Title: Effect of family characteristics on periodontal diseases in children and adolescents– a systematic review

Running title: Family-related predictors of periodontal diseases

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ABSTRACT

Aim: To synthesise the literature on the influence of family/parents characteristics on periodontal diseases in children and adolescents. **Methods:** An electronic search for relevant literature published between 2007 and 2017 was undertaken in PubMed, Embase, Cinahl and Cochrane databases; the search was updated in April 2018. Two reviewers independently reviewed the abstracts of these, of which 43 articles were reviewed in full. **Results:** Of the 746 retrieved titles, 649 remained after removing duplicates. Thirty articles met the inclusion criteria, and 13 were excluded. Also, two were included from the updated search. Data from the reviewed articles indicate that all three indicators of parent's socioeconomic status (income, education, and occupation) are significantly associated with periodontal diseases in children. Better periodontal status was observed in children of parents with higher SES than those whose parents were of lower SES. Although the association between parent's smoking practices, level of periodontal diseases, and children's periodontal status was explored only in few studies, findings indicate that children exposed to passive smoking and having parents with periodontal diseases are more likely to present with periodontal diseases as well. **Conclusions:** Most of the studies considered socioeconomic factors and had not attempted to explore the impact of parental psychosocial variables on periodontal diseases in children. The literature indicates that these variables significantly influence health practices, including oral hygiene practices, which could ultimately affect periodontal health. More studies are required to explore the association of these variables with periodontal outcomes in children.

INTRODUCTION

Although the information on the extent of periodontal diseases in younger age groups is lacking due to limited studies and non-uniform criteria for assessment ¹, it is believed that gingivitis of different degrees of severity is present among most children and adolescents worldwide ^{2,3}. Chronic gingivitis is the most common form of manifestation of periodontal diseases in children ⁴. As periodontal diseases also comprise gingival diseases, the term 'periodontal diseases' was preferred and used to represent gingival or periodontal diseases in this review.

Oral diseases including periodontal diseases in children could be influenced by several characteristics, which could be broadly categorised as child-level, family-level and community-level ⁵. In particular, family-level characteristics affect both the child level factors, such as self-care practices and service utilisation, and also periodontal disease status in children ^{6,7}. This is because; parents and children share similar cariogenic and periodontal pathogenic microbiota which could be attributed to the genetic and also the environmental factors that are shared between children and parents ^{8,9}. Therefore, many oral health promotion interventions are directed towards parents to improve the oral health-related behaviour and also oral health status of children ¹⁰.

Poverty has long been associated with poor dental status. Poor socioeconomic status in childhood has a deleterious effect on the oral status, and its effect is long lasting with adverse impacts extending into adulthood ¹¹. This is evident from longitudinal studies which observed that parental occupation or income or education at childhood is associated with periodontal diseases in adulthood ^{12,13}. In addition to the contextual socioeconomic factors, characteristics like parental rearing practices and family environment could also influence the severity of gingival diseases ^{6,7}.

This systematic review aims to synthesize the literature on the influence of various family/parents characteristics on periodontal diseases in children and adolescents. In addition, we intend to appraise the strength and weaknesses of the current literature. This information will be relevant for policy makers and program planners while planning health promotion or prevention programs for preventing periodontal diseases in children.

METHODS

The protocol of this review has been registered with the International prospective register of systematic reviews (CRD42017058822). This report conforms to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines ¹⁴. The P(I)ECO for this review was, children and adolescents (Population), family characteristics (Exposure) and periodontal diseases (Outcome).

Eligibility and search criteria

All studies that evaluated the influence of any family-related characteristic on periodontal diseases were considered for inclusion. Studies that assessed the impact of ethnicity, parent's perceptions of oral health, and health education interventions to parents were considered for exclusion. The search was limited to the articles published between 1st January 2007 and 31st January 2017. Studies that had microbiological outcomes rather than clinical periodontal outcomes were excluded. Both cross-sectional and longitudinal studies were considered for inclusion. Although the search was limited to children and adolescents, studies conducted on populations of all ages were considered for inclusion. This was done to facilitate the inclusion of longitudinal studies which evaluated the effect of childhood parental characteristics on periodontal diseases in adulthood. An electronic search for relevant literature was undertaken in PubMed, Embase, Cinahl and Cochrane databases in February 2017. Search

was updated in April 2018 with the date range customised from February 2017 to April 2018. The search strategy used in PubMed is presented in **Table 1**.

All titles and abstracts were independently reviewed by two researchers (SK and JT), abstracts containing information about a parent-related characteristic and a periodontal outcome were considered for full-text review. No discrepancy was observed between the two reviewers. Pre-piloted forms were used for data extraction by one researcher which was checked for accuracy by another reviewer. Data on the characteristics of the study population, periodontal outcome, the method used to assess the periodontal diseases, parental characteristics included in the study and their effect on periodontal outcomes were extracted.

