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Child oral health in migrant families: A cross-sectional study of caries in 1-4 year old children from migrant backgrounds residing in Melbourne, Australia

L. Gibbs[1], A.M. de Silva[2,3], B. Christian[1], Gold, L[4], M. Gussy[5], L. Moore[6], H. Calache[2], D. Young[1,7], E. Riggs[8], M. Tadic[7], R. Watt[9], I. Gondal[10] and E. Waters[1]

[1]Jack Brockhoff Child Health and Wellbeing Program, Melbourne School of Population and Global Health, University of Melbourne, Carlton, Australia; [2]Dental Health Services Victoria, Carlton, Australia; [3]Melbourne Dental School, The University of Melbourne, Carlton, Australia; [4]Deakin Health Economics, Deakin University, Burwood, Australia; [5]Department of Dentistry and Oral Health, La Trobe Rural Health School, La Trobe University, Bendigo, Australia; [6]MRC/CSO Social and Public Health Sciences Unit, University of Glasgow, Glasgow, Scotland ; [7]Merri Community Health Services, Brunswick, Australia ; [8]Healthy Mothers Healthy Families Research Group, Murdoch Children's Research Institute, Parkville, Australia; [9]Epidemiology and Public Health, University College London, London, England; [10]Federation University Australia and PAAM, Melbourne, Australia

Early Childhood Caries (ECC) is the most common, preventable disease of childhood. It can affect children's health and wellbeing and children from migrant families may be at greater risk of developing ECC. ***Objective:*** To describe ECC in children from migrant families, and explore possible influences. ***Basic research design:*** Cross-sectional analysis of caries data collected as baseline data for an oral health promotion study. ***Participants:*** The analysis sample included 630 1-4 year-old children clustered within 481 Iraqi, Lebanese and Pakistani families in Melbourne, Australia. ***Method:*** Child participants received a community-based visual dental examination. Parents completed a self-administered questionnaire on demographics, ethnicity, and oral health knowledge, behaviour and attitudes. ***Main outcome measure:*** Child caries experience. Bivariate associations between oral health behaviours and ethnicity were tested for significance using chi-square. Multivariate logistic regression analyses were performed to identify associations with ECC, adjusting for demographic variables and accounting for clustering by family. ***Results:*** Overall, 34% of children in the sample experienced caries (both non-cavitated and cavitated). For all caries lesions, parent' length of residence in Australia, consumption of sweet drinks and parental education remained as independent predictors of child caries experience. Adding sugar to drinks was an additional risk factor for cavitation. Ethnicity was associated with some individual oral health behaviours suggesting cultural influences on health, however the relationship was not independent of other predictors. ***Conclusion:*** Culturally competent oral health promotion interventions should aim to support migrant families with young children, and focus on reducing sweet drink consumption.

Key words: *oral health, dental caries, dental decay, child, pre-school, migrants, Australia*

Introduction

Early Childhood Caries (ECC) is the most common, preventable disease of childhood affecting children's health, wellbeing and development (Gussy *et al.*, 2006). Recent studies from the USA and the UK indicate that there are significant associations between social disadvantage, ethnicity/race and poorer child oral health outcomes (Marcenes *et al.*, 2013).

A recent review of the international literature reported clear indications that migrant children had worse oral health outcomes compared with their host-country counterparts (Riggs *et al.*, 2014b). There is limited research available in relation to cultural influences on oral health and health care (Riggs *et al.*, 2014b). However, new knowledge is emerging about traditional methods of oral health care, sociocultural differences in oral health knowledge, beliefs and practices, and access to dental services (Riggs *et al.*, 2012; 2014a). The extent to which cultural influences may contribute to or reduce ECC risk is unclear. For example, use of the *miswak*, a traditional chewing/brushing stick for cleaning teeth is common across many countries and in many cultures. It is used mostly by Muslim adults although it is occasionally adopted early by children. Conversely, practices associated with particular ethnic groups such as settling babies to sleep while sipping milk/sweet substances is associated with increased risk of ECC (Shiboski *et al.*, 2003).

The degree to which sociocultural differences in oral health knowledge, practices and service use is mediated by length of time in the host country and/or by acculturation has not been clearly established. However, there is some evidence to suggest that increased length of residence in the host country may be associated with reduced risk of caries in children (Maserejian *et al.*, 2008). Higher acculturation, a measure of the extent to which individuals adapt to and become integrated into a new cultural setting, including language proficiency, has also been shown in adults to be associated with fewer teeth affected by caries and increased oral health knowledge and use of dental services (Marino *et al.*, 2001).

