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Article type : Original Article

Oral health: epidemiology and concordance in Australian children and parents

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Short title: Child-parent oral health concordance

Funding: The Child Health CheckPoint study was supported by the National Health and Medical Research Council (NHMRC) of Australia (project grants 1041352 and 1109355), The Royal Children's Hospital Foundation (2014-241), the Murdoch Children's Research

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/CDOE.12662

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Institute (MCRI), The University of Melbourne, the National Heart Foundation of Australia (100660) and Financial Markets Foundation for Children (2014-055 and 2016-310).

NS was supported by the University of Queensland Graduate School Research Training Program Scholarship and the School of Dentistry research grant for resources supporting analysis of the data. MW was supported by the NHMRC (1160906). The MCRI administered the research grants for the study and provided infrastructural support (IT and biospecimen management) to its staff and the study, but played no role in the conduct or analysis of the trial. Research at the MCRI is supported by the Victorian Government's Operational Infrastructure Support Program.

Funding disclosure statement: The authors have no financial relationships relevant to this article to disclose.

Financial Disclosure: The authors have indicated they have no financial relationships relevant to this article to disclose.

Potential Conflicts of Interest: The authors have indicated they have no potential conflicts of interest to disclose.

Abbreviations: LSAC: The Longitudinal Study of Australian Children

Author contribution: All authors gave their final approval and agree to be accountable for all aspects of the work.

Nicole Stormon: Contributed to design of oral health study, majority of data acquisition and interpretation, performed all statistical analyses, drafted and critically revised the manuscript.

Susan Clifford, Katherine Lange and Melissa Wake: Contributed to the conception, design and data acquisition (including oral health imaging and survey data) of the broader Child Health CheckPoint study. Consulted on design of oral health study and critically revised the manuscript. Melissa Wake is the CheckPoint Principal Investigator.

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Clare Mangoyana: Contributed to photograph scoring and critically revised the manuscript.

Pauline Ford and Ratilal Lalloo: Contributed to design of oral health study and critically revised the manuscript.

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Abstract

Introduction: Studying parent-child pair health provides the opportunity to identify risk factors and opportunities for oral health prevention and intervention focusing on the family context. The aim of this study was to describe the oral health of children aged 11–12 years and their parents in a national sample of parent-child dyads in Australia.

Methods: The Child Health CheckPoint is a study of 11-12 year old children and one parent nested within the Longitudinal Study of Australian Children, a nationally-representative cohort study. In 2015-16, the study collected two-dimensional photographic intra-oral images and were scored using visual assessments of the teeth, oral hygiene and malocclusion.

Results: Of the 1874 CheckPoint families, 1396 biological parent-child pairs had at least one oral health measure recorded. Over two-thirds of children had moderate to severe gingival inflammation (69.7%, 95%CI 64.7 to 74.9). Parents had a lower proportion of poor oral hygiene (2.1%, 95% CI 1.4 to 3.0) than children (13.0%, 95% CI 11.3 to 14.9). High concordance was seen in the Modified Gingival Index correlation coefficient 0.49 (95%CI 0.44 to 0.53).

Conclusion: The high concordance in gingival health between child-parent pairs supports the familial and behavioural links established in previous studies. Children had poorer oral hygiene but fewer visible dental caries lesions than their parents. As dental caries is a chronic and cumulative disease, preventive interventions targeting children's oral hygiene are needed.

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Keywords: Parent-child relationship, oral health, dental caries, epidemiology, Australia, cohort studies

Introduction

Oral diseases affect more than 3.5 billion people globally, and are chronic, largely preventable and distributed inequitably throughout the population.[1] Much of the burden of untreated dental caries is experienced by children, with more than half of all children experiencing this preventable disease in many countries.[2] The National Child Oral Health Survey (NCOHS) in Australia found 27% and 11% of children aged 5 to 14 years had untreated dental caries in their primary and permanent dentitions, respectively.[3] Due to their cost and impact on quality of life, efforts to understand and prevent oral diseases are warranted.[1,4,5]

Oral diseases are influenced by genetic disposition to disease, health behaviours, and other interlinked social determinants of health, creating challenges in understanding and identifying effective prevention strategies.[6,7] Genetic disposition to disease and the patterns of health behaviours amongst families are intra- and inter-personal influences of non-communicable diseases (NCDs) including oral health in children.[8] Life course and intergenerational research has identified that, while genetic risk for NCDs is not easily changed, identifying those at risk of disease presents an opportunity to intervene in the other behavioural, environmental and social determinants of health.[7,9] Identifying high-risk children through parental oral health and risk indicators may present an opportunity to target (and intervene for) high risk children before dental diseases have occurred.[7,9] Policy and intervention on a population level cannot be justified without evidence that clearly identifies the continuity of oral health risk between parents and children, warranting further investigation into this link.[10]

