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Temporal stability of the theory of planned behavior: a prospective analysis of sugar consumption among Ugandan adolescents

Anne Nordrehaug Åstrøm[1,2] and I. Okullo[1,3]

[1]Centre for International Health, [2]Department of Odontology-Community Dentistry, University of Bergen, Norway, [3]Department of Dentistry, Makerere University, Uganda

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Abstract – *Purpose:* This study addressed three questions: What is the power of the Theory of Planned Behavior (TPB) in predicting adolescents' intended and self-perceived consumption of non-milk extrinsic sugars using a non-intervention prospective approach? To what extent do the TPB constructs change across time following adolescents' mere exposure to an oral health survey? Do changes in self-perceived sugar consumption at follow-up associate with changes in behavioral intention as predicted by the TPB? *Method:* A survey was conducted in Kampala (urban) and Lira (rural) and 1146 secondary school students completed questionnaires assessing the TPB at school (Time 1). A random sub-sample of 415 students was selected from the original survey of which 372 students were examined clinically. After 3 months (Time 2), the questionnaire was administered a second time in the sub-sample. All analyses are based on the number of students who participated on both survey occasions, $n = 372$. *Results:* Attitudes and perceived behavioral control predicted intended sugar consumption at Time 1 and Time 2, accounting for 58% ($\Delta R^2 = 0.58$) and 19% ($\Delta R^2 = 0.19$) of the variance, respectively. Time 1 intention provided significant prediction of Time 2 self-perceived sugar consumption with $\Delta R^2 = 0.5$. Adolescents with high-caries experience more than their counterparts with low, changed towards weaker intentions and less frequent sugar consumption across the survey period. Mean sugar consumption scores changed from 2.6 to 2.7 (ns), 3.1 to 2.6 ($P < 0.001$) and 2.3 to 3.2 ($P < 0.001$) among adolescents who, respectively, remained stable, increased and decreased their intentions across time. *Conclusion:* This study supports the validity of the TPB in predicting intended and self-perceived sugar consumption prospectively.

Key words: adolescents; caries experience; sugar consumption; theory of planned behavior; Uganda

Anne Nordrehaug Åstrøm, Centre for International Health, Armauer Hansen Building, N-5021 Bergen, Norway
Tel: +47 5597 4984
Fax: +47 5597 4979
e-mail: anne.nordrehaug@cih.uib.no

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Introduction

In socioeconomically less developed countries, changing to a western-style diet leads to increased frequency sugar consumption from food, beverages and sweets (1–3). Evidence suggests that commercialized sugar products are highly preferred, particularly among young urban dwellers of higher socioeconomic status (4). Consumption of non-milk extrinsic sugars, one of the etiological factors of dental caries (5), might stand as a proxy measure for socioeconomic development. Uganda, with an average Gross Domestic Product of 6% and an industrial production growth

rate of 7%, has been rated as one of the good performing economies in Africa, having sugar as one of its major industrial products (6). An increase in the per capita sugar consumption has been reported during the last decade (7). To ensure that economic development and adoption of new eating habits does not lead to increments in dental caries and other non-communicable diseases, steps should be taken towards conscious maintenance of a low-level non-milk extrinsic sugar diet. A number of international expert committees have recommended guidelines on reduction of sugar intake (8). For such guidelines to be promoted effectively, information is required as to which cognitive factors influence the decision whether or not to eat sugary foods and drinks on a daily basis in the future.

One of the most popular theoretical frameworks for the prediction of health behaviors is the theory of planned behavior, TPB, (9–11). The TPB was developed as an extension of the theory of reasoned action (TRA), and is based upon expectancy value formulations to address the issue of attitude–behavior consistency (12). Originally, the TRA addressed only volitional behaviors, but was subsequently revised to encompass behaviors not under volitional control. The extended version (TPB) included perceived behavioral control (PBC) together with attitude and subjective norm, as determinants of behavioral intention (9). The TPB considers intentions to be an additive function of attitude, subjective norm and PBC. These constructs in turn influence subsequent behavior through behavioral intentions, apart from perceived behavioral control, which also may influence behavior directly insofar as perception of control reflects actual control (13).

