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ORIGINAL ARTICLE

Application of AI and Machine Learning in Predicting Dental Diseases

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ABSTRACT
Purpose: This study aims to explore the potential of artificial intelligence (AI) and machine learning (ML) in predicting dental diseases like periodontitis, dental caries, and oral cancer. These are prevalent health issues worldwide, often leading to significant pain and suffering. The study evaluates the predictive capabilities of AI and ML in identifying dental diseases based on variables such as age, smoking and alcohol use, oral hygiene, genetic predisposition, and the frequency of dental check-ups annually.
Method: A cross-sectional method and a synthetic dataset are employed in this study. The Statistical Package for the Social Sciences (SPSS) software was used for conducting descriptive statistics, correlations, and logistic regression.
Findings: The results demonstrated that the frequency of annual dental check-ups significantly predicts dental disease. However, other variables like age, smoking, alcohol use, oral hygiene, and genetic predisposition did not exhibit a substantial independent connection with dental diseases.
Practical Implication: The findings emphasize the importance of regular dental check-ups in mitigating and managing dental diseases. This study provides significant insight for healthcare professionals to encourage patients to maintain routine dental visits for early detection and treatment of oral problems.
Conclusion: AI and ML have significant potential to enhance dental healthcare by allowing more accurate and proactive diagnosis and treatment of dental diseases. Nonetheless, future research should consider a broader range of variables and employ advanced AI and ML techniques to develop more comprehensive predictive models for dental disease.
Keywords: Artificial Intelligence, Machine Learning, Dental Diseases, Predictive Models, Dental Check-ups, Healthcare, Diagnosis, Treatment.

INTRODUCTION
Background: Healthcare delivery quickly integrates artificial intelligence (AI) and machine learning (ML), revolutionizing numerous facets of the medical industry. The extensive use of AI and ML in healthcare results from considerable improvements in computer power, complex algorithms, and the accessibility of big data. Increased diagnostic precision, disease progression prediction, individualized treatment plans, and improved patient outcomes are all possible with AI and ML in healthcare. Machine Learning (ML) is a branch of artificial intelligence that enables computers to learn and make judgments without explicit programming. It accomplishes this by seeing patterns in data, a talent that is becoming more crucial as the healthcare sector moves towards a data-driven economy. In summary, the primary purpose of AI and ML in healthcare is to improve upon, not replace, the skills of healthcare professionals. This assumes special significance in complex disease settings where the ability of ML systems to recognize patterns can improve human judgment.

Predicting dental disorders is one of the areas in dentistry where AI and ML are beneficial. Dental conditions such as periodontitis, dental caries, and oral cancer are serious public health problems on a global scale. They may result in significant pain and suffering, aesthetic impairments, difficulty eating, speaking, and interacting with others, and in extreme cases, systemic problems or mortality. Therefore, it is essential to improve public health and lessen the cost burden of treatment on patients and healthcare systems by preventing, early detecting, and managing these illnesses. To detect oral problems, dentists have traditionally used a combination of ocular examinations, patient histories, physical exams, and diagnostic techniques like X-rays. These methods have limits even if they have a history of success. They can be subjective and frequently rely on the dentist's professional judgment and personal experience, which can result in discrepancies in diagnosis. Furthermore, these techniques take a long time and can only miss infections once they proceed to a more severe stage.

On the other hand, AI and ML provide the possibility of solving these difficulties. These tools analyze enormous amounts of data rapidly and correctly, finding patterns that a human eye would miss. By providing more precise and early forecasts of dental problems, AI and ML's predictive power can potentially revolutionize dental healthcare. Electronic dental records, imaging data, and genetic data are among the digital health data that are becoming more widely available due to the development of digital dentistry. AI and ML may handle and analyze this enormous amount of data to forecast illness progression, suggest preventative actions, and enhance treatment regimens. AI and ML are progressively evolving into crucial tools in providing dental treatment because they provide a more accurate, effective, and proactive method of identifying and treating dental illnesses.
Objective: In order to improve the early detection and treatment of diseases like periodontitis, dental caries, and oral malignancies, this project will assess the efficacy of AI and machine learning in predicting dental disorders.

METHODOLOGY
The study uses a cross-sectional approach to evaluate the effectiveness of machine learning and artificial intelligence in foretelling dental disorders based on various factors. In this study, a synthetic dataset of 60 observations is used, and each observation is assigned one of the following six characteristics: age, smoking and alcohol use, oral hygiene, genetic predisposition, and the number of dental checkups per year. The Statistical Package for the Social Sciences (SPSS) software, a potent tool for managing and analyzing data, will be used for the data analysis process for this study (Hung et al., 2020). After data cleaning and validation, descriptive statistics will be generated to ensure the dataset is accurate and trustworthy. Measures like mean, median, mode, standard deviation, and range will be included in these statistics to give a general picture of the distribution of the dataset.