Quality assessment criteria of included articles

All included studies were assessed for quality using the Effective Public Health Practice Project quality assessment tool for quantitative studies (EPHPP 2010). EPHPP has been developed to assess the quality of a variety of study designs and is found to have good validity¹⁵. This involves rating a study as strong, moderate or weak in six methodological components: selection bias, study design, confounders, blinding, data collection methods and withdrawals and drop-outs. The component 'withdrawals and drop-outs' were excluded from the quality assessment for all the cross-sectional studies. The overall quality of a study was rated as strong if it did not have weak ratings in any of the five components while moderate and weak ratings were given when a study had at least one weak and two or more weak ratings respectively.

RESULTS

The search retrieved 419 titles in PubMed, 18 in Cinahl, 283 in Embase and 26 in Cochrane. After removing duplicates, 649 remained. Abstracts were reviewed for their possible inclusion in the full-text review. Forty-three articles were reviewed in full, and thirteen were excluded for several reasons: Three studies were excluded as no parent-related variables were recorded¹⁶⁻¹⁸. In seven studies, parent-related characteristics were recorded, and periodontal

diseases were the outcomes, but their association was not explored¹⁹⁻²⁵. Two were excluded as the data from the same study population was presented in separate articles^{26,27}. One was excluded as it used the type of school (viz. private, public) as an indicator of a family's socioeconomic status²⁸. Updated search retrieved 64 articles, of which, four were considered relevant for inclusion. However, the 'early view' versions of two among these four were already retrieved from the previous search^{29,30}. The flow of information to determine the final papers for review is presented in **Figure 1**.

Background characteristics of the included studies

Of the 32 articles included in the review, none could be rated as 'strong' quality while only seven were of moderate quality^{6,9,12,31-34}. As there was only one longitudinal study³³, it was also assessed for the quality criteria "Withdrawals and drop-outs" which was rated 'Strong' (not presented in tables). A majority (eight articles) of the studies were from Brazil, and three each were conducted on Iranian³⁵⁻³⁷ and Indian^{6,38,39} population. There were two articles each from Sri Lanka^{31,40}, Turkey^{41,42}, Sudan^{43,44} and Greece^{34,45}. There was one study each from Argentina¹⁰, Belgium⁴⁶, Estonia⁴⁷, Japan⁴⁸, New Zealand⁹, Romania²⁹, South Korea¹², Sweden⁴⁹, United States of America¹¹ and Yemen⁵⁰. Gingivitis was the outcome measure in a majority of the included studies. Gingival bleeding on probing was the measure used to evaluate gingivitis in most of the studies followed by the gingival index of Loe and Silness (Table 2).

Effect of family socioeconomic status (SES) on periodontal disease

Family income

Association of family income and gingival disease was analysed in eleven studies, of which six^{11,30,33,36,51,52} observed lower levels of gingival disease in children from high-income families than those who belonged to lower-income families while five studies found no association^{6,32,40,53,54}. Of these, four studies found an alternative measure of SES (for example,

education of the parent or employment of the parent) to have an impact on gingival bleeding in children.^{6,32,40,53,54}

Education status of the parents

Twenty and fourteen studies assessed the impact of mother's and father's education respectively on the gingival status of children. Of which, fifteen and eight studies found better gingival status in children of mothers' and fathers' with higher education respectively than children with less educated parents. Education status of either of the parent was used as a predictor of gingival disease in six studies^{10,37,44,45,49,53}. Only half of these studies observed a positive influence of higher level of parent's education on the gingival status of children^{10,44,53} while the remaining articles found no association.

Occupation of the parents

A country-wide study on representative adults of South Korea found that those whose mothers and fathers were in white-collar occupations were at less risk for periodontitis¹². Two^{36,40} and one³¹ studies assessed the association of mother's and father's occupation respectively with the gingival disease. It was found that children of parents who were unemployed or in manual occupations had poorer gingival status than those children whose parents' were employed or in professional occupations. However, there was one study from Turkey which found no association between maternal employment status and periodontal status in 6 to 17-year-old children⁴² while a study from India observed children of fathers in professional/semi-professional occupations had better gingival status than those children whose fathers were in semi-skilled or skilled occupations⁶.

Proxy measures of SES

A wide range of proxy measures of SES were used by studies. One study on a small sample of 11-12-year-old school children in Brazil found that children living in houses without

flush toilet were more likely to present with gingivitis than those who lived in houses that had a flush toilet⁵⁴. Home ownership was used as a proxy indicator of family income in one study which found it not to affect the gingival status of children⁵². All the four studies that assessed the association of household crowding or number of individuals in the house found poor gingival status in children living in crowded households^{29,30,40,52}. A composite SES scale comprising parents' education, occupation and income was used by a study on a large sample of Indian children, higher SES scale was observed to be inversely associated with gingival bleeding in multivariate analysis⁶.

