ARTICLE

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ASSESSMENT OF KNOWLEDGE–PRACTICE CONCORDANCE IN ORAL HYGIENE BEHAVIOURS AMONG SCHOOL CHILDREN AGED 11–16 YEARS IN AN URBAN AREA OF BELAGAVI DISTRICT

ABSTRACT

Background:
Despite considerable public health effort directed at oral health education, a gap can persist between what adolescents know about dental hygiene and what they practice. Quantifying this gap, behaviour by behaviour, is more useful for programme planning than an overall knowledge or practice score.This study was done to assess knowledge–practice concordance across eight specific oral hygiene behaviours among school children aged 11–16 years in an urban area of Belagavi district.

Methodology:
A cross-sectional study was conducted among 800 adolescents selected by multistage random sampling from four co-educational schools in Belagavi, India, between January and December 2021. Data were collected through structured, interviewer-administered questionnaires after ethical approval and informed consent/assent. For each of eight behaviours, knowledge (correct/incorrect) was cross-tabulated against self-reported practice (correct/incorrect) and compared using the chi-square test, with significance set at $p<0.05$.

Results:
A significant knowledge–practice gap was observed for brushing duration, toothbrush replacement, use of fluoride toothpaste, and post-meal rinsing, indicating that correct knowledge did not consistently translate into optimal practice. No significant gap was seen for regular brushing ($\chi^2=0.07$, $p=0.79$), brushing frequency ($\chi^2=0.30$, $p=0.58$), parental supervision ($\chi^2=3.27$, $p=0.07$), or tongue cleaning ($\chi^2=1.56$, $p=0.21$), suggesting these behaviours are followed as routine, largely independent of formal knowledge.

Conclusion:
Knowledge–practice gaps were evident in half of the behaviours assessed. School-based programmes should combine information-giving with supervised practice and demonstration for the behaviours where the gap is widest.

RIASSUNTO

Contesto:
Nonostante i notevoli sforzi di sanità pubblica volti all'educazione all'igiene orale, può persistere un divario tra ciò che gli adolescenti sanno sull'igiene dentale e le loro abitudini effettive. Quantificare tale divario, analizzando ogni singola pratica, è più utile per la pianificazione dei programmi rispetto all'utilizzo di un punteggio complessivo di conoscenze o comportamenti. Questo studio è stato condotto per valutare la concordanza tra conoscenze e pratiche relative a otto specifiche abitudini di igiene orale in studenti di età compresa tra gli 11 e i 16 anni, residenti in un'area urbana del distretto di Belagavi.

Metodologia:
È stato condotto uno studio trasversale su 800 adolescenti, selezionati mediante campionamento casuale a più stadi presso quattro scuole miste di Belagavi (India), tra gennaio e dicembre 2021. I dati sono stati raccolti tramite questionari strutturati somministrati da intervistatori, previa approvazione etica e acquisizione del consenso/assenso informato. Per ciascuno degli otto comportamenti, le conoscenze (corrette/errate) sono state incrociate con le pratiche dichiarate (corrette/errate) e confrontate utilizzando il test del chi-quadrato, con una soglia di significatività fissata a $p<0,05$.

Risultati:
È emerso un divario significativo tra conoscenze e pratiche per quanto riguarda la durata dello spazzolamento, la sostituzione dello spazzolino, l'uso di dentifricio al fluoro e il risciacquo post-prandiale; ciò indica che una conoscenza corretta non si traduceva sistematicamente in una pratica ottimale. Non è stato invece osservato alcun divario significativo per la regolarità dello spazzolamento ($\chi^2=0,07$; $p=0,79$), la frequenza dello spazzolamento ($\chi^2=0,30$; $p=0,58$), la supervisione dei genitori ($\chi^2=3,27$; $p=0,07$) o la pulizia della lingua ($\chi^2=1,56$; $p=0,21$), suggerendo che tali comportamenti vengano adottati come abitudini consolidate, in gran parte indipendentemente dalle conoscenze teoriche.

