#  Application of the integrated behavioral model to identify the predictors of toothbrushing practices among primary school children at Bahir Dar city, Ethiopia

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# Abstract

Knowing the level of behavioral intention and tooth brushing practices is crucial for the implementation of the intervention. However, such studies are **too limited in** Ethiopia. The current study employed a health behavior model to identify predictors that can serve to support primary school children's attitudes, intentions, knowledge, environmental constraints, and practices of tooth brushing. Thus, this study aimed to assess tooth brushing practices and their predictors among primary school children in Bahir Dar city, Ethiopia.

An Institutional based cross-sectional study was conducted among primary school children in Bahir Dar city. A multi-stage sampling technique was used to select 610 participants. Data were collected using **pre-tested interviewer-administered questionnaires**. Questionnaires adapted from items previous literatures were used and for integrated behavioral model constructs incorporate with elicitation study result. Data entry was performed by using Epi data and analysis by Stata version 14.1. Descriptive statistics were done. Confirmatory Factor analysis **(CFA) was performed to check the convergent validity of the measurement.** The Internal reliability of the items was also checked using Composite reliability. Multivariable Logistic regression was used to predict the role of independent variables on toothbrushing practices. Moreover, path analysis was performed to check the causal effect of integrated behavioral model constructs on toothbrushing practices.

Goodness of fit of the final model was checked using the Hosmer and Lemeshow test of best fit with a large p-value=0.97 and Area under receiver operating characteristics (ROC) curve = 0.98.

The overall prevalence of current practice of toothbrushing among the respondents was 45.4%. The prevalence of brushing frequency 243(89.01%), 27(9.89%) and 3 (1.09%) brushed once a day, twice a day and more than twice a day respectively. Female child’s [AOR= 3.23, 95%CI: 1.48-7.02], mothers’ education[AOR = 4.6; 95% CI: 1.22 –17.44], past experience of toothbrushing [AOR = .042; CI: .018–.101], knowledge about tooth brushing practices [AOR= 1.3; 95%CI: 1.09–1.60], behavioral intention[AOR= 2.01; 95% CI: 1.74–2.32], experiential attitude[AOR=1.09;95%CI:1.01–1.17],instrumental attitude [AOR= 1.02; 95%CI: 1.01–1.03], and descriptive norm [AOR=1.07; 95%CI: 1.01–1.14] were predictors of toothbrushing practices .

The findings indicate that the practice of toothbrushing practices among primary schools students was low. Sex, mother's education, knowledge, intention, experience, experiential attitude, instrumental attitude, and descriptive norm, have significant effects on toothbrushing practices; indicating that the integrated behavioral model showed adequate utility in predicting toothbrushing practices in the study area. School-based toothbrushing practices change interventions such as communication strategy. **Keywords**: toothbrushing practices, Integrated Behavioral model, Primary school children, predictors, Ethiopia

# Introduction

# An Integrated Behavioral Model(IBM) includes constructs from the theory planned behavior and other influential constructs. As in the Theory of reason action /Theory of planed behavior, the most important determinant of behavior in IBM is the intention to perform the behavior.  **The four** other components directly affect the behavior. Three of these are important in determining whether behavioral intentions can result in behavioral performance. First, even if a person has a strong behavioral intention, that person needs knowledge and skills to carry out the behavior. Second, there should be no or few environmental constraints that make behavioral performance difficult or impossible. Third, the behavior should be salient to the person, and experience in performing the behavior may make it habitual, so that intention becomes less important in determining behavioral performance for these individuals([1](#_ENREF_1)).

The toothbrush is the most common method for removing plaque from the oral cavity([2](#_ENREF_2)). Various studies have been made of the toothbrushing habits of children. Investigations have been directed primarily toward the ability of children to perform different methods of toothbrushing, and performance has been determined by the effectiveness of plaque removal([3](#_ENREF_3)). toothbrushes are the most widely used oral hygiene aids([4](#_ENREF_4)). Brushing twice a day with fluoride toothpaste is one of the most important habits for good oral health. Through Brush day and night activities, children learn about the benefits of good oral hygiene and are taught to brush their teeth twice daily with fluoride toothpaste ([5](#_ENREF_5), [6](#_ENREF_6))

Although great **achievements have** been made in the oral health of the global population, there are still problems in many countries around the world, especially in the poor group in developed and developing countries. Dental caries and periodontal diseases **are** regarded as the most important oral health burdens **worldwide**. At present, the distribution and severity of oral diseases vary in different regions of the world and within the same country or region. A large number of epidemiological investigations have **demonstrated** the important role of social behavior and environmental factors in oral diseases and health([7](#_ENREF_7)).

**The prevalence** of recommended tooth brushing behavior **has** increased in developed countries such as Estonia, Russia, Latvia, Finland, and Flemish Belgium([8](#_ENREF_8)) . In India and Indonesia children with the correct habit of brushing have a  **lower** incidence of dental caries compared to children who rarely brush their teeth([9](#_ENREF_9), [10](#_ENREF_10)). Furthermore, an Oral hygiene practice of primary school children in Saudi Arabia Suggested that poor oral hygiene practices **are** the main risk factor for dental decay among the students ([11](#_ENREF_11)).

