

การพัฒนาและตรวจสอบคุณภาพแบบสอบถามประเมินความถี่การบริโภคไขมันชั้นต่ำสำหรับประเมินความเสี่ยงการรับสัมผัสเคอร์คูมินในผู้ใหญ่

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บทคัดย่อ

เคอร์คูมินเป็นสารที่พบมากที่สุดในกลุ่มเคอร์คูมินอยด์ซึ่งเป็นสารออกฤทธิ์ทางชีวภาพในขมิ้นชัน แหล่งที่รับประทานได้ของเคอร์คูมินมีทั้งยาสมุนไพร ผลิตภัณฑ์เสริมอาหาร และอาหารที่มีขมิ้นชันเป็นส่วนประกอบ อย่างไรก็ตามยังขาดการประเมินการรับสัมผัสเคอร์คูมินจากการบริโภคจากทุกแหล่งดังกล่าวต่อเนื่องยาวนาน และยังขาดเครื่องมือประเมินการรับสัมผัสที่เหมาะสม งานวิจัยนี้จึงมีวัตถุประสงค์เพื่อพัฒนาและตรวจสอบคุณภาพของแบบสอบถามใหม่แบบออนไลน์สำหรับประเมินการรับสัมผัสเคอร์คูมินจากแหล่งที่รับประทานได้ ในการวิจัยนี้มีการพัฒนาแบบสอบถามใหม่แบบออนไลน์ ประกอบด้วยคำถามเกี่ยวกับแหล่งที่มาของผลิตภัณฑ์ที่บริโภค ปริมาณและความถี่การบริโภคผลิตภัณฑ์ขมิ้นชัน (ผลิตภัณฑ์ยาสมุนไพร และผลิตภัณฑ์เสริมอาหารชนิดนิยมนำ 10 รายการจากเว็บไซต์ 4 แหล่ง) การบริโภคอาหารที่มีขมิ้นชัน (อาหาร 11 เมนู จากเว็บไซต์ 8 แหล่ง เช่น สะเต๊ะ แกงส้มใต้ ข้าวหมกไก่ เป็นต้น โดยการรับสัมผัสเคอร์คูมินคำนวณจากปริมาณของเคอร์คูมินอยด์ที่ระบุบนฉลากและปริมาณขมิ้นชันที่ใช้ในแต่ละเมนู แบบสอบถามนี้ได้รับการตรวจสอบความตรงตามเนื้อหาโดยผู้เชี่ยวชาญ 7 ท่านและตรวจสอบความน่าเชื่อถือของการทดสอบซ้ำในผู้บริโภคผลิตภัณฑ์ขมิ้นชัน จำนวน 33 คน ผลการวิจัยพบว่า แบบสอบถามที่พัฒนาขึ้นมีดัชนีความตรงตามเนื้อหา เท่ากับ 1 ความน่าเชื่อถือของการทดสอบซ้ำมีค่าสัมประสิทธิ์สหสัมพันธ์ระหว่างการทดสอบครั้งแรกและครั้งที่สอง คือ 0.997, 0.869 และ 0.918 สำหรับผลิตภัณฑ์ขมิ้นชัน อาหารที่มีขมิ้นชัน และแหล่งที่มาของผลิตภัณฑ์ ตามลำดับ แบบสอบถามที่ผ่านการตรวจสอบแล้วนี้สามารถนำไปใช้ประเมินการรับสัมผัสสารเคอร์คูมินในคนไทยที่ใช้ผลิตภัณฑ์ขมิ้นชันเพื่อประเมินความเสี่ยงต่อสุขภาพในอนาคต

คำสำคัญ: เคอร์คูมิน ขมิ้นชัน ผลิตภัณฑ์จากขมิ้นชัน การประเมินการรับสัมผัส การตรวจสอบคุณภาพแบบสอบถาม

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Development and Validation of a New Food Frequency Questionnaire for Estimating the Consumption Frequency of Turmeric for Risk Assessment of Curcumin Exposure in Adults

