
Article:
da Silva, A.N., Alvares de Lima, S.T. and Vettore, M.V. orcid.org/0000-0001-6299-4432 (2018) Protective psychosocial factors and dental caries in children and adolescents: a systematic review and meta-analysis. International Journal of Paediatric Dentistry, 28 (5). pp. 443-458. ISSN 0960-7439

https://doi.org/10.1111/ipd.12375

Protective psychosocial factors and dental caries in children and adolescents: a systematic review and meta-analysis

Abstract

Background. Psychosocial protective factors include dispositional and family attributes that may reduce the occurrence of dental caries.

Aim. This review analyzed the evidence on the relationship between protective psychosocial factors and dental caries in children and adolescents.

Design. Primary studies involving children and adolescents were searched in the following electronic databases Medline, SCOPUS, LILACS, SciELO and Web of Science. The reference lists were also screened. Protective psychosocial factors descriptors were in accordance with the salutogenic theory. The outcome was clinical measure of dental caries. Quality assessments were performed using the Newcastle-Ottawa scale.

Results: The final search resulted in 35 studies, including 7 cohort, one case-control and 27 cross-sectional studies. Most studies were of moderate quality. Meta-analyses revealed that low parental internal locus of control (cohort studies OR=1.42, 95%CI:1.20-1.64; cross-sectional studies OR=1.30, 95%CI:1.19-1.41), high parental external chance (OR 1.20, 95%CI:1.10-1.29), high maternal sense of coherence (OR=0.77, 95%CI:0.62-0.93) were associated with dental caries in children. High social support (OR=0.81, 95%CI:0.68-0.93) and greater self-efficacy (OR= 1.50, 95%CI:1.12-1.22) were also associated with dental caries in adolescents.

Conclusions: The current evidence suggests that some salutogenic factors are important protective factors of dental caries during childhood and adolescence.

Introduction

Dental caries is considered a major public health challenge in most countries despite the global decline over the recent decades[1]. The identification of predictors of dental caries is predominantly underpinned by the individual risk factor approach, which suggests the role of poor family socioeconomic position and unhealthy behaviours on dental caries occurrence in young age groups[2,3]. However, the importance of the psychological and emotional aspects that influence oral health has been acknowledged[4]. Psychosocial factor is used as an umbrella term defined as the interrelation between social factors and individual's mind in influencing behaviours, health and wellbeing[5]. The psychosocial perspective of health acknowledges that people in lower social stratum experience greater levels of psychological problems than those in better-off social groups[6]. Direct and indirect mechanisms correlate psychological stress with oral health[7,8]. The former suggests that psychological stress can increase one's vulnerability to disease through neuroendocrine-immune stress effect on host defenses via central nervous system[7]. The indirect pathway argues that high psychological stressors increase the likelihood to adopt health compromising behaviours, which in turn influence oral health[8]. Adverse childhood experiences and maternal stress are also associated with oral health in adolescents[9,10]. Childhood psychosocial issues predicted adolescent's dental caries via oral health-related behaviours and access to dental care[9,10].

Protective factors have been occasionally defined as the absence or as the low end of a risk variable. However, there has been a consensus that these terms are conceptually distinct rather than opposite ends of the same construct[11]. Protective psychosocial factors may have their independent effects on health outcomes or may attenuate the relationship between a risk factor and health and is aligned with the salutogenesis theory (saluto = health; genesis = origin)[12,13]. Salutogenesis relies on the individual psychological aspects related to the ability to deal effectively with the difficulties in life, favoring the maintenance of the individual's health,

including those from socially disadvantaged groups. The salutogenic theory seeks to explain why individuals, despite living in adverse and stressful environments, stay well and are even able to maintain and improve their own health[12,13]. The key principles of the salutogenic theory include the orientation towards solutions to problems and the capacity to use effectively the available resources to improve health[12,13]. Sense of coherence is the central construct of salutogenesis representing an internal resource that enables people to manage tension, to identify and mobilize their external and internal resources, to promote effective coping by finding solutions, and resolve tension in a health promoting manner[12,13]. Salutogenesis also comprises other protective psychosocial factors, including resilience, coping, hardiness, self-efficacy, self-esteem and locus of control[14].

Recent systematic review papers have found evidence to suggest that psychosocial factors are related to periodontal disease, burning mouth and health-related behaviours[15-20]. Psychosocial factors were also identified as potential determinants of oral health behaviours in children and adolescents[17,18]. However, the effectiveness of psychological interventions in oral health behaviour and self-efficacy in toothbrushing is in dispute due to the low quality of intervention studies[19,20]. To date, no study reviewed the possible influence of protective psychosocial factors on dental caries in children and adolescents. The aim of this study was to systematically review the current literature to assess whether protective psychosocial factors are related to dental caries in children and adolescents.

Material and methods

Protocol development and registration

This systematic review was conducted in accordance with the Cochrane Collaboration Group guidelines[21] and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement checklist (PRISMA)[22]. The review protocol was

initially registered on the National Institute of Health Research Database (PROSPERO) under registration number CRD42016015060.

Eligibility criteria

Cohort, case-control, cross-sectional and intervention studies assessing the relationship between protective psychosocial factors and dental caries involving children (0-10 years of age) and adolescents (11-19 years of age) were included. The selected studies were then grouped according to the age of the participants as follows: 1) Children less than 6 years old at risk of early childhood caries[23]; 2) children between 6 and 10 years old; 3) early adolescents aged between 11 and 15 years); and 4) late adolescents aged between 16 and 19 years[24]. We excluded qualitative studies, descriptive studies, systematic and narrative reviews, editorials, letters to the editor, papers involving patients with mental illnesses and psychiatric problems. Studies involving participants with disabilities and metabolic disorders, other dental diseases and those not assessing dental caries through clinical examinations were also excluded. Only studies assessing protective psychosocial factors at the individual level were included. There were no language restrictions.

Information sources and literature search strategy

Comprehensive search on electronic databases, including Medline via Pubmed, SCOPUS, LILACS, SciELO and Web of Science was carried out up to March 2018. The descriptors of protective psychosocial factors were chosen based on the salutogenic theory[12-14], and included 'positive psychosocial factors', 'sense of coherence', 'self esteem', 'self efficacy', 'health locus of control', 'coping', 'resilience', 'hardiness', 'learned resourcefulness', 'learned optimism', 'learned hopefulness', 'connectedness', 'social capital', 'social support' and 'locus of control'. Search terms for the dental caries theme were 'DMFT index', 'dental caries' and 'tooth decay'. The protective psychosocial factors and dental caries themes were created in separate by using the operator ''OR'' to search for terms appearing as

either explored subject headings (MeSH) or text words. The Boolean operator 'AND' was then employed to combine the descriptors of the two themes. The reference lists of the selected papers were also thoroughly screened for additional relevant research.

Study selection

The selection of studies for inclusion was conducted independently by two reviewers (ANS and SAT). Initially, all identified papers were screened according to the title and abstract. Then, full text of papers were retrieved and assessed according to the eligibility criteria. If the abstract did not provide sufficient information to make a proper decision of inclusion or exclusion, the full paper was reviewed before a final decision was made. Disagreements between the two reviewers in selecting the papers were resolved by consensus after discussion with a third reviewer (MVV) in order to reach full agreement.

Data collection and data items

Data from the selected papers were extracted in duplicate using a piloted standardized electronic spreadsheet (Excel 2007, Microsoft, Redwood City, CA, USA) following the same protocol to that used for selecting papers. Collected information included: author and year of study's publication, study design, country, sample size, participant's characteristics (age and sex), study setting, psychosocial factor investigated and the instrument used for evaluation, clinical measure or dental index to evaluate dental caries, statistical approach and main findings.

Risk of bias in individual studies

The Newcastle-Ottawa Scale for cohort and case-control studies and the modified Newcastle-Ottawa Scale for cross-sectional studies were employed to assess the methodological quality of the selected studies by two reviewers using a system of points (stars)[25,26]. No clinical trials were selected. The quality assessment score for cohort studies consisted three categories: (1) group selection (four items), (2) comparability (one item), and

(3) outcome assessment (three items). The quality assessment score for case-control studies included three categories: (1) selection (four items), (2) comparability (one item), and (3) exposure (three items). Cross-sectional studies were assessed considering three categories: (1) sample selection (four items), (2) comparability (one item), and (3) outcome assessment (one item). High-quality studies at low risk of bias could receive a maximum score of 9 stars for cohort studies and 7 stars for case-control and cross-sectional studies. Cohort studies from 6 to 8 stars were classified as of moderate quality and those with 5 stars or less were considered of low quality. Case-control and cross-sectional studies rating between 4 and 6 stars were evaluated as moderate quality and those with 4 stars or less were considered to have low quality[27].

