Keywords

Artificial intelligence; dentistry; maxillofacial surgery; deep learning; diagnostic imaging; orthopantomography; telemedicine; Kyrgyz Republic; limited resources.

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Smartface.Ai: The Concept Of An Intelligent Platform Based On Artificial Intelligence To Increase The Availability Of Dental And Maxillofacial Care In Remote Regions In Kyrgyzstan And Lmics

Abstract
Late diagnosis of oral and maxillofacial diseases remains a pressing challenge in modern healthcare, particularly in resource-limited settings. In the Kyrgyz Republic, the high prevalence of advanced-stage caries and maxillofacial pathologies is driven by a shortage of specialized personnel, limited access to expert care, and inadequate digitalization of primary healthcare. This study aimed to systematically analyze current evidence on artificial intelligence (AI) applications in diagnosing dental and maxillofacial diseases and to develop the conceptual architecture of a locally adapted intelligent platform, SmartFace.AI.
We performed a systematic literature review across PubMed, Scopus, Web of Science, and Google Scholar (2019–2026). Conceptual modeling of the platform architecture leveraged deep learning methods, including convolutional neural networks and the U-Net architecture. Potential clinical efficacy was estimated by extrapolating international data to the local healthcare context. Of 42 analyzed publications, 13 high-quality studies were included in the final synthesis. Current AI algorithms demonstrate caries detection accuracies of 82–95%, retained/impacted tooth segmentation reaching an Intersection-over-Union (IoU) of 85.29%, and orthopantomogram analysis comparable to expert specialist assessment. We developed a conceptual SmartFace.AI model integrating modules for clinical image analysis, radiographic data interpretation, and telemedicine services. Implementation is projected to enhance early diagnostic accuracy by 20–35% and reduce diagnostic turnaround time by 25–40%.
SmartFace.AI thus represents a promising strategy to improve the accessibility and quality of specialized dental and maxillofacial care in resource-constrained environments. These findings provide a scientific rationale for future pilot clinical trials and the practical integration of digital health technologies into routine healthcare delivery.

Introduction
Dental and maxillofacial diseases remain among the most prevalent public health problems worldwide. According to the World Health Organization, permanent tooth decay is the most common non-communicable disease, affecting billions of individuals globally [1]. Despite ongoing advances in therapeutic technologies and treatment modalities, the problem of late diagnosis persists as a critical concern, particularly in resource-limited settings with underdeveloped primary healthcare infrastructure [2]. In the Kyrgyz Republic,

the current situation is shaped by several systemic constraints that undermine the effectiveness of early dental disease detection. Clinical practice indicates that a substantial proportion of patients first present for dental care only at advanced disease stages, including deep caries, pulpitis, and periodontitis [3] . A parallel pattern is observed in maxillofacial surgery, where late hospitalization is frequently recorded for extensive inflammatory conditions, trauma sequelae, and congenital anomalies requiring complex reconstructive interventions. One of the primary drivers of this trend is the limited availability of specialized care in the country's regions, compounded by inadequate organization of preventive screening programs and early diagnostic initiatives. An additional detrimental factor is the shortage of specialized personnel, particularly pediatric maxillofacial surgeons, which contributes to delayed diagnosis of congenital malformations, including cleft lip and palate, as well as maxillary anomalies [4]. This situation results in an increased frequency of functional impairments, elevated risk of permanent disability, and diminished quality of life for affected patients. The challenges are further exacerbated by insufficient digital transformation of the healthcare system, the absence of standardized diagnostic algorithms, and limited adoption of modern medical data processing technologies [5].

In recent years, artificial intelligence and deep learning methods have emerged as a promising direction for advancing medical diagnostics. Of particular interest are convolutional neural networks (CNNs), which have demonstrated high performance in analyzing medical images, including radiographic and clinical photographic data. Contemporary evidence indicates that deep learning algorithms can achieve diagnostic accuracy comparable to expert specialist assessment in classification, recognition, and segmentation tasks involving dental images [6]. Automatic segmentation methods have advanced considerably, with the U-Net architecture widely employed in biomedical imaging occupying a prominent position. These algorithms enable automated identification of anatomical structures and pathologically altered areas, thereby improving diagnostic accuracy, standardizing result interpretation, and alleviating clinician workload. Artificial intelligence technologies also demonstrate substantial application potential in dental practice [7]. Deep learning algorithms can detect carious lesions with high efficacy, assess periodontal tissue status, and analyze orthopantomograms, thereby expanding the scope of early diagnosis, enhancing objectivity in clinical decision-making, and optimizing the treatment workflow. Indeed, multiple studies have confirmed that convolutional neural networks provide high accuracy in detecting dental caries from radiographic data, underscoring the promise of machine learning for automated dental image interpretation [8].

