Review

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Chorioamnionitis and respiratory outcomes in prematurely born children: a systematic review and meta analysis

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Abstract

Introduction: To conduct a systematic review and meta-analysis of the association between chorioamnionitis and respiratory outcomes of prematurely born children.
Content: Pubmed, Medline and Embase were searched for relevant studies. Studies were included if they assessed prematurely born children, who had been exposed to chorioamnionitis and had either lung function testing or assessment of wheeze or asthma following NICU discharge. Two reviewers independently screened the search results, applied inclusion criteria and assessed methodological quality. One reviewer extracted the data and these were checked by a second reviewer.
Summary: A total of 1,237 studies were identified, but only eight which included 35,000 infants, fulfilled the inclusion criteria. One study looked at both lung function results and wheeze or asthma in childhood. Four of five studies found an association between wheeze/asthma in childhood and exposure to chorioamnionitis: the overall Odds Ratio (OR) for developing wheeze/asthma in childhood was OR 1.71 (95 % CI: 1.55–1.89). Four studies looked at lung function in childhood, three of which showed no statistically significant association between chorioamnionitis exposure and altered lung function. One study found lower lung function in those exposed to chorioamnionitis and lower expiratory flows with increasing levels of chorioamnionitis (forced expiratory flow at 50 % of exhaled forced vital capacity (=FEF_{50}) p=0.012, forced expiratory flow at 25–75 % of the forced vital capacity is exhaled (=$FEF_{25–75}$) p=0.014).
Outlook: There was a significant association between chorioamnionitis and the development of wheeze or asthma in childhood, but overall not in impairment of lung function.

Keywords: chorioamnionitis; lung function; prematurity; respiratory outcomes; wheeze

Introduction

Chorioamnionitis is frequently associated with premature birth, in as many as 40 % of cases [1]. It is defined as inflammation of the chorion, amnion and placenta. It is often associated with a Fetal Inflammatory Response Syndrome (FIRS), a systemic inflammatory response characterised by raised cytokines and markers of the innate immune system, combined with the presence of chorionic vasculitis or funisitis (inflammation of the umbilical cord). Chorioamnionitis is most commonly classified according to the maternal inflammatory response and a fetal inflammatory response [2]. Staging refers to progression of the disease based on infiltration of neutrophils into the chorion and amnion. Stage one is characterized by neutrophilic infiltration of the chorion or subchorionic space. Stage two is neutrophilic infiltration of the chorionic connective tissue, amnion or chorionic plate. Stage three is necrotizing chorioamnionitis with degenerating neutrophils. Grading refers to the intensity of the inflammation at a specific location. Grade one (mild to moderate) is where small clusters of maternal neutrophils infiltrate the chorion, amnion and placental tissues. Grade two (severe) is classed as the presence of three or more chorionic microabscesses or a confluence of neutrophils measuring 10×20 cells. Its occurrence is inversely correlated with gestational age and has been implicated in up to 70 % of extremely

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preterm deliveries (those born at less than 28 weeks of gestation), but only 16 % of deliveries at 34 weeks of gestational age [3–5]. Additionally, the severity of chorioamnionitis has been inversely related to gestational age [6].

Watterberg et al. [7] were the first to report that chorioamnionitis increased the rates of bronchopulmonary dysplasia (BPD), but reduced the risk of respiratory distress syndrome (RDS). This was explained by a potential maturation of the fetal lung on exposure to chorioamnionitis, but the affected lungs had increased vulnerability for postnatal damage. Since then, there have been conflicting results ranging from chorioamnionitis being associated with increased, decreased, or no risk of either RDS or BPD. Several systematic reviews, however, have concluded that exposure to chorioamnionitis is associated with an increased risk of developing BPD, but this association may be affected by several factors including gestational age, birth weight and risk of RDS [8, 9]. Villamor-Martinez et al. included 158 studies and concluded that preterm infants exposed to chorioamnionitis had a higher risk of developing BPD but this was modulated by gestational age and risk of RDS [8]. Hartling et al. included 59 studies and found less definitive results between chorioamnionitis and development of BPD. Their results did show an association between the two but this appeared to be affected by publication bias and, once this factor had been adjusted for, the association between chorioamnionitis and BPD disappeared [9]. The most recent systematic review, which included 16 studies, indicated that histological chorioamnionitis or funisitis increased lung injury incidence in premature infants [10]. The protective effect reducing RDS was only seen in infants born at less than 32 weeks of gestation, exposed to the most severe chorioamnionitis (grade 2) and mainly in developing countries. Only moderate to severe cases of BPD were positively correlated with chorioamnionitis [10].