Conclusione:
È emerso un divario tra conoscenze e pratiche per metà dei comportamenti esaminati. I programmi scolastici dovrebbero affiancare alla trasmissione di informazioni anche attività di pratica supervisionata e dimostrazioni pratiche, concentrandosi in particolare sui comportamenti che presentano il divario più ampio.

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INTRODUCTION

Oral health is an important part of overall wellbeing. A healthy mouth helps a person speak clearly, eat comfortably, and take part in social activities without discomfort or embarrassment [(1)].
Good oral health also supports proper nutrition and general health, while poor oral hygiene can lead to pain, infection, and reduced quality of life.

According to the Global Burden of Disease Study 2019, dental caries affects more than 3.58 billion people worldwide and is the most common chronic disease. More than 90% of school-going children have experienced dental caries at some point. The burden is especially high in Asian and Latin American countries, where access to preventive care and awareness may vary [(2)].

In India, government health systems reach school children through several programmes, including the School Health Programme, the Weekly Iron and Folic Acid Supplementation Programme, and Adolescent Friendly Health Clinics. These platforms provide regular contact with children and adolescents and offer opportunities for health education; however, oral health often receives less attention than other health issues, and teaching on dental hygiene tends to be limited to basic awareness rather than structured, repeated training [(3-5)].

Adolescence is a key period for the formation of long-term health habits, but knowledge alone does not always translate into correct practice. Forgetfulness, lack of repeated guidance, limited resources, low motivation, and the pull of already established habits can all interrupt the link between what is known and what is done [(6)].
Urban adolescents have comparatively good access to health information through schools, media, and digital platforms, but busy schedules, academic pressure, and competing distractions can affect whether healthy routines are followed consistently [(7-8)].
Most existing studies on this topic report oral health knowledge, attitudes, and practice as separate, broad scores[(9)]. Fewer studies have examined, behaviour by behaviour, how well specific knowledge items correspond to specific practices.

A behaviour-level comparison can identify exactly where a knowledge–practice gap exists and where it does not, which is more directly useful for designing an intervention than an aggregate KAP score.

This study therefore examined knowledge–practice concordance across eight specific oral hygiene behaviours – regular brushing, brushing frequency, brushing duration, parental supervision, toothbrush replacement, fluoride toothpaste use, tongue cleaning, and post-meal rinsing – among school children aged 11–16 years in an urban area of Belagavi district, Karnataka, India.
The present study focuses specifically on the correspondence between knowledge and practice for individual oral hygiene behaviours among adolescents.

METHODOLOGY

Study Design and Setting

A cross-sectional study was carried out among school children aged 11–16 years from four randomly selected co-educational schools in Belagavi city, Karnataka, India. Data collection took place from 26st January to 31st December 2021, as part of a broader study on oral health knowledge, attitude, and practice in this population.

Ethical Approval

Ethical clearance was obtained from the Institutional Ethics Committee, J.N. Medical College, KAHER, Belagavi (Letter No. MDC/DOME/76, dated 25 January 2021). Written informed consent was obtained from parents/guardians, and assent was obtained from each student, prior to enrolment.

Sample Size

The sample size was calculated for the parent KAP survey using the formula $n = Z^2p(1-p)/d^2$, where Z=1.96 (95% confidence level), p=33.6% was the reference proportion of adolescents with correct/ adequate oral hygiene practice reported in a comparable urban Indian adolescent population, [(1)] and d was the absolute precision (10% relative precision on p), giving a minimum requirement of 789 participants, rounded up to 800 to allow for non-response. The present analysis used data from the same study population as the parent KAP survey.

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Sampling Technique

A list of 322 co-educational schools registered in Belagavi city was obtained from the Office of the Deputy Director of Public Instruction [10].

Schools were stratified into four geographic zones (north, south, east, and west), and one school was selected at random from each zone using a random number table, giving four schools in total. Within each selected school, the number of eligible students (aged 11–16 years, classes 7–10) was obtained from school records, and the required sample of 800 was allocated proportionately across the four schools according to their respective enrolment.

