Longitudinal association of adolescents’ sense of coherence with tooth-brushing using an integrated behaviour change model


Abstract – Objective: To determine the association between adolescents’ sense of coherence (SOC) and their tooth-brushing behaviour. Methods: This 18-month longitudinal study involved a representative sample of 8th-graders (n = 1025) from 11 randomly selected public high schools in the Limpopo Province, South Africa. Data collected by means of a self-administered questionnaire included respondents’ socio-demographic profiles, vulnerability to depression, smoking status, dental treatment attendance pattern, frequency of and motivation for tooth-brushing. Based on the responses to the question on readiness to change brushing behaviour and in line with the integrated change model, respondents were also categorized as being in the pre-contemplation, contemplation or preparation/action stages. Respondents’ SOC was measured using a six-item adapted Antonovsky SOC scale. Data analysis included chi-squared analysis, t-tests and step-wise multiple logistic regression. Results: At baseline, 72.6% (n = 744) of the respondents reported that they were not consistently brushing twice daily. Of those who did not brush twice daily and were followed up on (n = 578), those living with their mother at baseline not only presented with a greater increase in their SOC over time (follow-up minus baseline), but they were also more likely to be brushing twice daily at the time of the follow-up (15.4% versus 10.6%; P = 0.04). Adding baseline intention state to a multivariate model attenuated the influence of baseline SOC to a statistically insignificant level. However, increasing within-subject SOC changes (β = 0.16; P < 0.01), living with the mother (β = 0.11; P < 0.05), smoking (β = −0.14; P < 0.05), being depression vulnerable (β = −0.23; P < 0.01) and in the preparation/action stage (β = 0.13; P < 0.05) remained associated with the transition to twice-daily tooth-brushing. Conclusions: In planning oral health promotion interventions, it should be considered that children’s psychological predisposition and family environment might significantly influence their tooth-brushing behaviour.

Key words: adolescents; behaviour change; sense of coherence; South Africa; tooth-brushing

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Brushing twice daily with fluoridated toothpaste is a universally recommended self-care practice to promote oral health. It remains the most effective practice for the prevention of periodontal disease (1) and dental caries (2). Considering the growing evidence of the association between poor oral health and systemic health (3), an understanding of the determinants of regular tooth-brushing behaviour is important to general public health.
School-based brushing programmes and dental education programmes have not so far been found to be effective in promoting oral health in the long term (4, 5). It has been argued that one of the main reasons for the ineffectiveness of many oral health promotion or education interventions is that most of these interventions have not been based on any theoretical framework and therefore have not been systematically developed to ensure efficient implementation and quality evaluation (4–6). Moreover, in recognition of the growing evidence of the social determinants of oral health (5, 7), it has recently been suggested that many of the existing psychological theories that focus mainly on the individual have limitations in contemporary oral health promotion practices (5). So, for instance, it has been suggested that affective states such as stress or fatigue tend to deter self-efficacy (8). Conversely, there is also a growing interest in the role of stress and coping as a determinant of oral health (9–11).

One of the theoretical models that has been suggested and that holds promise in oral health promotion is the salutogenic theory (5). According to this theory, stressors are intrinsic to the human condition, but people have internal and external resources which they can use in the face of stressful situations, and thus to maintain health. According to Antonovsky (12), a person’s sense of coherence (SOC) is a global orientation that expresses the extent to which the person has a pervasive, enduring but dynamic feeling of confidence enabling the person to apply general resistance resources (GRRs). These GRRs can be found in both the immediate and the distant environment of every person. It may include coping strategies, social support, religion, cultural identity, preventive health orientation and even money (13). A person’s SOC consists of three dimensions, namely comprehensibility (cognitive), manageability (behavioural) and meaningfulness (motivational). The stronger an individual’s SOC, the more adequately he or she will cope with stressors and maintain his or her health.