Several authors suggest that integrating artificial intelligence into dental practice can substantially improve diagnostic quality, enhance result reproducibility, and optimize clinical decision-making processes. Further supporting its adoption, AI has achieved notable success in related medical fields, including dermatology and ophthalmology, where algorithmic diagnostic accuracy in certain tasks has reached levels comparable to qualified specialists. Despite these substantial achievements, the practical translation of AI technologies into health systems of resource-limited countries remains insufficient [9] [10]. Key barriers include the absence of representative local clinical datasets, limited digital infrastructure, and inadequate digital literacy among healthcare professionals. In Kyrgyzstan, no national digital solutions currently offer comprehensive integration of clinical image analysis, radiological data, and telemedicine services into a unified clinical decision-support system [11]. Localized technological products that account for demographic, ethnic, clinical, and epidemiological characteristics of the population, as well as the specificities of local healthcare delivery, are of particular importance. The use of foreign algorithms without prior adaptation may result in diminished diagnostic accuracy due to differences in morbidity patterns, morphological features, and other population-specific parameters [12]. Consequently, establishing a national clinical dataset and developing an indigenous intelligent platform should be prioritized as strategic directions for healthcare modernization. Equally critical is the integration of telemedicine technologies and digital platforms that enable remote access to diagnostic services particularly relevant in regions with limited access to specialized care [13]. The combined use of artificial intelligence and telemedicine facilitates a doctor AI collaborative model, in which intelligent algorithms serve as clinical decision-support systems, enhancing efficiency, objectivity, and diagnostic precision [14] [15] .

Thus, the creation and implementation of the SmartFace.AI intelligent platform, designed for clinical image and radiographic data analysis, represents a promising avenue for modernizing dental and maxillofacial care. The system can substantially enhance diagnostic quality and expand the availability of specialized services. The platform's functionality addresses key healthcare priorities, including reducing late diagnosis rates, mitigating specialist shortages, and advancing the digitalization of clinical practice. The aim of this study is to systematically analyze current scientific evidence on the use of artificial intelligence in diagnosing dental and maxillofacial diseases, and to develop a conceptual architecture for the SmartFace.AI platform adapted to the healthcare conditions of the Kyrgyz Republic, with an assessment of its potential clinical and organizational effectiveness.

1. Materials and Methods

2.1 Research Design

This study was done as a systematic review of scientific literature and included some of the concepts of conceptual modeling. There exist two stages in the investigation: The first phase started with a systematic survey, selection, and analyticalreading of publications focused on the use of artificial intelligence in dentistry and maxillofacial surgery. The second part of the process was to create the conceptual design of SmartFace.AI platform and the clinical efficacy it might have which is predicted by extrapolating work done elsewhere that have been published across the world.

2.2 Literature Search Strategy

All four international bibliographic databases (PubMed, Scopus, Web of Science (WoS) and Google Scholar) were used for searching. The search was retrospective and from January 2019 to March 2026. Relevant publications have been found through the use of keywords and combinations thereof, where combinations include Boolean operators (AND, OR). The strategy included the following thematic blocks: "artificial intelligence", "deep learning", "machine learning"; "dentistry", "dental", "oral", "maxillofacial"; "caries detection", "orthopantomogram", "OPG", "radiograph"; "convolutional neural network", "CNN", "U-Net", and "resource-limited settings", "low- and middle-income countries", "LMIC". The two questions they created together allowed them to get a real survey of publications covering AI applications in dentistry, maxillofacial surgery and radiation diagnostics, as well as evaluation of the opportunities of implementation in resource-limited countries.

2.3 Inclusion and Exclusion Criteria

Inclusion criteria: Published articles that met the following criteria were included in the review: original scientific studies, systematic reviews, and meta-analyses; articles published in peer-reviewed scientific journals; published studies that assessed the diagnostic accuracy and clinical effectiveness of the use of AI algorithms in dental and maxillofacial diseases; and papers that evaluated medical image analysis, including clinical photographs, orthopantomograms, and data from imaging systems, such as cone-beam computed tomography (CBCT).

