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Early childhood otitis media and later school performance – A prospective cohort study of associations



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ABSTRACT

Introduction: Otitis media (OM) is a common disease in childhood and hearing loss (HL) is the most common complication. Prolonged HL may lead to language delay and cognitive difficulties. However, the consequences of HL due to OM are not fully understood.

The aim of this study was to determine the possible association between number of OM episodes in childhood and self-rated school performance controlling for potential confounders.

Methods: Prospectively gathered systematic interview data on OM episodes in early childhood and school performance at 11 years of age were obtained from The Danish National Birth Cohort, involving >100,000 individual pregnancies and their offspring. We defined four exposure groups (0, 1–3, 4–6 and ≥7 OM episodes) and assessed general school performance, mathematics and literacy. Possible confounders were recognized a priori and associations were determined using proportional odds regression.

Results: Out of 94,745 successful pregnancies, 35,946 children without malformations and their parents completed a questionnaire at age 11 years. No associations were observed between number of OM episodes and school performance, even in children with ≥7 OM episodes.

Conclusion: This national birth-cohort study did not support the hypothesis that the number of OM episodes in childhood is associated with reduced self-reported school performance in children at 11 years of age.

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1. Introduction

Otitis media (OM) is a common disease in childhood. In Denmark, 39% of children have experienced OM at 18 months of age and 60% by the time they reach seven years [1]. Hearing loss is the most common complication of OM [2]. Prolonged hearing loss may lead to language delay and has in some studies been shown to increase the risk of cognitive and social difficulties. The potential developmental consequences of hearing loss due to OM are not

fully understood, despite decades of research. Several possibly affected developmental aspects have been discussed in existing studies. A part of the literature has focused on the relationship between OM and speech and language development [3–5], while others have focused on school performance [6–12], especially literacy and mathematics. Yet, the literature remains unsettled and equivocal in its findings [13] with some studies reporting a negative effect [11,12,14–18] whereas others do not [3–5,7–10,19–21]. A possible reason for this disparity is the methodological inconsistencies throughout the literature. Study types, sample sizes and the control for confounding variables vary significantly. Important factors such as socioeconomic status (SES), gender, parental education and cohabiting parents have not always been controlled for [3]. The use of diverse tests for the measurement of the different developmental outcomes may in addition diversify

Abbreviations: ASDQ II, Academic Self Description Questionnaire II; AOM, acute otitis media; DAGs, Direct Acyclic Graphs; DNBC, Danish National Birth Cohort; OM, otitis media; OME, otitis media with effusion; SES, Socioeconomic Status.

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the results [7]. Regardless of the inconsistency in the literature, guidelines for clinical practices and treatments of OM are argued on the basis of potential negative developmental consequences [22,23].

The Danish National Birth Cohort (DNBC), involves more than 100,000 individual pregnancies and their offspring, and contains prospectively gathered interview data on parent-reported OM episodes and self-rated general school performance, mathematical proficiency and Danish literacy skills.

The aim of the present study was to elucidate possible associations between parent-reported OM and self-rated school performances controlling for potential confounding factors.

2. Study population and methods

2.1. Study population

Data derived from the DNBC, which was established in 1996 [24] with the aim of studying pregnancy complications and diseases developing later in life from a life-course perspective. A total of 100,329 individual pregnancies were recruited between 1996 and 2002, corresponding to approximately 30% of all births in Denmark during the enrollment period. Enrollment occurred either at the first visit to the general practitioner during pregnancy or the first visit with the midwife. Inclusion criteria was that the mother had a desire to carry the pregnancy to term and spoke Danish well enough to take part in telephone interviews [25]. The structured interviews were conducted at approximately gestational weeks 12 and 30 and again at age six and 18 months of the child. As follow-up, self-administered questionnaires were completed first by parent after seven years and again after 11 years by both parent and child. More information regarding DNBC can be found elsewhere [24]. The study is approved by the Danish National Committee on Biomedical Research Ethics (KF) 01–471/94.

