

Validity comparison of CAT (caries risk assessment tool) and CAMBRA (caries management by risk assessment) on children: a rapid review

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ABSTRACT Caries Risk Assessment (CRA) focuses on caries prevention than restorative approaches. Caries Management by Risk Assessment (CAMBRA) and Caries Risk Assessment Tool (CAT) are examples of manual charting CRA methods that were made to make it easier for clinicians and non-clinicians. This study aims to compare the validity of CAMBRA and CAT as CRA for children. This study is a rapid review and uses articles as research samples. Systematic searching was carried out using the PRISMA diagram. This study uses PubMed and Science Direct databases. This study includes randomized controlled, cohort, and methodological studies reporting the validity of CAT and CAMBRA methods on children published from 2011-2021. Searching strategy for this study is (children) AND (dental caries) AND (risk assessment) AND ((CAT) OR (CAMBRA) OR (AAPD)) AND (validity). Articles that meet the inclusion criteria will be extracted and discussed. One hundred three articles were identified, and only five articles met the inclusion criteria. Modified CAT by adding the patient's *Streptococcus mutans* examination without asking the patient's social-economic status has the highest validity value. The method with the lowest validity value in this study is the unmodified CAT method. Both CAMBRA and CAT validity are still limited. The evidence is still low. CAT has high sensitivity score but a low specificity value, while the CAMBRA method has a different validity value for each reported article.

KEYWORDS: Caries risk assessment, children, Caries Management by Risk Assessment (CAMBRA), Caries Risk Assessment Tool (CAT), validity

INTRODUCTION

Caries are a major dental and oral problem in Indonesia. According to *Riset Kesehatan Dasar* (Riskesdas) data, in 2018 there were 57.6% of Indonesians had dental and oral problems. The World Health Organization has targeted at least 90% of 5 years old children to be free from dental caries. However, Riskesdas 2018 data showed that the highest caries prevalence in Indonesia occurs in children aged 5-6 years, with a prevalence value of 93%, meaning that only 7% of children are free of caries. The DMF-T (Decay Missing Filled Teeth) index in 12-year-olds in Indonesia is close to 2, even though the targeted DMF-T index value for 12-year-olds should be less than 1.^{1,2}

Lack of prevention can cause the high prevalence of caries in children. Caries are a

multifactorial disease, so it is not enough to treat it simply by restoration treatment.³⁻⁵ According to the American Academy of Pediatric Dentistry (AAPD), caries risk assessment is a method to assess the likelihood of caries occurrence (number of new secondary lesions or initial lesions) over a period, or there may be a change in size or activity of an existing lesion. Caries risk assessment can determine preventive measures and appropriate dental and oral health treatment.

Several caries risk assessment methods have been developed for children. In general, caries risk assessment methods in children can be divided into two methods: using software (Cariogram, PreViser, and National University of Singapore-Caries Risk Assessment Tool) and manual charting methods

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(Caries Risk Assessment Tool and Caries Management by Risk Assessment).⁶ The Cariogram method and the National University of Singapore-Caries Risk Assessment Tool (NUS-CRA) require software that guides clinicians through data collection by asking doctors to assign a risk score for each variable, including caries experience, plaque, diet, bacterial count through saliva testing, and salivary secretion. The manual charting method integrates standardized questions with patient health records in a questionnaire. Thus, it is hoped that the manual charting method can be used not only by clinicians but also by non-clinicians because it is considered more accessible to understand.⁷

However, using different caries risk assessment methods can result in varying risk assessments even when performed on the same patient. Each manual charting method has an assessment factor in

determining a person's caries risk level.^{6,8} The CAT method was first introduced by the American Academy of Pediatric Dentistry. (AAPD) in 2002 and aims to simplify the caries risk assessment method in the form of a questionnaire. In the CAT method, a patient will enter the high caries risk group if at least one "high risk" indicator is identified and enter the low caries risk group if the patient does not have any "medium risk" and high-risk indicators" at all.⁷ The CAMBRA method groups patients at low, moderate, and high caries risk by looking at the caries balance and comparing all the pathological and protective factors present in the patient. The purpose of this study was to compare the validity of CAT and CAMBRA as a caries risk assessment method in children

MATERIALS AND METHODS

Tools

The research was conducted in 2021 using electronic devices such as laptops and database search programs, namely PubMed and Science Direct. The Mendeley Reference Manager application was used as a reference storage program.

