

Original Article

Salivary parameters, dental caries experience and treatment needs of hearing-impaired children in a special school for deaf in Kelantan, Malaysia

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Abstract Dental caries is the main oral health problem in hearing-impaired (HI) children and remains the most neglected need. The present study aimed to determine caries prevalence and treatment needs in HI children and the association with salivary parameters. A cross-sectional study was conducted on 63 HI children aged between 7-14 years who attended a special school for the deaf. Clinical oral examination was done and salivary parameters (resting flow rate and resting pH) were measured. Caries experience was charted using the index of decay-filled teeth (dft) and Decay-Missing-Filled Teeth (DMFT) for primary and permanent dentition respectively. Data were analysed using SPSS version 12.0. The mean age was 11.5 (SD 2.39) years and 53.8% were female. Dental caries prevalence was 88.0% (95% CI: 73.0, 100.0) in primary dentition and 85.0% (95% CI: 73.0, 96.0) in permanent dentition. The mean dft was 6.1 (SD 4.14) and the mean DMFT was 4.9 (SD 3.28). The mean resting flow rate was 0.14 (SD 0.08) ml/min while mean pH was 6.8 (SD 0.79). Both pit and fissure sealants and restorations were the highest (83.1%) treatment needs. Only 3.1% of the children did not require any treatment. There were no significant association between both salivary flow rate and salivary pH with caries experience in the primary ($p=0.342$, $p=0.610$ respectively) and permanent ($p=0.99$, $p=0.70$ respectively) teeth. In conclusion, children with HI have high caries prevalence and unmet need for dental treatments. Salivary pH and resting flow rate of the children were not associated with their caries experience.

Keywords: dental caries, health services need, hearing loss, saliva.

Introduction

Hearing impairment among children is a major public health problem in developing countries (Rao *et al.*, 2002) with an incidence of about one to three per 1,000 live births (Watkin, 1996). Hearing screening done at Hospital Universiti Sains Malaysia among the high-risk infants showed an incidence of 1:100 live births (Mohd Khairi *et al.*, 2005). Hearing impairment may affect speech, linguistic, cognitive, and educational development of the children (Kennedy *et al.*, 2006). Dalton *et al.* (2003) reported that hearing impairment is associated with reduced quality of life due to communication

difficulties to exchange information. Therefore, the dental health education might not be delivered effectively to these children and thus would compromise their oral health status.

Dental caries is one of the most prevalent oral diseases among school children worldwide and dental treatment is the greatest unattended health need of the disabled (Hennequin *et al.*, 2000; Nunn *et al.*, 1993). Jain *et al.* (2008) reported that the prevalence of dental caries in children with hearing impairment was very high due to the lack of oral care as parents were unaware about the importance of oral health. A study on children with visual impairment, hearing impairment, physical

handicaps or developmental disorders found that the prevalence of untreated dental caries was highest (86%) in hearing-impaired (HI) children (Shyama *et al.*, 2001). Consequences of high caries experience include a higher risk of hospitalizations and emergency dental visits (Majewski *et al.*, 1988), increased days with restricted activity and absence from school (Reisine, 1988) as well as diminished ability to learn (Sheiham, 2006).

The properties and function of saliva as well as its role in oral health have been well established in the literature (Stokey, 2008). Saliva is vital to maintain the integrity of teeth as well as the soft tissues (Gopinath and Arzreanne, 2006). In addition, saliva secretion rate and buffering capacity have been proven to be sensitive parameters in caries prediction models (Mittal *et al.*, 2011). Evaluation of saliva properties will provide useful information about the risk for developing dental diseases (Edgar, 1992). Although there have been numerous studies that aimed to establish a correlation between dental caries and saliva properties, evidence of correlation was found to be weak (Mittal *et al.*, 2011).

Therefore, the purpose of the present study was to determine the dental caries prevalence and its association with salivary flow rate and pH as well as treatment needs among the HI children in Kelantan, Malaysia.

Materials and methods

A cross-sectional study involving the HI children in a special school for deaf in Kelantan, Malaysia was carried out for a period of 3 weeks in June 2009. HI children aged between 6 and 14 years old without any medical problem related to mental retardation, systemic disease and xerostomia were included in the present study. The consent to participate in the study was obtained from their parents.

Sample size was calculated using the single proportion formula based on the prevalence of dental caries among deaf children which was reported to be at 83.9% (Jain *et al.*, 2008). The sample size obtained was 52 with a precision of 0.10 (10%) at 95% confidence interval (CI).

The children were listed and selected using simple random sampling method.