Within each school, class-sections were listed, and the required number of students per section was selected using computer-generated random numbers applied to the class attendance register.

Where a selected student was absent or declined participation, the next eligible student from the same section was randomly selected as a replacement.

Operational Definitions

For each of the eight oral hygiene behaviours, two paired variables were defined:

Knowledge (item-specific): A dichotomous variable (correct/incorrect) based on the participant's response to the corresponding knowledge question (e.g., "How long should one brush?", "How often should a toothbrush be replaced?"). A response was coded "correct" if it matched the standard recommendation for that item (e.g., brushing for at least two minutes; toothbrush replacement every three months; use of fluoride-containing toothpaste; rinsing the mouth with water after meals); all other responses, including "don't know," were coded "incorrect."

Practice (item-specific): A dichotomous variable (correct/incorrect) based on the participant's self-reported behaviour for the same item, coded using the same standard as above.

Knowledge–practice gap (primary outcome): For each behaviour, the gap was operationally defined as a statistically significant difference (chi-square test, $p<0.05$) in the proportion practising correctly between those with correct knowledge and those with incorrect knowledge for that item. A non-significant difference was interpreted as knowledge–practice concordance, indicating similar practice patterns irrespective of knowledge status.

In addition to these eight item-specific dichotomous variables, the parent KAP survey also computed a composite overall knowledge score (sum of correct responses across all knowledge items), which was classified as Good (>mean+2SD), Average (within mean±2SD), or Poor (<mean−2SD). The composite knowledge score was not used in the present knowledge–practice concordance analysis.

Sociodemographic variables (age, sex, religion, and socioeconomic status by the Modified BG Prasad scale, as applicable for the year of data collection) were recorded as covariates and are reported descriptively in **Table 1**.

Questionnaire

Data were collected using a pre-tested, structured, interviewer-administered questionnaire covering sociodemographic characteristics and knowledge and practice items for each of the eight oral hygiene behaviours under study. Knowledge and practice items were adapted from the WHO Oral Health Questionnaire for Children and from previously published, similarly structured KAP instruments used in Indian adolescent populations, [3-5] with wording simplified for this age group. Content validity was checked by two subject experts in Community Medicine and Public Health Dentistry, and the questionnaire was pilot-tested on 30 students (not included in the final sample) from a school outside the study area; minor wording changes were made following the pilot to improve comprehension.

Data Collection Procedure

Interviews were conducted individually by the principal investigator together with two trained field investigators, all of whom received a one-day training session on the questionnaire and standardised interview technique before data collection began. Each interview was conducted face-to-face in a quiet room within the school premises, away from teachers and classmates, to encourage candid responses; questions were read aloud in the language preferred by the student (Kannada or English) and responses

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recorded verbatim by the interviewer on a structured proforma. Each interview lasted approximately 15–20 minutes. Children with significant medical conditions that could affect oral hygiene practice (e.g., disabilities affecting manual dexterity) were excluded.

Data Analysis

Data were entered into Microsoft Excel and analysed using SPSS (Trial Version 28.0). Categorical data were expressed as frequencies and proportions. For each of the eight behaviours, knowledge status was cross-tabulated against practice status in a 2×2 table, and the association was tested using the chi-square test (Fisher's exact test was used in place of the chi-square test where any expected cell count was below 5), with $p<0.05$ considered statistically significant.

RESULTS

The study included 800 school children with a mean age of 13.5 ± 1.87 years (range 11–16 years). The sample was nearly evenly split by sex (51.25% male), and most participants were Hindu (75.00%). Socioeconomic distribution was predominantly Class I according to the Modified BG Prasad scale (93.88%).(**Table 1**)

Regular brushing was reported by almost all students (96.6%) regardless of knowledge status, and the difference between knowledge groups was not statistically significant ($\chi^2=0.07$, $p=0.79$). Although 98% of students knew that brushing twice daily is recommended, only about half reported actually doing so, but this shortfall was similar in both knowledge groups ($\chi^2=0.30$, $p=0.58$) – i.e., the low practice of twice-daily brushing was not explained by a lack of knowledge (**Table 2**).

