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*a systematic review with meta-analysis*


*Published in:*
Community Dentistry and Oral Epidemiology

*DOI:*
10.1111/cdoe.12224

*Link to publication*

*Citation for published version (APA):*

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Download date: 22 Jan 2020
Unsolicited Systematic Review

Psychosocial correlates of oral hygiene behaviour in people aged 9 to 19 – a systematic review with meta-analysis


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Abstract – Objectives: This systematic and meta-analytic review aimed to quantify the association of psychosocial correlates with oral hygiene behaviour among 9- to 19-year olds. Methods: A systematic search up to August 2015 was carried out using the following databases: PubMed, Psychnfo, Embase, CINAHL and Web of Science. If necessary, authors of studies were contacted to obtain unpublished statistical information. A study was eligible for inclusion when it evaluated the association between the psychosocial correlates and oral hygiene behaviour varying from self-reports to clinical measurements, including plaque and bleeding scores. A modified New Castle Ottawa Scale was applied to examine the quality of the included studies. Results: Twenty-seven data sets (k) presented in 22 publications, addressing nine psychosocial correlates, were found to be eligible for the meta-analysis. For both tooth brushing and oral hygiene behaviour, random effect models revealed significant weighted average correlation (r+) for the psychosocial factors: ‘intention’, ‘self-efficacy’, ‘attitude’ (not significant for tooth brushing), ‘social influence’, ‘coping planning’ and ‘action planning’ (r+, ranging from 0.18 to 0.57). Little or no associations were found for ‘locus of control’, ‘self-esteem’ and ‘sense of coherence’ (r+, ranges from 0.01 to 0.08). Conclusions: The data present indicates that ‘self-efficacy’, ‘intention’, ‘social influences’, ‘coping planning’ and ‘action planning’ are potential psychosocial determinants of oral health behaviour. Future studies should consider a range of psychological factors that have not been studied, but have shown to be important psychosocial determinants of health behaviours, such as ‘self-determination’, ‘anticipated regret’, ‘action control’ and ‘self-identity’. Effectiveness of addressing these potential determinants to induce behaviour change should be further examined by intervention trials.

Key words: behavioral science; dental health perceptions; oral hygiene; pediatric dentistry; psychosocial aspects of oral health

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Submitted 26 January 2015; accepted 31 January 2016

Despite great global improvements in oral health during the 21st century, oral diseases remain a major health problem1,2. According to the WHO report, dental caries affects approximately 60–90% of children and the vast majority of adults in developed countries2. The performance...
of adequate oral hygiene is important in the prevention of oral diseases, yet a large proportion of the population fails to sufficiently adopt or maintain adequate oral hygiene behaviour. Adolescence in particular can be a time of increased caries activity and periodontal disease due to a decline in the quality of oral hygiene behaviour. There is an urgent need for effective programmes to improve oral hygiene behaviour in this age group.

A systematic review of interventions in adolescents concluded that behavioural interventions to promote oral health of adolescents had limited success and alternative approaches of oral health promotion should be explored. There is increasing recognition that interventions should be guided by the intervention mapping (IM) protocol; however, none of oral health promotion programmes regarding adolescents have used the intervention mapping protocol for its development. According to the IM protocol, intervention development starts with the analysis of the health problem including the identification of the determinants related to the problem and the specific health-related behaviour. This is based on the assumption that it is possible to change health behaviour by targeting the determinants of this behaviour (the causal mechanism of behaviour), thus leading to an improvement of the health outcome.

Of these determinants, psychosocial factors have been identified as important modifiable determinants of behaviour. In adults, a systematic review demonstrated that interventions targeting psychosocial factors led to changes in oral hygiene behaviour. Until now, behavioural interventions regarding adolescents have, however, rarely targeted psychosocial determinants. This explains why these interventions had limited success. Therefore, insight into psychosocial factors is necessary to design evidence-based oral health interventions. No review has so far attempted to summarise the existing evidence regarding all psychosocial factors related to oral hygiene behaviour.

The purpose of this study was to analyse the associations between psychosocial factors and oral hygiene behaviours by a systematic and meta-analytic review. The research question states: ‘what are the associations between psychosocial factors and oral hygiene behaviour among people aged 9 to 19?’ We decided to limit our study to this age group, as previous meta-analysis has shown that psychosocial factors in young people are different from those in adults. The cut-off point of the age of 9 was chosen, because children aged 9 years and older are supposed to practice oral hygiene behaviour independently without parental supervision.

