

# Auditory Deprivation Caused By Early Otitis Media with Effusion



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## Abstract

**Introduction:** In the past 40 years, the literature has attempted to clarify the evidence on the effect of early auditory deprivation caused by early otitis media with effusion (OME) on central auditory processing (CAP). **Objective:** The aim of this study was to evaluate the scientific evidence on the effects of auditory deprivation caused by early OME on the CAP of children and adolescents. **Data Synthesis:** A systematic search was conducted in the following databases: Scientific Electronic Library Online (SciELO), Latin American and Caribbean Health Sciences (Literatura Latino-Americana e do Caribe em Ciências da Saúde-LILACS), PubMed, Scopus, and Web of Science, PubMed, Medline, and Cochrane databases from the earliest publication, up until October 2016. **Prospective studies** that reported children or adolescents (aged less than 18 years) with early OME in the first years of life. **Conclusions:** We selected eight studies on the research topic. The results indicated a correlation between auditory deprivation caused by early OME and changes in CAP in children and adolescents. The hearing ability that was consistently susceptible to auditory deprivation was the auditory figure-ground.

**Keywords:** Auditory Perception; Otitis Media; Children

## Introduction

Otitis media with effusion (OME) is a middle-ear inflammation characterized by the presence of fluid in the middle ear without signs or symptoms of acute infection and perforation of the tympanic membrane [1]. This condition reduces the mobility of the tympanic membrane and limits the transmission of sound waves [2]. The high prevalence of OME in early childhood has generated speculation about its effect on the development of the human auditory system because this condition is the most common reason for medical consultations and surgeries in children [3]. When it affects children in the first five years of life, it can be considered "early" [3,4]. It is believed that temporary and fluctuating hearing loss caused by the disease at this stage of life may impair hearing development [3-5] and is considered a form of auditory deprivation [6].

The first study that described a probable association between early auditory deprivation and changes in auditory development in the long term dates from 1962. This case report described the

effects of auditory deprivation on the late behavior of a patient [7]. Since then, several studies [3-6,8-13] have attempted to elucidate the effect of early auditory deprivation caused by early OME on central auditory processing (CAP) in the long term. However, despite the large number of studies published in the past 40 years, many controversies persist [13,14]. These controversies are criticized by several authors because most of these studies were retrospective [3,5,15,16] which limited the establishment of a precise correlation between the disease and outcomes [3]. Therefore, longitudinal studies are needed to see if the negative effects of early OME persist after the recovery of tonal auditory thresholds [16]. The aim of this study was to analyze the scientific evidence on the effects of auditory deprivation caused by early OME on the CAP of children and adolescents. Therefore, this study was developed by the following questions:

a) The association between hearing deprivation caused by early OME and changes in the CAP in children and adolescents;

b) The auditory skills of CAP that are susceptible to auditory deprivation caused by early OME.

## Review of Literature

This systematic review involved the search of studies on the effect of early OME on the CAP of children and adolescents. Systematic reviews are used as a starting point for the conduct of clinical practice and thus are crucial in health care [17]. The planning and development of this study were based on the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [17]. The search was conducted in the following databases: Scientific Electronic Library Online (SciELO), Latin American and Caribbean Health Sciences (Literatura Latino-Americana e do Caribe em Ciências da Saúde–LILACS), PubMed, Scopus, and Web of Science. The descriptors were searched using the structured and trilingual “Descriptors in Health Sciences” (Descritores em Ciências da Saúde–DeCS), prepared by the Latin American and Caribbean Center of Information in Health Sciences (Centro Latino-Americano e do Caribe de Informacoes em Ciências da Saúde) from the Regional Library of Medicine (Biblioteca Regional de Medicina–BIREME) for use in the indexing of articles from scientific journals, books, conference proceedings, technical reports, and other materials.

## The Search Strategy Was Performed With the Following Descriptors

“Auditory perception” OR “Auditory perceptual disorders” OR “Auditory diseases, central” AND “Otitis media.” There was no restriction of the initial date for the search of the articles and, therefore, the selection period involved all articles published until October 2016.

## The Following Inclusion Criteria Were Adopted

Studies that evaluated children or adolescents (aged less than 18 years) with early OME; studies with a prospective design about

to the monitoring of early OME and recommendation grade of at least B [18]; studies with detailed descriptions of the criteria used for the diagnosis of otitis media in the subjects investigated; studies that described the evaluation procedures and interpretation criteria of the auditory processing tests used; and studies published in English, Portuguese, and Spanish. The studies that did not agree with the inclusion criteria and those that did not present the data clearly were excluded from the selection process. The studies were selected from August to October 2016. The studies were selected by two independent researchers and subsequently analyzed by a third professional (judge), who analyzed whether the articles selected were in accordance with the established criteria.