Salivary parameters measured were resting flow rate and resting pH. Saliva collection was done in the classroom allocated by the teacher for research purposes. The teachers were asked to assist in communicating with the students. Prior to saliva collection, the child was not allowed to take any food or drink to ensure there was no food stimulation that may affect the accuracy of saliva parameters (Kirstilä *et al.*, 1988). The saliva collection procedures were done according to the protocol provided by the manufacturer of the saliva test kit, the Saliva-Check BUFFER® (GC Co., Japan). During the saliva collection procedure, the child was seated in an upright position with head slightly bending forward to facilitate saliva collection. It was done between 8:30 am to 10:30 am by asking children to unforcibly spit into a special cup provided by the manufacturer. To prevent the effect of circadian variation, samples were collected at the same time of the day (Sari-Sarraf *et al.*, 2007). The saliva was spat into the cup for the duration of five minutes. The digital stopwatch was used to time the duration of saliva collection. After five minutes, they were asked to stop and the volume of collected saliva was measured using level indicator at the cup. During the measurement of the saliva level, froth formed was excluded; and the result was recorded accordingly. The reading was then divided into five to get the resting flow rate in millimetre per min (ml/min).

Dental examination was performed on a portable dental chair, under good operating light, using disposable mouth mirror and dental probe. The two examiners were calibrated before the survey to reduce inter- and intra-examiner variability and improve reliability of measure. Caries experience was charted using the index of decay-filled-teeth (dft) for primary dentition and Decay-Missing-Filled Teeth (DMFT) for permanent dentition (Klein *et al.*, 1938). The following dental treatment needs were identified and recorded: pit and fissure sealant, topical fluoride application,

restoration of carious teeth, dental extraction, dental pulp treatment or no treatment required.

SPSS version 12 (SPSS Inc, Chicago, IL, USA) statistical software was used for data entry and analysis. Descriptive statistics such as means and standard deviation (SD) for continuous variables (age, salivary flow rate (ml/min), pH level and dft/ DMFT) and frequency and percentages for categorical variables (gender, ethnicity) were calculated. The prevalence of dental caries was determined at 95% confidence interval (CI). Bivariate correlation analysis and simple linear regression analysis were used to determine the association between dft and DMFT with resting flow rate and pH. The *p*-value was set at 0.05.

The study was performed in accordance with ethical principles in the Declaration of Helsinki and was approved by the Universiti Sains Malaysia, Human Ethics Committee (Reference no.: USMKK/PPP/JEPeM[213.3(15)]).

Results

A total of 63 children with hearing impairment participated in the study. Table 1 shows the demographic profile, salivary characteristics, dental caries experience and treatment needs of the children. Their mean age was 11.5 years (SD 2.39) and females were slightly more than males (53.8%). The majority were of Malay ethnic group (98.4%), reflecting the ethnic composition of Kelantan population. The mean saliva resting flow rate of patients was 0.14 ml/min (SD 0.083) and resting pH was 6.8 (SD 0.79).

The prevalence of dental caries was 92.0% (95% CI: 80.0, 100.0) in the primary dentition and 59.0% (95% CI: 46.0, 71.0) in the permanent dentition. Caries experience in the primary dentition (dft) and permanent dentition (DMFT) was 6.1 (SD 4.14) and 4.9 (SD 3.28) respectively.

The need for pit and fissure sealants and restorations were the highest (83.1%) dental treatment needs followed by topical fluoride (64.6%) and extraction (44.6%). The proportion of children who did not require dental treatment was low (3.1%).

Bivariate correlation analysis was done to determine the association between caries experience and salivary flow rate and pH. No significant association between salivary flow rate and caries experience in both primary and permanent dentition was found as shown in Table 2.

Discussion

The current study was conducted on HI children in a public school for the deaf. The prevalence of dental caries in primary dentition was 92.0% which was slightly lower compared to the caries prevalence among the deaf children in Saudi Arabia which was 95.7% (Al-Qahtani and Wyne, 2004). As for the permanent dentition, the caries prevalence was 59.0% (95% CI: 46.0, 71.0). The prevalence can be considered low when compared to other studies. In both India (Jain *et al.*, 2008) and Saudi Arabia (Al-Qahtani and Wyne, 2004), it was reported at 93.0%. The dental caries experience among children in the present study was 6.1 in primary dentition and 4.9 in permanent dentition. The dental caries experience for the primary dentition was similar with the normal children based on a previous study (Tin Oo *et al.*, 2011). For the permanent dentition, the caries experience was higher (4.9) compared to the result in that study (1.04). The difference of caries experience between the permanent and primary dentition was attributed to the long time exposure to oral environment (Al-Obaidi, 2006). When compared between the HI and normal children, a low DMFT among the normal children is expected due to the well-organized and extensive coverage of the school dental program under the Malaysian Ministry of Health. However, as stated by Jain *et al.* (2008), the oral health of disabled people is neglected because of the focus is given on their other disabling condition.