Data synthesis

Meta-analysis using the random-effects method was conducted according to the psychosocial factor, age group and study design. The pooled estimates were obtained from studies where ORs and 95% of CIs could be extracted or could be indirectly estimated according to the methodology proposed by Lipsey and Wilson[28]. Heterogeneity amongst studies was tested by Cochran's Q test. All tests were performed using STATA statistical software, version 14.0 (Stata Corp, TX, USA). The level of significance for all tests was 5% ($P \leq 0.05$).

Results

Study selection

The initial search of the electronic databases identified 3486 potential articles. After removal of duplicates 1659 remained. No additional paper was identified through manual search of the reference lists of the selected papers. After screening the titles and abstracts 1583 records were excluded since they did not meet the inclusion criteria. The remaining 76 papers

were subsequently selected for a full-text analysis. Of them, 35 were thereafter excluded according to the eligibility criteria, resulting in 40 papers for inclusion. Of them, 5 were duplicate reports of the same study and were also removed[29-33]. This systematic review included a total of 35 studies: 20 studies involving children and 15 studies involving early adolescents. The flow chart of the identification and selection of studies is presented in Fig. 1.

Study characteristics

The characteristics of the 35 selected studies are presented according to the age group and type of study. Table 1 presents the main characteristics of the 7 cohort studies: 5 involving children[35-39] and 2 involving early adolescents[9,34]; one case-control study in children[40]; and 27 cross-sectional studies: 14 involving children[41-54] and 13 involving early adolescents[55-67]. The sample sizes varied from 32 to 981 in children and from 100 to 2014 in adolescents. Most studies in children and adolescents were conducted in schools. The protective psychosocial factors investigated were as follows: health locus of control (12 studies)[35,36,39,40,41,43,46,52,54,58,60,62], self-efficacy (11 studies)[35,38,40,42,45,46,48,49,54,56,57], sense of coherence (10 studies)[44,46,49,50,53,60,63-65,67], social support (5 studies)[9,34,42,46,63], self-esteem (3 studies)[51,57,60], social network (2 studies)[40,61]. Coping[9], resilience[37], family functioning[47], self-concept[59] and optimism[66] were assessed in one study. The dmft, DMFT and ICDAS were the predominant clinical indices employed to evaluate dental caries.

Assessment of risk bias

The risk of bias assessment, according to the specific Newcastle-Ottawa scales for cohort, case-control and cross-sectional studies, of the included studies is presented in Supplementary Data files S1, S2, and S3, respectively. One cohort[36] and 13 cross-sectional studies[41,42,45,50,51,53,56,59,60,63-66], were considered of low quality. Six cohort[9,34,35,37-39], 1 case-control[42] and 14 cross-sectional[43,44,46-49,52,54,55,57,58,61,62,67] studies were assessed as moderate quality. **No study was considered of high quality. Of the 7 cohort studies, 2 studies**

achieved the maximum of 4 stars for the selection domain[34,35]. Most studies assessed the psychosocial factors using valid questionnaires. Six cohort[9,34,35,37-39] and 11 cross-sectional studies[44,46,47,49,52,54,55,57,61,62,67] scored the maximum of 2 stars for comparability of the study groups. Dental caries assessment was considered adequate in the 7 cohort[9,34-39], the case-control[40] and in 21 cross-sectional studies[41-44,46,48-50,52,54,55-62,64,65,67].

Meta-analysis

The relationship between protective psychosocial factors and dental caries was assessed through meta-analysis where ORs and 95%CI could be extracted or estimated using other numeric data. The different measures of protective psychosocial factors and dental caries used in the meta-analyses are described in Supplementary Data file S4. Twenty-one of the thirty-five studies provided data for eleven distinct meta-analyses according to the psychosocial factors, age group and study design[9,34,36,39,41,42,44-46,49,50,52,55-57,60-62,64,65,67].

Health locus of control was considered the exposure of interest in two cohort[36,39] and three cross-sectional[41,46,52] studies in children, and two cross-sectional studies in adolescents[60,62]. The pooled OR between low parental internal locus of control and dental caries in children from cohort studies involving 279 participants was 1.42 (95%CI: 1.20-1.64). According to cross-sectional data involving 1517 children, low parental internal locus of control (Pooled OR 1.30, 95%CI: 1.19-1.41) and high parental external chance (Pooled OR 1.20, 95%CI: 1.10-1.29) were associated with dental caries in children. There was no association between high parental external powerful (Pooled OR 1.10, 95%CI: 0.91-1.28). Heterogeneity was detected on the analysis of cross-sectional studies on the association between health locus of control and dental caries in adolescents (I^2 = 93.1%, P < 0.001) (Fig. 2A).

Heterogeneity was detected on the analysis of four cross-sectional studies[42,45,46,49] between maternal self-efficacy and dental caries in children (I^2 = 85.5%, P < 0.001). The pooled

OR involving 1225 participants from two cross-sectional studies[56-57] on the relationship between self-efficacy and dental caries in adolescents was 1.50 (95%CI 1.12-1.22) (Fig. 2B).

The odds of dental caries in children was 23% lower for mothers with high sense of coherence according to combined data from three cross-sectional studies[44,46,50] involving 1559 participants (Pooled OR 0.77, 95%CI: 0.62-0.93). Heterogeneity was detected on the analysis of cross-sectional data between sense of coherence and dental caries in adolescents (I^2 = 94.0%, P < 0.001) (Fig. 2C).

There was no statistical association between parental social support and dental caries in children using cross-sectional data from two studies[42,46] involving 1695 participants (Pooled OR 0.96, 95%CI 0.77-1.13). Cohort data involving 913 adolescents from two studies[9,34] showed that high social support was significantly associated with lower DMFT (Pooled OR 0.81, 95%CI 0.68-0.93) (Fig. 2D).

Heterogeneity was observed on the meta-analysis between self-esteem and dental caries in adolescents when cross-sectional data involving 950 participants from two studies[57,60] were combined (I^2 = 74.7%, P = 0.047) (Fig. 2E).

Discussion

As far as the authors are concerned, this is the first systematic review to investigate the current literature on the relationship between protective psychosocial factors and dental caries in children and adolescents according to the salutogenesis theory. Thirty-five papers involving 11 psychosocial factors were included in this review. Based on the present findings, parental locus of control and sense of coherence appear to act as protective factors for dental caries in children. In addition, the present study suggests that self-efficacy and social support are associated with dental caries in adolescents.

The investigation of the relationship between protective psychosocial factors and dental caries allows us to understand oral health from a salutogenic approach, an innovative and promising perspective to understand the origin of health. Instead of the traditional focus on risk factors for the development of dental caries, the salutogenic approach concentrates on the study of the factors that generate and promote oral health. The number of studies on the relationship between protective psychosocial factors and oral health has increased significantly in the last decade. Different outcomes were assessed, including oral health-related behaviours, use of dental services, oral clinical measures and oral health-related quality of life[17,18,68]. However, the theory is still little explored with regards dental caries in children and adolescents. Although health locus of control was commonly investigated, five of the 11 protective psychosocial factors were assessed in single studies.

The potential mechanisms by which protective psychosocial factors positively affect the lower risk of dental caries in children and adolescents might be related to the adoption of favourable oral health-related behaviours and adequate use of dental health services. Two previous systematic reviews showed that sense of coherence and other psychosocial correlates were relevant factors associated with oral health-related behaviors, including tooth brushing frequency, smoking, and dental attendance[17,18]. There is also consistent evidence from primary studies in dental research showing that protective psychosocial factors are associated with greater frequency of toothbrushing[47,69,70], lower consumption of sucrose[29,71], higher frequency of dental visits[34,56,69,72], and dental checkups[72]. Children with high self-esteem were more likely to report more regular toothbrushing[73,74] and to use dental services more frequently[74]. Greater maternal SOC was associated with adequate use of dental services and better gingival health in adolescences[30,72]. Resilience increased the likelihood of better gingival satus in underprivileged school children[75]. Positive coping strategies were correlated with children's self-rated oral health[76]. Higher SOC, dental coping beliefs and oral health beliefs predicted

better OHQoL in children[68,77]. Another possible explanation for our findings may be related to the influence of protective psychosocial factors on the neuro-immune-endocrine system, buffering the effect of stress[78] and, thus, reducing the inhibitory effect of cortisol on salivary flow and Secretory IgA antibody[79]. The buffering effect of protective psychosocial factors on stress and its consequences on health is in line with the salutogenic theory. According to this theory, some individuals develop the capacity to perceive and understand problems of daily living (stress) as predictable and explicable. They are also able to mobilize the resources at his disposal. For these individuals, demands are considered challenges that are worthy of investment and engagement. This orientation towards problem solving facilitates movement in a health promoting direction[12,13].

