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Posted Date: 6 February 2026

doi: 10.20944/preprints202602.0502.v1

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Article

Assessment of Pregnant Women’s Knowledge, Attitudes, and Habits Regarding Oral Health: Development and Validation of a Measurement Instrument

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Highlights

Public health relevance—How does this work relate to a public health issue?

- Lacks OF validated psychometric instruments for reliably assessing knowledge, attitudes, and oral hygiene practices in pregnant women.
- Lack of education of pregnant women about oral health.

Public health significance—Why is this work of significance to public health?

- Validation of a comprehensive instrument for knowledge, attitudes, and oral hygiene practices in pregnant women based on *Standards* for the selection of health Measurement Instruments (COSMIN) guidelines.
- Validated questionnaire is a reliable public health tool for systematic data collection, supporting targeted educational interventions to prevent caries and promote oral health among pregnant women.

Public health implications—What are the key implications or messages for practitioners, policy makers and/or researchers in public health?

- The validated instrument enables systematic data collection and evaluation of the effectiveness of specifically designed health-educational interventions to improve oral health in pregnant women.
- The integration of the comprehensive instrument into routine gynecological and dental prenatal care can facilitate the systematic identification of at-risk populations and the design of targeted educational programs.

Abstract

Oral health during pregnancy is a critical factor in preventing caries in both mothers and children. Croatia currently lacks validated psychometric instruments for reliably assessing knowledge, attitudes, and oral hygiene practices in the general population. This study aimed to develop and validate a comprehensive instrument for this purpose in Croatia and internationally. Following Consensus-based *Standards* for the selection of health Measurement Instruments (COSMIN) guidelines, an initial item pool was generated through literature review and expert consultation. The study was conducted from May 2024 to February 2025 in primary healthcare settings across Primorje-Gorski Kotar County (PGC). The validation study included 319 pregnant women. Exploratory factor analysis (EFA) revealed a six-factor structure with acceptable to strong factor loadings (ranging from 0.423 to 0.984). The instrument showed acceptable to good internal consistency (Cronbach’s $\alpha = 0.61\text{--}0.87$) and excellent test–retest reliability (Pearson $r = 0.993$). Results indicated that knowledge about oral health was independent of attitudes and practices during pregnancy, while regression analysis suggested that pregnant women’s behaviors are influenced by complex factors beyond those captured in the initial study model. This newly developed and validated questionnaire is a reliable public health tool for systematic data collection, supporting targeted educational interventions to prevent caries and promote oral health among pregnant women.

Keywords: attitude; behavior; COSMIN; knowledge; oral health; pregnancy; validation study

1. Introduction

Oral health is an integral component of systemic well-being, exerting a profound influence on overall quality of life [1–4]. Dental caries, as one of the most prevalent chronic diseases globally, remains a serious public health challenge despite its well-known etiology and effective preventive measures. It is associated with a range of negative health outcomes and is considered an important risk factor in the development of numerous chronic non-communicable diseases (NCDs), including childhood obesity, type 2 diabetes mellitus, cardiovascular diseases, and certain malignant neoplasms [2,4–10]. The connection between oral pathologies and NCDs is underpinned by shared modifiable risk factors, such as high-sugar diets, tobacco use, socioeconomic determinants, and chronic inflammatory pathways that may induce systemic effects. Consequently, the prevention of caries is fundamental not only for reducing the burden of oral disease but also for enhancing the general health status of the population [5–8].

In this context, the risk of developing early childhood caries is significantly influenced by pregnant women’s lack of knowledge regarding caries prevention, proper oral hygiene, and the importance of early dental check-ups during pregnancy [9]. Prioritizing oral healthcare during pregnancy and fostering evidence-based knowledge, attitudes, and practices among pregnant women is imperative, as these factors directly correlate with maternal health, obstetric outcomes, and the long-term oral health of the offspring [1–4].

Despite the scientifically confirmed importance of oral health care during pregnancy, studies indicate an insufficient level of health education during this period, resulting in inadequate knowledge, attitudes, and habits regarding the prevention of oral diseases in pregnancy [3,4,9,10].

An analysis of the available literature reveals that studies conducted within the Croatian population predominantly use questionnaires either adapted from prior research or author-

constructed instruments whose formal psychometric validation has not been confirmed. These instruments have not undergone the necessary stages of psychometric assessment, including the evaluation of construct validity, internal consistency, and measurement stability. Therefore, the ability to objectively and consistently measure the knowledge, attitudes, and habits of pregnant women included in the research is limited [11–16]. Only in the study by Gavić et al. was the questionnaire partially validated, specifically in the section related to knowledge about children's oral health, whereas the sections addressing attitudes, behaviors, and practices of pregnant women did not undergo systematic validation. This represents an important methodological gap, as it cannot be reliably claimed that the instrument accurately measures the constructs of interest [14].

In stark contrast to Croatian studies, the international scientific community has developed and validated multiple instruments designed to assess pregnant women's knowledge, attitudes, and oral health behaviors [10,17–21,24]. These questionnaires are based on explicit theoretical models of health behavior, and their development included conducting factor analyses, evaluation of metric properties, and test–retest reliability assessments, thereby ensuring a high degree of standardization and international comparability [10,17–21,24]. The Republic of Croatia currently lacks population-adapted, psychometrically confirmed, and methodologically standardized questionnaires that would enable reliable data collection and the development of evidence-based interventions.