 Due to poor oral hygiene, dental caries **has become** a major oral health problem affecting 2.43 billion people worldwide. Even though **the** WHO is working with countries to develop policies to prevent oral health problems, tooth decay affects an estimated 60 **%**–90% of schoolchildren and nearly 100% of adults worldwide. The incidence of tooth decay in low- and middle-income countries is rapidly increasing among adults and children and there will be a huge burden of this health problem in the future without sustainable prevention programs([12](#_ENREF_12)) . In Africa, poor oral hygiene is the leading cause of school absenteeism, with children who experience dental pain missing school and performing poorly academically ([13](#_ENREF_13)). In Ethiopia, the practice of oral hygiene lacks proper attention and care, and the habit of tooth brushing is very low([14](#_ENREF_14), [15](#_ENREF_15)) . Additionally, in Jimma, Angola, and Debre Tabor, Ethiopia the children showed that more than half of the children had adequate knowledge of proper hygiene but only one-third of children experienced tooth brushing ([15](#_ENREF_15), [16](#_ENREF_16))

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 The poor practice of toothbrushing is the major contributing factor to dental caries as a result **which** can lead to pain, suffering, and reduced quality of life throughout the life cycle. Children with poor oral health miss more school and receive lower grades than those with better oral health, while adults lose more school or work hours for urgent, unplanned dental services ([17](#_ENREF_17)).

. **The** WHO has identified key strategies for improving oral health including **cost-effectiveness**, has a high and sustainable impact and that includes a mix of preventive population-wide and patient-centered care, with a clear focus on health promotion and empowerment for effective self-care, with a focus on low-income and marginalized populations where the access to oral health care is limited ([18](#_ENREF_18)).

Toothbrushing practices is one element of quality of life. Primary school students are **an** appropriate age for the foundation for thelongstanding life of tooth brushing behavior, knowing the level of their behavioral intention and tooth brushing practices is crucial for **the** implementation of the intervention. However, such studies are scarce in Ethiopia. Since studies **conducted** in Ethiopia focus only **on** knowledge and Practices, this study employed a health behavior model to identify potential variables that can serve to support primary school children’s attitudes, intentions, knowledge, environmental constraints, and practices of toothbrushing practices. It also filled the gap well in the study area. Hence, this study aimed to determine toothbrushing practices and associated factors among Bahir Dar city primary school students using IBM as a conceptual framework.

This finding will **provide** supportive evidence for health professionals in addressing problems related to behavioral, normative, and control beliefs **about the** tooth brushing behavior of primary school children. The research findings also help policymakers, program managers, and political leaders to plan, monitor, and **evaluate** the program. It also helps researchers as baseline information for further investigation.

# Methods and materials

## Study setting, design, and period

An **institution-based** cross-sectional study was conducted from February 28 to March 28, 2021, in Bahir Dar City among students attending primary school. The city is located in northwestern Ethiopia and is the 5th largest city in Ethiopia **with** an estimated population of 750,991. Bahir Dar **City is the** capital of the Amhara land region. The city is located approximately 565KM **northwest** of Addis Ababa and at an elevation of 1840m above sea level .

Regarding Education services, there are a total of 19344 primary school students in Bahir Dar city.

**Population and sample**

All students attending primary school in Bahir Dar city were the target population for this study.  **The** selectedeight primary school students attending Bahir Dar city, who **fulfilled** the inclusion criteria were considered as **the** study population.

All students who were present at randomly selected primary schools during data collection were included in the study. Students who were unable to **respond** because of illness were excluded from the study.

The sample size was calculated using Epi info version 7.1; by taking **the** proportion (43%) toothbrushing practices from a cross-sectional study in Addis Ababa ([19](#_ENREF_19)). By considering **the** Level of confidence = 95%, (Z α/2 = 1.96), D (margin of error) = 0.05, design effect 1.5 and population size 19344 the sample size was calculated as:

Where n = (Zα/2)2 P(1-P)         n= (1.96)2 (0.43) (1-0.43) = 554

 d2 (0.05)2

**Thus,** that the total sample size was =554+10% non-response =610

A multi-stage sampling technique was employed to select the study units. After governmental and private primary schools were included in the study **20% of the schools were randomly selected.** There were 6194 total numbers of students in the selected schools. All grades were taken as a stratum and a final simple random sampling method was used to select the participants. The students’ **rosters** for each grade level were made available from each of the schools. The total sample size was proportionally allocated to each school based on the number of students in each grade. Finally, simple random sampling using a computer random number generator was used to select study participants in each grade using the student’s roster from the register to select 610 students. Of the 14 governmental primary schools 3 were randomly selected and in 26 private primary schools, 5 were randomly selected.

**Study variables and measurement**

The dependent variable in this study wastooth brushing behavior. The independent variables of the study were Socio-demographic factors (age, sex, father and mother educational status, father and mother Employment status, and the number of children).

 Intention, Experiential Attitude, Instrumental Attitude, Injunctive norm, Descriptive Norm, Perceived Behavioral Control, Self-efficacy, experience (Habit), Environmental **constraints,** and Knowledge.

**Toothbrushing practices:** Toothbrushing practice was assessed by the self-reported status of Brushing teeth at least once per day in the last week([20](#_ENREF_20)).

**Intention:** an indication of individual readiness/willingness/ to practice tooth brushing and how much effort they are planning to exert, to practice toothbrushing **four items were measured** using a 5-point bipolar Likert scale, summed up to go the score with higher scores indicating a higher intention to practice toothbrushing.

**Experiential attitude:** is defined as an individual’s emotional response toward performing the recommended behavior. Directly it was measured

With four items five-point SDS items were summed to obtain the score with higher scores indicating a favorable attitude and indirectly measured by behavioral belief five items using a five-point Likert scale summing up across to obtain the score with higher scores indicating a favorable attitude.

