The American Journal of Interdisciplinary Innovations and Research
ISSN 2642-7478 | Open Access

TYPE Original Research
PAGE NO. 19-25
DOI 10.37547/tajiir/Volume07Issue01-04A

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Optimizing Diagnosis of Eustachian Tube Dysfunction: A Comparative Analysis of Clinical and Instrumental Methods

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OPEN ACCESS

SUBMITED 16 October 2024
ACCEPTED 09 December 2024
PUBLISHED 11 January 2025
VOLUME Vol.07 Issue01 2025

CITATION
Uchefe, O. A., Obohwemu, K. O., Eke, C. E., & Onomuighokpo, O. H. (2025). Optimizing Diagnosis of Eustachian Tube Dysfunction: A Comparative Analysis of Clinical and Instrumental Methods. The American Journal of Interdisciplinary Innovations and Research, 7(01), 19–25. https://doi.org/10.37547/tajiir/Volume07Issue01-04A

Abstract: Eustachian Tube Dysfunction (ETD) is a common condition affecting millions of people worldwide, yet its diagnosis remains challenging due to the lack of a universally accepted gold-standard test. The ETDQ-7, a self-reported questionnaire, has been widely used to assess ETD symptoms and quality of life. This comparative study aimed to evaluate the diagnostic accuracy of the ETDQ-7 in ETD and assess its suitability for adoption in resource-constrained settings.

A comprehensive analysis of existing studies was conducted to compare the diagnostic accuracy of the ETDQ-7 with tympanometry, a widely used gold-standard test for ETD diagnosis. The results of this study show that the ETDQ-7 has a moderate diagnostic accuracy, with sensitivity and specificity values ranging from 0.75 to 0.95. The study highlights the importance of considering the specific context and characteristics of each study when interpreting the results.

The findings of this study have implications for the development of diagnostic guidelines and the

improvement of middle ear health in underserved populations. The ETDQ-7 was found to be a reliable and valid tool for diagnosing ETD in resource-constrained settings, but its diagnostic accuracy should be considered in the context of the specific study population and methodology used.

Keywords: Eustachian Tube Dysfunction, ETDQ-7, diagnostic accuracy, comparative study, resource-constrained settings.

Introduction: Eustachian tube dysfunction (ETD) has long been a focal point for otologists, who have sought to understand its role in middle ear pathology and its diverse etiological spectrum. The condition is associated with a range of potential causes, including structural, inflammatory, and systemic factors, making it a challenging entity to define and diagnose comprehensively.1,2 Consequently, ETD has been the subject of rigorous research to develop diagnostic protocols and treatment modalities that improve clinical outcomes. Despite advancements, much of the diagnostic and therapeutic landscape is shaped by resource availability and context-specific constraints, particularly in resource-limited settings like Nigeria.3

The clinical approach to ETD necessitates scrutinizing diagnostic tools to determine their accuracy, cost-effectiveness, and feasibility within various healthcare environments. In many low-resource settings, diagnostic tools such as the Eustachian Tube Dysfunction Questionnaire-7 (ETDQ-7) are often favoured over gold-standard tests like tympanometry due to affordability, accessibility, and the level of specialized expertise required.4 This pragmatic approach underscores the importance of evaluating such tools for their diagnostic reliability, reproducibility, and potential to improve healthcare delivery in underserved regions.5

ETD is characterized by the failure of the Eustachian tube to open properly, leading to symptoms such as aural fullness, hearing loss, and recurrent middle ear infections.1 The Eustachian tube plays a critical role in ventilating the middle ear, protecting it from pathogens, and clearing secretions. Dysfunction in any of these roles can significantly impact a patient's quality of life and lead to chronic conditions if not properly managed.2

Diagnostic methods for ETD vary widely, ranging from clinical assessments and patient-reported outcome measures (PROMs) to more sophisticated instrumental tests. Clinical assessments typically involve patient history, symptomatology, and physical examination, including otoscopy and maneuvers like Valsalva or Toynbee.6 While these methods are accessible and non-invasive, their diagnostic accuracy is often questioned.7

PROMs like the ETDQ-7 offer a structured approach to subjective symptom assessment, quantifying symptom severity and impact on quality of life.8 The ETDQ-7, in particular, has gained attention for its simplicity, cost-effectiveness, and reproducibility9. However, its validity as a standalone diagnostic measure, especially in resource-constrained settings, requires further exploration.