The high caries prevalence in this group of special children was complicated with lack of care in terms of health needs. This is evident through findings from various studies which reported that oral health care is the most unmet health care need for children with special needs (Martens *et al.*, 2000; Nicopoulos *et al.*, 2007). Findings of the present study

showed that about 83% of the children needed dental restorations and 45% were in need of dental extractions. This unmet need was reflected on the occurrence of high caries prevalence among this group of patients. According to Curzon and Toumba (1998) the unmet treatment needs might be due to inadequate funding and resources, insufficient trained dentists to treat patients with disabilities, and complex treatment needs requiring special care or need to be treated under general anaesthesia.

As for the HI children, they have communication problems that limit them towards accessing dental health education. Effective tooth cleaning is particularly challenging in HI children as they could not hear and dental practitioner also was not capable to communicate with them using sign language. Thus, more frequent visit for reinforcement of good oral habits is needed (Brown, 2009). This is in agreement with Champion and Holt (2000) who reported that about two thirds of the HI children from National Deaf Children's Society, UK had difficulties in communicating with the dentist or nurses. However, the use of oral communication and lip reading were possible in a quiet environment. It was also reported that the majority of the dentists had worn mask while communicating with these children and more than half complained that there were background noise during appointment (Champion and Holt, 2000). It was recommended that dentist should be trained to treat children with hearing impairment as well as being able to use cued speech and sign language.

Jain *et al.* (2008) suggested that dental health education should be provided to the parents, caregivers and school teachers of HI children. Bonito (2002) stated that due to limited dexterity and ability to control their own diet, the special needs children depend on their caregivers to practice appropriate oral hygiene behaviour or choose proper diet. However, the caregivers themselves did not have the prerequisite knowledge or values to recognize the importance of oral hygiene and did not practice appropriate

oral hygiene care or choose a proper diet for their own children (Bonito, 2002).

Appropriate flow of saliva is essential for oral health maintenance (Tenovuo, 1997). The mean saliva resting flow rate in the present study was 0.14 ml/min (SD 0.083) which was lower compared to results of a study done among normal population by Tenovuo (1997) which ranged from 0.25 to 0.35 ml/min. However, this amount is considered as normal because the accepted range of normal flow for unstimulated saliva is anything above 0.1 ml/min. (Humphrey and Williamson, 2001). Saliva facilitates demineralization and remineralisation of teeth, modulates adhesion of microorganisms to teeth and other oral surfaces, and buffers dietary acids (Pedersen *et al.*, 2002). Even the physical flow of saliva has caries-preventive effect by influencing the clearance rate of substrate, the higher the flow rate the faster the clearance rate (Miura *et al.*, 1991). However, there was no significant association between salivary flow rate and caries experience in both primary and permanent dentition was found in the present study. This is supported by Birkhed and Heintze (1989) and Russell *et al.* (1990) who stated that there is no linear relationship exists among salivary secretion rate and caries activity.

In the present study, the mean saliva pH was 6.8 (SD 0.79) which was within the normal range at 6.5 and 7.5 (Pedersen *et al.*, 2002). No significant association was found between salivary pH and caries experience in children with both primary and permanent dentition. The lack of association between salivary pH and resting flow rate with the children's caries experience probably can be explained by the fact that dental caries is a multi-factorial disease. Other etiological factors such as diet and contributing factors like oral hygiene habit may have contributed to the high caries prevalence among this group of children under study.

High dental caries prevalence found in children with hearing impairment in the present study indicates their need for special oral health attention. Efforts must be made to encourage parents and school teachers to help promote oral health and

improve oral health care of the children. Expansion of clinical preventive services such as topical fluoride applications and fissure sealant may also help to prevent dental caries in the disabled children. Efforts to raise awareness among physicians especially those who work closely with the children such as otorhinolaryngology (ORL) surgeon, audiologist and speech therapist on the need for early dental referrals will help to increase dental attendance of the children which will result in early disease detection and cure, and subsequent improvement in oral health status. This may significantly improve the psychological and social aspect of the children's life particularly the quality of life (Acs *et al.*, 2001). Conversely, the negative effect of dental

caries in children on their quality of life has been demonstrated (Low *et al.*, 1999) and discussed in the literature (Sheiham, 2006).