The correlations between the variables and their capacity to predict dental illnesses will then be examined using inferential statistics. The relationship between each predictor variable and the outcome variable (dental disease status) will be evaluated using chi-square tests for categorical data. We will use logistic regression analysis to build a prediction model. It will make it possible for us to comprehend how each element affects the chance of developing a dental illness separately and in combination. The accuracy, sensitivity, specificity, and area under the receiver operating characteristic (ROC) curve will be calculated to assess the model's prediction effectiveness. The main goal of the methodology is to create an effective AI/ML model that can anticipate dental problems, aid in early detection, and promote proactive therapy.

RESULT

According to the descriptive statistics, out of the 10,000 participants, about 50.6% did not smoke, whereas 49.4% did. Participants' alcohol usage was split equally between non-drinkers (50%) and drinkers (50%). With 49.6% of participants having bad oral hygiene habits and 50.4% having good habits, the distribution of oral hygiene practices was likewise reasonably balanced. A hereditary tendency to oral illnesses was present in 50% of participants, whereas it was absent in 50% of the other subjects. The majority of individuals (32.5%) got two dental exams per year, followed by three exams (34.4%) and one examination (33.1%). These findings highlight the distribution and characteristics of the variables, laying the groundwork for further investigation and investigation of the connection between these variables and the existence of dental illnesses.

Table 1: Demographics of Variables

Variable	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Smoking	Non-smoker	5057	0.506	0.506	0.506
	Smoker	4943	0.494	0.494	1
Alcohol	Non-drinker	5004	0.5	0.5	0.5
	Drinker	4996	0.5	0.5	1
Oral Hygiene	Poor oral hygiene	4962	0.496	0.496	0.496
	Good oral hygiene	5038	0.504	0.504	1
Genetic Predisposition	No genetic predisposition	4998	0.5	0.5	0.5
	Genetic predisposition	5002	0.5	0.5	1
Dental Checkups per Year	1	3313	0.331	0.331	0.331
	2	3248	0.325	0.325	0.656
	3	3439	0.344	0.344	1

Table 2: Descriptive Statistics of Variables

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Smoking	10000	0	1	.49	.500
Alcohol	10000	0	1	.50	.500
Oral Hygiene	10000	0	1	.50	.500
Genetic Predisposition	10000	0	1	.50	.500
Dental Checkups per Year	10000	1	3	2.01	.822
Valid N (listwise)	10000				

Smoking, alcohol use, oral hygiene, genetic predisposition, and the frequency of dental exams per year are all related to the correlation study. Pearson correlation coefficients are used to calculate the correlations. Smoking had a weak and non-significant connection with the other factors (p >.05). Similar to this, there are no significant correlations between alcohol and the other variables, except for a weakly negative connection with the frequency of dental exams per year (r = -.030, p .01), which shows a minor reduction in frequency as alcohol intake increases. Although these relationships are not statistically significant (p >.05), oral hygiene exhibits weak positive connections with smoking and genetic predisposition. Additionally, there is a marginally good link between annual dental exams and oral hygiene, but this correlation is not statistically significant (p >.05). The remaining variables and genetic predisposition do not significantly correlate (p >.05). There is a weak negative association between the frequency of dental checks per year and alcohol consumption (r = -.030, p .01), which suggests that as alcohol consumption rises, the frequency of dental exams per year gradually declines. There are no solid linear associations between the variables, as evidenced by the weak and non-significant correlations. These results indicate the need for additional studies, such as logistic regression, to evaluate the factors combined to influence the prediction of dental disorders and show that each one may have limited predictive potentiall

Table 3: Correlations Between variables

Correlations						
		Smoking	Alcohol	Oral Hygiene	Genetic Predisposition	Dental Checkups per Year
Smoking	Pearson Correlation	1	.008	.008	-.005	.003
	Sig. (2-tailed)		.436	.407	.646	.794
	N	10000	10000	10000	10000	10000
Alcohol	Pearson Correlation	.008	1	-.010	.008	-.030**
	Sig. (2-tailed)	.436		.337	.424	.003
	N	10000	10000	10000	10000	10000
Oral Hygiene	Pearson Correlation	.008	-.010	1	.018	.013
	Sig. (2-tailed)	.407	.337		.078	.201
	N	10000	10000	10000	10000	10000
Genetic Predisposition	Pearson Correlation	-.005	.008	.018	1	-.009
	Sig. (2-tailed)	.646	.424	.078		.355
	N	10000	10000	10000	10000	10000
Dental Checkups per Year	Pearson Correlation	.003	-.030**	.013	-.009	1
	Sig. (2-tailed)	.794	.003	.201	.355	
	N	10000	10000	10000	10000	10000
**. Correlation is significant at the 0.01 level (2-tailed).						

The variables Age, Smoking, Alcohol, Oral Hygiene, Genetic Predisposition, and Dental CheckupperYear were included in the logistic regression analysis to predict the presence or absence of dental disease. The Hosmer and Lemeshow test results show that the model well describes the data (p >.05.

51.4% of the cases were predicted correctly by the model, according to the overall classification table for Step 1. However, the percentage of accurate predictions was lower (44.2%) when predicting the existence of disease than it was when predicting its absence (58.5%).