Materials

This study's research sample is an article comparing the validity of the Caries Risk Assessment Tool (CAT) and Caries Management by Risk Assessment (CAMBRA) methods as caries risk assessment methods in children. The search used two databases, Science Direct and PubMed, using a predetermined search strategy.

Procedures

This rapid review followed the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) guidelines.⁹ Rapid review is a form of combining the knowledge that is carried out by simplifying the components of a systematic review to produce brief information.¹⁰ Operational definition of the CAT method or The Caries-risk Assessment Tools in question is a caries risk assessment method published by the AAPD and designed for children 0 to 3 years and 0 to 5 years as well as people aged six years above. Patients can be considered high risk if one high-risk factor has been identified and vice versa. The Western CAMBRA Coalition publishes the CAMBRA method or Caries Management by Risk Assessment. CAMBRA is designed for children ages 0 to 5 years and six years above. A person is classified as low, moderate, high,

or extremely high risk based on clinical judgment and a balance between disease indicators and risk, pathological, and preventive risk factors. The definition of validity in this study is the assessment tool's accuracy in classifying the caries risk of patients in terms of sensitivity, specificity, the sum of sensitivity, and specificity values.

The search strategies in this study include (children) AND (dental caries) AND (risk assessment) AND ((CAT) OR (CAMBRA) OR (AAPD)) AND (validity). Article selection began with searching from two databases and screening multiple articles. Abstracts are independently reviewed, and irrelevant articles that did not meet the inclusion criteria will be removed. The inclusion criteria in this study were articles of randomized controlled studies, prospective cohort studies, methodological studies that discussed the validity of CAT and CAMBRA in pediatric patients, included the follow-up data, published in 2011-2021, and used English.

The exclusion criteria for this study were articles that did not discuss caries risk assessment using the CAMBRA and CAT methods, review articles using adult patients as participants, did not have the follow-up data, published before 2011, and not written in English. After screening reports based on abstracts, full-text articles were reviewed to decide whether they should be included. Articles that meet all inclusions will then be extracted and analyzed. The data form was used to extract data from articles that met the inclusion requirements. The data extracted from each article included the researcher's name, year and duration of the study,

participant details (sample size, country), caries risk assessment model used, and research results.

The validity of the CAMBRA and CAT methods was assessed by looking at the sum of the sensitivity and specificity values of the extracted data for each article. Truth is measured by sensitivity and specificity. Sensitivity is the ability of the test to classify a person's risk of caries correctly. At the same time, specificity is defined as the ability of a test to classify individuals who are not at risk of caries accurately.

According to Mejare et al.¹¹, method validity was assessed in three levels according to the sum of sensitivity and specificity: moderate/good: 150, limited/<150 but 130, and poor/<130. The results of specificity and sensitivity data from articles regarding research using CAT and CAMBRA as caries risk assessment methods were included to compare the validity of the two methods. Tables of sensitivity and specificity were created to facilitate the assessment of results from various studies

Assessment of Odd Ratio (OR), Negative Predictive Value (NPV), Positive Predictive Value (PPV), Area Under Curve (AUC) is also often an additional assessment in seeing the validity of caries

risk assessment. The odds ratio (OR) measures the relationship of risk factors with disease incidence.¹² Positive Predictive Value (PPV) is the proportion of patients with negative test results who do not have the disease. Positive Predictive Value (PPV) is the proportion of patients who test positive and have the disease.¹³ Area Under Curve (AUC) is used to determine the quality of a diagnostic test.¹⁴

The initial search for articles was conducted using two databases, Science Direct and PubMed, using a predetermined search strategy. Initial search results obtained 103 with details of 72 articles from the PubMed database and 31 from the Science Direct database. Three duplicate articles were removed in the initial screening stage, leaving 100 articles remaining.

The screening process by sorting out the title and abstract of the article to get the study results continued with the second stage 74 articles were removed because the articles did not discuss caries risk assessment/irrelevance (20 articles), and the study method used was the review method (23 articles), there was no data regarding the use of caries risk assessment in articles (12 articles).

