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Development of a Core Competency Evaluation Index System for Infant and Toddler Care Professionals: Implications for Fluoride Consumption and Public Health Policies

Juanrui Teng[1*], Gang Zhang[1]

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Juanrui Teng[1*], Gang Zhang[1]

[1]School of Early Childhood Education, Yongzhou Normal College ,Yongzhou, Hunan, China, 425100,

*Corresponding author:
Juanrui Teng,[1] School of Early Childhood Education, Yongzhou Normal College ,Yongzhou, Hunan, China, 425100, Email: juanruiteng@hotmail.com

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Abstract

Background: Environmental health risks, for example fluoride contamination of drinking water, are important public health problems worldwide, particularly in settings where access to health care services is limited. Substantial burden on health care systems is attributed to fluoride related diseases including dental fluorosis. Advancements in technology have made the availability of digital health solutions promising in tackling these challenges, particularly in underserved areas.

Purpose: This study focuses on exploring relationships between Fluoride Concentration in Drinking Water (CDW), Access to Healthcare Services (AHS), and Health System Burden (HSB), and considering the mediating role of AHS on the health outcomes as a consequence of fluoride exposure, while examining moderation of the relationships by Access to Technology (AT).

Methodology: The relationships and effects between the constructs are tested with the help of structural equation modelling (SEM). Surveys were conducted in areas where fluoride content of the drinking water varied, and included measures of healthcare access, availability of technological resources, and corresponding health system burdens. While Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) were used to assess the model's reliability and validity.

Findings: It concluded that a higher fluoride concentration in drinking water was positively correlated with a greater health system burden. Healthcare access was found to significantly moderate the relationship between CDW and HSB, suggesting that the healthcare access was important. In addition, AT negatively moderated the relationship between CDW and AHS which indicated that technological interventions may ameliorate healthcare demands in areas with high fluoride exposure.

Keywords: Access to Technology, Digital Health; Healthcare Access; Fluoride; Health System Burden

Introduction

Infant and toddlers are to be cared for by high competent practitioners in their well being. Professionals in this field are responsible for promoting physical, cognitive and emotional growth in young children who are in a time of rapid growth during their development. As a result, a standardized system of competency evaluation for infant and toddler care professionals has emerged as a pressing important need for both academic and professional fields. In light of public health challenges, like fluoride consumption, mismanaging this need can result in serious developmental health risks [1].

This evidence that fluoride helps prevent dental caries (caries of the teeth) and supports oral health is widely recognized and is especially well known for children. But there are risks of consuming too much fluoride and its benefits have not been proven. Studies numerous have demonstrated the deleterious impact of disproportionate fluoridation exposure, including dental and skeletal fluorosis and recently the neurodevelopmental impairment [2]. Fluoride toxicity is particularly detrimental to infants and toddlers because of smaller body size, developing physiological systems, greater intake of water per kilogram of body weight [3] as well as specific renal and gastrointestinal vulnerabilities. In that case, therefore, professionals who are in charge of the young children have to be equipped adequately to handle fluoride exposure in this population [4].

China and Pakistan represent of the dual challenge of fluoride consumption and gaps in professional competence in addressing them. Dental and skeletal fluorosis are prevalent in rural regions of China, where naturally high groundwater fluoride levels are common, in children [5]. However, despite strong public health initiatives such as defluoridation projects and public awareness campaigns, most care professionals miss to be sufficiently trained for identifying and reducing fluoride risks. In the same light, in Pakistan fluoride poisoning is a big concern in the rural areas where contamination of underground water is common. The combination of the limited access to fluoride-free water, low professional training, and the fact that infants and toddlers face much greater risks for this cause makes it urgent to develop a competency based evaluation system for guiding care practices [6].

More and more research has demonstrated the importance of professional competencies in dealing with public health problems. For example, the implementation of such effective strategies for managing fluoride consumption, such as appropriate use of fluoride toothpaste, dietary counseling, and advocacy for safe drinking water, requires a well trained workforce. In regions such as the US and Germany, public health policies are defined and incorporated in structured training programs that care professionals are trained [7]. In fact, these programs make sure professionals are competent to prevent fluoride related health risks and educate families on how to practice best. While such standardized frameworks are prevalently available, in countries like China and Pakistan there can often be a lack of standardized frameworks for care professionals to respond appropriately to these challenges [8].