In conclusion, children with hearing impairment in the present study have high caries prevalence and unmet needs for dental treatment. Saliva parameters like pH and resting flow rate did not influence the caries experience. Collaboration between trained dental personnel, ORL surgeons, audiologists and speech therapists in managing HI children is recommended to improve oral health status of this disadvantaged group. Early clinical preventive measures such as pit and fissure sealant and fluoride therapy may help to prevent dental caries in the children.

Table 1 Demographic profile, salivary parameters, dental caries experience and treatment needs of hearing-impaired children (n=63)

Variable	Mean (SD)	Frequency (%)
Demographic profile		
Age	11.5 (2.39)	
Gender		
Male		29 (46.2)
Female		34 (53.8)
Ethnic		
Malay		62 (98.4)
Chinese		0 (0.0)
Indian		0 (0.0)
Others		1 (1.6)
Salivary characteristics		
Resting flow rate (ml/min)	0.14 (0.083)	
pH	6.8 (0.79)	
Dental caries experience		
Primary dentition (n=24)		
dft	6.1 (4.14)	
d	5.6 (4.17)	
f	0.4 (0.65)	
Permanent dentition (n=39)		
DMFT	4.9 (3.28)	
D	2.7 (2.35)	
M	0.15 (0.49)	
F	2.1 (1.84)	
Dental treatment needs		
Pit and fissure sealant		54 (83.1)
Topical fluoride		42 (64.6)
Restoration		54 (83.1)
Extraction		29 (44.6)
Pulp care		8 (12.3)
No treatment required		2 (3.1)

Table 2 Association between dental caries experience and saliva resting flow rate and pH using simple linear regression analysis

Variable	b (95%CI β)	p-value	r ²
Primary dentition (dft)			
Saliva resting flow rate	0.2 (-0.24, 0.66)	0.342	0.041
Saliva pH	0.6 (-1.67, 2.78)	0.610	0.012
Permanent dentition (DMFT)			
Saliva resting flow rate	-0.0 (-0.20, 0.20)	0.996	<0.001
Saliva pH	-0.3 (-1.82, 1.24)	0.703	0.004

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References

- Acs G, Pretzer S, Foley M, Ng MW (2001). Perceived outcomes and parental satisfaction following dental rehabilitation under general anaesthesia. *Pediatr Dent*, **23**(5): 419-423.
- Al-Obaidi WA (2006). Nine-year cohort study to predict caries in permanent teeth from caries in primary teeth in the same individuals. *J Bagh Coll Dent*, **18**(3): 70-72.
- Al-Qahtani Z, Wyne AH (2004). Caries experience and oral hygiene status of blind, deaf and mentally retarded female children in Riyadh, Saudi Arabia. *Odontostomatol Trop*, **27**(105): 37-40.
- Birkhed D, Heintze U (1989). Salivary secretion rate, buffer capacity, and pH. In: Tenovuo JO (ed.), *Human Saliva: Clinical Chemistry and Microbiology*. Boca Raton, FL: CRC Press. pp. 25-74.
- Bonito AJ (2002). Executive summary: dental care consideration for vulnerable populations. *Spec Care Dentist*, **22**(3 Suppl): 5S-10S.
- Brown A (2009). Caries prevalence and treatment needs of healthy and medically compromised children at a tertiary care institution in Saudi Arabia. *East Mediterr Health J*, **15**(2): 378-386.
- Champion J, Holt R (2000). Dental care for children and young people who have a hearing impairment. *Br Dent J*, **189**(3): 155-159.
- Curzon ME, Toumba KJ (1998). The case for secondary and tertiary care by specialist dental services. *Community Dent Health*, **15**(Suppl 1): 312-315.
- Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl, DM (2003). The impact of hearing loss on quality of life in older adults. *Gerontologist*, **43**(5): 661-668.
- Edgar WM (1992). Saliva: its secretion, composition and functions. *Br Dent J*, **172**(8): 305-312.
- Gopinath VK, Arzreanne AR (2006). Saliva as a diagnostic tool for assessment of dental caries. *Arch Orofac Sci*, **1**: 57-59.
- Hennequin M, Faulks D, Roux D (2000). Accuracy of estimation of dental treatment need in special care patients. *J Dent*, **28**(2): 131-136.
- Humphrey SP, Williamson RT (2001). A review of saliva: normal composition, flow, and function. *J Prosthet Dent*, **85**(2): 162-169.
- Jain M, Mathur A, Kumar S, Dagli RJ, Duraiswamy P, Kulkarni S (2008). Dentition status and treatment needs among children with impaired hearing attending a special school for the deaf and mute in Udaipur, India. *J Oral Sci*, **50**(2): 161-165.
- Kennedy CR, McCann DC, Campbell MJ, Law CM, Mullee M, Petrou S *et al.* (2006). Language ability after early detection of permanent childhood hearing impairment. *N Engl J Med*, **354**(20): 2131-2141.
- Kirstilä V, Häkkinen P, Jentsch H, Vilja P, Tenovuo J (1988). Longitudinal analysis of the association of human salivary antimicrobial agents with caries increment and cariogenic micro-organisms: a two-year cohort study. *J Dent Res*, **77**(1): 73-80.
- Klein H, Palmer CE, Knutson JW (1938). Studies on dental caries. I. Dental status and dental needs of elementary school children. *Pub Health Rep*, **53**: 751-765.

