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# Determinants of oral-health related quality of life and overall quality of life among early adolescents with type-1 diabetes

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***Objective***: To identify determinants of oral health-quality of life (OHRQoL) and its association with overall quality of life (QoL). ***Basic research design***: Cross-sectional analytic study. Predictors variables were selected based on Wilson and Cleary's model for patient outcomes including individual factors and socioeconomic status (SES) to represent environmental and clinical/biological factors. ***Participants***: 444 children aged 11 to 14 years. ***Main outcome measures***: OHRQoL and overall QoL. Data were analysed using univariate correlation coefficients and structural equation modelling. The initial path was analysed for the goodness-of-fit. The level of significance adjusted at 5% and 95% confidence intervals. ***Results***: In the final model, sense of coherence (SOC) and dental coping behaviour displayed direct and indirect effects on OHRQoL and QoL. Gingival condition and metabolic disease control displayed bidirectional effects on overall QoL. SES was directly and indirectly associated with OHRQoL. The fit of final model indicators was CFI = 0.99, GFI = 0.99. AGFI = 0.68, TLI = 0.97, RMSEA =0.03, $\chi^2$ = 13.25, and $\chi^2$/d.f. ratio = 1.43 ($p > 0.05$). ***Conclusions***: Enhancing the SOC and SE of early adolescents with T1DM may improve their oral-health related quality of life and overall quality of life.

**Keywords:** *Quality of Life; Diabetes Mellitus Type-1; Sense of Coherence; Adolescents*

## Introduction

The shift of definitions of health from the absence of disease to a state of physical and biopsychosocial well-beings reflected in greater emphasis on health-related quality of life and its subsidiary, oral health-related quality of life (OHRQoL). These variables have been conceptualised as subjective, dynamic and multidimensional perspectives (Bakas *et al.*, 2012). The use of a comprehensive and explicit theoretical model to study a chronic illness like $T_1$DM, allows for a more thorough understanding of the complex interactions between different factors at different levels (Nuccitelli *et al.*, 2018). In particular, the Wilson and Cleary model has proved useful when linking clinical, factors to quality of life and has implicated a number of individual factors in determining OHRQoL (Gururatana *et al*., 2014).

One such individual factor is health locus of control (HLOC). Individuals with a high internal HLOC are more likely to ascribe their health situation to their own actions whereas those with an extrinsic HLOC will attribute their health to the influence of powerful others "powerful others HLOC" or to the influence of fate or destiny "chance HLOC". Self-efficacy (SE) is a related concept that reflects individuals' convictions about their capability of initiating or enduring successful health behaviour. In oral health, SE can play a role in changing health behaviours (Gururatana *et al.*, 2014). The mechanisms of action of SES on OHRQoL are not fully understood. However, psychosocial resources have been suggested to mediate the impact of SES on OHRQoL and general health (Sanders and Spencer, 2005).

The health-related quality of life (HRQoL) of early adolescents with $T_1$DM worsens with advancing disease. In addition to the adverse physical, social and emotional complications, especially those encountered with poorly controlled metabolic disease, OHRQoL is documented to have a negative impact on HRQoL (Azogui-Levy *et al.*, 2018).

A deeper analysis of the complex interaction of the clinical and non-clinical factors that may be associated with the OHRQoL of early adolescents with $T_1$DM will aid in a better understanding of their oral and general health and allow the introduction of more efficient healthcare interventions. Up to date, no previous study of the quality of life of young people with this condition has conceptualized the interactions between individual, clinical and environmental variables using a theoretical model. This study aimed to identify determinants of oral health-quality of life and its association with general health related quality of life.

## Method

Participants were adolescents with $T_1$DM, who attended the Endocrinology Outpatient Clinic, Paediatric Department, Faculty of Medicine and Paediatric Dentistry Department, Minia University, during the period from November 2017 to June 2019. The number of participants included was calculated based on the following formula for qualitative variables; $Z_{1-\alpha/2}$ 2P (1-P)/$d^2$, where $Z_{1-\alpha/2}$ is the standard normal variate at a level of significance less than or equals 5% ($p \leq 0.05$) and d is the degree

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of precision that adjusted at 0.05. As there were no previous studies reported the prevalence of quality of life (QoL) among adolescents with $T_1DM$, the prevalence was adjusted at 50%. To compensate for non-participation, an additional 20% was added to the intended sample. Therefore, the final sample size was 444 early adolescents with $T_1DM$.