Studying concordance in parent-child pair health provides the opportunity to identify risk factors and may highlight opportunities for prevention.[11] Parent-child concordance has been reported for lung function, hearing and other health aspects[12,13] but has been limited for oral health. Many studies exploring children's oral health have used observational methods to test for associations between parent and child, but fail to account for 'pseudo-unilaterality' or error introduced by the non-independence of the pairs being studied.[11,14] Studying dyadic pairs can account for and highlight the influence of the parent on the child, as well as the child on the parent.[11] Other limitations of previous dyadic oral health studies include the challenges associated with small non-generalisable sample sizes, narrowly focused oral

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health measures and insufficient power to find associations and control for confounding factors.[7]

Studies reporting paired parent/child oral health relationships have primarily focused on oral microbial, behavioural and psychosocial aspects.[15-17] Children and parents show strong association in their salivary Streptococcus composition, oral hygiene behaviours and oral health related quality of life.[15,17,18] Longer parental brushing times are associated with fewer decayed, missing and filled teeth in 5-year-old children in The United States of America.[15] Positive parental oral hygiene behaviours resulted in children having lower odds of having experienced caries lesions in the past.[15] Maternal diet and smoking behaviours have also been reported to predict early childhood caries in children as lower oral health literacy and socio-economic factors indirectly influenced oral health.[19]

However, no studies have been identified which have large sample sizes and have reported at a population level parent-child concordance on clinical tooth, gingival and orthodontic (as opposed to behavioural or microbial) measures.[15,17-19] Paired parent-child studies have been undertaken to investigate oral health previously, but tended to focus on young children or single oral health factors, or use small sample sizes.[7] Few previous studies have included biological fathers in their investigations, thereby failing to explore possible sex-related bias.[15,17-19] Larger population-level studies have reported parental predictors and associations with children's oral health but did not use true matched pair study designs[19] where both the parent and child would have had the same measures recorded.

This study addresses this gap. The Child Health CheckPoint study is a national study exploring NCDs using a paired dyad design. It presents the opportunity to investigate oral health, overcoming some of the limitations of previous intergenerational research.[20] This study aims to describe the oral health of children aged 11–12 years and their parents, along with parent–child concordance.

Methods

Study design and participants

This study used the STrengthening the Reporting of OBservational studies in Epidemiology (**STROBE**) checklist. The Longitudinal Study of Australian Children (LSAC) is a cross-sequential dual cohort study run biennially.[21] A birth cohort of 5,107 0-1-year-old children was recruited in 2004 by random cluster sampling by area to be nationally-representative of

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Australia. The Child Health CheckPoint was a nested cross-sectional module that undertook a variety of health assessments in LSAC's birth cohort in 2015-16, between LSAC waves six and seven.[22] At wave six, 74% (n= 3,764) of the original birth cohort were remaining in the LSAC and 93% (n= 3,513) agreed at this wave to be contacted by the Child Health CheckPoint study. Approximately half (53%, 1874 families) of the Wave 6 sample participated in the Child Health CheckPoint (Figure 1). Health assessments were undertaken at centres in key locations in each Australian state and territory, as well as in mini assessment centres and families homes to increase geographic reach. Participants included in this study were those who had assessment undertaken in the main and mini assessment centres (Figure 1). Most of the parents attending the health assessment were the biological mother (n=1,628; 88%).

Ethical approval for the Child Health CheckPoint module was granted by the Royal Children's Hospital Human Research Ethics Committee (33225), Australian Institute of Family Studies Ethics Committee (14-26) and the University of Queensland Human Research Ethics committee (2019000327/HREC/33225). The attending parent provided written consent for themselves and their child to participate.

Data source

Intra-oral photographs were taken as part of the 'Tooth Booth' station at the CheckPoint main and mini assessment centres in seven large and eight small cities nationally; participants opting for a home visit did not have oral measures available. Two-dimensional photographic images were taken of the participants using a Canon Digital SLR 70D camera. Photographs were taken prior to the station where participants consumed food, to avoid debris contaminating the oral cavity. One intra-oral photograph with a view of the dorsum of the tongue fully extruded was taken (Supplementary Figure 1). With cheek retractors in place, photographs were taken with the teeth in full occlusion and then the teeth slightly apart with all incisal edges visible (Supplementary figure 1). Calibration and sterilisation challenges meant that, photographs of the occlusal surfaces of the teeth were unable to be taken. Logistic and other constraints meant that clinical dental examinations were unable to be undertaken.

Measurements

Oral photographs were scored by two qualified dental professionals who were trained on the measures prior to analysis. Since partial scoring of the images was possible, where an oral

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health measure was unable to be completed the score was marked missing. Two-dimensional open-mouth-position images were assessed using previously validated indices. Measures were selected for their ability to visually assess oral health conditions and not make clinical diagnoses. Supplementary Table 1 provides a summary of the measures and the scoring used to assess photographs. For two edentulous parents, oral hygiene and malocclusion measures were not recorded. In the case of participants missing index teeth, the data were marked as missing and scales calculated as required to handle missing data. Participants with fixed orthodontics appliances visible in photographs (65 children, one parent) were unable to have some tooth, oral hygiene and malocclusion measures scored.