A recent narrative review [2], which included 13 studies, concluded that chorioamnionitis could delay lung aeration via an inflammatory-mediated respiratory depression, increasing the need for prolonged and more extensive resuscitation.

Prematurely born individuals compared to those born at term have worse lung function at follow-up [11, 12], it would be important to determine if chorioamnionitis played a role, as a potentially modifiable factor. Our aim, therefore, was to review the literature to determine the impact of chorioamnionitis on respiratory outcomes of children born prematurely.

Methods

Sources and search strategy

A literature search was undertaken using three databases: PubMed, Medline and Embase. The databases were searched from their beginning (1996, 1964 and 1947 respectively) until 28th March 2024. The search terms included *chorioamnionitis*, *preterm birth*, *lung function*, *outcomes*. Additionally, manual review of the bibliography of key articles which fulfilled the eligibility criteria were carried out.

Studies were included if they included preterm infants (that is those born at less than 37 weeks of gestational age), who were exposed to chorioamnionitis and had either lung function testing or assessment of wheeze or asthma after discharge from the NICU.

Data extraction

Once the papers were selected, extraction of data was carried out by one person and checked by a second for each study. This included citation information, location of research, language of publication, time period of the study, study objective, design of study, definitions of chorioamnionitis, definitions of wheeze or asthma inclusion and exclusion criteria and the results.

Validity assessment

None of the studies were randomised, but all were cohort studies, hence the Newcastle-Ottawa Quality Assessment Scale (NOS) [13] was used to assess methodological quality. The NOS scores three areas of a study: selection of the sample (0–4) and comparability between the groups (0–2) and outcomes (0–3). There are a total of nine points available and studies scoring a minimum of six points (3,1,2) were classified as good quality, studies scoring a minimum of five points (2,1,2) were of fair quality and those with a score less than that were classified as poor quality.

Publication bias was assessed by visual inspection of a funnel plot for the papers assessing wheeze/asthma prevalence, but there were an insufficient number of studies to evaluate publication bias for the papers which reported lung function results.

Results

Of 1,237 potentially relevant studies, only eight studies met the inclusion criteria [14–21]. The PRISMA flow diagram of the search process is shown in Figure 1.

The included studies evaluated 30,500 preterm infants, of which 1,993 were exposed to chorioamnionitis.