Participants were aged 11 to 14 years, had been diagnosed as having $T_1DM$ for two years or more. Exclusion criteria included having orthodontic treatment or severe malocclusion, the presence of systemic, psychological or intellectual disabilities, and having an emergency dental visit in the last three months.

Predictor variables were adopted based on the Wilson and Cleary (1995) model. Individual factors included Sense of Coherence (SOC), measured using Antonovsky's short-form questionnaire. This 13-item instrument uses 7-point Likert scales used to calculate response scores ranging from 7 to 91. The Dental Coping Beliefs Scale (DCBS) questionnaire was used to enquire about internal and external HLOC (8 items each), self-efficacy scale for self-care (15-itemSESS) and oral health beliefs (6 item OHB scale). All four DCBS dimensions asked participants to respond on a 5-point Likert scale ranging from "strongly agree" (scored 1) to "strongly disagree" (scored 5) (Gururatana *et al.*, 2014). Socioeconomic status included education level of parents, employment situation and household expenditures. Parental education level was classified into four categories (greater than secondary, secondary, less than secondary and illiterate). Employment status was assessed using one question with a "yes" or "no" answer. Household expenditures per person recorded in the local currency (Egyptian LE) per month then divided by 30 days. The cut-off poverty point per day was 3.20 US$.

Clinical variables included disease status, as assessed using $HbA_{1c}$, recorded as metabolically controlled ($HbA_{1c} \leq 8\%$) and poor metabolic control ($HbA_{1c} > 8\%$) (Carneiro *et al.*, 2015). The clinical state of the mouth was recorded using the number of decayed teeth (DT) and the gingival index (GI). For statistical analysis, all clinical variables were expressed as continuous and categorical data.

A validated Arabic version of the $CPQ_{11-14}$ short-form questionnaire was used to assess OHRQoL domains; oral symptoms and functional status which included functional limitation, emotional well-being and social well-being (4 items each). Responses were recorded on a 5- point Likert scale with categories of never, once or twice, sometimes, often and every day or almost every day (scored 0–4 respectively). OHRQoL was seen to correspond to the Functional status category within the Wilson and Cleary model and was scored as the sum of the item codes for the 12 items.

Participants' perceived general health (GHP) was measured using the following question: "What is your perception about your current state of health"? Possible responses were poor, fair, good, very good and excellent (scored 0-4)(Subramanian *et al.*, 2009).

Overall quality of life (QoL) was measured using a 7 item Students' Life Satisfaction Scale (Huebner, 1991), with responses recorded on a 6-point Likert scale from strongly disagree (scored 1) to strongly agree (6).

An Arabic linguist and the researcher translated all questionnaires except the $CPQ_{11-14}$ short form, into Arabic independently then translated each version back into English for comparison with the original version. These procedures were repeated until the final refined version was obtained.

Two dentists with at least two years of residency at the Paediatric and Dental Public Health Department, Faculty of Dentistry, Minia University, trained for two weeks. For calibration, scores of 35 teenagers were reported and tested for intra-examiner and inter-examiner reliability.

Data analysis was conducted in the Statistical Program Statistical Package for the Social Sciences (SPSS) version 20. Descriptive statistics were frequency tables, means and standard deviations (SD). Preliminary analysis used correlation coefficients between variables. The significant factors were included in the theoretical model. Analysis of Moment Structures (AMOS) software version 22 was used to construct an SEM of the complex inter-relations among independent and outcome variables. Models were tested for goodness-of-fit using chi-squared test with ($p < 0.05$ and chi-square ($\chi^2/df \leq 2$), absolute and incremental fit indices such as the root mean square error of approximation (RMSEA<0.06), the comparative fit index (GFI>0.95), the Tucker Lewis index (TLI>0.95) and adjusted goodness of fit index (AGFI>0.95). Bootstrapping was used to detect the direct and indirect effect of predictor variables on the outcomes.

## Results

The inter-examiner agreement (Kappa coefficients) for clinical examinations was 0.93 and 0.89 for DT and GI scores, respectively. The response rate was 86%. Internal consistency for the individual factor scales was measured using Cronbach's alpha (α) as follows: SOC=0.74; SESS=0.77; HLOC=0.80; OHB= 0.83; Symptoms=0.81; Function status=0.79; GHP=0.85 and QoL=0.82.