Correspondence to: Lisa Gibbs, Jack Brockhoff Child Health and Wellbeing Program, Melbourne School of Population and Global Health, University of Melbourne, Level 5, 207 Bouverie Street, Parkville 3010 Victoria, Australia. Email: lgibbs@unimelb.edu.au

This seems to contradict the 'healthy immigrant' effect which has been well established in public health research in developed countries with a migration program, showing new arrivals often have better health than their counterparts in the host country, although this tends to deteriorate over time (Australian Institute of Health and Welfare, 2000; McDonald and Kennedy, 2004). This evidence of better health in migrants on arrival may arise from the health screening requirements of migration programs and skilled migration programs recruiting higher social class individuals from a given population group. This is not part of the process for refugee migration and therefore, the 'healthy immigrant' effect may be less evident in their case.

Currently, little is known about the risk factors for poor oral health in young children from migrant backgrounds. This paper presents a cross-sectional analysis of child caries risk factor and clinical data for children aged 1-4 years from three distinct migrant populations in Melbourne, Australia. It aims to present patterns of ECC in children from migrant families, and explore possible influences on poor oral health.

Methods

The data were collected between March and September 2012 as baseline data for Teeth Tales, an exploratory trial implementing a community-based child oral health promotion intervention for Australian families from migrant backgrounds (Gibbs *et al.*, 2014).

The target population for Teeth Tales were families with children aged 1-4 years, self-identified as being from Iraqi, Lebanese or Pakistani backgrounds residing in metropolitan Melbourne, Australia. The selection of these particular communities was based on factors such as community dental profiles, community access points and migration settlement data in the intervention site, described in more detail elsewhere (Gibbs *et al.*, 2014; Riggs *et al.*, 2014a).

Participants were recruited into the study by Teeth Tales trained peer educators from their respective cultural communities using purposive and snowball sampling methods, which are known to be effective in recruiting hard to reach populations (Thompson and Phillips, 2007). Families with young children were contacted by peer educators using existing client databases, schools, childcare centres, community and social networks and invited to participate in the study. Study materials were available in English, Arabic and Urdu.

Child participants aged 1-4 years received a dental screening. This visual clinical examination was conducted in a community setting, with the child's head resting on the dental practitioner's lap while using a disposable mouth mirror, head lamp and standard infection control equipment. Dental caries was assessed using a modified version (no drying of teeth) of the International Caries Detection and Assessment System – ICDAS (Ismail *et al.*, 2007). Clinical data were recorded on paper odontograms by a trained recorder and later entered into an electronic database. Children identified with caries were referred to the local public dental service for treatment.

Parents were invited to complete a structured self-administered questionnaire, collecting information on child and parent demographics, oral hygiene behaviour, dental visiting behaviour, self-reported health measures, child dietary practices and parent oral health knowledge, confidence and attitudes. The analyses reported in this paper draw on the demographic and child oral hygiene behaviours and dietary practices components of the questionnaire.

A number of procedures were in place to ensure that the study data were of the highest quality. A pilot study provided the opportunity to test the data collection tools prior to trial implementation. Several aspects of the implementation process were modified following the pilot. The dental examiners were trained to use ICDAS and calibrated against two senior clinicians (MG and HC) with discrepancies settled by discussion. Inter-rater kappa coefficients ranged from 0.63 to 0.70, which is considered to be a good strength of agreement (Acock, 2012). Teeth and surfaces were examined in a standard order. Headlamps used in the dental examination process were from the same manufacturer and the batteries were changed periodically. All the data recorders were trained in the recording. The collected data were entered twice into electronic databases and data entry errors were identified and corrected by examining the data consistency across the two sets of data. To ensure standardised reporting the STROBE statement was used to guide the content of this paper (von Elm *et al.*, 2007).

In data analysis, the main outcome variable was child caries experience using the dmfs index derived from the ICDAS scores, where a surface was coded as decayed at the ICDAS decay code 1 or higher - both non-cavitated and cavitated lesions ($d_1$mfs) (Ismail *et al.*, 2007). We also report a dmfs score using the more commonly used WHO caries criteria ($d_4$mfs), which captures caries at the level of cavitation into dentine.