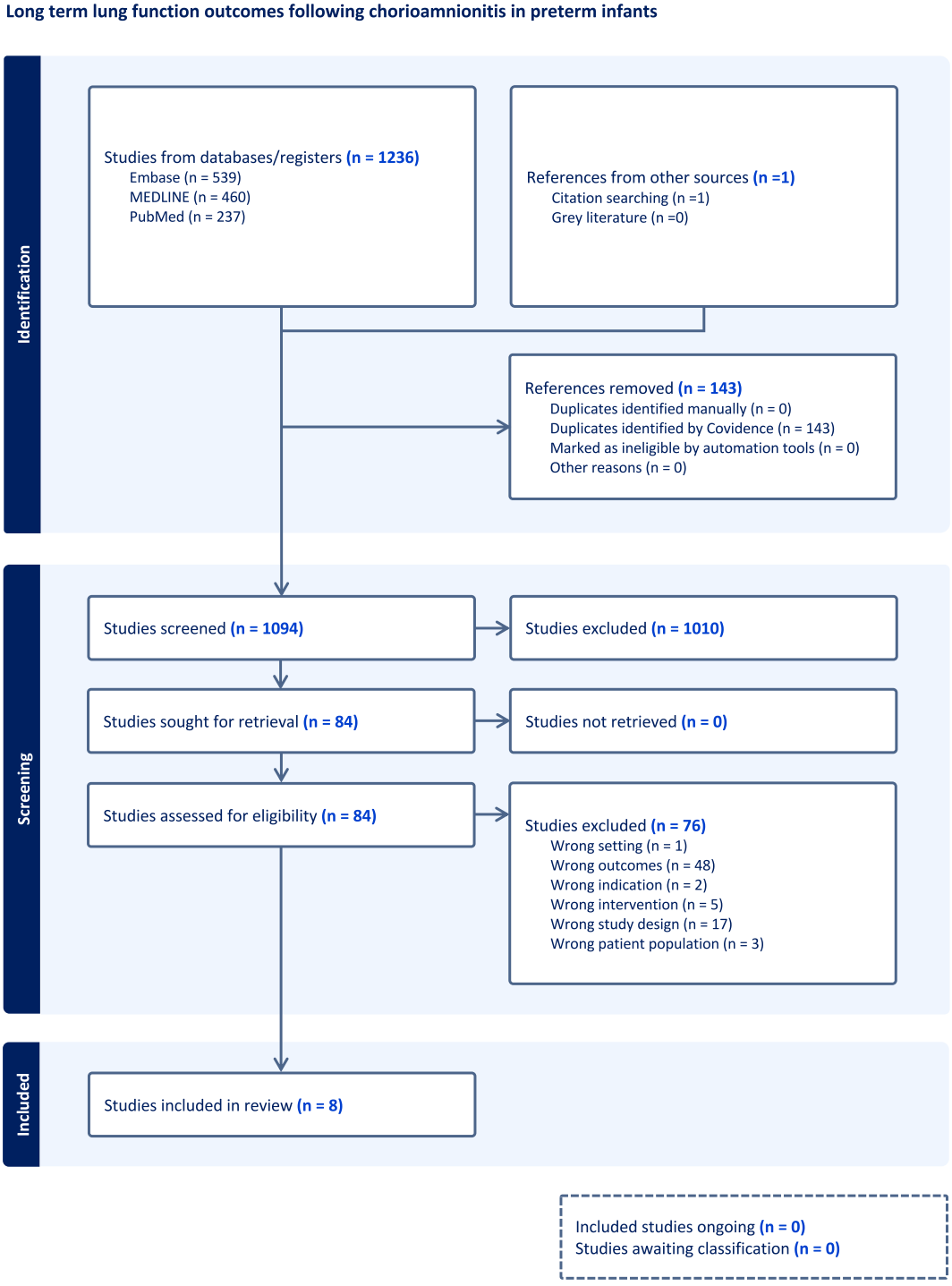

Figure 1: PRISMA flow diagram.

All of the studies were cohort studies, with five being prospective and three being retrospective. Three studies measured lung function at varying points after discharge from NICU. Four studies determined if there was wheeze or asthma in childhood. One study assessed at both lung function and a diagnosis of wheeze or asthma (Table 1).

Validity assessment

Four studies received nine points with the other studies scores ranging from five to eight points. Points were lost for adequacy of follow up and representativeness of exposed cohorts. One paper did not describe how the chorioamnionitis

Table 1: Study characteristics.

