Original Article

Attack rate and household secondary attack rate of acute conjunctivitis during an outbreak in South India: A community-based survey

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Introduction: Knowledge on epidemiology of the disease in the contemporary world will help to develop appropriate strategies to curtail the transmission during an outbreak. This study was carried out during an outbreak of conjunctivitis in selected areas of Puducherry, South India, to assess the attack rate of conjunctivitis, identify factors associated with developing conjunctivitis and calculate household secondary attack rate (HSAR) of conjunctivitis and its correlates. **Methodology:** During December 2014, a community-based survey was conducted in a selected urban and rural area in Puducherry, South India. Simple random sampling was used to select primary sampling units and systematic sampling to select households. All individuals in the selected households were studied. A questionnaire was used to obtain data on sociodemographic characteristics, conjunctivitis during September–November, 2014, and number of household contacts who developed conjunctivitis within 7 days of index case. The attack rate and HSAR of conjunctivitis was expressed as percentage. Multivariate logistic regression was used to find factors independently associated with developing conjunctivitis and also 100% HSAR. **Results:** Of 3193 study participants from 772 households, 509 (15.9%, 95% confidence interval 14.7–17.2%) had an attack of conjunctivitis during the reference period. Of the 772 households, 218 (28.2%) had at least one case of conjunctivitis. Of 218 households, 33 (15.1%) households had 100% HSAR. Lower age, not being unemployed, low socioeconomic status, and residing in rural area were independently associated with developing conjunctivitis. Index case being male and living in a household with ≥5 members were independently associated with 100% HSAR. **Conclusion:** In the outbreak under study, more than one-fourth of households had at least one case of conjunctivitis and about one in every six individuals had an attack of conjunctivitis.

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Conjunctivitis is a disease of ocular adnexa caused due to the inflammation of the mucous membrane of conjunctiva. The common symptoms of conjunctivitis consist of redness, itching, watering or discharge, and foreign body sensation. Conjunctivitis can be classified as epidemic and nonepidemic conjunctivitis. Epidemic conjunctivitis is mainly the hemorrhagic type and is subject to surveillance by world health systems. The main feature of outbreak of conjunctivitis is the rapid spread and number of cases that tend to occur in a short duration of time.[1]

India being a tropical country is vulnerable to many ocular infections. The first reported outbreak of conjunctivitis was in the year 1965; since then more than 25 outbreaks have been recorded. Most of the outbreaks were due to viral etiology.[2,3] Even during an outbreak, the number of conjunctivitis cases clinically reported will be less as it is usually benign and self-limiting condition and use of over the counter drugs for the same will decrease the reporting. Hence, with hospital-based reporting, there is a gross underestimate of the disease burden. Hospital-based studies mostly emphasized on the microbiological pattern rather than the actual disease burden.[4,5] There is need for community-based studies to find the actual extent of conjunctivitis during an outbreak.

Community-based studies in India, assessing attack rate of conjunctivitis, were done at least two decades back. The studies showed high attack rate during the outbreak; a study in Goa (1981) reported 29.4% and study in Delhi (1994) reported 47.8%.[6,7] Over the time, there has been steady improvement in the literacy level and also awareness related to personal hygiene. The anticipated decline in attack rate can be taken as a proxy for the impact of public health interventions widely practiced in the country. Also, identifying the risk groups with high attack rate in the present scenario will help to deliver focused public health interventions.

There are no data from India regarding household secondary attack rate (HSAR) of conjunctivitis. Conjunctivitis has high transmission potential and hence susceptible household contacts are at high risk of developing disease. The studies from other parts of the world show HSAR as high as

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50%.[8,9] Assessing HSAR and its correlates plays a major role in curtailing the household transmission. There was an outbreak of acute conjunctivitis with increased number of cases being reported during the months of September–November, 2014 in Puducherry, South India. Hence, the study was carried out in the selected areas of Puducherry (1) to assess the incidence proportion (attack rate) of conjunctivitis during the outbreak, (2) identify factors associated with developing conjunctivitis, and (3) calculate HSAR of conjunctivitis among the household contacts and its correlates.