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Abstract

Curcumin is the primary type of curcuminoids, which are the bioactive compounds in turmeric (*Curcuma longa* L.). There are multiple edible sources of curcumin, including turmeric-containing herbal medicines, dietary supplements, and culinary preparations. However, the total long-term continuous exposure to curcumin from all these sources and its safety profile had not yet been established, and no appropriate tool for measuring such exposure was available. This study aims to develop and validate a new online questionnaire to estimate curcumin exposure from edible sources. A new online questionnaire was developed. It includes questions about the source of consumed products, dosage, and frequency of turmeric product consumption (10 popular herbal medicines and dietary supplement products based on 4 websites), and turmeric food consumption (11 turmeric-based dishes from 8 websites such as satay, Southern-style sour soup, and chicken biryani). The amount of curcumin in products and food was estimated based on the curcuminoid content specified on the product label and the amount of turmeric in the recipe. Seven experts validated the content of the questionnaire. Test-retest reliability of the questionnaire was assessed in 33 users of turmeric products. The developed questionnaire achieved a content validation index of 1. The test-retest reliability had correlation coefficients of 0.997, 0.869, and 0.918 for the turmeric product consumption, turmeric food consumption, and source of product sections of the questionnaire, respectively. This validated questionnaire can be further used to assess the curcumin exposure and risk assessment among Thai consumers of turmeric-containing products in future studies.

Keywords: Curcumin, Turmeric, Turmeric products, Exposure assessment, Questionnaire validation

Received: 17 July 2025, *Revised:* 22 September 2025, *Accepted:* 2 October 2025

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Introduction

Turmeric (*Curcuma longa* L.) is a plant in the ginger family. It is commonly used as a spice or food coloring agent in Thai, Indian, and Chinese cuisines¹⁻². The major bioactive compounds, including curcuminoids and volatile oils, are known to have health benefits such as improved digestion, antioxidant, antimicrobial, anti-inflammatory, anti-arthritis, anticancer, and antilipidemic activities¹⁻⁷.

Among curcuminoids, curcumin is the major compound of the total curcuminoid². Turmeric products have a wide range of applications, including use as food ingredients, cosmetics, dietary supplements, and herbal medicine. The International Trade Centre reported that China and India are the major global exporters of turmeric products. While Thailand ranks 10th in exports, the country has produced and domestically used turmeric products in large quantities⁸. Due to its multiple uses, turmeric was recognized as Thailand's herbal product champion and established on the National List of Essential Herbal Medicines in Thailand, with indications for relieving bloating, flatulence, and reducing gas⁹⁻¹⁰.

Currently, products containing herbal ingredients are in high demand among health-conscious consumers, as evidenced by the continuous growth of the herbal products market, with a CAGR of 20.9% from 2024

to 2030¹¹. Both curcuminoid-containing herbal medicines and dietary supplement products are popular worldwide. Since the packaging of both types of products looks similar and can be purchased without a prescription, people may misunderstand that turmeric therapeutic items are dietary supplements. Since the doses of curcuminoids in herbal medicines are higher than those of dietary supplements, such a misunderstanding may lead to long-term continuous consumption of high-dose curcumin from herbal medicine. The European Food Safety Authority (EFSA) has established an acceptable daily intake (ADI) for curcumin, limiting the safe daily dose to 3 milligrams per kilogram of body weight per day¹². If a person's standard body weight is 60 kilograms, the maximum daily intake is 180 milligrams. If a consumer takes curcumin more than this amount regularly, there may be a health risk due to liver damage¹². Therefore, exposure and risk assessment of curcumin from all sources for long-term continuous exposure is needed. Currently, there are only studies on curcumin exposure from food in Iran, Korea, and the United Kingdom¹³⁻¹⁵. However, no studies have determined the total exposure to curcumin from all edible sources, including herbal medicines, dietary supplements, and culinary preparations or common turmeric-based dishes. This is due to the lack of a suitable tool to

estimate the total exposure of curcumin from these sources. Therefore, the objective of this study was to develop a new online questionnaire to estimate curcumin exposure from all edible sources and validate it among Thai consumers of curcuminoid-containing products. The validated questionnaire can be used in future studies to assess exposure and risk associated with curcumin.

Materials and Methods

Ethical aspects and setting

The protocol of this study was approved by the Mahidol University Central Institutional Review Board (MU-CIRB) of Mahidol University. The project ID is 2024/264.1806, and the COE number is 2024/109.1107.

Study design

This research is an observational study aimed at developing and assessing the content validity and test-retest reliability of a new questionnaire for estimating

curcumin exposure from various edible sources.

