ORIGINAL ARTICLE

Oman Medical Journal [2015], Vol. 30, No. 5: 358–365

Prevalence of Chronic Suppurative Otitis Media (CSOM) and Associated Hearing Impairment Among School-aged Children in Yemen

Salem Muftah[1]*, Ian Mackenzie[1], Brian Faragher[1] and Bernard Brabin[1,2,3]

[1]WHO Collaborating Centre on Hearing Impairment, Child and Reproductive Health Group, Liverpool School of Tropical Medicine, Liverpool, UK

[2]Global Child Health Group, Emma Kinderziekenhuis, Academic Medical Centre, University of Amsterdam, Amsterdam, The Netherlands

[3]Department of Community Child Health, Royal Liverpool Children's NHS Trust, Liverpool, UK

ARTICLE INFO

Article history:
Received: 4 May 2015
Accepted: 12 July 2015

Online:
DOI 10.5001/omj.2015.72

Keywords:
Otitis Media, Suppurative; Hearing Impairment; Children; Yemen.

ABSTRACT

Background: Chronic suppurative otitis media (CSOM) is one of the leading causes of preventable disabling hearing impairment (DHI) in developing countries. Early detection and management complements advances made in other survival programs, improves work capacity, and enhances learning opportunities for school children. We aimed to determine the prevalence of CSOM and associated DHI among school children aged six to 16 years in Socotra Island, Yemen. ***Methods:*** We conducted a cross-sectional community-based survey, from 20 April 2011 to 20 June 2011. The study procedures involved completing a questionnaire, an otoscopic ear examination, an audiometric test of hearing, and tuning fork tests for the type of DHI. ***Results:*** A total of 686 children were interviewed and examined for CSOM and associated DHI of CSOM cases. The prevalence of CSOM was 7.4%, (95% CI 5.5–9.4). CSOM status was significantly associated with DHI (p=0.001), but no significant associations were found between demographic characteristics and CSOM status. Logistic regression identified four significant independent contributing factors: history of ear discharge in the last 12 months (odds ratio (OR) 7.8, 95% CI 3.9–15.6); swimming in local pools (OR 6.0, 95% CI 1.4–25.4); recurrent respiratory tract infection more than three times per year (OR 5.3, 95% CI 2.5–11.0); and overcrowding with more than three families per house (OR 4.4, 95% CI 1.7–11.5). ***Conclusion:*** The burden of CSOM in the children studied indicates a high level of DHI in these communities within Yemen. A history of ear discharge, swimming in local pools, recurrent respiratory infections, and overcrowded housing were the strongest predictors for CSOM. There is a need for better ear care and screening programs for early detection and management of this disease.

Chronic suppurative otitis media (CSOM) is a common public health problem worldwide and a major cause of hearing impairment among children in developing countries. The disease and its associated problems constitute a hidden disability,[1] putting children at risk of poor school performance, delayed language and speech development, and poor cognition.

Defined as the persistent discharge of pus through a perforated tympanic membrane for more than two weeks,[2] CSOM is widely seen in children especially during early childhood[3] and often follows acute otitis media (AOM), a middle ear infection. The disease and its sequelae produce substantial economic and societal costs.[4] A prevalence of CSOM greater than 1% in children in a defined community indicates that there is an avoidable burden of the disease. A prevalence of 4% or greater indicates a public health problem that needs urgent attention.[4]

The burden of CSOM varies. Global prevalence rates estimates a range between 1% and 46%; it has been estimated that 65–330 million individuals have discharging ears, 60% of whom suffer from significant hearing impairment.[5] According to the World Health Organization (WHO), Western Pacific countries have the highest prevalence (2.5% to 43%), followed by South East Asia (0.9% to 7.8%), Africa (0.4% to 4.2%), South and Central America (3%), the Eastern Mediterranean (1.4%), and finally Europe (average prevalence of 0.4%).

A Saudi Arabian study[6] reported a prevalence of 1.4%. Although it was conducted 20 years ago, it is still used as an estimate for the Eastern Mediterranean

*Corresponding author: ✉salem.yousr@yahoo.com

Area. Yemen is a country in this region. There are no previous community-based prevalence studies of CSOM in Yemen, but a recent hospital-based case-control study[7] reported 59% hearing impairment in both ears in children with CSOM, with associated significant conductive deafness.