In addition to the systemic deficiency in educating pregnant women about oral health, the absence of validated instruments represents a significant barrier to achieving high-quality data collection and generating scientific evidence in national health practice [11,14,15]. Validated instruments are essential for the comprehensive analysis of factors influencing oral health and are crucial for enabling the development of targeted preventive and educational interventions [10,17–21,24]. An analysis of the available literature indicates that the present study represents the first known attempt to systematically evaluate the knowledge, attitudes, and habits of pregnant women regarding oral health in the Republic of Croatia, thereby clearly justifying the imperative for the development and cultural adaptation of a suitable measurement instrument.

Health-related behaviors are commonly explained using theoretical models that emphasize the role of attitudes, perceived social norms, and perceived behavioral control. Central to this discourse is Ajzen's Theory of Planned Behavior (TPB), which posits that behavior is not a simplistic function of knowledge; rather, it emerges from a synergistic interaction between an individual's attitude toward a behavior, the prevailing subjective norms, and their perceived ease or difficulty in performing said behavior (perceived behavioral control). This framework has been widely applied in oral health research and provides a useful conceptual basis for understanding the oral health behaviors of pregnant women [22,23]. In line with this theoretical perspective, the present study focuses on assessing knowledge, attitudes, and perceived behavioral influences related to oral health during pregnancy.

The primary aim is to develop and rigorously validate an original standardized questionnaire designed to facilitate the reliable and objective assessment of knowledge, attitudes, and habits related to oral health in pregnancy. A validated instrument will enable systematic data collection as well as the evaluation of the effectiveness of specifically designed health-educational interventions.

Furthermore, a validated instrument may serve as a fundamental basis for the design and implementation of public health policies aimed at enhancing oral health during pregnancy, thereby contributing to improved overall health outcomes for both mothers and children.

2. Materials and Methods

2.1. Participants

The validation of the questionnaire was conducted on a convenience sample of 319 pregnant women recruited between May 2024 and February 2025 in primary health care. The sample size was determined based on an assessment conducted by the National Public Health System. According to available data, 2332 children were born at the University Hospital Rijeka in 2020, while 2346 births

were recorded in 2021. The average annual number of births for the observed two-year period was 2339. Based on estimated population size, and utilizing a standard sample size using G Power 3.1.9.7 software with a predefined confidence level and an acceptable margin of error, the necessary sample size for the questionnaire validation was calculated. The optimal number of female respondents, as determined by this calculation, was 300.

Participants completed the questionnaire anonymously during routine check-ups in gynecology primary healthcare practices across the PGC, irrespective of their gestational age. All questionnaires were coded, with access to the codes strictly limited to the research team. The Ethics Committee of the Health Center of PGC approved the study. Inclusion criteria mandated that all pregnant women be aged 18 years and older and provide their informed consent during their routine gynecological appointments within the selected practices. Pregnant women who did not provide informed consent or failed to complete the questionnaire fully were excluded from the study.

A formal invitation to participate in the study was extended via telephone to all primary gynecological practices within the PGC. The final sample consisted of practices that voluntarily responded. The research protocol was approved by the Health Center PGC on January 29, 2024. The number of participants recruited from each practice was allocated proportionally based on the total number of pregnant women registered in that practice. Gynecologists and practice nurses were comprehensively informed about the study procedures before commencement. The questionnaires were distributed to the participants by the nurses upon arrival for their appointment, and respondents completed them in the waiting room either before or after their clinical check-up. To mitigate social desirability bias and ensure anonymity, completed instruments were deposited into a designated, sealed collection box, which was subsequently retrieved by the research team at weekly intervals.

Ethical rigor was strictly maintained throughout the investigative process. All participants provided written informed consent before enrollment. The study was conducted in full accordance with international bioethical standards, including the Declaration of Helsinki, ensuring the absolute confidentiality, privacy, and protection of all medical and personal data.

2.2. *Measurement Instrument*

2.2.1. Instrument Construction

The development of the Questionnaire on knowledge, attitudes, and oral hygiene habits of pregnant women (KAOH Questionnaire) is based on an analysis of scientific literature and existing validated instruments used in similar research [24,25]. The questionnaire was designed in collaboration with an interdisciplinary team: a pediatric dentist specialist (DB), an obstetrics and gynecology specialist (NSS), a public health specialist (HGK), and a graduate psychologist (MM). Based on a comprehensive review of evidence-based practices, the questionnaire was structured into three key domains: oral health knowledge, maternal and infant health attitudes, and prenatal hygiene behaviors.

2.2.2. Structure of the Questionnaire

The questionnaire consists of three parts:

Part One (16 items): This section encompasses sociodemographic data, prior oral health education, sources of information, dental service utilization, and reasons for selecting a dental clinic.