Research procedure

A Thai-language questionnaire was developed to estimate turmeric consumption by reviewing curcumin-containing herbal medicines and dietary supplement products approved by the Thai FDA, and common turmeric-based dishes. The online questionnaire consisted of four sections: screening questions, general information, turmeric product use, and intake of turmeric-containing meals. Seven experts assessed content validity, and the questionnaire was revised accordingly until a favorable validity was achieved. The validated questionnaire was then further evaluated for test-retest reliability. Thirty-three participants completed the online questionnaire twice, one week apart. Then, the correlation between the answers from the first and second rounds of the questionnaire was calculated. The steps in the development of the Food Frequency Questionnaire (FFQ) are illustrated in Figure 1.

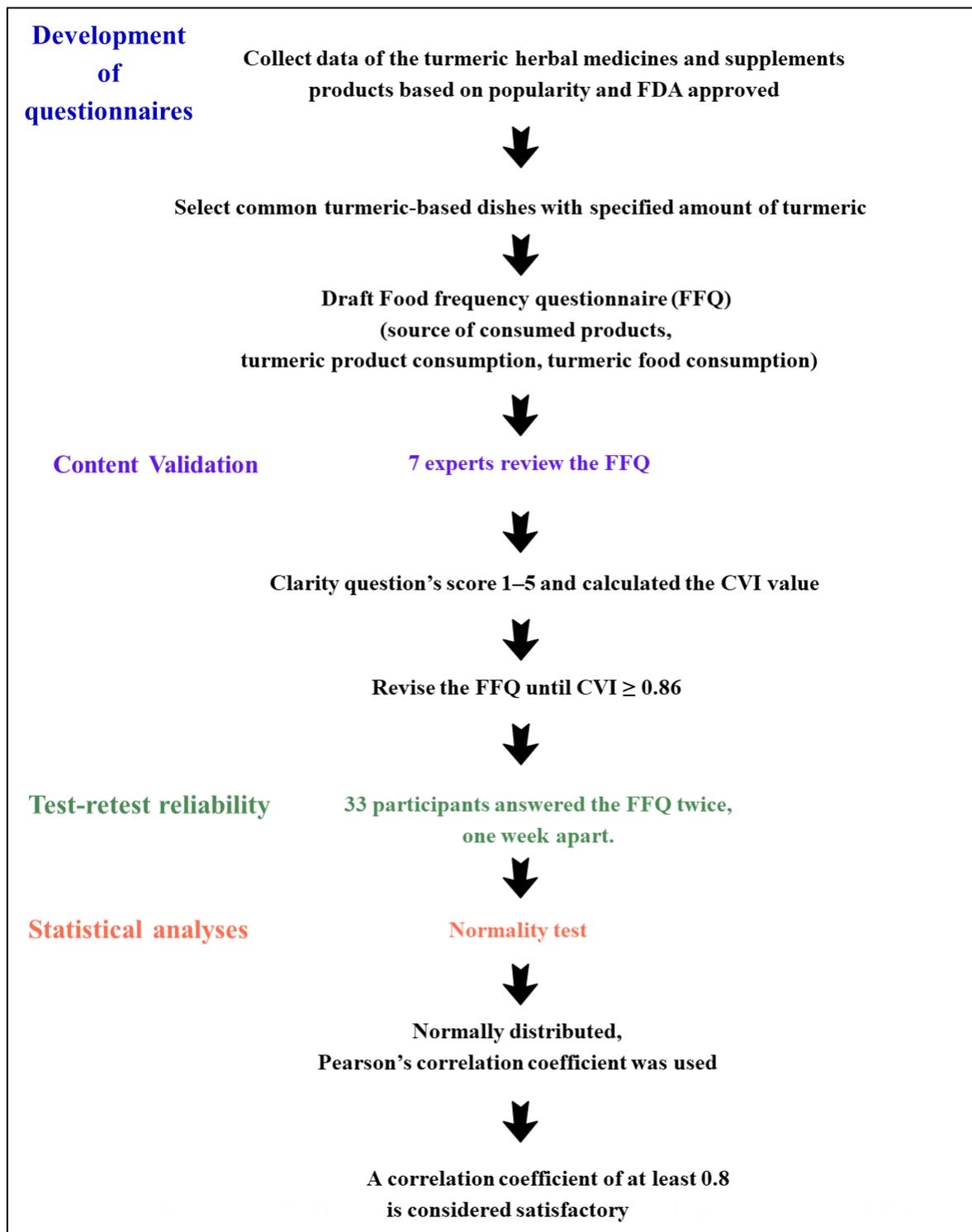


Figure 1. Procedures for development and validation of the questionnaire

Development of the questionnaire

The design of this new online questionnaire began with a search on the Thai Food and Drug Administration (FDA) databases for approved lists of herbal medicines and dietary supplements containing curcumin. Therefore, seven brands of herbal medicines and three brands of turmeric dietary supplements were identified based on commonly recommended turmeric products from online sources. Then, popular Thai turmeric-containing menus are compiled, including Southern-style sour soup, Southern Stir-Fried Pork with Yellow Curry Paste, boiled chicken with turmeric, Chicken Biryani, Satay, Ayam Golek, Southern Khanom Jeen Salad, Turmeric Grilled Chicken, Turmeric Fish Soup, Khao Soi, and White Turmeric. Ten popular and widely consumed turmeric-based dishes, with recipes specifying the amount of turmeric used, were selected from eight cooking-related websites¹⁶⁻²³. The developed questionnaire also allowed respondents to specify turmeric products or other turmeric-based dishes beyond the top ten chosen options.

Next, the questionnaire is created and divided into four sections: screening questions, general information, consumption of turmeric products, and intake of turmeric-containing meals. The questions of general information include weight, height, age, congenital disorders, gender, region of

residence, history of turmeric intake during pregnancy, and breastfeeding. Questions regarding the intake of turmeric products include the brand, the amount of daily consumption, the consistency and regularity of intake, the person who prescribes or suggests the use of these items, and the sources for turmeric products. This research selected the top ten popular products approved by the Thai Food and Drug Administration (Thai FDA), comprising seven brands of turmeric herbal medicine and three brands of turmeric dietary supplements. The list of popular products was selected based on four websites²⁴⁻²⁷. Respondents can add other brands by completing the questionnaires. For questions about the turmeric-containing food, eleven common menus are available. The question pertains to the quantity and frequency of meals consumed each week, as well as the consumption of a variety of turmeric-containing dishes in a single day. To estimate exposure to curcumin based on the questionnaires, the curcuminoid amounts in each product and menu had been compiled. The amount of curcuminoids in turmeric products was obtained from the label. If the % curcuminoid content on the label is absent, the standard value from the Thai Herbal Pharmacopoeia at 5% curcuminoid²⁸. Then, the value was multiplied by 0.77, as curcumin accounts for 77% of the total curcuminoids in commercial turmeric products²⁹.