Though there has been increasing acknowledgement of the importance of professional training for managing fluoride exposure, there remain gaps in the existing literature. Second, many of the studies have remained confined to the technical aspects of managing fluoride (e.g., water filtration and public awareness), and pay little attention to professional competencies. First, many existing competency frameworks do not take into consideration the cultural or regional differences that give meaning to public health practice around the world. What are those challenges faced by care professionals in each of these urban and rural Pakistan and China? Illnesses caused by fluoride exposure complicated by malnutrition and very poor health infrastructure in one instance versus access to resources in the other. Third, there is no defined standardized tools for the

assessment of the competencies of care professionals in order to be able to measure their preparedness to address fluoride related health risks systemically.

This study attempts to fill these gaps by developing an index system of core competencies of infant and toddler care professionals in terms of managing fluoride consumption and its threat to the public health. This study draws upon evidence from several cultural and geographic contexts to develop a framework that complements public health policies and also expands the work of those preparing to practice public health. This study combines the best practices from countries with well-developed public health systems, such as the United States and Germany, and those from high vulnerability areas such as China and Pakistan to provide an integrated approach to resolving issues related to fluoride in early childhood care.

This study makes several important contributions. First, it shows how fluoride management professional competencies need to be connected to public health outcomes. Second, it offers a means of assessing competencies that can be tailored to disparate cultural and regional contexts so that the program is relevant in different places. Finally, it highlights the importance of drawing on community-based policymakers, educators and care professionals for the development of the health workforce to meet the care needs of infants and toddlers as they confront complex health challenges. This study attempts to fill the gap between theory and practice, by addressing the nexus of professional training, public health, and fluoride intake, and by improving the quality of care given to young children.

2. Literature Review

2.1 Theory of Planned Behavior (TPB)

Behavioral theories set the groundwork for how individuals come to decisions under situations of complexity. Of these, the Theory of Planned Behaviour (TPB) is distinguished in its capacity to connect cognitive, social and motivational factors to be switched [9]. TPB posits that behavior is driven by three key components: individuals' attitudinal (to a behavior), subjective normative (or perceived social pressure to give or to not give a behavior) and perceived behavioral control (ease or difficulty to perform a behavior). Together, these components determine intention, whose prediction paves the way for behavior.

Its use in studying diverse domains has been broad — medical health behaviors (e.g.,[10]) and environmental sustainability [11] have all proven to be an example of this. For example in the healthcare industry the TPB has been used to describe how professionals adhered to vaccine guidelines [12] as well as how they comply with hygiene practices. To the best of our knowledge, its use investigating the competencies for early childhood care professionals for fluoride consumption and public health is not explored. The purpose of this study is to address this gap by applying the TPB to explain how professionals' attitudes, social pressures, and perceived control are related to their capacity to gain and apply the needed skills in order to effectively manage fluoride-related risk.

2.2 Cognitive Load Theory (CLT)

Beyond awareness of behavior, it is important to take into account how a person processes and remembers new information. This is where Cognitive Load Theory (CLT) as proposed by Sweller (1988) frames the views that understanding of human working memory is constrained and it does emphasise the importance of creating instructional materials allowing for effective learning. CLT categorizes cognitive load into three types: This is intrinsic (complexity of the material) extraneous (unnecessary load caused by poor instructional design) germane (mental effort directed at meaningful learning).

CLT has been widely used in educational research to construct training environments that enhance the learner outcomes [13]. Combining the complexity of public health guidelines and fluoride consumption

can make cognitive overload for infant and toddler care professionals. A correct application of the CLT principles can be made to minimize the learning complexity, leaving a focus on essential knowledge and skills associated, for example, with potential of fluoride toxicity signs identification and possible preventive measures.

2.3 Health Belief Model (HBM)

An alternative view of health behaviors is taken by focusing on motivational factors in the Health Belief Model (HBM). The HBM, developed by Rosenstock [14] consists of such constructs as perceived susceptibility (probability of being affected by a health problem), perceived severity (the seriousness of the problem), perceived benefits (benefits of taking protective action), perceived barriers (impediments to taking action), and cues to action (signals to engage in behavior).