Tooth measures

The numbers of primary and permanent teeth were counted (excluding third molars). Visible dental caries lesions (classified as a visible breakdown of the enamel including discolouration) and restorations were recorded for the anterior and posterior regions. The Modified Developmental Defects of Enamel (M-DDE) index was used to score the type of enamel defect on maxillary and mandibular incisors.[24,25] M-DDE sub-types were not reported because full mouth examination was not undertaken.[26] The prevalence of participants with at least one of each defect type were reported(Supplementary Table 1).[26]

Oral hygiene measures

The Modified Gingival Index (MGI) and the Simplified Oral Hygiene Index (OHI-S) were used to visually assess oral hygiene.[27,28] The MGI assessed gingival health through visual assessment of tissue surrounding three index teeth. The mean MGI score (range 0 to 4) was categorised according to severity: no inflammation; mild; moderate; and severe inflammation (Supplementary table 1). The OHI-S was used to score the severity of plaque and calculus visually present on the three index teeth.[29] An ordinal scale was used to score the severity of plaque and calculus, with scores categorised according to severity as none, mild, moderate, or severe (Supplementary Table 1). The scores for plaque and calculus were summed to give an overall raw OHI-S score (range 0 to 6), which was categorised as good, fair or poor oral hygiene (Supplementary Table 1).[29]

Malocclusion measures

Two-dimensional biting position images were scored for molar occlusion, the overjet position, open bite, posterior crossbite and the aesthetic component of the Index of

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Orthodontic Treatment Need (IOTN) (Supplementary Table 1). The aesthetic IOTN categorised orthodontic treatment needs based on visual assessment only of the teeth positioning.[30] The raw score (range 1 to 10) was then categorised following measure cut-offs: no treatment need (1 to 4), borderline need (5 to 7) and definite need (8 to 10).

Demographic data collected in the Checkpoint study including child and parent age (years), gender, state of residence and socio-economic status were included. Neighbourhood disadvantage was indicated by quintiles of the Socio-Economic Indexes for Area (SEIFA) Disadvantage scores, a postcode-level social and economic population scale derived from census data.[31]

Statistical methods

Analyses used IBM SPSS version 25. Descriptive analysis of the dental measures was undertaken stratified by child and parent characteristics. Nominal variables (including the categorised scale variables) were summarised by number, percentage and 95% confidence interval (CI) of the proportion. Continuous variables were summarised using means, standard deviations and 95% CI. Non-overlapping CIs were compared to assess differences between point estimates.

Demographic and descriptive analyses were undertaken using survey weights calculated considering the selection probability of each child; they were adjusted for non-response and loss to follow-up, and benchmarked to population numbers in majority (post-stratification) categories of the population of children born in 2004. Further information on the calculation of survey weights is available from a CheckPoint technical report.[32]

Concordance between biological parents and children was assessed by: (1) Cohen's kappa for nominal variables; (2) Two-way mixed-effects Intraclass Correlation Coefficients (ICC) were calculated for scale/ordinal variables. Three different correlation coefficients (CC) were selected as outcome measures had differing data types. CCs were selected for analysis to indicate the strength of the relationship between variables, with 1 indicating a strong positive and -1 a strong negative relationship.[33] All measures of correlation were reported with 95% CIs. Correlation analysis was repeated using weighted survey analysis and compared with unweighted analysis using 95% CIs. Because the weighted analyses were similar, the unweighted analysis was reported for correlations. To assess for socio-economic and sex-related influences, concordance analysis was undertaken stratifying by SEIFA quintile and by

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mother-daughter, mother-son, father-daughter and father-son pairs. Non-overlapping 95% CIs between groups were considered different.

Reliability

Measures selected for the photograph scoring were piloted on a small sample of adult volunteers (n= 5) who were not study participants. Clinical examinations were undertaken by a trained dental professional and a series of intra-oral photographs which were scored later. The scoring on the photographs had perfect matches on most measures, although visible caries lesions and restorations were under-identified in the posterior region (80% and 60% matches in assessments, respectively). All malocclusion measures were categorised identically in the clinical examination and intra-oral photograph assessments.

Intra-rater reliability was determined for all measures by each coder re-scoring photographs for 40 randomly selected participants. Inter-rater reliability was determined by the two coders independently scoring photographs for a further 40 randomly selected participants. For nominal measures, Cohen's Kappa was calculated. For scale/ordinal measures two-way mixed-effects ICC were calculated.

Results

Figure 1 shows the participant flow from LSAC's first wave. Of the 1874 families that took part in CheckPoint[20], 1417 parents and 1419 children had at least one oral health measure including 1396 biological parent-child pairs. Study children were on average 11.9 (SD 0.4) years and parents 44.4 (SD 5.1) years (Table 1). There were equal numbers of boys and girls (50.1%) and less from the lowest disadvantage quintile areas (7.8%). The majority of participating parents were female (86.7%) and a biological parent (99.4%). There was a higher proportion of participants from the least disadvantaged quintile when compared to data weighted to the Australian child population.