Name	Country	Sample size	Mean GA, weeks	Inclusion criteria	Prospective/ retrospective	LFT or wheeze/ asthma	Age at follow up (mean)
Schulzke et al. [15]	Australia	Total 58, 6 with CA	27.8	All infants born between April 2005–Sept 2006 who consented for LFT CA diagnosis unclear	Prospective	LFT	2.13 years
Jones et al. [16]	Brazil	Total 95, 66 with CA	34.2	<37 weeks GA 12 month period Histological CA	Prospective	LFT	22.4 weeks post birth
Hirata et al. [17]	Japan	Total 192, 80 with CA	26.6	ELBW<1,005 g 1990–2004 Histological CA	Retrospective	LFT	8.02 years
McDowell et al. [18]	USA	Total 138, 46 with CA	35.7	32–36+6 weeks Histological CA 2009–2012 years	Prospective	LFT+wheeze/ asthma	32 weeks post birth
Kumar et al. [19]	USA	Total 771, 325 with CA	Split into >37 weeks, 33–36.9, <33 weeks	<37 weeks or <2,500 g Singleton Clinical/histological CA	Prospective	Wheeze/asthma	2.2 years
Getahun et al. [20]	USA	Total 57,738, 2,636 with CA Preterm total=28,869, 1,318 CA	Split into 23–28, 29–33, 34–36, >37 weeks	23 weeks – term Singleton 1991–2007 years Clinical CA	Retrospective	Wheeze/asthma	<8 years
Dessardo et al. [21]	Croatia	Total 262, 105 with CA	29.2	<32 weeks Jan 1999–Dec 2008 Histological CA	Prospective	Wheeze/asthma	3 years
Wang et al. [14]	China	Total 115, 47 with CA	31.66	<34 weeks Singleton June 15–Aug 17 Histological CA	Retrospective	Wheeze/asthma	2.5 years

group was selected, nor how chorioamnionitis was defined and therefore had a low score. Please see Supplementary Material 1 (Figure A.1) for full results.

Publication bias

The five studies considering wheeze/asthma diagnoses in childhood were assessed for publication bias by visual inspection of a funnel plot (Supplementary Material 2, Figure A.2). The studies were evenly distributed across the vertical axis of the funnel plot. Horizontally, aside from one outlier, there was relatively even distribution and thus was not indicative of publication bias.

Four of the five studies which looked at chorioamnionitis exposure and wheeze or asthma in childhood, showed a statistically significant correlation in the chorioamnionitis exposed group with an overall OR 1.71 (95 % CI 1.55–1.89). Data for 29,493 infants were included, of which 1,566 were exposed to chorioamnionitis. The heterogeneity had an I^2 value of 47 % suggesting homogeneity between the studies.

Kumar et al. [19] assessed 771 infants: 335 had chorioamnionitis. They had a primary outcome of recurrent wheeze defined as more than two episodes of physician documented wheeze. Asthma was a secondary outcome, although they reported that it was physician diagnosed, they did not define how the diagnosis was made. They showed the risks of wheezing (OR: 4.0, 95 % CI: 2.0–8.0) and physician diagnosed asthma (OR: 4.495 % CI: 2.2–8.7) were present in the very prematurely born (less than 33 weeks of gestation) children with chorioamnionitis exposure, but there were no significant differences in either wheeze or physician diagnosed asthma in those born between 33 and 36.9 weeks. Those born at 37 weeks of gestation or greater had a significant association between chorioamnionitis exposure and early childhood wheeze (OR: 2.0, 95 % CI 1.1–3.8) but not with physician diagnosed asthma. The strongest association of chorioamnionitis exposure and wheeze/asthma diagnoses was in very preterm children of African American origin: OR for recurrent wheeze 5.4 (95 % CI 2.4–12) and OR for physician diagnosed asthma 5.2 (95 % CI 2.3–11.9).

In a large retrospective cohort study of 28,869 preterm infants [20], after adjusting for confounding variables, those born between 23 and 36 weeks of gestational age exposed to clinically diagnosed chorioamnionitis (not graded), had an increased risk of physician diagnosed asthma (harm ratio 1.68, 95 %, CI 1.52–1.87). Physician diagnosed asthma was based on having two prescriptions of medication specific to asthma (e.g. beta agonists or asthma controller medications for example steroid inhalers).