Potential predictor variables examined were participant ethnicity, length of residence in Australia and preferred language. For the purpose of this paper ethnicity refers to cultural identification, which is fluid and may change over time and encompasses shared origins or social background, shared culture and traditions maintained between generations, common language and/or religious beliefs that lead to a sense of identity (Australian Bureau of Statistics, 2011). Self-definition of ethnicity is presently recommended for health research (Australian Bureau of Statistics, 2011) and for this study self-defined ethnic background, determined through self-allocation to targeted recruitment sessions conducted by our cultural partners, was used to classify families into ethnic groups. Parent's length of residence in Australia was constructed from questions on parent's country of birth and year of arrival in Australia and was analysed as a categorical variable in 5 year intervals with the final category as over 15 years. If parents indicated they were born in Australia they were allocated to a separate category of 'born in Australia'. Preferred language was analysed as English versus non-English.

Other potential predictor variables included: child tooth cleaning frequency, child tooth cleaning assistance, frequency of consumption of tap water, cariogenic food and drinks, adding sugar to child's food and drink, and parental education and healthcare card status (a card issued to individuals or families who have been deemed economically vulnerable by the Australian Government to allow access to subsidized goods and services, particularly in relation to medical care). Potential confounders included in analysis were: child age and gender, and parent age and gender.

The following categorical variables were collapsed for analysis due to small numbers in some categories. The five level variable 'child's tooth cleaning frequency' was collapsed into three levels, 'never or few times per week', 'once a day' and 'more than once a day'. The variables 'add sugar to child's food and drink' had categories 'never' combined with 'rarely' and 'sometimes' combined with 'always'. Parent education was re-categorised into primary or less, secondary, trade and university levels. The variables for the frequency of consumption of tap water, cariogenic drinks and food were constructed on a per week scale using the relevant frequency questions. For example, the consumption frequency of cariogenic drinks was constructed on a week scale from questions on the frequency of consumption of flavoured milk, soft drinks, cordials and diet soft drinks.

The outcome variable (child caries experience) was dichotomised for this analysis into those children with and without dental caries for both levels of caries experience – $d_1$mfs (all caries lesions) and $d_4$mfs (cavitated caries lesions). The distribution of the outcome by potential predictors was described using mean (SD), median (interquartile range) and frequency (percent) where appropriate.

Bivariable associations between child oral health behaviours and ethnicity were tested for significance using the chi-square test. Multivariable logistic regression analyses were then performed to estimate the partially adjusted odds ratios (odds of experiencing caries; 95% Confidence Interval (CI)), adjusted for child gender, child age, parent gender and parent age, for the association of child caries experience with each of the potential risk factors. Next, multivariable logistic regression, adjusted for child gender, child age, parent gender and parent age, and with simultaneous adjustment of each of the potential predictors was conducted to explore the independent effect of each potential predictor variable on child caries experience (fully adjusted odds ratios). To account for clustering by family, robust standard errors were calculated for all logistic regression analyses. Data were analysed using STATA v.12.1.

Ethical approval for the study was provided by the University of Melbourne Human Research Ethics Committee and the Department of Education and Early Childhood Development Research Committee. The trial was registered on the Australian New Zealand Clinical Trials Registry (ACTRN12611000532909).

Results

The recruitment resulted in 521 families (697 children) participating in the study. Of those children, 26 (4%) were excluded due to missing questionnaire data, 20 (3%) were excluded due to missing clinical data, and a further 21 (3%) were excluded due to either missing child age or they did not meet the age inclusion criterion of 1-4years. The final analysis sample included 630 children from 481 families.

On average, children in this study were 3 years of age, with 51% males. For 83% of children the respondent was the mother. The mean age of parents was 33 years. The distribution of children by ethnicity was 37% Iraqi, 29% Lebanese and 34% Pakistani. Overall, 34% of children in this sample experienced caries lesions (both non-cavitated and cavitated). Using the traditional WHO measure of caries, which does not capture non-cavitated lesions, a caries prevalence of 15% was observed (Table 1).