Summary statistics for child and parent tooth measures are reported in Table 2. The number of teeth, dental caries lesions and restorations were higher in parents than children. On average children had 24.8 (95% CI 24.7 to 24.9) teeth and parents 26.2 (95% CI 26.0 to 26.3). More parents than children had hypoplastic enamel lesions. Rates of visible caries lesions and restorations were lower in children than parents. Children and parents had similar distributions on malocclusion measures. The majority had a class I molar occlusion, positive

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overjet, overbite <100% and no posterior crossbite. The IOTN aesthetic assessment found a higher proportion of children had a definitive treatment need than parents.

Children generally had poorer oral hygiene than parents (Figure 2). Rates of moderate to severe gingival inflammation were higher in children than parents (Figure 2a). Poor OHI-S scores were also more common in children than parents (Figure 2d).

Table 3 reports parent and child oral heath correlations. Tooth measures overall had weak correlations. The presence of any M-DDE lesions had modest concordance, although this was weak for hypoplastic enamel lesions. The oral hygiene and malocclusion measures had overall higher concordance. The largest oral hygiene correlation for parents and children was observed for the MGI. The OHI-S and IOTN also had modest concordance.

There were no differences in point estimates for parent-child concordance stratified by SEIFA quintiles (data not reported). Supplementary Figure 2 presents the correlations for oral health measures by gender pair combinations. Father-daughter pairs had a lower negative overbite correlation (CC -0.08, 95% CI -0.14 to -0.02) than parent-child, mother-daughter and mother-son pairs. No other differences between mother, father, daughter and son pairs were observed.

Reliability analysis

Intra-rater reliability Kappa scores were substantial to almost perfect, ranging between 0.61 and 1.00 (Supplementary Table 2). For scale and ordinal measures, the ICC for intra-rater reliability ranged between 0.53 and 0.99 (Supplementary Table 3). Agreement between scorer one and two for nominal measures ranged between 0.65 and 1.00, and for scale/ordinal variables between 0.63 and 0.99 (Supplementary Tables 2 and 3).

Discussion

This study described the oral health and concordance of Australian children (11-12 years of age) and parents in a national sample, using objectively-assessed dental photographs. Previous studies have found scoring dental photographs to be comparable to clinical examination for many of the indices used in this study.[24,25] While children had fewer visible

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dental caries lesions and restorations than their parents, their oral hygiene was poorer. Substantial parent-child concordance was observed for gingival health. There were no evidence of socio-economic or sex-related bias in concordance among oral health measures. These findings can inform agenda for policy reform and present opportunities for interventions to improve child oral health on a population level by identifying patterns of disease and inter-generation oral health relationships.

The strengths of this study include the recruitment of a large national cohort of children and their parents, who were broadly representative of the Australian population.[34] We used validated, reliable measures to assess oral health photographs. Calibrated dental professionals used a specified scoring protocol that produced moderate to near-perfect inter- and intra-rater reliability.

Limitations included under-representation of disadvantaged families due to unequal attrition in the broader LSAC and CheckPoint study. Application of survey weights does not suggest that our concordance findings would have differed greatly if more representative. Low concordance in parent-child tooth measures may also have been influenced by mediating factors such as access to prevention and dental care. As the oral photographs did not include occlusal images and could not be validated with clinical dental examinations or intra-oral radiographs to assess interproximal areas, our data suggests the prevalence of caries and restorations in posterior regions may be underestimated. Nonetheless the measures were selected not for their diagnostic ability but to identify high risk participants, particularly for caries. Previous studies have found dental photographs to be a valid tool for caries risk identification.[23] Those identified with caries and restorations in the anterior region indicate a high risk for oral disease and previous studies have found these participants to have high decayed, missing and filled teeth scores. Future studies should use clinical examinations to validate the discriminatory ability of photographs to identify oral health conditions and risk factors considering the ability for this method to easily reach large and representative samples of the population.

Children had poorer oral hygiene and less dental caries than their parents, highlighting a major preventive opportunity. Cumulative exposure to fermentable carbohydrates and plaque biofilm over time is a causative factor for dental caries. The poor oral hygiene observed in the children combined with the high prevalence of visible caries in parent could suggest poor hygiene is a risk for future caries experience.[35] The delayed effect of poor plaque control and

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diet may have contributed to the low concordance observed. Three longitudinal cohort studies in England, New Zealand and Brazil have examined life course perspectives on oral health [36], identifying distinct trajectories whereby plaque and caries predicted levels at later ages in adulthood.[37] This study and other international cohort studies support the need for public health policy and multi-strategy interventions in early life to prevent caries development.[36] Future studies should consider utilising dyad analysis in life course investigations of dental caries, following up intergenerational pairs over multiple stages of life that includes childhood. This type of study design allows for the investigation of contextual and environmental factors such as dental system characteristics in the population. The LSAC presents an opportunity to do so, and oral photography could be a cost-efficient way of following oral health over time into adulthood.