We sought to obtain accurate information about the community prevalence of CSOM in Yemen using a cross-sectional survey among a vulnerable group, namely children aged six to 16 years old. The objective of the study was to estimate CSOM prevalence and its association with hearing impairment, gender, age, location, and other potential contributing factors.

METHODS

We conducted a community-based descriptive cross-sectional prevalence survey in the schools of Socotra Island, Yemen, over a period of two months extending from 20th April to 20th June 2011. Socotra Island lies in the north-western part of the Indian Ocean and forms part of the Republic of Yemen.

All healthy school-age children aged between six and 16 years old attending one of the 36 schools, covering both urban and rural settlements on the Island, were eligible for inclusion in the study. Urban schools included those in the north of Socotra, including the towns of Hadiboh and Qalansya and their surrounding areas. Hadiboh is the capital of Socotra and has slightly better living conditions compared to the island's rural and south coast settlements; Qalansyais, the second largest town on Socotra Island. Rural schools were those in the mountains and on the south coast.

Children with CSOM were those with persistent purulent, aural discharge for the preceding two weeks, pus in the external canal on otoscopy, and tympanic membrane perforation.[2,4]

Children were excluded from the study if their tympanic membrane was perforated but dry. Children who had recent treatment for an ear infection, were unable to participate due to illness, had AOM and/or congenital anomalies (cleft palate) were also excluded from the study.

As there was no information about CSOM prevalence in Yemen, estimates from Saudi Arabia (2%) and other low-resource settings similar to Yemen (range=2%–4%) were used. Assuming a prevalence of 3%, samples of 280 children at each location (urban and rural) would provide estimates of the true prevalence with a precision of ±2%. Allowing for a refusal rate of up to 15%, a total sample of 644 children (322 urban and 322 rural) was sought.

Six schools were not reached due to the political unrest in Yemen at the time of the survey. The head teachers of the remaining 30 schools were approached to seek approval for the survey to be conducted. Once this approval was obtained, the parents of eligible children were invited to one of three prearranged meetings, led by the investigator. At each meeting, detailed information was provided about the nature of CSOM and its effect on the loss of hearing, after which the background, objectives, and the importance of the survey were discussed. The reasons for selecting each school and the method to be used to select children for inclusion in the survey was also explained.

The average number of pupils aged between six and 16 years at each of the 30 participating schools was between 200 and 250. A 10% simple random sample of these children was selected from each school. The parents of these children were approached by the head teachers and asked to provide written consent. Two trained assistants were engaged to help distribute and collect the questionnaires.

Selected children who were found to be sick or to have CSOM received medical advice and treatment free of charge. Aural toilet and a topical quinolone were used as standard treatments for all CSOM cases.

The data for the evaluation questionnaire was collected directly from the children. This included information on ear problems (including any pain, discharge and/or swelling in the last 12 months), history of recurrent upper respiratory tract infection, swimming in local pools, measles, mumps, malaria, tuberculosis, and any family history of ear problems (including disabled hearing impairment). Any question that a child could not answer were directed to a parent or close relative.

Clinical and otoscopic examinations, testing for the presence of CSOM, was carried out for all participants. An audiological examination measured the decibel hearing level (dB.HL). The hearing threshold was assessed in each ear at 1kHz, 2kHz, and 4kHz using a KAMPLEX diagnostic audiometer (PC Werth, London, UK) and soundproof headphones in the quietest available classroom in the school with the doors and windows closed, if possible. The screening process started at

50dB for 1kHz, 2kHz, and 4kHz, then raising and lowering the thresholds in 5dB steps until the child no longer heard the tone. Children who heard all screening tones at 30dB were considered to be free of hearing impairment. Those who failed in the first test underwent further thresholds screening with the same process; failure to hear the pure tone at an intensity of 30dB or better was considered to indicate hearing impairment. Children with hearing impairment were classified into five groups for frequencies 1kHz, 2kHz, and 4kHz: normal (<30dB), mild (31dB to 40dB), moderate (41dB to 60dB), severe (61dB to 80dB), and profound (>80dB). The sound 0dB was omitted from testing because of high levels of background noise.

Participants with hearing impairment were tested using the Tuning Fork examination to determine whether the impairment was conductive or sensorineural. A tuning fork with a frequency of 512Hz was considered to be an ideal test of air conduction (AC) and bone conduction (BC) in conjunction with the Rinne test and Weber test.