Methodology

Study design and setting

A community-based cross-sectional analytical study was conducted in selected areas of Puducherry, South India. The study was conducted in the urban and rural field practice area of a tertiary care teaching institute. Puducherry is a union territory located on the shores of Bay of Bengal in South India. This study was part of a larger study that captured health seeking behavior and economic loss during an episode of conjunctivitis.

The urban field practice area is located within the city of Puducherry. It has a population of around 9000 spread over four wards, namely, Kuruchikuppam, Vaithikuppam, Vazhaikulam, and Chinnayapuram. With an urban slum, fishermen colony, and French colony, the urban field practice area has very diverse population. Both private and public healthcare providers are located within this area, and people have good access to health facilities.

The rural field practice area is located around 16 km from Puducherry. Rural practice area has a population of around 9500 spread over villages, namely, Ramanathapuram, Pillaiyarkuppam, Thondamanatham, and Thuthipet. People mainly depend on agriculture and cattle rearing for livelihood. There are few migrants settled in Thuthipet village, who work in industries nearby. A majority of them seek care from rural health center. There are two private care providers in the area and also a medical college hospital at around 5 km.

Study population and participants

All the individuals in the selected areas were included in the study. Using nMaster software (Department of Biostatistics, Christian Medical College, Vellore, India), the minimum sample size was calculated to be 1900, assuming 10% attack rate of conjunctivitis during outbreak, relative precision of 20%, design effect of 2, and nonresponse rate of 10%.

Multistage sampling was used to select the participants. The primary sampling units (PSUs) were wards and villages in the urban and rural practice area, respectively. Out of four wards and four villages, two of each were selected through simple random sampling. The PSUs randomly selected were Pillaiyarkuppam, Thuthipet, Chinnayapuram, and Vaithikuppam. The households in each of these selected PSUs were included in the study using systematic random sampling. The first household among initial 10 households in each PSU was selected using simple random sampling. After selecting first household, further households were included with sampling interval of three. All the individuals in each of the selected houses were included in the study. If house was locked during the initial visit, one more visit was done next day before dropping that house from the study. The informant in each house was interviewed after obtaining informed verbal consent. The study protocol was approved by the clinic administration panel.

Study variables and tool

Data on household variables such as number of individuals residing in the house and number of individuals who developed conjunctivitis within 7 days of index case were collected. Sociodemographic variables such as age, gender, education, occupation, marital status, and monthly income were also captured.

A self-designed structured interview schedule was used to collect data. The interview schedule was pretested for appropriateness of each question. Prior to field activities, training session was held for MBBS interns involved in data collection. Data were collected under the supervision of residents of the Department of Preventive and Social Medicine.

Operational definition

1. Acute conjunctivitis: Those who had developed redness of eye (one or both eyes) with either lacrimation or foreign body sensation during the reference period (September–November, 2014) were considered as cases of acute conjunctivitis
2. Attack rate: Proportion of people who developed conjunctivitis out of the total population surveyed expressed as percentage
3. Individual HSAR: It was calculated for each household which had at least one case of conjunctivitis. It is the proportion of people who developed conjunctivitis out of the total number of people living in respective household (excluding the first case) within 7 days of index case. It is expressed as percentage
4. Aggregate HSAR: It was calculated as percentage of household contacts developing conjunctivitis within 7 days of index case.

Data entry and analysis

Data were single entered using EpiData software version 3.1 (EpiData Association, Odense, Denmark). Data were analyzed using R software Version 3.1.1 (R Development Core Team. R Foundation for Statistical Computing, Vienna, Austria). The outcome variables such as attack rate and HSAR were summarized as proportions. Bivariate logistic analysis was carried out to find association of conjunctivitis with individual's sociodemographic factors. Individual factors with $P < 0.1$ in bivariate analysis were included in stepwise multivariate logistic model. Factors with $P < 0.05$ were considered independently associated with having conjunctivitis. The measure association of sociodemographic variables with acute conjunctivitis and also 100% HSAR was expressed as relative risk with 95% confidence interval (CI).

Results

In total, 3193 individuals were included from 772 houses. Of the total 3193 participants, 1655 (51.8%) were females, 1730 (54.2%) were from rural area and mean (standard deviation) age was 30 (18.8) years. About 60% of the participants had completed at least 6 years of schooling, and 2666 (83.5%) belonged to socioeconomic status Class III or lower. Of the 3193 participants, 1100 (34.5%) were currently employed and 1595 (50%) were currently married [Table 1].