 **Instrumental attitude:** This is based on the cognitive outcome evaluation of tooth brushing behavior. The direct measure of attitude toward performing the practices was obtained using five-point SDS four items were summed to obtain the score with a higher score indicating a favorable attitude and indirectly measured by the behavioral belief of ten items using a five-point Likert scale and multiplied by the corresponding outcome evaluation of ten items. The score was computed by summing the products of beliefs and evaluations with higher scores indicating a favorable attitude.

**Injunctive norm**: refers to the social pressure from others that an individual feels. Directly measured by four items with 5 points' Likert scale, summing up to obtain the score with a higher score indicating a highly influential. Indirect measurement was obtained by having participants rate normative beliefs concerning whether different sources of influence approve the participant to practice tooth brushing behavior and the participant's motivation to comply with those sources. The score was calculated by computing the products of four items of normative belief and their motivation to comply and summing up to obtain an overall score, a higher score indicating approval of the behavior.

**Descriptive norm:** refers to whether the referents perform tooth brushing behavior.  **Four items were** Directly measured based **on the belief that** most people perform the behavior by using a 5-point Likert scale summed up to obtain the score with higher scores indicating more practice of toothbrushing. four items **were indirectly measured** by normative belief summed up to obtain the score with a higher score indicating more to practice toothbrushing.

**Perceived control**: one’s perception of the degree to which various environmental factors make it easy or difficult to carry out the behavior. Perceived control was directly measured by the overall measure of perceived control over the behavior by four items with five-point SDS and summed up to obtain the score with higher scores **indicating that** the factor was under control and indirectly measured by control belief five items multiplied by five perceived power items. The scores were computed by summing the products of control beliefs and perceived power values with a higher score indicating **that the** factor was under control.

 **Self-efficacy**: is one’s degree of confidence in the ability to perform the behavior even in the face of various obstacles or challenges. **They are** Directly measured by 5-point Likert scales containing three items and indirectly measured by 5-point Likert scales containing five items and summed up to obtain the score with a higher score **indicating better confidence** in the practice of toothbrushing.

**Knowledge:** The study participants were asked 11 knowledge questions and, the total score was obtained for each respondent summed up to obtain the score a **high score indicated** better knowledge.

**Data collection instrument**

An elicitation study was conducted on 20 Shimbit primary school children in Bahir Dar city, before developing closed-ended questions ([1](#_ENREF_1)). Elicitation study is a critical step in the application of an integrated behavioral model. The participants were asked to answer 12 open-ended questions to elicit their behavioral beliefs, normative beliefs, and control beliefs about toothbrushing practices (Annex 1.1).

## Data collection tools and techniques

An interviewer-administered questionnaire was used to collect data. Eight data collectors and two supervisors were recruited and **data were collected in** the class setting. All data collectors were oriented for half a day before the data collection period by the principal investigator on the objectives of the study and how to administer the questionnaires, the issues of verbal consent, the writer not to participate in the study, and how to assist the respondents on questions that were not clear during data collection. Questionnaires were adapted from items **used in previous studies** and IBM constructs incorporated with elicitation study results([21](#_ENREF_21)). The questionnaires included; socio-demographic variables (8 items), practice of toothbrushing 5 items ) ,knowledge about tooth brushing(12 items) , Intention(4 items) ,Experiential attitude ( 9 items) , instrumental attitude (24 items) ,Injunctive norm ( 12 items), Descriptive norm (8 items), perceived control (14 items) ,self –efficacy(8 items) and environmental **constraints** (2 items).

**Statistical analysis**

Data **were** checked for completeness and consistency. Data **were** entered into Epi data version 3.02 and exported to Stata version 14.1 for analysis. Descriptive statistical analysis **such as** frequency and percentage for categorical variables.

Logistic regression was performed to determine whether the constructs of IBM **could be** associated with toothbrushing practices. For all statistical significance tests, the cut-off value set was p < 0.05 with a Confidence interval of 95%. Those variables whose p-values are less than 0.25 during the simple binary logistic regression analysis were fitted to the final multivariable binary logistic regression model to adjust for potential confounders. The odds ratio was used to observe the strength of the association between toothbrushing practices and each significant independent variable. Path analysis was **performed** to check the causal effect of IBM constructs on toothbrushing practices. Goodness of fit of the final model was checked using the Hosmer and Lemeshow test of best fit with a large p-value=0.97 and Area under receiver operating characteristics (ROC) curve = 0.98.

 **Data Quality Assurance**

The questionnaire was prepared in English and translated into the Amharic version. Finally, it was back-translated into English by **another** person to ensure consistency. **Pretests were performed** on 5% (31) of the study population in Felege Abay primary schools in Bahir Dar City. After the **pre-test, the** necessary amendment was made. One day **of** training was given to the data collectors and supervisors on the questionnaire and data collection process. Close supervision was **performed** by the principal investigator and supervisors throughout the data collection period. The collected data were checked for completeness and consistency. To increase the data quality double data entry to **the** Epi data was considered. To determine **the** face validity of the questionnaire, the collected views **and** comments of advisors and experts in the fields of health promotion were taken. Confirmatory factor analysis was conducted to check **the** convergent validity of the measurements. Based on this analysis, Factor loadings and Eigenvalue of intention (all), Experiential Attitude (all), Instrumental Attitude (dropping two items), Injunctive Norm (all), Descriptive Norm (all), Perceived control (all), and **self-efficacy** (all) are greater than 0.4and 1 respectively. **The** Kaiser-Meyer-Olkin Measure of Sampling Adequacy ranged from 0.74-to 0.94 and Bartlett's Test of Sphericity was significant. (Annex 1.3)

Reliability analysis was conducted to check the internal consistency of the measurement of this study using composite reliability and Cronbach's alpha (α).