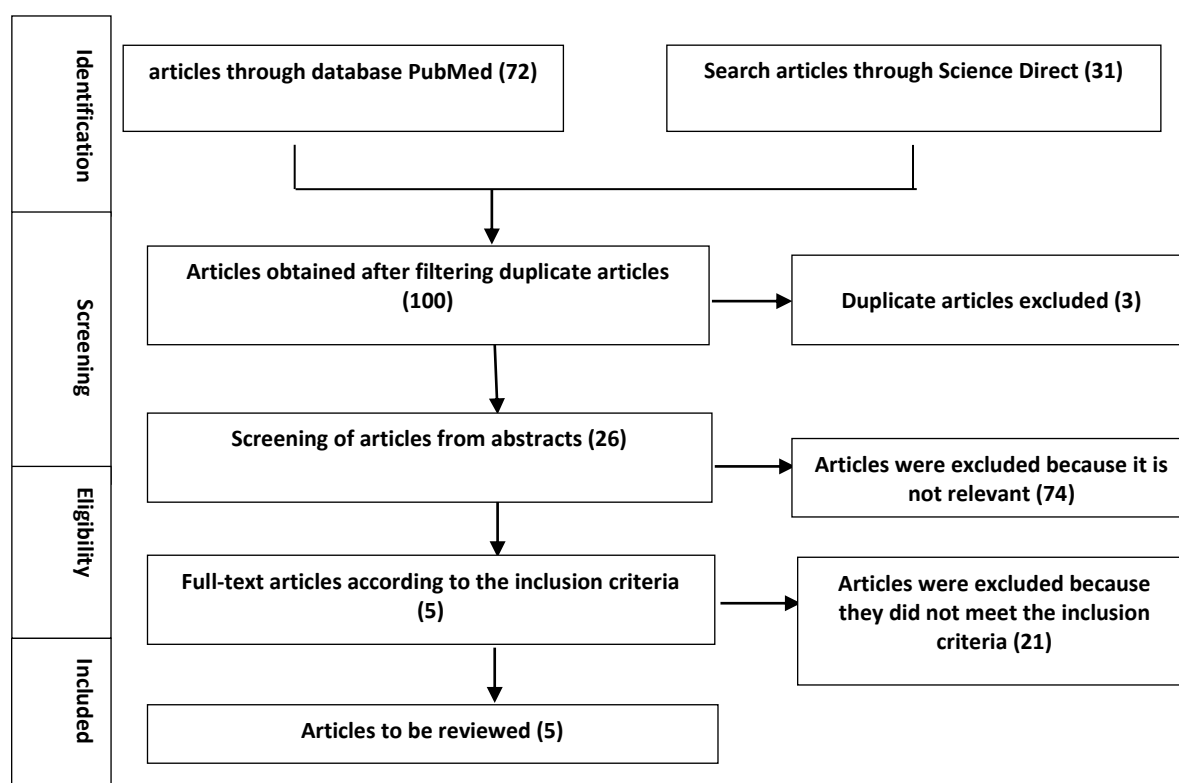


Figure 1 Flowchart of article search based on the PRISMA method

The final screening was carried out by reading 26 articles in full text so that there were 21 articles removed because the study method used was the

review method (7 articles), there was no data on the use of caries risk assessment in the study (3 articles), there was data on the use of caries risk assessment

but not the CAMBRA or CAT method (9 articles), and the research subjects did not match the inclusion (2 articles). Obtained 5 full-text articles that

meet the inclusion criteria and will be analyzed. The research procedure is briefly shown in Figure 1.

RESULTS

Five articles were identified with inclusion criteria from Australia¹⁵, India¹⁷, United States^{16,18}, and Hong-Kong³. Four articles^{3,16-18} used a cohort prospective study design, and one article¹⁵ used a methodological study model. No article used a randomized controlled study model. All papers included follow-up data with a study duration ranging from 1 to 4 years.

The research sample included is children aged 0-18 years. An article¹⁵ had a selection aged 18 months, two articles^{3,18} reported using a sample age of 0-3 years, one article¹⁶ had a sample aged 2-5 years, and only one article¹⁷ reported using a piece aged 12-13 years.

The validity of the CAMBRA method was assessed on three articles¹⁵⁻¹⁷, while the CAT was

evaluated in one article¹⁸. One article³ assessed the comparative validity of the CAT and CAMBRA methods. Three articles¹⁵⁻¹⁷ list Area Under Curve (AUC) as an additional outcome measure. One article¹⁸ added other outcome measures in the form of Negative Predictive Value (NPV) and Positive Predictive Value (PPV). Only one article¹⁷ lists the Odd Ratio (OR) as an additional outcome measure.

Christian divided data into 36 months and 48 months.¹⁵ d Yoon et al.¹⁸ assessed the validity of the CAT under three conditions, namely when using the CAT method without modification, when using the CAT method without asking for social and economic status and without testing for *Streptococcus mutans*, and when using the CAT method without asking for social and economic status.