They showed an inverse correlation between gestational age at birth and asthma incidence.

Wang et al. [14] found that preterm children exposed to chorioamnionitis had a 2.72 fold increased risk of wheezing (aOR 2.720, 95 % CI 1.02–7.23) compared to their non-exposed counterparts. They diagnosed wheeze based on a medical diagnosis and need for treatment with inhaled steroids and/or bronchodilators. The results were collected from a nationwide epidemiological survey and it was not possible to identify if this information was collected by the patient/parent or a medical professional.

McDowell et al. [18] used a health questionnaire about respiratory symptoms and medication use between 6 and 12 months corrected age and 18 and 24 months corrected age. This was reported to trained nurses by parents or care givers. Parents were asked about doctor visits for respiratory problems, emergency room visits for respiratory problems, respiratory medication prescription and hospitalization. They showed that preterm infants exposed to chorioamnionitis had increased caregiver reports of wheezy symptoms (OR 1.98 CI 1.00–3.92), higher numbers of doctor visits for respiratory conditions (OR 2.82, CI 1.39–5.69) and more physician made diagnoses of bronchitis, bronchiolitis and pneumonia (OR 2.31 CI 1.06–5.04). Additionally, in those with severe chorioamnionitis there was increased caregiver reported wheezing at 6 to12 months of age. They also found that both mild and severe exposure to chorioamnionitis resulted in more doctor's visits for respiratory problems.

Dessardo et al. [21] showed no statistically significant association between chorioamnionitis and early childhood wheeze (OR 2.87, CI 0.77–2.37). Chorioamnionitis was defined histologically but they did not classify it by severity of disease. Early childhood wheezing was defined as the presence of three or more episodes of bronchial obstruction per year for which a bronchodilator was prescribed. The final assessment was at three years. They looked additionally to see if there was an association between FIRS and early childhood wheezing. Whilst this association was significant with an OR 4.49 (95 % CI 2.29–8.80, p<0.001), when chronic lung disease was included as a risk factor for wheeze in the regression model, the significance of FIRS disappeared.

Of the four studies which reported on lung function test results, three showed no statistically significant difference in lung function results between the group exposed to chorioamnionitis compared to the group who were not.

One study [16] found that lung function z scores were lower in the chorioamnionitis group (n=66) compared to those with no exposure (n=29): FEF_{50}, FEF_{25-75}, $FEV_{0.5}$, $FEV_{0.5}$/FVC but not for FVC. They defined chorioamnionitis histologically and graded the disease according to the intensity of the inflammation (Table 2). An association was found when children exposed to grade 2 chorioamnionitis was compared with grade 1 and no chorioamnionitis, as well as when all chorioamnionitis was compared to no chorioamnionitis. Infants had lower expiratory flows with increasing level of chorioamnionitis (p=0.012 for FEF_{50}, p=0.014 for FEF_{25-75}).

Additionally, when the data were compared by gender, chorioamnionitis was significantly correlated to lower maximal flows in females but not males:

$$FEF_{50} = 8.76\ (p = 0.004), FEF_{25-75} = 8.11\ (p = 0.005) \text{ and } FEV_{0.5} = 4.81 (p = 0.031).$$

Hirata et al. [17] defined chorioamnionitis histologically, but did not grade the severity. They found that chorioamnionitis was associated significantly with developing 'bubbly/cystic appearances' of the lungs on the chest radiograph on day 28 (p<0.001). They observed this as a precursor to chronic lung disease which was associated with reduced lung function (FEV1/FVC ratio<80 %) at eight years (OR 4.84 CI 95 % 1.26 to 18.70, p<0.02).

Table 2: Lung function Z scores by grades of chorioamnionitis.