The SOC has recently received significant empirical research support as a determinant of oral health behaviour in adults (14, 15). However, so far, there have been only two published studies on adolescents’ SOC in relation to oral health. One showed that adolescents’ SOC was associated with children’s dental attendance pattern (16); and the other demonstrated that mothers’ SOC was associated with their children’s oral health and dental attendance pattern (17). The latter study’s findings suggest that the SOC construct may also provide insights into life-course influences on oral health (18).

Considering that every psychological theory or model is limited in its approach, one possibility for improvement is to develop multidimensional models (19), as exemplified by the integrated model of change (the I-Change model) (20). This integrated model incorporates insights from the theory of planned behaviour (TPB) (21), social cognitive theory (8) and the trans-theoretical model (22). The I-Change model, like the TPB, assumes that the most important determinant of behaviour is behavioural intention, which is in turn influenced by three proximal factors, namely a person’s overall evaluation of a behaviour (attitude), the behaviour of significant others (social influence, for example, that of the mother) and the control people perceive themselves to have over that behaviour (self-efficacy). However, differentiating the I-Change model from its constituent models or theories, distal factors such as socio-demographic factors (for example, age, gender and social environment) and psychological or other behavioural factors (for example, depression and smoking) are assumed to influence behaviour via the proximal factors. Another difference between the I-Change model and its constituent models or theories is that the I-Change model explicitly identifies the role of awareness factors (20).

Although the different theoretical components of the I-Change model have been successfully used previously in predicting oral self-care (17, 23–25) most of the studies have been cross-sectional or involved only a small sample of adults with short clinical follow-up periods. To date, no longitudinal study has examined the applicability of any of these models, either separately or in combination, in predicting tooth-brushing behaviour among adolescents, particularly in low-resource settings. Hence, using an adapted I-Change model as a conceptual model (Fig. 1), this study sought to examine the determinants of a transition to regular tooth-brushing among a population of South African adolescents. In addition, because several studies have suggested that mothers have a significant impact on their children’s oral health (17, 26), and considering that people’s SOC has been related to perceived social support (27, 28), it was a secondary aim of this study to explore the role of adolescents’ SOC as a mediator of the mother’s influence on adolescents’ tooth-brushing behaviour.
Methods

Study population and sample design
The participants in this study were 8th-graders from 11 randomly selected public high schools in the Limpopo Province in South Africa. A two-stage sampling technique was used to produce a provincially representative sample of 8th-graders \((n = 1025)\). The first stage of the sampling consisted of a random selection of 11 of the 31 school districts in the Limpopo Province. School districts were selected with a probability proportional to the number of schools in the district. The second stage consisted of a random selection of one school from the cluster of high schools in each selected school district. All the 8th-graders in the selected schools were eligible to participate in this study. The study required the informed consent of the participants, as well as that of their parents.

Procedures
After providing informed consent, the participants completed a pre-tested self-administered questionnaire during class time at baseline (T1), at 12 months (T2) and 18 months (T3). The original English questionnaires were translated into two local languages, namely Afrikaans and Sepedi for use with a few learners who were not proficient in English; otherwise the surveys were conducted in English. The validity of the translation was tested by means of back translation. The study protocol received approval from the University of Pretoria’s Ethics Committee (22/2005).

Measures and definitions
Socio-demographic features
The study participants provided information about their age, gender, ethnicity (black African and others) and the type of dwelling they lived in (formal housing: a brick house/flat; or informal housing: huts/tents or a non-brick house). The type of dwelling indicated served as a proxy measure for the socio-economic status of the participating adolescents.

Information was also collected on the living arrangements of the study participants. About half of the children in the Limpopo province who are 15 years and younger live with only their mother; and another half live either with both parents (22%) or with neither of their parents (29%) (29). The data on the living arrangements of the study participants were therefore divided according to whether or not they lived with their mother. We also took into account the fact that previous studies have suggested that, irrespective of the level of resources available, children in South African households with mothers or headed by women, and children of household heads, as opposed to grandchildren or other children, have greater food security (30, 31). Hence, we reasoned that the children living with their mothers may be those in environments with better application of GRR, which may in turn affect their SOC levels.