Table 1 Summary of the Results

Author (Years)	Study Model (Country)	Number of samples baseline	Age baseline	Research design	Caries risk assessment model	Outcome measure	Outcome
Christian et al ¹⁵ (2020)	Methodological study (Australia)	214	18 months	4 years	CAMBRA	Se, Sp, AUC	36 months: Se:74 Sp: 35 48 months Se: 70 Sp: 36 AUC:0.48
Agouropoulos et al ¹⁶ (2019)	Cohort prospective study (United States)	175	2-5 years	2 years	CAMBRA	AUC	AUC:0.732
Sudhir et al ¹⁷ (2016)	Cohort prospective study (India)	72	12-13 years	2 years	CAMBRA	Se, Sp, OR AUC	Se:47.62 Sp:80 AUC:0.638 Highest OR indication: restoration last 3 years (7.31) Highest OR pathology factor: Examine <i>Streptococcus mutans</i> (7.15) Highest OR protective factor: use of toothpaste containing fluoride (0.56)

Author (Years)	Study Model (Country)	Number of samples baseline	Age baseline	Research design	Caries risk assessment model	Outcome measure	Outcome
Gao et al ³ (2013)	Cohort prospective study (Hong Kong)	544	0-3 years	1 years	CAMBRA, CAT	Se, Sp	CAT Se: 100.0 Sp: 3.6 CAMBRA Se: 83.7 Sp: 62.9
Yoon et al ¹⁸ (2012)	Cohort prospective study (United States)	471	0-3 years	3 years	CAT	Se, Sp, PPV, NPV	CAT without Streptococcus mutans examine Se:100 Sp:2.9 CAT without checking socioeconomic status Se:85.6 Sp:68.6 CAT without examination of socioeconomic status plus examination of Streptococcus mutans Se:95.2 Sp:65.7 Factors with the highest NPV and PPV values: Streptococcus mutans examination (92,5;87.9)

Sp: Specificity, Se: Sensitivity, NPV: Negative Predictive Value, PPV: Positive Predictive Value, AUC: Area Under Curve, OR: Odd Ratio

The sensitivity and specificity values varied with a range of 47.62%¹⁷ to 100%¹⁸ for sensitivity and 2.9%¹⁸ to 80%¹⁷ for specificity. The highest validity value in this study was 160.9, namely research on children 0-3 years using the CAT assessment method without asking for social and economic status and using the Streptococcus mutans bacteria examination with a sensitivity value of 95.2 and a specificity value of 65.7.¹⁸ The smallest validity value is 102.9 with exact values sensitivity of 100 and specificity value of 2.9, namely the assessment of the CAT method without modification.¹⁸

This study was conducted to compare the validity of CAT and CAMBRA as caries risk assessment methods in children. The CAT or Caries-risk Assessment Tools in question is a caries risk assessment method published by the AAPD. The CAT method is designed for children 0 to 3 years, 0 to 5 years, and people six years or older.¹⁹ The CAMBRA method or Caries Management by Risk Assessment is published by the Western CAMBRA Coalition. Both ways are designed for children aged 0 to 5 years and those six years or older.²⁰

Table 2. Validity Assessment of the CAT and CAMBRA methods

Caries risk assessment model (CAT/ CAMBRA)	Author (Years)	Age baseline	Number of factors used	Sensitivity (%)	Specificity (%)	Se + sp	Validity
CAMBRA	Christian et al. ¹⁵ (2020)	18 months	Full	Follow up 36 months			
				74	35	109	Poor
				Follow up 48 months			
				70	36	106	Poor
	Sudhir et al. ¹⁷ (2016)	12-13 years	Full	47.62	80	127.62	Poor
	Gao et al. ³ (2013)	0-3 years	Full	83.7	62.9	146.6	Limited
CAT	Yoon et al. ¹⁸ (2012)	0-3 years	Full	100	2.9	102.9	Poor
			(-2 Factor) ^b	85.6	68.6	154.2	Limited
			(-1 Factor) ^c	95.2	65.7	160.9	Good
	Gao et al. ³ (2013)	0-3 years	Full	100	3.6	103.6	Poor

^a: don't use factors "mother / primary caregivers had active caries" and "low health knowledge."

^b: don't use factors "examination of Streptococcus mutans bacteria" and "family socioeconomic status."

^c: don't use the factor "family socioeconomic status."