The data for all 444 participants are described in Table 1. Slightly more girls than boys participated. No participants had missing or filled teeth, so the number of decayed teeth (DT) was used to describe their dental status. Most (80.6%) had at least one carious lesion and mean DT was 1.22 (SD=1.03).

Table 2 indicates that a number of individual factors correlated with the subscales of $CPQ_{11-14}$, GHP and overall quality of life. Maternal education was the only socioeconomic factor associated with OHRQoL, GHP and QoL satisfaction. Disease metabolic status correlated with the symptoms domain of $CPQ_{11-14}$. The state of the mouth, as measured by DT and GI also correlated with symptoms.

To derive the final SEM, two non-significant pathways were eliminated from the final model: From dental coping beliefs (DCBS) to functional status and from SES to overall QoL.

Other potential pathways identified in the correlation matrix were added, but only those that remained significant pathways were kept in the final model. The final pathways and standardized estimates are illustrated in Figure 1. The fit of the final model indicators was CFI=0.99, GFI=0.99, AGFI=0.68, TLI= 0.97, RMSEA =0.03, $\chi^2$=13.25, and $\chi^2$/d.f. ratio=1.43 ($p$=0.21).

Table 3 summarises the direct and indirect (mediating) effects of individual, environmental and clinical factors on OHRQoL and overall QoL. SOC and DCB displayed statistically significant direct and indirect effects on OHRQoL. Oral health status and metabolic condition also had direct and indirect effects on OHRQoL. The overall QoL was significantly influenced by OHRQoL.

**Table 1**. Descriptive statistics of the dependent and independent variables among 444 adolescents with $T_1DM$.

| *Variables* | *%* | *Mean (SD)* | *Range (midpoint)* |
|---|---|---|---|
| Gender | | | |
| Male | 46.4 | - | - |
| Female | 53.6 | | |
| Age (years) | | | |
| 11 | 16.7 | | |
| 12 | 24.3 | 12.68 | - |
| 13 | 33.3 | (1.03) | |
| 14 | 25.7 | | |
| Father education | | | |
| Greater than high school | 37.8 | | |
| High school | 37.4 | - | - |
| Less than high school | 14.0 | | |
| Illiterate | 10.8 | | |
| Mother education | | | |
| Greater than high school | 44.4 | | |
| High school | 39.4 | - | - |
| Less than high school | 9.0 | | |
| Illiterate | 7.2 | | |
| Parent at work | | | |
| Yes | 80.4 | - | - |
| No | 19.6 | | |
| Family income (per day) | | | |
| ≤3.20$ | 39.4 | - | - |
| >3.20$ | 60.6 | | |
| Decayed teeth (DT) index | | | |
| =0 | 19.4 | 1.22 | - |
| >0 | 80.6 | (1.03) | |
| Gingival index (GI) | | | |
| =0 | 35.1 | 1.93 | - |
| >0 | 64.9 | (0.78) | |
| Glysated hemoglobin ($HbA_{1c}$) | | | |
| ≤8 | 51.8 | 9.47 | - |
| >8 | 48.2 | (6.80) | |
| Sense of coherence (SOC) | - | 47.39 (17.94) | 7-91 (49) |
| Self-efficacy scale for self-care (SESS) | - | 41.83 (8.64) | 15-75 (40) |
| Children's health locus of control scale (CHLC) | - | 49.74 (4.16) | 16-80 (48) |
| Oral health beliefs questionnaire (OHB) | - | 19.66 (4.16) | 6-30 (18) |
| Oral symptoms | - | 8.75 (3.68) | 0-16 (8) |
| Function status | - | 27.24 (8.13) | 0-48 (24) |
| General Health Perception (GHP) | - | 2.12 (0.96) | 0-4 (2) |
| Overall Quality of Life (QoL) | - | 29.91 (11.72) | 7-42 (24.5) |

## Discussion

This investigation illustrates the complex interrelationships that may shape the quality of life of adolescents with $T_1DM$ through an examination of a set of independent predictors postulated with Wilson and Cleary's theoretical model. Structural Equation Modelling offered advantages over conventional regression methods for several reasons: (i) SEM allows the development of complex path models with direct and indirect effects, and (ii) it is more comprehensive and permits testing of diverse hypotheses and outcomes in one model. This is in contrast to the regression method, which cannot consider one level of independent variables at a time (Kueh *et al.*, 2015).