Ethical approval was obtained from the Institutional Review Board (IRB) of Bahir Dar University, College of Medicine and Health Science, and a Permission letter was taken from Bahir Dar city educational office.

Permission to undertake the study was **performed** at all levels. Caretakers were given detailed information about the purpose of the study, data collection procedures, and possible risks/ discomforts and benefits of participating in the study through the consent process. Informed written consent was obtained from all caretakers whose children participated in the study. In this case, caretakers were **the families** of each student and were presented as caretakers. A child was included in the study only if **the caretakers agreed with the child**. Despite the caretakers, consent, a child’s decision not to participate in the study was respected. Informed consent was obtained from each study participant before the commencement of data collection. Confidentiality of information was received from the study participants maintained by using codes rather than the name of participants during data collection procedures. Participants were informed that participation **was** voluntary.

**Findings**

## Socio-demographic characteristics

A total of 601 primary school students participated in Bahir Dar city with a response rate of 98.5%. The mean age of the respondents was 13 (± 0 .064). Three hundred forty-six (57.57%) of the study participants were female. Concerning the educational status of their family, 171 (28.45%) of the mothers were able to read and write and 105(17.47%) **were** unable to read and write. **Of the fathers, 200 (33.28 %)** had College and above education and 159 (26.46%) of the fathers were able to read and write. About 259(43.09%) mothers and 233(38.77%) of the fathers of the students were **housewives** and merchants respectively. Regarding the number of children in the family, the highest proportion was 200(33.28%) who had more than three children, followed by 188(31.28%) with two children, 162(26.96%) with three children, and 51 (8.49%) one child (table 1).

Table 1: Participants’ socio-demographic characteristics among primary schools children, Bahir Dar city, Ethiopia, April 2021.

|  |  |  |
| --- | --- | --- |
|  Variable Category  | Frequency | Percent |
| School type  | Government | 347  | 57.74 |
| Private | 254  | 42.26 |
| Child’s sex  | Male  | 255  | 42.43 |
| Female | 346  | 57.57 |
| Number of children in the family  | One child  | 51  | 8.49 |
| Two child  | 188  | 31.28 |
| Three child  | 162  |  26.96 |
| More than three child | 200  | 33.28 |
| Father’s job  | Government employee | 197  | 32.78 |
| Merchant | 233  | 38.77 |
| Farmer | 48  | 7.99 |
| Others | 123  | 20.47 |
| Mother’s employment status  | housewife  | 259  | 43.09 |
| Merchant  | 176  | 29.28 |
| governmental employee | 131  | 21.80 |
| Others | 35  | 5.82 |
| Fathers’ education  | unable to read and write | 44  | 7.32 |
| Able to read and write | 159  | 26.46 |
| Elementary school | 66  | 10.98 |
| secondary school | 63  | 10.48 |
| grade 12 complete | 69  | 11.48 |
|  College and above | 200  | 33.28 |
| Mothers’ education | unable to read and write | 105  | 17.47 |
|  Able to read and write | 171  | 28.45 |
| Elementary school | 54  |  8.99 |
| secondary school | 38  | 6.32  |
| grade 12 complete | 67  | 11.15 |
| College and above | 166  | 27.62 |

## Knowledge and practice of toothbrushing practices

The mean toothbrushing knowledge score of the respondents was found to be 7.23(±2.08) with a range of 2 to11. Most (95.51%) of the participants had ever heard about toothbrushing and 47.4 %( CI: 0.434- 0.514) of respondents were aware of electronic toothbrushes. Of the respondents who heard about toothbrushing 153 (26.66%), 146(25.44%), 113(19.69 %), 81(14.11 %), 63 (10.98%), 12 (2.09%), and 6 (1.05%) of the respondents got the information from dentists, television, internet, school, family, friends, and others respectively.

Regarding participant’s toothbrushing practice, most of the respondents (87.52%) had ever brushed their tooth, 273(45.42%) currently practiced toothbrushing at least once per day, and 363(60.40%) had experience toothbrushing practices. The prevalence of brushing frequency was 243(89.01%), 27(9.89%), and 3 (1.09%) **brushed** once a day, twice a day, and more than twice a day respectively. **The majority** (56.77%) of the study participants preferred toothbrushing in the morning session (table 2).

*Table 2 toothbrushing practices among primary schools children, Bahir Dar city, Ethiopia, April 2021.*

|  |  |  |
| --- | --- | --- |
|  Variables  | Frequency | Percent |
| Have ever brushed your teeth | **yes**  | **526**  | **87.52** |
| **No** | **75**  | **12.48** |
| Do you brush your teeth within the last one week daily  | **yes**  | **273**  | **45.42(CI: 0.414- 0.494)** |
| **No** | **328**  | **54.58** |
| Do you brush your teeth before last week | **yes**  | **363**  | **60.40(CI: 0.564- 0.642)** |
| **No** | **238**  | **39.60** |
| How many times per day do you brush your teeth | **Once a day**  | **243** | **89.01** |
| **Twice a day** | **27** | **9.89** |
| **More than twice**  | **3** | **1.09** |
| When do you brush your teeth | **In the morning**  | **155**  | **56.77** |
| **After eating**  | **10** | **3.66** |
| **Before I go to bed**  | **78** | **28.57** |
|  | **In the morning and Before I go to bed**  | **30** | **11.00** |
| Practice of toothbrushing | **yes**  | **273** | **45.42** |
| **No** | **328**  | **54.58** |
| access to toothpaste in our town | **Yes**  | **595** | **99.00** |
| **No** | **6**  | **1.00** |
| a program that is working to make students aware of tooth brushing in primary school | **Yes**  | **215** | **35.77** |
| **No** | **386** | **64.23** |

**Environmental constraints**

Most 595 (99%) of the respondents said access to toothpaste in their town and 386 (64.23%) of the respondents said no program was working to make students aware of tooth brushing in their school.