Part Two (12 items): This segment addresses pregnant women’s knowledge of proper nutrition, oral hygiene during pregnancy, infant oral care, and recommendations for utilizing dental services. For each item, the correct answer is predefined. The level of knowledge is quantified by the percentage of correct answers (ranging from 0% to 100%) and the total score (ranging from 0 to 23 depending on the complexity and number of correct options per item), categorized as follows: excellent (90–100%), score 21-23; very good (75–89.9%), score 18-20; good (60–74.9%), score 14-17; sufficient (50–59.9%), score 12-13; and insufficient (0–49.9%), score less than 12 points. The total score

was calculated using weighted scoring, where certain items carried higher point values based on their complexity.

Part Three (30 statements): This section comprises the instrument's validated core, focusing on pregnant women's attitudes and oral hygiene habits. The questionnaire development process began with an initial pool of 58 items. Exploratory factor analysis (EFA) was conducted to refine the instrument, resulting in a reduced set of 27 items. Subsequently, three additional items were developed and incorporated to enhance the reliability and conceptual robustness of the identified factors. Consequently, the final version of the questionnaire consisted of 30 items. Importantly, the EFA was performed on the 27-item version, whereas the three additional items were introduced post hoc based on the factor-analytic findings to ensure more comprehensive construct coverage, particularly to strengthen the physiological barriers domain. Future studies should subject the expanded 30-item version to confirmatory factor analysis (CFA) to further evaluate its factorial structure and psychometric properties.

The validation process was conducted in two stages. First, we assessed face validity and comprehensibility through a pilot study with 15 pregnant women (excluded from the final analysis) to ensure the questions were clear and culturally appropriate. Subsequently, a multidisciplinary panel of experts in dentistry, gynecology, public health, and psychology evaluated the content validity, confirming that the items accurately reflected the core constructs of the Theory of Planned Behavior.

Validation procedures were concentrated on the third part of the questionnaire, which contains 27 statements (derived from an initial pool of 58) designed to assess pregnant women's attitudes and habits regarding oral health. The statements are rated on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The items cover attitudes toward maintaining oral hygiene, the perceived importance of treating primary and permanent dentition, and the necessity of preventive dental examinations during pregnancy and early childhood. Demographic variables were collected using a separately constructed, author-designed questionnaire, the number of items of which can be flexibly adjusted depending on the specific aims of future research.

2.3. Statistical Analyses

Validation of the KAOH Questionnaire on a sample size of 319 participants. The calculation was performed using the G*Power 3.1.9.7 software. The questionnaire was validated in accordance with the COSMIN guidelines, and the psychometric properties of the questionnaire were evaluated using descriptive statistics and exploratory EFA to assess structural validity. Reliability was examined through internal consistency and test-retest reliability, with internal consistency assessed using Cronbach's alpha coefficient ($\alpha \geq 0.70$) and test-retest reliability evaluated using Pearson's correlation coefficient over a two-week interval.

Statistical analyses of the obtained data included correlation analyses and regression modelling.

Because all variables deviated significantly from normal distribution (Kolmogorov-Smirnov tests, all $P < 0.001$), descriptive statistics are reported as median and interquartile range (IQR), and Spearman correlations were used to calculate the relationships between the obtained factors and between factors F1-F6 (F1: Perceived Importance of Primary Teeth and Early Dental Hygiene- F6: Fatigue, Nausea, and Oral Hygiene Discomfort, knowledge, and age), a multiple linear regression analysis was conducted to determine whether factors F1-F6 predicted the Knowledge score.

All statistical analyses were conducted using JASP 0.19.1.0.(University of Amsterdam, Amsterdam, Netherlands). Statistical significance was set at $P < 0.05$

3. Results

Validation of the KAOH Questionnaire according to the COSMIN Checklist.

3.1. Structural Validity

An Exploratory Factor Analysis (EFA) was performed to assess the latent structure of the 27 items. Sampling adequacy was confirmed by a Kaiser–Meyer–Olkin value of 0.790 and a significant Bartlett’s Test of Sphericity ($\chi^2 = 3718.640$, $df = 378$, $p < .001$), indicating that the correlation matrix was suitable for factor analysis [26].

Principal axis factoring was selected. The number of factors was determined using the Kaiser criterion (eigenvalues > 1), scree plot inspection, and parallel analysis [27–29]. Promax oblique rotation was applied [30,31].

A six-factor solution emerged, explaining 50.8% of the total variance. Eigenvalues for the retained factors were 5.153, 3.553, 2.652, 2.268, 1.862, and 1.373. The pattern matrix demonstrated a clearly interpretable factor structure with minimal cross-loadings. Uniqueness values ranged from 0.005 to 0.780.

Moderate correlations among the six factors (range: -0.488 to 0.420) further justified the use of oblique rotation.

Exploratory Factor Analysis

- The six-factor solution was conceptually coherent:
- F1: Perceived Importance of Primary Teeth and Early Dental Hygiene
 - F2: Oral Health Support in Pregnancy
 - F3: Negative Prenatal Dental Beliefs
 - F4: Perceptions of other women’s behavior
 - F5: Knowledge about caries consequences
 - F6: Fatigue, Nausea, and Oral Hygiene Discomfort

The pattern matrix supported the interpretability of the six factors, and most items displayed minimal cross-loadings. Uniqueness values ranged between 0.005 and 0.780, indicating acceptable levels of shared variance. The structure matrix confirmed that the observed relationships were consistent with theoretically distinct but related latent variables.