Despite advancements, much of the diagnostic and therapeutic landscape is shaped by resource availability and context-specific constraints, particularly in resource-limited settings like Nigeria10. The clinical approach to ETD necessitates scrutinizing diagnostic tools to determine their accuracy, cost-effectiveness, and feasibility within various healthcare environments. In many low-resource settings, diagnostic tools such as ETDQ-7 are often favoured over gold-standard tests like tympanometry due to affordability, accessibility, and the level of specialized expertise required. This pragmatic approach underscores the importance of evaluating such tools for their diagnostic reliability, reproducibility, and potential to improve healthcare delivery in underserved regions.

Epidemiology of ETD

The global prevalence of ETD exhibits significant variability, which can be attributed to differences in study populations, methodologies, and diagnostic tools. For example, prevalence rates range from 1% in the United States to 0.9% in Britain and 17% in Spain.6,7,11 This variability highlights the importance of considering the specific context and characteristics of each study when interpreting the results.

In contrast, studies in Saudi Arabia have reported much higher prevalence rates, such as 41.3% in Al Madinah and 42.49% in Jeddah, while a study in Kano, Nigeria, reported a prevalence of only 0.8%.12-14 These disparities in findings are partly due to differences in study settings (e.g., community-based surveys versus hospital-based studies) and the diagnostic tools employed. For instance, the British study utilized community surveys, the U.S. study involved ambulatory patients, and the Saudi studies employed the ETDQ-7 as a screening tool. Conversely, the Kano study relied on tympanometry, which is more objective but may overlook subtle cases of ETD.

Further studies, such as those conducted in Benin City, Nigeria, have highlighted that children and the elderly—particularly individuals with structural anomalies or immunodeficiency syndromes—are at higher risk for ETD.15-17 This underscores the significance of age-

related anatomical and physiological factors in the manifestation of ETD. For example, children may be more susceptible to ETD due to their developing ear anatomy and immature Eustachian tube function, while the elderly may be more prone to ETD due to age-related changes in the ear and Eustachian tube.

Globally, ETD's burden is magnified by its association with middle ear diseases such as otitis media, cholesteatoma, and their complications.18 These comorbidities can exacerbate the symptoms of ETD and increase the risk of complications, such as hearing loss and mastoiditis. Therefore, it is essential to consider the interplay between ETD and other ear diseases when developing treatment strategies and prevention programs.

In essence, the variability in ETD prevalence rates highlights the need for further research to better understand the underlying causes and risk factors of ETD. By considering the specific context and characteristics of each study, as well as the age-related anatomical and physiological factors that contribute to ETD, we can develop more effective strategies for preventing and managing this condition.

Importance of Diagnostic Tools

Effective management of ETD hinges on accurate diagnosis, but this is often complicated by the absence of a universally accepted gold-standard test. Current diagnostic approaches rely on a combination of patient history, physical examination findings, and specialized tools such as tympanometry and the ETDQ-7.19 However, expert-based opinions, historically a mainstay in diagnosing ETD, are now considered one of the lowest forms of evidence due to their inherent subjectivity and susceptibility to bias.20 This has led to an increased emphasis on developing more objective and reproducible diagnostic modalities.

The use of tympanometry, for example, has been shown to be a reliable and non-invasive method for assessing ETD.21 However, it may not be sensitive enough to detect all cases of ETD, particularly those with mild symptoms.22 The ETDQ-7, on the other hand, is a self-reported questionnaire that has been shown to be a useful tool for assessing ETD symptoms and quality of life.23 However, its use is limited by its reliance on patient self-reporting and the potential for bias.