	Chorioamnionitis exposure grade 1+2 Z score mean (±SD)	Grade 2 chorioamnionitis Z score mean (±SD)	Grade 1 chorioamnionitis	No chorioamnionitis Z score mean (±SD)
FEF_{50}	−0.98 (±1.45)[a]	−1.46 (±1.80)[b]	−0.89 (±1.38)	−0.32 (±1.83)
FEF_{25-75}	−1.23 (±1.68)[a]	−1.69 (±1.93)[b]	−1.14 (±1.64)	−0.42 (±1.88)
$FEV_{0.5}$	−0.31 (±0.96)[a]	−0.45 (±0.79)[b]	−0.27 (±1.00)	−0.20 (±1.36)
$FEV_{0.5}$/FVC	−1.03 (±1.41)[a]	−1.33 (±1.41)[b]	−1.00 (±1.33)	−0.50 (±1.54)

[a]p<0.05 for comparison between no chorioamnionitis and chorioamnionitis exposure. [b]p<0.05 for grade 2 chorioamnionitis compared with grade 1 and no chorioamnionitis.

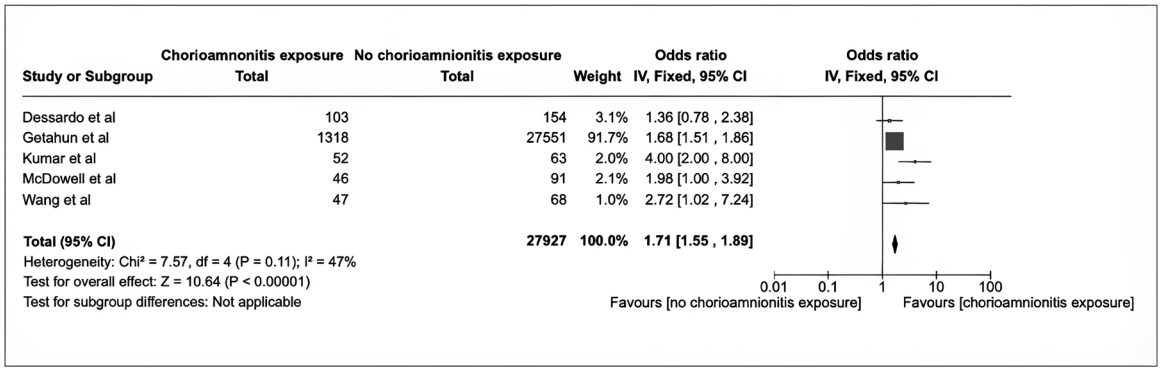

Figure 2: Forest plot for the studies assessing development of wheeze/asthma in childhood following chorioamnionitis exposure.

Schulzke et al. [15] had six patients with chorioamnionitis (of which three were lost to follow up) and they did not classify whether these had been exposed to clinically or histologically diagnosed chorioamnionitis. They showed no statistically significant changes following chorioamnionitis exposure in any of the lung function parameters.

McDowell et al. [18] showed no statistically significant differences in any of the pulmonary function test results between children who had and had not exposed to chorioamnionitis. The cohort included 20 with chorioamnionitis exposure and 49 with no exposure. Chorioamnionitis was defined histologically but was not graded.