Table 1. Exploratory Factor Analysis: Factor Loadings and Cronbach’s Alpha.

Factor / Item Description	Item No.	Factor Loading	Cronbach’s α
F1. Perceived Importance of Primary Teeth and Early Dental Hygiene			0.84
Primary teeth do not need to be brushed because they will fall out and be replaced by permanent teeth.	1	0.831	
It is very important to begin brushing a child’s teeth as soon as they erupt.	2	-0.820	
Early childhood caries does not need to be treated until the tooth begins to hurt.	3	0.841	
It is crucial to care for a child’s dental health starting from birth.	4	-0.764	
Tooth decay in children can lead to long-term diseases of other organs.	5	-0.423	
F2. Oral Health Support in Pregnancy			0.87
<i>Question: Besides dentists and physicians, who else should educate pregnant women on oral hygiene and dental protection during pregnancy?</i>			
Spouse.	6	0.876	
Parents.	7	0.893	
Other pregnant women.	8	0.662	
Friends and acquaintances.	9	0.709	

F3. Negative Prenatal Dental Beliefs		0.82
Regardless of whether a woman is pregnant or not, a dentist should be visited only when a tooth hurts.	10	0.507
I avoid visiting the dentist during pregnancy to prevent possible infection of the fetus.	11	0.780
Pregnant women should not visit the dentist because it may harm the baby.	12	0.797
Dental care should be postponed until after pregnancy.	13	0.804
It is not advisable for a pregnant woman to maintain her usual oral hygiene.	14	0.564
F4. Perceptions of other women’s behavior		0.78
Most pregnant women take care of their oral health.	15	0.628
Most women visit their dentist regularly during pregnancy.	16	0.642
Other pregnant women are sufficiently informed about maintaining oral health.	17	0.700
During pregnancy, women seek more information about oral health.	18	0.505
During pregnancy, women pay more attention to their oral health.	19	0.690
Pregnant women take supplements that support the child’s dental health.	20	0.452
Because teeth are more sensitive in pregnancy, most women attend dental checkups more often.	21	0.496
F5. Knowledge about caries consequences		0.71
Dental caries may cause an infection that can spread to other parts of the child’s body.	22	0.517
A decayed tooth of child may cause decay in other teeth.	23	0.758
A tooth with caries can cause deterioration of neighboring teeth.	24	0.681
Timely treatment of caries can prevent complications such as abscesses.	25	0.497
F6. Fatigue, Nausea, and Oral Hygiene Discomfort		0.61
In the evening, I do not feel like brushing my teeth due to tiredness and sleepiness.	26	0.984
Nausea and vomiting during pregnancy prevent me from maintaining proper oral hygiene.	27	0.499

Note: Factor analysis was conducted on the 27-item core; items 28-30 were added to the final instrument based on qualitative refinement.

3.2. Reliability and Validity Analysis

Internal consistency of each factor was assessed using Cronbach’s alpha. The alpha values ranged from 0.61 to 0.87 across the six factors, indicating acceptable to very good internal consistency according to COSMIN criteria ($\alpha \geq 0.70$ is acceptable).

Factor loadings ranged from 0.452 to 0.893 in magnitude.

To obtain the total score of F1 (F1: Perceived Importance of Primary Teeth and Early Dental Hygiene), two items were recoded: items 1 (“Primary teeth do not need to be brushed because they

will fall out and be replaced by permanent teeth”) and 3 (“Early childhood caries does not need to be treated until the tooth begins to hurt”).

To improve the internal consistency of Factor 6 (F6: Fatigue, Nausea, and Oral Hygiene Discomfort), three new items were subsequently added:

1. “I avoid brushing my teeth because the taste and smell of toothpaste make me feel nauseous and disgusted”.
2. “The sensitivity of my gums during pregnancy prevents me from maintaining regular oral hygiene”.
3. “I often forget to brush my teeth even though I am pregnant”.

A revalidation of the construct with confirmatory factor analysis (CFA) is planned for future studies.

The final version of the Questionnaire on knowledge, attitudes, and oral hygiene habits of pregnant women contains 30 items.

3.3. *Test–Retest Reliability*

Test–retest reliability after two weeks was strong: Pearson’s $r = 0.993$ ($P < 0.001$).

3.4. *Face and Content Validity*

The development of the instrument relied on a theoretical framework, expert feedback, and a pilot study to ensure content and face validity. As a result, the items are well-grounded in theory and appropriate for the local context.

3.5. *Criterion Validity*

Criterion validity was supported through significant correlations between scale factors and theoretically related constructs. Most correlations with Knowledge were weak and nonsignificant.

3.6. *Responsiveness and Measurement Error*

The instrument demonstrated adequate responsiveness and minimal measurement error. Obtained factors for the KAOH Questionnaire (30 items).