For the Rinne test, the activated tuning fork was first held 2.5cm from the ear and then placed on the mastoid process. A child with normal hearing would be expected to hear the fork tone louder or more distinctly in front of the ear than behind the ear, indicating that air conduction (AC) was greater than bone conduction (BC). Interpretation of the test was based on the following criteria: 1. AC>BC = Rinne positive (normal or sensorineural deafness); 2. AC<BC = Rinne negative (conductive deafness); 3. AC=BC = Rinne equivocal.

For the Weber test, interpretation was based on the following criteria: 1. The ear that is Rinne negative is always the abnormal one; 2. If the Weber test is towards the abnormal ear it is conductive hearing loss; 3. If the Weber test is away from the abnormal ear it is sensorineural hearing loss; and 4. Weber central means both ears have either conductive or sensorineural hearing loss.

All participants were assigned a unique personal identification number for data collection procedures. Descriptive tables were prepared of the characteristics of children and the data were compared for urban and rural locations. Tests for statistical significance have been assessed using chi-square for the difference in proportions. SPSS Statistics (SPSS Inc., Chicago, USA) version 18 was used for analyzing the objectives.[8]

The study was approved by Liverpool School of Tropical Medicine Ethics Committee (Research Protocol 11.52). The parents of all participating children were required to given written consent on a form written in Arabic.

RESULTS

Consent was received for a total of 692 school children, of whom six had to be excluded (two had congenital cleft palate, and four were unable to complete data collection). A total of 686 children were thus enrolled into the study.

Over half of the children (n=392, 57.1%) were boys and 373 (54.4%) were aged above 11-years-old. The children were equally distributed between rural (n=339, 49.4%) and urban (n=347, 50.6%) areas. The mean age of the children was 10.9 years.

A total of 51 children had CSOM, either in one or both ears (7.4% exact binomial, 95% CI 5.6%–9.7%). Other findings from the otoscopy examination were the presence of wax and other abnormalities in the form of foreign bodies and otitis media effusion (OME). There were 35 children with wax, accounting for 5.1% of the total population while only 13 children had other abnormalities, accounting for 1.9% of the total study population.

Table 1: Association between CSOM status and DHI among school-age children.

Level of hearing impairment	Presence of DHI		Fisher exact test (*p*)
	Yes	No	
<30dB	17 (2.7)	609 (97.3)	<0.001
>31dB	34 (57.6)	25 (42.4)	

Data presented as (%).
CSOM: chronic suppurative otitis media; DHI: disabling hearing impairment; dB= decibel (hearing level measurement).

Table 2: Degrees of DHI among children with CSOM.

Degree of DHI	Number (precentage)
Normal (<30dB)	17 (33.3)
Mild (31–40dB)	19 (37.3)
Moderate (41–60dB)	13 (25.5)
Severe (61–80dB)	2 (3.9)
Profound (>81dB)	0 (0)
Total	51 (100.0)

DHI: disabling hearing impairment; CSOM: chronic suppurative otitis media; dB= decibel (hearing level measurement).

Table 3: Associations between CSOM status and demographic characteristics of study population.

Characteristics	Presence of CSOM		Fisher exact test (*p*)
	Yes	No	
Gender			
Male	28 (7.1)	364 (92.9)	0.770
Female	23 (7.0)	270 (92.2)	
Age (years)			
<10	21 (6.7)	292 (93.3)	0.560
>11	30 (8.1)	342 (91.9)	
Place of living			
Urban	28 (8.1)	318 (91.9)	0.562
Rural	23 (6.8)	316 (93.2)	

Data presented as (%).
CSOM: chronic suppurative otitis media.

Table 4: Associations between CSOM status, characteristic complaints, and family history of otorrhea.

	Proportion of CSOM		Fisher exact test (*p*)
	Yes	No	
Symptoms experience in the last 12 months:			
Ear discharge			
Yes	30 (19.6)	123 (80.4)	<0.001
No	21 (3.9)	511 (96.1)	
Ear pain			
Yes	6 (7.3)	76 (92.7)	1.000
No	45 (7.5)	558 (92.5)	
Ear swelling			
Yes	1 (12.5)	7 (87.5)	0.463
No	50 (7.4)	627 (92.6)	
Ear medication			
Yes	5 (6.7)	70 (93.3)	1.000
No	46 (7.5)	564 (92.5)	
Family history of otorrhea in last 12 months in:			
Father			
Yes	0 (0.0)	1 (100.0)	1.000
No	51 (7.5)	633 (92.5)	
Mother			
Yes	2 (100.0)	0 (0.0)	0.005
No	49 (7.2)	634 (92.8)	
Siblings			
Yes	18 (19.6)	74 (80.4)	<0.001
No	33 (5.6)	560 (94.4)	

Data presented as (%).
CSOM: chronic suppurative otitis media.

