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Diagnostic Accuracy of Smartphone-Based Intraoral Photography for Detection of Dental Caries: A Clinical Study

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BSTRACT

Background: Smartphone-based intraoral photography may support remote dental screening, but its diagnostic performance depends on image quality, lesion characteristics, and the reference standard. This analysis demonstrates how diagnostic accuracy could be reported.

Objective: To estimate the hypothetical diagnostic accuracy of smartphone-based intraoral photographs for detecting dental caries compared with a standardized clinical visual examination.

Methods: A synthetic study representing 200 adults and one index tooth per participant was constructed. Clinical examination was treated as the reference standard and smartphone photograph interpretation as the index test. Caries was classified as present or absent using a binary threshold. Sensitivity, specificity, predictive values, accuracy, likelihood ratios, and Cohen's kappa were calculated.

Results: In the study, 80/200 index teeth were carious by the reference standard. Smartphone assessment correctly identified 68 positive and 102 negative cases, with 12 false-negative and 18 false-positive results. sensitivity was 85.0%, specificity 85.0%, positive predictive value 79.1%, negative predictive value 89.5%, and overall accuracy 85.0%. Cohen's kappa was 0.69.

Conclusion: The synthetic example demonstrates a framework for evaluating smartphone-based caries screening. These estimates are not clinical evidence. Actual prospective validation using a prespecified protocol, blinded interpretation, and an appropriate reference standard is required before clinical implementation.

Keywords: dental caries; smartphone; intraoral photography; diagnostic accuracy; teledentistry; sensitivity; specificity.

INTRODUCTION

Dental caries remains a major, preventable oral-health condition and may progress from early enamel changes to cavitation and pulpal involvement when not detected and managed appropriately. Timely identification is important for preventive intervention, risk-based recall, and minimally invasive treatment. Conventional diagnosis relies on a structured clinical examination, supported where indicated by radiographic assessment and other adjunctive methods.

Digital photography has become increasingly accessible through smartphone cameras. Intraoral photographs can be transmitted to dental professionals and may facilitate triage, referral prioritization, patient communication, and teledentistry, particularly when direct access to dental services is limited. These developments form part of a

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broader movement toward technology-enabled dental care and education, including emerging digital and immersive approaches [7]. However, photographic assessment is not equivalent to a complete clinical examination. Image capture may be affected by illumination, focus, moisture, saliva, plaque, angulation, restricted access to posterior surfaces, and the presence of restorations or stains.

Recent evidence suggests that clinical photographs can provide useful diagnostic information, although performance varies according to lesion depth and study design. A 2025 systematic review and meta-analysis reported pooled sensitivity and specificity estimates that differed between enamel and dentine lesions, emphasizing the importance of defining the diagnostic threshold. Studies comparing smartphone and intraoral cameras have also reported high specificity but reduced sensitivity for early enamel lesions in some settings.

The present document uses a synthetic study to demonstrate a diagnostic-accuracy analysis for smartphone-based intraoral photography. The objective is methodological and educational: to illustrate how sensitivity, specificity, predictive values, likelihood ratios, and agreement may be reported when smartphone photographs are compared with a clinical reference examination.

MATERIALS AND METHODS

Study design and reporting framework

This is a cross-sectional diagnostic-accuracy analysis. The design described below is a proposed framework and was not implemented in patients. A future empirical study should be planned prospectively and reported in accordance with the STARD 2015 recommendations.

Setting and participants

The synthetic study represents 200 adults aged 18 years or older attending a dental outpatient service. For demonstration, one index tooth was assigned to each hypothetical participant, yielding 200 independent participant-level observations. In a real study, the clinical site, recruitment dates, sampling approach, participant flow, eligibility screening, and reasons for exclusion must be reported.

Eligibility criteria

Proposed inclusion criteria are adults aged 18 years or older who can provide informed consent and permit adequate intraoral photography and clinical examination. Proposed exclusions include inability to obtain an interpretable photograph, extensive debris or bleeding that prevents assessment, and an index tooth with a full-coverage restoration or other condition that makes the target surface unassessable. These criteria require confirmation by the investigators before study commencement.

Index test: smartphone-based intraoral photography

The proposed index test is interpretation of standardized intraoral photographs captured using a smartphone rear-facing camera. A reproducible protocol should specify the smartphone manufacturer and model, camera resolution, focal distance, flash or auxiliary illumination, image format, use of cheek retractors and mirrors, tooth surfaces photographed, and any image processing. Images should be captured after removal of gross debris and with standardized positioning. Digital enhancement that could alter lesion appearance should be prohibited or prespecified.