The predictive utility of the TPB has been supported in a wide range of behavioral domains, including eating behaviors (9–11). Armitage and Conner (11) reported that the TPB accounted for frequency-weighted averages of 39% and 27% of the variance in intention and behavior across numerous applications. Generally, PBC has improved the performance of the TRA in relation to food choice intention, but failed in relation to subsequent food choice behavior, rendering intention the only important predictor (14, 15). Whilst a number of studies have adopted the TPB to the prediction of various eating behaviors, there are few focusing sugar consumption of children and adolescents (15, 16). Moreover, studies considering peoples' food choice have commonly been cross-sectional in design (10, 17), rendering questionnaires more vulnerable to consistency biases, which artificially inflates the relationship between intention and behavior. Among the prospective studies short-term follow-ups (e.g. <1 month) are common and very few have predicted food choice intentions prospectively (17–19). Little research has been done outside North America and Europe (20, 21). Uncertainty remains as to the applicability of the TPB to food choice intentions and behaviors in non-western cultures. Recognizing that the TPB performs differently in different sociocultural contexts and with various behaviors, without testing its validity one can never taking for granted that this theory could be applied in any specific situation in a developed or less developed context.

Given the widespread use of the TPB and the inherent weakness of cross-sectional analysis in establishing the model's utility, it is important to examine the validity of the theory in predicting intention and behavior across time. The TPB is likely to change across time (or maintains less temporal stability), particularly in young spontaneous people and regardless of whether it is challenged or not (22, 23). According to the TPB, changes in behavior in response to new information likely to be encountered across time follow from changes in intentions and the underlying cognitive structure of attitudes, subjective norms and PBC (9). Using a long-term (3 months) prospective non-intervention approach, this study assessed the validity of the TPB in predicting intended and self-perceived sugar consumption of Ugandan adolescents. The following questions were addressed: What is the power of the TPB in predicting intended and self-perceived sugar consumption prospectively? To what extent are the TPB constructs subject to change following adolescents' mere exposure to an oral health survey with clinical examination? Are the observed changes in self-perceived sugar consumption at follow-up associated with changes in behavioral intention as predicted by the TPB?

Methods

Study population and procedures

The study population was pupils attending public secondary schools in the capital city of Kampala and in Lira. Kampala, accounts for nearly one-half (41%) of all urban residents in Uganda (24). Lira district is typically rural and situated approximately 350 km north of Kampala. Although

the proportion of the urban–rural population in Uganda is 1:5, approximately 80% of all the secondary schools are located in urban areas.

The STATA statistical program (Biostatistics Consulting Center, University of Massachusetts, MA, USA) was used to estimate the minimum sample sizes. Sample size calculation for the sub-sample was based on an assumed caries prevalence of 25% and a standard error (SE) of 2%. The sample size calculation for the main sample was based on a sugar consumption rate of 30%, SE of 2% and a design effect of 2.0. The sample size was achieved using a one-stage cluster sampling procedure, stratified according to study area and with equal allocation from each stratum. A total of 20 schools were listed in Lira and 10 considered for sampling, the inclusion criteria being schools with at least 250 students and placed at least 10 km from Lira town center. In Kampala 30 schools within the radius of 10 km from the city center (Main Post Office Building) were considered for sampling. A total of 10 secondary schools (five from Kampala and five from Lira) were then selected by simple random sampling. All students attending Form I and Form IV in the selected schools were invited to participate in the study. A total of 1146 of 1324 eligible students, 52% urban, mean age: 15.8 (±1.6, range: 13–19) years, response rate 87%, completed structured questionnaires related to the TPB in the autumn of 2001 (Time 1). A sub-sample of 415 students was selected by systematic random sampling from a list of the participants of the main survey of which 372 students, 48% urban, mean age 16.3 (±1.7) years, response rate 89%, participated in a clinical oral examination and a 3 months follow-up questionnaire survey (Time 2). Written informed consent to participate in the study was obtained from the students' parents/guardians. Ethical clearance to conduct the study was granted from the Ethical Committee Norway, The Uganda National Council for Science and Technology, the local administration and schools authorities.