Tobacco use status
Using items previously used in national and international youth tobacco surveys (32), the respondents themselves were categorized as current daily smokers if they indicated that they had smoked a cigarette within the 24 hours preceding the survey and had responded in the affirmative to a similar question on smoking in the last week and in the last 30 days preceding the date of the survey. A similar approach was used to define daily oral smokeless tobacco users.
Depression vulnerability
Because the concept of SOC is closely linked to mental health (13), and because depression has been linked to poor oral health (33), in this study vulnerability to depression in the recent past among the study participants was also measured. The depression screening item used was similar to the one recently demonstrated to be a valid proxy measure of vulnerability to depression (34). Briefly, participants were asked the following: ‘During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities?’ Those who answered in the affirmative were classified as being vulnerable to depression.

Sense of coherence
In line with a study by Freire et al. (16), the 13-item short version of Antonovsky’s 7-point Likert-type SOC scale was used in this study. The questions were included in the survey instrument. However, because the SOC scale has been less frequently used among adolescents, and in particular it has not been previously validated among South African adolescents, the instrument also had to be validated.

Tooth-brushing frequency
To measure brushing frequency, respondents were asked the following question: ‘In the past month (30 days), how often have you been brushing/cleaning your teeth?’ Guided by the findings from the pilot test, the response options provided were: (i) ‘I did not always clean daily’; (ii) ‘Always once daily’; (iii) ‘Most days once, but some days twice daily’; (iv) ‘Most days twice, but sometimes once’ and (v) ‘Always at least twice daily’. Respondents who indicated always brushing at least twice were classified as having ‘twice-a-day’ or regular brushing behaviour.

Self-reported gum bleeding
Respondents were asked how frequently they had experienced bleeding gums while brushing in the last 3 months. Those who indicated that their gums bled frequently or often were categorized as having bleeding gums and those who reported that their gums never bled or seldom bled were categorized as not having bleeding gums.

Recent dental attendance (awareness factor)
Because it is usually recommended that people visit their dentist every 6 months, we controlled for dental attendance status 6 months before the last follow-up survey. Based on the responses to the survey question at T2 (6 months before T3) on what the main reason was for past dental visits, if at all they had visited a dental clinic within the last 12 months, the respondents were categorized as either having never paid a visit to a dentist, or having had a recent pain visit or having had a recent check-up visit.

Motivation for brushing teeth
In line with the approach used in a study by MacGregor et al. (35), at baseline, the respondents were asked to report their main reason for brushing or cleaning their teeth. Response options were: ‘Because I like fresh breath’, ‘Makes my mouth feel clean’, ‘So that my teeth will look nice’, ‘So as to avoid toothache’ and ‘So as to avoid false teeth’. Respondents who brush in order to avoid toothache or false teeth were classified as being motivated to brush more by preventive dental health or cognitive reasons, while the others were classified as being motivated by social or affective reasons.

Readiness to change brushing behaviour (stage of change)
To assess intention state, the respondents were asked the following: ‘At any time during the next 6 months, do you think you will always be brushing twice every day?’ Response options were: ‘Definitely not’, ‘Probably not’, ‘Probably would’, ‘Definitely would’ and ‘I already brush twice sometimes’. Respondents who indicated at baseline that they would definitely or probably not be brushing twice were classified as being in the pre-contemplation stage; those who stated that they probably would or definitely would were classified as being in the contemplation stage; and those who already sometimes brush twice were classified as being in the preparation/action stage of change.

Data analysis
Only those who reported not consistently brushing at least twice a day at baseline were the focus of analysis. Descriptive and multivariate analyses were conducted to assess the rates and correlates of tooth-brushing at the follow-up. The chi-squared test and t-tests were used in order to test for group differences among categorical variables and continuous variables, respectively.