**Methods**

**Data sources and search strategy**

This systematic and meta-analytic review is reported in consistent with MOOSE guidelines. The following databases were searched from inception up to 24 August 2015: PubMed, Embase, Ebsco/PsycInfo, Ebsco/CINAHL and ISI/Web of Science. All languages were accepted. The comprehensive search strategy was designed in collaboration with health sciences librarian (JS and JK). As psychosocial factors can be reported by studies that apply social-cognitive models to explain or predict behaviour, social-cognitive models were included as search terms to create a sensitive and complete search. Search terms (including synonyms and closely related words) were first chosen and used as index terms or free-text words in PubMed (Table 1). Consequently, the search strategy was adapted and optimized for all consulted databases (available on request). Manual cross-referencing of bibliographies was carried out. Additionally, we utilized indexing sources to retrieve subsequent relevant articles that have cited the included publications.

**Eligibility criteria**

A study was eligible for inclusion if it described the association between psychosocial correlates and oral hygiene behaviour of healthy children with a mean age in the range of 9–19. We defined the dependent variable ‘oral hygiene behaviours’ as oral self-care behaviours which impact or have the potential to impact the oral health of an individual. We included indices of oral hygiene behaviour, if the outcome encompasses one of more oral hygiene behaviours such as tooth brushing, interdental cleaning, fluoride use and flossing behaviour. Studies reporting oral health behaviours like dental visits and sugar consumption were only included if this behaviour was studied in combination with the oral hygiene behaviours mentioned above. Measurement of oral hygiene behaviour could vary from self-report to clinical measurements. The clinical measurements included plaque and gingival indices indirectly measuring the quality oral home care behaviours, a proxy measure of behaviour.
Table 1. Search strategy (in PubMed)


#6 ((#1 OR #2 OR #3) AND #4 AND #5)


Furthermore, in the event of several publications reporting the outcomes on an identical group of participants, only the most recent publication was included. Studies were excluded, when the study population was exposed to an intervention prior to measurement. In case of an intervention study, data from the baseline measurement prior to the intervention or no-treatment control group were included. Only literature in English, Dutch and German was included. Qualitative studies, reviews, expert opinion, conference proceedings and case studies were excluded.

Study selection

The study selection was performed in two stages. In the first stage, two persons (JS and EW) independently read the title and abstract of potentially relevant articles against the eligibility criteria. If the abstract contained insufficient information for the decision on whether to include or exclude, the full-text article was obtained and reviewed before a decision was made. In the second stage, full-text articles were obtained and the same two persons independently applied the eligibility criteria to confirm the final selection. If necessary, a third reviewer (PE) was consulted to resolve disagreements or the authors of the included studies were contacted to verify eligibility. Consensus was reached in 100% of the cases.

Data extraction

Two authors (JS and PE) performed the data extraction using a predefined data extraction form. Information was extracted from each included study on authors and year of publication, setting, country, description of the study population (sample size, age and gender), study design, psychological theory or behavioural model used for the design of the study, used definition and measurement of the oral hygiene behaviour under study, the psychosocial correlates assessed and the reported effect sizes. In addition, we contacted authors of studies to obtain unpublished statistical information or for clarification. To ensure the comparability of the psychosocial correlates across studies, measures of the correlates were coded based on actual operationalizations presented in Table 2, rather than the name that the concepts were given in the articles. The psychosocial correlates and outcomes of the included studies were coded so that higher scores indicated greater engagement in oral hygiene behaviour.
Quality assessment of the included studies

The reviewers (JS & EW) independently assessed the methodological quality of the selected articles with a method adapted from Elyasi et al. (2015), which was based on a modified Newcastle–Ottawa Scale. As one item with regard to controlling for confounders was inapplicable, this item was skipped. For cross-sectional studies, a quality score was based on five items of the following categories: group selection, outcome and exposure. For cohort studies, two items were added: duration and adequacy of follow-up. A maximum score of five points for cross-sectional studies and seven points for prospective studies represented the highest methodological quality. Discrepancies between the assessors were resolved via discussion with third reviewer (PE) until reaching a consensus. The report of this procedure is available on request from the corresponding author.
Results

Study selection

Figure 1 shows the flow diagram presenting the selection process of the included articles. After removing duplicates, a total of 3548 unique articles were found by searching the databases. Screening on title and abstract led to retention of 203 potentially relevant articles. Reading on full-text resulted in exclusion of 179 publications. The flow diagram displays a summary of the excluded papers and the reasoning behind their exclusion. The final sample contained 31 unique data sets (k) reported in 24 articles20,21,25–27,31,32,36–52.