Parent's knowledge, practices, or clinical status

Data from four studies indicated that poor gingival or periodontal status of the mother or father is associated with poor gingival or periodontal status in children^{9,36,47,48}. Two studies found that exposure to passive tobacco smoke at home was associated with greater risk of gingivitis⁴⁶ and lower levels of clinical attachment⁴¹. Other parent-related variables considered by the studies included, caregiver's sense of coherence^{54,55}, parent's oral health, knowledge, attitudes, practices^{10,42}, parental involvement with brushing^{44,46} but none of these were found to have any effect on the gingival status in children. One study on Indian child population evaluated the effect of parenting practices and found that those parents who are coercive had children with greater levels of gingival bleeding⁶. Gingival bleeding prevalence of orphan children was compared with non- orphans in a study from India which observed a higher prevalence of gingival bleeding in children who were orphans³⁹.

DISCUSSION

There have been no previous attempts to review the literature on family-related determinants of periodontal diseases in children and adolescents, while in contrast there are several systematic reviews on predictors of dental caries⁵⁶⁻⁵⁸. Studies that assessed the impact of health

education intervention on parents and the ethnicity of children were excluded as these characteristics were not relevant to the aim of this review. The search period was limited to the past ten years as the inclusion of studies published before would have been overwhelming to manage. The search criteria were kept very broad as preliminary search with family-related keywords did not retrieve a comprehensive list of titles. Further, it was not feasible to predict what parent-related factors have been evaluated by the studies. Therefore, the search was constructed to retrieve any article that had a combination of keywords related to child, gingiva and parents. Most of the studies included used bleeding on probing to assess the gingival disease. Gingival bleeding on probing is considered as a valid and reliable measure of gingival disease as it satisfies all the criteria (simple, easy to communicate, and amenable to statistical analysis) for a good objective measure ⁵⁹.

Systematic reviews on dental caries in the past have unequivocally concluded that low socioeconomic status of parents is associated with higher disease burdens ⁵⁶⁻⁵⁸. Similar observations could be made from most of the studies reviewed here with children of higher income demonstrating better gingival status than those from families with low income. Although some studies found no impact of family income on gingival disease in children, all except observed a proxy indicator of poor socioeconomic status to be associated with poor gingival status. With no exception, all the studies that evaluated the impact of house crowding observed that children living in crowded households experience more gingival disease than those living in less crowded houses. Literature suggests that house crowding is an important predictor for the wellbeing of children even after controlling for socioeconomic status ⁶⁰. Being a proxy indicator of income status, there could be two pathways through which house crowding would affect gingival status. Children living in crowded houses often have low family income which determines oral health behaviours and utilisation of dental services.^{61,61} Literature suggests that house crowding leads to less-responsive parenting and negative parent-child

relationships^{60,62} resulting in poor health-related behaviour including oral hygiene habits⁶³. A study on a small sample of children which was found to be of low quality found that children living in houses with no flush toilet to be more likely to have gingivitis whereas other socioeconomic variables, family income and parents' education were not found to be associated with the gingival status of children⁵⁴. Although the authors did not elaborate on this, most of the socioeconomic status variables were insignificant in the study due to a small sample size making the multivariate statistics with multiple explanatory variables underpowered.

Parents' education is another family-related characteristic which has been studied widely in the literature. Most of the studies which evaluated the association of mother or father's education with gingival status found it to be significant predictors. Only a few did not find an association between parents' education and gingival diseases, most of these used several socioeconomic variables which could have masked the effect of parent's education and were of weak quality. This impact of parent's education level has been observed in previous systematic reviews on oral health outcomes in children^{58,64}. Findings from the included studies also support that children of unemployed parents or those in manual occupations have poor oral health status. In addition, a longitudinal study found that parental occupation status in childhood is associated with periodontal status in adulthood¹² which confirms that childhood socioeconomic position could impact disease burden in later life⁶⁵. Among those articles which studied the effect of a family socioeconomic status indicator, all except three found them to be associated with gingival bleeding in children with those belonging to poor socioeconomic status experiencing poorer gingival status. Two of these studies were of weak quality and therefore it could be concluded that the evidence supports that poorer socioeconomic status is closely associated with poorer gingival status. It needs to be ascertained here that a socioeconomic indicator which might seem relevant for an outcome in one region or country

might not be applicable in other regions, this could be the reason why an indicator significant in one study might not be the same in another from a different region.⁶⁶