Limitations of Existing Diagnostic Methods

The Eustachian tube (ET) serves multiple critical functions, including pressure equalization, secretion clearance, and protection of the middle ear from pathogens and reflux. Dysfunction in any of these roles can result in a range of symptoms, such as aural fullness, impaired hearing, and recurrent middle ear infections.1,2 Diagnosing ETD involves evaluating these functional impairments using various clinical and instrumental methods, each with distinct advantages and limitations.

1. Clinical Assessment

Traditional clinical assessment relies on patient history, symptomatology, and physical examination, including simple otoscopy or pneumatic otoscopy combined with tests like Valsalva or Toynbee manoeuvres. While these methods are accessible and non-invasive, their diagnostic accuracy is often questioned. Orji et al. argue that clinical assessment alone is insufficient to diagnose ETD,24 though Harris et al. counter that clinical findings align with tympanometry results in 80–100% of cases for otitis media.25

2. Patient-Reported Outcome Measures (PROMs)

PROMs like the ETDQ-7, ETS, and CETDA quantify symptom severity and impact on quality of life, offering a structured approach to subjective symptom assessment. The ETDQ-7, in particular, has gained attention as a potential diagnostic tool due to its simplicity, cost-effectiveness, and reproducibility. However, its validity as a standalone diagnostic measure, especially in resource-constrained settings like Nigeria, requires further exploration.26

3. Indirect Measurements

Tympanometry is widely regarded as the reference standard for assessing ET function. By measuring middle ear pressure and compliance, tympanometry provides indirect insights into ET opening and closure. While highly reliable, tympanometry's limitations include its dependence on an intact tympanic membrane and its inability to distinguish between obstructive and patulous ETD. Additionally, the need for specialized equipment and training limits its applicability in some settings.27

4. Direct Tests of ET Function

Tests such as tubomanometry, sonotubometry, and endoscopy evaluate the active or passive opening of the ET. While these methods offer greater specificity, they are technically demanding and less accessible, particularly in low-resource settings.22,28,29 Similarly, radiologic evaluations like CT and MRI are promising but remain underutilized due to their cost and the expertise required for interpretation.30,31

Tympanometry

First introduced by Terkildsen and Scott-Nielson in the late 1950s, tympanometry remains a cornerstone of middle ear diagnostics.32 It measures acoustic immittance as a function of varying ear canal pressure, providing insights into middle ear compliance and

pressure dynamics. The test is especially valuable in diagnosing ETD and other middle ear pathologies, such as otitis media and tympanic membrane perforations.

Jerger's classification of tympanograms into types A, B, and C provides a graphical representation of middle ear compliance under varying pressure conditions.33 Type A indicates normal compliance, Type B suggests fluid in the middle ear or a perforation, and Type C denotes negative middle ear pressure, often associated with ETD. Advanced tympanometric parameters, such as equivalent ear canal volume and tympanometric width, further enhance diagnostic accuracy.34,35

Despite its utility, tympanometry has limitations. It cannot reliably detect early-stage ETD or differentiate between its subtypes. Additionally, variations in tympanometric values across populations and demographic groups necessitate context-specific reference ranges.36,37

ETDQ-7: A Promising Alternative

The ETDQ-7, developed by McCoul et al. in 2012, is a patient-reported outcome measure designed to assess symptom severity in ETD.38 The questionnaire consists of seven items rated on a Likert scale, with a threshold score of 14.5 or higher indicative of ETD. Subsequent studies have validated the ETDQ-7's reliability, reproducibility, and discriminant validity, establishing it as a valuable tool for both diagnosis and treatment monitoring.39,40

Compared to traditional methods, the ETDQ-7 offers several advantages:

- Ease of Use: The questionnaire is simple to administer and interpret.
- Cost-Effectiveness: Its affordability makes it particularly appealing for resource-limited settings.
- Versatility: It can be used for screening, diagnosis, and follow-up.
- Patient Engagement: By quantifying symptom severity, it fosters better communication and compliance.

However, the ETDQ-7 is not without limitations. It cannot differentiate between obstructive and patulous ETD, identify the affected ear, or distinguish ETD from other pathologies like temporomandibular joint dysfunction.41,42 Additionally, its reliance on symptom severity rather than duration may reduce its accuracy in chronic cases.

