

CROSS-SECTIONAL EPIDEMIOLOGICAL STUDY OF THROAT SWAB OF SCHOOL CHILDREN IN AL-BAHA, KSA

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ABSTRACT

Objectives:

1. To assess the prevalence of bacterial throat infections, including those caused by groups A, B, C, D, E, F, and G β -hemolytic streptococci as well as *Staphylococcus aureus*, among school children
2. To assess the prevalence of the aforementioned organisms in specific children groups based on gender, age, social standard, recurrence of infection, and consanguinity of parents

Methods: Throat swabs were collected from 5,048 children of ages 6–13 across elementary schools in Al-Baha during November–December 2008 after obtaining parental consent. The samples were validated and sent to the microbiology lab in King Fahad Hospital in Al-Baha for testing. The samples were tested for the following organisms: groups A, B, C, D, E, F, and G β -hemolytic streptococci as well as *Staphylococcus aureus*.

Results: In total, the review includes 10 studies and one literature review, most of which were undertaken in developed countries and published between 2000 and 2014. The studies employ the qualitative, quantitative, or mixed methods approaches. The review establishes various challenges in implementing the discharge planning process, such as the lack of clear policies related to executing the process, communication issues, and the lack of clarity regarding the nurse's role.

Conclusion: The study reveals a high prevalence of group A β -hemolytic streptococcus, *Staphylococcus aureus*, and group B β -hemolytic streptococcus carriers among school children. Effective control against group A β -hemolytic streptococcus should be considered, as it was the most dominant in all epidemiological variants of our study.

Keywords: Throat infection, β -hemolytic streptococcus, throat swab, school children, Al-Baha, KSA, pediatrics

Citation: Edrees B. Cross-sectional epidemiological study of throat swab of school children in Al-Baha, KSA. Gulf Medical Journal. 2016;5(1):16–20.

INTRODUCTION

Throat infections are common among children of 5–15 years¹. Throat infections are caused by both viruses and bacteria². Viruses account for most of the cases and are usually self-limiting. Bacterial throat infections require a precise diagnosis and microorganism detection to initiate an appropriate antibiotic treatment to minimize local effects and prevent further

serious complications such as rheumatic fever, which causes the death of about 6 million individuals annually³.

Our aim was to have a cross-sectional overview and assess the prevalence of bacterial throat infections, including those caused by groups A, B, C, D, E, F, and G β -hemolytic streptococci as well as *Staphylococcus aureus*, among school children. Moreover, we compared the prevalence in specific children groups based on gender, age, social standard, recurrence of infection, and consanguinity of parents.

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METHODS

The study was conducted in Al-Baha during November–December 2008 by physicians from King Fahad Hospital, in collaboration with the pediatrics department of Umm Al-Qura University (UQU). The study included 5,048 children (2,734 males and 2,314 females) of 6–13 years across elementary schools in Al-Baha. After receiving approval from the UQU ethics committee, consent was sought from the parents of the children.

Weight and height were measured using a stadiometer (Roche, Germany). Throat swabs were taken using moist sterile Rayon-tipped swabs in Amies transport media (Copan, Italy). The samples were validated by UQU professors and sent to the microbiology lab in King Fahad Hospital in Al-Baha. The samples were tested for the following organisms: groups A, B, C, D, E, F, and G β -hemolytic streptococci and *Staphylococcus aureus*. The social standard of the subjects was classified according to a scoring system based on the type of house (5 points), crowding index (2 points), father's education (4 points), mother's education, and work (4 points)⁴. The maximum score was 20. The mean score for the entire group was 10+3. The socioeconomic status was classified as follows: low = score <10, middle = 10–15, and high = 16–20.

STATISTICAL ANALYSIS

The children were divided into groups based on age, gender, social standard, presence of renal complaints, presence of recurrent throat infections, and the consanguinity of parents; each group was subsequently analyzed for the prevalence of positive swabs. Furthermore, each group was divided into subgroups of children with positive swabs only to analyze the prevalence of specific organisms within each group. The frequency distribution was determined for demographic data, clinical presentation data, and swab results. The swab results of the different children groups were compared using the Chi-square test for significance. The types of organisms present in

the positive swabs of the different children groups was compared using the Chi-square test for significance.

DEMOGRAPHIC ANALYSIS

The study included 5,048 children; 2,314 (46% of sample) were female and 2,734 (54%) were male. The children were 6–13 years old, with a mean of 9.34 ± 1.89 years. As per World Health Organization growth charts, most of the children's weights were within normal percentiles, except for 687 children (13.6% of sample). Furthermore, most of the children's heights were within normal percentiles, except for 690 children (13.7% of sample). Almost every child's (99.6% of sample) head circumference was within the normal percentile as well.

The majority of the children (3,923 or 78% of sample) belonged to the middle class social standard. The parents of 1,951 children (39% of sample) were relatives. (Refer Table 1.)