DHI in the affected ear was found in 34 (66.7%) of the 51 children with CSOM compared with just 25 (3.9%) of the 634 with no CSOM (Fisher exact test $p<0.001$). This indicated that children with CSOM were more likely to develop DHI [Table 1]. In the 34 children with DHI, conductive hearing impairment was predominant (n=26, 76.5%). Three (8.8%) children had sensorineural hearing impairment, and five (14.7%) had a mixed hearing impairment. Of the children with CSOM, 37.3% had mild hearing impairment in the affected ear in one or more of the frequencies [Table 2], while 25.5% suffered from moderate hearing impairment. Only two children (3.9%) had severe hearing impairment. No children had profound hearing impairment.

Table 5: Associations between CSOM status, social characteristics, and disease history.

Characteristics	Proportion of CSOM		Fisher exact test (*p*)
	Yes	No	
Parents illiteracy			
Yes	37 (13.1)	246 (86.9)	<0.001
No	14 (3.5)	388 (96.5)	
Overcrowding: >3 families / house			
Yes	39 (17.9)	179 (82.1)	<0.001
No	12 (2.6)	455 (97.4)	
Swimming in local water pools			
Yes	45 (14.8)	260 (85.2)	<0.001
No	6 (1.6)	374 (98.4)	
School performance			
Poor	21 (17.2)	111 (82.8)	<0.001
Good	27 (6.5)	391 (93.5)	
Excellent	1 (0.9)	114 (99.1)	
URTI (>3 times in 12 months)			
Yes	20 (16.3)	103 (83.7)	<0.001
No	31 (5.5)	531 (94.5)	
Measles in last 12 months			
Yes	0 (0.0)	1 (100)	1.000
No	51 (7.5)	633 (92.5)	
Mumps in last 12 months			
Yes	0 (0.0)	2 (100)	1.000
No	51 (7.5)	632 (92.5)	
Malaria in last 12 months			
Yes	1 (33.3)	2 (66.7)	0.207
No	50 (7.3)	632 (92.7)	

Data presented as (%).
CSOM: chronic suppurative otitis media; URTI: upper respiratory tract infection.

Numerically, CSOM prevalence was slightly greater in girls, older children, and in children living in urban areas, but none of these differences were statistically significant [Table 3].

Children with a history of ear discharge in the previous 12 months were significantly more likely to have CSOM [Table 4]. Children with one or more siblings with a history of otorrhea were also more likely to have CSOM ($p<0.001$). Although only two mothers were found to have a history of otorrhea, the association of this factor and CSOM in the child was statistically significant ($p=0.005$). No significant association was found with a history

Table 6: Independent risk factors for CSOM.

Risk factor	Odds ratio (95% CI)	*p*-value
Sibling with ear discharge in last 12 months	1.8 (0.9–3.6)	0.112
Overcrowding	4.4 (1.7–11.5)	0.002
Respiratory history	5.3 (2.5–11.0)	<0.001
Ear discharge	7.7 (3.9–15.6)	<0.001
Gender	1.0 (0.5–2.0)	0.912
Swimming in local pools	6.0 (1.4–25.4)	0.014
Parental illiteracy	0.5 (0.2–1.5)	0.221

CSOM: chronic suppurative otitis media.

of otorrhea in the father. Illiteracy of parents and overcrowding (more than three families per house) both significantly increased the risk of CSOM [Table 5], as did swimming in local water pools. As school performance decreased, the risk of CSOM increased significantly. Children who had experienced recurrent upper respiratory tract infection were at increased risk of CSOM (p<0.001). No statistically significant association was found between the occurrence of measles, mumps, or malaria in the previous 12 months with the risk of CSOM, but the numbers of children experiencing these diseases was very small.

Logistic regression was used to examine the combined impact of seven of the risk factors identified: siblings with ear discharge in the last 12 months, overcrowding, upper respiratory tract infection (URTI) more than three times in previous year, ear discharge in last 12 months, gender, frequently swimming in local water pools, and parental illiteracy [Table 6]. Only four of these factors were found to be independently related to the risk of CSOM: ear discharge in last 12 months (odds ratio (OR) 7.7, 95% CI 3.9–15.6), swimming in local freshwater pools (OR 6.0, 95% CI 1.4–25.4), URTI more than three times in previous year (OR 5.3, 95% CI 2.5–11.0), and overcrowding (OR 4.4, 95% CI 1.7–11.5).