Participants with stronger SOC exhibited fewer symptoms and functional limitations of oral conditions on everyday life. This supports other studies demonstrating the positive influence of SOC on OHRQoL and general health (Gururatana *et al.*, 2014; Gomes *et al.*, 2018). Antonovsky's salutogenic theory might explain this association through the three mechanisms: (i) High SOC might allow the efficient use of generalized resistance resources (GRR). Higher SOC is strongly associated with the availability of external resources including education and family expenditure. Here, diabetic early adolescents with higher SOC showed a positive link with maternal education, although family income did not correlate with SOC. (ii) Adolescents with stronger SOC may have adopted healthy strategies and maintained healthy habits to control their disease, so preventing unwanted oral consequences of $T_1DM$ (Ahola *et al.*, 2010). (iii) People with higher SOC may have better coping abilities as an internal factor. In this study, adolescents with stronger SOC adhered to preventive measures such as tooth brushing and mouthwash use and held good coping beliefs. Adolescents with $T_1DM$ who have greater SOC might perceive the disease as a challenging stressor rather than a stress-producing stimulus (Oliva *et al.*, 2019).

The development of SOC is said to begin in early adulthood and gradually increases up to the age of 30 (Super *et al.*, 2016). Therefore, interventions to enhance the SOC of early adolescents with $T_1DM$ may positively influence their OHRQoL and overall QoL, as has been demonstrated among school children in Thailand (Nammontri *et al.,* 2013).

The data also show correlations between SOC and other internal factors, such as SESS and HLOC that are in agreement with previous literature (Geyer, 1997) and suggest that these factors may not be discrete, but may overlap. Participants with high dental coping beliefs (including internal HLOC) reported better OHRQoL and overall QoL. This was consistent with Peters et al. (2019).

Socio-economic status was not related to the dependent or other independent variables, except for maternal education. Several studies have reported a direct significant correlation between maternal education and oral health status (Castilho *et al.*, 2013). The dynamic and cumulative nature of SES may explain the current findings which displayed a correlation between oral health and both family income and occupational status (Reisine and Psoter, 2001).

The present study elucidated the association between clinical status and OHRQoL, GHP and overall QoL. All

**Table 2**. Correlation matrix for relationships among variables

| *Variables* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gender | 1 | 0.03 | 0.04 | 0.04 | 0.03 | 0.08 | 0.04 | 0.07 | 0.04 | 0.04 | 0.06 | 0.06 | 0.07 | 0.08 | 0.07 | 0.03 |
| 2. SOC | | 1 | -0.87** | -0.66** | -0.51** | 0.08 | 0.09 | 0.11* | 0.078 | -0.33** | -0.48** | -0.54** | -0.54** | -0.73** | 0.80** | -0.82** |
| 3. SESS | | | 1 | 0.69** | 0.53** | -0.08 | -0.10* | -0.08 | -0.03 | 0.34** | 0.44** | 0.52** | 0.50** | 0.74** | -0.79** | 0.78** |
| 4. HLOC | | | | 1 | 0.65** | -0.06 | -0.21** | -0.03 | -0.03 | 0.13** | 0.48** | 0.48** | 0.56** | 0.69** | -0.70** | 0.72** |
| 5. OHB | | | | | 1 | -0.08 | -0.03 | -0.11* | -0.08 | 0.27** | 0.49** | 0.42** | 0.54** | 0.58** | -0.67** | 0.64** |
| 6. Father education | | | | | | 1 | 0.72** | 0.10 | 0.41** | -0.13** | -0.03 | -0.01 | -0.04 | -0.09 | 0.02 | -0.07 |
| 7. Mother education | | | | | | | 1 | 0.16** | 0.31** | -0.13** | -0.07 | -0.04 | -0.14** | -0.20** | 0.11* | -0.11* |
| 8. Family income | | | | | | | | 1 | 0.02 | -0.11* | -0.08 | -0.01 | -0.06 | -0.11* | 0.04 | -0.03 |
| 9. Parent at work | | | | | | | | | 1 | -0.08 | 0.03 | 0.03 | -0.02 | -0.07 | 0.03 | -0.05 |
| 10. DT | | | | | | | | | | 1 | 0.33** | 0.20** | 0.57** | 0.56** | -0.52** | 0.46** |
| 11. GI | | | | | | | | | | | 1 | 0.62** | 0.62** | 0.63** | -0.58** | 0.57** |
| 12. $HbA_{1c}$ | | | | | | | | | | | | 1 | 0.69** | 0.66** | -0.70** | 0.57** |
| 13. Symptoms | | | | | | | | | | | | | 1 | 0.41** | -0.71** | 0.67** |
| 14. Function status | | | | | | | | | | | | | | 1 | -0.33** | 0.78** |
| 15. GHP | | | | | | | | | | | | | | | 1 | -0.25** |
| 16. Overall QoL | | | | | | | | | | | | | | | | 1 |