Discussion

This review and meta-analysis demonstrated that there was a significant association between chorioamnionitis and childhood wheeze, but overall no significant association with impairment in childhood lung function. Getahun et al. [20] carried out a large retrospective cohort study (n=28,869). In addition to showing an increase in asthma in those exposed to chorioamnionitis, they also showed that the relationship was inversely correlated with gestational age even after adjustment for BPD. Kumar et al. [19] showed a strong correlation between very prematurely born infants i.e. born at less than 33 weeks of gestational age for both wheeze and asthma. This was not seen in the 33–36.9 week group and only wheeze was associated with chorioamnionitis in the post 37 week group (with a lower OR than in the very preterm group). These results were in keeping with the study done by Getahun et al. [20] showing a stronger association with chorioamnionitis and wheeze/asthma in the lowest gestational age group. Wang et al. [14] found a 2.72 fold increased risk of wheezing, but the effect size was smaller than the other studies (Figure 2). Of note, they only included children born at less than 34 weeks of gestation. McDowell et al.'s results [18] also supported an association between chorioamnionitis exposure and an increased incidence of wheeze. This study relied on care giver assessment of the child, either to report wheeze or the need to make an appointment to see a physician which could have introduced bias to their results. When assessing the severity of chorioamnionitis, there was no positive association with physician diagnoses, although this could have been affected by the relatively low numbers of infants exposed to severe chorioamnionitis. Dessardo et al. [21] did not report a significant association between chorioamnionitis exposure and subsequent wheeze diagnosis. Wheeze was assessed, however, with stricter criteria than those used in the other trials, most of which required a maximum of two episodes over any time point, compared to the three episodes per year required in this study.

No correlation overall was seen between chorioamnionitis and impairment of lung function in childhood of prematurely born infants, however, there were a low number of studies and relatively few patients included in them. The timing of when the lung function testing was carried out could have affected the results, as there was a broad range in the ages of the children at which lung function testing was carried out. The earliest being at 22.4 weeks post birth, the latest being at eight years of age [16]. The only significant findings were seen at 22.4 weeks, which could suggest that lung function is more affected by chorioamnionitis earlier on in life. Jones et al. [16] showed a significant association between increasing levels of chorioamnionitis and lower expiratory flows (although this correlation was only true for female infants). The authors postulated a 'masculization effect' of chorioamnionitis on lung function of female prematurely born infants. The usual superior lung function and higher expiratory flows seen in female infants [22], were not seen following exposure to chorioamnionitis. The studies assessed different aspects of lung function. Jones et al. [16] measured forced vital capacity (FVC), FEF_{50}, $FEF_{25–75}$, $FEV_{0.5}$, $FEV_{0.5}$, $FEV_{0.5}$/FVC and found significant results for all except

FVC. McDowell et al. [18] looked at $FEV_{0.5\%pred}$, $FEV_{0.5\%pred}$ but did not find significant results. Hirata et al. [17] measured the FEV_1/FVC ratio and defined abnormal as <80 % of predicted and Schulze et al. [15] measured FRC, MV, Vt, RR. None of the latter three studies [15, 17, 18] found significant differences between the groups.

In conclusion, there was a strong association between chorioamnionitis and increased rates of wheeze or asthma in childhood. There was an inverse correlation between gestational age at birth with exposure to chorioamnionitis and development of wheeze. Overall, there was no significant association of impaired lung function and chorioamnionitis, but this may reflect the low numbers of patients assessed.