Only 35.87% of students knew the recommended brushing duration, and among them only about half practiced it correctly, with a significant difference compared with those who lacked this knowledge ($\chi^2=5.26$, $p=0.02$). Knowledge about three-monthly toothbrush replacement was very low (9.00%), as was correct practice overall (4.87%); even so, those with correct knowledge were significantly more likely to practice correctly than those without ($\chi^2=4.00$, $p=0.04$) (**Table 3**).

Fluoride toothpaste use showed the strongest knowledge–practice association in the study, with correct practice clearly more common among those with correct knowledge ($\chi^2=36.24$, $p<0.001$).
Tongue cleaning was practiced by a large majority of students regardless of knowledge status, and the difference between knowledge groups was not statistically significant ($\chi^2=1.56$, $p=0.21$), consistent with this being a routine habit rather than a knowledge-dependent behaviour (**Table 4**).

Post-meal rinsing was practiced by more than 95% of students in both knowledge groups, but the small remaining difference reached statistical significance given the large sample size ($\chi^2=14.29$, $p<0.001$); in absolute terms, this behaviour was already close to universal in both groups. Parental supervision of brushing did not differ significantly by knowledge status ($\chi^2=3.27$, $p=0.07$) (**Table 5**).

A knowledge–practice gap, as operationally defined, was evident in 4 of the 8 domains examined (50%): brushing duration, toothbrush replacement, fluoride toothpaste use, and post-meal rinsing.
The remaining 4 domains (50%) showed no statistically significant gap, indicating that practice in these areas did not differ meaningfully by knowledge status (**Table 6**).

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TABLE 1 SOCIODEMOGRAPHIC PROFILE OF STUDY PARTICIPANTS (N=800)		
VARIABLE	**CATEGORY**	**N (%)**
Age (years)	Mean ± SD: 13.5 ± 1.87; Range: 11–16 years	–
Sex	Male	410 (51.25)
	Female	390 (48.75)
Religion	Hindu	600 (75.00)
	Muslim	120 (15.00)
	Christian	80 (10.00)
Socioeconomic Status (Modified BG Prasad Scale)	Class I (Upper)	751 (93.88) *
	Class II (Upper Middle)	36 (4.50)
	Class III–V (Middle/Lower)	13 (1.62)

TABLE 2.A - REGULAR BRUSHING OF TEETH KNOWLEDGE–PRACTICE COMPARISON – REGULAR BRUSHING AND BRUSHING FREQUENCY			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	351 (96.43)	13 (3.57)	364 (45.50)
Incorrect Knowledge	422 (96.79)	14 (3.21)	436 (54.50)
Total	**773 (96.63)**	**27 (3.37)**	**800 (100)**

$\chi^2 = 0.07$, df = 1, p = 0.79

TABLE 2.B - BRUSHING TWICE DAILY KNOWLEDGE–PRACTICE COMPARISON – REGULAR BRUSHING AND BRUSHING FREQUENCY			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	398 (50.77)	386 (49.23)	784 (98.00)
Incorrect Knowledge	7 (43.75)	9 (56.25)	16 (2.00)
Total	**405 (50.62)**	**395 (49.38)**	**800 (100)**

$\chi^2 = 0.30$, df = 1, p = 0.58

TABLE 3.A - BRUSHING DURATION (TWO MINUTES) KNOWLEDGE–PRACTICE COMPARISON – BRUSHING DURATION AND TOOTHBRUSH REPLACEMENT			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	145 (50.52)	142 (49.48)	287 (35.87)
Incorrect Knowledge	216 (42.11)	297 (57.89)	513 (64.13)
Total	**361 (45.12)**	**439 (54.88)**	**800 (100)**

