CVI/UA was 0.88, and the S-CVI/Ave was 0.97.

Table II. Summary of the items for all domains in BEKAP Version 1.0 following the first-round content validity analysis.

Domain	Number of Items				S-CVI/ Ave
	Initial	Revised	Deleted	Retained	
Knowl- edge	25	14	4	21	0.97
Attitude	28	10	6	22	0.80
Practice	10	8	2	8	0.83
Total	63	32	12	51	

S-CVI= Scale-level Content Validity Index; Ave= Average

In total, 12 items were removed from the questionnaire with four items from the knowledge domain (K9,K11,K16,K25), six items from the attitude domain (A10,A11,A15,A19,A20,A22) and two items from the practice domain (P6,P9). According to the experts,

Table III. Summary of the items for all domains in BEKAP Version 3.0 following the face validity analysis.

Domain	Number of Items				S-FVI/ Ave
	Initial	Revised	Deleted	Retained	
Knowl- edge	21	3	-	21	0.95
Attitude	22	4	-	22	0.95
Practice	8	-	-	8	0.98
Total	51	7	0	51	

S-FVI= Scale-level Face Validity Index; Ave= Average

the structure of the item was deemed either irrelevant or redundant. Hence, it was removed. The majority of experts recommended improving the structure and grammar of each item and avoiding double-barrelled questions to improve comprehension. 51 elements were revised and re-evaluated. The summary of the items for all domains is shown in Table II.

During the re-evaluation, the content validation assessment score improved after editing the items. The I-CVI values for all 51 items reached the recommended value of 1 including the S-CVI/UA and S-CVI/Ave for each domain. The final questionnaire was set up with 21 items in knowledge domain, 22 items in attitude domain and 8 items in practice domain agreed by the experts. Hence, BEKAP Version 2.0 was produced.

Phase II: questionnaire translation and validation

The questionnaire development process resulted in the finalization of 51 items for translation. The forward translation revealed multiple alternatives for certain items, such as "gas station," translating to either "*stesen gas*" or "*stesen minyak*". The backward translation similarly exhibited diverse alternatives, reflecting the nuances of the Malay language. However, for some items, neither translator used a different index term, with the primary difference being the use of active or passive voice. The review committee adjusted the terms for precision in items like K12, K19, K20, A19, and A20, opting for more accurate Malay equivalents.

Despite differences in translation terms, the understanding and concept of each item were maintained, ensuring the questionnaire's integrity. The majority of items were translated directly into Malay, with only a few exceptions. Adjustments, such as inserting "*negatif*" after "*kesan*" in item K9 or substituting "*kanak-kanak*" with "*bayi dalam kandungan*" in item K10, aimed to enhance precision. Notably, the translation complexity varied, with item K14 having the fewest words and straightforward translation, while item K11 presented a more intricate process due to its higher word count in English and Malay versions. The translation process navigated these intricacies, striving for accuracy and cultural adaptation.

The response process validation involved BEKAP version 2.0 of the translated questionnaires in Malay. Similar

to the content validity, the computation of response process validity also included the Item-level Face Validity Index (I-FVI), Scale-level Face Validity Index (S-FVI), Universal Agreement calculation method (S-FVI/UA), and the Averaging calculation method (S-FVI/Ave) of items that are judged clear or comprehensible across 33 respondents. A total of 11 males and 22 females was tested with the mean (SD) age of the respondents 35.94 ± 5.47 years (range 27-48 years). The Item-level Face Validity Index (I-FVI) for 44 items exceeded 0.80, indicating acceptable face validity, while seven items were revised based on feedback. All values for the Scale-level Face Validity Index (S-FVI/Ave) across domains exceeded the allowable cutoff mark of 0.9. Table III displays the summary of the items for all domains in BEKAP after conducting the face validity analysis. The final BEKAP Version 3.0 retained the same number of items but demonstrated improved clarity and relevance, at the same time concluding this phase of the questionnaire development process.

Beyond the content validation and translation assessment, the construct validity and reliability of the Malay-version BEKAP questionnaire were rigorously examined in a subsequent study involving 182 parents from five schools in Johor Bahru. The knowledge domain was assessed through the Item Difficulty Index (IDI) and Item Discrimination Index (DI), demonstrating that 20 items exhibited moderate difficulty and satisfactory performance, with a reliability coefficient (KR-20) of 0.79. The attitude and practice domains were subjected to the exploratory factor analysis (EFA), which identified two subdomains within each domain. The overall Cronbach's alpha values were 0.82 for the attitude domain and 0.66 for the practice domain, indicating acceptable internal consistency. A comprehensive analysis of these psychometric properties was disseminated in a separate publication.

DISCUSSION

The primary objective of this study was to develop, validate, and translate a questionnaire that effectively measures the Knowledge, Attitudes, and Practices (KAP) regarding benzene exposure among primary school children. There is no universally established guideline regarding the optimal number of items in a questionnaire. It is crucial for the questionnaire to include an adequate number of items to effectively measure the targeted construct, while simultaneously ensuring that it is concise enough to prevent respondents' fatigue or diminished motivation during completion (22,23). In Phase I, the questionnaire development involved the identification and construction of sixty-three questions related to benzene exposure. Literature reviews emphasized the significant links between benzene exposure in children and parental knowledge, educational levels, perceptions, and practices providing a comprehensive foundation for the questionnaire.