The amount of turmeric used in the selected menus was estimated by averaging ingredient quantities from standard recipes collected from popular Thai online cooking platforms, including <https://cookpad.com/>, <https://www.wongnai.com/recipes/>, <https://cooking.kapook.com/>, and <https://www.thai-tastetherapy.com/>. The curcumin content per dish was then calculated using reference values for curcumin concentration in turmeric, as reported in the literature^{6,30}.

Content validation

The developed questionnaire was distributed to a panel of 7 specialists. For content validity, seven specialists in herbal product registration, toxicology, food science, home economics, contemporary medicine, traditional Thai medicine, and pharmacists evaluated the research instrument by assigning a score to each question. Each query was assessed by each expert on a scale of 1 to 5. The criteria for evaluation: 5 = extremely clear (comprehensible by all), 4 = quite clear (comprehensible by most individuals), 3 = fair (comprehensible but requiring a minor edit to enhance clarity), 2 = requires revision, and 1 = unacceptable (requires question modification). The scores were utilized to compute the content validity index. After review, the questionnaire was revised according to their recommendations until favorable content validity was attained.

Test-retest reliability

A previous study suggested that at least 30 participants were required for the test-retest reliability³¹. In this study, the inclusion criteria were healthy individuals aged 18 or above who had resided in Thailand for at least five consecutive years, had a history of consuming turmeric products within the past year, were proficient in Thai, and could complete the questionnaires online. Exclusions from this study were made based on the following criteria: (1) suspected of dementia; (2) prescribed antipsychotic medications; (3) diagnosed with liver illness; (4) confirmed with kidney disease. Participants were recruited via an announcement on social media platforms. In this study, thirty-three individuals who met the inclusion and exclusion criteria were recruited and provided consent by signing appropriate forms. Prospective participants in the research project were required to click on the link to complete the online screening process. Once the conditions were fulfilled, informed consent was obtained online. Next, the participants completed the initial set of surveys, which took about 5 minutes to complete. One week later, the researcher contacted the same participants via email to request their completion of the second round of questionnaires. Based on the correlation analysis, questions with notable variations in responses between the first

and second rounds were modified. Then, the participants were instructed to repeat the questionnaire filling, and the data were re-analyzed until satisfactory reliability was achieved.