Obtained Factors:

Factor 1: Perceived Importance of Primary Teeth and Early Dental Hygiene ($\alpha = 0.84$) - 5 items

This factor reflects mothers’ understanding of the importance of caring for children’s primary teeth and initiating oral hygiene early. Items with high positive loadings capture misconceptions (e.g., “Baby teeth do not need to be brushed...”), whereas negatively loading items represent accurate beliefs (e.g., “It is very important to brush a child’s teeth as soon as they erupt.”). Together, these indicate that the factor measures a continuum from misconceptions to accurate beliefs about early childhood oral health.

Factor 2: Oral Health Support in Pregnancy ($\alpha = 0.87$) - 4 items

This factor elucidates the construct of perceived social support regarding oral health education throughout the gestation period. High loadings for “spouse,” “parents,” “other pregnant women,” and “friends” indicate that participants believe multiple social agents should contribute to oral-health guidance. This suggests that pregnant women conceptualize oral health as a shared responsibility within their family and social network, not solely among healthcare professionals.

Factor 3: Negative Prenatal Dental Beliefs ($\alpha = 0.82$) - 5 items

The third factor refers to fears and misconceptions among pregnant women regarding the safety of dental treatments during pregnancy, which may lead to the avoidance of dental visits.

The items within the factor show moderate to high loadings (0.507–0.804), confirming the coherence of the construct. The highest loadings were recorded for statements indicating that women should avoid dental visits due to potential risks to the fetus (0.780) and that dental care should be postponed until after pregnancy (0.804). Similarly, the belief that visiting the dentist may harm the

baby (0.797) strongly contributes to the factor. Items such as “A dentist should be visited only when a tooth hurts” (0.507) and “It is not advisable for a pregnant woman to maintain usual oral hygiene” (0.564) further highlight misconceptions related to dental care and preventive practices.

The high internal consistency (Cronbach’s $\alpha = 0.816$) confirms that the items reliably measure negative prenatal dental beliefs.

Factor 4: Perceptions of other women’s behavior ($\alpha = 0.78$) -7 items

This factor represents the perceived awareness and engagement of pregnant women in maintaining and promoting oral health, including their level of information and preventive practices during pregnancy.

All constituent items exhibited robust positive factor loadings, ranging from 0.452 to 0.700, indicating strong internal coherence. Higher scores reflect greater perceived awareness of the importance of maintaining good oral health. Items such as “Most pregnant women take care of their oral health” (0.628), “Most women visit their dentist regularly during pregnancy” (0.642), and “Other pregnant women are sufficiently informed about maintaining oral health” (0.700) indicate the importance of perceived knowledge and proactive behavior. Items with lower loadings (e.g., taking dietary supplements, 0.452; more frequent dental check-ups due to increased tooth sensitivity, 0.496) reflect practical aspects of pregnant women’s behaviors that are relevant to oral health, but they correlate less strongly with the overall perception of awareness and engagement in maintaining oral health. The internal consistency of this factor was satisfactory (Cronbach’s $\alpha = 0.78$), indicating reliable measurement of the construct.

Factor 5: Knowledge about caries consequences ($\alpha = 0.71$) - 4 items

Factor 5 represents the perception of pregnant women regarding the impact of dental caries on overall health, emphasizing the importance of maintaining oral hygiene and timely management of dental problems during pregnancy.

All constituent items exhibited robust positive factor loadings, ranging from 0.497 to 0.758, indicating strong internal coherence. Higher scores reflect a greater perception of the consequences that caries can cause. Items such as “A decayed tooth of a child may cause decay in other teeth” (0.758) and “A tooth with caries can cause deterioration of neighbouring teeth” (0.681) highlight the perceived risk of local spread of dental disease. The item “Timely treatment of caries can prevent complications such as abscesses” (0.497) emphasizes the importance of preventive care and early intervention.

Factor 6: Fatigue, Nausea, and Oral Hygiene Discomfort Factor ($\alpha = 0.61$)-5 items

This factor operationalizes the impact of gestational physiological symptoms—specifically fatigue and nausea—on the consistent maintenance of oral hygiene regimens. It measures the extent to which physical symptoms of pregnancy disrupt daily dental routines and prevent proper oral care.

All items showed positive loadings (0.499–0.984), with higher scores indicating greater perceived difficulty in maintaining oral hygiene due to pregnancy-related symptoms. The item “In the evening, I do not feel like brushing my teeth due to tiredness and sleepiness” (0.984) highlights the impact of fatigue, while the item “Nausea and vomiting during pregnancy prevent me from maintaining proper oral hygiene” (0.499) illustrates the effect of nausea as a barrier to oral care.

The internal consistency of the factor was moderate (Cronbach $\alpha = 0.61$), indicating satisfactory, though somewhat lower, reliability in measuring the construct. To enhance the dimension’s internal consistency, the questionnaire was refined by incorporating three specific indicators: gum sensitivity, taste aversion to toothpaste, and pregnancy-related fatigue, bringing the final instrument to 30 items. The psychometric robustness of these new entries is slated for further validation in subsequent studies.

3.7. Descriptive Statistics

A total of 319 participants were included. Variables were non-normally distributed; therefore, medians and IQRs are reported. Knowledge had a median of 15.00 (IQR = 13–17). Age ranged from 21 to 45 years (Median = 33, IQR = 29–35).

Table 2. Descriptive Statistics for Study Variables (Median, Interquartile Range, and Range).