Table 2 explores bivariable associations between child oral health behaviours and ethnicity. The association of 'who cleans child's teeth'with ethnic/cultural group was significant ($p<0.001$), showing more Iraqi children (50%) cleaned their teeth without adult assistance compared to Lebanese and Pakistani children (14% and 13%, respectively). Variation in the frequency of consumption of cariogenic food and tap water, and also tooth cleaning frequency were significantly associated with ethnicity ($p<0.001$). Ethnicity was also associated with adding sugar to drinks and food ($p<0.001$), with Pakistani groups more likely to report adding sugar to children's drinks sometimes/always (32%) compared to Iraqi and Lebanese groups (11% and 18% respectively), and adding sugar to children's food sometimes/always at 46% compared to 12% and 21% for Iraqi and Lebanese groups.

Table 3 provides the results of the multivariable logistic regression analysis for both levels of caries (all caries and cavitated caries lesions) experience. For all caries lesions, parent's length of residence in Australia, cariogenic drinks consumption and parent education remained as independent predictors of child caries experience, after adjusting for parent and child demographics, and child oral health behaviours. Children in families that had resided in Australia for 6-10 years were 51% less likely (fully adjusted OR=0.49 (0.25, 0.97)) to experience any caries compared with children in families that had been in Australia for 0-5 years ($p=0.04$). This advantage of increased length of residence extended to 15 years but not beyond. Having parents born in Australia did not show as an advantage in terms of oral health outcomes.

For cavitated lesions, adding sugar to children's drinks was shown to be an added risk factor for progression of lesions to cavitation, where children whose parents reported adding sugar sometimes or always to their child's drink were 3.44 times more likely to experience cavitated lesions (fully adjusted OR=3.44 (1.51, 7.84)). An anomaly was evident with increased tooth brushing frequency associated with increased likelihood of cavitation. Those children that brushed at least twice per day were 2 times more likely to experience cavitated lesions compared with those that brushed never or a few times per week (fully adjusted OR= 2.06 (0.93, 4.54)).

Discussion

This study examined the oral health status of young children from Lebanese, Iraqi and Pakistani families in Melbourne, Australia and identified parent length of residence in Australia, parental education and child consumption of cariogenic drinks as independent predictors of child oral health outcomes. Approximately 1 in 3 children had caries, of which about half had progressed to cavitation. Further exploration is needed to determine if the pattern in overall caries experience reflects the extent to which secondary prevention, treatment and restorative needs are being met. Earlier research suggests that this may be an area of inequality because families from migrant background experience difficulties in accessing dental services and have low health literacy due to migrating to a new country (Riggs *et al.*, 2014a).

Table 1. Child caries experience for any caries lesions ($d_1$mfs) and cavitated caries lesions ($d_4$mfs/WHO level) by socio-economic-demographic factors

Variables and Categories				All caries lesions*				*Cavitated lesions only***				
	N	*%*	*cp%*	*Mean*	*sd*	*Mdn*	*IQR*	*cp%*	*Mean*	*sd*	*Mdn*	*IQR*
Overall	630	100	34	1.90	4.62	0	0-2	14.9	0.91	3.47	0	0-0
Child and parent demographics												
Child age groups (mean 3.07yrs, SD 1.11)												
1-year-old	139	22	6	0.31	1.61	0	0-0	1	0.08	0.86	0	0-0
2-year-old	147	23	18	0.83	2.64	0	0-0	9	0.43	1.94	0	0-0
3-year-old	191	30	46.0	2.11	4.70	0	0-2	17	0.77	3.02	0	0-0
4-year-old	153	24	59	4.12	6.59	1	0-6	31	2.29	5.59	0	0-2
Child gender												
Male	322	51	34	1.95	4.76	0	0-2	13	1.00	3.86	0	0-0
Female	308	49	34	1.85	4.48	0	0-2	17	0.81	3.00	0	0-0
Parent age groups (mean 33.57yrs, SD 6.22)												
18 to 25 years	45	8	36	2.15	5.91	0	0-2	13	1.26	5.24	0	0-0
26 to 35 years	371	63	29	1.42	3.25	0	0-1	13	0.56	2.15	0	0-0
36 to 45 years	153	26	42	2.77	6.60	0	0-2	16	1.42	4.95	0	0-0
46 years and older	23	4	43	2.39	4.78	0	0-3	17	1.34	4.29	0	0-0
Parent gender												
Male	111	18	32	1.90	5.16	0	0-2	13	1.08	4.41	0	0-0
Female	515	82	34	1.91	4.52	0	0-2	16	0.88	3.24	0	0-0
Ethnicity												
Iraqi	234	37	38	2.15	4.15	0	0-2	21	1.06	2.96	0	0-0
Lebanese	183	29	31	1.51	3.95	0	0-1	10	0.58	2.99	0	0-0
Pakistani	213	34	31	1.97	5.56	0	0-1	12	1.02	4.27	0	0-0
Parent's length of stay in Australia (mdn 9yrs, IQR 5-18)												
0-5 years	120	21	32	2.15	5.26	0	0-2	16	1.30	4.37	0	0-0
6-10 years	170	29	31	1.69	3.96	0	0-2	13	0.77	2.94	0	0-0
11-15 years	114	19	33	1.92	3.99	0	0-2	18	0.82	2.44	0	0-0
>15 years	70	12	40	1.64	3.75	0	0-2	22	0.72	2.47	0	0-0
Born in Australia	111	19	35	1.65	4.06	0	0-2	9	0.58	3.23	0	0-0
Parent's preferred language												
English	187	30	32	1.52	3.84	0	0-1	7	0.54	3.07	0	0-0
Non-English	443	70	35	2.06	4.91	0	0-2	18	1.06	3.61	0	0-0
Socio-economic status												
Parental education												
Primary or less	108	18	46	2.51	4.70	0	0-3	23	1.30	3.80	0	0-0
Secondary	216	35	35	1.88	4.13	0	0-2	18	0.85	2.99	0	0-0
Trade	69	11	29	1.85	3.84	0	0-1	10	0.76	2.70	0	0-0
University	224	36	27	1.63	5.24	0	0-1	9	0.80	3.93	0	0-0
Healthcare card status												
Yes	448	72	35	1.95	4.18	0	0-2	9	0.93	3.13	0	0-0
No	173	28	2	1.76	5.64	0	0-1	17	0.84	4.23	0	0-0