Exclusion criteria: Conference proceedings and abstracts, editorial articles and letters to editors were excluded as well as publications with insufficient research methodology description or lacking any statistical support, studies lacking any additional documented ethical approval (where applicable) and publications that were duplicate publications.

2.4 Selection and Data Analysis Process

A preliminary search brought up 327 publications. Following removal of duplicate articles (n=58), titles and abstracts of 269 articles were screened by two independent reviewers. A total of 84 publications were considered at the full-text level. In the end 42 scientific papers were included, and 13 of them scientifically robust and most relevant focusing on the Kyrgyzstan regionwere chosen for in-depth analysis and results presented and interpreted on the basis of 5 studies (Table 1). We attempted to resolve any discrepancies between reviewers via consensus or in consultation with a third independent reviewer.

Table 1. Characteristics of key studies included in the analysis

No.	Authors, Year	Study Design	Clinical Domain	Main Findings	DOI
1	Al-Khalifa K.S. et al., 2024	Systematic review	Caries detection	CNN accuracy: 82–95%	10.3390/bioengineering11090936 [16]
2	Durmus M. et al., 2025	Original research	Segmentation of retained/impacted teeth	U-Net + EfficientNetB7: IoU 85.29%	10.1109/j.2024.3523816
3	Carvalho B.K.G. et al., 2024	Meta-analysis	Approximal caries detection	Sensitivity: 0.88; Specificity: 0.91	10.1016/j.jdent.2024.105388
4	J. Maxillofac. Oral Surg., 2025	Systematic review	Craniofacial pathology	AI performance comparable to expert clinicians	10.1007/s12663-025-02601-5
5	Umer F. et al., 2024	Review	AI implementation in LMICs	Critical shortage of local datasets identified	10.1186/s12903-024-03970-y

2.5 Conceptual Modeling of the SmartFace.AI Platform

The results of the systematic literature analysis were used to create a conceptual architecture of the SmartFace.AI platform. Some features of the system include integration of key digital elements, delivering automated diagnostic assistance and clinical decision-making. The platform comprises three main functional modules:

2.5.1 Clinical Image Analysis Module: SmartFace. installed in the laboratory, facilitating image analysis with advanced techniques. This module trains and utilizes pre-trained CNNs (such as ResNet-50 and EfficientNet-B4) to automatically segment and classify a wide range of apparently visible pathological conditions from facial and intraoral images. It mainly focuses on the detection of the carious lesions on the accessible surfaces of teeth, signs of gingivitis, malocclusion of the teeth, and asymmetry in the face.

2.5.2 The Radiographic Data Analysis Module (SmartFace): is a module of software designed to analyze radiographic data.Radio). This module is based on U-Net architecture and advanced modifications like Attention U-Net and is used to generate anatomical structure segmentation and pathological changes on orthopantomograms. Main activities are: automatic detection of carious cavities, quantitative evaluation of bone resorption, identification of presence of retained/impacted teeth and its topographic location with the mandibular canal.

2.5.3 Telemedicine Integration Module (SmartFace.Connect): This module allows for a secure transfer of the clinical data, automated generation of preliminary AI-based reports as well as remote consultation with specialists at the republican and referral centres.

2.6 Assessment of Potential Clinical Effect

The projected effectiveness and precision of implementing the SmartFace.AI platform was evaluated significantly by comparative extrapolation using published international data. Calculations were based on diagnostic accuracy, sensitivity, and specificity metrics reported in systematic reviews and meta-analyses. By comparing these data with the specific organizational features of primary healthcare in Kyrgyzstan, we estimated the expected increase in early detection rates for dental and maxillofacial diseases and the potential reduction in diagnostic time following integration of the SmartFace.AI platform into primary care practice.