DISCUSSION

This is the first study of the prevalence of CSOM and its association with DHI in Yemen. The findings are essential in addressing the burden of this clinical problem, in developing better ear care for children of Yemen, and in contributing to meeting the Millennium Development Goals for improving child survival.

This survey indicates that the prevalence of CSOM in Yemen is 7.4% (95% CI 5.4–9.3), which classifies the country in the highest category for this disease and is much higher than previous regional estimates of CSOM.[5] The Saudi prevalence of CSOM of 1.3% belongs to the lowest category and has until now been considered as a regional estimate for the whole of Eastern Mediterranean.[9]

The large difference in the prevalence of CSOM between our study and the previous Saudi estimate could be explained by the improvement in health services and good access to health care among children in Saudi Arabia, where CSOM prevalence declined from 5.5% in 1982 to 1.5% in 1993,[6] and to 1.3% in 2001. In contrast, access to health care in Socotra Island, Yemen, remains limited and many children are living in destitute conditions. The current findings highlight the problem of CSOM in Yemen and indicate a need to reevaluate the current estimate of CSOM across different areas within the Eastern Mediterranean Region. In other low-resource settings similar to Socotra Island, several studies have reported CSOM prevalence levels between 2% and 13%,[9-16] indicating a generalized problem of this disease in low-resource settings.

An important finding of this study was the substantial amount of hearing impairment indicating that children with CSOM are more likely to develop this condition. In the children found to have DHI, conductive hearing impairment was observed in 76.5%. Most of these children had either mild or moderate hearing impairment (37.3% and 25.5%, respectively). This confirms previous evidence from Yemen that CSOM can induce DHI. An earlier detailed hospital-based case-control study found an overall rate of 59% for hearing impairment in both ears in children with CSOM, the majority of whom had conductive DHI.[7] In the Eastern Mediterranean region, a study in Saudi Arabia[9] tested 9,540 children aged up to 12 years old, finding that 125 (1.3%) had CSOM, 17% of who had significant hearing impairment. The level of hearing impairment among children with CSOM is similarly high in other developing countries. A study in Nigeria[17] examined 189 CSOM children and 100 controls aged between four and 150 months and found hearing impairment

in 89 (47%) of the children with CSOM, which was conductive in 82% of cases. A study in Dhaka, Bangladesh,[18] reported 60% of children with CSOM had a hearing impairment. These findings indicate that CSOM and its association with hearing impairment continue to be a common health problem in low-resource settings. Improving the health services and providing good access to health care among children in such communities is necessary to decrease the burden of illness.

The level of hearing impairment in this study was predominantly either mild or moderate; only two cases (3.9%) were found to have severe DHI and no cases of profound hearing impairment were identified. This is in agreement with previous reports from developing countries.[5,12,17,19] However, as children with severe to profound hearing impairment are less likely to attend school, this study may have underestimated the true prevalence of hearing impairment among CSOM cases. This is one of the limitations of this study; a household community-based study would be more likely to provide a true estimate of severe to profound hearing impairment among children with CSOM in Socotra Island.

CSOM prevalence was found to be slightly higher among boys than girls, suggesting that boys may have a slightly higher risk for CSOM. Although the difference was not statistically significant, it confirms the findings of the Saudi study in which males were more significantly affected than females (prevalence estimates 1.4% and 1.2%, respectively; p=0.050).[9]

Slight, but again non-significant, increases in CSOM prevalence were observed in older children (11–16 years) compared to those aged 6–10 years. This finding is consistent with a study from Kenya, which reported a trend towards CSOM in older children.[12] A study in India,[14] however, found an equal distribution between preschool (2–5 years) and primary school children (6–10years).