Table 1: Sociodemographic characteristics of study participants (*n*=3193)

Sociodemographic characteristics	Frequency (%)
Age (in years)	
≤5	310 (9.7)
6-19	744 (23.3)
20-39	1189 (37.2)
40-59	673 (21.1)
≥60	277 (8.7)
Gender	
Male	1538 (48.2)
Female	1655 (51.8)
Education (years of schooling)	
No formal schooling	810 (25.4)
1-5	466 (14.6)
6-10	1195 (37.4)
≥11	722 (22.6)
Occupation	
Unemployed	615 (19.3)
Employed	1100 (34.4)
Student	814 (25.5)
Homemaker	664 (20.8)
Marital status	
Never married	1371 (42.9)
Married	1595 (50.0)
Separated/divorced/widow	227 (7.1)
Socioeconomic status*	
Class I (Rs. 5571 and above)	148 (4.6)
Class II (Rs. 2786-5570)	379 (11.9)
Class III (Rs. 1671-2785)	777 (24.3)
Class IV (Rs. 836-1670)	1159 (36.3)
Class V (Rs. 835 and below)	730 (22.9)
Family size	
Up to 5	1664 (52.1)
≥5	1529 (47.9)
Area	
Urban	1463 (45.8)
Rural	1730 (54.2)

*Modified Prasad's classification, May 2014, based on per capita monthly income

Among the study participants, 509 (15.9%, 95% CI 14.7–17.2%) had an attack of conjunctivitis during the reference period and of them, 426 (83.7%) had both their eyes affected.

Of the 772 households, 218 (28.2%) had at least one case of conjunctivitis. There were 1030 individuals residing in these 218 houses. Of these 1030 individuals, 218 were index cases and 812 were household contacts. Of the 812 household contacts, 291 (35.8%) individuals developed conjunctivitis within 7 days of index case developing conjunctivitis (aggregate HSAR). Also, the median (interquartile range) of individual HSAR was found to be 33.3% (0–66.7%). Of these, 100% individual HSAR was found in 33 (15.1%) households whereas 80 (36.7%) households had zero individual household SAR.

On bivariate logistic regression, factors such as age, socioeconomic status, number of individuals living in a household, and area of living were found to be significantly ($P < 0.05$) associated with developing conjunctivitis. On multivariate analysis, lower age, not being unemployed, socioeconomic status of Class III or lower, and residing in a rural area were independently associated with developing conjunctivitis [Table 2].

On multivariate analysis, primary cases of being a male and living in a household consisting of more than or equal to five members were found to be independently associated with developing 100% individual HSAR in houses with a conjunctivitis case [Table 3].

Discussion

In the present study, about one in six individuals had developed conjunctivitis during the outbreak. The aggregate HSAR was found to be 35.8% and individual HSAR of 100% was 15%. Lower age, not being unemployed, socioeconomic status of Class III or lower, and residing in a rural area were independently associated with developing conjunctivitis. Individual HSAR of 100% was found significantly associated with the index case being male and living in a household with ≥5 members.

Two studies from India, one done in urban slums (1994) and another done in a rural area, (1981) showed an attack rate of 49.8% and 29.4%, respectively.[6,7] In the current study, the attack rate was 15.9%, comparatively lower than previous studies. This difference may be due to the fact that the previous studies were conducted at a time when the awareness about conjunctivitis transmission and also hygienic practices were low. The most recent report on attack rate of conjunctivitis outbreak from Puerto Rico (2003) showed overall attack rate of around 13%, which was similar to our study result.[10] A facility-based study among school children in Gyeongju, South Korea (2002), showed a high attack rate of 57.1%; however, this cannot be generalized to the general population and it may not represent the magnitude of outbreak.[11]

Similarly, age-specific attack rates were varied across different studies. The study from urban slums in India showed higher attack rates in persons aged more than 45 years whereas the study from rural Goa showed high attack rate among individuals aged between 15 and 24 years.[6] A study done in Guangdong province in China (1988) showed high attack rate in the age group between 20 and 59 years.[12] The attack rate was higher in school-aged children aged 5–14 years in the study done at Puerto Rico.[9] The current study result contradicts all the previous study results showing high attack rate in the age group of 5 years or less. Further research is needed to find the cause for this shift in age groups.