The subsequent content validation process, was conducted to exclude items that did not represent the complete range of the attributes under the study (24). In this study, an expert panel consisting of four experts with various experiences was formed to avoid an inflated estimate of validity. The content validation process, focusing on the English version, revealed high CVI scores for knowledge domain but highlighted the need for refinement in the practice and attitude domains. The authors opted to exclude item A10 from the attitude domain (Statement: I think during the last month, the air quality level for benzene in my area is acceptable) based on experts' apprehensions regarding the respondents' capacity to precisely assess benzene levels in their locality. This concern stems from the potential lack of factual information on air quality (25) and the variations in environmental awareness and data availability specific to the Malaysian context.

The decision to exclude item A15 (Statement: People think my child is sick when they are wearing a face mask) and A22 (Statement: Most parents put on face mask to their child when going to school) was based on expert concerns about their relevance, especially in the situation of the ongoing COVID-19 pandemic. The experts highlighted that wearing face masks has become a commonplace practice due to pandemic-related precautions, making the statement potentially unfair and tricky. Given the normalized use of face masks for health and safety reasons, the question was deemed not applicable and could elicit responses that may not accurately reflect perceptions related to benzene exposure. Consequently, to ensure the appropriateness and fairness of the questionnaire, items A15 and A22 were removed from the final version. Expert feedback not only contributed to the elimination of irrelevant and redundant items but also facilitated grammar enhancements, ultimately yielding a refined questionnaire. These includes items in practice domains that were mostly rewritten to avoid ambiguity and keep the questions simple (25).

Phase II delves into the translation process, addressing the crucial need for cultural and linguistic appropriateness. The preparation stage, where modifications were made for Malaysia's setting, is a pivotal step in ensuring the questionnaire's relevance to the target population. The forward and backward translation stages exposed challenges in language nuances, prompting a review committee to make necessary adjustments. Furthermore, the translation process revealed nuanced linguistic variations, as seen with terms like "*gas station*" and their Malay equivalents. Such differences underline the challenges of maintaining the semantic integrity across languages. The decision of the review committee to alter certain translations, such as replacing "*tidak baik*" with "*tidak sihat*" for the term "unhealthy," demonstrates a careful consideration of language in conveying precise meaning. This refinement process is crucial in

minimizing the misunderstanding or misinterpretation of questionnaire items and adapting them to the thinking process of an average person (26,27). This process reflects the intricacies involved in the cross-cultural questionnaire development, emphasizing the importance of precise terminology. Search engines such as the Pusat Rujukan Persuratan Melayu by Dewan Bahasa dan Pustaka were also utilized for these purposes (28).

The response process validation evaluates questionnaire items from the perspective of the target population (29). It was performed using BEKAP version 2.0 of the translated questionnaires (Malay Version). From a total of 51 items, 44 items achieved acceptable I-FVI values (>0.80). This indicates that the questionnaire possesses clarity and is readily comprehensible to the parents who are participating, thereby enhancing its validity. Nevertheless, modifications were made to the seven items exhibiting lower I-FVI values, highlighting the significance of enhancing these aspects to achieve improved clarity and comprehension. The consistently high S-FVI/Ave values (>0.9) in all domains enhance the assurance in the questionnaire's validity and pertinence, specifically in evaluating parents' understanding, attitudes, and behaviours concerning benzene exposure.

Ensuring that the modified instrument maintains cultural and linguistic equivalence is essential for expanding the potential for a comparative analysis across various cultures. After undergoing extensive translation and cultural adaptation procedures, a pilot study was necessary to determine the suitability of the Malay version of BEKAP for parents of primary school children in Johor, Malaysia. Participants will fill in the survey using both online and paper-based forms during future pilot tests. The pilot test results will be subjected to a statistical analysis in order to depict the distribution of responses for each item and evaluate the reliability and validity.

This study boasts several notable strengths that enhance its validity and applicability. The comprehensive approach to questionnaire development resulted in a detailed tool comprising 63 items. The study's multifaceted validation process, encompassing content validation, translation, and response process validation, ensures the robustness of the questionnaire in terms of suitability, linguistic accuracy, and clarity for the targeted population. Additionally, the engagement of a diverse expert panel contributes to a well-rounded evaluation and minimizes the risk of an inflated estimate of validity. However, a single geographic focus on the parents of primary school children in Johor, Malaysia, introduces a potential limitation regarding the questionnaire's applicability to regions with different socio-cultural contexts, suggesting a need for a more comprehensive approach in future research.

CONCLUSION

In conclusion, the meticulous process of developing, translating, and validating the questionnaire not only ensures its suitability for the Malaysian context but also contributes significantly to the field of environmental health research. Assessing the items of the instrument through the expertise of content specialists and the input of respondents is essential to guarantee its validity. The process has finalized the 51-item BEKAP Malay version that is ready for the pilot study and psychometric analysis. These assessments will determine the appropriateness of the 51-item BEKAP Malay version for parents of primary school children in Johor, Malaysia.

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