For this analysis, each index tooth received a binary photographic interpretation: caries present or caries absent. The synthetic study does not represent images read by actual examiners and therefore cannot establish inter- or intra-examiner reproducibility.

Reference standard

The proposed reference standard is a calibrated clinical visual examination conducted after cleaning and drying the index tooth under adequate illumination. The International Caries Detection and Assessment System (ICDAS) provides a standardized framework for recording lesion severity. For the binary analysis demonstrated here, a threshold of ICDAS code 1 or greater is treated as caries present and code 0 as caries absent. The precise threshold must be selected before data collection and should match the intended clinical use. Bitewing radiographs may be obtained when clinically indicated, but their use and interpretation must be prespecified; radiographs should not be added selectively based on the smartphone result.

Blinding and examiner calibration

In an empirical study, the clinical examiner should be blinded to the photographic interpretation, and photographic readers should be blinded to the clinical findings and participant identifiers. Examiners should undergo calibration using a separate training set. Agreement should be assessed before study commencement and periodically during data collection. The same reference-standard procedure should be applied to all participants to reduce differential verification bias.

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Synthetic study and outcome definition
A synthetic 2×2 contingency table was specified for 200 observations: 80 reference-standard positive and 120 reference-standard negative index teeth. Smartphone interpretation yielded 68 true positives, 12 false negatives, 18 false positives, and 102 true negatives. The primary outcome was binary diagnostic accuracy at the participant/index-tooth level.

Statistical analysis
Sensitivity was calculated as TP/(TP+FN), specificity as TN/(TN+FP), positive predictive value (PPV) as TP/(TP+FP), negative predictive value (NPV) as TN/(TN+FN), and accuracy as (TP+TN)/N. Positive and negative likelihood ratios were calculated as sensitivity/(1−specificity) and (1−sensitivity)/specificity, respectively. Cohen's kappa was used to summarize agreement beyond chance. Wilson 95% confidence intervals were calculated for proportions. McNemar's test is appropriate for paired discordant classifications; the comparison of 12 false negatives and 18 false positives does not indicate a statistically significant asymmetry (two-sided exact p approximately 0.36). All values are synthetic and are presented to demonstrate calculation and reporting, not to make inferential claims about a real population.

RESULTS

Participant profile
The study contained 200 hypothetical participants, each contributing one index tooth. The reference standard classified 80 index teeth (40.0%) as carious and 120 (60.0%) as non-carious. No real demographic or clinical data were supplied in the source document; therefore, no age, sex, tooth-type, or lesion-severity distributions are asserted.

Diagnostic performance

Reference standard	Smartphone positive	Smartphone negative	Total
Caries present	68 (TP)	12 (FN)	80
Caries absent	18 (FP)	102 (TN)	120
Total	86	114	200

Table 1. 2×2 contingency table. TP: true positive; FN: false negative; FP: false positive; TN: true negative.

Measure	Calculation	estimate
Sensitivity	68/80	85.0% (95% CI: 75.6–91.2)
Specificity	102/120	85.0% (95% CI: 77.5–90.3)
Positive predictive value	68/86	79.1% (95% CI: 69.3–86.3)
Negative predictive value	102/114	89.5% (95% CI: 82.5–93.9)
Overall accuracy	170/200	85.0% (95% CI: 79.4–89.3)
Positive likelihood ratio	0.85/(1−0.85)	5.67
Negative likelihood ratio	(1−0.85)/0.85	0.18
Cohen's kappa	Observed vs chance agreement	0.69

Table 2. diagnostic-accuracy estimates. Confidence intervals for proportions use the Wilson method. Predictive values are dependent on the prevalence (40.0%) and should not be transported to populations with different prevalence without recalculation.
The smartphone interpretation correctly classified 170 of 200 index teeth. Twelve reference-positive teeth were classified as negative by photography, while 18 reference-negative teeth were classified as positive. The likelihood ratios indicate the magnitude of change in odds implied by the hypothetical test result; they are not validated estimates of real-world performance.

DISCUSSION

This study demonstrates how smartphone-based intraoral photography may be evaluated as an index test for dental caries. The synthetic sensitivity and specificity were both 85.0%, with an overall accuracy of 85.0% and substantial agreement beyond chance (κ=0.69). These values are selected for demonstration and must not be interpreted as findings from the named investigators or institutions.
The clinical rationale for photographic screening is supported by the increasing role of teledentistry in facilitating access, triage, and communication. A systematic review and meta-analysis of clinical photography reported that diagnostic performance differed by lesion depth, with lower pooled sensitivity for enamel lesions than for dentine lesions in the included evidence [1]. This is clinically plausible because early enamel changes may be subtle, non-cavitated, and difficult to distinguish from stains, developmental defects, or surface irregularities in two-dimensional images.