*$p < 0.05$; **$p < 0.01$

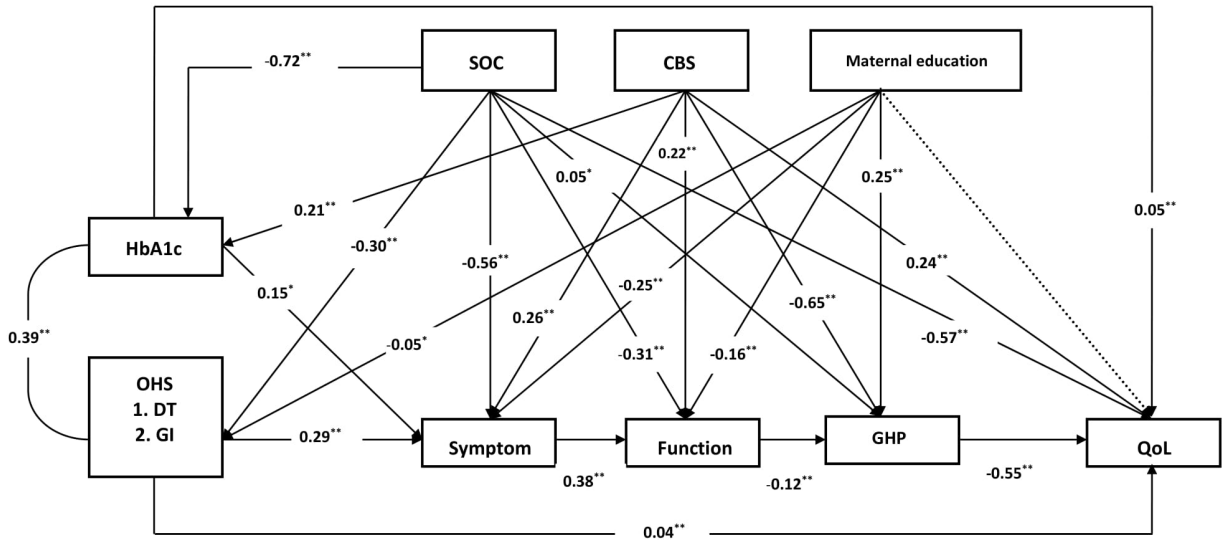


*Figure 1. Final Structural Equation Model for determinants of Oral Health Related Quality of Life and overall Quality of Life. Values are standardised path coefficients.*p<0.05 ** p< 0.01*

clinical variables predicted the symptoms domain of $CPQ_{11\text{-}14,}$ which mediated their effects on OHRQoL and GHP. Both oral health status and metabolic status had direct relationships with overall QoL. These relationships might be explained in several ways. For instance, the Wilson and Cleary model is a model of the consequences of disease, especially chronic diseases. In additon, the prevalence of caries and gingival disease was high among participants, which may have intensified the influence of clinical factors on the subjective outcomes. The analysis also suggests a mediating role for clinical variables. In other words, the environmental and individual factors also had indirect effects on OHRQoL and subsequently overall QoL through the clinical status of adolescents with $T_1DM$.

The positive point in the current study was using a comprehensive analysis based on a theoretical model. The second point was the high reliability and internal consistency of different scales used in the investigation.