The strengths of the present study were the adoption of the protocol for systematic reviews according to Cochrane Collaboration Group[21] and the use of the Newcastle-Ottawa Scale (NOS) to assess the methodological quality of the selected studies[25,26]. In addition, data from **20** original studies were extracted allowing the conduction of separate meta-analyses. However, our study has some limitations. No intervention study on psychological interventions to tackle dental caries in children and adolescents was identified which limits the strength of evidence. This finding is in agreement with previous systematic reviews of psychological and behavioural interventions to improve oral health[19,20]. Most studies on psychological interventions focused on periodontal disease and oral hygiene behaviour outcomes[19,20]. In this systematic review, separate meta-analyses were conducted according to participant's age and the psychosocial factor under investigation. However, the age range of the subjects and the psychosocial constructs in the selected studies varied considerably. For instance, self-efficacy was assessed as maternal oral health-related self-efficacy[42] and maternal self-efficacy in oral hygiene[49], and locus of control was measured as dental health locus of control[35] and health locus of control[36]. This might have resulted in some imprecision when grouping the studies.

Although most studies used valid instruments to evaluate the psychosocial factor, the scales varied considerably between the studies that evaluated the same psychosocial factor. Furthermore, there was a lack of proper adjustment for potential confounders in nearly half of the studies according to the comparability domain of the Newcastle-Ottawa Scale.

The methodological discrepancies between the studies included in meta-analyses may explain the statistical heterogeneity observed in four of the **16** the meta-analyses reported in this study. Heterogeneity derived from combining studies using different methods results in fallacious pooled estimates and generates biased conclusions. Thus, in this study the results from meta-analyses with clear heterogeneity were not considered in the conclusions. Another aspect that deserves attention is the fact the majority of meta-analyses included very few number of studies due to limited data availability. Apparently, the main limitation of this review refers to the methodological quality of studies selected. **No** cross-sectional study was classified to be of high quality and nearly half of the studies had low quality (one cohort and 13 cross-sectional). Our findings should be carefully interpreted due to the aforementioned limitations. In addition, the validity of our results are not ideal and are difficult to generalize.

Qualitative studies adopting the salutogenic approach must be carried out to analyse internal and external resources, skills and competencies related to the salutogenic theory that are difficult to measure using quantitative methods. Therefore, it will be possible to identify the most important material and symbolic resources for oral health in the different life stages of children and adolescents in different social contexts. Future longitudinal studies exploring the potential mechanisms by which salutogenic factors affect children and adolescents' oral health are necessary to provide a better understanding about the role of protective psychosocial factors on dental caries. In addition, randomized controlled trials are needed to establish the causal relationship between protective psychosocial factors and dental caries.

The current available evidence on the relationship between protective psychosocial factors and dental caries during childhood and adolescence suggests that some salutogenic factors are important predictors of dental caries in these age groups.

References

1. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ 2005; **83**: 661-669.

2. Schwendicke F, Dorfer CE, Schlattmann P, Foster Page L, Thomson WM, Paris S. Socioeconomic inequality and caries: a systematic review and meta-analysis. J Dent Res 2015; **94**: 10-18.

3. Kumar S, Tadakamadla J, Kroon J, Johnson NW. Impact of parent-related factors on dental caries in the permanent dentition of 6-12-year-old children: A systematic review. J Dent 2016; **46**: 1-11.

4. Locker D, Gibson B. The concept of positive health: a review and commentary on its application in oral health research. Community Dent Oral Epidemiol 2006; **34**: 161-173.

5. Oxford English Dictionary. Available from: http://dictionary.oed.com.

6. Stronks K, van de Mheen H, Looman CW, Mackenbach JP. The importance of psychosocial stressors for socio-economic inequalities in perceived health. Soc Sci Med 1998; **46(4-5)**: 611-623.

7. Dorian B, Garfinkel PE. Stress, immunity and illness - a review. Psychol Med 1987; **17**: 393-407.

8. Warren KR, Postolache TT, Groer ME, Pinjari O, Kelly DL, Reynolds MA. Role of chronic stress and depression in periodontal diseases. Periodontol 2000 2014; **64**: 127-138.

9. Nelson S, Lee W, Albert JM, Singer LT. Early maternal psychosocial factors are predictors for adolescent caries. J Dent Res 2012; **91**: 859-864.

10. Bright MA, Alford SM, Hinojosa MS, Knapp C, Fernandez-Baca DE. Adverse childhood experiences and dental health in children and adolescents. Community Dent Oral Epidemiol 2015; **43**: 193-199.

11. Jessor R. Successful adolescent development among youth in high-risk settings. Am Psychol 1993; **48:** 117-126.

12. Antonovsky A. Health, Stress and Coping. London. London: Jossey-Bass, 1979.

13. Antonovsky A. Unraveling mystery of health. How people manage stress and stay well. . San Francisco: Jossey-Bass, 1987.

14. Eriksson M, Lindstrom B. Bringing it all together - The salutogenic response to some of the most pertinent public health dilemmas. In: Morgan A DM, Ziglio E (eds). Health Assets in a Global Context. New York: Springer, 2010: 339-352.

15. Peruzzo DC, Benatti BB, Ambrosano GM et al. A systematic review of stress and psychological factors as possible risk factors for periodontal disease. J Periodontol 2007; **78**: 1491-1504.

16. Galli F, Lodi G, Sardella A, Vegni E. Role of psychological factors in burning mouth syndrome: A systematic review and meta-analysis. Cephalalgia 2017; **37**: 265-277.

17. Scheerman JF, van Loveren C, van Meijel B et al. Psychosocial correlates of oral hygiene behaviour in people aged 9 to 19 - a systematic review with meta-analysis. Community Dent Oral Epidemiol 2016; **44**: 331-341.

18. Elyasi M, Abreu LG, Badri P, Saltaji H, Flores-Mir C, Amin M. Impact of Sense of Coherence on Oral Health Behaviors: A Systematic Review. PloS one 2015; **10**: e0133918.

19. Renz A, Ide M, Newton T, Robinson PG, Smith D. Psychological interventions to improve adherence to oral hygiene instructions in adults with periodontal diseases. The Cochrane Database Syst Rev 2007; **18**: CD005097.

20. Werner H, Hakeberg M, Dahlström L et al. Svanberg T, Svensson L, Wide Boman U. Psychological Interventions for Poor Oral Health: A Systematic Review. J Dent Res 2016; **95**: 506-14.

21. Alderson P, Green S, Higgins JPT. Cochrane reviewers' handbook 4.2.2. The Cochrane Library Issue. Chichester, UK: John Wiley & Sons Ltda, 2004.

22. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009; **6**: e1000097.

23. American Academy on Pediatric Dentistry; American Academy of Pediatrics. Policy on Early Childhood Caries (ECC): Classifications, Consequences, and Preventive Strategies. Pediatr Dent 2008-2009; **30**: 40-43.

24. Cobb NJ. Adolescence: continuity, change, and diversity. Mountain View, CA, US: Mayfield Publishing Co, 1992.

25. Wells GA, Shea B, O'Connell D et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Available from http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. Accessed June, 2016.

26. Terwee CB, Bot SD, de Boer MR. Quality criteria were proposed for measurement properties of health status questionnaires. J Clin Epidemiol 2007; **60**: 34-42.

27. Javidi H, Vettore M, Benson PE. Does orthodontic treatment before the age of 18 years improve oral health-related quality of life? A systematic review and meta-analysis. Am J Orthod Dentofacial Orthop 2017; **151**: 644-655.

28. Lipsey MW, Wilson DB. Procedures for computing effect size values from eligible study reports. In: Practical Meta-Analysis. London, UK: Sage Publications, 2000: 172-206.

29. Litt MD, Reisine S, Tinanoff N. Multidimensional causal model of dental caries development in low-income preschool children. Public Health Rep 1995; **110**: 607-617.