Table 1. Demography of subjects

Grouping	N ^o (%)	
Weight (kg)	Less than 23 kg	1,138 (22%)
	23–28 kg	1,406 (28%)
	More than 28 kg	2,501 (50%)
Height (cm)	Shorter than 120 cm	660 (13%)
	120–140 cm	3,362 (67%)
	Taller than 140 cm	1,026 (20%)
Head circumference (cm) (males)	Less than 49.2 cm	95 (3%)
	49.2–52.2 cm	585 (21%)
	More than 52.2 cm	2,111 (77%)
Head circumference (cm) (females)	Less than 48.5 cm	73 (3%)
	48.5–51.3 cm	1,054 (46%)
	More than 51.3 cm	1,185 (41%)
Social standard	Low	328 (7%)
	Middle	3,923 (78%)
	High	793 (15%)
Consanguinity of parents	Relatives	1,951 (39%)
	Non-relatives	3,097 (61%)

Clinical and Family History

Only 124 children (2% of sample) presented with renal complaints, defined mainly as hematuria and recurrent urinary tract infection. Furthermore, 136 children (2.7% of sample)

presented with a chronic illness, including bronchial asthma, diabetes mellitus, hypertension, and rheumatic heart disease. There were 1,461 children (29% of sample) with a history of a recurrent throat infection.

RESULTS

Prevalence of Positive Throat Swabs

Swab results were positive for infection by the studied organisms in 828 children (16% of sample). Of this, 352 swabs (43% of infected group) contained group A β -hemolytic streptococcus (GAS), 242 (29.6%) contained *Staphylococcus aureus*, 107 (13%) contained group B β -hemolytic streptococcus (GBS), 37 (4.5%) contained group D β -hemolytic streptococcus (GDS), 31 (3.8%) contained group C β -hemolytic streptococcus (GCS), 19 (2.3%) contained group F β -hemolytic streptococcus, 18 (2.2%) contained group E β -hemolytic streptococcus (GES), and 12 (1.46%) contained group G β -hemolytic streptococcus (GGS).

Prevalence of Positive Swabs According to Groups

There was no difference between age groups in terms of the number of positive swabs ($p < 0.05$). The positive swabs percentage in the female group was 9% higher than that in the male group ($p < 0.001$). The positive swabs percentage decreased as the social standard of the children increased, with 23% in low class, 17% in middle class, and 11% in high class ($p < 0.001$). The positive swabs percentage among children whose parents were relatives was 20% compared with 16% among children with parents that were not relatives ($p < 0.001$). The positive swabs percentage was significantly higher in children that presented with a recurrent throat infection (41%) than children that did not have a recurrent infection (7%) ($p < 0.001$). The positive swabs percentage in children that presented with renal complaints (33%) was almost double the percentage of children that did not present with any renal complaints (16%) ($p < 0.001$). (Refer Table 2.)

Table 2. Prevalence of positive versus negative throat swabs

Grouping		Positive swabs	Negative swabs
Age ($p > 0.05$)	6–8 years	307 (17%)	1,546 (83%)
	9–11 years	415 (17%)	2,014 (83%)
	12–13 years	106 (14%)	660 (86%)
Gender ($p < 0.001$)	Female	491 (21%)	1,823 (79%)
	Male	337 (12%)	2,397 (88%)
Social standard ($p < 0.001$)	Low class	74 (23%)	254 (77%)
	Middle class	670 (17%)	3,253 (83%)
	High class	84 (11%)	709 (89%)
Consanguinity of parents ($p < 0.001$)	None	443 (14%)	2,654 (86%)
	Relatives	385 (20%)	1,566 (80%)
Recurrent throat infection ($p < 0.001$)	Absent	236 (7%)	3,348 (93%)
	Present	592 (41%)	869 (59%)

Prevalence of Organisms According to Type in the Groups

a. Age

In the 6–8 years group, GAS was by far the most prevalent organism, isolated in 176 children (57% of group), followed by *S. aureus* in 57 children (19%) and GBS in 30 children (10%). In the 9–11 years group, *S. aureus* was the most prevalent organism, isolated in 160 children (39% of group), followed by GAS in 123 children (29.64%) and GBS in 66 children (16%). In the 12–13 years group, GAS was the most prevalent, isolated in 53 children (50% of group), followed by *S. aureus* in 57 children (19%) ($p < 0.001$). (Refer Table 3.)

b. Gender

In the male group, *S. aureus* was the most prevalent organism, isolated in 167 children (50% of group), followed by GAS in 104 children (30.9%) and GBS in 27 children (8%). In the female group, GAS was the most prevalent organism, isolated in 248 children (51% of group), followed by *S. aureus* in 84 children (17%) and GBS in 80 children (16%) ($p < 0.001$). (Refer Table 3.)

c. Social standard

Across the social standard groups, GAS was the most prevalent organism, isolated in 35 children

from the low class (47.3% of group), 271 from the middle class (40.45%), and 46 from the high class (54.75%). *S. aureus* came second in the middle and high class groups, isolated in 208 children (31% of group) and 30 children (36%), respectively; it came third in the low class group, isolated in 13 children (18%). GBS came third in the middle and high class groups, isolated in 82 children (12% of group) and 4 children (5%), respectively; it came second in the low class group, isolated in 21 children (28%) ($p < 0.01$). (Refer Table 3.)