Most of the studies considered for inclusion in this review explored the association of parental socioeconomic status and gingival status in children while no studies were found which assessed the impact of wider parent-related characteristics, such as parenting practices except one ⁶. A study from Brazil observed high levels of bleeding gums in those children who experienced high levels of paternal punishment but it could not be included due to the time limiters of search criteria ⁷. Evidence from literature indicates that parental rearing practices influence health-related behaviours including oral hygiene-related practices which predispose children to poor oral health ⁶⁷. Parents involvement in tooth-brushing, mother's sense of coherence and parents' knowledge, attitudes towards oral health were not found to have any influence on the gingival status of children; this evidence comes from studies that were of 'weak' methodological quality and should, therefore, be interpreted with caution. In particular, mother's sense of coherence, which represents an individual's perception of life being comprehensive, manageable, and meaningful,⁶⁸ has been widely studied and found to influence oral health behaviours and dental caries in children.^{68,69} On the other hand, parents' poor oral health was a significant predictor of greater levels of gingival disease in children. It was interesting to note that two studies reported an association between the exposure to environmental tobacco smoke and increased levels of gingivitis or loss of periodontal attachment.^{40,45} However, neither of these studies, which were of 'weak' quality, could explain the rationale for this association which might be confounded by social factors and attitudes to health behaviours. Further studies on large representative samples might help in understanding this association.

One limitation that needs mentioning in this systematic review is that a quantitative analysis could not be conducted. Meta-analysis was not possible due to the heterogeneity in data collected by individual studies both in terms of explanatory (family-related) and outcome variables. Most of the studies included considered socioeconomic factors with no attempt to explore the impact of parental psychosocial variables on periodontal diseases in children. Literature indicates that these variables significantly influence health practices, including oral hygiene practices^{70,63,71}, which could ultimately impact periodontal health. More studies should be conducted to explore the association of these variables with periodontal outcomes in children.

CONCLUSIONS

Data from the reviewed articles indicate that all the three commonly used indicators of parent's SES namely income, education, and occupation are significantly associated with periodontal diseases in children. Better periodontal status was observed in children of parents with higher SES than those children whose parents were of lower SES. Although the association between parent's smoking practices, level of periodontal diseases, and children's periodontal status was explored in only a few studies, findings indicate that children exposed to passive smoking and having parents with periodontal diseases are at greater risk of periodontal diseases themselves.

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COMPETING INTERESTS

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*Updated search in April 2018

Figure 1: PRISMA flowchart demonstrating the titles identified, screened and included in the review

477 **Table 1:** Search strategy used in PubMed to retrieve literature related to family-related
478 predictors of periodontal diseases

#1	Child* OR adolescent*
#2	Gingivitis OR gingiva* OR 'gingival bleeding' OR 'gingival inflammations' OR 'necrotizing ulcerative gingivitis' OR 'periodontal index' OR 'periodontal disease' OR periodontitis
#3	Parent* OR mother OR father OR caregiver*
#4	#1 AND #2 AND #3

479

480 **Table 2:** Background characteristics, main findings, and quality of the included studies

Design	Study population	Age Sample size (Response rate)	Periodontal or Gingival index	Source of parent-related information	Parent-related variables recorded	Outcome variable	Significant in univariate analysis	Significant in multivariate analysis	Selection Bias	Design	Confounding	Blinding	Data collection	Overall quality	Reference
CS	Children with Down syndrome attending three special schools of Sanaa city, Yemen	6-16 N=101	Gingival index (GI) of Loe and Silness,	Parents	- Mother's education - Father's education (No information on how educational status was categorized)	Gingival index used as a continuous measure	Not conducted	- Mother's education - Father's education	Weak	Weak	Moderate	Moderate	Strong	Weak	Al-Sufyani et al. 2014
CS	Children with congenital heart defects attending Ahmed Gasim cardiac centre, Sudan and control children from three	3-12 Cases- N=111 (95.7%) Controls – N=182 (94.8%)	Modified GI index was used to measure gingivitis in six pairs of teeth	Interviews with child's caregivers	- Mother's education - Caregiver's knowledge of caries - Caregiver's brushing - Caregiver's service utilisation	Gingivitis score dichotomised (median used as cut-off)	Mother's education	- Mother's educational level (poor GI in children of mother's with lower education)	Moderate	Weak	Strong	Moderate	Weak	Weak	Ali et al. 2016