30. Freire M, Hardy R, Sheiham A. Mothers' sense of coherence and their adolescent children's oral health status and behaviours. Community Dental Health 2002; **19**: 24-31.

31. Albino J, Tiwari T, Henderson WG et al. Learning from Caries-Free Children in a High Caries American Indian Population. J Public Health Dent 2014; **74**: 293-300.

32. Acharya S, Pentapati KC, Singhal DK, Thakur AS. Development and validation of a scale measuring the locus of control orientation in relation to socio-dental effects. Eur Arch Paediatr Dent 2015; **16**: 191-197.

33. Wilson AR, Mulvahill MJ, Tiwari T. The impact of maternal self-efficacy and oral health beliefs on early childhood caries in Latino children. Front Public Health 2017; **5**: 228.

34. Bernabé E, Stansfeld SA, Marcenes W. Roles of Different Sources of Social Support on Caries Experience and Caries Increment in Adolescents of East London. Caries Res 2011; **45**: 400-407.

35. Reisine S, Litt M, Tinanoff NA. Biopsychosocial model to predict caries in preschool children. Pediatr Dent 1994; **16**: 413-418.

36. Chase I, Berkowitz RJ, Proskin HM, Weinstein P, Billings R. Clinical outcomes for Early Childhood Caries (ECC): the influence of health locus of control. Eur J Paediatr Dent 2004; **5**: 76-80.

37. Sanders AE, Lim S, Sohn W. Resilience to Urban Poverty: Theoretical and Empirical Considerations for Population Health. Am J Public Health 2008; **98**: 1101-1106.

38. Ismail AI, Lim S, Sohn W, Willem JM. Determinants of early childhood caries in low-income African American young children. Pediatr Dent 2008; **30**: 289-296.

39. Östberg AL, Skeie MS, Skaare AB, Espelid I. Caries increment in young children in Skaraborg, Sweden: associations with parental sociodemography, health habits, and attitudes. Int J Paediatr Dent 2017; **27**: 47-55.

40. Duijster D, de Jong-Lenters M, de Ruiter C, Thijssen J, van Loveren C, Verrips E. Parental and family-related influences on dental caries in children of Dutch, Moroccan and Turkish origin. Community Dent Oral Epidemiol 2015; **43**: 152-162.

41. Brandão IM, Arcieri RM, Sundefeld ML, Moimaz SA. Early childhood caries: the influence of sociobehavioral variables and health locus of control in a group of children from Araraquara, São Paulo, Brazil. Cad Saude Publica 2006; **22**: 1247-1256.

42. Finlayson TL, Siefert K, Ismail AI, Sohn W. Psychosocial factors and early childhood caries among low-income African American children in Detroit. Community Dent Oral Epidemiol 2007; **35**: 439-448.

43. Lenčová E, Pikhart H, Broukal Z, Tsakos G. Relationship between parental locus of control and caries experience in preschool children - cross-sectional survey. BMC Public Health 2008; **8**: 208.

44. Bonanato K, Paiva SM, Pordeus IA, Ramos-Jorge ML, Barbabela D, Allison PJ. Relationship between Mothers' Sense of Coherence and Oral Health Status of Preschool Children. Caries Res 2009; **43**: 103-109.

45. Kakudate N, Morita M, Sugai M et al. Development of the self-efficacy scale for maternal oral care. Pediatr Dent 2010; **32**: 310-315.

46. Tiwari T, Quissell DO, Henderson WG et al. Factors Associated with Oral Health Status in American Indian Children. J Racial Ethn Health Disparities 2014; **1**: 148-156.

47. Duijster D, van Loveren C, Dusseldorp E, Verrips GHW. Modelling community, family, and individual determinants of childhood dental caries. Eur J Oral Sci 2014; **122**: 125-133.

48. Anaya-Morales M, Villanueva-Vilchis MC, Aleksejūnienė J, De la Fuente Hernández J. Mothers' self-efficacy and children's oral health. Int J Dent Hyg 2017; **15**: e128-e135.

49. Lin YC, Wang WC, Chen JH, Chen PH, Lee CH, Huang HL. Significant caries and the interactive effects of maternal-related oral hygiene factors in urban preschool children. J Public Health Dent 2017; **77**: 188-196.

50. Sa-Pinto AC, Silveira-Coelho V, Fernandes IB, Menezes-Silva R, Ramos-Jorge ML. Relationship Between Mother's Sense of Coherence and Oral Health of Babies aged 6-36 Months: A Pilot Study. Braz Res Ped Dent Int Clinic 2016; **16**: 185-193.

51. Maharani DA, Adiatman M, Rahardjo A, Burnside G, Pine C. An assessment of the impacts of child oral health in Indonesia and associations with self-esteem, school performance and perceived employability. BMC Oral Health 2017; **17**: 65.

52. Nunes VH, Perosa GB. Dental decay in 5-year-old children: sociodemographic factors, monitoring points and parental attitudes. Cien Saude Colet 2017; **22**: 191-200.

53. Kaur M, Jindal R, Dua R, Gautam A, Kaur R. Salutogenesis: A new approach toward oral health promotion. Contemp Clin Dent 2017; **8**: 387-390.

54. Tiwari T, Wilson AR, Mulvahill M, Rai N, Albino J. Maternal factors associated with early childhood caries in urban Latino Children. JDR Clin Trans Res 2018; **3**: 83-90.

55. Freire MC, Sheiham A, Hardy R. Adolescents' sense of coherence, oral health status, and oral health-related behaviours. Community Dent Oral Epidemiol 2001; **29**: 204-12.

56. Basak CA, Nilufer K, Murtomaa H. Self-efficacy perspective on oral health among Turkish pre-adolescents. Oral Health Prev Dent 2005; **3**: 209-215.

57. Cinar AB, Murtomaa H, Tseveenjav B. The Life-course Approach in Assessment of Dental Health: A Cross Sectional Study among Finnish and Turkish Pre-adolescents. Eur J Dent 2008; **2**: 153-160.

58. Acharya S, Pentapati KC, Singh S.Influence of socioeconomic status on the relationship between locus of control and oral health. Oral Health Prev Dent 2011; **9**: 9-16.

59. Virk P, Jain RL, Pathak A, Sharma U, Rajput JS. Inter-relationship of intelligence-quotient and self-concept with dental caries amongst socially handicapped orphan children. J Indian Soc Pedod Prev Dent 2012; **30**: 127-132.

60. Motamedi MK, Behzadi A, Khodadad N, Zadeh AK, Nilchian F. Oral health and quality of life in children: A cross-sectional study. Dent Hypotheses 2014; **5**: 53-58.

61. Fontanini H, Marshman Z, Vettore M. Social support and social network as intermediary social determinants of dental caries in adolescents. Community Dent Oral Epidemiol 2015; **43**: 172-182.

62. Acharya S, Pentapati KC, Singhal DK, Thakur AS, Acharya S. Development and Validation of a Socio-Dental Impact Locus of Control (SILOC) Scale. J Psychol Psychother 2014; **4**: 1000151.

63. Viswanath D, Krishna AV. Correlation between dental anxiety, sense of coherence (SOC) and dental caries in school children from Bangalore North: A cross-sectional study. J Indian Soc Pedod Prev Dent 2015; **33**: 15-18.

64. Lyra MCA, Cruz M, Menezes V, Heimer MV. Association between Sense of Coherence and Dental Caries Experience in Adolescents. Braz Res Ped Dent Int Clinic 2015, **15**: 235-241.

65. Shilpa M, Naik SP, Potdar S, Reddy SG, Patwardhan PK, Shree SS. Sense of Coherence and Oral Health Status among 16 to 17-year-old Preuniversity Students of Virajpet Taluk: A Cross-sectional Study. J Contemp Dent Pract 2016; **17**: 388-393.

66. Thiruvenkadam G, Asokan S, Baby John J, Geetha Priya PR. Association between Optimism, Psychosocial Well Being and Oral Health: A Cross-Sectional Study. J Clin Pediatr Dent 2016; **40**: 200-206.

67. Lage CF, Fulgencio LB, Corrêa-Faria P, Serra-Negra JM, Paiva SM, Pordeus IA. Association between dental caries experience and sense of coherence among adolescents and mothers. Int J Paediatr Dent 2017; **27**: 412-419.

68. Gururatana O, Baker SR, Robinson PG. Determinants of children's oral-health-related quality of life over time. Community Dent Oral Epidemiol 2014; **42**: 206-215.