Statistical analysis

The content validation index (CVI) was determined by dividing the number of experts who provided favorable judgments (score of at least 3 out of 5) by the total number of experts³². The CVI of each question was computed, and a CVI of 0.86 or above was considered acceptable. For the test-retest reliability since the data were normally distributed, Pearson's correlation coefficient was calculated to determine the relationship between the answers of the first and the second rounds. A correlation coefficient of at least 0.8 is considered satisfactory³³. All statistical analyses were performed using SPSS V. 26.

Results

Content validity of turmeric consumption

An initial review by seven experts resulted in an unsatisfactory content validity index. However, as shown in Table 1, after revision according to the experts' suggestions, all questions in the questionnaire achieved a content validity index of 1. As a result, the content validity is acceptable.

Test-retest reliability

As shown in Table 2, the study included 33 participants. Most of them are female, aged 23-59 years old, and living in the Northern part of Thailand. Almost seventy percent had a medical history. Most female participants never got pregnant or gave breastfeeding. Since there are three sections of turmeric-related questions in the questionnaire, as shown in Table 3, the correlation coefficients between the answers of the first and second tests of all three sections were between 0.869 and 0.997, with p-values < 0.01. Thus, the test-retest reliability of the questionnaire is considered satisfactory.

Table 1. The raw scores from seven experts with each item's content validity index (I-CVI)

Question No.	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Expert7	I-CVI
1	5	5	5	4	5	5	5	1
2	4	5	5	3	5	5	5	1
3	4	5	5	3	5	5	5	1
4	4	5	5	3	5	5	5	1
5	4	5	5	4	5	5	5	1
6	3	4	5	4	5	5	5	1
7	3	4	5	4	5	5	5	1
8	4	5	5	4	5	5	5	1
9	3	5	5	4	5	5	5	1
10	3	5	5	4	5	5	5	1
11	3	4	5	3	5	5	5	1
12	3	4	5	4	5	5	4	1
13	3	4	5	4	5	5	5	1
14	4	4	5	4	5	5	5	1
15	3	5	5	4	5	5	5	1
16	3	5	5	4	5	5	5	1
17	3	4	5	4	5	5	5	1
18	3	4	5	3	5	5	5	1
19	3	4	5	4	5	5	5	1
20	3	4	5	4	5	5	5	1
21	4	4	5	4	5	5	5	1
22	3	4	5	4	5	5	5	1
23	3	5	5	4	5	5	5	1
24	3	4	5	4	5	5	5	1
25	3	4	5	4	5	5	5	1
26	3	5	5	4	5	5	4	1
27	4	3	5	4	5	5	4	1
28	4	3	5	4	4	5	5	1
29	4	3	5	4	4	5	4	1
30	3	5	5	4	5	5	5	1
31	3	3	5	4	5	5	5	1
32	3	3	5	4	4	5	4	1

Scoring criteria: 5 = very clear (understandable by all), 4 = quite clear (understandable by most people), 3 = fair (understandable but minor edit would improve clarity), 2 = needs revision, 1 = unacceptable (needs question change).

Table 2. Characteristics of participants (n=33)

Characteristics		Mean ± SD	
Weight (kg)		61.43 ± 12.35	
Height (cm)		161.42 ± 8.31	
BMI (kg/m ²)		23.82 ± 4.26	

Characteristics		Number of persons	Percent (%)
Age	18 - 22	0	0.00
	23 - 43	22	66.67
	44 - 59	8	24.24
	60 - 80	3	9.09
Medical history	Yes	23	69.70
	No	10	30.30
Sex	Male	10	30.30
	Female	20	60.61
	LGBTQ+	1	3.03
	Not specified	2	6.06
Turmeric product consumption history • During pregnancy	Yes	1	3.03
	No	7	21.21
	Never pregnant	25	75.76
• During breastfeeding	Yes	0	0.00
	No	7	21.21
	Never give breastfeeding	26	78.79
Domicile	Northern region	16	48.48
	Central region	3	9.09
	Northeastern region	3	9.09
	Southern region	5	15.15
	Eastern region	5	15.15
	Western region	1	3.03

Table 3. Pearson's correlation coefficients between the first and second answers of the Turmeric-containing Product, Turmeric-containing food Consumption, and the source of the product sections of the questionnaire