CS	localities , Sudan Children attending secondary schools in the Nattandiya education division of the Puttalam district of Sri Lanka.	15 400 (100%)	GI of Loe and Silness (measured on four surfaces of each tooth) Pocket depth measured but parental predictors not evaluated	Children completed questionnaire	- Father's occupation - Mother's education	Gingivitis status dichotomised as good and poor based on Median GI	- Father's occupation - Mother's education	Mother's education (higher level of mother's education and higher father's occupation associated with less severe gingivitis)	Moderate	Weak	Moderate	Moderate	Strong	Moderate	Amarasena et al. 2010
CS	School children of few selected schools in Greece	9-10 N=266	Simplified GI (presence or absence of gingival bleeding)	Parents by questionnaire	- Parent's education - Parent's brushing frequency - Parent's involvement in brushing	Number of teeth with bleeding on probing used as a continuous variable	None	Not conducted	Weak	Weak	Weak	Moderate	Weak	Weak	Angelopoulos et al., 2016
CS (used data from The US National Survey	Non-institutionalised children from all the states of USA	1-17 N=75,676	Presence or absence of gingival bleeding in last 6 months	Interviews with parents	- Family income Below variables adjusted in multivariate analysis - Most knowledgeable	Dichotomised into Presence or absence of bleeding gums	Has been stated that crude Odds ratios were calculated	Family income (children from higher income families less likely to have	Strong	Weak	Strong	Strong	Weak	Weak	Bernabe et al. 2015

of Children's Health)					ble person's (MKP) relationship to the child - Caregiver's education level - Maternal age - Family structure - Household size		ed but the values are not to be seen in the article	gingival bleeding)							
CS	Children attending private and public preschools in city of Belo Horizonte, Brazil	5 N=546 (85.8%)	Visual examination of gingiva (Gingivitis present when gingival contour and colour were abnormal)	Guardians completed questionnaire	Mother's Sense of Coherence (SOC)	Dichotomised into presence or absence of gingivitis	None	None	Moderate	Weak	Strong	Moderate	Weak	Weak	Bonanto et al. 2009
CS	Children and adolescents attending a reference centre for cerebral palsy in Campina Grande, Brazil	2-18 N=80 (82.5%)	Gingival bleeding index (GBI) for 2-6-year-old Community Periodontal Index (CPI) for 7-18 with index teeth	Interview with caregivers	- Caregiver's education - Family income	Presence or absence of Periodontal alterations (GBI of $\geq 1\%$ vs less And CPI 0 vs others)	Caregiver's education	Caregiver's education (≤ 8 years of education associated with periodontal changes)	Weak	Weak	Strong	Moderate	Strong	Weak	Cardoso et al. 2015

CS	Schoolchildren of Pelotas, Brazil	8-12 N=121 (69.2%)	Gingival bleeding on all four sites of index teeth was assessed (no information on which teeth were index teeth)	Parents completed a questionnaire	- Maternal schooling - Family income	- Presence or absence of gingivitis - Gingivitis severity (dichotomised into < median and > median)	<i>Presence of gingivitis</i> None <i>Severity of gingivitis</i> - Maternal schooling - Family income (less schooling and income associated with more extent of gingivitis)	None	Moderate	Weak	Moderate	Strong	Weak	Weak	Chiapinotto et al. 2013
CS	Children attending public and private preschools of Piracicaba, Brazil	5 N=728 (89.5%)	Gingival bleeding on probing assessed using CPI probe on four sites (distal, buccal, mesial, lingual) of each tooth	Parents answered the questionnaire	- Family income - Number of people living in the household - Parent's education - Home ownership - Car ownership	Presence of gingivitis (gingival bleeding in more than 3 teeth) vs. absence of	- Family income - Number of people living in household - Father's	Family income	Strong	Weak	Strong	Moderate	Weak	Weak	Cortellazi et al. 2008

						gingivitis	education - Mother's education (more children from low-income families, less educated parents, and crowded houses had gingivitis)								
CS	School children of one public school in Sao Joao de Meriti city, Brazil	11-12 N=190	Bleeding on probing on six sites (mesiobuccal, buccal, distobuccal, distolingual, lingual, and mesiolingual) of all teeth	Parents by questionnaire	- Mother's education - Father's education - Family income - Mother's SOC - Type of bathroom - Water supply	Bleeding on probing divided into 3 categories (low, moderate and high based on % of sites with	Type of bathroom (children living in houses with no flush toilet were more likely to have	Type of bathroom	Weak	Weak	Strong	Moderate	Strong	Weak	Da silva et al. 2014

						bleeding)	gingiviti s)									
CS	Children seeking dental treatment at Department of Paediatric dentistry, Kirikkale University, Turkey	6-12 109	-GI of Loe and Silness -Gingival bleeding (presence/absence) based on Ainamo and Bay) -Pocket depth and clinical attachment loss measured on six sites of 4 teeth in maxilla	Parent's completed a questionnaire	- Smoking in the presence of child (Exposure to passive tobacco smoke) - Father's smoking status - Mother's smoking status (parents' smoking categorised into non-smoker, <10, 10-20, >20)	- Bleeding on probing dichotomised (presence or absence) - Clinical attachment level, pocket depth and gingival index score used as continuous measures	<i>Clinical attachment level</i> - Exposure to passive tobacco smoke - Father's smoking status - Mother's smoking status - Mother's smoking status (better clinical attachment level in children not exposed to passive tobacco smoke)	<i>Clinical attachment level</i> - Exposure to passive tobacco smoke - Father's smoking status - Mother's smoking status	Weak	Weak	Moderate	Moderate	Strong	Weak	Erdemir et al. 2010	