*Caries diagnosed at ICDAS decay level 1 or above (non-cavitated and cavitated lesions); **Caries experience diagnosed at ICDAS decay level 4 or above (cavitation into dentine), which corresponds to the WHO decay level; cp%, percentage caries prevalence; Mdn, Median; IQR, Inter-Quartile Range

Consistent with earlier studies, increased parent length of residence in Australia was confirmed to be associated with reduced risk of caries in the first 15 years in Australia (Maserejian *et al.*, 2008). Our earlier research indicated that recent arrival families are not always able to participate in child health promotion activities while still dealing with settlement issues. However, the benefits of increased time in Australia did not extend beyond the 15 years. This may be an artefact of socioeconomic status as parents who had resided in Australia over 15 years, were less likely to have experienced tertiary education and more likely to have a healthcare card. They were also more likely to be Lebanese (86%) but there were no oral health behaviours associated with this group that increased risk. Understanding the relationships between influencing factors such as acculturation, preferred language, health literacy, knowledge and behaviours is complicated by changes in migration policies relating to visa conditions, language services, and settlement support programs, which can differentially affect different cohorts of migrant families.

Table 2. Child oral health behaviours by ethnicity (n=630)

Child oral health behaviours	*Iraqi % (n=234)*	*Lebanese % (n=183)*	*Pakistani % (n=213)*	*p value **
Child age groups				0.339
1-year-old	18.8	22.4	25.3	
2-year-old	25.6	20.2	23.4	
3-year-old	29.4	35.5	26.7	
4-year-old	26.0	21.8	24.4	
Child's teeth cleaned by				<0.001
No one	12.8	10.4	8.25	
Child	50.2	13.7	13.1	
Child with adult	28.7	59.3	51.9	
Adult	8.1	16.4	26.7	
Tooth cleaning frequency				<0.001
<Once/day	61.8	28.2	22.4	
Once/day	20.2	39.2	48.9	
>Once/day	17.8	32.5	28.5	
Cariogenic drinks consumption				0.257
Several times/wk	42.4	50.2	47.8	
Several times/day	57.5	49.7	52.1	
Cariogenic food consumption				<0.001
Several times/wk	23.6	45.6	44.6	
Several times/day	76.3	54.4	55.4	
Tap water consumption				<0.001
Several times/wk	35.7	15.3	7.5	
Several times/day	64.2	84.7	92.4	
Add sugar to child's drink				<0.001
Never/Rarely	88.7	82.5	67.9	
Sometimes/Always	11.3	17.5	32.1	
Add sugar to child's food				<0.001
Never/Rarely	88.3	78.6	54.5	
Sometimes/Always	11.6	21.3	45.5	

*General association based on the Chi-square

Parental education was a predictor of child caries in this study. The impact of education on health outcomes, including oral health, is well documented. Higher levels of education are associated with more positive health behaviours and better health outcomes (Baker *et al.*, 2011). The US Surgeon General's report on oral health reported that among those people over 25 years of age, the prevalence of annual dental visits was 41% among those with less than a high school education compared with 74% for those with at least some college education (US DHHS, 2000). This may reflect increased ability to access and understand relevant information and services. Previous education is a factor influencing capacity to learn English (Beiser, 2009) and language skills are vital for accessing services in a person's new country (Ager and Strang, 2008).