2. **Results and discussion**

3.1 Diagnostic accuracy of artificial intelligence in dentistry and maxillofacial surgery

The systematic evaluation of the up-to-date and available scientific publications reveals a high and continuously growing efficiency of artificial intelligence algorithms particularly belonging to the group of deep learning to solve diagnostic tasks in dentistry and maxillofacial surgery. One of the best outcomes has been in medical image analysis, due to the ability of neural network models to automate recognition of pathological changes and enhance clinical data interpretation's objectivity and speed [17]. Overall accuracy indicatorsaccuracyvary from 80% to 95% depending on the type of clinical task, the algorithm applied, and the size of the training set and the original images' quality. Those findings reflect a level of maturity of modern intelligent technologies and a potential for their real application as Medical Decision Making (MDM) support tool. In standard diagnostic task scenarios, the highest accuracy can be achieved within the context of radiologic imaging analysis, whereas, in clinical photography (as a content domain with high heterogeneity), a broad range of accuracy indicators is possible [18].

The most investigated one is the automated diagnosis of caries from X-ray data. Based on a metaCarvalho-analysis of Carvalhoetal. AI algorithms (2024) performed with a 21 independent study, yielded a specificity of 91% and a sensitivity of 88% for diagnosis of approximal caries on occlusive X-rays [19]. The resulting ones are in line with the diagnostic skills of the dentist and can therefore be considered as reliable and reproducible tools for mass screening in the case of a limited human resource. The importance of these findings is that the lesions of caries can be detected at an early stage before complicated caries forms. This is particularly the case with healthcare systems that have a large number of patients already in need of aid at the stage of pulpitis or periodontitis [20]. The introduction of such algorithms in primary care can enhance the early detection of the initial stages of pathology, limit the cost of treatment and minimize the burden on the dental service [21].

It is a particular subject of relevance in the recent literature the problem of segmentation of complex anatomical structures/pathological formations from panoramic images and cone-beam computed tomography data. Here, segmentation is one of the more technically challenging steps in computer analysis and involves the ability to accurately delineate the boundaries of objects correctly despite the variations of anatomy, overlap of organs and differences in image quality [22]. In a study R Widyaningrum el al. (2022) compared the different modern segmentation models for detection of retinated teeth on panoramic radiographs. The best performance was obtained with U-Net and the EfficientNetB7 encoder, obtaining a union intersection rate (IoU) of 85.29%. Such an accuracy depicts a superior capability to accurately delineate the contours of the teeth within the occlusion and surrounding anatomic structures [23].

The information that they provide is directly applicable to maxillofacial surgery and accurate visualization of retinated teeth, their relationship to the mandibular canal and position allows for a safer planning of surgical procedures, minimizes damage to the neurovascular bundle and reduces postoperative complications. The following were the approaches that led to creation of the SmartFace's diagnostic module [24]. Radiofocus Workstation for automatic analysis of PAs and for helping the doctor to interpret radiation data. It must be noted, that the high diagnostic efficiency of the artificial intelligence algorithms does not mean that a specialist doctor should be replaced, but a new model of "doctor-electronic doctor", where the intelligent system performs the function of preliminary analysis, sorting of cases by the degree of risk, provision of quantitative parameters for the clinical interpretation [25]. In this way, you can boost the doctor's efficiency, diminish the odds of overlooking minor pathological issues and expand the quality of medical care.

Therefore, the findings from the analysis proved their ability to be highly beneficial in dental practice and oral and maxillofacial surgery from the viewpoint of modern artificial intelligence technologies. Automatic detection of caries, analysis of orthopantomograms, segmentation of the dentition (with retineration) and bone structure assessment are the most promising fields of research. This generates basic science and engineering conditions for the ushering in of a new generation of smart platforms, such as SmartFace.In general, AI in clinical practice.

3.2 Comparison of the effectiveness of artificial intelligence and specialist doctors.

New systematic reviews and meta-analyses of AI algorithms analysing medical images suggest that the algorithms are at a comparable level of diagnostic accuracy to those of expert physicians. For several aspects concerned with the analysis of X-ray information, intelligent systems are able to exhibit high sensibility, specificity and repeatability, such as carious lesions detection, segmentation of anatomical structures and detection of hidden pathologies [26]. One thing is great about the algorithms within artificial intelligence is they operate consistently and they produce the same accuracy even if they are given huge chunks of data multiple times. AI can work effectively without getting tired, stressed, overworked or fatigued and can work around the clock, a four-hour shift or more, compared to humans. This is particularly crucial in conditions of heavy workload of clinical practice where the risk of human factor-related diagnostic errors is naturally higher [27].