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A diagnostic-accuracy study comparing smartphones with intraoral cameras for early childhood caries reported high specificity and accuracy for both modalities, while sensitivity for enamel lesions was lower for smartphone images. These findings highlight that the clinical usefulness of smartphone photography may depend on the target lesion threshold. A binary endpoint that combines early non-cavitated lesions with more advanced cavitated lesions can obscure important differences in performance. Future studies should therefore report accuracy separately for enamel and dentine thresholds, and ideally at tooth-surface level with appropriate adjustment for clustering.

Image acquisition is a central determinant of performance. Standardized lighting, retraction, focus, image orientation, and surface visibility are essential. Occlusal photographs may be adequate for some fissure lesions but inadequate for proximal lesions or surfaces obscured by adjacent teeth. Smartphone photographs should consequently be considered an adjunct to clinical assessment rather than a replacement for comprehensive examination or radiographic assessment when indicated. In future workflows, automated image analysis may assist with image classification or segmentation; related methods have been investigated in broader biomedical imaging, including transfer-learning and deep-learning segmentation applications [8,9]. These cross-domain studies provide methodological context only and do not establish diagnostic performance for dental caries.

The false-negative cases in the synthetic table illustrate a key safety concern: a negative photograph cannot reliably exclude caries when the image is incomplete or the suspected lesion is proximal, early, or obscured. A positive photographic finding should prompt clinical assessment rather than automatic treatment. The role of the photograph is best framed as screening, triage, documentation, or referral support.

For an actual diagnostic-accuracy study, the reference standard must be prespecified and applied consistently. Blinding is important because knowledge of the clinical examination may influence photographic interpretation. A representative clinical population should be recruited rather than a case-control sample of obvious disease and healthy controls, as spectrum effects can inflate accuracy. Reporting should follow STARD, including participant flow, test execution, prespecified thresholds, missing or indeterminate results, and confidence intervals.

LIMITATIONS

The primary limitation is that all observations and results in this manuscript are . They do not arise from patients, photographs, or clinical examinations and cannot establish diagnostic validity, reproducibility, feasibility, or clinical utility. The example also uses one index tooth per hypothetical participant and a binary outcome, so it does not address tooth-surface clustering, lesion severity, multiple readers, inter-examiner reliability, image failure rates, or performance across different smartphone models. Predictive values are prevalence-dependent. The proposed protocol requires specification of the actual device, image-capture settings, recruitment setting, examiner calibration, ethics approval, and consent procedures before it can be implemented.

Clinical implications

If validated in a prospective clinical study, smartphone-based intraoral photography may support remote triage, patient education, follow-up documentation, and referral prioritization. A positive finding should lead to an appropriate clinical assessment and, when indicated, preventive or restorative care. Research on silver diamine fluoride pretreatment and subsequent glass-ionomer bonding illustrates one example of a caries-management question that may arise after lesion identification; it does not validate photographic diagnosis [10]. Smartphone photography should not be used as a stand-alone rule-out test or as a substitute for indicated clinical and radiographic examinations.

CONCLUSION

This diagnostic-accuracy analysis illustrates the reporting of smartphone-based intraoral photography for dental caries detection in 200 hypothetical observations. The constructed study produced sensitivity, specificity, and accuracy of 85.0%, with a Cohen's kappa of 0.69. These are synthetic estimates only. Prospective validation using real participants, standardized image acquisition, blinded examiners, a prespecified reference standard, and transparent STARD-compliant reporting is necessary before any clinical conclusions can be drawn.

REFERENCES

1. Ku JCK, Mao K, Wang F, Porto Carreiro A da F, Lam WYH, Yu OY. Accuracy of clinical photography for the detection of dental caries: a systematic review and meta-analysis. J Dent. 2025;157:105737. doi:10.1016/j.jdent.2025.105737.
2. Ismail AI, Sohn W, Tellez M, Amaya A, Sen A, Hasson H, et al. The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries. Community Dent Oral Epidemiol. 2007;35(3):170-178. doi:10.1111/j.1600-0528.2007.00347.x.
3. Aly NM, El Kashlan MK, Giraudeau N, El Tantawi M. Comparison of intraoral cameras and smartphones in early childhood caries detection: a diagnostic accuracy study. J Evid Based Dent Pract. 2024;24(4):102041. doi:10.1016/j.jebdp.2024.102041.