While tooth brushing with fluoride toothpaste is promoted as an important protective factor for ECC, in this study those children brushing their teeth twice per day with fluoride toothpaste were found to be twice as likely to have a cavitation. The majority of families (80%) also reported drinking fluoridated tap water. Hence, this finding may reflect reverse causation, with increased tooth brushing occurring in response to treatment for cavitation, or it could reflect a response bias towards over-reporting of tooth brushing when parents were aware their child had oral health problems.

Children's consumption of cariogenic drinks was also associated with higher levels of caries and the addition of sugar to drinks as an additional risk factor for progression to cavitation. Consumption of drinks containing sugar is a recognised contributor to poor oral health (Levy *et al.*, 2003) as well as to the global burden of other diseases such as: cardiovascular, diabetes, cancers and obesity (Singh *et al.*, 2015). As such, this is an important point of intervention for any child health promotion activity (Sheiham and Watt, 2000). A recent research report argues that free sugars (added sugars and those sugars naturally present in honey, syrups and fruit juices and concentrates) are the single specific cause of dental caries and that other known risk/protective factors, such as, fluoride, saliva flow and oral hygiene behaviours, only alter the rate of the cariogenic properties of free sugars (Sheiham and James, 2015).

A strength of this study is the reporting of both cavitated and non-cavitated lesions, and exploration of both outcomes for association with risk factors. However, the modification to ICDAS of not drying teeth prevented recording of caries code 1 lesions on smooth surfaces, as these lesions can only be viewed when teeth are dried prior to examination. Despite this, the advantage of this method is that it allows screening to be conducted outside of the clinical setting, thereby supporting community-based studies and engagement of larger numbers of migrant families. Inclusion of additional ethnic groups and a comparison Anglo-Australian born population group would be of benefit in future studies to provide further insights into influences on oral health behaviours and outcomes for migrant families.

Conclusion

For the first time, this study provides information about caries prevalence in pre-school children from migrant backgrounds in Australia, adding to the body of evidence already existing by distinguishing between ethnic background and time spent in a new developed country. The findings indicate that oral health promotion interventions need to be culturally competent, family-centred and support those who have recently settled in Australia to access oral health care information and services, and to limit children's sugar consumption.

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Table 3. Odds of experiencing dental caries at the levels of any caries and cavitated caries lesions