Study characteristics

Table S1 presents the characteristics and cumulative score of the methodological quality assessment of all studies selected for the systematic review. For cross-sectional studies, the quality assessment scores range from three to five points. Prospective studies scores range from five to six points. Across the studies, the quality scores vary in three items, namely information about the nonrespondents, validation of measurement of the psychosocial factors and assessment of the outcome. The included articles were published from 1972 onwards. Selected studies were conducted in seventeen different countries, located in Europe (k = 15), North America (k = 3), South America (k = 1), Africa (k = 1), Asia (k = 8) and Oceania (k = 3). In total, the studies sampled 104288 participants. The majority of the studies (k = 25) focused on self-reported tooth brushing frequency. Five data sets focused on self-reported oral hygiene behaviour, which comprised a set of different activities. Finally, the remaining data sets focused flossing frequency (k = 9) and/or plaque score (k = 3). Twenty-nine data sets were cross-sectional in design, including papers that presented baseline results of a longitudinal study. Six data sets were prospective in design. Only 39% of the studies based their research on a behavioural theory, the remaining 61% of the studies did not refer to a specific theoretical framework. The most dominant theoretical framework used for the design in the included studies (25%) was the ‘Theory of Planned Behaviour’17.

Synthesis of results

Twenty-seven unique data sets reported in 22 publications were included in quantitative synthesis (meta-analysis)20,21,25–27,36–52. Meta-analyses were

Statistical procedure

Meta-analyses were undertaken using Comprehensive Meta-Analysis (CMA) software (version 2.0). A weighted average correlation (r) and its 95% confidence interval (CI) were calculated per psychosocial correlate and oral hygiene behaviour (range: −1.0 to +1.0) using Fisher’s Z-transformations30. Pearson and Spearman correlation coefficients (r) were used as the effect size for analyses. When the odds ratio (OR) was reported instead of the correlation coefficient, CMA converted the crude OR to a correlation coefficient. CMA computed the oral hygiene behaviour outcome by combining the independent variables of each included study and calculating a mean effect size. Random effects models were chosen due to the heterogeneity across studies caused by various operationalizations of outcomes. Only bivariate analyses were synthesized because multivariate analyses were incommensurable over studies as the studies adjusted for different confounders in their models. This resulted in exclusion of two articles from the analysis31,32. Meta-analyses were only performed if data of two or more independent correlations were available (k > 1). This latter resulted in the exclusion of one study from the analysis27. If a study reported an effect size for boys and girls, but not for mixed gender, a mean effect size was computed by CMA. Heterogeneity analyses, Q and I² statistics, were conducted to determine whether the variation among correlations was greater than chance33,34. Additionally, subgroup analyses were conducted to test if the study designs (cross-sectional vs. prospective) could explain the observed heterogeneity among effect sizes. If the mixed-effect models revealed significant differences, the results of cross-sectional and prospective design were separately reported. By contrast, if the mixed-effect models revealed non-significant differences, a combined effect size was reported to serve as a summary. To assess the extent of publication bias, we calculated the Rosenthal’s fail-safe number (FSN), which estimates the number of studies with null findings necessary to nullify the significant weighted effect35. A larger FSN value indicates a more robust weighted average effect size. As a rule of thumb, it has been suggested that the recommended tolerance is 5k + 10, where k is the number of studies retrieved35. FSN could only be calculated when k > 2. If the FSN is larger than the recommended tolerance, then the results are robust35.
performed for the most frequently reported outcome: tooth brushing and for a combined oral hygiene behaviour outcome, which combined various oral hygiene behaviours. The results of the meta-analyses and the heterogeneity analyses for the psychosocial correlates of tooth brushing are presented in Table 3, and for oral hygiene behaviour, in Table 4. The majority of the heterogeneity tests were significant (Tables 3 and 4). Nine psychosocial correlates were addressed across the included studies. These correlates include the following: coping planning, action planning, intention, self-efficacy/perceived behavioural control, social influences, attitude, sense of coherence, self-esteem and locus of control. The results of the meta-analysis for each psychosocial correlate of tooth brushing are described next in order of strength.

**Coping planning.** Tooth brushing frequency was found to be related positively to ‘coping planning’ with a $r_+ = 0.57$ ($k = 2; P < 0.001$).

**Action planning.** A significant weighted average correlation of 0.47 was observed for action planning with tooth brushing ($k = 2; P < 0.001$). Mixed-effect models showed significant moderate effects, which indicate that the study design accounted for the heterogeneity in the overall distribution ($Q$-value = 7.9; $P = 0.005$). Prospective studies reported stronger correlations for action planning on tooth brushing ($r_+ = 0.57; P < 0.001; k = 2$) than for cross-sectional studies ($r_+ = 0.35; P < 0.001; k = 2$).

