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Jarvis, JN; Wainwright, H; Harrison, TS; Rebe, K; Meintjes, G  
(2010) Pulmonary cryptococcosis misdiagnosed as smear-negative pulmonary tuberculosis with fatal consequences. *International journal of infectious diseases*, 14 Sup. e310-2. ISSN 1201-9712 DOI: <https://doi.org/10.1016/j.ijid.2010.02.2255>

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DOI: [10.1016/j.ijid.2010.02.2255](https://doi.org/10.1016/j.ijid.2010.02.2255)

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# The role of adults in household outbreaks of pertussis

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Received 24 April 2008; received in revised form 2 October 2008; accepted 31 March 2009

Corresponding Editor: William Cameron, Ottawa, Canada

## KEYWORDS

*Bordetella pertussis*;  
Whooping cough;  
Transmission;  
Adults;  
Vaccination;  
Household contact

## Summary

**Objectives:** This study describes the role of adults in 57 household outbreaks of pertussis.

**Methods:** Parents/guardians of children with suspected pertussis seen at a university hospital were interviewed. Once a case of pertussis was confirmed, all household members were enrolled in the study. The US Centers for Disease Control and Prevention (CDC) definitions for pertussis were used. **Results:** Among 349 household members, 150 were adults and one in five had pertussis during the household outbreaks. Of the adult cases, 70.6% were aged 19–39 years. The secondary attack rate in adults was 12.6%. Adults were the primary case in a 21.1% of households, resulting in 43% of all secondary cases. Most adult cases had typical symptoms of pertussis, but none had been diagnosed before the investigation.

**Conclusions:** Adults, particularly those aged between 19 and 39 years, play an important role in pertussis transmission in households. Pertussis vaccination in adolescents/young adults may decrease the dissemination of pertussis in households.

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## Introduction

Since the 1980s, there has been an increase in the number of reported cases of pertussis and of outbreaks of pertussis, even in countries with high vaccine coverage.<sup>1–3</sup> In the USA, the burden of pertussis among adults is estimated at around 600 000 cases every year.<sup>4–6</sup> It appears that adults—in whom the disease is not severe or easily diagnosed—are an important source of infection transmission to children.<sup>7–12</sup> There is

evidence that the pertussis vaccine reduces transmissibility in vaccinated children.<sup>13,14</sup>

This paper reports on the role of adults in 57 household outbreaks of pertussis in Brazil, identified because of a diagnosis of pertussis in a child, and describes pertussis among adults in this setting.

## Methods

In 2003 there was a significant increase in the number of pertussis cases referred to the Oswaldo Cruz Hospital. In response to this, an intensive program was set up in Recife in 2003 to refer children with symptoms consistent with per-

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tussis to the Oswaldo Cruz Medical School Hospital (HUOC), a sentinel surveillance hospital for infectious diseases.

Of the children referred for investigation, 51 received a confirmed diagnosis of pertussis, and their household contacts were investigated. The pertussis immunization status of all children who lived in the same household as adults with pertussis was determined by examination of their health card, with the exception of eight children whose parents informed of their pertussis vaccination status by recall.

Details of the study design have been published in detail elsewhere,<sup>14</sup> but in brief: when parents/guardians of children with suspected pertussis attended the hospital, they were interviewed using a standard questionnaire. Information was collected for all household members and other contacts (relatives and neighbors), including details of age and recent history of cough (presence of symptoms and date of onset). Nasopharyngeal swabs for culture of *Bordetella pertussis* were collected from suspected cases and all their contacts who had reported a cough within the previous 21 days. When pertussis was confirmed in a household member, all members of the household were enrolled in the study. Definitions of the CDC for pertussis was used: confirmation was done by culture, by epidemiologic linkage with a culture-confirmed case and by household outbreak definitions – an acute cough illness lasting 2 weeks or longer without other symptoms and household exposure to a culture-confirmed case.<sup>14</sup>

Households were treated as the epidemic unit.<sup>15</sup> For the purposes of this analysis, subjects aged 19 years and over were considered adults; those aged under 19 years were considered children/adolescents. We estimated the proportion of household outbreaks in which the infection was introduced by an adult; the proportion of all secondary cases resulting from adults introducing pertussis into the household; the proportion of adult contacts who developed pertussis during the household outbreaks; and the proportion of adult secondary cases in household outbreaks where the primary or co-primary case was another adult. Finally, we calculated the proportion of adult secondary cases in household outbreaks where the primary case was a vaccinated child aged between 7 months and 5 years.