Comparative studies have demonstrated AI's ability to outperform experts in tasks such as mass screening and primary patient sorting, in information processing speed. Algorithms are able to thoroughly examine multiple images in seconds and automatically direct cases for detailed review by an expert with a high likelihood of disease [28]. This method allows for the effective use of human resources and patients' waiting period for diagnosis. It is important to stress that AI technology should not be used as a substitute for the doctor or in place of all human expertise: specialized clinical discernment. The best supported idea is that of AI acting as a second opinion" system, which works like the intelligent decision support system. Here, the algorithm starts to process images, points out suspicious zones, determines quantitative parameters, and offers more information for final diagnosis to the doctor [29].

Using "doctor-AI" model minimizes the number of pathological changes missed, minimizes the discrepancies in conclusions between experts, and improves reliability in diagnostics. In dentistry and maxillofacial surgery, this method has a high potential of success and where a correct interpretation of the radiation studies has a direct influence on the selection and choice of the treatment tactics, and the prognosis of the intervention [30]. In addition, the introduction of AI can play an important educational role. Smart platforms could also support young professionals as auxiliary training tools showing typical diagnostic signs of diseases and encouraging the development of skills in clinical analysis in relation to objective digital data. For this reason, a side-by-side evaluation of competence of doctors and AI does not lead to competition, rather to the combination of the two into one diagnostic system. Doctors' experience and the power of AI computation can help form the foundation for better, faster and more convenient specialized medical service.

3.3 Addressing health equity challenges in Low and Middle Income Countries

Revolutionary changes in early diagnosis and access to medical services with the help of artificial intelligence.Among the highlights of the availability of AI technologies for clinical practice is the evolution of new possibilities to detect pathological conditions at an early stage [31]. The minimization of morphological changes in clinical images and radiation studies can be detected by modern machine and deep learning algorithms, but miss the doctor's eye in the setting of high workload or limited receiving time of the doctor [32]. Initial enamel demineralization reflecting the early stages of the carious process, slight violation of the symmetry of the facial bones, suspected inflammatory foci in the periapical zone, poorly expressed changes in the periodontal tissues, initial resorption of alveolar bone, are among the early signs, among others. As these changes can be detected at a preclinical stage or early signs of clinical disease, timely treatment can be initiated which helps to not allow the disease to progress and reduce the risk of complications [33].

According to published studies, the proportions of cases diagnosed in the early stages increase by 20-35% as a result of the use of intelligent diagnostic assistants. What this effect means is that algorithms are highly sensitive to slight changes and somewhat capable of learning from and picking up on information without sacrificing the effectiveness of interpretation. A certain level of practical importance exists in dentistry, as early detection of the disease allows to avoid the intervention for complicated forms and focus on preventive and organ-preserving interventions [34]. The accessibility of specialized care to the territory for the Kyrgyz Republic is very important not only in terms of improving the quality of diagnostics but also in terms of its availability. Additionally, patients' access to specialized dental and maxillofacial specialists is restricted, especially given the mountainous terrain, the great distances reached to get to the centres and the uneven distribution of human resources. This results in late visits, inability to treat diseases and escalation of resources required to treat patient's using an expensive inpatient service [35].

The current status analysis of the international picture reveals that in two dimensions Low and Middle Income Countries are grappling with the same dilemma: the lack of adequate in-house research activities on medical AI, and insufficient availability of established solutions tailored to national healthcare contexts [36]. Imported digital products without adaptation to the country are not necessarily accurate and reliable in real life clinical practice. On this occasion the creation and adoption of the platform SmartFace.AI can be seen as a game-changing solution [37]. Connection with the system that is built in and integrated with telemedicine will enable a GP or primary care dentist to receive intelligent assistance for clinical photos and X-ray analysis, even from a remote location. In case of complex pathologies the system can automatically include the patient for remote consultation or face to face treatment in a special republican centre [38].

Such model of interaction can decrease the time needed for referrals, decrease the time spent for specialized assistance and enhance the correctness of referral to specialized places. However, the load of the consultation centres is reduced because of the initial digital simplexation of request by the level of complexity of the clinical condition.