**Table 3.** Direct and indirect effects of individual, environmental and clinical factors on oral health related quality of life (OHRQoL) and overall quality of life (QoL)

| *Effects* | *Direct effect* | | | | *Indirect effect* | | | |
|---|---|---|---|---|---|---|---|---|
| | *β* | *SE* | *95% CI* | *p* | *β* | *SE* | *95% CI* | *p* |
| Symptoms | | | | | | | | |
| SOC | -0.50 | 0.02 | -0.62; -0.39 | ** | -0.36 | 0.06 | -0.44; -0.28 | ** |
| CBS | 0.33 | 0.01 | 0.23; 0.43 | ** | 0.13 | 0.03 | 0.09; 0.15 | ** |
| Maternal education | -0.09 | 0.12 | -0.02; -0.03 | ** | - | - | - | - |
| DT | 0.33 | 0.28 | 0.04; 0.17 | ** | - | - | - | - |
| GI | 0.10 | 0.30 | 0.25; 0.41 | ** | - | - | - | - |
| $HbA_{1c}$ | 0.14 | 0.25 | 0.06; 0.21 | ** | - | - | - | - |
| Functional status | | | | | | | | |
| SOC | -0.43 | 0.02 | -0.35; -0.54 | ** | -0.46 | 0.05 | -0.54; -0.38 | ** |
| CBS | 0.31 | 0.02 | 0.22; 0.49 | ** | 0.23 | 0.04 | 0.15; 0.30 | ** |
| Maternal education | -0.06 | 0.26 | -0.12; -0.01 | * | -0.03 | 0.01 | -0.06; -0.01 | ** |
| DT | - | - | - | ** | 0.04 | 0.01 | 0.01; 0.07 | ** |
| GI | - | - | - | - | 0.13 | 0.02 | 0.09; 0.18 | ** |
| $HbA_{1c}$ | - | - | - | - | 0.06 | 0.02 | 0.02; 0.09 | ** |
| Symptoms | 0.38 | 0.11 | 0.28; 0.45 | ** | - | - | - | - |
| Overall QoL | | | | | | | | |
| SOC | -0.53 | 0.20 | -0.95; -0.33 | ** | -0.70 | 0.14 | -0.81; -0.35 | ** |
| CBS | 0.23 | 0.14 | 0.09; 0.54 | ** | 0.45 | 0.09 | 0.27; 0.55 | ** |
| Maternal education | - | - | - | - | -0.01 | 0.01 | -0.03; 0.02 | 0.33 |
| DT | 0.04 | 0.01 | 0.01; 0.06 | * | 0.03 | 0.02 | -0.01; 0.08 | 0.09 |
| GI | 0.05 | 0.02 | 0.01; 0.09 | * | 0.07 | 0.04 | 0.02; 0.16 | ** |
| $HbA_{1c}$ | 0.07 | 0.02 | 0.03; 0.12 | ** | 0.01 | 0.01 | 0.004; 0.03 | ** |
| GHP | -0.56 | 0.14 | -0.71; -0.25 | ** | - | - | - | - |
| Symptoms | - | - | - | - | 0.02 | 0.01 | 0.01; 0.05 | ** |
| Function status | - | - | - | - | 0.06 | 0.03 | 0.02; 0.12 | ** |

β: Beta coefficient; SE: Standard error; *$p < 0.05$; **$p < 0.01$

As is the case with all research, this study had limitations. The cross-sectional design does not provide strong evidence of causation. It is likely that the relationships between individual factors and oral health are dynamic, so measuring them at one point in time may not capture such effects (Hayes and Rockwood, 2017). Longitudinal studies such as those by Nammontri *et al.* (2013) and Gururatana *et al.* (2014) are required to overcome these drawbacks to allow a deeper understanding of causality and mutual relationships. These findings should be generalised with caution because the participants were hospital outpatients and might have specific characteristics. Finally, severe or multiple complications might have prevented some adolescents from taking part in the investigation, which may have influenced the apparent relationships in the models (Kueh *et al.*, 2015).

## Conclusion

In summary, the Wilson and Cleary model again provided a good theoretical paradigm for studying chronic conditions like oral diseases and diabetes. Internal factors such as SOC and DCB predicted OHRQoL and overall QoL among early adolescents with $T_1DM$. Enhancing the SOC of early adolescents with $T_1DM$ may improve their OHRQoL and overall QoL. Oral health status and metabolic disease had direct effects on overall QoL. The SES was unrelated to overall QoL but had direct and indirect effects on OHRQoL.

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