The study was approved by the HUOC Ethics Committee. Patients signed an informed consent form. Results of the analysis of vaccine efficacy and of the dynamics of transmission in the households, which include the identification of all primary cases, have been published elsewhere.<sup>7,14,16</sup>

## Results

Two hundred and eighty-seven children under 11.5 years of age with suspected pertussis were referred to the Pediatric Infectious Disease Service of HUOC. Among these children, 179 had received none or fewer than three doses of pertussis vaccine, 88 had received three or four doses, and parents/guardians of 20 children did not inform of their child's pertussis vaccination status.

Pertussis was confirmed by culture or epidemiologic linkage in 17.8% (51/287). Members of 57 households had substantial intra-domiciliary contact with these 51 index cases (children cared for by their grandparents during the day). All parents/guardians of the children and the adults living in these 57 households and with a recent history of cough were interviewed. In 51 of the 57 households there was at least one culture-confirmed case and in the remaining six households, pertussis cases were confirmed by epidemiologic linkage to a culture-confirmed case. Among the 349 individuals who were living in the 57 households, 190 (54.4%) were younger than 19 years of age and 159 (45.6%) were aged 19 years or older (and were considered adults in this analysis). Information for 22 household members was insufficient to classify them as cases or not. These 22 household members were excluded from the analysis. Among the household members excluded from the study, nine were adults (>19 years); hence 150 adults remained in the study. Among adults members of the households, 70.7% (106/150) were aged between 19 and 39 years. There were 32 adult cases of pertussis in the household outbreaks, corresponding to 21.3% of adult household members: 15 were primary or co-primary cases and 17 were secondary cases (Table 1).

Among adult secondary cases, 70.6% (12/17) were aged between 19 and 39 years and 29.4% (5/17) were older than 39 years. The majority of the 158 cases of pertussis (whether primary or secondary) were younger than 19 years old (126 cases). Among the 126 children who lived in the same household as these adults, there were 36 infants under 6 months of age who had received none or fewer than three doses of DwPT (diphtheria–whole cell pertussis–tetanus vaccine); among the children older than 6 months of age, two had received fewer than three doses, 64 had received three or four doses, and for 24 there was no information on their pertussis vaccination status.

Among the adults, 9.4% (3/32) of pertussis cases were confirmed by culture (compared to one third of overall cases diagnosed by culture), 59.4% (19/32) were confirmed by

**Table 1** Frequency of primary cases, co-primary cases, secondary cases, and those with no symptoms among adult household members, by age

Case type	Age, years					Total
	<19	19–28	29–38	39–48	49+	
Primary case	45 (78.9)	5 (8.8)	4 (7.0)	1 (1.8)	2 (3.5)	57 (100)
Co-primary case	5 (62.5)	3 (37.5)	–	–	–	8 (100)
Secondary case	76 (81.7)	7 (7.5)	5 (5.4)	3 (3.2)	2 (2.2)	93 (100)
No symptoms (not a case)	51 (30.2)	50 (29.6)	32 (18.9)	16 (9.5)	20 (11.8)	169 (100)
Total	177 (54.1)	65 (20.0)	41 (12.5)	20 (6.1)	24 (7.3)	327 (100)

Results are *n* (%).

epidemiologic linkage with a culture-positive case, and 31.2% (10/32) were confirmed by the 'household outbreak' definition.<sup>14</sup>

Infection was introduced into the household by adults (who were primary or co-primary cases) in a quarter (15/57) of the household outbreaks; these adults were parents, uncles and aunts, and grandparents. Forty-three percent (40/93) of all secondary cases occurred in a household where the primary or a co-primary case was an adult, and 80% (12/15) of the primary and co-primary cases were in the 19–39 age group.

Most of the secondary cases that occurred in households where an adult was a primary or co-primary case, were aged 10 years or younger (75% (30/40)).

The secondary attack rate among the 135 adult household contacts was 12.6% (17/135). Among the adult secondary cases, 64.7% (11/17) occurred in a household where the primary case was a relative older than 10 years, 23.5% (4/17) occurred in a household where the primary case was an infant younger than 6 months, and 35.3% (6/17) occurred in a household where the primary case was another adult. No adults living in the 14 households where the primary case was a vaccinated child aged between 7 months and 5 years acquired pertussis.

Among adults with pertussis, 68.8% (22/32) reported an illness with cough lasting at least two weeks with at least one of the following pertussis-associated symptoms: paroxysm of coughing, inspiratory whooping, and post-tussive vomiting; 31.2% (10/32) reported a coughing illness lasting at least two weeks. No adult had had their pertussis disease diagnosed before the diagnosis of pertussis in the child in his or her household.