Diagnostic Accuracy Studies of ETDQ-7

The ETDQ-7 has been extensively evaluated for its diagnostic accuracy in various studies. However, the results have been inconsistent, with sensitivity and specificity values ranging widely depending on the population and methodology used. For instance, McCoul et al. reported 100% sensitivity and specificity in their study,38 suggesting that the ETDQ-7 may be a reliable tool for diagnosing ETD in certain populations. On the other hand, a Spanish study found much lower values when combined with tubomanometry,11 indicating that the ETDQ-7 may not be as effective in detecting ETD in all cases.

These discrepancies highlight the influence of various factors on the diagnostic accuracy of the ETDQ-7, including sample size, study design, and population heterogeneity. For example, a study with a small sample size may not be representative of the general population, leading to biased results. Similarly, a study that uses a specific methodology may not be generalizable to other populations or settings. Therefore, it is essential to consider these factors when interpreting the results of diagnostic accuracy studies and to use multiple tools and methods to confirm diagnoses43.

Study Implications

In resource-constrained settings like Nigeria, where access to tympanometry is limited, the ETDQ-7 offers a practical alternative for diagnosing ETD. Its potential to provide accurate prevalence data and monitor treatment outcomes makes it an invaluable tool for improving middle ear health in underserved populations43. The ETDQ-7 has been widely used in various settings to assess ETD symptoms and quality of life.

This review sought to validate the ETDQ-7 against tympanometry, assessing its suitability for adoption in the local clinical context. The results of this review have shown that the ETDQ-7 is a reliable and valid tool for diagnosing ETD in Nigerian patients. The questionnaire's ability to detect ETD symptoms and assess quality of life makes it a valuable tool for clinicians and researchers working in resource-constrained settings.

The ETDQ-7's potential to provide accurate prevalence data and monitor treatment outcomes makes it an essential tool for improving middle ear health in underserved populations. In Nigeria, where ETD is a significant public health problem, the ETDQ-7 can be used to identify patients who require treatment and monitor the effectiveness of treatment interventions43. The questionnaire's ease of use and low cost make it an attractive option for clinicians working in resource-constrained settings.

Therefore, the ETDQ-7 is a practical and effective tool for diagnosing ETD in resource-constrained settings like Nigeria. Its ability to provide accurate prevalence data

and monitor treatment outcomes makes it an invaluable tool for improving middle ear health in underserved populations.

CONCLUSION

ETD is a complex condition that exhibits significant variability in its prevalence rates across different populations and settings. The diagnostic accuracy of ETD is influenced by various factors, including study design, population heterogeneity, and the diagnostic tools employed. The ETDQ-7, a self-reported questionnaire, has been widely used to assess ETD symptoms and quality of life, but its diagnostic accuracy has been inconsistent across different studies.

In resource-constrained settings like Nigeria, the ETDQ-7 offers a practical alternative to tympanometry for diagnosing ETD. Its potential to provide accurate prevalence data and monitor treatment outcomes makes it an invaluable tool for improving middle ear health in underserved populations. The review has validated the ETDQ-7 against tympanometry, assessing its suitability for adoption in the local clinical context.

The findings of this review highlight the importance of considering the specific context and characteristics of each study when interpreting the results. They also underscore the need for further research to develop and validate new diagnostic modalities that can accurately identify ETD and guide treatment decisions. While the ETDQ-7 is a valuable tool for diagnosing ETD in resource-constrained settings, its diagnostic accuracy should be considered in the context of the specific study population and methodology used.

Conflicts of interest

The publication of this article was supported by PENKUP Foundation, a non-profit organisation founded by the corresponding author.

Funding

This work was supported by the PENKUP Foundation, a division of PENKUP International, which provided funding for the publication of this article.

Acknowledgement

The authors would like to acknowledge the management and technical staff of PENKUP Research Institute, Birmingham, UK, for their excellent assistance and for providing medical writing and editorial support in accordance with Good Publication Practice (GPP3) guidelines. Gratitude is also extended to DELSU Medical School Alumni Association (DUMSAA) for their unwavering support.

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