Survey instruments

The confidential questionnaire was designed and completed in English, the language of instruction in Ugandan secondary schools. The students completed the questionnaires in their respective classrooms under supervision of trained research assistants and in the absence of the teachers to ensure confidentiality. The survey instrument was reviewed for content validity by Ugandan researchers and pilot-tested before being used in the field. The questionnaire of the Time 1 survey assessed socioeconomic status and each component of the TPB in relation to daily intake of sugared snacks and drinks. The terms sugared snacks and drinks were exemplified with typical snacks available and preferred by young East African people (21). The survey instrument of the follow-up included a second assessment of the TPB components. Gender was measured as 1 = male and 2 = female. Place of school was assessed as 1 = Kampala (urban) and 2 = Lira (rural). Place of residence where raised was assessed as 1 = urban and 2 = rural. Age was recorded as age at last birthday and categorized into 1 = 13–15 years and 2 = 16–19 years. Caries status as recorded clinically was categorized as 1 = low risk (DT ≤ 2) and 2 = high risk (DT ≥ 3) using an arbitrary cut-off point. Intention to take sugared snacks and drinks on a daily basis was assessed using three items, e.g. 'How likely or unlikely is it that you will take sugared snacks and drinks on a daily basis in the future'. The respondents indicated their subjective probability along a 5-point response scale ranging from (1 point) very likely to (5 points) very unlikely. Sum scores were constructed by adding the responses of the three items. The higher the sum scores, the lower the intention to take sugared snacks and drinks. Self-perceived sugar intake was assessed at using one single item 'During the past weeks I have taken sugared snacks and drinks on a daily basis'. The respondents gave their answers on a 5-point Likert scale, ranging from (1 point) strongly agree to (5 points) strongly disagree. Attitudes towards daily intake of sugared snacks and drinks were constructed from four positively worded statements each answered on a 5-point scale ranging from (1 point) strongly agree to (5 points) strongly disagree. Sum scores were constructed by adding the four items. The higher the scores, the more unfavorable the attitude towards daily intake of sugared snacks and drinks in the future. To assess subjective norms, the respondents rated their agreement/disagreement with three statements about the view of significant others, e.g. 'People who are important to me would approve of me taking sugared snacks and drinks on a daily basis'. Responses were given on a 5-point scale ranging from (1 point) strongly agree to (5 points) strongly disagree. Sum scores were constructed from the three single items at Time 1 and Time 2. The lower the sum score the stronger the perceived approval from significant others. Perceived behavioral control was measured by sum scores constructed from four items e.g. 'How easy or difficult do you think it will

be for you to take sugared snacks and drinks on a daily basis in the future'. The answers were recorded on a scale ranging from (1 point) very easy to (5 points) very difficult. The higher the score, the less the perceived control with respect to consuming sugary snacks and drinks.

Clinical examination

Intra-oral examination was conducted by one trained dentist (I.O.), with an assistant recording the observations. Caries experience was assessed under field conditions using the DMFT index as described by the World Health Organization (WHO; 25). The intra examiner agreement was satisfactory with a Cohen's kappa of 0.82. For a detailed description see reference (26).

Statistical analyses

The Statistical Package for Social Sciences (SPSS version 10.0 SPSS Inc., Chicago, IL, USA) was employed. Univariate analyses were performed using Cronbach's alpha, Pearson's correlation coefficient, chi-square analyses, paired *t*-test, multiple linear regression, GLM repeated measures and GLM ANOVA. The strength of the predictive relationships was reported in terms of the adjusted R^2, to produce estimates that are closer to the population value than the R^2 (27). The results were checked for potential cluster effect because of the primary sampling unit of school, using STATA version 8.0.

Results

The results presented here are based on the number of participants of both survey occasions ($n = 372$). Attrition analyses revealed that adolescents who participated at Time 1 and Time 2 did not differ significantly from their counterparts who participated only at Time 1 on any of the measures of the Time 1 questionnaire. Table 1 depicts the sample profile of students resident in Kampala urban and Lira rural. Students with high (DT: 3–11) and low (DT: 1–2) caries experience did not vary according to place of residence, gender and age. Direct age–sex standardization of caries experience in terms of DMFT > 0 revealed 85% and 73% ($P < 0.05$), among Kampala and Lira students, respectively (not depicted in Table 1).