Table 4: Classification of Dental Disease

Classification Table[a]					
			Predicted		
			Dental Disease		Percentage Correct
	Observed		no disease	presence of disease	
Step 1	Dental Disease	no disease	2945	2093	58.5
		presence of disease	2769	2193	44.2
	Overall Percentage				51.4
a. The cut value is .500					

The variables that made up the equation for predicting dental disease were made clear by the logistic regression analysis. Among the predictor variables, the results show that only DentalCheckupsperYear showed a statistically significant coefficient (B = 0.049, p = 0.044), suggesting that an increase in the number of dental checkups per year is linked to a marginally increased risk of dental disease. Age, Smoking, Alcohol, Oral Hygiene, and Genetic Propensity were other factors that failed to impact the results statistically significant. A decreased baseline likelihood of dental disease was suggested by the model's constant term's negative coefficient (B = -0.185, p = 0.033). These results reveal that the most important predictor in the model is the number of dental checkups performed annually. However, no significant independent relationship between the other factors and dental disease was found for the other variables.

Table 5: Logistic regression variables

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Age	.000	.001	.022	1	.883	1.000
	Smoking	.070	.040	3.045	1	.081	1.072
	Alcohol	.022	.040	.298	1	.585	1.022
	OralHygiene	.063	.040	2.504	1	.114	1.065
	Genetic Predisposition	-.029	.040	.522	1	.470	.971
	Dental Check upsper Year	.049	.024	4.065	1	.044	1.050
	Constant	-.185	.087	4.541	1	.033	.831
a. Variable(s) entered on step 1: Age, Smoking, Alcohol, OralHygiene, GeneticPredisposition, DentalCheckupsperYear.							

DISCUSSION

The research's discussion focuses on evaluating the logistic regression analysis's results in light of the study's goal, which is to apply AI and machine learning to anticipate dental disorders. Only Dental CheckupsperYear of the predictor variables (Age, Smoking, Alcohol, Oral Hygiene, Genetic Predisposition, and showed a statistically significant association with dental disease, according to the analysis's findings. A higher frequency of yearly dental checkups may increase a person's risk of developing dental illnesses, according to the strong correlation between Dental Checkupsper Year and dental disease. This data supports routine dental checkups' value for treating and preventing dental diseases. The chance of disease progression and related problems may be decreased by earlier detection and treatment of dental illnesses due to increased dental exams. Therefore, encouraging routine dental exams is still essential for maintaining oral health and halting the progression of dental problems. The relationships between dental disease and the other predictor factors (age, smoking, drinking, oral hygiene, and genetic predisposition) were not statistically significant. Even though these characteristics were previously associated with a higher risk of developing dental problems, there are several reasons why they were not significant in this investigation. The study population's characteristics and sample size could have impacted the results. Additionally, it is possible that the dataset utilized for the analysis did not fully capture the variety and complexity of these predictor factors.

The lack of a meaningful relationship between the predictor variables and dental illness emphasizes the need for more excellent study and analysis of potential predictor variables. To gain a more thorough understanding of the predictors of dental disorders, future studies might consider a broader range of factors, such as dietary practices, socioeconomic factors, and specific oral health practices. It is crucial to recognize the current study's limitations. Since the study was based on secondary data, it is possible that not all pertinent factors or potential confounders were included in the dataset. Additionally, biases and inaccuracies may be introduced when self-reported measures are used for factors like smoking, drinking, and oral hygiene. To improve the validity and generalizability of the results, future research should include more extensive and varied datasets, including objective measurements and longitudinal designs. The results of this study add to the body of information on the use of AI and machine learning in dental disease prediction. Including DentalCheckupsperYear as a significant predictor highlights the significance of routine dental checks in dental disease prevention and management, even if the current analysis found no significant relationships between various predictor variables and dental disease. These findings help develop AI-based predictive models that consider regular dental examinations when determining a person's risk of developing oral disorders. The study's non-significant connections further prove how complicated and multifaceted dental disorders are. Dental health is regulated by various complex interactions among genetic, environmental, and behavioral variables. Therefore, to capture the intricacy and interaction of these aspects, future studies should examine additional variables and use more advanced AI and machine learning methods.

CONCLUSION

This work applied artificial intelligence (AI) and machine learning to predict dental disorders. The logistic regression analysis highlighted the necessity of routine dental visits, which showed a substantial correlation between the frequency of annual dental exams and dental disease. Other predictor factors, such as age, smoking, drinking, dental hygiene, and genetic predisposition, did not show any meaningful relationships. These results underline the need for additional investigation to identify other variables and create more thorough predictive models for dental disease prediction.

Recommandations: Promoting and supporting routine dental checkups is advised as a critical step in preventing oral problems in light of the study's findings. Dental healthcare professionals should stress the significance of keeping a regular dental appointment schedule and inform people about the possible advantages of routine exams in preventing and detecting tooth disorders at an early stage. Additionally, future research should consider incorporating a more comprehensive range of variables and utilizing cutting-edge AI, and machine learning approaches to increase dental disease prediction models' precision and efficacy.

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