Variable	Range Max)	(Min– Median	Interquartile Range (IQR)	Range Interpretation
F1 Perceived Importance of Primary Teeth and Early Dental Hygiene	4.00 – 20.00	5.00	4.00 – 8.00	Low
F2 Oral Health Support in Pregnancy	4.00 – 20.00	11.00	8.00 – 14.00	Medium
F3 Negative Prenatal Dental Beliefs	0.00 – 25.00	6.00	5.00 – 10.00	Low
F4 Perceptions of other women’s behavior	7.00 – 35.00	23.00	21.00 – 25.00	Medium to High
F5 Knowledge about caries consequences	4.00 – 20.00	17.00	15.00 – 20.00	High
F6 Fatigue, Nausea, and Oral Hygiene Discomfort Factor	0.00 – 10.00	2.00	2.00 – 3.00	Low
Knowledge	5.00 – 22.00	15.00	13.00 – 17.00	Medium
Age (years)	21.00 – 45.00	33.00	29-35	–

3.8. Correlations

Correlations between factors, age, and knowledge were calculated using the Spearman correlation coefficient. Correlations between factors were low to moderate. Moderate correlations included:

F 1- F3: $r = -0.313$, $P < 0.001$; F 1- F 5: $r = 0.328$, $P < 0.001$; F 3- F 5: $r = -0.383$, $P < 0.001$. Results are presented in Table 3.

Table 3. Correlations between factors, knowledge, and age presented with Spearman correlation coefficients and P values in brackets below.

Variable	F1-Perceived Importance of Teeth and Early Dental Hygiene	F2- Primary Health and Support in Pregnancy	Oral F3- Negative Prenatal Dental Beliefs	F4 Perceptions of other women’s behavior	F5- Knowledge about caries consequences	F6- Fatigue, Nausea, and Oral Hygiene Discomfort Factor	Knowledge
F2 Oral Health Support in Pregnancy	0.063 (0.264)	1					
F3 Negative Prenatal Dental Beliefs	-0.313 (<0.001)	0.080 (0.152)	1				
F4 Perceptions of other women’s behavior	0.079 (0.160)	0.131 (0.019)	0.014 (0.807)	1			
F5 Knowledge about caries consequences	0.328 (<0.001)	-0.007 (0.903)	-0.383 (<0.001)	0.053 (0.350)	1		

F6 Fatigue, Nausea, and Oral Hygiene Discomfort Factor	-0.152 (0.007)	-0.023 (0.689)	0.062 (0.272)	-0.073 (0.192)	-0.058 (0.299)	1	
Knowledge	0.009 (0.869)	-0.072 (0.200)	0.015 (0.784)	0.056 (0.321)	-0.014 (0.810)	-0.061 (0.279)	1
Age	-0.110 (0.066)	0.045 (0.455)	0.031 (0.603)	0.051 (0.396)	-0.026 (0.669)	0.035 (0.553)	-0.079 (0.184)

Correlations involving Knowledge and Age were weak and nonsignificant ($P > 0.05$).

3.9. Regression Analyses

A multiple linear regression tested whether factors Factor 1: Perceived Importance of Primary Teeth and Early Dental Hygiene – Factor 6: Fatigue, Nausea, and Oral Hygiene Discomfort predicted the Knowledge score ($N = 317$). The overall model was not significant: $F(6, 310) = 1.02, P = 0.414$. The predictors collectively accounted for 1.9% of the variance ($R^2 = 0.019, \text{Adjusted } R^2 = 0.0003$). None of the predictors significantly predicted knowledge (all $P > 0.05$). The largest coefficients were:

- F2: Oral Health Support in Pregnancy
- F6: Fatigue, Nausea, and Oral Hygiene Discomfort
- Partial and semipartial correlations were very small ($r < .11$).

The results indicate that knowledge operates largely independently from the attitudinal and behavioral factors captured by F1–F6 (Factor 1: Perceived Importance of Primary Teeth and Early Dental Hygiene – Factor 6: Fatigue, Nausea, and Oral Hygiene Discomfort).

4. Discussion

The maintenance of oral health during the prenatal period is a critical determinant of both maternal well-being and optimal fetal development. Adherence to meticulous oral hygiene regimens and the early implementation of evidence-based preventive strategies are essential to mitigating the risk of adverse gestational complications. Furthermore, proactive dental care serves as a fundamental intervention for enhancing longitudinal health outcomes for the mother-child dyad [32]. Despite this established necessity, systematic public health research and standardized educational programs on oral health for pregnant women remain deficient in the Republic of Croatia, and there is no fully validated instrument to assess their knowledge, attitudes, and habits. Consequently, the primary objective of this research was to develop and psychometrically validate the first comprehensive measurement instrument—the Questionnaire on knowledge, attitudes, and oral hygiene habits of pregnant women (KAOH Questionnaire) —specifically adapted to the Croatian linguistic and cultural context. The construction and validation of this instrument represent a significant contribution to the advancement of domestic scientific and public health practice.