3.4 Projected Socio-Economic Impact and Conceptual Architecture of SmartFace.AI

Socio-economic impact of early diagnosis must be considered also. Timely detection of diseases helps to reduce the number of complicated cases, reduce the temporary disability of patients, reduce the cost of inpatient treatment and improve the quality of life of the population. The public health system benefits from the rational use of the resources and from the transition towards a prevention-based approach, instead of mostly a cure-based approach. Therefore, the effects of Artificial Intelligence (AI) technology on early diagnosis and provided medical service resources are complex [39]. The laying of intelligent algorithms to telemedicine technologies is most promising to the

Kyrgyz Republic, equipping all regions with specialized care. Developed conceptual model of the platform SmartFace.AI (Figure 1) provides an integrated digital ecosystem, existing on top of other new techniques, such as deep learning, automated analysis of medical images, and telemedicine interaction. The architecture of the system is aimed at solving crucial issues in dental and maxillofacial services, including early diagnosis of diseases, more availability of specialized services, and optimum routing of patients [40].

The platform is structured in a functional way and composed of multiple interconnected elements. The first of these links is a data upload and standardization unit which gives clinical photographs of the face and oral cavity, orthopantomograms, cone beam computed tomography data and related clinical information [41]. The information is then fed into the system's analytical 'core' comprising of powerful algorithms running deep learning. Photographic images are analyzed with convolutional neural networks trained on visual pathological changes and X-rays are analyzed with U-Net segmentation architectures and variations [42].

The next step on the platform is the interpretation module to prepare a preliminary diagnosis, quantitative risk indicators, visualization of suspicious areas and recommendations for additional tactics in the patient treatment process. The last part involves the telemedicine unit: transmission of data from a distance to experts level specialists, organization of distant consultations and rapid referral of complicated clinical cases to specialized centers. The proposed architecture reflects the current trend in digitalization of the healthcare sector in which today artificial intelligence is not used alone, but rather within one decision support system. This enables the use of automatic data processing in combination with an expert clinical judgment of the doctor and so increases the level of quality of medical care.

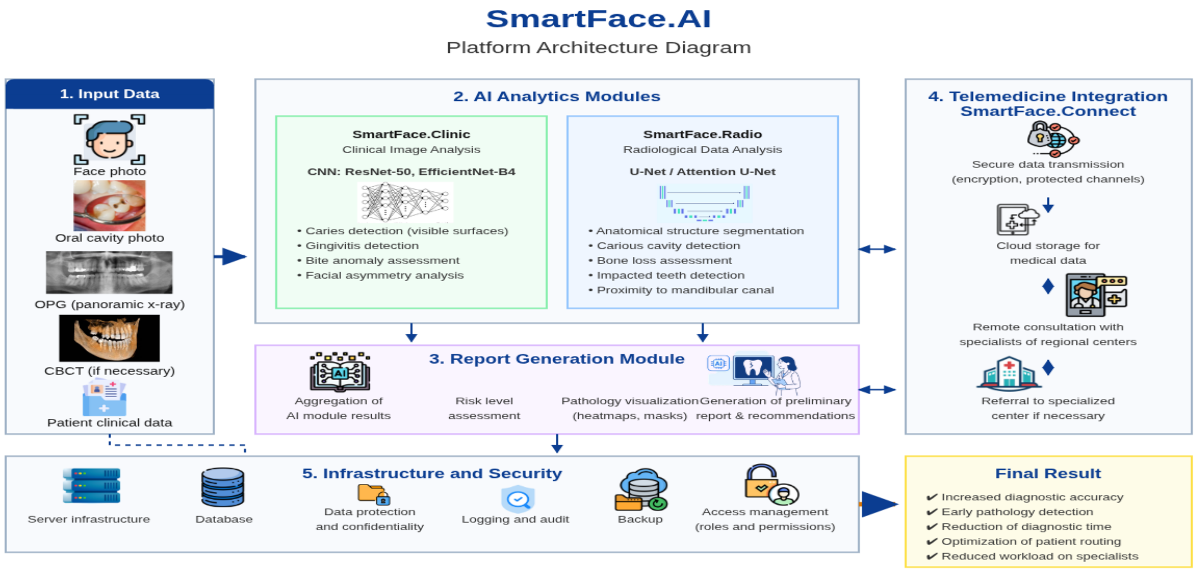

Figure 1. Diagram of the platform architecture SmartFace.AI

3. Future recommendation and challenges

Based on published literature data extrapolations the clinical and the organizational impact of introducing the SmartFace platform is expected.There are a lot of positive things that can be changed by AI.