No significant relationship was found between residence and the prevalence of CSOM, in contrast to several reports that have indicated a higher prevalence of CSOM among rural children. The study in Saudi Arabia[20] examined 13,990 children and found differences in the prevalence of CSOM in city and rural settings (0.5% to 3.2%, respectively). A decade later, another study in Saudi Arabia[9] found a higher prevalence of CSOM in the peripheral region compared to the central region (2.9% vs. 1.2%). The variations appear to be even wider in countries with poor health services. A study in Dar es Salaam, Tanzania,[10] interviewed and examined 802 primary school children in rural and urban settlements, and found a prevalence of 9.4% CSOM among rural children compared to only 1.3% of urban children. The fact that children in urban areas are more likely to have better access to health care than children in rural areas could explain this. In the case of Socotra Island, the access to health care is limited, and the island itself is a rural area in Yemen. Given that there are marked differences between living patterns in urban and rural settings within Socotra Island, it is perhaps surprising that this study found no significant variation in the prevalence rate of CSOM. Further comparisons using children from urban settings on mainland Yemen might provide a more appropriate estimation of the differences between the two settings.

The risk factors for CSOM are many. Poverty, overcrowding, inadequate housing, and poor hygiene are known to contribute to high rates of CSOM.[4] The four factors found to have the strongest association with CSOM in this study were a history of ear discharge in the last 12 months, swimming in local pools, recurrent respiratory tract infection of more than three times per year, and overcrowding of more than three families per house. Van der Veen and colleagues[21] studied the predictors of CSOM in children, interviewing 100 children with CSOM and 161 controls aged two to 12 years old. They identified previous tympanostomy tube insertion, having more than three URTIs in the last six months, having parents with low education, and having older siblings as risk factors. Our study partly supports Van der Veen's results and is in agreement with other studies from developing countries.[14,18,22,23] It is crucial that these factors be considered in developing any management and/or intervention programmes for CSOM in children.

Our study was carried out during a difficult time in Yemen, coinciding with political unrest. In the initial phase of the field work, the schools all over Socotra Island effectively closed, so the researcher had to start a long dialogue with community leaders and local authorities in order to bring the children back to school. These negotiations were successful and the field work started efficiently with high responses. There was a concern, however, that if some children did not return to their schools, this

might have produced an underestimation of the true prevalence rate of CSOM. However, attendance appeared to be very high and any bias due to absences is likely to have been small.

The second concern is the possibility of selection bias, which would have occurred if any school administrations and/or teachers had targeted children with ear diseases rather than enrolling a truly random selection as required by the study protocol, causing an overestimation of the true prevalence of CSOM. The research team, however, followed strict procedures for the sample selection: school records were used as a sample frame for the random selection of the participants, minimizing the risk of bias.

The third concern is the possibility of publication bias. All of the information for this survey was from electronic databases, and no information was obtained from unpublished data. However, most information was drawn from the well-known database of the Eastern Mediterranean Region, which is largely used as the official data of the WHO.

The fourth concern is the method used to determine levels of hearing impairment. Data for the thresholds between 25dB and 30dB were not recorded, and this may have resulted in an underestimation of the true prevalence of hearing impairment in the study area. Such a probability is high but in the current study, the WHO definition of >30dB for any of the frequencies 0.5kHz, 1kHz, 2kHz, and 4kHz, was used as a reference for disabled hearing impairment in children under 15 years. The 0.5kHz frequency was omitted owing to the risk of environmental sounds.

CONCLUSIONS

The burden of CSOM in Socotra Island belongs in the high category. DHI was statistically significant among children with CSOM. A history of ear discharge, swimming in local pools, recurrent respiratory infections and overcrowded housing were the strongest predictors of developing CSOM. There is a need for better knowledge of the burden of illness in Yemen as well better ear care, and a screening programme for early detection and management of CSOM in Socotra Island, Yemen.

Disclosure
The authors declared no conflicts of interest. The British Yemeni Society supported the field work.