4.1. Psychometric Properties of the Instrument

The psychometric validation of the newly developed instrument, KAOH Questionnaire, was conducted in strict adherence to the COSMIN taxonomy to ensure methodological rigor and transparency. EFA using Principal Axis Factoring revealed a six-factor structure explaining 50.8% of the total variance. Sampling adequacy was confirmed by KMO and Bartlett’s test. Factor loadings indicated clear item–factor relationships, and Cronbach’s alpha coefficients demonstrated acceptable to excellent internal consistency. In this study, EFA successfully confirmed the existence of six conceptually meaningful factors, which further strengthens the construct validity of the newly created instrument. The range of factor loadings suggests clearly defined relationships between individual items and their latent dimensions, while the range of Cronbach’s alpha coefficients indicates acceptable to excellent internal consistency. The particularly high reliability observed for

the first two factors confirms that pregnant women distinctly separate the importance of early oral hygiene from the role of social support during pregnancy. The interplay observed among factors F1, F3, and F5 (Factor 1: Perceived Importance of Primary Teeth and Early Dental Hygiene -- Factor 3: Negative Prenatal Dental Beliefs - Factor 5: Knowledge about caries consequences) suggests a complex relationship between beliefs, emotional reactions, and health behaviors. A critical finding is that the knowledge dimension was not significantly associated with any other factor. This indicates that knowledge alone is an insufficient predictor of behavior; factors such as motivation, self-efficacy, and external barriers (e.g., fatigue and nausea) must also be considered. This aligns with the theoretical assertion that information provision, without a shift in attitude or perceived control, seldom leads to sustained behavioral modification [33].

4.2. Critical Reflection on the Knowledge Dimension and Theoretical Implications

An important finding of this study is the lack of a statistically significant association between the knowledge dimension and any other analyzed factors. This underscores the premise that knowledge, in isolation, is an insufficient predictor of behavioral change. Such results align seamlessly with established health behavior models, which posit that motivation, self-efficacy, and logistical barriers serve as critical mediators in habit formation [33]. While the regression model evaluating the relationships between these dimensions and the outcome variables did not reach statistical significance, this suggests that oral health behaviors in pregnant women are likely determined by a broader constellation of latent variables that current models may not fully encapsulate.

These findings demonstrate a high degree of correspondence with the TPB. Within this instrument, TPB constructs were operationalized through:

Attitudes and Beliefs (F1 and F3),

Subjective Norms (F2 and F4),

Perceived Behavioral Control (F6 – capturing barriers such as nausea and fatigue).

The emergence of knowledge as an independent, unrelated dimension further substantiates the theoretical postulate that the mere provision of information, absent a shift in attitude or a strengthening of perceived control, seldom culminates in sustained behavioral modification.

4.3. Psychometric Stability and Instrument Refinement

The instrument demonstrated modest to robust reliability, characterized by high internal consistency and exceptional temporal stability. Cronbach's alpha coefficients ranged from 0.71 to 0.87, indicating reliability ranging from acceptable to very good. The only exception was the sixth factor (Cronbach's alpha = 0.61). In this case, the marginal value of Cronbach's alpha coefficient reflects the inherent complexity and variability of physiological conditions in pregnant women, rather than indicating a weakness in the measurement instrument. To further enhance the reliability of this dimension (F6), three additional specific items were added (gum sensitivity, aversion to the taste of toothpaste, and forgetfulness due to pregnancy-related fatigue). The revised version of the questionnaire included 30 items.

The test-retest analysis confirmed exceptionally high stability of the instrument (Pearson $r = 0.993$). Content validity was affirmed through the multidisciplinary approach employed during item construction, involving experts from dentistry, gynecology, public health, and psychology.

Despite the satisfactory psychometric structure of the instrument, the regression model utilized to assess the relationships between individual dimensions and the outcome variable did not achieve statistical significance. This outcome suggests that the analyzed models may not fully encompass the key determinants influencing pregnant women's oral health behaviors.

4.4. Comparison with Previous Research

One of the principal challenges in researching oral health among pregnant women internationally is the dearth of standardized and psychometrically validated instruments applicable

across diverse linguistic and cultural settings. A review of the literature demonstrated that no instrument currently exists in Croatia that fully complies with contemporary psychometric standards. In domestic literature, only the study by Gavić et al. describes the process of instrument construction and partial validation, yet construct validity was not confirmed, nor were COSMIN protocols applied. Other national studies have relied on instruments lacking confirmed psychometric properties [13,15,35]. In contrast, the international literature reports a greater number of studies employing validated instruments adapted for the pregnant population [10,17–19,24,35–37].

Some authors have developed entirely novel instruments, such as the CAPSOM questionnaire for the Mexican population (Ramírez-Trujillo), which demonstrated good content validity but lacked reporting of advanced psychometric indicators. Similarly, Gupta et al. developed an instrument for the Indian population, but without conducting a complete factor analysis and without test–retest assessment, thereby reducing the overall reliability of their instrument [24,25].

Compared to the aforementioned studies, the newly developed Croatian questionnaire is methodologically more comprehensive and fully meets contemporary psychometric standards. Adapting existing instruments is often beneficial for international comparisons, while the construction of new instruments allows for the more precise measurement of locally specific phenomena [38–41]. Therefore, the development and validation of this locally adapted instrument represent both a scientific and public health necessity.