d. Consanguinity of parents

Among the children with related parents, GAS was the most prevalent organism, isolated in 180 children (47% of group), followed by *S. aureus* in 113 children (29%) and GBS in 52 children (14%). Likewise, among the children

with non-related parents, GAS was the most prevalent organism, isolated in 172 children (39% of group), followed by *S. aureus* in 138 children (31%) and GBS in 55 children (12%) ($p < 0.01$). (Refer Table 3.)

e. Recurrence of throat infection

Among children presenting with a recurrent throat infection, GAS was the most prevalent organism, isolated in 273 children (40% of group), followed by *S. aureus* in 165 children (28%) and GBS in 105 children (18%). Among the children not presenting with a recurrent throat infection, GAS and *S. aureus* were clearly dominant, isolated in 273 children (49% of group) and 236 children (36%), respectively ($p < 0.001$). In this study, no adverse events were reported. (Refer Table 3.)

Table 3. Prevalence of organisms in positive swabs across children groups

	Group	GAS	GBS	GCS	GDS	GES	GFS	GGs
Age ($p < 0.001$)	6–8 years	176 (57%)	30 (10%)	23 (7%)	9 (3%)	0 (0%)	12 (4%)	0 (0%)
	9–11 years	123 (30%)	66 (16%)	9 (2%)	26 (6%)	18 (4%)	7 (2%)	6 (1%)
	12–13 years	53 (50%)	11 (10%)	0 (0%)	2 (2%)	0 (0%)	0 (0%)	6 (6%)
Gender ($p < 0.001$)	Female	248 (51%)	80 (16%)	22 (4%)	17 (3%)	16 (3%)	12 (2%)	12 (2%)
	Male	104 (31%)	27 (8%)	10 (3%)	20 (6%)	2 (1%)	7 (2%)	0 (0%)
Social standard ($p < 0.01$)	Low class	35 (47%)	21 (28%)	1 (1%)	1 (1%)	1 (1%)	0 (0%)	2 (3%)
	Middle class	271 (40%)	82 (12%)	31 (5%)	33 (5%)	17 (3%)	18 (3%)	10 (1%)
	High class	46 (55%)	4 (5%)	0 (0%)	3 (4%)	0 (0%)	1 (1%)	0 (0%)
Consanguinity of parents ($p < 0.01$)	None	172 (39%)	55 (12%)	17 (4%)	28 (6%)	12 (3%)	16 (4%)	5 (1%)
	Relatives	180 (47%)	52 (14%)	15 (4%)	9 (2%)	6 (2%)	3 (1%)	7 (2%)
Recurrent throat infection ($p < 0.001$)	Absent	115 (49%)	2 (1%)	4 (2%)	12 (5%)	6 (3%)	2 (1%)	9 (4%)
	Present	237 (40%)	105 (18%)	28 (5%)	25 (4%)	12 (2%)	17 (3%)	3 (1%)

DISCUSSION

To the best of our knowledge, this study was one of the first large-scale studies in the Middle East to analyze the prevalence of multiple throat organisms. The prevalence of infection caused by the studied organisms was 16.39% among the school children. GAS was the most isolated organism across study groups, followed by GBS and *S. aureus*; groups C, D, E, F, and G β -hemolytic streptococci were absent or did not exceed 5% of the study sample. We assumed that epigenetic factors such as the consanguinity of parents would contribute to the prevalence of the aforementioned organisms; however, the results were similar in the groups with related

parents and non-related parents. The prevalence of organisms in different social standard groups varied significantly; specific correlation analysis should be conducted in further studies.

The prevalence of GAS infection stood at 43.1%, higher than results from studies conducted in Egypt (24%) and Tunisia (20.7%), and similar to results reported from an earlier study conducted in Saudi Arabia on 73 children up to age 12 (40%)^{5, 6, 7}. In a previous study, GAS was the most commonly isolated bacteria among children with recurrent throat infection⁸; this is in agreement with our study, where we found that in the recurrent throat infection

group, GAS was the most dominant organism isolated (40% of group).

The prevalence of *S. aureus* was 29.6% in our study and raises no concerns, especially in this study age group. *S. aureus* is a human commensal and a common cause of clinically important infections. The incidence of invasive disease caused by *S. aureus* is 5–20 times higher than that of invasive diseases caused by group A streptococcus^{9, 10}. Longitudinal studies indicate that about 20% (range: 12–30%) of individuals are persistent *S. aureus* nasal carriers; approximately 30% (range: 16–70%) are intermittent carriers¹¹. Generally, *S. aureus* does not cause any harm; infections only occur when a breach of the skin or mucosal barrier allows staphylococci to access adjoining tissues or the bloodstream¹².

The prevalence of GBS was 13.1%. GBS infects pregnant mothers and neonates, and raises concerns in our study age group only if accompanied with another underlying condition (neurologic disorders, immunosuppressive conditions, asthma, malignancy, renal disease), as bacteremia without focus is common, followed by meningitis and pneumonia to a lesser extent¹³.

CONCLUSION

The study reveals a high prevalence of GAS, *Staphylococcus aureus*, and GBS carriers among school children. Effective control against GAS should be considered, as it was the most dominant organism in all epidemiological variants of our study.

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