PREDICTIVE RISK ASSESSMENT FOR EARLY DETECTION OF HEARING IMPAIRMENT IN ADULTS: ORGANIZATIONAL AND PUBLIC HEALTH PERSPECTIVES

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Relevance: *Hearing impairment is one of the most common chronic health conditions worldwide and represents a significant medical, social, and economic challenge. According to the World Health Organization, more than 1.5 billion people experience some degree of hearing loss, and this number is expected to increase substantially in the coming decades due to population aging and the growing prevalence of chronic diseases. Untreated hearing impairment is associated with communication difficulties, reduced quality of life, social isolation, cognitive decline, depression, and decreased work productivity.*

Despite advances in audiological diagnostics, a considerable proportion of hearing disorders remain undetected during the early stages. Many patients seek medical attention only after substantial deterioration of hearing function has occurred, reducing opportunities for timely treatment and rehabilitation. Existing healthcare systems primarily rely on passive case detection, whereas modern public health approaches increasingly emphasize risk-based screening and proactive identification of high-risk individuals.

The development of predictive models capable of identifying adults at increased risk of hearing impairment may contribute to earlier diagnosis, improved referral pathways, and more efficient allocation of healthcare resources. Therefore, the implementation of risk-oriented strategies represents a promising direction for improving hearing healthcare services and strengthening preventive medicine programs.

Materials and Methods. A population-based observational study was conducted between 2021 and 2025 in primary healthcare facilities, otorhinolaryngology departments, and specialized audiological centers. The study included 1,246 adults aged 18–75 years who underwent comprehensive audiological assessment.

All participants received otorhinolaryngological examination, pure-tone audiometry, speech audiometry, and tympanometry. Demographic characteristics, occupational history, lifestyle factors, and medical conditions potentially associated with hearing impairment were collected using structured questionnaires and medical records.

Particular attention was paid to age, occupational noise exposure, chronic middle ear diseases, arterial hypertension, diabetes mellitus, smoking status, and family history of hearing disorders. In addition, organizational aspects of healthcare delivery, including referral pathways, accessibility of audiological services, and delays in diagnosis, were analyzed.

Statistical analysis was performed using logistic regression to identify independent predictors of hearing impairment. Based on the obtained results, a predictive risk assessment model and digital decision-support tool were developed. The predictive performance of the model was evaluated using receiver operating characteristic analysis.

Results. Hearing impairment was identified in 25.5% of participants. The prevalence increased significantly with age, ranging from 11.8% among individuals aged 18–39 years to 48.9% among participants older than 60 years. Occupational noise exposure was found to be one of the strongest risk factors, particularly among individuals employed in manufacturing, transportation, and construction industries.

Multivariable analysis demonstrated that age above 60 years, prolonged occupational noise exposure, chronic middle ear diseases, diabetes mellitus, arterial hypertension, and smoking were independent predictors of hearing impairment. Based on these variables, a predictive risk assessment model was developed and validated.

The model demonstrated good diagnostic performance, with an area under the ROC curve of 0.84, sensitivity of 82.1%, and specificity of 78.6%. Application of the model enabled stratification of participants into low-, moderate-, and high-risk groups, allowing identification of individuals most likely to benefit from audiological examination.

Analysis of healthcare utilization revealed substantial delays in diagnosis. Less than one-third of patients sought specialized audiological assessment during the first year after symptom onset, while the average interval between initial symptoms and formal diagnosis exceeded three years. These findings indicate significant deficiencies in current referral pathways and hearing healthcare organization.

Conclusion. Hearing impairment remains a significant public health problem and is frequently diagnosed at advanced stages. Age, occupational noise exposure, chronic middle ear diseases, diabetes mellitus, arterial hypertension, and smoking were identified as major predictors of hearing loss among adults.

The developed predictive model demonstrated high diagnostic accuracy and may serve as an effective tool for risk-based screening and early detection of hearing disorders. Integration of digital decision-support technologies into primary healthcare settings can improve referral efficiency, reduce diagnostic delays, and optimize healthcare resource allocation.

Implementation of a risk-oriented organizational model has the potential to strengthen hearing healthcare services, increase early detection rates, and improve hearing-related health outcomes among adult populations.