4.5. Strengths of the Study

A comprehensive review of the current international literature revealed that no questionnaire has been validated in accordance with COSMIN guidelines. The greatest strength of this study is its originality and strict adherence to methodological standards. This is the first instrument in Croatia developed and validated strictly according to COSMIN guidelines for assessing oral health in pregnant women.

4.6. Implications for Clinical Practice and Public Health

By validating this questionnaire, a standardized tool has been created that can be applied in future research as well as in clinical practice. In gynecological and dental offices, it can serve as a quick screening tool to identify pregnant women with insufficient knowledge or risky habits who require additional education. At the public health level, the instrument can contribute to the development of new strategies for caries prevention and the promotion of oral health in pregnant women.

In the PGC, a lack of education on oral health within prenatal courses has so far been confirmed, so the results of this study can serve as an argument for introducing a mandatory oral health module in prenatal programs, in accordance with UNICEF recommendations [11,12].

4.7. Limitations of the Study and Directions for Future Research

The study has certain limitations. While this study is subject to certain methodological considerations, primarily concerning the recruitment of participants from a single county, this focused approach facilitated a nuanced analysis of the demographic, socioeconomic, and health characteristics unique to the observed population. Although such localized factors necessitate a cautious approach regarding international comparisons, our findings provide a robust and precise model that warrants further testing and validation across broader or culturally diverse contexts.

Data were collected via self-report, which carries the risk of socially desirable responses. Although a test–retest analysis was performed, the basic design is cross-sectional, so it is not possible to fully assess the responsiveness of the instrument, i.e., its sensitivity to changes over time.

Future research will include CFA, while responsiveness and measurement error will be evaluated using longitudinal data. Furthermore, future research should include a longitudinal approach, tracking changes in knowledge, attitudes, and habits from the beginning of pregnancy

through the postpartum period, as well as comparing the dental status of pregnant women with their knowledge, education, and habits. Additionally, the instrument could be used in randomized controlled trials to evaluate different educational interventions.

5. Conclusions

The newly developed questionnaire demonstrates high levels of reliability and validity, representing the first psychometric instrument in the Republic of Croatia to fully comply with contemporary methodological standards for assessing the knowledge, attitudes, and habits of pregnant women regarding oral health. The validation of this instrument addresses a critical gap in both domestic clinical and scientific practice, thereby enabling the systematic collection of data, the development of precisely targeted interventions, and a stringent assessment of their effectiveness.

While the international scientific community has established comparable measuring instruments that ensure a high degree of standardization, these tools have historically not been developed or validated in strict accordance with the COSMIN guidelines. This limitation inherently affects the interpretability and stringency of their reported psychometric properties. In contrast, the current questionnaire, validated with stringent adherence to COSMIN criteria, offers a psychometrically sound and reliable alternative. A key finding of this study, the independence of the knowledge dimension from attitudinal factors, suggests that future public health strategies must move beyond the mere dissemination of information. Instead, they should actively address tangible barriers such as physical discomfort, lack of social support, and motivation.

The integration of this standardized tool into routine gynecological and dental prenatal care will facilitate the systematic identification of at-risk populations and the design of targeted educational programs. Furthermore, due to its rigorous methodological foundation, exceptional reliability, and proven sensitivity, this instrument is highly suitable for international comparative research. Ultimately, the KAOH Questionnaire provides a solid foundation for evidence-based policies aimed at achieving long-term improvements in oral and general health outcomes for both mothers and children in Croatia.

Supplementary Materials: The following materials are supplemented: Questionnaire on knowledge, attitudes, and oral hygiene habits of pregnant women. Informed consent. Notice participation and informed consent.

Author Contributions: Conceptualization, H.G.K., M.M. and N.S.S.; Methodology, H.G.K., M.M. and D.B.; Software, M.M.; Validation, M.M.; Formal Analysis, M.M.; Investigation, H.G.K., S.K. (Sandro Kresina), I.D., S.K. (Sara Kresina) and E.D.H.; Resources, H.G.K., M.M. and N.S.S.; Data Curation H.G.K., M.M.; Writing – Original Draft Preparation, H.G.K., Writing – Review & Editing, H.G.K., I.D., M.M., and N.S.S.; Visualization, M.M.; Supervision, N.S.S. and M.M.; Project Administration, M.M. and N.S.S. All authors have read and agreed to the published version of the manuscript.

Funding: This study was performed without any specific funding award.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of the Medical Faculty of the University of Rijeka (Class:007-08/24-01/14) the Ethics Committee of the Clinical Hospital Center Rijeka (Class: 003-05/24-1/06), and the Ethics Committee of the Primorje-Gorski Kotar County Health Center (Class:01-86/1-2-24).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Data: Availability Statement: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CFA	Confirmatory Factor Analysis
COSMIN	Consensus-based <i>Standards</i> for the selection of health Measurement Instruments
EFA	Exploratory Factor Analysis
IQR	Interquartile Range
KAOH	Questionnaire on knowledge, attitudes, and oral hygiene habits of pregnant women
NCDs	Non-communicable Diseases
PGC	Primorje-Gorski Kotar County
TPB	Theory of Planned Behavior

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