69. Peker K, Bermek G. Oral health: locus of control, health behavior, self-rated oral health and socio-demographic factors in Istanbul adults. Acta Odontol Scand 2011; **69**: 54-64.

70. Finlayson TL, Siefert K, Ismail AI, Sohn W. Maternal self-efficacy and 1-5-year-old children's brushing habits. Community Dent Oral Epidemiol. 2007; **35**: 272-281.

71. Lindmark U, Hakeberg M, Hugoson A. Sense of coherence and its relationship with oral health-related behaviour and knowledge of and attitudes towards oral health. Community Dent Oral Epidemiol 2011; **39**: 542-553.

72. da Silva AN, Mendonca MH, Vettore MV. The association between low-socioeconomic status mother's sense of coherence and their child's utilization of dental care. Community Dent Oral Epidemiol 2011; **39**: 115-126.

73. Kallestal C, Dahlgren L, Stenlund H. Oral health behavior and self-esteem in Swedish adolescents over four years. J Adolesc Health 2006; **38**: 583-590.

74. Macgregor ID, Regis D, Balding J. Self-concept and dental health behaviours in adolescents. J Clin Periodontol 1997; **24**: 335-339.

75. da Silva AN, da Silva CM, Vettore MV. Are resilience and maternal sense of coherence associated with gingival status in adolescents from low-income families? Int J Paed Dent 2014; **24**: 450-459.

76. Watson JM, Logan HL, Tomar SL. The influence of active coping and perceived stress on health disparities in a multi-ethnic low income sample. BMC Public Health 2008; **8**: 41.

77. Baker SR, Matm A, Robinson PG.. What psychosocial factors influence adolescents' oral health? J Dent Res 2010; **89**: 1230-1235.

78. Aspinwall LG, Tedeschi RG. The value of positive psychology for health psychology: progress and pitfalls in examining the relation of positive phenomena to health. Ann Behav Med 2010; **39**: 4-15.

79. Costalonga M, Herzberg MC. The oral microbiome and the immunobiology of periodontal disease and caries. Immunol Lett 2014; **162**: 22-38.

Why this paper is important to paediatric dentists

- This review paper reveals the importance of some protective psychosocial factors on the occurrence of dental caries in children and adolescents.
- It demonstrates that different protective psychosocial factors are associated with dental caries among children and adolescents.
- It provides evidence on the importance of considering protective psychosocial factors in future intervention studies to reduce dental caries in children and adolescents.

List of illustrations

Table 1. Individual characteristics of the selected studies.

Author, year	Age group	Study design	Country, demographic characteristics of participants	Setting	Psychosocial factor and scale	Dental caries measure/ index	Statistical analysis	Main results
Reisine *et al.*, 1994[35]	Children	Cohort (1 year)	United States Parents and their children Baseline N = 355 Follow-up N=184 42% girls and 58% boys 3-4 years old	School	Caretaker dental health locus of control, Dental self-efficacy	dmfs index	Discriminant function analysis Structural equations modeling	Caretakers' dental health locus of control and self-efficacy were not associated with dental caries in children
Chase *et al.*, 2004[36]	Children	Cohort (6 months)	United States Parents and their children Baseline N = 79 Follow-up N=36 2.3-7.3 years (mean 4.2 years) GA	University Hospital for ECC treatment	Parental health locus of control	dmfs index	t-test	Health locus of control was not associated with new dental caries lesion
Sanders *et al.*, 2008[37]	Children	Cohort (18- to 24-months)	United States Caregiver and their child Baseline N = 1021 Follow-up N=788, Range: 0-5 years, Mean age=3 years	Households	Parental resilience	ICDAS	Poisson regression	Parental resilience was associated with lower risk for new caries lesions in children
Ismail *et al.*, 2008[38]	Children	Cohort (18- to 24-months)	United States Baseline N = 1021 Follow-up N=788 caregiver and their child, Range: 0-5 years, Mean age=3 years	Households	Oral health self-efficacy	ICDAS	Logistic regression and logit multinomial model	Oral health self-efficacy was not associated with new caries lesions in children
Österbg *et al.*, 2017[39]	Children	Cohort (3 years)	Sweden. Baseline N = 271 Follow-up N=243 Parents and their child, Age: 3 years, Mean age=3 years (SD 2 months) 46% girls and 54% boys	Public dental clinics	Parental health locus of control	Unclear	Logistic regression	Locus of control was not associated with caries increment
Duijster *et al.*, 2015[40]	Children	Case-control	Netherlands Cases = 46 Controls = 46 Parents and their child, Age=5-6 years, Mean age=6.1 (SD 0.5 years) 60% girls and 40% boys	Paediatric dental care centre	Dental self-efficacy Dental health locus of control Social network	DMFT index	t-test Logistic regression	Locus of control decreased the likelihood of being case.
Brandão *et al.*, 2006[41]	Children	Cross-sectional	Brazil Parents and their children N = 110 Age range= 24- 35 months	Public schools	Maternal health locus of control	dmft index	t-test	Maternal health locus of control was not associated with early childhood caries
Finlayson *et al.*, 2007[42]	Children	Cross-sectional	United States Parents and their children N = 719 Age range=1–5 years	Households	Maternal oral health-related self-efficacy Social support	ICDAS	Logistic regression	Maternal oral health self-efficacy and social support were not significantly associated with children's caries status

Lenčová *et al.*, 2008[43]	Children	Cross-sectional	Czech Republic Parents and their children N=285 44% girls, 66% boys), Mean age= 4.3 years, 3.6- 4.8 years	Households	Parental locus of control	dmft index/ ICDAS II	Logistic regression	High parental locus of health control was associated with free untreated caries and free caries experience
Bonanato *et al.*, 2009[44]	Children	Cross-sectional	Brazil, N=546 51% girls, 49%boys, Mean age=66 months (60-71 months)	Public and private preschools	Maternal sense of coherence	dmft index	Logistic regression	Low maternal sense of coherence was associated with dental caries lesions and filled teeth
Kakudate *et al.*, 2010[45]	Children	Cross-sectional	Japan N=119 Age range: 1-8 years	Private dental clinic	Self-efficacy scale for maternal oral care	Unclear	Spearman's rank correlation coefficient.	High Maternal self efficacy was correlated with lower number of decayed teeth
Tiwari *et al.*, 2014[46]	Children	Cross-sectional	United States N=981 Age range = 3-4 years 50% boys, 50% girls	Local community centres	Maternal oral Health Locus of Control, Self-Efficacy Sense of Coherence, Social Support	dmfs index	Multiple linear regression Multiple logistic regression	Maternal oral Health Locus of Control, Self-Efficacy, Sense of Coherence, Social Support were not associated with early childhood caries
Duijster *et al.*, 2014[47]	Children	Cross-sectional	The Netherlands N=630 48% girls, 52% boys Age range = 5.1-6.7 years	Dental clinics	Family functioning	dmft index	Linear regression	Family functioning dimensions were not associated with dental caries
Anaya-Morales *et al.*, 2016[48]	Children	Cross-sectional	Mexico N=130 Age range = 1-8 years	Public child institutions	Maternal self efficacy	DMFT/dmft index	Correlation coefficient	Maternal self-efficacy for dentist consultations was correlated to dental caries experience in primary dentition
Lin *et al.*, 2016[49]	Children	Cross-sectional	Taiwan N = 495 Age = 4-6 years 46% girls, 54% boys	Public and private schools	Maternal self-efficacy in oral hygiene	SiC	Multivariate Polytomous Logistic Regression	Lower maternal self-efficacy in oral hygiene was associated with dental caries
Sa-Pinto *et al.*, 2016[50]	Children	Cross-sectional	Brazil Parents and their children N= 32 Age range: 6-36 months (mean=27.13 months)	Dental clinic	Maternal Sense of Coherence	dmfs index	t-test, Pearson correlation coefficient	Mother's sense of coherence was not associated with dental caries
Maharani *et al.*, 2017[51]	Children	Cross-sectional	Indonesia N=445 Age range = 10-11 years 45% girls, 42% boys, 13% missing data	Public schools	Children's self-steem	DMFT index	Not reported	No significant association was reported between child's self-esteem and caries experience
Nunes *et al.*, 2017[52]	Children	Cross-sectional	Brazil N=426 Age = 5 years 47% girsl, 53%boys	Public and private pre schools	Maternal health-related locus of control	dmft index	Logistic regression	Maternal internal and external locus of control was associated with dental caries experience
Kaur *et al.*, 2018[53]	Children	Cross-sectional	India N=200 Age range= 4-8years	Public school	Maternal Sense of coherence	dmfs/DMFS index	One-way analysis of variance F-test and post hoc Tukey	Mother's sense of coherence was inversely associated with dental caries