							havin g non- smoki ng father s and mothe r)								
CS	Subjects born in 1987 living in two areas of the county council of Vastra Gotaland , Sweden	19 N=506 (72%)	Bleeding on probing (presence of absence on six sites of each tooth	Subject s complet ed a questio nnaire	Parent with the highest education	Percenta ge of sites with gingival bleeding dichoto mised (lowest quartile in the study, ≤41% vs >41%)	Not conduct ed	None	Mod erate	Wea k	Modera te	Mod erate	Weak	Wea k	Ericsson et al. 2016
CS	School children of Khartou m Province , Sudan	12 N=636 (99.3%)	- Loe and Silness GI - Pocket depth (parental predictors not evaluated)	Intervie wing children	Parent's education (no info if this meant mother or father)	Mean gingival index	Parent's educatio n (greater mean GI score in children of illiterate parents)	Not conducte d	Mod erate	Wea k	Weak	Wea k	Stron g	Wea k	Farah et al. 2009
CS	Children attending public nurseries of Canoas	3-5 N=490	Gingival bleeding index of Ainamo and Bay (All	Parent's complet ed a questio nnaire	- Mother's education - Family income	Mean percenta ge of teeth with	None	None	Mod erate	Wea k	Modera te	Mod erate	Stron g	Mod erate	Feldens et al. 2006

	City, Brazil		surfaces of each tooth probed)			gingival bleeding										
CS	Schoolch ildren of Buchares t, Romania	10-17 N=159 5 (75%)	Gingival index of GI	Childre n complet ed the questio nnaire	- Father's education - Mother's education - Standard of living (Low=>1pe rson/room and High= $\leq$ 1/ro om)	- Dichot omised into presenc e (mean gingiva l index more than 0) or absence of gingivit is - Extent of gingivit is (% of surface s with gingivit is)	<i>Presenc e of gingiviti s</i> - Mother 's educati on - Father' s educati on - Living standar d (More childre n living in low standar d and with less educate d parents had gingivit is) <i>Extent of gingiviti s</i> - Mother 's	Not conducte d	Mod erate	Wea k	Weak	Mod erate	Stron g	Wea k	Funieru et al. 2016	

							educati on - Father's educati on (childre n of parents with no Univers ity diploma had greater mean gingival index)								
CS	Subjects attending a special needs school in Udaipur, India	12-30 N=254	Periodontal status assessed using CPI (subjects below 15 assessed only bleeding and calculus)	No information on how parent-related information was sought	- Father's education - Mother's education - Socioeconomic status- (no information on how these were categorised in multivariate analysis)	CPI score dichotomised (No information on how this was done)	Not conducted	-Mother's education -Socioeconomic status (children of mother's with less education and poor SES had poor periodontal status)	Weak	Weak	Moderate	Moderate	Strong	Weak	Jain et al. 2009
CS	School children of	15-19 N=867	Periodontal health status	Children completed	- Father's education	Prevalence of CPI (No	Not conducted	- Father's	Moderate	Weak	Strong	Moderate	Weak	Weak	Kazemn ejad. et al 2008

	Tehran, Iran		assessed using CPI on only 6 Ramjford teeth	ed a questio nnaire	- Mother's education - Occupation (Not used in analysis)	informat ion on what prevalen ce meant)		educati on - Mother's educati on (preval ence of periodo ntal disease more in childre n of less educate d parents)								
CS	School children and adolescents of Anatolia n city, Turkey	6-17 N=4534	CPI One tooth with highest score in each sextant was scored.	Questio nnaire complet ed by parents	- Father's education - Mother's education - Father's employmen t status (data not seen in tables) - Mother's employmen t status	Dichoto mised into presence or absence of bleeding gums (Gum bleeding also used as an independ ent variable)	<i>Males</i> - Father's educat ion - Mothe r's educat ion (children with better SES and greater parents' educatio n had poor CPI) <i>Females</i> None	None	Mod erate	Wea k	Weak	Mod erate	Weak	Wea k	Kesim et al. 2012	