In this study, gingivitis showed by far the strongest parent-child concordance, at 0.49. Interestingly, the other oral hygiene measures plaque and calculus had much lower (though still important at the population level) concordance. This may reflect differing gingival responses to bacterial load in children than adults[18], or time and dental care factors. Studies of twins have provided mixed evidence to support a genetic link to the susceptibility and host response in gingivitis and periodontal diseases.[38] These studies also acknowledge the complexity of periodontal diseases and the role of environmental factors such as oral hygiene and oral microbes.[38] The association between parent-child oral hygiene behaviours and oral microbes in other dyadic studies could also explain the concordance observed in this study.[15,16,39] Screening for gingival inflammation could provide a quick and easy risk assessment for children's oral health, which can be undertaken by both dental and general health professionals and allow for timely preventive intervention in children.[40]

Similarities can be drawn between the findings in this study and other Australian population oral health studies. The NCOHS 2012-2014 found 10.9% and 15.6% of 6-to-14 year olds with dental caries lesions and restorations respectively.[3] Our findings showed 5.5% and 11.0% with caries lesions and restorations respectively. Our study sample had similar proportions of severe plaque and gingival index scores to population norms, with more than a third of 11-12-year-old children in both studies with poor oral hygiene.[3] Similar to our findings, higher proportions of caries and restorations and healthier gingival scores were observed in adults in the National Survey of Adult Oral Health 2017-2018 than in the national child oral health data.[41] Differences between proportions in this study and other

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Australian population studies could be attributed to cohort effects, differing age ranges reported, or differences between the clinical and non-clinical measures used.

Enamel defect and malocclusion measures were also recorded in this study. On average, children had higher proportions of teeth with demarcated or diffuse enamel lesions than parents, but lower proportions of teeth with enamel hypoplasia. Similarly, modest concordance between parent-child demarcated and diffuse lesions was observed, but not for hypoplastic lesions, which had no relationship. The proportions of severe enamel defects, in this study were lower than other Australian population studies.[3] Due to the environmental aetiology of enamel defects differences between children and parents, as well as to other population studies, may be due to cohort effects and the regulation of fluoride use in Australia.[42] Future studies are warranted to investigate whether enamel defects differ across differing residential locations. Malocclusion occurrence between children and parents differed and had low concordance. This may be attributed to cohort effects such as differing diets, access to dental care factors and orthodontic intervention. Previous studies have found more severe malocclusions and poorer dental aesthetics to be predict receiving orthodontic intervention by mid-adulthood.[43] Additionally, orthodontic treatment commencement often occurs after early adolescence due to the risk of adverse outcomes and may explain why children had a higher proportion of treatment need.

Conclusion

This study explored parent-child concordance for oral health measures at a population level in Australia. Similar patterns of oral disease were found between this study and other Australian population oral health studies. Children had poorer oral hygiene than their parents. Since dental caries is a chronic and cumulative non-communicable disease, the poor oral hygiene observed in the children suggests a risk for future caries experience due to the ongoing accumulation of plaque which is a key biological cause of dental caries. Poor oral hygiene in children highlights the need for effective preventive interventions in early childhood, prior to oral disease occurring.

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Acknowledgements

The Child Health CheckPoint study was supported by the National Health and Medical Research Council (NHMRC) of Australia (project grants 1041352 and 1109355), The Royal Children's Hospital Foundation (2014-241), the Murdoch Children's Research Institute (MCRI), The University of Melbourne, the National Heart Foundation of Australia (100660) and Financial Markets Foundation for Children (2014-055 and 2016-310).

NS was supported by the University of Queensland Graduate School Research Training Program Scholarship and the School of Dentistry research grant for resources supporting analysis of the data. MW was supported by the NHMRC (1160906). The MCRI administered the research grants for the study and provided infrastructural support (IT and biospecimen management) to its staff and the study, but played no role in the conduct or analysis of the trial. Research at the MCRI is supported by the Victorian Government's Operational Infrastructure Support Program.

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Table 1. Unweighted and weighted sample characteristics for child (n= 1419) and parent (n= 1417) participants with any oral health measures.