Tiwari *et al*., 2018[54]	Children	Cross-sectional	United States N=99 Age range= < 6 years (mean=3.99 years) 46 % girls and 54% boys	Dental clinic	Maternal oral health locus of control and self-efficacy	dmfs index	Negative binomial regression	Maternal oral health locus of control and self-efficacy were not associated with dental caries
Bernabé *et al*., 2011[34]	Adolescents	Longitudinal	United Kingdom N=689 46% boys, 54% girls Age= 11- 12 years (mean = 11.7 years)	Schools	Adolescent Perceived social Support	DMFT index	Poisson regression analysis	Social support was negatively related to dental caries experience and increment
Nelson *et al*., 2012[9]	Adolescents	Longitudinal	United States, N=224 53% girls, 47% boys Age = 14 years	Hospitals	Maternal perceived social support and Maternal coping	DMFT index	Structural equation modelling	Higher maternal social support at child's age 3 was associated with lower DMFT at 14 yrs Greater maternal coping skills at child's age 8 was associated with higher DMFT at 14-years
Freire *et al*., 2001[55]	Adolescents	Cross-sectional	Brazil, N= 664 52%girls and 48% boys Age = 15 years	Public and private school	Adolescents and maternal sense of coherence	DMFT index and UK children's dental health survey criteria	Multiple logistic regression and polytomous ordered Regression analyses	Adolescents' SOC was not associated with DMFT. Maternal SOC was associated with adolescents' caries severity and caries experience in anterior teeth
Basak *et al*., 2005[56]	Adolescents	Cross-sectional	Turkey N=611 Age range= 10-12 years	School in Istanbul	Adolescent tooth-brushing and modified dietary self-efficacy scale	DMFT index	Pearson correlation coefficient and t-test	Tooth-brushing self-efficacy but not dietary self-efficacy was correlated with lower DMFT
Cinar *et al*., 2008[57]	Adolescents	Cross sectional	Turkey and Finland N= 459 Turkey; N= 155 Finland Range= 10-12 years	Schools	Adolescent Tooth-brushing self-efficacy and self-esteem	DMFT index	Logistic regression analysis	Adolescent high self-esteem was associated with greater DMFT among Turkish but not among Finnish pre-adolescents. Adolescent tooth-brushing self-efficacy was not associate with DMFT in both groups.
Acharya *et al*., 2011[58]	Adolescents	Cross sectional	India, N=318 72% girls, 28% boys Mean age= 15 years	Private and government al schools	Health locus of control	DMFT index	Hierarchical multiple regression	Internal locus of control was inversely associated with dental caries experience
Virk *et al*., 2012[59]	Adolescents	Cross-sectional	India, N=100 Range=10-14 years	Orphanages	Self concept	DMFT index	Pearson Correlation Coefficient, t test	Self-concept was not correlated with DMFT
Motamedi *et al*., 2014[60]	Adolescents	Cross sectional	Iran, N=336 49.4% girls, 50.6% boys Range = 11-15 years Mean age= 13 years	Schools	Adolescents' sense of Coherence, self-esteem, health locus of	DMFT index	Cox's regression model, Spearman's test, and	Adolescents' sense of coherence, self-esteem, and health locus of control

					control		Pearson's tests.	did not show significant relationships with dental caries
Fontanini *et al*., 2014[61]	Adolescents	Cross sectional	Brazil, N=542 51% girls, 49% boys Range = 12-14 years	School	Social support, Social network	DMFT index	Multivariate Poisson regression	Low social networks and low social support from family were associated with DMFT ≥ 1 and current dental caries.
Acharya *et al*., 2014[62]	Adolescents	Cross sectional	India, N=509 40% girls, 60% boys Range=15-17 years	Pre-university colleges	Locus of control	DMFT index	Multiple logistic regression	A more external locus of control was associated with higher dental caries experience
Viswanath *et al*., 2015[63]	Adolescents	Cross sectional	India, N=529 Range=12-16 years	Schools	Sense of Coherence	DMFS index	ANOVA and multiple comparison procedures	Low sense of coherence predicted high dental caries
Lyra *et al*. 2015[64]	Adolescents	Cross sectional	Brazil, N=100 43% girls, 57% boys Range = 11-15 years	Schools	Sense of Coherence	DMFT index	Spearman correlation coefficient	DFMT, decayed, missing and filled teeth were correlated with Sense of coherence
Shilpa *et al*., 2016[65]	Adolescents	Cross sectional	India, N=361 58% girls, 42% boys Range=16-17 years	Schools	Sense of Coherence	DMFT index	Chi-square and ANOVA	Sense of coherence was not associated with DT and DMFT
Thiruvenkadam *et al*., 2016[66]	Adolescents	Cross sectional	India, N=2014 45% girls, 55% boys Range=12-15 years	Private schools	Optimism	DMFT index	Pearson Chi-Square test and Mann-Whitney test	Girls with high optimism were more likely of having dental caries, whereas boys with high optimism were less likely to have dental caries
Lage *et al*., 2017[67]	Adolescents	Cross sectional	Brazil, N=1195 56%girls, 44%boys Range: 13-15 years	Public and private schools	Adolescents' and maternal Sense of Coherence	DMFT index	Chi-Square test, Poisson regression	Adolescents' and mothers' Sense of coherence were associated with decayed teeth

Fig 1. Flowchart of studies through the review.