**Descriptive statistics for the components of the integrated behavioral model**

Descriptive **statistical** analysis was performed to measure the mean score of IBM components. Intention, instrumental attitude, injunctive norm, descriptive norm, and self–efficacy had mean scores of 13.51(SD=4.8), 172.78(SD=51.04), and 56.95(SD=31.01), 13.56 (SD=4.58), and17.88 (SD=5.32) respectively. The mean score of experiential attitude was 15.54 (SD= 5.25) which approached the maximum value of the experiential attitude sum score. Perceived control had a low mean score of 55.96(SD=33.76) (table 3 ).

Table 3 Descriptive statistics for the components of the integrated behavioral model of toothbrushing practices among primary schools students, Bahir Dar city, Ethiopia, April 2021.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | No of items | Min | Max | Mean | SD |
| Intention | 4 | 4 | 20 | 13.51 | 4.84 |
| Experiential Attitude | 5 | 4 | 20 | 15.54 | 5.25 |
| Instrumental Attitude | 10 | 45 | 250 | 172.78 | 51.04 |
| Injunctive Norm | 4 | 4 | 100 | 56.95 | 31.01 |
| Descriptive Norm | 4 | 4 | 20 | 13.56 | 4.58 |
| Perceived control | 5 | 5 | 125 | 55.96 | 33.76 |
| Self –efficacy | 5 | 5 | 25 | 17.88 | 5.32 |

**Correlation between direct and indirect IBM constructs**

 IBM construct measures (indirect EA, IA, IN, DN, PBC, and SE) have strongly relationship with their corresponding global measures (direct EA, IA, IN, DN, PBC,and SE), (r=0.82, p < 0.001), (r=0.85, p < 0.001), (r=0.80, p < 0.001), (r=0.79, p < 0.001), (r=0.57, p < 0.001), and (r=0.57, p <0.001) respectively, indicating that the three beliefs (behavioral beliefs, normative beliefs and control beliefs) which were identified by the elicitation study were adequately captured their corresponding overall measures (Table 4).

Table 4: Correlation between direct and indirect measures of IBM model among primary schools students, Bahir Dar city, Ethiopia, April 2021*.*

 | DEA DIA DIN DDN DC DS IEA IIA IIN IDN IC IS

 DEA | 1.0000

 DIA | 0.8265\*\*1.0000

 DIN | 0.7501\*\*0.7921\*\*1.0000

 DDN | 0.7084\*\*0.7291\*\*0.8139\*\*1.0000

 DC | 0.6931\*\*0.6906\*\*0.7345\*\* 0.7582\*\*1.0000

 DS | 0.5297\*\*0.6179\*\*0.5587\*\*0.4986\*\*0.5285\*\*1.0000

 IEA | 0.8163\*\* 0.8316\*\*0.7055\*\*0.6511\*\*0.6342\*\*0.5696\*\*1.0000

 IIA | 0.8137\*\*0.8494\*\*0.8210\*\*0.7368\*\*0.7385\*\*0.5653\*\*0.7943\*\*1.0000

 IIN | 0.6736\*\*0.7317\*\* 0.7996\*\*0.7894\*\*0.7158\*\*0.4993\*\*0.6583\*\*0.7641\*\*1.0000

 IDN | 0.6414\*\*0.6542\*\*0.7290\*\*0.7873\*\*0.7602\*\*0.5070\*\*0.6067\*\*0.6982\*\*0.7038\*\*1.0000

 IC | 0.5145\*\* 0.5070\*\*0.5167\*\*0.5059\*\*0.5707\*\*0.3978\*\* 0.5091\*\*0.5345\*\* 0.4887\*\* 0.4699\*\* 1.0000

 IS | 0.6995\*\*0.6895\*\*0.6840\*\*0.7010\*\*0.6773\*\*0.5703\*\*0.6353\*\*0.6981\*\*0.6436\*\*0.6473\*\*0.5349\*\* 1.0000

\*\*Significant at p <0.001

**NB**: (DEA=direct experiential attitude, DIA= direct instrumental attitude, DIN =direct injunctive norm, DDN=direct descriptive norm, DC=direct control, DS=direct self-efficacy, IEA =indirect experiential attitude, IIA= indirect instrumental attitude, IIN=indirect injunctive norm, IDN=indirect descriptive norm, IC=indirect control, IS=indirect self-efficacy)

**Factors affecting tooth brushing behavior**

Multivariable logistic regression was performed to **determine** the effect of independent variables on toothbrushing practices In this model, variables **with** a p-value < 0.25 were taken and analyzed together by multivariable logistic regression. **The confounding** factors were adjusted using multivariable logistic regression models. After controlling for the effects of potentially confounding variables using multivariable logistic regression, grade level, child’s sex, mothers’ education, past experience of toothbrushing, knowledge , behavioral intention , experiential attitude , instrumental attitude ,and descriptive norm were found to be significantly associated with toothbrushing practices at P-value <0.05.