2.2. Exclusion criteria

Children born with congenital malformations were excluded from this study ($n = 1610$) as malformations may lead to different developmental pathways in combination with early OM experience. Moreover, genetic disorders such as Down syndrome and anatomical abnormalities such as cleft palate increase the risk of OM [23]. Also, malformations of the ears, eyes or brain may by itself lead to an increased risk of neuropsychological deficits and developmental delay.

2.3. Exposure

Exposure was defined as parent-reported episodes of OM at age six and 18 months of the child. The mothers were asked if their child had suffered from middle ear infection and if so, how many times. Children were allocated into four groups according to the reported numbers of experienced episodes of OM defined as: 0, 1–3, 4–6 and, ≥ 7 episodes of OM. The different types of OM were not explored in this study.

2.4. Outcome

At 11 years of age the children answered three items concerning their school performance. The first regarded their general school performance ($N = 35,946$): “How would you rate your academic performance in school?”. The second concerned mathematical proficiency ($n = 35,947$): “In your own opinion, how good are you at mathematics?”. Finally, in an item regarding Danish literacy skills ($n = 35,590$): “In your own opinion, how are your Danish literacy

skills?”. All items were rated on a four point Likert-like scale: “Excellent”, “Good”, “Fair” and “Poor”.

2.5. Confounding factors

Ten confounders were recognized a priori based on review of the literature and visualized with Direct Acyclic Graphs (DAGs) [26] (not shown). Seven of the variables were adjusted for dichotomously. (1) Sex; (2) Prematurity, defined as birth before 37 completed weeks of gestation; (3) Breastfeeding, if the child was still breastfed at six months of age; (4) Day care attendance, if the child had attended an institution with other children by 18 months of age; (5) Maternal smoking, if the mother had smoked during the first seven years of the child's life; (6) Maternal education, if mandatory lower secondary education was the highest level of attainment; (7) Cohabiting parents, if both parents lived in the same household until age seven of the child. The remaining three confounders were adjusted for as five-level dummy variables. (1) SES (range 1–5, 1 representing the highest status; (2) Child's age when responding to the questionnaire (10–14 years of age) and finally; (3) parity (0, 1, 2, 3 and 4+).

Data for all confounders, except SES and prematurity, were retrieved from the following DNBC interviews: six months, 18 months and seven years. The SES variable was categorized into five strata based on socioeconomic information from registers at Statistics Denmark calculated from level of educational attainment, employment status, income and type of family. Data for the prematurity variable was taken from an additional DNBC dataset where supplementary information concerning each birth had been retrieved.

It was decided not to control for treatment of OM like insertion of ventilation tubes as it was regarded to be a proxy for OM. Further, prompt versus late insertion has not been shown to make any difference with respect to developmental outcomes such as academic achievements in nine to 11 year old children [27].

2.6. Statistical analyses

All statistical analyses were performed using SAS 9.4 (SAS institute Inc. Cary, North Carolina). Firstly, characteristics of responders versus non-responders were performed. Secondly, a baseline characteristic analysis was conducted where the variables were cross tabulated for the four exposure groups. Thirdly, associations between OM and the three outcome variables were examined with a crude proportional odds regression, a proportional odds regression adjusted for the confounders and with a test for trend.

3. Results

3.1. Study population

Out of 100,329 pregnancies enrolled initially, information about self-rated school performances as well as parent-reported OM episodes was available for 35,946 children, and thus eligible for this study. Out of these children, 982 experienced seven or more episodes of OM at 18 months of age (see Fig. 1).

3.2. Responder vs non-responder characteristics

As there was substantial loss to follow up, we conducted an analysis to explore potential participation bias (see Table 1). We included the chi-square p-values even though they were likely to be significant solely due to our large sample size. We compared demographic characteristics of responders to the item regarding

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