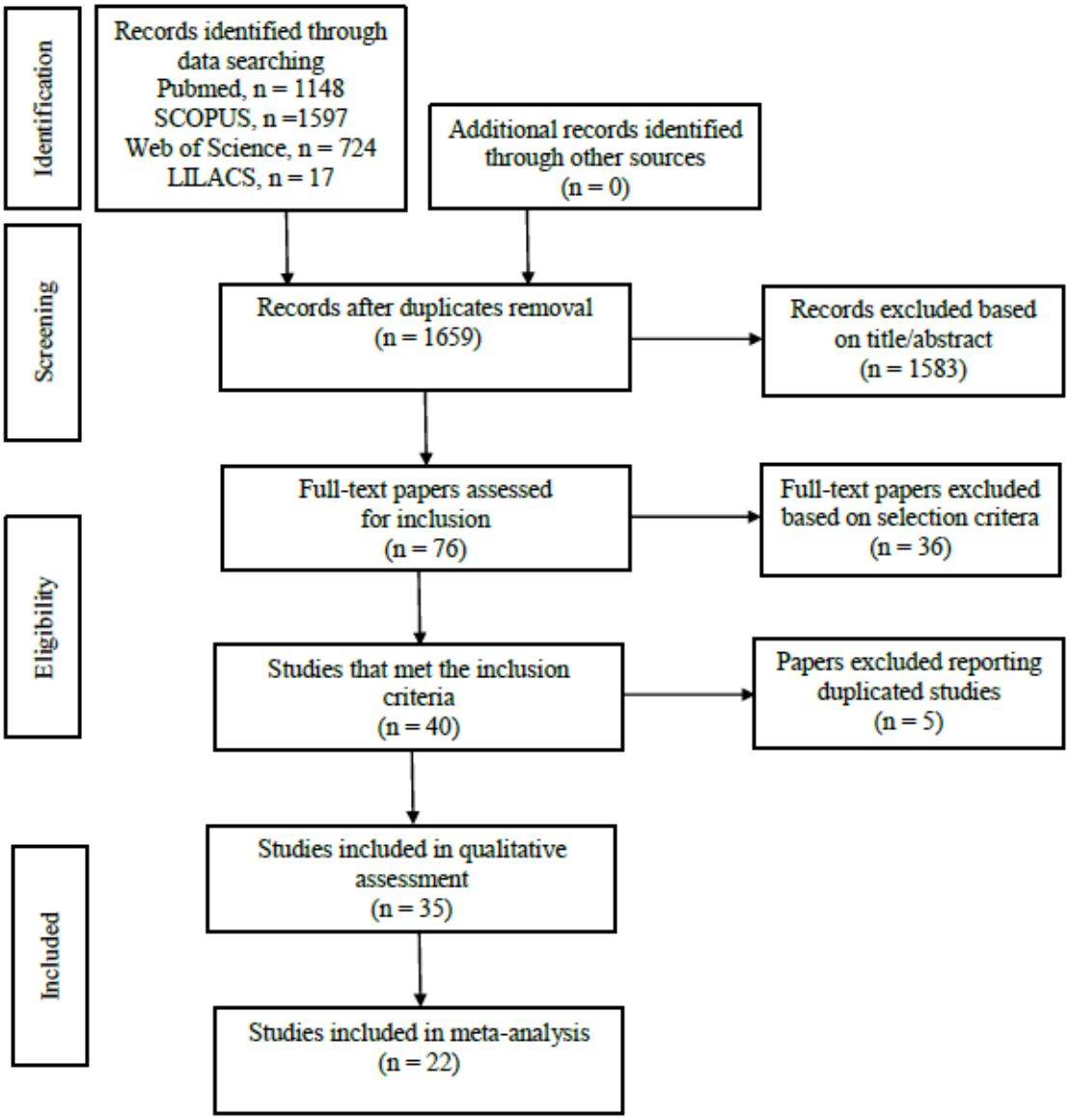
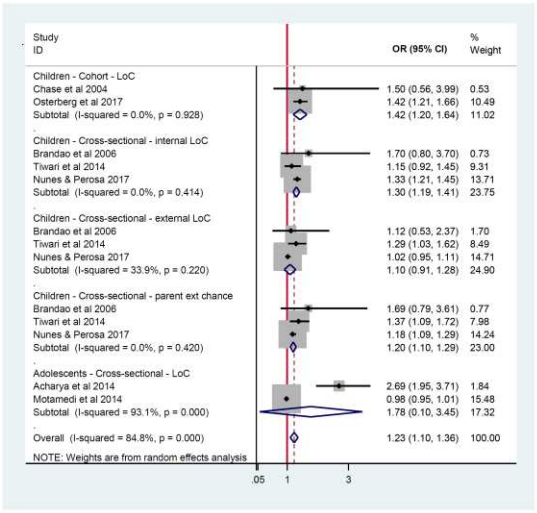
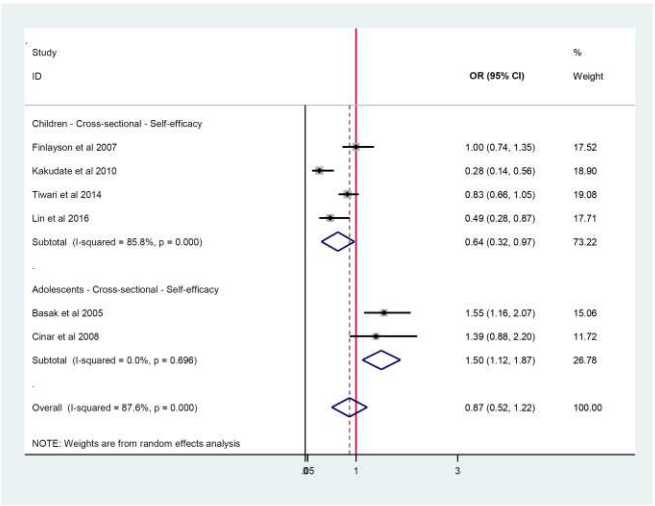


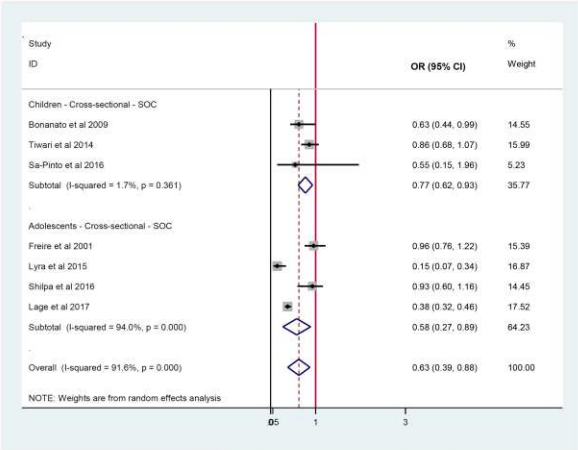
Fig 2. Forest plots presenting the Odds Ratio (ES) and 95% confidence intervals (CI) for the studies on the association between protective psychosocial and dental caries in children and adolescents.



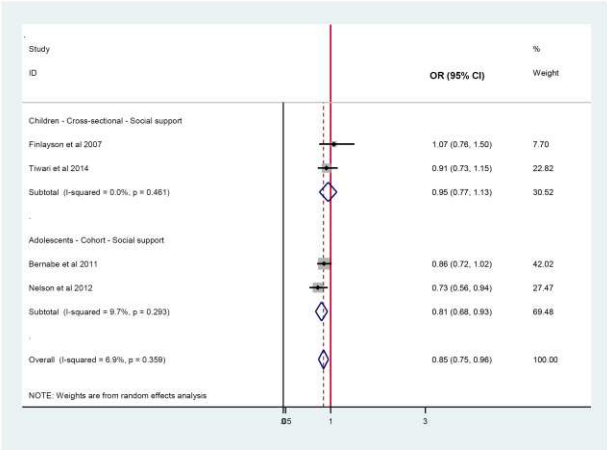
A. Locus of control



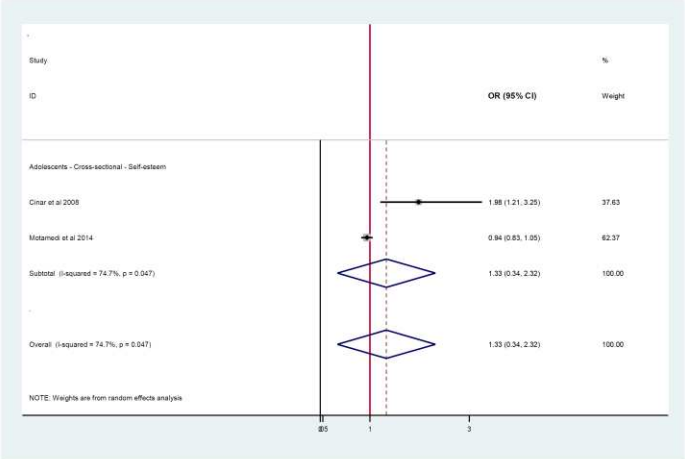
B. Self-efficacy



C. Sense of coherence



D. Social support



E. Self-esteem

Supplementary Data 1. New Castle Ottawa (NOS) Quality Assessment of longitudinal studies.

Supplementary Data 1. New Castle Ottawa (NOS) Quality Assessment of cohort studies.

Author/year	**Selection**				**Comparability**	**Outcome**			**Summary**
	Represent ativeness	Selection	Psychosocial factor	Outcome of interest	Comparability of cohorts	Assessment of dental caries	Follow-up was long enough	Adequacy of follow up	**Score max. 9 stars**
Children									
Reisine *et al*., 1994[35]	b*	a*	a*	a*	ab**	a*	a*	c	******** (8)
Chase *et al*., 2004[36]	c	a*	a*	a*	c	a*	b	c	**** (4)
Sanders *et al.,* 2008[37]	c	a*	a*	a*	ab**	a*	a*	c	******* (7)
Ismail *et al*., 2008[38]	c	a*	a*	a*	ab**	a*	a*	c	******* (7)
Österbg *et al*., 2017[39]	c	a*	b	a*	ab**	a*	a*	b*	******* (7)
Adolescents									
Bernabé *et al*., 2011[34]	a*	a*	a*	a*	ab**	a*	a*	c	******** (8)
Nelson *et al*., 2012[9]	c	a*	b	b	ab**	a*	a*	b*	****** (6)

Selection (Maximum 4 stars)
1) Representativeness of the exposed cohort: a) truly representative of the average in the target population (random sampling)*, b) somewhat representative of the average in the target population (non-random sampling)*, c) selected group of patients, d) no description of the derivation of the cohort.
2) Selection of the non exposed cohort: a) drawn from the same community as the exposed cohort*, b) drawn from a different source, c) no description of the derivation of the non exposed cohort.
3) Measurement of the psychosocial factor: a) Validated measurement tool*, b) Non-validated measurement tool, but the tool is available or described, c) No description of the measurement tool.
4) Demonstration that outcome of interest was not present at start of study: a) yes*, b) no
Comparability (Maximum 2 stars)
1) Comparability of cohorts on the basis of the design or analysis: a) study controls for socioeconomic status*, b) study controls for any additional factor*, c) No description related to the adjustment analysis for confounding factors.
Outcome (Maximum 3 stars)
1) Assessment of dental caries: a) Independent blind assessment using clinical indices by calibrated examiners*, b) Record linkage using clinical indices by calibrated examiners*, c) Self report or clinical indices without description of calibration, d) No description.
2) Was follow-up long enough for outcomes to occur: a) yes (follow-up of 12 months or over)*, b) no
3) Adequacy of follow up of cohorts: a) complete follow up*, b) small subjects lost to follow up unlikely to introduce bias (≥ 80 % follow up, or description provided of those lost)*, c) follow up rate < 80% or no desription of those lost, d) no statement

Supplementary Data 2. New Castle Ottawa (NOS) Quality Assessment of case-control study.