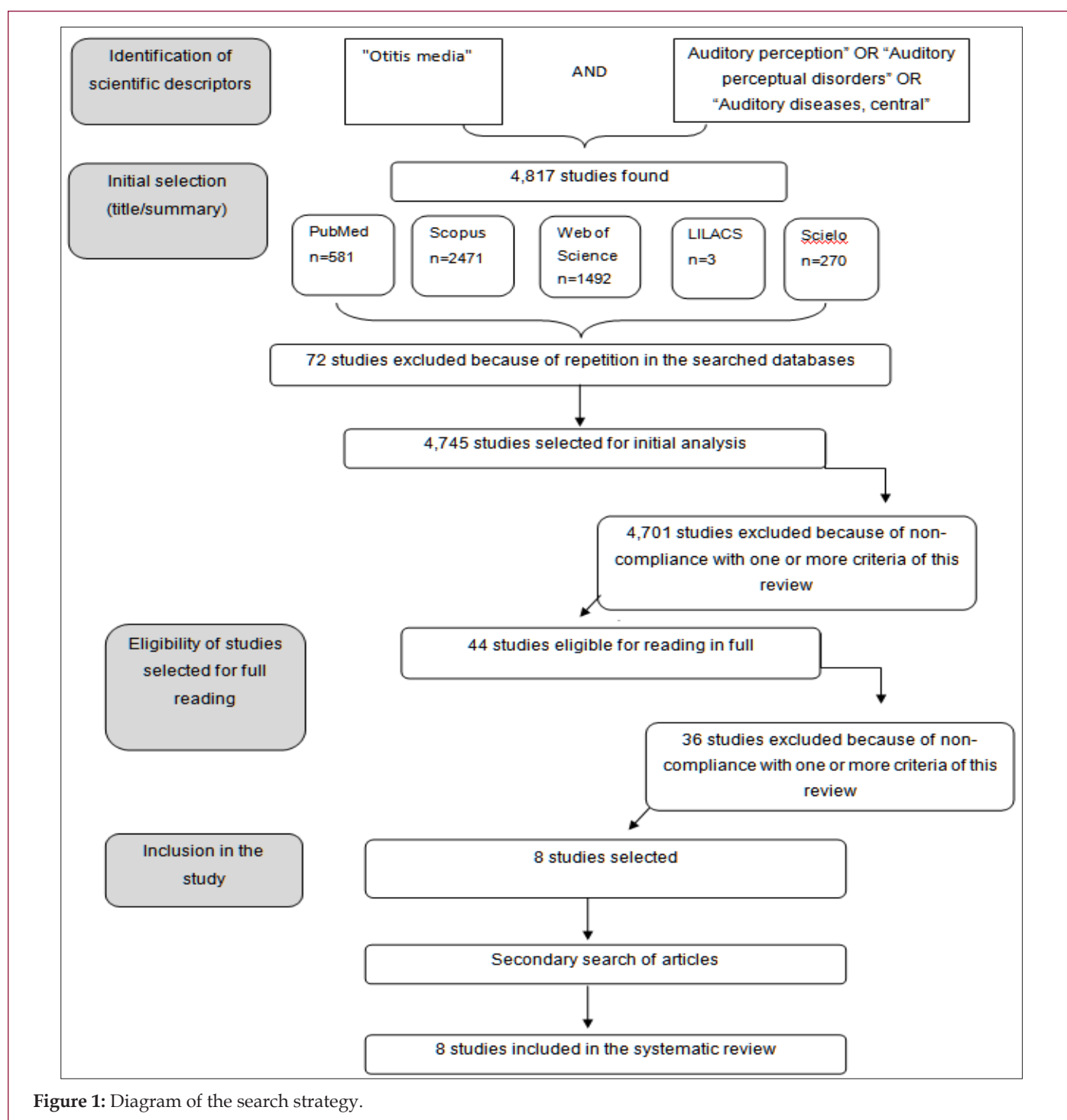
## Results

(Figures 1) & (Table 1) the results observed in the selected studies will be presented according to the assessed auditory ability. In the auditory figure-ground, three studies [5,15,19] that used tests for their evaluation verified changes. Only one of the studies 6 showed no evidence of changes in this ability. Furthermore, the study by Hogan and Moore [3] found changes only in children with very persistent OME. The binaural hearing was investigated in cases of asymmetric OME, but no alterations were found in the study sample [10]. One study 3 found alteration in this ability only in children with very persistent OME (> 45%), two studies found no evidence of deficit in this aspect [19,20]. The auditory temporal resolution was evaluated in a single study included in this review [4], wherein this ability was recovered after normalization of the hearing thresholds changed by OME. Other hearing abilities were less emphasized in the selected studies, including binaural integration and auditory closure. Only one study evaluated these abilities [19] and indicated no changes in the comparison of the group with and without early OME. In addition to these abilities, Gravel et al. [6] evaluated sound localization and found no changes in the study sample.