The first of which is the improvement in the precision of diagnosis of caries, periodontal diseases and pathological changes which will be at a minimum of 85%, predicted by the orthopantomogram. The indicator complies with the contemporary international parameters for an intelligent diagnostic system and establishes conditions for platform's general practical application in the outpatient sphere [43].

Secondly, it will cut back on time required for the creation, from the moment of image acquisition to the moment the pre-trial detention has been prepared, by 25-40%. Fast decision making is particularly crucial at high capacity facilities as it directly influences the ability to provide care and levels of patients' satisfaction [44].

Third, there will be a 20-30% rise in the amount of diseases caught/identified at an early stage. By identifying disease in the early stages, a greater amount of preventive and minimally invasive treatment options will be used, complicated forms of diseases will be less frequent, and expensive surgical procedures will not be needed as often [45].

Fourth, there is another big advantage – a less load on radiologists, narrow-profile dentists, as well as the specialists of republic centers – by automating repeated routine tasks such as first reading of an image, risk level sorting of the cases, preparation of a preliminary conclusion. This will enable specialists to see patients with more complex clinical conditions and raise the efficiency of the service [46] .

For the Kyrgyz Republic, the possibility of equalizing differences between regions in the level of accessibility of specialized care is of particular importance. The addition of telemedicine will give those in more rural areas qualified advice without having to make several journeys to big cities to do so.

The conceptual platform of SmartFace is therefore created. Hence, the conceptual platform of SmartFace is built. A high level of clinical and organisational effectiveness is anticipated from AI. The activation of this platform can be a significant step towards digital modernization of dental and maxillofacial services, increasing the quality of diagnostics, the efficient utilization of human resources and enabling an increase in the supply of specialized medical care [47]. Although the potential of applying the technologies based on Artificial Intelligence in dentistry and maxillofacial surgery is high, there are several organizational, technological and regulatory issues that can be surmounted through a systematic approach. Development of a representative local clinical dataset is one of the most important factors to support successful implementation, for use in further training and adaptation of algorithms in the real-world conditions of the national health system for subsequent validation [48]. Training of models solely based on foreign samples might lead to an accuracy loss when differences in the demographic aspects of population, the nature of disorder, the quality of images and clinical practice peculiarities are taken into account. In this context, development of national picture archive of dental images, maxillofacial picture archive is looked at as an important scientific and practical task [49].

An equally important aspect is the issues of information security and protection of personal data of patients. Any smart platform engaging with clinical photos, X-ray images, medical documents, etc., should also adhere to the standards of today for regards over cybersecurity, privacy, and regulation in the legal field. This involves the use of data encryption mechanisms, delineation of access levels, secure storage of information, and transparent procedures for obtaining patients ' informed consent to data processing. However, one of the mainstays is the need for training of medical staff to adopt new digital instruments [50]. The impact of the AI systems implemented is dependent on the digital literacy of the physicians, their willingness to validate the outputs of the algorithms and the integration of the data retrieved by them in the treatment workflow. In this context, there is a need to establish further training programs based on education to build capabilities in the area of digital medicine and artificial intelligence [51]. There are technical obstacles, such as inadequate equipment (especially computers with updated technology) in medical institutions, high bandwidth Internet networks in rural areas, and incompatibility with existing medical information systems. These are especially topical issues in the Kyrgyz Republic regarding the territorial diversity of the development processes in different regions. It should also consider the importance and need to regulate the medical applications of artificial intelligence (AI), such as the establishment of responsibility for extending the use of algorithmic recommendations, the definition of the clinical validation process and the certification of medical software products [52].

In this way, SmartFace platforms will be successful on implementation.However, to employ AI, companies need to be prepared, not just technologically, but also in terms of having a full-fledged solution for HR processes, information security policy, adherence to regulations, and the development of high-quality local information. It is not possible to realize a sustainable clinical effect or organizational effect with AI in healthcare unless these conditions are fulfilled. Key results based on systematic review on the impact of results on the clinical setting to be illustrated using the SmartFace.All relevant aspects for the translation of these AIs into Kyrgyz health care will be summarised in Table 2.