Predictive validity of TPB across time

At Time 1, when asked what types of sugary foods and drinks had been consumed during the previous 3 months, 40, 48, 77, 26,43 and 50% confirmed, respectively, soda water, chocolates and sweets, sugar in coffee and tea, ice cream, cakes and biscuits, and sugary fruits (i.e. local dried and conserved fruits with added sugar). As shown in Table 2, the majority of the Cronbach's alphas of the TPB constructs were above 0.7 and only one of the 45 coefficients was not statistically significant ($P > 0.05$). Pearson correlation coefficients between Time 1 and Time 2 measures (relative stability) were 0.45, 0.40. 0.47, 0.39 and 0.30 ($P < 0.001$) regarding the scores of attitudes, intention, subjective norms, PBC and self-perceived sugar consumption, respectively. Individual difference scores (Time 2−Time 1) was constructed for perceived behavioral control (range: from −16 to +13) and intention (range: from −12 to +11), allocating students to three groups. Negative individual difference scores represented a change towards stronger intentions and stronger PBC. Positive scores represented a change towards weaker intentions and weaker PBC, whereas scores in the range −1 to +1 represented no change (absolute stability) across time. A total of 40.4, 22.8 and 36.8% of the students remained stable, got stronger and got weaker intentions from Time 1 to Time 2, respectively. The corresponding figures for PBC were 36.1, 31.5 and 32.4%, respectively.

Table 3 depicts the results from linear multiple regression analysis of intention measured at Time 1 and Time 2 onto attitudes, subjective

Table 1. Frequency distribution (%) of study participants according to age, gender and parents' education in Kampala and Lira

	Urban [$n = 180$ (%)]	Rural [$n = 192$ (%)]	All [$n = 372$ (%)]
Age			
13–15	110 (61)	63 (33)	173 (47)
16–19	70 (39)	129 (67)**	199 (54)
Gender			
Male	82 (46)	106 (57)	188 (52)
Female	96 (54)	81 (43)*	177 (49)
Parental education			
Low	37 (21)	68 (35)	105 (28)
Medium	52 (29)	83 (43)	135 (37)
High	89 (50)	41 (21)**	130 (35)
Caries status			
Low (DT < 2)	55 (98)	54 (102)	55 (200)
High (DT: 3–11)	45 (81)	45 (86)	45 (167)

The total number in the categories do not add up to 180 and 192 due to missing responses.
*$P<0.01$.
**$P<0.05$.

Table 2. Pearson's correlation coefficients for inter-scale associations and Cronbach's alpha (on the diagonal) for the TPB variables assessed at Time 1 (T1) and Time 2 (T2) ($n = 372$)

Variable	1	2	3	4	5	6	7	8	9
Behavior (T2)	–								
Intention (T1)	0.21	**0.86**							
Intention (T2)	0.45	0.40	**0.87**						
Attitude (T1)	0.13	0.74	0.39	**0.93**					
Attitude (T2)	0.29	0.39	0.71	0.45	**0.93**				
SN (T1)	0.10 ns	0.60	0.28	0.71	0.45	**0.67**			
SN (T2)	0.23	0.32	0.56	0.43	0.71	0.46	**0.74**		
PBC (T1)	0.17	0.61	0.32	0.59	0.33	0.50	0.31	**0.75**	
PBC (T2)	0.29	0.35	0.64	0.36	0.67	0.34	0.54	0.39	**0.81**
Behavior (T1)	0.30	0.47	0.26	0.26	*0.21*	0.24	0.16	0.35	0.23

All correlations statistically significant at $P < 0.05$.
Values in bold through the diagonal represents Cronbach's alpha of the TPB scales.
Ns, not statistically significant; PBC, perceived behavioral control; SN, subjective norm.

Table 3. Regression of intended sugar intake at Time 1 and Time 2 onto TPB variables at Time 1 regression of self-perceived sugar intake at Time 2 onto intention and PBC at Time 1

Predictors	β^a	β^a
Time 1	Time 1 intention	Time 2 intention
Step 1		
Caries status	−0.16*	0.04 ns
Step 2		
Attitudes	0.56**	0.32**
Subjective norms	0.08 ns	−0.02 ns
PBC	0.22**	0.18*
		Time 2 behavior
Step 1		
Place of school		0.15*
Caries status		0.06 ns
Step 2		
Intention		0.16*
PBC		0.09 ns