		Unweighted				Weighted		
		n	%	(95% CI)		%	(95% CI)	
Child (n= 1419)								
Age, years (mean, SD)				11.9 (0.4)			11.9 (0.4)	
Gender	Female	711	50.1	(47.5 – 52.7)		49.9	(47.1 – 52.5)	
SEIFA	1 (most disadvantaged)	111	7.8	(6.5 – 9.3)	*	12.4	(10.7 – 14.2)	*
Disadvantage	2	202	14.2	(12.5 – 16.1)	*	17.2	(15.3 – 19.3)	*
Quintiles	3	243	17.1	(15.2 – 19.2)		19.4	(17.4 – 21.6)	
	4	327	23.0	(20.9 – 25.3)		22.6	(20.4 – 24.9)	
	5 (least disadvantaged)	536	37.8	(35.3 – 40.3)	*	28.4	(26.0 – 30.8)	*
State of	NSW	420	29.6	(27.3 – 32.0)		31.2	(28.8 – 33.7)	
Residence	VIC	294	20.7	(18.7 – 22.9)		24.1	(21.9 – 26.4)	
	QLD	288	20.3	(18.3 – 22.4)		20.0	(17.9 – 22.2)	
	SA	113	8.0	(6.6 – 9.5)		7.1	(5.8 – 8.5)	
	WA	187	13.2	(11.5 – 15.0)		12.1	(10.5 – 14.0)	
	TAS	46	3.2	(2.4 – 4.3)		2.2	(1.5 – 3.1)	
	NT	18	1.3	(0.8 – 2.0)		0.8	(0.4 – 1.4)	
	ACT	53	3.7	(2.8 – 4.8)		2.5	(1.7 – 3.4)	
Parent (n= 1417)								
Age, years (mean, SD)				44.4 (5.1)			43.7 (5.5)	
Gender	Female	1229	86.7	(84.9 – 88.4)		87.0	(85.2 – 88.7)	
Relationship to study child	Biological parent	1405	99.4	(98.8 – 99.7)		99.2	(98.6 – 99.6)	

CI= Confidence interval.

* Non-overlapping confidence intervals were considered different.

Table 2. Weighted tooth and malocclusion characteristics in oral photographic assessment of Australian children (n= 1419) and parents (n= 1417).

	Child			Parent		
	Mean	SD	95% CI	Mean	SD	95% CI
Number of primary teeth visible	2.8	3.7	(2.6 - 3.0)	0.0	0.2	(0.0 - 0.0)
Number of permanent teeth visible	22.0	4.6	(21.7 - 22.2)	25.9	3.1	(25.7 - 26.0)

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Total number of teeth visible[#]		24.7	2.0	(24.6 - 24.9)	25.9	3.1	(25.7 - 26.1)
		N	%	95% CI	N	%	95% CI
M-DDE	Demarcated lesion[#]	367	31.6	(29.0 - 34.3)	320	26.2	(23.8 - 28.8)
	Diffuse lesion[#]	663	57.2	(54.2 - 59.9)	397	32.5	(30.0 - 35.2)
	Hypoplasia lesion[#]	18	1.5	(1.0 - 2.4)	42	3.4	(2.5 - 4.6)
	Any lesion[#]	842	72.5	(69.9 - 75.0)	620	50.8	(48.1 - 53.7)
Visible caries: Any		72	5.5	(4.3 - 6.8)	383	28.6	(26.2 - 31.0)
Visible caries: Mx anteriors		24	1.8	(1.2 - 2.7)	154	11.6	(10.0 - 13.4)
Visible caries: Mnd anteriors		7	0.5	(0.2 - 1.0)	51	3.8	(2.9 - 5.0)
Visible caries: Mx posteriors		15	1.2	(0.7 - 1.9)	87	6.6	(5.4 - 8.0)
Visible caries: Mnd posteriors		48	3.7	(2.8 - 4.8)	253	18.9	(16.9 - 21.1)
Visible restorations: Any		145	11.0	(9.4 - 12.8)	999	74.6	(72.2 - 76.9)
Visible restorations: Anteriors		44	3.4	(2.5 - 4.4)	343	25.7	(23.4 - 28.1)
Visible restorations: Posteriors		105	8.1	(6.7 - 9.7)	948	71.3	(68.8 - 73.7)
Molar occlusion	Class I	844	82.0	(79.6 - 84.3)	850	76.6	(74.0 - 79.0)
	Class II	60	5.8	(4.5 - 7.4)	133	12.0	(10.2 - 14.0)
	Class III	125	12.1	(10.3 - 14.2)	127	11.4	(9.7 - 13.4)
Overjet	Positive	1165	87.9	(86.0 - 89.5)	1083	81.9	(79.8 - 83.9)
	Edge to edge	117	8.8	(7.4 - 10.4)	212	16.0	(14.1 - 18.1)
	Reverse	43	3.2	(2.4 - 4.3)	27	2.0	(1.4 - 2.9)
Overbite	Overbite <100%	1126	86.6	(84.6 - 88.3)	1165	90.3	(88.6 - 91.8)
	Overbite ≥100%	120	9.2	(7.7 - 10.9)	59	4.6	(3.5 - 5.8)
	Openbite	55	4.2	(3.2 - 5.4)	66	5.1	(4.0 - 6.4)
Posterior crossbite	No	1139	88.0	(86.2 - 89.7)	1065	81.3	(79.2 - 83.4)
	Yes to mild	101	7.8	(6.4 - 9.4)	202	15.5	(13.6 - 17.5)
	Yes to no functional occlusal contact	14	1.1	(0.6 - 1.8)	18	1.4	(0.8 - 2.1)
	Posterior openbite	40	3.1	(2.3 - 4.1)	24	1.9	(1.2 - 2.7)
IOTN Aesthetic assessment	No treatment need	884	69.4	(66.9 - 71.9)	1132	86.5	(84.6 - 88.3)
	Borderline need	264	20.7	(18.6 - 23.0)	149	11.4	(9.8 - 13.2)
	Definite need	125	9.8	(8.3 - 11.5)	27	2.0	(1.4 - 2.9)

╪All values are weighted.