CS	Pre-school children of Flanders, Belgium	3 and 5, N=1071 (3 years old) N=1119 (5 years old)	Visual inspection of gingiva on buccal surfaces of four teeth (55, 52, 72 and 75) Gingivitis is considered as absent when no discoloration and swelling were observed	Questionnaire completed by parents	- Home situation (child living with both parents or living with one parent or others) - Mother's education - Father's education - Help with brushing - Family smoking status	Dichotomised into visible gingivitis on at least one tooth or no gingivitis on any tooth	Not conducted	3 years old None 5 years old Family smoking status (greater risk of gingivitis in children of families who smoked previously than in those who never smoked)	Strong	Weak	Strong	Moderate	Weak	Weak	Leroy et al. 2011
CS	Preschool children of Kegalle District, Sri Lanka	48-72 months N=784 (94%)	Bleeding on probing on four surfaces (mesial, distal, buccal/labial and lingual/palatal) of six index teeth (55, 61, 63, 75, 81 and 83)	Parents completed questionnaire	- Father's education - Mother's education - Employment status of mother - Family income - Number of children in family	- Dichotomised into presence or absence of gingival bleeding in univariate (No information present)	- Father's education - Mother's education - Mother's employment status - Number of children	- Mother's employment status - Number of children in family	Strong	Weak	Strong	Moderate	Weak	Weak	Nayana kkara. et al 2014

						ce or absenc e of bleedin g in all teeth or any teeth) - Gingiv al bleedin g in multiv ariate Not define d how presen ce or absenc e was classifi ed (all teeth or any teeth)	n in family (More number of children with less educate d, unempl oyed parents and with ≥3childr en in family had bleedin g on probing)								
CS	School children of Tehran, Iran	11-12 N=383	CPI used to record healthy gingiva bleeding n probing and calculus	Questio naire complet ed by mothers	- Mother's education - Mother's age - Mother's occupation - Family income - Maternal CPI - Mother's body mass index	Outcome not clearly defined (Proporti onal odds regressio n model was used for multivari	Not conduct ed	- Mother 's educati on - Mother 's occupat ion - Family income - Matern al CPI	Wea k	Wea k	Strong	Mod erate	Stron g	Wea k	Nourijel yani et al. 2014

						ate analysis)	(Poor family income, mother's education and occupatio n, and higher mother's CPI were associate d with greater CPI scores in children)								
CS	Children and mothers attending Hiroshi ma Universit y Dental Hospital, Hiroshi ma, Japan	8-11 N=117	Oral rating index for children (ORI-C) was used to assess gingival status (consists of subjective rating of 5 categories ranging from +2- excellent, too -2 – very poor)	No informa tion on how informa tion on ORI was sought	ORI of mothers	ORI-C used as a continuo us variable	ORI of mothers (Better ORI-C associat ed with better ORI of mothers)	ORI of mothers	Wea k	Wea k	Strong	Mod erate	Weak	Wea k	Okada et al. 2008
CS	Children and mothers attending	2 groups Childr en of	Gingival inflammati on	Mother' s clinical	Mother's periodontal status	Median % of bleeding sites on	Bleedin g on probing more in	Not conducte d	Wea k	Wea k	Weak	Mod erate	Weak	Wea k	Pahkla et al. 2010

	polyclinics of the Tartu University Dental Clinic, Estonia	mothers with chronic periodontitis 5-17 34 Children of mothers with no periodontitis 10-16 13	- modified gingival index (MGI; 0 – healthy with no bleeding on probing; 1 – pinprick, bleeding on probing, 2 – immediate and overt bleeding on probing, 3 – spontaneous bleeding Periodontal pocket depth on six points in each tooth	examination		probing (BOP) Median of modified gingival index Presence or absence of periodontitis	children of diseased mothers								
Longitudinal study	Children from two cohort studies (1982 and 1993 Pelotas birth cohort studies)	12-year-old – N=339 (94.4%) 24 year old	- Gingival bleeding on probing recorded as presence or absence in both	Mothers through interviews	- Mother's schooling at birth - Family income at birth	-Mean gingival bleeding on probing -Mean pocket depth	Not conducted	12 years old None 24 years old For both the outcomes - Mother's	Moderate	Strong	Strong	Moderate	Weak	Moderate	Peres et al. 2012

	who were born in the five hospitals of Pelotas, Brazil	N=720 (81.1%)	12 and 24-year population - Pocket depth assessed only in 24-year-old (absence, shallow-4-5 mm depth and deep - ≥6mm) Assessments for bleeding and pocket depth done on six sites of each tooth														schooling - Family income (higher income and mother's education associated with better bleeding on probing and pocket depth scores)
CS	School children from three schools in Buenos Aires, Argentina	6-8 9-11 12-14 N=300	Bleeding on probing index to evaluate gingival status	Parents completed the questionnaire	-Education of the parent with the highest education -Parent's oral health Knowledge -Parent's oral health attitudes -Parent's oral health practices	No description on what was the outcome	<i>For all the age groups together</i> -Parent's education -Parent's oral health practices (poor	Not conducted	Weak	Weak	Weak	Moderate	Weak	Weak			Ravera et al. 2012