Variables and Levels	*Odds of having any caries lesions(d$_1$mfs)*						*Odds of having cavitated caries lesions*					
	Partially adjusted†			Fully adjusted‡			Partially adjusted†			Fully adjusted‡		
	OR	*95%CI*	*P*	*OR*	*95%CI*	*P*	*OR†*	*95%CI*	*P*	*OR*	*95%CI*	*P*
Ethnicity (ref. Iraqi)												
Lebanese	0.73	0.43,1.22	0.23	0.55	0.23, 1.28	0.17	0.34	0.17,0.66	0.00	0.41	0.12,1.11	0.08
Pakistani	0.75	0.46,1.23	0.26	1.09	0.45, 2.64	0.83	0.52	0.27,0.98	0.04	0.71	0.19,2.62	0.60
Parent's length of stay in Australia (ref. 0-5 years												
6-10 years	0.53	0.29,0.96	0.03	0.49	0.25, 0.97	0.04	0.44	0.20,0.94	0.03	0.41	0.17,0.95	0.04
11-15 years	0.63	0.34,1.18	0.15	0.44	0.22, 0.89	0.02	0.69	0.30,1.60	0.39	0.48	0.18,1.27	0.14
>15 years	0.72	0.31,1.67	0.45	0.47	0.19, 1.17	0.10	0.86	0.31,2.34	0.77	0.77	0.26,2.25	0.63
Born in Australia	0.90	0.46,1.72	0.75	0.89	0.37, 2.13	0.80	0.30	0.12,0.76	0.01	0.46	0.31,1.57	0.22
Parent's preferred language (ref. English)												
Non-English	0.91	0.57,1.44	0.70	0.59	0.31, 1.13	0.11	2.68	1.35,5.29	0.00	1.93	0.76,4.90	0.16
Child oral health factors												
Who cleans child's teeth (ref. No one)												
Child	2.27	0.82,6.23	0.11	1.66	0.20,13.52	0.69	1.44	0.46,4.52	0.53	0.20	0.02,1.67	0.14
Child with adult	1.67	0.61,4.51	0.31	1.50	0.18,12.22	0.79	1.06	0.32,3.44	0.91	0.21	0.02,1.83	0.15
Adult	1.36	0.46,3.98	0.57	0.99	0.11, 8.52	0.96	0.94	0.25,3.51	0.92	0.12	0.01,1.31	0.08
Tooth cleaning frequency (ref. Never/ Few times per week)												
Once/day	1.22	0.76,1.96	0.39	1.44	0.82, 2.53	0.20	1.18	0.64,2.17	0.59	2.69	1.23,5.88	0.01
More than once/day	0.73	0.42,1.27	0.27	1.00	0.54, 1.97	0.97	0.90	0.46,1.75	0.76	2.06	0.93,4.54	0.07
Frequency cariogenic drinks (ref. several times/week)												
Several times/day	1.75	1.17,2.62	0.01	1.95	1.16, 3.28	0.01	2.37	1.36,4.14	0.01	2.41	1.18,4.89	0.01
Frequency cariogenic food (ref. several times/week)												
Several times/day	1.19	0.76,1.85	0.43	0.99	0.57, 1.71	0.98	1.27	0.74,2.19	0.38	0.60	0.29,1.23	0.16
Tap water consumption frequency (ref. several times/week)												
Several times/day	0.92	0.58,1.47	0.75	0.90	0.50, 1.61	0.72	0.91	0.50,1.68	0.78	1.10	0.47,2.57	0.82
Add sugar to child's drink (ref. never/rarely)												
Sometimes/Always	0.77	0.46,1.30	0.33	1.04	0.50, 1.61	0.90	1.77	0.98,3.21	0.05	3.44	1.51,7.84	0.01
Add sugar to child's food (ref. never/ rarely)												
Sometimes/Always	0.61	0.37,1.01	0.06	0.58	0.29, 1.16	0.12	0.79	0.44,1.43	0.44	0.64	0.27,1.47	0.29
Socio-economic status												
Parental education (ref. primary or less)												
Secondary	0.68	0.37,1.21	0.19	0.73	0.40, 1.34	0.31	0.77	0.38,1.54	0.46	0.85	0.40,1.78	0.67
Trade	0.55	0.26,1.18	0.12	0.50	0.22, 1.14	0.10	0.45	0.17,1.15	0.09	0.39	0.14,1.02	0.05
University	0.50	0.27,0.91	0.03	0.38	0.15, 0.92	0.03	0.41	0.19,0.88	0.02	0.37	0.09,1.49	0.16
Healthcare card status												
Yes	1.17	0.74,1.86	0.48	0.93	0.50, 1.72	0.83	2.23	1.11,4.49	0.02	2.37	0.94,6.04	0.06

† Partially adjusted odds ratios (OR): adjusted for child age, child gender, parent age and parent gender;
‡ Fully adjusted odds ratios (OR): adjusted for other potential predictors of dental caries presented in the table as well as child age, child gender, parent age and parent gender; P, p-value

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References

Acock, A.C. (2012): Measurement, reliability and validity. In, *A gentle introduction to Stata*. Texas: Stata Press**,** 325-356.

Ager, A. and Strang, A. (2008): Understanding integration: a conceptual framework. *Journal of Refugee Studies* **21**, 166-191.

Australian Bureau of Statistics. (2011): *Australian Standard Classification of Cultural and Ethnic Groups* http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/1249.0main+features22011.

Australian Institute of Health and Welfare, AIHW (2000): *Australia's health 2000: biennial health report of the Australian Institute of Health and Welfare*. Canberra, AIHW.

Baker, D.P., Leon, J., Smith Greenaway, E.G., Collins, J. and Movit, M. (2011): The education effect on population health: a reassessment. *Population and Development Review* **37**, 307-332.