[#]Participants could have more than one type of lesion, therefore column percentages do not total 100%.

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Abbreviations: CI= Confidence Interval; IOTN= Index of Orthodontic Treatment Needs; M-DDE= Modified Developmental Defects of Enamel; Mnd= Mandibular; Mx= Maxillary.

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Table 3. Parent-child concordance for oral health measures.

		Coefficient type	N	CC	95% CI
Tooth measures	Number of primary teeth visible	ICC	1309	0.07	(-0.05 to 0.06)
	Number of permanent teeth visible	ICC	1318	0.02	(-0.04 to 0.07)
	Total number of teeth counted	ICC	1307	0.04	(-0.01 to 0.10)
	Any visible caries	Cohen's kappa	1338	0.02	(-0.02 to 0.06)
	Maxillary anteriors	Cohen's kappa	1321	0.03	(-0.01 to 0.08)
	Mandibular anteriors	Cohen's kappa	1332	-0.01	(-0.01 to 0.00)
	Maxillary posteriors	Cohen's kappa	1275	0.01	(-0.02 to 0.06)
	Mandibular posteriors	Cohen's kappa	1313	0.04	(0.00 to 0.09)
	Any visible restorations	Cohen's kappa	1339	0.03	(0.01 to 0.05)
	Anteriors	Cohen's kappa	1336	0.01	(-0.02 to 0.05)
	Posteriors	Cohen's kappa	1313	0.04	(0.02 to 0.05)
	M-DDE demarcated lesions	Cohen's kappa	1117	0.15	(0.09 to 0.20)
	M-DDE diffuse lesions	Cohen's kappa	1117	0.12	(0.08 to 0.18)
	M-DDE hypoplasia lesions	Cohen's kappa	1117	0.05	(-0.02 to 0.01)
	M-DDE any lesions	Cohen's kappa	1117	0.11	(0.05 to 0.17)
Oral hygiene measures	Modified Gingival Index	ICC	1359	0.49	(0.44 to 0.53)
	Plaque Index	ICC	1324	0.12	(0.07 to 0.17)
	Calculus Index	ICC	1338	0.10	(0.05 to 0.16)
	Simplified Oral Hygiene Index	ICC	1319	0.12	(0.07 to 0.18)
Malocclusion measures	Molar occlusion	Cohen's kappa	927	0.08	(0.02 to 0.14)
	Overjet	Cohen's kappa	1342	0.10	(0.05 to 0.15)
	Overbite	Cohen's kappa	1276	0.07	(0.01 to 0.12)
	Posterior crossbite	Cohen's kappa	1302	0.06	(0.01 to 0.11)
	IOTN Aesthetic assessment	ICC	1289	0.10	(0.04 to 0.15)

Abbreviations: IOTN= Index of Orthodontic Treatment Needs; ICC= Intraclass Correlation Coefficients; M-DDE= Modified Developmental Defects of Enamel; CI= Confidence Interval.

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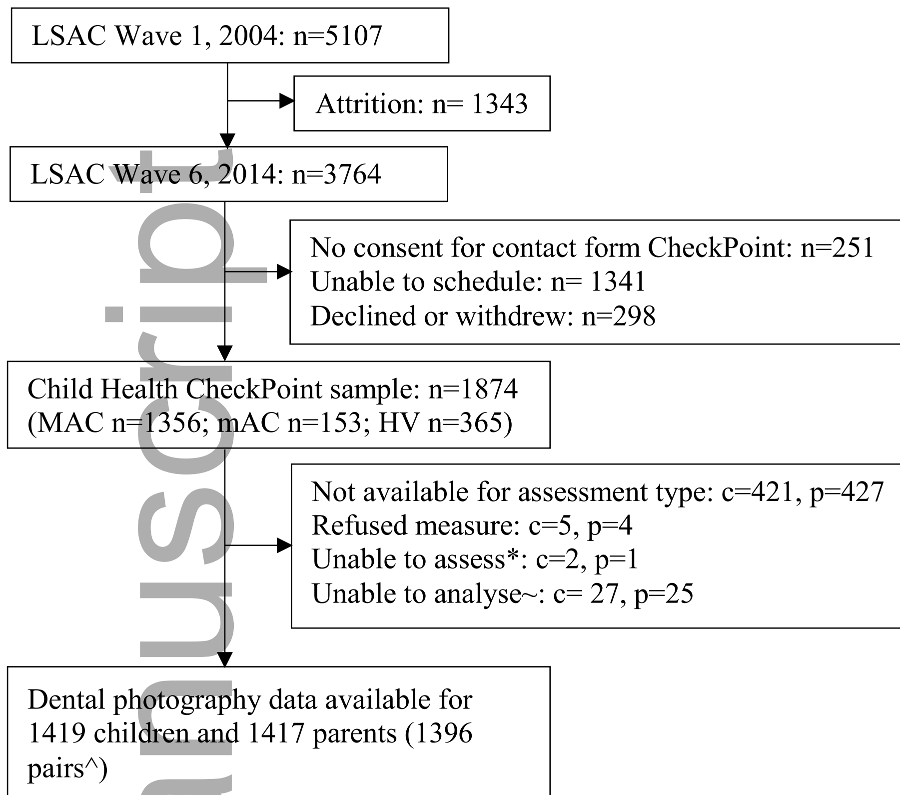
Figure 1. Participant flow through Child Health CheckPoint.