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4. Cakmakci B, Yildiz Telatar G. Diagnostic accuracy of smartphone and macro camera imaging for dental caries and oral health conditions. BMC Oral Health. 2026;26:1156. doi:10.1186/s12903-026-08523-z.
5. Bossuyt PM, Reitsma JB, Bruns DE, Gatsonis CA, Glasziou PP, Irwig L, et al; STARD Group. STARD 2015: an updated list of essential items for reporting diagnostic accuracy studies. BMJ. 2015;351:h5527. doi:10.1136/bmj.h5527.
6. Schwendicke F, Tzschoppe M, Paris S. Radiographic caries detection: a systematic review and meta-analysis. J Dent. 2015;43(8):924-933. doi:10.1016/j.jdent.2015.02.009.
7. Brar AD, Pallavi K, Das M, Saxena P, Kulkarani K, Priya P, Kashwani R. Metaverse in dentistry: Bridging virtual innovation with real-world patient care and education. Bioinformation. 2025;21(2):262.
8. Gunturu V, Maiti N, Toure B, Kunekar P, Banu SB, Lenin DS. Transfer learning in biomedical image classification. In: 2024 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI); 2024 May 9. p. 1-5. IEEE.
9. Malathy V, Maiti N, Kumar N, Lavanya D, Aswath S, Banu SB. Deep learning-enhanced image segmentation for medical diagnostics. In: 2024 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI); 2024 May 9. p. 1-6. IEEE.
10. Balivada A, Gill S, Makam S, Dutta B, Agrawal A, Shah N. Impact of silver diamine fluoride pretreatment on the bonding performance of glass ionomer cement to human dentin: An in vitro evaluation. World J Dent. 2026;17(6):569-572.
11. Brar AD, Pallavi K, Das M, Saxena P, Kulkarani K, Priya P, Kashwani R. Metaverse in dentistry: Bridging virtual innovation with real-world patient care and education. Bioinformation. 2025 Feb 28;21(2):262.
12. Bahadur R, Kashwani R, Sawhney H, Kumar S, Gupta G. Platelet rich fibrin integration in impacted third molar extraction sockets for bony regeneration: a case report. J Dent Probl. 2024;6(1):46-51.
13. Kumari A, Sawhney H, Kashwani R, Gupta G, Das S. Triple antibiotics: A synergistic approach to combating infection. IP Indian J Conserv Endod. 2023;8(4):189-92.
14. Das A, Karande V, Tripathi A, Thomas LR, Pasha Z, Malhotra V, Kashwani R. Palatal bone thickness for mini-implant placement in different skeletal facial patterns: A CBCT approach. Bioinformation. 2025 Apr 30;21(4):635.
15. Singh J, Salam S, Pasha Z, Sharma R, Khan N, Chunara F, Kashwani R. Genetics in dentistry: A review of advances and implications. Journal of Pharmacy & Bioallied Sciences. 2025 Feb 10;17(Suppl 1):S181.
16. Kumar V, Naik GN, Tuteja S, Bhasin MT, Chattopadhyay D, Chowdhury S, Kashwani R. Evaluation of radiographic and clinical outcomes in the use of bone substitutes in periapical surgery and periodontal regeneration. Journal of Pharmacy & Bioallied Sciences. 2025 Sep 8;17(Suppl 3):S2218.
17. Katara AA, Minhas R, Kumar A, Dasgupta S. A case report on the excision of irritational fibroma using the diode laser. Journal of Dental Research and Review. 2020 Jan;7(1):24-6.
18. Chandra N, Swati M, Chandrakar L, Katara AA, Shrivastava A, Bhansali D. Comparison of hyaluronic acid, chlorhexidine and persica during SRP. Bioinformation. 2026 Feb 28;22(2):1212.
19. Katara A, Waghmare M, Kadakia N, Samson S, Minhas R. A case series of treatment of oral mucosal lesions using diode lasers. Scientific Dental Journal. 2021 Jan 1;5(1):47-51.
20. Katara AA, Parwani RA. The silent pandemic within: Using AI to decode the relationship between sleep disorders and orofacial pain.
21. Mahobia A, Sahoo SR, Maiti N, Sathyanarayanan R, Aravinth R, Pandraveti RR, Tiwari H. Diabetic retinopathy and its effect on quality of life: an original research. Journal of pharmacy & bioallied sciences. 2021 Nov 10;13(Suppl 2):S1365.
22. Maiti N, Das UK. Vital tooth bleaching: A case report. The Journal of Dentists. 2014 Feb 5;2(1):24-8.
23. Maiti N, Chawla R, Quraishi A, Soni M, Rusho MA, Pande SD. Generative Intelligence-Based Federated Learning Model for Brain Tumor Classification in Smart Health. Generative Artificial Intelligence for Biomedical and Smart Health Informatics. 2025 Jan 9:435-53.
24. Gunturu V, Maiti N, Toure B, Kunekar P, Banu SB, Lenin DS. Transfer learning in biomedical image classification. In2024 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI) 2024 May 9 (pp. 1-5). IEEE.
25. Malathy V, Maiti N, Kumar N, Lavanya D, Aswath S, Banu SB. Deep learning-enhanced image segmentation for medical diagnostics. In2024 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI) 2024 May 9 (pp. 1-6). IEEE.
26. Ravindar K, Gupta M, Abdul-Zahra DS, Maiti N, Chawla R, Prashanth KS. Utilizing nlp and machine learning to predict patient outcomes from electronic health records in cloud environments. In2023 International Conference on Artificial Intelligence for Innovations in Healthcare Industries (ICAIIHI) 2023 Dec 29 (Vol. 1, pp. 1-7). IEEE.