In order to assess the structure of the SOC-13 scale, principal component analyses with oblique rotation were implemented with the 13 SOC items. Because the usual factor retention criterion of an
eigenvalue >1 sometimes produces too many factors (36), we also applied the criteria of interpretability and content validity (36). The internal consistency of the scale was measured using Cronbach’s alpha coefficient. To assess content validity, we compared the components of the items loaded with those of the standard 13-item scale and its components. In order to assess construct validity, using the cross-sectional sample of the baseline study participants, the association between their SOC score and established correlates, such as vulnerability to depression (37) and socio-economic status (38) was assessed. We also compared the SOC scores of the two ethnic groupings (Black Africans versus non-blacks) and gender, as it was anticipated that they would not differ (12). SOC was analysed as a continuous variable because the analysis on whether to transform the summed scores showed a normal distribution. Given that the SOC may not be fully stable in adolescence (37), we computed a variable (which we called SOC development) by subtracting baseline SOC scores from the last follow-up SOC score. This variable was used in the multivariate analysis, while controlling for baseline SOC. Adjustment for the baseline level of SOC was necessary to control the floor effect constraining score declines on groups at the bottom and ceiling effects constraining score increases on groups at the top. It was also done to control the decreased likelihood that adolescents with higher levels of SOC would report changes in SOC, as they tend to buffer life stress more effectively, and generally experience less instability than individuals with a low SOC (38).

To test the difference between the direct effects of the potential explanatory variables on the transition to consistently brushing twice daily, a sequential multiple logistic regression analysis was carried out, using a stepwise approach, with age as a covariate, irrespective of the level of significance. To test for any possible mediating effects of SOC, we applied the approach suggested by Baron and Kenny (39). According to Baron and Kenny (39), perfect mediation holds when the independent variable has no effect on the dependent variable (brushing twice daily) when the mediator (SOC) is controlled, and the independent variable and the mediator are correlated. Similar to the approach described by De Vries et al. (20) and guided by our conceptual framework, logistic regression analysis was done, entering the variables in four blocks: (i) socio-demographic variables, including risk behaviours; (ii) baseline SOC and the extent of SOC development; (iii) motivation for brushing and awareness factor (main reason for recent dental visit) and (iv) intention to start always brushing twice daily. Those respondents who reported not brushing consistently twice daily at the follow-up stage was used as the reference category.

For the modelling, only subjects for whom complete data were available for the models were included in the analysis. All statistical analyses were done using the STATA Release 8 package (Stata Corporation, College Station, TX, USA). The option ‘robust cluster’ for the procedure ‘logit’ in Stata was used to take into account the complex sample design used in this study, particularly the fact that participants were nested in schools, which were the ultimate sampling units. Differences are significant when $P < 0.05$.

Results

Psychometric evaluation of the SOC-13 and validity test

Although all the items of the SOC-13 loaded on three factors, the original three-factor structure of the SOC-13 could not be replicated in this adolescent population. Only one meaningful or interpretable factor with six items emerged from this scale (Appendix). These six items contained at least one item from each of the three domains of the original SOC-13 and accounted for 35% of the total variance of the scale. The internal consistency coefficient was similar to that of the SOC-13 when both were compared as a unidimensional scale (Cronbach $\alpha = 0.63$). The summed SOC-6 scores for those respondents positive on depression screening and those respondents living in informal housing were significantly lower than the scores of the respondents who were negative on depression screening (25.06 versus 26.42; $P = 0.02$) and those who lived in formal housing structures (23.70 versus 26.51; $P < 0.001$), respectively. However, the SOC scores among those who identified themselves as black Africans and boys were not significantly different from those of non-black Africans (26.22 versus 25.63; $P = 0.59$) and girls (26.02 versus 26.28; $P = 0.58$), respectively.