**Table 1:** Characteristics of the studies included in this review.

Authors and year of publication	Country	Objective	Study sample		Diagnosis of early OME		CAP tests	Assessed hearing abilities
			n	Average age (years)	Procedures	Criteria		
Gravel and Wallace [15]	United States	Examine a cohort of preschool children whose middle ear conditions were properly documented during the first year of life.	23	4,1	Periodic otoscopy during the first year of life.	Presence of effusion in the bilateral middle ear in 30% of the evaluations.	Adaptive PSI	Auditory figure-ground.
Hutchings et al. [20]	UK	Evaluate the MLD in infants, children, and adults with normal hearing and compare these results with MLD of infants with documented OME.	37	0,58 (infants). 9,5 (children) 23,9 (adults)	Otoscopy and tympanometry monthly home visits initiated 4 to 7 weeks after birth.	Type B tympanogram (at least 3 evaluations).	MLD	Binaural integration.

Schilder et al. [19]	Netherlands	Evaluate the effect of OME in preschool children on auditory perception in school age.	89	8,02	Tympanometry every 3 months during screening for OME at ages 2 to 4 years.	Type B tympanogram on either ear.	SNT FST BFT DLT	Binaural integration, binaural interaction, auditory closure, auditory figure-ground.
Stoolman et al. [10]	Netherlands	Assess the possible effects of early asymmetric OME on binaural hearing.	5	11,1	Tympanometry every 3 months for 2 to 4 years.	OME predominantly unilateral (at least 5 episodes in 9 evaluations).	MLD	Binaural interaction
Hogan & Moore [3]	UK	Correlate the history of OME with binaural hearing in children with the status of the middle ear documented prospectively.	31	6,7	Otoscopy and tympanometry every month in the first 5 years of life.	Type B tympanogram on either ear.	MLD	Binaural interaction
Hartley & Moore [4]	UK	Investigate the residual effects of OME in auditory perception in school age.	42	8,2	Tympanometry every month in the first 5 years of life	Type B tympanogram on either ear (at least 34% of evaluations)	CRM	Temporal resolution.
Gravel et al.[6]	United States	Analyze peripheral and central auditory processes in a group of children aged 8 years, whose middle ear function and auditory acuity were documented prospectively.	73 (cohort 1) 59 (cohort 2)	8,2 (cohort 1) 8,1 (cohort 2)	Cohort 1= Otoscopy every 3 months for 7 to 39 months.  Cohort 2= Tympanometry every 3 months for 7 to 39 months.	Cohort 1= Presence of effusion in the middle ear  Cohort 2= Type B tympanogram	- MLD - AVL - PSI	- Binaural interaction; - Sound localization; - Auditory figure-ground.
Zumach et al. [5]	Netherlands	The evaluation of the history of early OME and its associated hearing loss has long-term effects on auditory perception.	55	7,2	Otoscopy, tympanometry and audiometry every 3 months for 0 to 24 months.	Presence of effusion in the middle ear and type B tympanogram.	SPIN test	Auditory figure-ground.



## Discussion

This study was conducted to elucidate the likely changes in the CAP in children and adolescents with a history of early OME documented prospectively. The auditory figure-ground ability is usually affected in children with a history of early OME documented prospectively [5,15,19]. Furthermore, the analysis of the ages at follow-up indicated that the changes in the auditory figure-ground persisted even in cases in which the OME was documented only in the first year of life 15. Other studies extended the follow-up to the first 2 years of life 5, and between 2 and 4 years of life [19]. There-

fore, it is possible to infer that early OME is a risk factor for changes in the auditory figure-ground even in cases in which the episodes are limited to the first year of life. On the other hand, the three studies that evaluated binaural interaction did not identify changes [6,10,20]. Regarding temporal resolution, the results demonstrated in the selected study [4] presented evidence of recovery of this ability after hearing normalization. For other auditory abilities that compose the CAP, no data were found in the studies selected for this review. This review included only prospective studies because of the need for adequate documentation of episodes of early OME for the validation of relevant scientific evidence.

The discussion held in this study allowed the clarification of the pre-established guiding questions. With regard to the presence of a correlation between hearing deprivation caused by early OME and likely changes in the CAP of children and adolescents, it can be inferred that this correlation occurs to some extent. For CAP abilities that are considered susceptible to early OME, it is possible to infer that the auditory figure-ground ability is considered susceptible because the changes were consistently observed in different studies with a high level of scientific evidence [5,15,19]. Therefore, the auditory figure-ground ability is negatively affected by a history of early OME [15].

It should be noted that the speech-in-noise perception might have negative consequences in everyday situations and might limit communication in adverse listening situations [5]. Therefore, interventions are essential in these children considering the significant impact of this ability in the social environment, especially in schools, when the ability in competitive speech is necessary for children to acquire a primary message and ignore concurrent messages, which are potentially distorted [15]. Moreover, the association between age at the first episode and the score in the noise speech test [5] should be a warning sign to clinicians of cases of early OME.

## Conclusion

Finally, the results presented in this study demonstrate that the fluctuating nature of OME may strongly compromise the normal pattern of hearing development, at least with respect to the figure-ground ability. Therefore, it is important to emphasize the need for referral of children diagnosed with early OME to medical intervention and therapy because this condition is treatable.

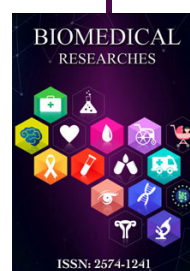
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