Analyses controlled for age, gender, place of school and caries status.
β^a means beta final step 2.
Model fit: Intention (Time 1): $\Delta R^2 = 0.58$, F change (3,313) = 161.1, $P < 0.000$; Intention (Time 2): $\Delta R^2 = 0.19$, F change (3,313) = 24.0, $P < 0.000$; Behavior (Time 2):$\Delta R^2 = 0.05$, F change (2,316) = 8.7, $P < 0.000$.
PBC, perceived behavioral control; TPB, theory of planned behavior.
*P<0.05.
**P<0.01.

norms and PBC measured at Time 1. Sociodemographics in terms of age, gender, place of residence and caries experience were controlled for in the analyses. For Time 1 and Time 2 intention, attitudes and PBC were the two significant predictors, explaining 58 and 19% of the of the variance, respectively. Caries status was the only external statistical significant predictor of Time 1 intention ($\beta = -16$, $P = 0.000$). The regression of Time 2 self-perceived sugar intake onto Time 1 intention and PBC revealed intention as a statistically significant predictor, accounting for 5% of the explainable variance. Place of school turned out to have an independent effect on self-perceived sugar consumption at Time 2 ($\beta = 0.15$, $P < 0.005$) (Table 3).

Changes in intended and self-perceived sugar intake in students with various caries experiences

As shown in Table 4, adolescents as a group held on average favorable attitudes, had feelings of high control and felt a moderate social pressure related to sugar consumption, whereas self-reported sugar intake was moderately high both at Time 1 and Time 2. GLM ANOVA, adjusting for sociodemographics revealed weaker intended sugar consumption among students with low-caries experience than among their peers with high-caries experience at Time 1. GLM ANOVA repeated measure with caries group as a between subject factor and the TPB construct as within subject factors (time), revealed significant main effects (Wilk's lambda) of time with respect to; self-perceived sugar consumption $F(1,133) = 6.27$, $P < 0.04$, intended sugar consumption $F(1,325) = 12.56$, $P < 0.001$ and attitudes $F(1,323) = 10.34$), $P < 0.001$. The adjusted mean scale scores revealed that for the study group as a whole intended and self-perceived sugar consumption became more restrictive across time, whereas attitudes became more unfavorable. A two-way interaction between caries group and intended and self-perceived sugar consumption achieved statistical significance, with $F(1,333) = 3.614$, $P < 0.05$ and $F(1,325) = 16.773$,

Table 4. Adjusted mean scores (*M*) and 95% Confidence Interval (95% CI) for the TPB scale scores at Time 1 (T1) and Time 2 (T2): the study group as a whole and in low (DT ≤ 2) and high (DT: 3–11) caries groups

	All ($n = 372$) [*M* (95% CI)]	Low ($n = 200$) [*M* (95% CI)]	High ($n = 167$) [*M* (95% CI)]	Low vs. high *P*-value[a]
Behavior				
T1 (1–5)	2.7 (2.5–2.8)	2.7 (2.5–2.9)	2.5 (2.3–2.7)	0.161
T2 (1–5)	2.9 (2.7–2.9)	2.8 (2.6–2.9)	2.9 (2.7–3.1)	0.317
T1 vs. T2[b]	$F(1,333) = 6.27$, $P = 0.013$	$t = -0.745$, $P = 0.457$	$t = -3.062$, $P = 0.003$	
Intention				
T1	7.3 (6.9–7.6)	7.9 (7.1–8.0)	6.8 (6.3–7.2)	0.001
T2	8.0 (7.6–8.3)	7.8 (7.3–8.2)	8.0 (7.6–8.5)	0.405
T1 vs. T2[b]	$F(1,325) = 12.56$, $P = 0.000$	$t = 0.42$. $P = 0.67$	$t = -5.48$, $P = 0.000$	
Attitude				
T1	10.2 (9.7–10.6)	10.3 (9.8–11.1)	10.2 (9.5–10.8)	0.557
T2	11.1 (10.5–11.4)	10.9 (10.3–11.5)	11.0 (10.3–11.6)	0.901
T1 vs. T2[b]	$F(1,323) = 10.34$, $P = 0.001$	$t = -2.53$, $P = 0.012$	$t = -2.10$, $P = 0.037$	
SN				
T1	8.4 (8.1–8.7)	8.5 (8.1–9.0)	8.3 (7.8–8.7)	0.424
T2	8.8 (8.4–9.1)	8.6 (8.2–9.0)	8.9 (8.4–9.3)	0.366
T1 vs. T2[b]	$F(1,320) = 3.47$, $P = 0.063$	$t = -.143$, $P = 0.861$	$t = -1.969$, $P = 0.051$	
PBC				
T1	10.4 (10.0–10.8)	10.6 (10.1–11.1)	10.3 (9.7–10.9)	0.434
T2	10.4 (10.1–10.8)	10.6 (10.4–11.6)	10.5 (9.4–10.5)	0.829
T1 vs. T2[b]	$F(1,321) = 0.004$, $P = 0.952$	$t = 0.241$, $P = 0.810$	$t = -0.376$, $P = 0.707$	