Consumption Data	Coefficient value	p-value
Turmeric product consumption	0.997	< 0.01
• Herbal medicine	0.995	< 0.01
• Dietary supplement	1.000	< 0.01
Turmeric food consumption	0.869	< 0.01
Source of Product	0.918	< 0.01

Discussion

This study developed and validated a Thai-language questionnaire to estimate curcumin exposure from turmeric-containing products. The CVI achieved a value of 1, suggesting that the questionnaire items were relevant and representative of turmeric consumption, thereby confirming adequate content validity. Test–retest reliability for the turmeric product consumption, turmeric food consumption, and source of product sections yielded correlation coefficients of 0.997, 0.869, and 0.918, respectively, suggesting that the FFQ produced consistent responses over time. The questionnaire demonstrated satisfactory content validity and test–retest reliability. Together, these results indicate that the newly developed FFQ is both valid and reliable for assessing curcumin exposure, confirming its suitability as a data collection tool. To our knowledge, this is the first questionnaire that comprehensively covers

curcumin exposure from edible sources, including turmeric herbal medicines, dietary supplements, and turmeric-based food items.

In comparison to previous studies, this research offers a more inclusive approach. For instance, Hashemian et al. utilized a Food Frequency Questionnaire (FFQ) focused on dietary turmeric intake, but excluded medicinal products¹³. Similarly, Kwon's study in Korea used 24-hour recall data, focusing on food intake without assessing turmeric product use, which resulted in an underestimated exposure¹⁴. In Europe, particularly in the UK, exposure assessments conducted by the EFSA focused primarily on food data from national surveys, excluding herbal medicines and supplements¹⁵. This may have led to lower exposure estimates. In contrast, our current study accounted for both medicinal and dietary sources, including brand-specific product intake,

frequency, dosage, and consumption habits. By incorporating all potential sources, including high-concentration herbal products, the present study provides a more comprehensive estimation of curcumin exposure.

Besides covering all edible sources, this study develops a questionnaire on an online basis, which is useful for future applications. The questionnaire captured details such as daily intake amounts, frequency, and continuity of consumption, providing relevant data for a risk assessment. Consistently, the study by Hashemian et al. also utilized a validated questionnaire to roughly estimate turmeric consumption¹³. However, such an approach may not be suitable for risk assessment because the extracted data did not have implications for high-curcumin product consumers, such as those who take turmeric herbal medicine. Our current study developed a questionnaire to estimate the amount of curcumin exposure among turmeric consumers. Therefore, it is more appropriate for future risk assessment studies that have important implications for high-risk groups, including regular users of turmeric herbal medicines and dietary supplements and populations with culinary preparation turmeric intake. These individuals are more likely to exceed the acceptable daily intake (ADI) of curcumin, which has been associated with

hepatotoxicity and other adverse health effects.

This study has several strengths. First, the questionnaire was developed based on reliable evidence, including governmental databases and literature. Second, it was carefully validated by experts from various fields, including medical professionals, scientists, and regulators for food, products, and herbal medicines. Third, the test-retest reliability test was conducted with a one-week gap between the first and second rounds of the questionnaire. Nevertheless, some limitations should be noted. First, the questionnaire selects popular turmeric products based on 4 websites. Therefore, it may not cover all kinds of products. Some food products such as beverages, medical foods, and food products containing curcumin as food additive are not included. Nevertheless, for additive application, food industry usually use a trace amount of curcumin as coloring agent (much lower amount of curcumin than those of herbal medicines or dietary supplement). For medical food, the target group is more likely specific groups of patients. Thus, this questionnaire is more suitable for general population. However, future studies can further modify the questionnaire to be used in specific patients. Second, the curcumin content was estimated based on product labeling, which may not reflect actual concentrations. Laboratory verification

using analytical methods³⁴ is recommended in future studies. Third, the use of convenience sampling via online platforms may not represent the full geographic and demographic diversity of Thailand. In this study, the Northern Thai population appears to be dominant, while the Southern population, where turmeric consumption is traditionally high, was recruited in small percentages. A stratified sampling approach should be considered in future studies to ensure an even distribution across the region and reduce bias³⁵. Fourth, reliance on self-reported online surveys may introduce reporting bias. Future studies, if possible, should include both an online survey with a large sample size and face-to-face interviews with a small group to obtain more accurate responses.