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References

1. Lamont RF. Vaginal markers of preterm birth. Acta Obstet Gynecol Scand 2005;84:537–8.
2. Panneflek TJR, Kuypers KLAM, Polglase GR, Derleth DP, Dekker J, Hooper SB, et al. The influence of chorioamnionitis on respiratory drive and spontaneous breathing of premature infants at birth: a narrative review. Eur J Pediatr 2024;183:2539–47.
3. Lahra MM, Jeffery HE. A fetal response to chorioamnionitis is associated with early survival after preterm birth. Am J Obstet Gynecol 2004;190: 147–51.
4. Goldenberg RL, Hauth JC, Andrews WW. Intrauterine infection and preterm delivery. N Engl J Med 2000;342:1500–7.
5. Galinsky R, Polglase GR, Hooper SB, Black MJ, Moss TJM. The consequences of chorioamnionitis: preterm birth and effects on development. J Pregnancy 2013;2013:412831.
6. Mueller-Heubach E, Rubinstein DN, Schwarz SS. Histologic chorioamnionitis and preterm delivery in different patient populations. Obstet Gynecol 1990;75:622–6.
7. Watterberg KL, Demers LM, Scott SM, Murphy S. Chorioamnionitis and early lung inflammation in infants in whom bronchopulmonary dysplasia develops. Pediatrics 1996;97:210–5.
8. Villamor-Martinez E, Álvarez-Fuente M, Ghazi AMT, Degraeuwe P, Zimmermann LJI, Kramer BW, et al. Association of chorioamnionitis with bronchopulmonary dysplasia among preterm infants: a systematic review, meta-analysis, and metaregression. JAMA Netw Open 2019;2:e1914611.
9. Hartling L, Liang Y, Lacaze-Masmonteil T. Chorioamnionitis as a risk factor for bronchopulmonary dysplasia: a systematic review and meta-analysis. Arch Dis Child Fetal Neonatal Ed 2012;97:F8–17.
10. Liu WL, Zhou Y, Zhang C, Chen J, Yin XF, Zhou FX, et al. Relationship between chorioamnionitis or funisitis and lung injury among preterm infants: meta-analysis involved 16 observational studies with 68,397 participants. BMC Pediatr 2024;24:157.
11. Vollsæter M, Røksund OD, Eide GE, Markestad T, Halvorsen T. Lung function after preterm birth: development from mid-childhood to adulthood. Thorax 2013;68:767–76.
12. He B, Kwok MK, Au Yeung SL, Lin SL, Leung JYY, Hui LL, et al. Birth weight and prematurity with lung function at ~17.5 years: "Children of 1997" birth cohort. Sci Rep 2020;10:341.
13. Wells G, Shea B, O'Connell D, Peterson je, Welch V, Losos M, et al. The Newcastle–Ottawa Scale (NOS) for assessing the quality of non-randomized studies in meta-analysis; 2000.
14. Wang X, Li H, Zhang Q, Shen Q, Zhu D, Li H, et al Histological chorioamnionitis is associated with an increased risk of wheezing in preterm children less than 34 gestational weeks. BMC Pediatr 2021;21: 104.
15. Schulzke SM, Hall GL, Nathan EA, Simmer K, Nolan G, Pillow JJ. Lung volume and ventilation inhomogeneity in preterm infants at 15–18 months corrected age. J Pediatr 2010;156:542–9.e2.
16. Jones MH, Corso AL, Tepper RS, Edelweiss MIA, Friedrich L, Pitrez PMC, et al. Chorioamnionitis and subsequent lung function in preterm infants. PLoS One 2013;8:e81193.
17. Hirata K, Nishihara M, Shiraishi J, Hirano S, Matsunami K, Sumi K, et al. Perinatal factors associated with long-term respiratory sequelae in extremely low birthweight infants. Arch Dis Child Fetal Neonatal Ed 2015;100:F314–9.
18. McDowell KM, Jobe AH, Fenchel M, Hardie WD, Gisslen T, Young LR, et al. Pulmonary morbidity in infancy after exposure to chorioamnionitis in late preterm infants. Ann Am Thorac Soc 2016;13: 867–76.
19. Kumar R, Yu Y, Story RE, Pongracic JA, Gupta R, Pearson C, et al Prematurity, chorioamnionitis, and the development of recurrent wheezing: a prospective birth cohort study. J Allergy Clin Immunol 2008;121:878–84.e6.
20. Getahun D, Strickland D, Zeiger RS, Fassett MJ, Chen W, Rhoads GG, et al. Effect of chorioamnionitis on early childhood asthma. Arch Pediatr Adolesc Med 2010;164:187–92.
21. Dessardo NS, Dessardo S, Mustać E, Banac S, Petrović O, Peter B. Chronic lung disease of prematurity and early childhood wheezing: is foetal inflammatory response syndrome to blame? Early Hum Dev 2014;90:493–9.
22. Harris C, Zivanovic S, Lunt A, Calvert S, Bisquera A, Marlow N, et al. Lung function and respiratory outcomes in teenage boys and girls born very prematurely. Pediatr Pulmonol 2020;55:682–9.

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