*Unable to collect photographs due to equipment failure or time constraints.
~Photographs unable to be scored due to quality criteria.
^Data from 12 non-biological child-parent pairs from concordance analyses.

c, child; HV, home visit assessment; LSAC, Longitudinal Study of Australian Children; MAC, main assessment centre; mAC, mini assessment centre; n, number of families; p, parent.

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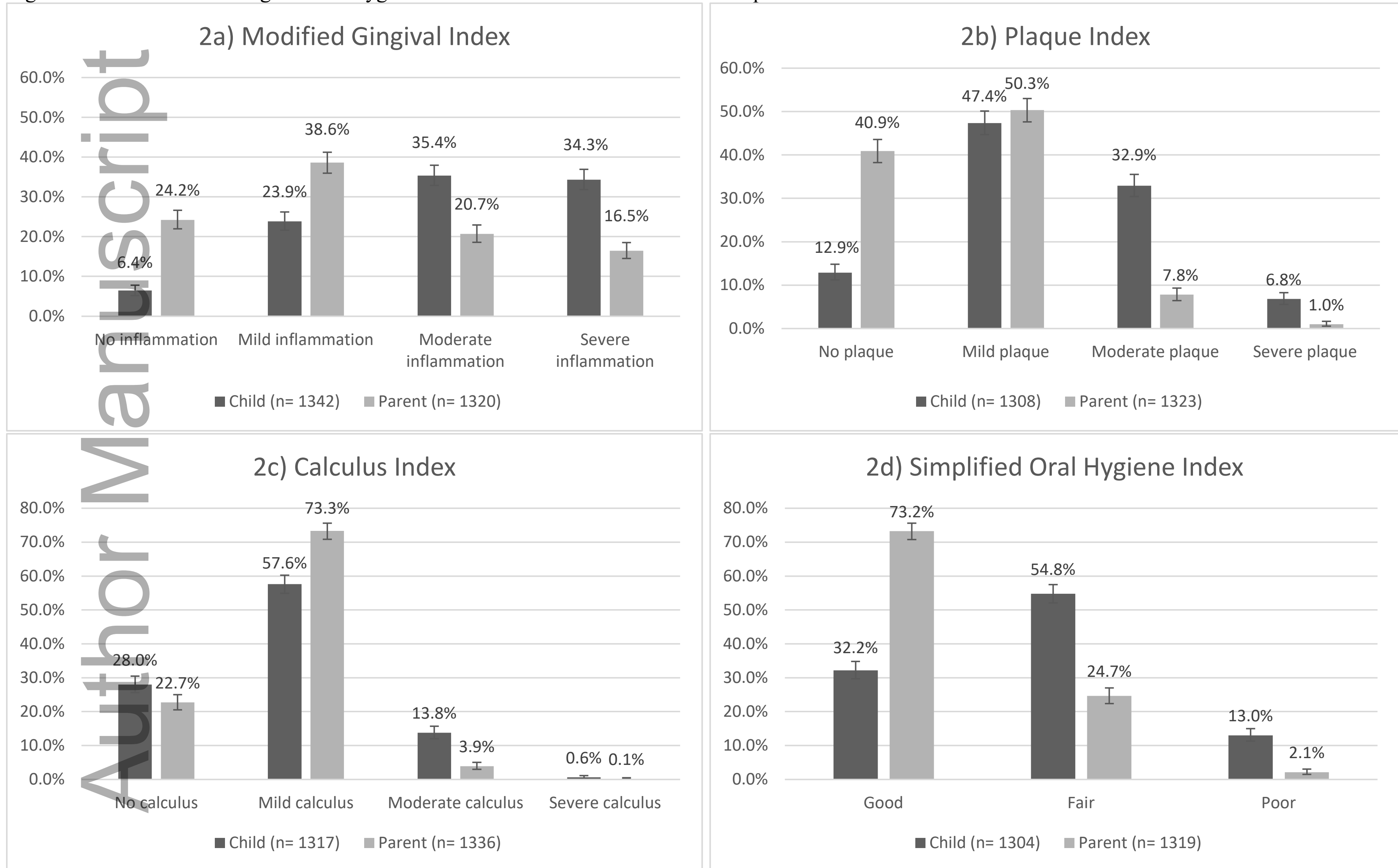
Figure 2. Distribution of weighted oral hygiene measures in Australian children and parents.



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