$\chi^2 = 5.26$, df = 1, p = 0.02

TABLE 3.B - TOOTHBRUSH REPLACEMENT (EVERY 3 MONTHS) KNOWLEDGE–PRACTICE COMPARISON – BRUSHING DURATION AND TOOTHBRUSH REPLACEMENT			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	7 (9.72)	65 (90.28)	72 (9.00)
Incorrect Knowledge	32 (4.39)	696 (95.61)	728 (91.00)
Total	**39 (4.87)**	**761 (95.13)**	**800 (100)**

$\chi^2 = 4.00$, df = 1, p = 0.04

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TABLE 4.A - BRUSHING DURATION (TWO MINUTES) USE OF FLUORIDE-CONTAINING TOOTHPASTE			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	289 (65.53)	152 (34.47)	441 (55.12)
Incorrect Knowledge	159 (44.29)	200 (55.71)	359 (44.88)
Total	**448 (56.00)**	**352 (44.00)**	**800 (100)**

$\chi^2 = 36.24$, df = 1, $p < 0.001$

TABLE 4.B - TOOTHBRUSH REPLACEMENT (EVERY 3 MONTHS) TONGUE CLEANING DURING BRUSHING			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	565 (80.03)	141 (19.97)	706 (88.25)
Incorrect Knowledge	70 (74.47)	24 (25.53)	94 (11.75)
Total	**635 (79.38)**	**165 (20.63)**	**800 (100)**

$\chi^2 = 1.56$, df = 1, $p = 0.21$

TABLE 5.A - RINSING MOUTH WITH WATER AFTER EVERY MEAL KNOWLEDGE–PRACTICE COMPARISON – POST-MEAL RINSING AND PARENTAL SUPERVISION			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	600 (99.34)	4 (0.66)	604 (75.50)
Incorrect Knowledge	187 (95.41)	9 (4.59)	196 (24.50)
Total	**787 (98.38)**	**13 (1.62)**	**800 (100)**

$\chi^2 = 14.29$, df = 1, $p < 0.001$

TABLE 5.B - BRUSHING TEETH IN FRONT OF A PARENT KNOWLEDGE–PRACTICE COMPARISON – POST-MEAL RINSING AND PARENTAL SUPERVISION			
KNOWLEDGE STATUS	**CORRECT PRACTICE N (%)**	**INCORRECT PRACTICE N (%)**	**TOTAL N (%)**
Correct Knowledge	319 (78.57)	87 (21.43)	406 (50.75)
Incorrect Knowledge	288 (73.10)	106 (26.90)	394 (49.25)
Total	**607 (75.88)**	**193 (24.13)**	**800 (100)**

$\chi^2 = 3.27$, df = 1, $p = 0.07$

TABLE 6 CHI-SQUARE ANALYSIS OF KNOWLEDGE–PRACTICE GAP ACROSS ORAL HYGIENE BEHAVIOUR DOMAINS					
ORAL HYGIENE DOMAIN	**X^2**	**DF**	**P-VALUE**	**SIG.**	**GAP?**
Regular brushing	0.07	1	0.79	NS	No
Brushing frequency (twice daily)	0.30	1	0.58	NS	No
Brushing duration (2 minutes)	5.26	1	0.02	S	Yes
Toothbrush replacement (3-monthly)	4.00	1	0.04	S	Yes
Fluoride toothpaste use	36.24	1	<0.001	HS	Yes
Tongue cleaning	1.56	1	0.21	NS	No
Post-meal rinsing	14.29	1	<0.001	HS	Yes
Parental supervision	3.27	1	0.07	NS	No

NS = Not Significant; S = Significant ($p<0.05$); HS = Highly Significant ($p<0.001$)

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DISCUSSION

This study examined knowledge–practice concordance across eight specific oral hygiene behaviours among 800 urban school adolescents. The findings suggest two broad patterns: some behaviours are followed (or not followed) fairly uniformly regardless of formal knowledge, likely reflecting habit and family/cultural influence, while others show practice that tracks more closely with what students actually know.