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27. Khan N, Kinra E, Verma N, Singh G, Kondhalkar S, Karande V, Kashwani R. Awareness and Attitude toward Cervical Cancer and HPV Vaccination among Female Medical Students. International Journal of Pharmacy Research & Technology (IJPRT). 2025 Sep 9;15(2):1771-7.
28. Sahoo A, Kumari A, Gill S, Parihar AS, Dhull KS, Jena D. Efficacy of Green Tea Catechins as an Adjunct to Scaling and Root Planing in Chronic Periodontitis: A Systematic Review and Meta-analysis. World Journal of Dentistry. 2026 Jun 26;17(6):581-7.
29. Balivada A, Gill S, Makam S, Dutta B, Agrawal A, Shah N. Impact of Silver Diamine Fluoride Pretreatment on the Bonding Performance of Glass Ionomer Cement to Human Dentin: An In Vitro Evaluation. World Journal of Dentistry. 2026 Jun 26;17(6):569-72.
30. Ahuja G, Pandey S, Gill S, Galani MM, Pasha Z, Chandrasekaran S, Kumari A. Comparing the biological response to immediate versus delayed implants placement in terms of osseointegration and bone quality. Bioinformation. 2026 Mar 31;22(3):1695.
31. Gill S. Effect of Preoperative Dexamethasone on Postoperative Sequelae Following Mandibular Third Molar Surgery: A Randomized Clinical Study.
32. Sahoo A, Kumari A, Gill S, Parihar AS, Dhull KS, Jena D. Efficacy of Green Tea Catechins as an Adjunct to Scaling and Root Planing in Chronic Periodontitis: A Systematic Review and Meta-analysis. World Journal of Dentistry. 2026 Jun 26;17(6):581-7.
33. Balivada A, Gill S, Makam S, Dutta B, Agrawal A, Shah N. Impact of Silver Diamine Fluoride Pretreatment on the Bonding Performance of Glass Ionomer Cement to Human Dentin: An In Vitro Evaluation. World Journal of Dentistry. 2026 Jun 26;17(6):569-72.
34. Ahuja G, Pandey S, Gill S, Galani MM, Pasha Z, Chandrasekaran S, Kumari A. Comparing the biological response to immediate versus delayed implants placement in terms of osseointegration and bone quality. Bioinformation. 2026 Mar 31;22(3):1695.
35. Gill S. Effect of Preoperative Dexamethasone on Postoperative Sequelae Following Mandibular Third Molar Surgery: A Randomized Clinical Study.
36. Aeran H, Agarwal A, Kumar V, Seth J. Study of The Effect of Disinfectant Solutions On The Physical Properties Of Dental Impressions. Indian Journal of Dental Sciences. 2014 Sep 1;6(3):001.
37. Kumar V, Gupta S, Krishnan Y, Vishnoi L. Tooth supported overdenture-A preventive approach in prosthodontics. International Journal of Oral Health Dentistry. 2018;4(3):184.
38. Aeran H, Nautiyal V, Kumar V, Uniyal S. Implant supported overdenture in the patients with history of radio and chemotherapy for the prostate malignancy. National Journal of Maxillofacial Surgery. 2015 Jul;6(2):200.
39. Kumar V, Arya G, Singh P, Chauhan P. A meta-analysis for evaluation of marginal bone level changes at dental implants. National Journal of Maxillofacial Surgery. 2021 Mar 16;12(1):13.

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