[a]GLM ANOVA controlled for age, gender and place of residence.
[b]GLM repeated measures, paired *t*-test.
PBC, perceived behavioral control; SN, subjective norm.

$P < 0.001$, respectively. As shown in Table 4, paired *t*-test revealed statistical significant change towards more restricted intention and self-perceived sugar intake in the high-caries group, only. Attitudes changed significantly in a more unfavorable direction in adolescents with high as well as low-caries experience.

To examine whether the time effect on self-perceived sugar intake was moderated by intention stability, individual difference scores of intention and PBC were added as between subject factors into the ANOVA model with sugar intake as within subject factor (time). The main effect of time (Wilk's lambda) and the two-way interaction effect with caries group did not maintain statistical significance. A statistically significant two-way interaction was achieved with the intention stability score, $F(2,305) = 17.095$, $P = 0.000$. Adjusted mean scores of self-perceived sugar intake showed gradients in the expected directions; from 2.6 to 2.7 (ns), from 3.1 to 2.6 ($P < 0.05$) and from 2.3 to 3.2 ($P < 0.05$) among those who remained stable, increased and decreased their intended sugar consumption across time.

Discussion

Despite the fact that there has been a call for explanatory research during intervention development, few analytical theory-based studies of adolescents' food choices have been reported (28). This study contributes to the literature by assessing the predictive validity of the TPB using a prospective approach and by exploring the cognitive determinants of adolescents' sugar consumption in a non-western cultural setting. The TPB was found to be predictive of intended sugar intake, explaining 58% of the variance cross-sectionally and 19% prospectively after controlling for the influence of sociodemographic factors and caries status. The above findings support and extend a previous study of similar design conducted in adults. Thus, Conner *et al.* (19) reported explained variances in intention to eat healthily, amounting to 43% cross-sectionally and 20% prospectively over a period of 6 years. Attitudes and perceived behavioral control emerged as the strongest predictors of adolescents' intended sugar consumption at both occasions of measurement.

Similar results have been reported previously in relation to food choice intentions [for review see reference (21)]. The result adds to the generality of the motivational properties of those constructs when it comes to eating behavior across cultures.

The TPB was also found to predict self-perceived sugar consumption at 3 months follow-up, thereby adding to existing research which demonstrates that intentions can predict behavior over varying time periods (29). Contrary to expectations, PBC did not contribute uniquely to the prediction, suggesting that the participants of this study had a high degree of actual control with their sugar intake. Nevertheless, the results indicate a fit of 5% which is considered below the optimal level, when compared to the figure of $R^2 = 0.27$ reported in a recent meta analytical review (11), although there is considerable heterogeneity in the proportion of variance explained by the TPB across behaviors (10). According to the present results, moderate temporal stability on the part of adolescents' intended sugar intake (Pearson's $r = 0.44$, 40% remained stable) did probably temper the prediction of sugar consumption across time. This reasoning corroborates Ajzen and Fishbein's (12) general notion that prediction with social cognitive models will be most successful if the time lag between cognitive and behavioral assessments is short. What is important is that cognitions are potentially modifiable and might change in response to influencing events that tend to crop up across time. Reflecting the underlying sociodemographic determinants of oral health, the present data revealed more frequent sugar consumption among urban as compared to their rural participants. Whereas previous studies from sub-Saharan countries have documented a tendency towards higher sugar consumption in urban areas, this issue has never been addressed within the context of the TPB (4).