Female participants were three times more likely to perform toothbrushing practice **than** male participants [AOR=3.23, 95% CI: 1.48-7.02]. Those students whose mother**’s** educational status was secondary school and above were 60% more likely to perform toothbrushing practice **than** those whose motherswere unable to read and write [AOR= 4.6; 95% CI: 1.22 –17.44]. Students who **had** no experience with toothbrushing were 4% less likely to perform toothbrushing practice **than** those who had experience in toothbrushing practices [AOR = 0.042; CI: .018–.101]. With a positive unit change in the knowledge sum score, the odds of toothbrushing practice increased by 30% [AOR= 1.3; CI: 1.09–1.60]. A positive unit change in intention to brush **teeth led to** an increase **in** toothbrushing practice by two times [AOR= 2.01; CI: –2.32]. One unit increase in experiential attitude **led** to a 9% increase in toothbrushing practice [AOR= 1.09; CI: 1.01–1.17]. a positive unit change in instrumental attitude **led** to a 2% increase in tooth brushing practice [AOR= 1.02; CI: 1.01–1.03]. a positive unit change in descriptive norm **led** to a 7% increase in toothbrushing practice [AOR= 1.07; CI: 1.004–1.144]. (Table 5)

Table 5 Factors affecting toothbrushing practices of Bahir Dar city primary school students, Ethiopia, April 2021.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variables  |  | Tooth brushing practice  | COR | AOR | P-value |   95% CI |
| Lower | Upper |
| Yes  | No |
| Age |  |  |  | 1.1 | 1.0 | 0.872 | 0.752 | 1.274 |
| Child’s sex  | Male  | 93 | 162 | RC | RC | RC | RC | RC |
| Female | 180 | 166 | 1.9 | 3.23 | 0.003\* | 1.481 | 7.022 |
| Fathers’ education  | unable to read and write | 11 | 33 | RC | RC | RC | RC | RC |
| Able to read and write | 57 | 102 | 1.7 | 1.1 | 0.929 | 0.094 | 13.292 |
| Elementary school | 32 | 34 | 2.8 | .9  | 0.946 | 0.057 | 14.446 |
| secondary school and above  | 173 | 159 | 3.3 | .9 | 0.979 | 0.085 | 11.029 |
| Mothers’ education | unable to read and write | 27 | 78 | RC | RC | RC  | RC | RC |
|  Able to read and write | 59 | 112 | 1.5 | 2.7 | 0.124 | 0.766 | 9.143 |
| Elementary school | 13 | 41 | 0.9 | 1.3 | 0.797  | 0.207 | 7.784 |
| secondary school and above  | 174 | 97 | 5.2 | 4.6 | 0.024\* | 1.218 | 17.446 |
| Experience in tooth brushing | No | 20 | 218 | 0.03 | 0.04 | 0.000\*\* | 0.018 | .101 |
| Yes | 253 | 110 | RC | RC | RC | RC | RC |
| Knowledge  |  |  | 1.7 | 1.3 | 0.004\* | 1.09 | 1.607 |
| Behavioral intention  |  |  | 2.02 | 2.01 | 0.000\*\*  | 1.74 | 2.32 |
| Experiential Attitude |  |  | 1.4 | 1.09 | 0.024\* | 1.01 | 1.17 |
| Instrumental Attitude |  |  | 1.04 | 1.02 | 0.000\*\* | 1.01 | 1.03 |
| Injunctive Norm |  |  | 1.04 | 1.01 | 0.052  | 0.99 | 1.02 |
| Descriptive Norm |  |  | 1.3 | 1.07 | 0.038\* | 1.004 | 1.144 |
| Perceived control |  |  | 1.03 | 1.007 | 0.094 | 0.998  | 1.015 |
| Self –efficacy |  |  | 1.3 | 1.056 | 0.067 | 0.996 | 1.120 |

*RC-reference category \*Significant at p<0.05 \*\*Significant at p <0.001*

**Causal path analysis of tooth brushing behavior**

# Intention to ****toothbrushes**** was assessed using experiential attitude, instrumental attitude, injunctive norms, descriptive norm, perceived control, and self-efficacy as exogenous variables. In this model, 54% (Adjusted R2 =0.54) of the variance ****was**** explained. Experiential attitude, instrumental attitude, Injunctive Norm, and Perceived control have a positive significant association with behavioral intention (P < 0.05) with path coefficients of 0.21, 0 .04, 0 .02, and 0.01 holding all other relevant variable constants respectively. Knowledge, behavioral intention, and experience of toothbrushing practice ****were**** used as exogenous variables to have a ****significant positive**** association with toothbrushing practices (P < 0.05) with path coefficients of 0.04, 0 .06, and 0 .30 respectively. Indirect effects were shown through experiential attitude (β=.012, P < 0.001), instrumental attitude (β=.002, P < 0.001), injunctive norm (β=.001, P < 0.001) and perceived control (β=.001, P < 0.05) of toothbrushing practices . The Comparative Fit Index (CFI) (0.96), Tucker-Lewis index (TLI) (0.92), and ****root mean square**** residual (SRMR) (0.024) proved t****hat**** the model used to predict behavioral intention and IBM constructs showed acceptable model fit indices (Figure 1).