Conclusion

This study developed and validated a Thai-language questionnaire to estimate curcumin exposure from all edible sources. The developed questionnaire achieved a content validation index of 1. The test-retest reliability had correlation coefficients of 0.997, 0.869, and 0.918 for the turmeric product consumption, turmeric food consumption, and source of product sections of the questionnaire, respectively. The instrument demonstrated acceptable levels of content validity and test-retest reliability, covering a range of curcumin sources

including herbal medicines, dietary supplements, and turmeric-containing foods. While further validation in broader populations is recommended, the questionnaire provides a promising tool for supporting future research. This tool may serve as a helpful starting point for evaluating curcumin exposure from turmeric intake and supporting future safety assessments in Thai consumers.

Acknowledgment

The authors thank the seven experts for reviewing the questionnaire in the content validity process and all participants in the test-retest reliability study.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

1. Liu S, Liu J, He L, *et al.* A comprehensive review on the benefits and problems of curcumin with respect to human health. *Molecules* 2022; 27(14): 4400.
2. Kotha RR, Luthria DL. Curcumin: biological, pharmaceutical, nutraceutical, and analytical aspects. *Molecules* 2019; 24(16): 2930.
3. Neira M, Mena C, Torres K, *et al.* The potential benefits of curcumin-enriched diets for adults with colorectal cancer: a systematic review. *Antioxidants* (Basel) 2025; 14(4): 388.
4. Daily JW, Yang M, Park S. Efficacy of turmeric extracts and curcumin for alleviating the symptoms of joint arthritis: a systematic

- review and meta-analysis of randomized clinical trials. *J Med Food* 2016;19(8):717-29
5. Tian WW, Liu L, Chen P, et al. *Curcuma Longa* (turmeric): from traditional applications to modern plant medicine research hotspots. *Chin Med* 2025; 20(1):76.
 6. Horticultural Research Institute, Department of Agriculture. Academic documents: *Curcuma longa* L, 2023. Available at: <https://www.doa.go.th/hort/wp-content/uploads/2023/02/เอกสารวิชาการ-ขมิ้นชัน-กลุ่มวิชาการ-สวส.pdf>, accessed on Jul 13, 2025.
 7. The Nation Public Health Ministry promotes Thai traditional medicine, 2024. Available at: <https://www.nationthailand.com/news/general/40039821>, accessed on Sep 14, 2023.
 8. Trade Policy and Strategy Office (TPSO). Trade opportunities of Thai herbal products: a case study of turmeric, 2022. Available at: https://uploads.tps.go.th/2022-09-11_raayngaankhminchbabyaaw_final.pdf, accessed on Sep 14, 2025.
 9. Department of Thai Traditional and Alternative Medicine. National action plan on herbal medicines, No. 2, 2566-2570, 2023. Available at: <https://www.dtam.moph.go.th/dtam-action-plan/>, accessed on Sep 14, 2025.
 10. Food and Drug Administration, Herbal products division. National list of essential Herbal medicines, 2023. Available at: <https://herbal.fda.moph.go.th/media.php?id=565337537405657088&name=2023-11-15%20ebook%20D3.pdf>, accessed on Sep 11, 2023.
 11. Grand view research. herbal medicine market (2024–2030), 2024. Available at: <https://www.grandviewresearch.com/industry-analysis/herbal-medicine-market-report>, accessed on Sep 11, 2025.
 12. European Food Safety Authority. Refined exposure assessment for curcumin (E 100). *EFSA J.* 2014; 12(10): 3876.
 13. Hashemian M, Poustchi H, Murphy G, et al. Turmeric, pepper, cinnamon, and saffron consumption and mortality. *J Am Heart Assoc* 2019; 8(18): e012240.
 14. Kwon Y. Estimation of curcumin intake in Korea based on the Korea National Health and Nutrition Examination Survey (2008-2012). *Nutr Res Pract.* 2014; 8(5):589-94.
 15. Committee on Toxicity of Chemicals in Food, consumer products and the environment (COT). First draft statement on the potential risk to human health of turmeric and Curcumin, 2022. Available at: <https://cot.food.gov.uk/First%20draft%20statement%20on%20the%20potential%20risk%20to%20human%20health%20of%20turmeric%20and%20curcumin>, accessed on Sep 12, 2025.
 16. Wongnai. 10 Turmeric recipes: bringing the home herb into delicious dishes, 2025. Available at: <https://www.wongnai.com/cooking/cookbooks/recipes-from-turmeric>, accessed on Sep 14, 2025.
 17. Cookpad. Turmeric recipes: aromatic and beneficial dishes you can easily make at home, 2025. Available at: <https://cookpad.com/th/search/ขมิ้น>, accessed on Sep 14, 2025.
 18. Office of Agricultural Economics. Chachoengsao local wisdom: turmeric, 2024. Available at: https://www.opsmoac.go.th/chachoengsao-local_wisdom-preview-431491791864, accessed on Sep 14, 2025.
 19. Salehere. 6 Turmeric recipes: fragrant and herbal dishes, 2023. Available at: <https://salehere.co.th/articles/giving-away-turmeric-menu-recipes>, accessed on Sep 14, 2025.