The association between knowledge and brushing duration (p=0.02) is a relevant example of the latter pattern. Only 35.87% of participants knew that brushing should last at least two minutes, and even among them, only about half reported doing so. Comparable findings were reported among school children in Tamil Nadu, where many students did not brush for the recommended duration despite being aware of it [(3)].
This points to a behaviour that is hard to sustain without external cues such as a timer or supervision, rather than one that depends purely on awareness.

Knowledge about toothbrush replacement was very low (9.00%), and correct practice was correspondingly rare (4.87%); the association, although modest in absolute numbers, was statistically significant (χ^2=4.00, p=0.04). A similarly low level of awareness around toothbrush replacement has been reported among adolescents in Manipur,[(4)] suggesting this specific gap is not unique to this setting.

The strongest knowledge–practice association was for fluoride toothpaste use (χ^2=36.24, p<0.001), consistent with findings among school children in Davangere, where knowledge appeared to influence product choice [(5)].
Interestingly, a considerable proportion of students with incorrect knowledge were still using fluoride toothpaste, indicating that correct practices may sometimes occur even in the absence of adequate knowledge.

Although a statistically significant association was observed for post-meal rinsing (p<0.001), the practice was highly prevalent in both knowledge groups (99.34% vs 95.41%).
This finding suggests that rinsing after meals is a commonly established habit among adolescents, possibly influenced by family and cultural practices, as reported in other Indian school-based studies [(6)].

No significant knowledge–practice difference was found for regular brushing (p=0.79), brushing frequency (p=0.58), parental supervision (p=0.07), or tongue cleaning (p=0.21).
These behaviours appear to be established through routine and family influence to a degree that additional knowledge adds little further explanatory power, a pattern broadly consistent with other school-based studies [(7)].

Taken together, these findings suggest that interventions are unlikely to be equally effective across all eight behaviours.
For habitual behaviours already practiced near-universally, further knowledge-only messaging may have limited marginal benefit. For behaviours that depend on specific technical understanding – brushing duration, toothbrush replacement timing, and toothpaste selection – structured demonstration, repeated reinforcement, and environmental cues (e.g., timers, school-distributed brushes on a fixed schedule) are more likely to close the gap than information alone.

RECOMMENDATIONS

School health programmes should incorporate hands-on demonstration of correct brushing technique and duration, alongside scheduled reminders for toothbrush replacement.

Parent and teacher involvement in reinforcing these practices at home and in the classroom would help convert awareness into sustained behaviour.

Targeted modules addressing brushing duration, toothbrush replacement, and informed toothpaste selection should be embedded within existing platforms such as the School Health Programme and Adolescent Friendly Health Clinics, where contact with this age group is already established.

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LIMITATIONS

This study has several limitations that should be considered when interpreting the findings.

1. The cross-sectional design does not allow causal inference about the direction of the relationship between knowledge and practice.
2. Practice was based on self-report rather than direct observation, which may have introduced social desirability bias and could have led to overestimation of compliance.
3. The study was conducted exclusively in urban schools, limiting generalisability to rural or peri-urban adolescent populations.
4. The knowledge–practice gap was assessed at the level of individual behaviours; the analysis did not adjust for potential confounders (e.g., parental education, household income) that may influence both knowledge and practice simultaneously.

CONCLUSION

Among 800 urban adolescents aged 11–16 years, knowledge–practice gaps were identified in half of the eight oral hygiene behaviours assessed – brushing duration, toothbrush replacement, fluoride toothpaste use, and post-meal rinsing – while regular brushing, brushing frequency, parental supervision, and tongue cleaning showed no significant gap, consistent with these being routine, habit-driven behaviours.

School oral health education should move beyond providing information alone and incorporate supervised practice and demonstration, particularly for the behaviours where knowledge and practice diverge most.

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