Baseline characteristics of the study population and attrition analysis

The study participants were between 12 and 19 years old, with a mean (SD) age of 14.4 (SD
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Table 1. Baseline characteristics of study participants compared with that of drop-outs who were not regularly brushing their teeth at least twice daily

<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>% Study participants (n = 578)</th>
<th>% Drop-outs (n = 165)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Africans</td>
<td>96.1 (n = 547)</td>
<td>92.6 (n = 151)</td>
<td>0.17</td>
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<tr>
<td>Lives in informal housing structure</td>
<td>11.7 (n = 67)</td>
<td>18.6 (n = 30)</td>
<td>0.02</td>
</tr>
<tr>
<td>Lives without the mother</td>
<td>25.2 (n = 145)</td>
<td>31.5 (n = 52)</td>
<td>0.11</td>
</tr>
<tr>
<td>Daily smoker</td>
<td>7.5 (n = 42)</td>
<td>4.3 (n = 7)</td>
<td>0.20</td>
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<tr>
<td>Female</td>
<td>52.8 (n = 304)</td>
<td>48.5 (n = 80)</td>
<td>0.36</td>
</tr>
<tr>
<td>Owns a toothbrush</td>
<td>99.1 (n = 567)</td>
<td>99.4 (n = 164)</td>
<td>0.78</td>
</tr>
<tr>
<td>Does not always brush daily</td>
<td>23.7 (n = 136)</td>
<td>26.8 (n = 44)</td>
<td>0.44</td>
</tr>
<tr>
<td>Brush motive – affective/social</td>
<td>83.5 (n = 476)</td>
<td>80.6 (n = 133)</td>
<td>0.43</td>
</tr>
<tr>
<td>In the preparation/action stage</td>
<td>22.4 (n = 127)</td>
<td>18.9 (n = 31)</td>
<td>0.51</td>
</tr>
<tr>
<td>Mean SOC-6 score (SD)</td>
<td>26.3 (7.2)</td>
<td>25.7 (7.2)</td>
<td>0.35</td>
</tr>
<tr>
<td>Mean age (SD)</td>
<td>14.4 (1.5)</td>
<td>14.7 (1.8)</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Totals (n) may be lower than expected because of missing data. SOC, sense of coherence.

1.5) years. Of those who were not brushing twice daily at baseline (n = 744), a total of 77.7% (n = 578) provided data at follow-up. An analysis of those lost to follow-up showed that they were more likely to have been those living in informal housing structures (18.6% versus 11.7%; P = 0.02) and tended to be slightly older (14.7 years versus 14.4 years; P = 0.06). No other significant differences were noted between the baseline social or behavioural characteristics of the current study participants and those lost to follow-up (Table 1).

About one in four adolescents participating in the study did not live with the mother. Compared with the participants living with their mothers, those who did not live with their mothers also tended to live in informal housing structures (31.3% versus 24.5%; P = 0.11). Table 1 also illustrates that almost all the study participants owned a toothbrush, but 23.7% (n = 136) did not always brush daily. Most of the adolescents (45.3%) were in pre-contemplation, and only 22.4% (n = 127) could be classified as being in the preparation/action stage of transition to consistently brushing twice daily. The majority of the adolescents are motivated by social or affective reasons.

Prospective analysis

By the last follow-up (T3), only 14.4% (n = 81) had started brushing consistently twice or more daily, while 30.1% (n = 166) did not always brush daily. None of those who identified themselves as non-black Africans (n = 22) or used oral snuff at baseline (n = 8) had made the transition to consistently brushing twice daily. Oral snuff users were significantly more likely not to be brushing daily (62.5% versus 29.6%; P = 0.03). The proportion of those in late adolescence (15–19 years) did not differ significantly from the proportion of those in early adolescence (12–14 years) who started brushing consistently twice daily (16.3% versus 12.9%; P = 0.33).

Of those who provided follow-up data on the most recent dental visit (n = 550), only 19.4% (n = 110) had made a dental visit. Of these, 63.6% (n = 70) had visited the dentist because of pain. Only 16.6% (n = 94) of the respondents who reported frequent bleeding gums at baseline did not report frequent bleeding gums at follow-up. Those who had started brushing regularly twice were significantly more likely to have experienced a reduction in frequently bleeding gums compared to those who were still not regularly brushing at least twice daily (22.2% versus 15.6%; P = 0.04).