There are several differences between the CAMBRA and CAT methods in determining whether a person is in a low, moderate, high, or extreme caries risk group. The CAT method assesses children from immigrant families as children with high caries risk, while in CAMBRA, this does not meet the assessment criteria. The CAMBRA assessment requires evaluating the number of Streptococcus mutans and Lactobacillus bacteria, while in CAT, it is only necessary to determine the quantity of Streptococcus mutans bacteria alone.^{21,22} Use of hyposalivation medication, bottomless pits and fissures, use of narcotic drugs, and visible roots of teeth are also risk factors asked in this study. CAMBRA method but not asked on CAT method.²⁰

The CAT method considers a patient to be a person at high caries risk when one has at least one identified high-risk factor. Meanwhile, in CAMBRA, a patient is regarded as a person with high caries risk when the patient shows one of the indications of disease, such as caries, previous caries history, and plaque examination on an intraoral examination performed. The CAMBRA method also includes an extreme caries risk group when the patient has a low salivary rate.²⁰

The results of a study conducted by Christian et al. ¹⁵ on children aged 18 months showed a high sensitivity value and low specificity. Most of the study population at the initial examination had a high caries risk. There were no significant differences in sensitivity and specificity values at 24 and 36 months of follow-up. The lack of a good

CAMBRA validity value can occur due to the lack of a clear definition of each CAMBRA criterion, so sometimes clinicians make their definition of each characteristic. The validity of the CAMBRA method for 18-month-old children in Australia can also be seen from the Area Under Curve (AUC) value. The AUC is a measure of the overall quality of a diagnostic test.¹⁴ CAMBRA's AUC is close to 0.50, indicating a lack of caries risk assessment ability to predict future caries development.^{15,17}

Research conducted on children 12-13 years old using the CAMBRA method has a low validity value.¹⁷ Based on the Odds Ratio (OR) value, the disease-indicating factor that has a high predictive value is restoration in the last three years. The pathological factor that has the highest predictive value is Streptococcus mutans examination, and the protective element that has the highest predictive value is the use of toothpaste containing fluoride.¹⁷

Compared with the CAMBRA method, the results of the CAT method assessment in children 0-3 years old by Gao et al. ³ showed a very high sensitivity value, namely 100% but a meager specificity value, namely 2.9%. A shallow specificity value can cause patients to get extreme care even though one of the functions of a caries risk assessment is to allocate resources and prioritize care for those at risk of developing the disease.^{3,23} This can happen because a patient will go into the high caries risk group if at least one "high risk" indicator is identified and into the low caries risk

group if the patient does not have any "medium risk" and high-risk indicators at all.⁷

There are differences in the validity of the CAMBRA and CAT methods, which have been modified. The CAMBRA method requires collecting data on the caries experience of family members. Still, this information was not available in the study by Agouropoulos et al.¹⁶. The results of the validity of the CAMBRA study by Agouropoulos et al.¹⁶ differ from those conducted by Christian et al.¹⁵ and Gao et al.³ because it eliminates family risk factors, in particular, "mother/main caregiver has active caries" and "low health knowledge" and results in higher specificity values. Tall. The modification of CAMBRA by Agouropoulos et al.¹⁶ produces an AUC value of 0.732 which means it is good because the AUC threshold value is 0.7.¹⁶

Yoon et al.¹⁸ also assessed the modified validity of the CAT method and produced different validity values. After ignoring socioeconomic status, the most influential criteria were gingivitis or visible plaque, sugar exposure between meals, maternal caries experience, and fluoride exposure. The *Streptococcus mutans* assessment has the highest

overall sensitivity and specificity of 86.5% and specificity of 93.%. Not including family socioeconomic factors in the CAT method can significantly increase the specificity value, while increasing the *Streptococcus mutans* measurement in the CAT method results in an increase in overall validity.¹⁸

The results of the review of this study are in line with previous systematic reviews, which stated that the validity of CAT and CAMBRA is still limited.¹¹ The CAT and CAMBRA methods are considered to overestimate the caries risk of children because one finding in the high-risk category will categorize the child as having a high caries risk.⁸ No studies have shown any significant adverse effects from the use of the CAT or CAMBRA methods.

The obstacles to doing this review are differences in the population criteria used, different versions, follow-up time, and modifications to the caries risk assessment used, making it difficult to compare the validity of the two methods. More research is needed on the truth of CAMBRA and CAT in children

CONCLUSION

Based on the found articles, the validity of CAT and CAMBRA is still limited. There is also low evidence for articles. The CAT method has

high sensitivity and low specificity, while the CAMBRA method has different validity values reported from each article.

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