Supplementary Data 2. New Castle Ottawa (NOS) Quality Assessment of case-control study

Author/year	**Selection**				**Comparability**	**Exposure**			**Summary**
	Case definition	Represent ativeness	Selection of controls	Definition of controls	Control for confounders	Psychosocial factor	Ascertainment	Non-Response rate	**Score** max.7 stars
Children									
Duijster *et al*., 2015[40]	a*	a*	b	a*	b*	a*	a*	b	****** (6)

Selection: (Maximum 4 stars)
1) Definition of case: a) Adequate with independent validation or record linkage using clinical indices by calibrated examiners*, b) Self report or clinical indices without description of calibration, c) No description.
2) Representativeness of the cases: a) consecutive or obviously representative series of cases*, b) potential for selection biases or not stated
3) Selection of Controls: a) community controls*, b) hospital controls, c) no description
4) Definition of Controls: a) no history of disease (endpoint)*, b) no description of source
Comparability: (Maximum 2 stars)
1) Confounding factors are controlled. a) The study controls for socioeconomic status*, b) The study control for any additional factor**, c) No description related to the adjustment analysis for confounding factors.
Exposure: (Maximum 3 stars)
1) Measurement of the psychosocial factor: a) Validated measurement tool*, b) Non-validated measurement tool, but the tool is available or described, c) No description of the measurement tool
2) Same method of ascertainment for cases and controls: a) yes*, b) no
3) Non-Response rate: a) same rate for both groups*, b) non respondents described, c) rate different and no designation

Supplementary Data 3. New Castle Ottawa (NOS) Quality Assessment of cross-sectional studies.

Supplementary Data 3. New Castle Ottawa (NOS) Quality Assessment of cross-sectional studies

Author/year	Sample selection criteria				Comparability	Outcome	Summary Score
	Representativeness	Sample size	Non-respondents	Psychosocial factor	Control for confounders	Assessment of dental caries	max.7 stars
Children							
Brandão *et al*., 2006[41]	b*	b	c	a*	c	a*	*** (3)
Finlayson *et al*., 2007[42]	a*	b	c	a* (self-efficacy) b (social support)	c	a*	*** (3) ** (2)
Lenčová *et al*., 2008[43]	a*	a*	b	a*	a*	a*	***** (5)
Bonanato *et al*., 2009[44]	a*	a*	b	a*	ab**	a*	****** (6)
Kakudate *et al*., 2010[45]	c	b	c	a*	c	d	* (1)
Tiwari *et al*., 2014[46]	b*	b	b	b	ab**	a*	**** (4)
Duijster *et al*., 2014[47]	b*	a*	b	a*	ab**	c	***** (5)
Anaya-Morales *et al*., 2016[48]	b*	b	a*	a*	c	b*	**** (4)
Lin *et al*., 2016[49]	a*	b	c	b	ab**	a*	**** (4)
Sa-Pinto *et al*., 2016[50]	c	b	c	a*	c	a*	** (2)
Maharani *et al*., 2017[51]	b*	b	a*	a*	c	c	*** (3)
Nunes & Perosa, 2017[52]	b*	b	b	a*	ab**	a*	***** (5)
Kaur *et al*., 2018[53]	d	b	c	b	c	c	*** (3)
Tiwari *et al*., 2018[54]	c	b	c	a*	ab**	a*	**** (4)
Adolescents							
Freire *et al*., 2001[55]	a*	a*	c	a*	ab**	a*	****** (6)
Basak *et al*., 2005[56]	d	b	c	a*	c	a*	** (2)
Cinar *et al*., 2008[57]	a*	b	c	b	ab**	a*	**** (4)
Acharya *et al*., 2011[58]	c	a*	c	a*	a*	a*	**** (4)
Virk *et al*., 2012[59]	d	b	c	a*	c	a*	** (2)
Motamedi *et al*., 2014[60]	b*	b	b	a*	c	a*	*** (3)
Fontanini *et al*., 2014[61]	a*	a*	b	a*	ab**	a*	****** (6)
Acharya *et al*., 2014[62]	c	b	c	a*	ab**	a*	**** 4
Viswanath & Krishna, 2015[63]	d	b	c	b	c	c	(0)
Lyra *et al*., 2015[64]	c	b	c	a*	c	a*	** (2)
Shilpa *et al*., 2016[65]	a*	b	c	a*	c	a*	*** (3)
Thiruvenkadam *et al*., 2016[66]	a*	b	c	b	c	d	* (1)
Lage *et al*., 2017[67]	a*	a*	c	a*	ab**	a*	****** (6)

Supplementary Data 4. Protective psychosocial factors and dental caries measures of studies included in the meta-analyses

Meta-analysis A - Locus of control	**Psychosocial factor measure**	**Dental caries measure**
Children / Cohort / Locus of control		
Chase et al 2004[36]	Mean score	Increment of dental caries 0 vs ≥1
Östberg et al 2017[39]	Low or high based on the median	Increment of dental caries 0 vs ≥ 1
Children / Cross-sectional / Locus of control		
Brandão et al 2006[41]	Mean score	Dental caries = 0 vs dental caries ≥ 1
Tiwari et al 2014[46]	Mean score	dmfs score
Nunes et al 2017[52]	Mean score	dmfs < 5 vs dmfs ≥ 5
Adolescents / Cross-sectional / Locus of control		
Acharya et al 2014[62]	Mean score	Dental caries = 0 vs dental caries ≥ 1
Motamed et al2014[60]	Mean score	DMFT score
Meta-analysis B – Self-efficacy	**Psychosocial factor measure**	**Dental caries measure**
Children / Cross-sectional		
Finlayson et al 2007[42]	Mean score	Dental caries = 0 vs dental caries ≥ 1
Kakudate et al 2010[45]	Mean score	Number of decayed teeth
Tiwari et al 2014[46]	Mean score	dmfs score
Lin et al 2016[49]	Low or high. Unclear the criteria	dmft < 6 vs dmft ≥ 6
Adolescents / Cross-sectional		
Basak et al 2005[56]	Low or high based on the median	dmfs score
Cinar et al 2008[57]	Low or high based on the median	DMFT = 0 vs DMFT > 0
Meta-analysis C – Sense of coherence	**Psychosocial factor measure**	**Dental caries measure**
Children / Cross-sectional		
Bonanato et al 2009[44]	Low or high based on the median	Number of decayed teeth
Tiwari et al 2014[46]	Mean score	dmfs score
Sá-Pinto et al 2016[50]	Mean score	Number of decayed teeth
Adolescents / Cross-sectional		
Freire et al 2001[55]	Mean score	Dental caries = 0 vs dental caries ≥ 1
Lyra et al 2015[64]	Mean score	Number of decayed teeth
Shilpa et al 2016[65]	Low, intermediate or high based on the tertiles of scores	Number of decayed teeth
Lage et al 2017[67]	Low or high based on the median of scores	Dental caries = 0 vs dental caries ≥ 1
Meta-analysis D - Social support	**Psychosocial factor measure**	**Dental caries measure**
Children / Cross-sectional		
Finlayson et al 2007[42]	Dichotomous yes vs no	Dental caries = 0 vs dental caries ≥ 1
Tiwari et al 2014[46]	Mean score	dmfs score
Adolescents / Cohort		
Bernabé et al 2011[34]	Mean score	DMFT score
Nelson et al 2012[9]	Mean score	DMFT score
Adolescents / Cross-sectional		
Bernabé et al 2011[34]	Mean score	DMFT score
Fontanini et al 2014[61]	Low, moderate or high based on the tertiles	DMFT = 0 vs DMFT ≥ 1
Meta-analysis E - Self-esteem	**Psychosocial factor measure**	**Dental caries measure**
Adolescents / Cross-sectional		
Cinar et al 2008[57]	Low or high based on the median	DMFT = 0 vs DMFT ≥ 1
Motamedi et al 2014[60]	Mean score	DMFT score