The mean (SD) total SOC score of the adolescents at baseline was 26.3 (SD 7.4) and this increased to an average of 27.2 (SD 8.6) by the follow-up (T3) 18 months later (pairwise t-test; P = 0.06). Compared to the respondents who were not living with their mother, those living with their mother at baseline not only tended to have experienced an increase in SOC (−0.36 versus +1.36; P = 0.11), but were also significantly more likely to be brushing twice daily at the follow-up stage (10.6% versus 15.4%; P = 0.04). Conversely, although they were not different in the SOC level at baseline, when compared to those who did not make the transition to consistently brushing twice daily (26.4 versus 26.2; P = 0.89), those who made the transition to consistently brushing twice daily had attained a significantly higher SOC level by T2 (28.9 versus 26.6; P = 0.02) and T3 (29.3 versus 26.9; P = 0.02).

Frequent brushing was also significantly lower among those positive on depression screening at the follow-up stage (Step 1; Table 2). Adding
within-subject SOC changes to the model did not change the significant influence of living with the mother (Step 2). With the addition of the motivational variables, daily smoking and baseline SOC became significant predictors, and having had a recent dental check-up visit and, reporting preventive dental health as the motive for brushing were also significantly associated with making the transition to regularly brushing twice daily (Step 3). Being in the preparation/ action stage of change at the baseline was also a significant predictor of the transition to consistently brushing twice daily (Step 4; Table 2). Furthermore, the addition of the intention state attenuated the influence of baseline SOC to a statistically insignificant level. Being vulnerable to depression had the strongest, but negative influence on adolescents’ transition to consistently brushing twice daily ($\beta = -0.23$; $P < 0.01$).

**Discussion**

This study’s findings supported the applicability of the SOC construct in a South African adolescent population and demonstrated that the most significant determinants of transition to consistently brushing twice daily are related to the psychological predisposition of the individual concerned, namely the person’s SOC levels and vulnerability to depression. This corroborates findings from previous studies on the influence of psychological mood (11, 33) and self-concept (35) on oral health behaviours. No evidence was found to support the hypothesis of SOC as a mediator of mothers’ influence on children’s oral health behaviour, but, in line with the I-Change model assumptions and consistent with the salutogenic theory, there was evidence to suggest that the influence of SOC on adolescent tooth-brushing may be partly mediated through the adolescents’ intention state.

Considering that the change in SOC among adolescents who were living with their mothers compared with adolescents who were not living with their mothers was more positive (albeit statistically insignificant) and the fact that those living with their mothers also tended to live in formal housing structures, which in turn was associated with significantly higher SOC, it may be reasonable to suggest that a family environment with a mother may be an important salutogenic factor. Such a family environment could indeed support further development of children’s SOC by making available the GRR that would promote healthy behaviours. Nevertheless, the fact that living with the mother also had a direct influence on brushing behaviour is also suggestive of a more proximal social influence. This is consistent with
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the suggestion that parents, particularly mothers, may be important role models for the oral health behaviour of their children well into their adolescence (40).

Furthermore, the fact that baseline SOC levels became significant only while controlling for motivational variables, including dental attendance patterns, suggests that these motivational factors provided the context for the relevance of an SOC. This finding is consistent with the central construct of salutogenesis and corroborates findings from previous studies that demonstrated that people with a higher SOC are more likely to make regular dental visits (14) and that, when they do so, they do so mainly for check-ups (16). Considering that SOC has also been connected with attitudes and behaviours (13), it is conceivable that adolescents with a higher SOC might have been able to comprehend the benefit of regular brushing better and perceive there to be greater value or worth in pursuing good oral health, as this also relates to social relations (in other words, a higher positive outcome expectancy) (41). It was also noteworthy that the inclusion of these motivational variables also significantly increased the influence of not being a regular smoker on the adoption of regular tooth-brushing habits. Although dental service utilization in this study was much lower than in Scotland (40), this finding is nevertheless consistent with previous observations of an association between smoking and dental visit patterns in a Scottish adolescent population of similar age (40). Considering that a high SOC has been associated with a lower risk for adolescent smoking (42), taken together, our study findings suggest that a high SOC, and by implication a greater ability to cope with stress and perhaps a better attitude to oral health, may be a common salutogenic factor promoting smoking abstinence and regular tooth-brushing.