															practices and education on level associated with poor gingival bleeding)
CS data from a Prospective study	Subjects born at Queen Mary Hospital, Dunedin, New Zealand between 1 April 72 to 31 st March 73	32 N=915	- Clinical attachment loss (CAL) - Bleeding on probing Three sites (mesiobuccal, buccal, and distolingual) of all teeth except the third molar - Gingival recession - Probing depth (parental predictor not	Parents through interviews	Familial risk for periodontal disease (High familial risk: if 1 or both parents reported periodontal disease and 1 or both had lost tooth due to periodontal disease and Low familial risk: if parents had no periodontal disease)	Percentage of sites with -1 or more sites with 4+mm CAL -2 or more sites with 4+mm CAL -1 or more sites with 5+mm CAL -Bleeding on probing (only in	<i>Familial periodontal risk</i> - % of 1+ sites with 4+ mm CAL - % of 1+ sites with 5+ mm CAL - Mean % of sites with bleeding on probing (low % in low	<i>Familial periodontal risk</i> - % of 1+ sites with 4+ mm CAL - % of 1+ sites with 5+ mm CAL	Weak	Moderate	Strong	Moderate	Moderate	Moderate	Shearer et al. 2011

			evaluate d)			univaria te analysis)	familia l risk subject s)								
CS	Data from Korean National Health and Nutrition Examination conducted in a representative population	30-59 N=928 (89%)	Periodontal assessed using CPI in six sextants with two index teeth examined in each sextant	Interviews with subjects	- Father's education when 14 years old - Mother's education when 14 years old - Father's job when 14 years old - Mother's job when 14 years old	Presence or absence of periodontitis (CPI ≥3 in any index teeth vs. CPI<3)	- Father's education when 14 years old - Mother's education when 14 years old - Father's job when 14 years old - Mother's job when 14 years old (subjects with less educated parents and	None	Strong	Weak	Strong	Moderate	Strong	Moderate	Sim et al. 2015

								lower occupa tion were at greater risk of period ontitis)								
CS	Schoolch ildren of Medak District, India	11-14 N=153 9	Gingival bleeding assessed using CPI (WHO 2013 criteria)	Parents complet ed the questio nnaire	- Socioecon omic status (parents education, occupatio n and income) - Family structure - Number of children - Parent's oral hygiene behaviour - Parenting practices	Percenta ge of teeth with gingival bleeding	- Mother 's educati on - Father' s occupa tion	- Socioec onomic status - Parenti ng practice s (childre n belongi ng to poor socioec onomic status and with parents who are power assertiv e has greater % of teeth gingival bleedin g)	Stron g?	Wea k	Strong	Mod erate	Stron g	Mod erate	Kumar et al., 2017	

CS	Children from orphanages and schools in Mysore, India	Mean age 11.39±2.74 N= 957	Gingival bleeding assessed using CPI (WHO 2013 criteria)	-	- Orphans Vs Non-orphans	Prevalence of gingival bleeding (not defined how prevalence was calculated)	- Gingival bleeding more prevalent in orphans than non-orphans	Not conducted	Weak	Weak	Weak	Moderate	Strong	Weak	Thetaka la et al. 2017
CS	Schoolchildren of city of Santa Maria, Brazil	12 N=1134 (93%)	Gingival bleeding assessed using CPI (0=healthy, 1 – bleeding) on six gingival sites per tooth	Parents completed the questionnaires	- Father's education - Mother's education - Family income - Household crowding	Number of teeth with gingival bleeding	- Father's education - Family income - Household crowding (children of parents with less income, education, living in house with less than 1 person/room had	- Father's education	Moderate	Weak	Strong	Moderate	Weak	Weak	Tomazoni et al. 2016

							more teeth with gingiv al bleedin g)									
CS	Represen tative school children of Greece	12 years old- N=122 4 15 years old- N=125 7	CPI treatment needs was used (Not described in detail)	Questio naire complet ed by children through intervie ws	- - Father's education - Mother's education	CPITN used as a continuo us variable	- Not conduct ed	- <i>12 years old</i> Mother's education (as mother's education increased, CPITN score decreased) <i>15 years old</i> None	Mod erate	Wea k	Strong	Mod erate	Stron g	Mod erate	Vadiaka s et al. 2011	
CS	School children of public schools of Tehran, Iran	15 N=506	CPI used to assess gingival status (scores 0, 1 and 2 were used; a separate score was given used for index teeth with both bleeding and calculus-	Questio naire complet ed by children	- Father's education - Mother's education (But only used as parent's education in the table) - Wealth status of family (own home vs. rented home) but not used in	% of children with different CPI scores	<i>For gingival bleedin g</i> None	Not conducte d	Mod erate	Wea k	Weak	Mod erate	Stron g	Wea k	Yazdani et al. 2008	

	but related data not seen in tables)	CPI analysis
481		
482		