Our study shows people living in rural area have high attack rate and contradicts the finding from the Puerto Rico study which shows living in urban as more susceptible.[10] Comparatively, rural India is less literate and has poor hygienic practices compared to those living in urban. Although the urban slums mimic that of rural areas in India, the present study did not cover any typical urban slum.

Table 2: Association of sociodemographic characteristics with presence of acute conjunctivitis among study participants (*n*=3193)

Sociodemographic characteristics	Total (*n*=3193)	Conjunctivitis present (*n*=509)	95% CI	
			Crude RR[#]	Adjusted RR
Age (in years)*				
≤5	310	78 (25.2)	3.5 (2.2-5.5)	7.6 (4.0-14.7)
6-19	744	148 (19.9)	2.8 (1.8-4.3)	2.4 (1.3-4.4)
20-39	1189	203 (17.1)	2.3 (1.5-3.7)	1.8 (1.1-2.9)
40-59	673	60 (8.9)	1.2 (0.8-2.0)	0.9 (0.5-1.5)
≥60	277	20 (7.2)	1	1
Gender				
Male	1538	242 (15.7)	1	1
Female	1655	267 (16.1)	1.0 (0.9-1.2)	1.0 (0.8-1.2)
Education				
No formal schooling	810	128 (15.8)	1	-
1-5	466	78 (16.7)	1.0 (0.8-1.4)	
6-10	1195	206 (17.2)	1.1 (0.9-1.3)	
≥11	722	97 (13.4)	0.9 (0.7-1.1)	
Occupation				
Unemployed	615	97 (15.8)	1	1
Employed	1100	156 (14.2)	0.9 (0.7-1.1)	2.0 (1.2-3.3)
Student	814	159 (19.5)	1.2 (1.0-1.6)	2.7 (1.5-5.0)
Homemaker	664	97 (14.6)	0.9 (0.7-1.2)	1.8 (1.1-3.0)
Marital status*				
Never married	1371	256 (18.7)	2.9 (1.8-4.9)	0.8 (0.4-1.5)
Married	1595	238 (14.9)	2.3 (1.4-3.8)	1.5 (0.9-2.6)
Separated/divorced/widow	227	15 (6.6)	1	1
Socioeconomic status[$]*				
Class I	148	11 (7.4)	1	1
Class II	379	40 (10.6)	1.4 (0.7-2.7)	1.5 (0.8-2.8)
Class III	777	123 (15.8)	2.1 (1.2-3.8)	2.1 (1.2-3.9)
Class IV	1159	187 (16.1)	2.2 (1.2-3.9)	2.0 (1.1-3.7)
Class V	730	148 (20.3)	2.7 (1.5-4.9)	2.4 (1.4-4.4)
Family size*				
Up to 5	1664	242 (14.5)	1	1
≥5	1529	267 (17.5)	1.2 (1.0-1.4)	1.0 (0.9-1.2)
Area*				
Urban	1463	166 (11.3)	1	1
Rural	1730	343 (19.8)	1.7 (1.5-2.0)	1.9 (1.5-2.1)

*$P<0.05$ in bivariate logistic regression using binomial (log) function, [#]RR: Relative risk, [$]Modified Prasad's classification, May 2014, based on per capita monthly income. CI: Confidence interval

HSAR depends not only on the causative agent, its nature, or virility but also on hygienic practices, sociodemographic characteristics, environmental and sociocultural factors in the study population. This was the first study from India to calculate the aggregate HSAR (35.8%) in a conjunctivitis outbreak. The aggregate HSAR was similar to those found in studies done in other countries such as Mexico (37%) and Taipei city (33%).[8,9]

This was the first study to find the correlates of the primary case (or index case) in the house with developing a 100% individual HSAR. The results show that being a male and living in a house with five or more members were at the highest risk of having HSAR of 100%. Thus, awareness about disease transmission and safe hygiene practice interventions must be targeted at these people so as to reduce the HSAR and hence mitigate the spread of conjunctivitis.