## Discussion

All the adults with pertussis were identified only because of an investigation following the diagnosis of a child case of pertussis in the household. The finding that among 158 pertussis cases, 32 were adults suggests that undiagnosed pertussis is not rare among adults and should be considered as a potential diagnosis in those adults with prolonged cough. One fifth of all adults in these households had pertussis during the household outbreaks; half acquired it in the household, and the secondary attack rate among adults was 12.6%.

Pertussis in adults has been reported elsewhere: in Germany, among 246 adults with cough, 64 had evidence of *B. pertussis* infections, and of these 38% had whooping cough.<sup>17</sup> Another study observed that 31% of adult cases of pertussis acquired it by exposure in the household.<sup>18</sup> In our study there were no adult secondary cases in households with vaccinated primary cases aged between 6 months and 5 years. This observation supports the finding that the pertussis vaccine can be effective in reducing transmissibility in breakthrough vaccinated cases.<sup>13,14</sup> In Brazil, until 2004 the last dose of DwPT (fourth dose) was given at 15 months of age. In this study all individuals were older than 19 years and if vaccinated against pertussis, they had received the last dose of DwPT at least 17 years before. Among the adult secondary cases, 64.7% (11/17) were living in households where the primary case was a relative older than 10 years; in this age group, pertussis vaccine given during childhood would have lost its protective effect.<sup>19,20</sup> The fact that in our study, 87%

of adults exposed to pertussis in the household did not acquire the disease may be attributed to naturally acquired immunity (and the reduced infectiousness of recently vaccinated breakthrough vaccinated cases aged between 6 months and 5 years).

Some countries recommend pertussis vaccine for adolescents and adults. The finding that vaccine reduces the transmissibility of breakthrough vaccinated cases suggests that revaccination of adolescents and adults may help to decrease pertussis transmission.<sup>9,21,22</sup> Although adults were the primary case in a quarter of the households, they were responsible for 42% of all secondary cases and 40% of all adult secondary cases. In addition, more than 50% of the household members exposed to an adult primary case acquired pertussis. These findings suggest that adults have a major role in the transmission of pertussis to children in households and to susceptible adult household members.

Most (68.8%) adult cases had typical symptoms of pertussis, while the remaining 31.2% reported only an illness with cough lasting at least 14 days. This has been found elsewhere: in one study, 81% (68/84) of adults with pertussis had typical disease and 19% (16/84) had atypical pertussis,<sup>18</sup> and in other studies, evidence of pertussis infections was found in adults with persistent cough.<sup>23–27</sup> In our study, no adult case, not even those with typical symptoms of pertussis, had pertussis diagnosed before diagnosis of their household child case. Given that healthcare is free and accessible in Brazil, this suggests that pertussis is seldom considered a potential diagnosis in adults even when typical pertussis symptoms are present.<sup>27</sup> Previously undiagnosed pertussis was common among adults in household outbreaks of pertussis where the index case was a child. Adults had a substantial role in introducing infection into these households.

This study has some limitations. Pertussis cases were confirmed by culture or epidemiologic linkage with a culture-confirmed case. PCR and serology were not done; had these been done, the number of cases and the secondary attack rate would likely have been higher. Some households had individuals who fulfilled the clinical criteria for a pertussis diagnosis, but they were not included in the study because there were no positive cultures among them. Further, the diagnosis of pertussis among adults was done after the diagnosis of a child household member; we are addressing the potential cases of pertussis not linked to a child. Many adults were primary cases or secondary cases whose disease had started more than 2 weeks before examination in the study. This might have contributed to the low rate of positivity of the cultures. The study only included households where children were the index cases of pertussis; this may have contributed to the young age of contacts, with 70% of the adult contacts being aged between 19 and 39 years. Since adults appear to be an important source of infection with pertussis for children and for other adults, awareness that an adult with persistent cough (with or without associated symptoms such as paroxysm of coughing, inspiratory whooping, post-tussive vomiting) can be a pertussis case is essential for the early treatment of cases and prophylaxis of contacts to control the transmissibility of pertussis.

In conclusion, there is a need to consider pertussis as a differential diagnosis in prolonged cough in adults. Adults, particularly those aged between 19 and 39 years, play an

important role in pertussis transmissibility within the household. A program of pertussis vaccination in adolescents/young adults could decrease the dissemination of pertussis in households.

*Conflict of interest:* No conflict of interest to declare.

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