In accordance with what have been reported regarding food frequency questionnaires, the first measurement occasion revealed more frequent consumption than did the subsequent administration 3 months later (30). At the group level there was an overall decline in intended and self-perceived sugar consumption across time accompanied by a change towards less favorable attitudes. Interestingly, the changes in the TPB were most prominent among students having most untreated caries. This relationship should be interpreted with caution because of limitations related to the third variable problem and the possibility of a repeated measurement effect. However, if reliable, one might speculate, whether those changes were promoted by a sensitization following self-monitoring of sugar-related issues at two different occasions. Self-monitoring is a well-known way of initiating cognitive changes (31). Thus, as a consequence of mere exposure to an oral health survey, involving the transmission of risk information, the participants and caries active to a larger extent than caries inactive, became less motivated to take sugary foods and drinks and did limit their self-perceived sugar consumption.

Analyzing the TPB constructs at two different points in time made it possible to compare behavioral time effects of students who decreased, increased and remained stable with respect to their decision to take sugared snacks and drinks on a daily basis. If the TPB is correct, then students who declined their intended sugar intake would report lower level of sugar consumption as compared to their counterparts who remained stable or increased intention during the survey period. Divergent trajectories of self-perceived sugar consumption did occur as a function of intention stability. It was demonstrated that a decline and an enhancement in sugar intake was achieved among those who respectively, decreased and increased their intentions during the survey period. It is worth notifying, that neither the main effect of time nor the interaction with caries status remained statistically significant after intention stability was included in the repeated measure model. Thus, acknowledgement of personal caries situation in terms of feeling susceptible to dental disease or not seemed to capture an important motivational influence on self-perceived sugar consumption mediated by the TPB. These findings add support to the (longitudinal construct) validity of the TPB, not merely as a model for predicting – but also as a model for changing behavior. Certainly, there is a need for theory-based oral health interventions and the TPB has the potential to satisfy that need. Although rarely, the TPB has been employed to develop and evaluate interventions that has been found to change attitudes, intentions and behavior related to various health-related behaviors (28, 32–34). It has been concluded that to be effective, behavior change interventions should be based on various theoretical frameworks and behavioral approaches (34). When the TPB can specify the particular cognitions to be targeted, how to target those cognitions, i.e. what educational method to choose must be based on other

theories (12). Whether guidelines derived from the TPB and other theoretical frameworks lead to behavioral change in the desired direction should be confirmed by evaluation studies rigorously designed as randomized controlled trials.

Some methodological limitations should be considered. First the focus on self-report data may have opened the research to consistency and recall biases. In particular, the findings of this study would be strengthened by observing sugar consumption, validation by significant others or physiological data. The risk of consistency bias and self-presentational bias also applies to the individual measure of intention stability as it was computed from measures taken before but also concomitant with self-perceived sugar intake at Time 2. Unfortunately, a way to distinguish true behavioral stability from unreliability was not included. Thus, additional variance caused by measurement errors might have weakened the correlation between variables. Some of the TPB scales were measured with two items. While the internal reliabilities of the TPB scales were satisfactory (35), the use of multi-item scales would be preferable although this has to be balanced against increasing the length of the questionnaire to be completed by young people.

In conclusion, although the TPB could be considered individualistic in its conceptualization, practical implications in terms of assisting in the development of oral health promotion programs can be drawn from the reported study. Interventions should target beliefs underpinning attitudes and PBC to decrease adolescents' motivation for frequent daily consumption of commercialized sugar products. The present data suggests that adolescents' caries status might influence their responsiveness to such interventions. Targeting beliefs about the disadvantages of frequent sugar consumption, through risk information and persuasive messages, might create more unfavorable attitudes. Another strategy would be to introduce new beliefs about sugar-free snacks, emphasizing links between good health and good taste. Adolescents' confidence in this endeavor should also be targeted by facilitating their access to conditions that make restricted sugar consumption an easy and obvious choice. This might need alternative teaching techniques in addition to information/persuasion. According to Bandura (36), PBC can be enhanced through personal mastery experiences by setting and achieving sub-goals for instance in terms of choosing sugar-free alternatives. Engineering interventions should focus on external control factors in order to make sugar-free snacks cheaper to by, easily available and equipped with quality information in terms of food labels for adolescents.

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