20. Naamchoop. Turmeric and black pepper: Traditional Thai herbal combination, 2024. Available at: [https://www.naamchoop.com/port_detail.php?port_id=63&port_name=ไ้ก้ขมิ้นและ%20\(ปีตดาณี](https://www.naamchoop.com/port_detail.php?port_id=63&port_name=ไ้ก้ขมิ้นและ%20(ปีตดาณี), accessed on Sep 14, 2025.
21. Wongnai. Restaurants with turmeric dishes in Thailand, 2025. Available at: <https://www.wongnai.com/restaurants?regions=1&productTags=49&page.number=1&page.size=10&rank=false&domain=1>, accessed on Sep 14, 2025.
22. Mahidol University, Institute of Nutrition. Southern Thai-style rice noodles with turmeric curry and shrimp paste dip, 2025. Available at: https://inmu.mahidol.ac.th/gallery/inmucooking/South_food/ขนมจีนน้ำพริกน้ำชาปีกษ์ใต้.html, accessed on Sep 14, 2025.
23. SGE Thailand. Khao Soi (Northern Thai-style curry noodle soup), 2025. Available at: <https://recipe.sgethai.com/recipes/khao-soi/>, accessed on Sep 14, 2025.
24. Best review Asia. Best turmeric extract supplements. Available at: <https://bestreview.asia/best-turmeric-extract-supplements/>, accessed on Sep 14, 2023.
25. Thai Health Promotion Foundation. Apichai Kwarangwanphol receives product award, 2018. Available at: <https://www.thaihealth.or.th/เอก-คว้ารางวัคผลิดกัณฑ์ส/>, accessed on Sep 14, 2025.
26. Ouay Un Osoth Co., Ltd. Kaminchan plus capsule (60 capsules). Available at: <https://shop.ouayun.com/en/product/68427/product-68427>, accessed on Sep 14, 2023.
27. Top10 Thailand. Turmeric capsules: best products review. Available at: <https://www.top10.in.th/สุขภาพ/ขมิ้นชันแคปซูล-อี้ห้อ/>, accessed on Sep 14, 2025.
28. Bureau of Drug and Narcotics, Department of Medical Sciences, Ministry of Health. Thai Herbal Pharmacopoeia 2021 Supplement 2023. Available at: <https://bdn-thp.dmsc.moph.go.th/ebook/qQycBUtlpR9gC3q0GT5gMJq0qT5co3uw>, accessed on Jul 13, 2025.
29. Sharifi-Rad J, Rayess YE, Rizk AA, *et al.* Turmeric and its major compound curcumin on health: bioactive effects and safety profiles for food, pharmaceutical, biotechnological and medicinal applications. *Front Pharmacol* 2020; 11: 01021.
30. Bos R, Windono T, Woerdenbag HJ, *et al.* HPLC-photodiode array detection analysis of curcuminoids in *Curcuma* species indigenous to Indonesia. *Phytochem Anal* 2007; 18(2): 118-22.
31. Bujang MA, Omar ED, Foo DHP, *et al.* Sample size determination for conducting a pilot study to assess reliability of a questionnaire. *Restor Dent Endod* 2024; 49(1): e3.
32. Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? critique and recommendations. *Res Nurs Health* 2006; 29(5):489-97.
33. Polit DF. Getting serious about test-retest reliability: a critique of retest research and some recommendations. *Qual Life Res* 2014; 23(6): 1713-20.
34. Kotra VSR, Satyabanta L, Goswami TK. A critical review of analytical methods for determination of curcuminoids in turmeric. *J Food Sci Technol* 2019; 56(12): 5153-66.
35. Christensen JM. Human exposure to toxic metals: factors influencing interpretation of biomonitoring results. *Sci Total Environ* 1995; 166: 89-135.