# Discussion

In the present study, toothbrushing practices and associated factors among Bahir Dar city primary school students using IBM as a conceptual framework **were** assessed. The overall prevalence of **the** current practice of toothbrushing among the respondents was 45.4%(CI: 0.414- 0.494). This result is in **agreement** with the findings **of 43% of primary school students in Addis Ababa**([19](#_ENREF_19)). **However,** it was found to be higher than the prevalence **reported in** a study conducted among primary school students in Bahir Dar city, Ethiopia which was 14.3% in 2016 ([22](#_ENREF_22)). **This** was lower than the prevalence **reported in a study conducted** in Iran which was 56.5% ([10](#_ENREF_10)). These differences might be **due to** the study settings (community or institution and rural or urban), study time, educational **status, socio**-economic background status, **and** differences among the studies' participants.

In this study, 60.40 % (95%CI: 0.564-0.642) of respondents had **previous** experience in toothbrushing practices. This result was lower than **that reported in a** study in Indonesia which was 97.1%([23](#_ENREF_23)) . The difference might be due to educational exposure to toothbrushing practices and socio-economic backgrounds.

In this study, knowledge **was** significantly associated with toothbrushing practices which were consistent with **the** study done in Gondar, in which good knowledge is the determinant factor for toothbrushing practices([20](#_ENREF_20)) . This indicated that providing actual information and increasing the knowledge of the students about toothbrushing practices needs to be incorporated into oral health educational programs **to enhance** toothbrushing practice. In the present study, 47.4%(CI:0.434-0.514) of respondents were aware of electronic toothbrushes but **a much** higher study done in **India** showed that about 96% of the participants were aware of electronic toothbrushes([24](#_ENREF_24)) . These discrepancies might be due to the study settings, **and technological** advancements.

According to the correlational analysis, there was a positive relationship between indirect and direct measurements of **the** integrated behavioral model. From this, the commonly held salient beliefs extracted from attitudes perceived norms, and perceived behavioral control toward toothbrushing tooth brushing practices were well explained and explored through indirect constructs of the integrated behavioral model. This is consistent with the suggestion of the integrated behavioral model principles in which there is a positive relationship between indirect measurements and their corresponding direct measurements of **an** integrated behavioral model([1](#_ENREF_1)) . This implies that intervention can be designed on the salient beliefs identified during the elicitation study; **thus,** by influencing the direct measures of the IBM, intention to toothbrushing practices can be increased.

In this study, knowledge, intention, and Past experiences of toothbrushing practices were significantly linked to toothbrushing practice, as **suggested** by IBM([1](#_ENREF_1)). When a person has a strong intention to perform practice tooth brushing, knowledge about the tooth brushing practice past experiences of tooth brushing strongest predictors of tooth brushing practice. This indicated that IBM showed adequate utility in predicting toothbrushing practices in the study area since the model assumption is inline with study findings .

The present study revealed that only mothers' education **determined** the toothbrushing practice but fathers' education did not play a critical role in determining toothbrushing practices among participants. In contrast, a previous study involving students showedthat higher parental education **plays** a significant role in overall toothbrushing practices([25](#_ENREF_25), [26](#_ENREF_26)). This implies that the prediction of attitude, perceived norm, and perceived behavioral control is not different among the various categories of other socio-demographic characteristics of participants.

 **Strength and limitations of the study**

The present study has several strengths, **which** account for toothbrushing practices to be predicted based on the IBM constructs which may show how much intention could be translated into the practices. Moreover, the strength of this study was conducted entirely based on IBM which provided multiple health behavior factors such as knowledge, environment, and experience (habit) were considered. The elicitation study **explored** salient beliefs **in designing** a culturally appropriate survey instrument to measure IBM constructs.

This study had some limitations, since the study design is **a cross-sectional study type**, it may provide poor prediction and understanding of previous behavior because the time order of constructs IBM and practices cannot be separated in time. **A prospective** study design is recommended when IBM is used as **a** conceptual framework to measure the intention of behavior and the behavioral performance at two separate points in time; **however,** due to a lack of resources and time, the current study did not employ **this** type of research design. In addition, it may be affected by social desirability bias since the study was self-reported. It should be considered that these statements might **differ** from actual ones. **Children’s oral hygiene needs to be evaluated through** clinical examination.

**Conclusions**

The findings of this study indicated **that the** practice of toothbrushing behavior among primary **school** students is considerably low. Experiential attitude, instrumental attitude, injunctive norm, and perceived behavioral control **had** significant effects on intention to **brush teeth** Knowledge, intention, and having experience have significant factors in toothbrushing practices**, indicating** that the IBM indicates that adequate utility in predicting tooth brushing behavior in the study area. Socio-demographic variables such as sex, and maternal education were significant predictors of toothbrushing practices. School-based toothbrushing practices change interventions such as Communication strategy and research will be important. **In particular,** such interventions should give due emphasis to enhancing students' intention to tooth brushing behavior, attitudinal changes, addressing barriers of tooth brushing behavior, and creating positive social pressure from significant others.

**Abbreviations**

IBM: Integrated Behavioral Model: PBC: Perceived Behavioral Control: SDS: Semantic Differential Scale: TPB: Theory of Planned Behavior and WHO: World Health Organization

**Declarations**

**Consent for publication**

Not applicable

**Conflict of interest**

The authors declare no conflict of interest exist

 **Funding**

 No funding was received for this study

**Authors’ contribution**

# NKT: Conceptualizations of the study, Methodology, validation, **and,** Statistical analysis coordinate data collection HW, LM, TF, EA, EK, YM, GH, and BA performed the statistical analysis, software, and supervision. The author(s) read and approved the manuscript.

**Data availability statement**

The data used for analysis is fully available in the manuscript file without restriction.