The strengths of our study were as follows: First, this study covered a large number of people and hence giving more credibility for the results thus obtained. Second, the study was conducted in both rural and urban areas which helped in finding out the urban rural differentials in terms of attack rate during an outbreak of conjunctivitis. Third, we calculated both aggregate and also individual HSAR for the 1st time in this region. Fourth, this study was first study in our setting which tried to find the correlates of developing conjunctivitis in the index case with occurrence of 100% HSAR.

Table 3: Association of sociodemographic characteristics of index case with high individual household secondary attack rate (100%) among houses affected with conjunctivitis (*n*=218)

Sociodemographic characteristics of first case	Total (*n*=218)	High HSAR	95% CI	
			Crude RR[#]	Adjusted RR
Age (in years)				
≤5	40	13 (32.5)	1	1
6-20	77	7 (9.0)	0.3 (0.1-0.6)	0.4 (0.2-0.9)
20-39	72	9 (12.5)	0.4 (0.2-0.8)	0.6 (0.3-1.2)
40-59	20	2 (10.0)	0.3 (0.1-1.2)	0.4 (0.1-1.4)
≥60	9	2 (22.2)	0.7 (0.2-2.5)	1.1 (0.4-3.2)
Gender*				
Male	108	26 (24.0)	3.8 (1.7-8.3)	2.7 (1.2-5.9)
Female	110	7 (6.4)	1	1
Education				
No formal schooling	59	14 (23.7)	2.0 (0.8-5.2)	-
1-5	37	5 (13.5)	1.2 (0.4-3.7)	
6-10	79	9 (11.4)	1.0 (0.4-2.7)	
≥11	43	5 (11.6)	1	
Occupation				
Unemployed	48	14 (29.2)	4.0 (1.0-16.6)	
Employed	59	10 (17.0)	2.4 (0.6-10.1)	
Student	83	7 (8.4)	1.2 (0.3-5.4)	
Homemaker	28	2 (7.1)	1	
Marital status				
Living single	135	22 (16.3)	1	
Married	83	11 (13.2)	0.8 (0.4-1.6)	
Socioeconomic status[$]				
Class I	3	0	-	
Class II	19	2 (10.5)	0.8 (0.2-3.7)	
Class III	58	10 (17.2)	1.4 (0.6-3.4)	
Class IV	82	14 (17.1)	1.4 (0.6-3.2)	
Class V	56	7 (12.5)	1	
Family size*				
Up to 5	100	4 (4.0)	1	1
≥5	118	29 (24.6)	6.1 (2.2-16.9)	5.5 (2.0-14.8)
Area				
Urban	75	10 (13.3)	1	
Rural	143	23 (16.1)	1.2 (0.6-2.4)	

*$P<0.05$ in bivariate logistic regression using binomial (log) function, [#]RR: Relative risk, [$]Modified Prasad's classification, May 2014, based on per capita monthly income. CI: Confidence interval, HSAR: Household secondary attack rate

This study had few drawbacks: As this was interview-based study with a recall period of last 3 months, recall bias cannot be ruled out. The case definition was largely based on symptom nature and not on confirmed case records or investigations; hence, the agent factors could not be studied. Factors such as adequate knowledge and practices of personal hygiene were not studied as this may have a vital role in developing conjunctivitis.

This study has few implications. Our study showed that living in rural areas, having a lower socioeconomic status, and being an under-five child has a risk for developing conjunctivitis. The study also showed if the primary case is a male and living in a house with five or more members was associated with developing 100% HSAR. Awareness regarding the transmission of disease and its spread, especially targeted toward individuals living in lower socioeconomic strata and those in rural areas, has to be carried out to prevent the spreading of conjunctivitis. Safe, hygienic practices while handling under 5-year-old children can reduce the risk of developing conjunctivitis. These messages have to be given before the predicted outbreaks and also carried out intensively during the outbreak so as to mitigate the spread and reduce the number of affected people.

Conclusion

In the reference period, about one in six individuals had an attack of conjunctivitis. Under 5-year-old children were more affected compared to those in other age groups. Living in a rural

area and belonging to low socioeconomic status had increased risk of developing conjunctivitis. Index case being male and living in a household of five or more members was found to be associated with 100% HSAR.

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Conflicts of interest

There are no conflicts of interest.

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