**Intention.** A significant weighted average correlation of 0.43 was observed for intention with tooth brushing ($k = 4; P = 0.002; FSN = 410$).

**Self-efficacy or perceived behavioural control.** The average weighted correlation between ‘self-efficacy’ or ‘perceived behavioural control’ and tooth brushing was estimated at 0.36 ($k = 5; P < 0.001; FSN = 625$).

**Social influences.** A significant weighted average correlation of 0.32 was observed for social influences with tooth brushing ($k = 2; P < 0.001$).

**Attitude.** The weighted average correlation between attitude and tooth brushing was estimated at 0.18 ($k = 3$), which was not significant ($P = 0.109$).

**Sense of coherence.** A nonsignificant pooled correlation for sense of coherence and tooth brushing was observed ($r_+ = 0.04; k = 3; P = 0.092$).
Self-esteem. Self-esteem had a negligible association with tooth brushing in the analysis ($r_s = 0.08; k = 7; P < 0.001; \text{FSN} = 235$).

Locus of control. The average weighted correlation between locus of control and tooth brushing was estimated at $r_s = 0.04 (k = 6; P = 0.001; \text{FSN} = 13$).

Analysis for the outcome oral hygiene behaviour revealed significant positive weighted average correlations for the variables: ‘intention’ ($r_s = 0.46; k = 7; P < 0.001; \text{FSN} = 1000$), ‘self-efficacy’ ($r_s = 0.44; k = 10; P < 0.001; \text{FSN} = 2441$), ‘coping planning’ ($r_s = 0.43; k = 3; P = 0.001; \text{FSN} = 374$), ‘social influences’ ($r_s = 0.32; k = 5; P < 0.001; \text{FSN} = 272$), ‘action planning’ ($r_s = 0.31; k = 3; P = 0.021; \text{FSN} = 210$), ‘attitude’ ($r_s = 0.23; k = 11; P < 0.001; \text{FSN} = 984$), ‘sense of coherence’ ($r_s = 0.06; k = 3; P = 0.008; \text{FSN} = 2$) and ‘self-esteem’ ($r_s = 0.05; k = 7; P = 0.001; \text{FSN} = 84$). A nonsignificant pooled correlation was observed between ‘locus of control’ and oral health behaviour ($r_s = 0.01; k = 6; P = 0.144$) (Table 4).

Discussion

The present systematic and meta-analytic review of 27 unique data sets aimed to identify psychosocial determinants of oral hygiene behaviour in young people aged 9 to 19. A higher tooth brushing frequency was observed among those with higher ‘intention’, ‘social influences’, ‘self-efficacy’,...
‘action planning’ and ‘coping planning’, which suggests that these factors are potential psychosocial determinants of tooth brushing. The pooled correlations found for ‘intention’, ‘social influences’ and ‘self-efficacy’ for tooth brushing are in accordance with a previous meta-analysis regarding to other types of health behaviour, for example physical activity and diet behaviours. Little or no associations were found for the factors: ‘locus of control’, ‘self-esteem’ and ‘sense of coherence’. Our findings indicated that more commonly studied psychosocial factors (e.g. ‘locus of control’, ‘sense of coherence’ and ‘self-esteem’) were less likely to be associated with tooth brushing, whereas factors that illustrated a strong association were relatively understudied (e.g. ‘action planning’ and ‘coping planning’). In addition, it is noteworthy that none of the included studies examined the determinants such as ‘self-determination’, ‘anticipated regret’, ‘action control’ and ‘self-identity’ that have found to be important in explaining health behaviours. Future studies should test for these determinants to advance in the field.

Apart from tooth brushing, we examined whether our findings were consistent for combined oral health behaviour outcome. Generally, the findings were comparable, with exception of ‘coping planning’ and ‘action planning’, which showed lower correlations for the combined outcome. The differences between tooth brushing and oral hygiene behaviours for these variables could potentially be explained through to the nature of the behaviour, as the oral hygiene behaviour outcome includes flossing. Flossing is a more complex task, which might require other skills affected by other psychosocial factors. Another reason might be measurement bias, as the method of measuring the psychosocial constructs differed between the studies, that is single items or a more refined assessment tool of five items.

The most frequently used theory for the design of the studies was the ‘Theory of Planned Behaviour’ (TPB). Nonetheless, the TPB is not without its limitations as highlighted in a recent critique by Sniehotta and his colleagues. They state that TPB does not account for all of the variance in intentions and behaviour. Our findings do suggest that determinants other than TPB variables (‘social influences’, ‘attitude’, ‘perceived behavioural control’ and ‘intention’) could be relevant to explain oral hygiene behaviour, such as ‘action planning’ and ‘coping planning’. Hence, alternative theories that focus for instance on these and other self-regulatory processes (e.g. Health Action Process Approach) might improve the understanding of tooth brushing or oral hygiene behaviours as well as provide better means for behavioural change.