**Acknowledgments**

The authors would like to thank Bahir Dar University College of Medicine and the Health Science Department of Health Promotion and Behavioral Science for the coordination of the overall activity. The authors would also acknowledge the data collectors, supervisors, and all personnel who were involved in the accomplishment of this study.

 **References**

Alexander B, Rosenberg ML, Linda D, Alison H (2008) Preventing violence in developinPromotion 15:

1. Montano DE, Kasprzyk D. Theory of reasoned action, theory of planned behavior, and the integrated behavioral model. Health behavior: Theory, research and practice. 2015;70(4):231.

2. Pujar P, Subbareddy V. Evaluation of the tooth brushing skills in children aged 6–12 years. European archives of paediatric dentistry. 2013;14(4):213-9.

3. Rugg‐Gunn A, MacGregor I. A survey of toothbrushing behaviour in children and young adults. Journal of Periodontal Research. 1978;13(4):382-9.

4. Braun PA, Lind KE, Henderson WG, Brega AG, Quissell DO, Albino J. Validation of a pediatric oral health-related quality of life scale in Navajo children. Quality of Life Research. 2015;24(1):231-9.

5. Gallagher JE, Hutchinson L. Analysis of human resources for oral health globally: inequitable distribution. International dental journal. 2018;68(3):183-9.

6. Atarbashi-Moghadam F, Atarbashi-Moghadam S. Tooth brushing in children. Journal of Dental Materials and Techniques. 2018;7(4):181-4.

7. Levine R, Stillman-Lowe CR. The scientific basis of oral health education: Springer; 2019.

8. Amin MS, Perez A, Nyachhyon P. Parental awareness and dental attendance of children among African immigrants. Journal of immigrant and minority health. 2015;17(1):132-8.

9. Wigen TI, Wang NJ. Tooth brushing frequency and use of fluoride lozenges in children from 1.5 to 5 years of age: a longitudinal study. Community dentistry and oral epidemiology. 2014;42(5):395-403.

10. Asgari F, Majidi A, Koohpayehzadeh J, Etemad K, Rafei A. Oral hygiene status in a general population of Iran, 2011: a key lifestyle marker in relation to common risk factors of non-communicable diseases. International journal of health policy and management. 2015;4(6):343.

11. Pullishery F, Panchmal GS, Shenoy R. Parental attitudes and tooth brushing habits in preschool children in Mangalore, Karnataka: A cross-sectional study. International journal of clinical pediatric dentistry. 2013;6(3):156.

12. Boustedt K, Roswall J, Twetman S, Dahlgren J. Influence of mode of delivery, family and nursing determinants on early childhood caries development: a prospective cohort study. Acta Odontologica Scandinavica. 2018;76(8):595-9.

13. Jackson SL, Vann Jr WF, Kotch JB, Pahel BT, Lee JY. Impact of poor oral health on children's school attendance and performance. American journal of public health. 2011;101(10):1900-6.

14. Aynalem YA, Alamirew G, Shiferaw WS. Magnitude of dental caries and its associated factors among governmental primary school children in Debre Berhan Town, North-East Ethiopia. Pediatric Health, Medicine and Therapeutics. 2020;11:225.

15. Gualie YT, Tayachew AT. Assessment of knowledge, attitude, and practice toward oral hygiene among governmental secondary school students in Debre Tabor Town, Amhara Region, North Central Ethiopia 2018: Institutional-based cross-sectional survey. International Journal of Oral Health Sciences. 2018;8(2):92.

16. Dechssa M, Cherie A, Luelseged B. Tooth brushing practice and its determinants among adults attending dental health institutions in Addis Ababa, Ethiopia. Age. 2017;30(39):105.

17. Dye BA, Li X, Thornton-Evans G. Oral health disparities as determined by selected healthy people 2020 oral health objectives for the United States, 2009-2010: US Department of Health and Human Services, Centers for Disease Control and …; 2012.

18. Organization WH. World Oral Health Report. 25 March 2020.

19. Burnett D, Aronson J, Asgary R. Oral health status, knowledge, attitudes and behaviours among marginalized children in Addis Ababa, Ethiopia. Journal of Child Health Care. 2016;20(2):252-61.

20. Dagnew B, Dagne H, Andualem Z. Determinants of Tooth Brushing Practice among Medical and Health Sciences Students of University of Gondar, northwest Ethiopia. 2019.

21. . !!! INVALID CITATION !!!

22. Mulu W, Demilie T, Yimer M, Meshesha K, Abera B. Dental caries and associated factors among primary school children in Bahir Dar city: a cross-sectional study. BMC research notes. 2014;7(1):1-7.

23. Andayasari L, Nurlinawati I, Maulia S, editors. The Relationship Between Tooth Brushing Behavior and Dental Caries in Children in Bandung. 4th International Symposium on Health Research (ISHR 2019); 2020: Atlantis Press.

24. Akshaya K, Duraisamy R, Ganapathy D. Knowledge, attitude, and practice on brushing habits among transgenders residing in Chennai City: Cross-sectional questionnaire Study. 2019.

25. Gautam D, Vikas J, Amrinder T, Rambhika T, Bhanu K. Evaluating dental awareness and periodontal health status in different socioeconomic groups in the population of Sundernagar, Himachal Pradesh, India. Journal of International Society of Preventive & Community Dentistry. 2012;2(2):53.

26. Narang R, Mittal L, Jha K, Anamika R. Caries experience and its relationship with parent’s education, occupation and socio economic status of the family among 3-6 years old preschool children of Sri Ganganagar City, India. Open J Dent Oral Med. 2013;1(1):1-4.