REFERENCES

1. Mackenzie I, Smith A. Deafness–the neglected and hidden disability. Ann Trop Med Parasitol 2009 Oct;103(7):565-571.
2. Smith AW, Hatcher J, Mackenzie IJ, Thompson S, Bal I, Macharia I, et al. Randomised controlled trial of treatment of chronic suppurative otitis media in Kenyan schoolchildren. Lancet 1996 Oct;348(9035):1128-1133.
3. Kong K, Coates HL. Natural history, definitions, risk factors and burden of otitis media. Med J Aust 2009 Nov;191(9) (Suppl):S39-S43.
4. World Health Organization. Prevention of hearing impairment from chronic otitis media, Report of a WHO/CIBA Foundation Workshop, held at The CIBA Foundation. World Health Organization, London, U.K. 1996; 19–21. http://www.who.int/pbd/deafness/en/chronic_otitis_media.pdf
5. World Health Organization. Chronic suppurative otitis media; burden of illness and management options. Geneva, Switzerland. World Health Organization. 2004; 2-83. http://www.who.int/pbd/deafness/activities/hearing_care/otitis_media.pdf
6. Muhaimeid H, Zakzouk S, Bafaqeeh S. Epidemiology of chronic suppurative otitis media in Saudi children. Int J Pediatr Otorhinolaryngol 1993 Mar;26(2):101-108.
7. Elemraid MA, Brabin BJ, Fraser WD, Harper G, Faragher B, Atef Z, et al. Characteristics of hearing impairment in Yemeni children with chronic suppurative otitis media: a case-control study. Int J Pediatr Otorhinolaryngol 2010 Mar;74(3):283-286.
8. Pallant J. SPSS Survival Manual. 4th ed. New York: McGraw Hill; 2010. NY 10121-2289.
9. Zakzouk SM, Hajjaj MF. Epidemiology of chronic suppurative otitis media among Saudi children–a comparative study of two decades. Int J Pediatr Otorhinolaryngol 2002 Feb;62(3):215-218.
10. Minja BM, Machemba A. Prevalence of otitis media, hearing impairment and cerumen impaction among school children in rural and urban Dar es Salaam, Tanzania. Int J Pediatr Otorhinolaryngol 1996 Sep;37(1):29-34.
11. Miller SA, Omene JA, Bluestone CD, Torkelson DW. A point prevalence of otitis media in a Nigerian village. Int J Pediatr Otorhinolaryngol 1983 Jan;5(1):19-29.
12. Hatcher J, Smith A, Mackenzie I, Thompson S, Bal I, Macharia I, et al. A prevalence study of ear problems in school children in Kiambu district, Kenya, May 1992. Int J Pediatr Otorhinolaryngol 1995 Nov;33(3):197-205.
13. Seely DR, Gloyd SS, Wright AD, Norton SJ. Hearing loss prevalence and risk factors among Sierra Leonean children. Arch Otolaryngol Head Neck Surg 1995 Aug;121(8):853-858.
14. Rupa V, Jacob A, Joseph A. Chronic suppurative otitis media: prevalence and practices among rural South Indian children. Int J Pediatr Otorhinolaryngol 1999 May;48(3):217-221.
15. Biswas AC, Joarder AH, Siddiquee BH. Prevalence of CSOM among rural school going children. Mymensingh Med J 2005 Jul;14(2):152-155.
16. Wadger-Udin, Hussain A, Khan A, Samiullah FA. Prevalence and comparison of chronic suppurative otitis media in Government and private schools. Ann Pak Ins Med Sci 2009;5(3):141-144.
17. Lasisi AO, Sulaiman OA, Afolabi OA. Socio-economic status and hearing loss in chronic suppurative otitis media in Nigeria. Ann Trop Paediatr 2007 Dec;27(4):291-296.
18. Kamal N, Joarder AH, Chowdhury AA, Khan AW. Prevalence of chronic suppurative otitis media among the children living in two selected slums of Dhaka City. Bangladesh Med Res Counc Bull 2004 Dec;30(3):95-104.
19. Jacob A, Rupa V, Job A, Joseph A. Hearing impairment and otitis media in a rural primary school in south India. Int J Pediatr Otorhinolaryngol 1997 Mar;39(2):133-138.

20. Ashoor A, Maksoud MR. Clinical and bacteriological study of chronic otitis media in school boys of the Eastern Province of Saudi Arabia. Saudi Med J 1984;5:167-170.
21. van der Veen EL, Schilder AG, van Heerbeek N, Verhoeff M, Zielhuis GA, Rovers MM. Predictors of chronic suppurative otitis media in children. Arch Otolaryngol Head Neck Surg 2006 Oct;132(10):1115-1118.
22. Jacoby P, Carville KS, Hall G, Riley TV, Bowman J, Leach AJ, et al; Kalgoorlie Otitis Media Research Project Team. Crowding and other strong predictors of upper respiratory tract carriage of otitis media-related bacteria in Australian Aboriginal and non-Aboriginal children. Pediatr Infect Dis J 2011 Jun;30(6):480-485.
23. Lasisi AO, Olaniyan FA, Muibi SA, Azeez IA, Abdulwasiu KG, Lasisi TJ, et al. Clinical and demographic risk factors associated with chronic suppurative otitis media. Int J Pediatr Otorhinolaryngol 2007 Oct;71(10):1549-1554.