Table 2: Systematic review findings, projected SmartFace.AI outcomes, and implementation relevance to the Kyrgyz Republic

Domain	Key Finding / Projected Outcome	Relevance to Kyrgyz Republic Implementation
AI Diagnostic Performance – Caries Detection	Accuracy ranges from 82–95% across CNN models. Pooled sensitivity of 88% and specificity of 91% for approximal caries on bitewing radiographs.	Helps primary care dentists in remote oblasts to detect early caries on their own, eliminating advanced pulpitis and periodontitis that is high among rural clinics these days.
AI Diagnostic Performance – Radiographic Segmentation	U-Net with EfficientNetB7 encoder achieved IoU of 85.29% for retained/impacted tooth segmentation on panoramic radiographs.	Allows a safer treatment approach to pre-surgical planning in district hospitals for impacted teeth, where costly transfers of patient to Bishkek for CBCT interpretation are not necessary and risk of inferior alveolar nerve injury is reduced.
AI vs. Clinical Experts	AI algorithms demonstrate diagnostic efficiency comparable to expert specialists in detection, classification, and segmentation tasks.	Solves the urgent problem of an inadequate number of maxillofacial radiologists and pediatric surgeons in Kyrgyzstan, while offering a reliable initial diagnosis and providing the general practitioner with expert feedback that allows him/her to make a proper diagnosis.
SmartFace.AI – Clinical Module (SmartFace.Clinic)	Utilizes ResNet-50 and EfficientNet-B4 CNNs for automated detection of caries, gingivitis, malocclusion, and facial asymmetry from clinical photographs.	Capable of affecting and adapting the use of ordinary cameras to be used for screening remote, mountainous populations for visible pathologies, facilitating the exchange of referrals before surgeries in the community are performed.
Projected Clinical Impact – Overall Accuracy	Expected diagnostic accuracy for caries, periodontal disease, and OPG abnormalities ≥85%.	Increases the clinical competence of non-specialist dentists in the DH, supporting them in making critical clinical decisions at their own place of

		service to decrease unnecessary transportation of patients from the DH to urban areas of the country.
Implementation Constraints – Infrastructure & Regulation	Limited digital infrastructure, low digital literacy, and lack of regulatory/cybersecurity frameworks pose significant barriers.	Supports the government to simultaneously allocate resources for the creation of internet access in rural areas, to define a national program for education of digital health for physicians and other clinicians using AI tools for diagnosis, and to establish legislative guidelines for the ethical and legal use of artificial intelligence in clinical practice.

4. Conclusion

Systematic analysis of modern scientific literature has led to the conclusion that AI technologies have a high diagnostic value in the field of dentistry and maxillofacial surgery. Current deep-learning algorithms are capable of making a diagnosis just as accurately as high-quality specialist evaluation and have the potential to augment the speed and reproducibility of clinical image and radiological interpretations. These results provide a solid foundation for the use of AI as a powerful and reliable means of clinical decision support in outpatients and specialized practice. The conceptual SmartFace.The AI model, based on cutting-edge deep learning architectures like convolutional neural networks and U-Nets with deep semantics for segmentation, was perfectly integrated with the telemedicine services and holds a revolutionary potential to face the digital modernization of dental care. This platform will help to better accurately diagnose patients earlier, to accelerate the patient routing process, to relieve specialists' burden, and significantly increase the availability of patients for quality care, especially in geographically isolated and less resourced areas of the Kyrgyz Republic. This study has a practical value as it will provide a scientific justification to embark on a pilot implementation of SmartFace.Insertion of AI in primary and specialized healthcare facilities, coupled with simultaneous establishment of a clinical imaging national archive of dental and maxillofacial pathologies. Building such locally representative datasets is a crucial first step toward being able to algorithmically adapt and fully assess against the regional clinical and demographic features.To facilitate further testing and clinical implementation, prospective clinical trials should be conducted in real-world health care settings, with in-depth health-economic analysis of cost-effectiveness, potential cost savings, and the impacts on early diagnoses and treatment outcomes and response measures. There is a need for specific attention to be paid to measuring organization efficiency, clinician satisfaction, and integration into daily clinical practice. These innovations have the potential to create a space that improves the quality, access, and technological robustness of healthcare systems and benefit beyond Kyrgyzstan to other contexts with limited resources globally.

Ethics Approval and Consent to Participate: Not Applicable

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