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Unveiling the Smell of Health: E-Nose-Based Volatile Organic Compound Analysis of Exhaled Breath in Early Lung Cancer Detection

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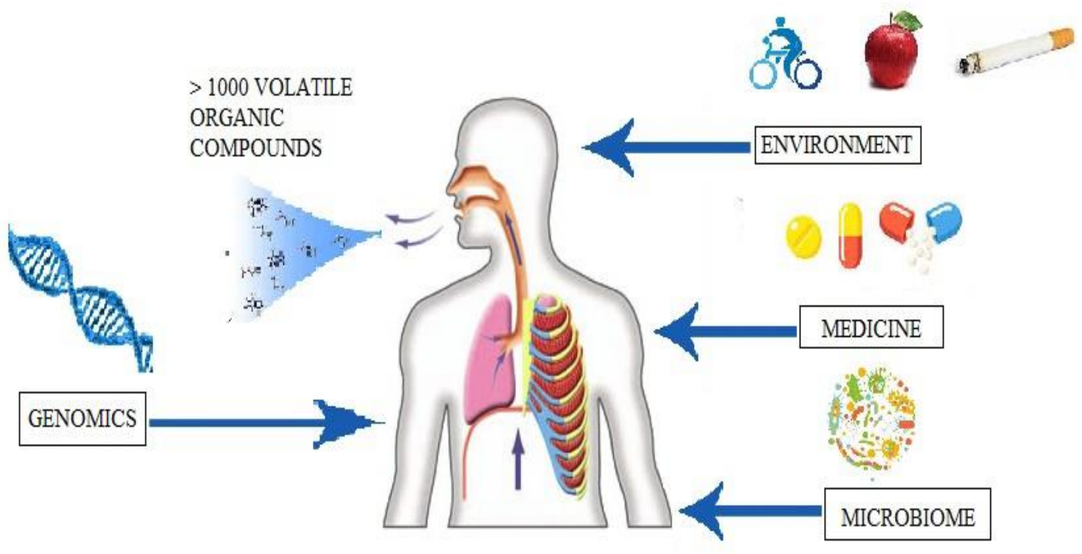
INTRODUCTION & AIM

- Lung cancer poses a significant global health challenge, underscoring the need for innovative diagnostic methods for early detection.
- This review explores the use of electronic nose (e-nose) technology to analyze exhaled breath for volatile organic compounds (VOCs) as potential biomarkers of lung cancer.
- Inspired by the human olfactory system, e-nose technology employs sensor arrays to detect and distinguish complex odor profiles.
- This work explains the principles and applications of e-nose technology in capturing unique VOC signatures present in exhaled breath, indicative of underlying physiological conditions.
- Special attention is given to the methodology and advancements in e-nose-based VOC analysis, particularly focusing on its potential for early detection of lung cancer, with insights into recent studies and developments.
- Highlighted the significance of early detection in lung cancer management and emphasized the potential of e-nose technology as a non-invasive and promising approach for early diagnosis.



METHOD

- Conducted systematic search until December 2023 in databases like EMBASE, Google Scholar, Pubmed, and Google for relevant publications.
- Used specific keywords such as electronic nose, lung cancer, breath analysis, biomarkers, etc., to find literature on e-nose-based exhaled breath analysis for early lung cancer detection.
- Reviewed references of identified studies for additional original works and selected peer-reviewed articles for inclusion.
- Inclusion criteria: Studies focusing on detecting VOC biomarkers for early stage lung cancer using e-nose technology.
- Exclusion criteria: Studies lacking accuracy, sensitivity, or specificity data, studies not detecting early stages of lung cancer, studies on VOC analysis for other pulmonary diseases, and studies not in English.
- Extracted data from studies including author names, publication year, country, number of participants, breath sample collection and VOC detection methods, data analysis techniques, and performance parameters (accuracy, sensitivity, specificity).

RESULTS & DISCUSSION

A total of 59 studies were retrieved for this systematic review. Some of the papers were duplicate works and the majority of the papers were not meeting the criteria for inclusion. Finally, 12 studies were included for this systematic review.

Subjects	Accuracy (%)	Sensitivity (%)	Specificity (%)	E-nose used	Data Analysis		Reference
					Feature Extraction	Classification	
229	81.10	70.00	86.00	Colorimetric sensors based e-nose	Not reported	logistic regression	1
235	93.59	95.60	91.09	Metal oxide, Hot wire, and Electrochemical gas sensors based e-nose	KPCA	XGBoost	2
52	91.59	91.58	91.72	Metal oxide, Hot wire, and Electrochemical gas sensors based e-nose	LDA	fuzzy k-NN	3
85	75.00	79.00	72.00	Metal oxide gas sensors	PCA	MLP	4
268	86.42	Not reported	Not reported	Metal oxide, Hot wire, and Electrochemical gas sensors based e-nose	ICA	Random forest	5
146	Not reported	81.00	91.00	QMB sensors based eNose	Not reported	PLS-DA	6
87	94.25	97.83	90.24	Metal oxide, Hot wire, and Electrochemical gas sensors based e-nose	SGL	SVM	7
335	87.30	87.30	71.20	Cyranose 320	PCA	SVM	8
191	Not reported	88.00	81.30	Cyranose 320	Not reported	DFA	9
682	87.00	86.00	89.00	SpiroNose	PCA	Discriminant Analysis	10
261	91.67	88.89	93.75	Metal oxide gas sensors based e-nose	KPCA	XGBoost	11
137	94.16	96.34	90.91	Metal oxide gas sensors based e-nose	PCA	XGBoost	12

CONCLUSION

In conclusion, the utilization of e-nose technology for exhaled breath analysis shows promising potential in the early detection of lung cancer through the identification of volatile organic compounds (VOCs) as biomarkers. Despite some limitations and challenges, the comprehensive review underscores the importance of continued research and development in this field to realize the full diagnostic capabilities of e-nose technology, ultimately contributing to improved patient outcomes and healthcare practices.

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