- Low W, Tan S, Schwartz S (1999). The effect of severe caries on the quality of life in young children. *Pediatr Dent*, **21**(6): 325-326.
- Majewski RF, Synder CW, Bernat JE (1988). Dental emergencies presenting to a children's hospital. *ASDC J Dent Child*, **55**(5): 339-342.
- Martens L, Marks L, Goffin G, Gizani S, Vinckier F, Declerck D (2000). Oral hygiene in 12-year-old disabled children in Flanders, Belgium, related to manual dexterity. *Community Dent Oral Epidemiol*, **28**(1): 73-80.
- Mittal S, Bansal V, Garg S, Atreja G, Bansal S (2011). The diagnostic role of saliva: a review. *J Clin Exp Dent*, **3**(4): e314-e320.
- Miura H, Isogai E, Hirose K, Wakizaka H, Ueda I, Ito N (1991). Application of a sucrose indicator strip to evaluate salivary sucrose clearance. *J Dent*, **19**(3): 189-191.
- Mohd Khairi MD, Din Suhaimi S, Shahid H, Normastura AR (2005). Hearing screening of infants in Neonatal Unit, Hospital Universiti Sains Malaysia using transient evoked otoacoustic emissions. *J Laryngol Otol*, **119**(9): 678-683.
- Nicopoulos M, Brennan MT, Kent ML, Brickhouse TH, Rogers MK, Fox PC *et al.* (2007). Oral health needs and barriers to dental care in hospitalized children. *Spec Care Dentist*, **27**(5): 206-211.
- Nunn JH, Gordon PH, Carmichael CL (1993). Dental disease and current treatment needs in a group of physically handicapped children. *Community Dent Health*, **10**(4): 389-396.
- Pedersen AM, Bardow A, Jensen SB, Nauntofte B (2002). Saliva and gastrointestinal functions of taste, mastication, swallowing and digestion. *Oral Dis*, **8**(3): 117-129.
- Rao RS, Subramanyam MA, Nair NS, Rajashekhar B (2002). Hearing impairment and ear diseases among children of school entry age in rural South India. *Int J Pediatr Otorhinolaryngol*, **64**(2): 105-110.
- Reisine ST (1988). The impact of dental conditions on social functioning and the quality of life. *Annu Rev Public Health*, **9**: 1-19.
- Russell JI, MacFarlane TW, Aitchison TC, Stephen KW, Burchell CK (1990). Caries prevalence and microbiological and salivary caries activity tests in Scottish adolescents. *Community Dent Oral Epidemiol*, **18**(3): 120-125.
- Sari-Sarraf V, Reilly T, Doran DA, Atkinson G (2007). The effects of single and repeated bouts of soccer-specific exercise on salivary IgA. *Arch Oral Biol*, **52**(6): 526-532.
- Sheiham A (2006). Dental caries affects body weight, growth and quality of life in pre-school children. *Br Dent J*, **201**(10): 625-626.
- Shyama M, Al-Mutawa SA, Morris RE, Sugathan T, Honkala E (2001). Dental caries experience of disabled children and young adults in Kuwait. *Community Dent Health*, **18**(3): 181-186.
- Stokey GK (2008). The effect of saliva on dental caries. *J Am Dent Assoc*, **139**(Suppl): 11S-17S.
- Tenovuo J (1997). Salivary parameters of relevance for assessing caries activity in individuals and populations. *Community Dent Oral Epidemiol*, **25**(1): 82-86.
- Tin Oo MM, Naing L, Mani SA, Ismail AR (2011). Dental caries experience and treatment needs in the mixed dentition in North East Malaysia. *Arch Orofac Sci*, **6**(2): 41-48.
- Watkin PM (1996). Outcomes of neonatal screening for hearing loss by otoacoustic emission. *Arch Dis Child Fetal Neonatal Ed*, **75**(3): F158-F168.