Beiser, M. (2009): Resettling refugees and safeguarding their mental health: lessons learned from the Canadian Refugee Resettlement Project. *Transcultural Psychiatry* **46**, 539.

Gibbs, L., Waters, E., de Silva, A., Riggs, E., Moore, L., Armit, C., Johnson, B., Morris, M., Calache, H., Gussy, M., Young, D., Tadic, M., Christian, B., Gondal, I., Watt, R., Pradel, V., Truong, M. and Gold, L. (2014): An exploratory trial implementing a community based child oral health promotion intervention for Australian families from refugee and migrant backgrounds: A protocol paper. *BMJ open* **4**, e004260.

Gussy, M.G., Waters, E.G., Walsh, O. and Kilpatrick, N.M. (2006): Early childhood caries: Current evidence for aetiology and prevention. *Journal of Paediatrics and Child Health* **42**, 37-43.

Ismail, A.I., Sohn, W., Tellez, M., Amaya, A., Sen, A., Hasson, H. and Pitts, N.B. (2007): The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries. *Community Dentistry and Oral Epidemiology* **35**, 170-178.

Levy, S.M., Warren, J.J., Broffitt, B., Hillis, S.L. and Kanellis, M.J. (2003): Fluoride, beverages and dental caries in the primary dentition. *Caries Research* **37**, 157-165.

Marcenes W., Muirhead VE., Murray S., Redshaw P., Bennett U. and Wright D. (2013): Ethnic disparities in the oral health of three- to four-year-old children in East London. *British Dental Journal* **215**, E4-E4.

Marino, R., Stuart, G.W., Wright, F.A., Minas, I.H. and Klimidis, S. (2001): Acculturation and dental health among Vietnamese living in Melbourne, Australia. *Community Dentistry and Oral Epidemiology* **29**, 107-119.

Maserejian, N.N., Trachtenberg, F., Hayes, C. and Tavares, M. (2008): Oral health disparities in children of immigrants: dental caries experience at enrollment and during follow-up in the New England Children's Amalgam Trial. *Journal of Public Health Dentistry* **68**, 14-21.

McDonald, J.T. and Kennedy, S. (2004): Insights into the 'healthy immigrant effect': health status and health service use of immigrants to Canada. *Social Science & Medicine* **59**, 1613-1627.

Riggs, E., Gemert, C.V., Gussy, M., Waters, E. and Kilpatrick, N. (2012): Reflections on cultural diversity in oral health promotion and prevention. *Global Health Promotion* **19**, 60-63.

Riggs, E., Gibbs, L., Kilpatrick, N., Gussy, M., van Gemert, C., Ali, S. and Waters, E. (2014a): Breaking down the barriers: A qualitative study to understand child oral health in refugee and migrant communities in Australia. *Ethnicity and Health* **20**, 241-257.

Riggs, E., Gussy, M., Gibbs, L., Gemert, C., Waters, E., Priest, N., Watt, R., Renzaho, A. and Kilpatrick, N. (2014b): Assessing the cultural competence of oral health research conducted with migrant children. *Community Dentistry and Oral Epidemiology* **42**, 43-52.

Sheiham, A. and James, W.P. (2015): Diet and Dental Caries: The pivotal role of free sugars reemphasized. *Journal of Dental Research* **94**, 1341-1347.

Sheiham, A. and Watt, R. (2000): The Common Risk Factor Approach: a rational basis for promoting oral health. *Community Dentistry and Oral Epidemiology* **28**, 399-406.

Shiboski, C.H., Gansky, S.A., Ramos-Gomez, F., Ngo, L., Isman, R. and Pollick, H.F. (2003): The association of early childhood caries and race/ethnicity among California preschool children. *Journal of Public Health Dentistry* **63**, 38-46.

Singh, G.M., Micha, R., Khatibzadeh, S., Lim, S., Ezzati, M. and Mozaffarian, D. (2015): Estimated global, regional, and national disease burdens related to sugar-sweetened beverage consumption in 2010. *Circulation* **132**, 639-666.

Thompson, S. and Phillips, D. (2007): Reaching and engaging hard-to-reach populations with a high proportion of nonassociative members. *Qualitative Health Research* **17**, 1292-1303.

U.S. Department of Health and Human Services, US DHHS (2000): *Oral health in America: A report of the Surgeon General.* Rockville, US DHHS.

von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gotzsche, P.C. and Vandenbroucke, J.P. (2007): The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* **370**, 1453-1457.