Prior to discussions of the practical implications, several strengths and limitations should be acknowledged. Random effects models were chosen due to the heterogeneity across studies. This heterogeneity may have been due to different operationalization of the variables, mixed gender, mixed cultures and different definitions of the outcomes across the included studies. As the majority of the studies demonstrated results for mixed gender, it was not possible to test moderation of psychosocial factors with oral hygiene behaviour by gender of participants. However, one of the included studies noticed differences between genders in the psychosocial correlates of oral hygiene behaviour, namely ‘locus of control’ and ‘self-esteem’. Therefore, gender should be given consideration in future studies. In general, the reliance on the availability of published results is a limitation. Studies that show negative or insignificant results are less likely to be published. Therefore, an overestimation of the robustness of the effect sizes may occur due to publication bias. Additional analysis (FSN) was performed to assess the extent of publication bias. All significant effect sizes showed FSN larger than the recommended tolerance, which indicates robust results. Another limitation is the lack of a validated assessment tool to measure the quality of the included studies. Although no validated checklist exists to assess the risk of bias of the included studies, we did measure the quality of their studies by a modified NOS assessment tool adapted by Elyasi et al. (2015). The majority of the included studies scored low on the outcome measurement, as they assessed oral hygiene behaviour by self-report. It is reasonable to expect inaccuracy of self-reported measures. An attempt should be made to obtain objective measurements of oral hygiene behaviour. Modern technology provides novel ways of collecting reliable data about a person’s behaviour, for example registration of behaviour by an electric toothbrush with Bluetooth connectivity. The final limitation is that most studies have used cross-sectional designs, which means that evidence for these correlates to be determinants is somewhat hypothetical. A next step to verify the causal role of these psychosocial factors is to examine them in studies using more complex longitudinal or experimental designs.

The practical implication of the present review is that oral health promotion could be improved by
targeting the following potential determinants: ‘intention’, ‘social influences’, ‘self-efficacy’, ‘coping planning’ and ‘action planning’. Two notions should be considered: existing oral health promotion interventions for adolescents rarely targeted these factors, which could explain the generally limited success of oral health promotion programmes and preliminary evidence of intervention studies that have targeted (some of) these determinants have indeed shown that this may result in improved oral hygiene behaviour.

Behaviour change interventions need to incorporate methods directly targeting these potential determinants. Various methods have previously been defined in relation to these determinants. One could think of skill building as a method to enhance ‘self-efficacy’. Skill building compromises the following activities: (i) providing instruction, (ii) demonstrating the behaviour and (iii) guiding practice with feedback and reinforcement. To achieve ‘intention’ formation, a method might include goal setting, that is prompting planning what a person will do, including a definition of goal-directed behaviours that result in the targeted behaviour. With regard to ‘action planning’ and ‘coping planning’ enhancement, methods might include implementation intentions, that is prompting making if-then plans. A practical application for this method is the use of volitional help sheets. To change ‘social influences’, a method could be providing information about what others think about the persons’ behaviour and whether others will approve or disapprove any proposed behavioural change.

In conclusion, this systematic and meta-analytic review highlights the importance of psychosocial factors as potential determinants in explaining oral hygiene behaviour among pre-adolescents and adolescents. In addition, the review identifies various gaps in the literature: (i) psychosocial factors that appear to be the most important received relatively little attention, for instance ‘action planning’ and ‘coping planning’; (ii) psychosocial factors: ‘self-determination’, ‘anticipated regret’, ‘action control’ and ‘self-identity’ that have found to be important in explaining health behaviours and have not been studied in relation to oral health in young people; and (iii) the quality of the study design requires improvement. There is a need for prospective or experimental research. Apart from these improvements, future research should include objective measurement of oral hygiene behaviour. Finally, this review discussed practical implications to optimize and design evidence-based interventions to promote oral hygiene behaviour.

Acknowledgements
The authors would like to thank L.M. Ouwehand, and J. Bouwman for assisting in the search, as well as A.J. van Wijk, N.M. Weightman, I.L.A. Martens and the reviewers for valuable comments on an earlier version of this article. The authors report no conflict of interest related to this meta-analysis.

References

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Supporting Information
Additional Supporting Information may be found in the online version of this article:
Table S1. Characteristics of the included studies.