The fact that the influence of SOC is mediated through the intention state further supports a salutogenic interpretation for the I-Change model. It is indeed conceivable that those with a high SOC would be more optimistic, perceive themselves to have more control or be more confident in their ability to attain the goal of brushing consistently twice daily. This view is supported by a previous report that suggests that there is a pathway that connects SOC with the concept of self-efficacy (27). However, unlike self-efficacy measures, which are of necessity tailored to specific domains of functioning and possibly to specific population characteristics (43), SOC is a general construct with cross-cultural applications (12). With the additional benefit of having to administer fewer questions, this study’s findings suggest that it may be useful to investigate the inclusion of the SOC-6 scale in the I-Change model further by examining the determinants of other health behaviours, instead of function-specific self-efficacy measures that require several items for measurement (20).

The findings of this study should be considered in relation to its methodological strengths and limitations. A major limitation of this study is the reliance on self-reported tooth-brushing behaviour, creating potential reporting bias. However, to limit the possibility of socially desirable responses, the most conservative definition for brushing twice daily was used in this study. Moreover, the fact that those who reported a transition to more regular brushing experienced a 40% greater reduction in bleeding gums provides some support for the validity of the measure used. It is possible that respondents could also have been misclassified in terms of their stage of change, but, given that the distribution of the study population in the different stages closely matched that reported as a rule of thumb for at-risk populations (22), we are fairly confident that our stage classification is fairly reflective of the true stage. Lastly, the internal consistency of the SOC-6 ($\alpha = 0.63$) was lower than the benchmark of 0.70 (13). However, considering that only six items were used and this questionnaire performed better than the 0.42 obtained using the SOC-13 scale in a recent study among a South African adult population (28), the SOC-6 scale could be considered fairly reliable for the studied population. Nevertheless, we acknowledge that the scale and the model performance could still be significantly improved.

Despite these limitations, this study, the first to examine the longitudinal relationship between SOC and oral health behaviour among adolescents, provides useful information. It has several implications for oral health promotion practice and public policy.

The study findings provide support for the integration of the salutogenic construct with the I-Change model as this is instructive with regard to planning and evaluating oral health promotion interventions. For instance, it highlights the need to tailor oral health counselling to the stage of change of an individual (44). Furthermore, given that smoking was found to be a significant modifiable
risk factor for irregular brushing, this model provides the theoretical basis for the integration of oral health promotion with smoking prevention programmes that could target improvements in the attitude to oral health and could also provide life-skill training such as coping skills. The influence of the family environment should also not be underestimated. With an increasing proportion of South African households with at least one maternal orphan (45), the implication for the promotion of adolescents’ oral and general health becomes apparent from such an integrated salutogenic behaviour model.

In conclusion, when planning oral health promotion interventions, due consideration should be given to the fact that children’s psychological predispositions and family environment might significantly influence their tooth-brushing behaviour, and subsequently their oral health.

Acknowledgements

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References

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Appendix

Six-item sense of coherence (SOC) questionnaire used

<table>
<thead>
<tr>
<th>Question item</th>
<th>Very often</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Never 7</th>
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<tbody>
<tr>
<td>1. How often do you have the feeling that you are in an unfamiliar situation and don’t know what to do?</td>
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<td>2. How often do you have very mixed-up feelings and ideas?</td>
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<td>3. How often does it happen that you have feelings inside you that you would rather not feel?</td>
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<td>4. In general, how often do you have the feeling that you’re being treated unfairly?</td>
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<td>5. How often do you have the feelings that you’re not sure you can keep under control?</td>
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<td>6. How often do you have feelings that there’s little meaning in the things you do in your daily life?</td>
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