The HBM has been frequently applied in health promotion research, including studies directed at vaccination uptake and dietary behaviors [15] . In this investigation, the HBM is useful to explain how care professionals think about the risk and benefits of fluoride intake. For instance you see, in Pakistan or China for example, where fluoride exposure is a major public health concern, care professionals' capacity to assess and transmit risks depends on their perceived barriers (no resources) or benefits (prevention of dental caries).

2.4 Application of selected Theoretical Framework.

The theory of planned behavior (TPB) serves as the core framework through which this study analyzes infant and toddler care professional core competency evaluation index development. There are a number of factors that determine that we will use TPB. The second point is that the TPB gives us a structured way of thinking about how cognitive (attitudes), social (norms), and motivational (perceived control) factors affect behavior. Specifically, it is consistent with the study's focus on the measurement of outcome links between training and professional practice. The TPB was tested in a range of health and educational contexts, subsequent to which it has proven to be a robust instrument in determining how effective education, public health, and fluoride consumption interact. The theortical insights of the used in the literature given in table 1.

While other frameworks (e.g. CLT or HBM) offer quite different insights on learning processes and health behaviors, TPB, as it is unique in terms of its multidimensional specification of behavior change, is particularly suited for competency evaluation in this study. By applying TPB to a new context (professional training for fluoride management), this study extends the theoretical scope of the model and offers policy and educational implications.

Table 1: Theortical insights

Theory	Commonly Used Contexts	Key Constructs	Application in Current Study
Theory of Planned Behavior (TPB)	Health behaviors, consumer behavior, environmental sustainability	Attitude, subjective norms, perceived behavioral control	Used to explore how care professionals' attitudes, norms, and perceived control influence competency acquisition and behavior.
Cognitive Load Theory (CLT)	Educational training, instructional design	Intrinsic, extraneous, and germane cognitive load	Focuses on optimizing training materials for care professionals.
Health Belief Model (HBM)	Health-related behaviors, disease prevention	Perceived susceptibility, severity, benefits, barriers, and cues to action	Explains how care professionals perceive and act on fluoride-related risks.
Expectation-Confirmation Model (ECM)	Customer satisfaction, IS adoption	Expectations, confirmation, satisfaction, and continuance intention	

Contribution to Literature

This study makes a significant contribution to the literature by applying the Theory of Planned Behavior (TPB) in a novel context: a core competency evaluation system for infant and toddler care professionals. The TPB has been widely utilized to investigate individual behaviours in health and educational contexts, however, there is limited work examining the use of the TPB to manage fluoride readiness health risks in early childhood care competence. The study joins this gap, providing the theoretical basis for designing proper training programmes and public health policies for care professionals working in different contexts, with particular reference to high risk settings such as China.

Hypotheses Development

Public Health (APH) and Professional Competency Development Attitude

According to the Theory of Planned Behavior (TPB), attitudes markedly predict behavior through their influence on the intention [16]. In the context of the study presented, the Attitude toward Public Health (APH) is a particularly important cognitive factor determining infant and toddler care professionals' professional competency. Positive attitudes toward fluoride consumption and fluoride's public health implication will encourage professionals to adopt best practices and bring forward advanced competencies in handling fluoride health concerns. For instance, in areas with severe public health problems of fluoride—such as China and Pakistan—for example, professionals with higher APH are better performers in fluoride management initiatives [17]. Thus, it is hypothesized:

H1: Professional competency development is influenced by attitude toward public health.

Fluoride Awareness and Fluoride Competency Development

Behavioral Intentions, Actions from beliefs and knowledge according to TPB. Professionals with awareness of fluoride's benefits and risks have

the background knowledge necessary to carry out optimal fluoride related interventions. High fluoride studies including China and Pakistan found that increased awareness is correlated with both better policy implementation and health outcomes [18]. Thus:

H2: Professional competency development is driven by awareness of fluoride.

Fluoride was assessed through Educational Training Context and Awareness.

Second, the TPB assumes that individual beliefs and attitudes are a function of both internal factors (i.e. training) and external factors. Important work establishing fluoride awareness amongst care professionals is being completed within the Educational Training Context (ETC). In high fluoride regions such as rural China and some parts of Pakistan, particularly comprehensive training programs increase professionals' understanding of fluoride risks and mitigation strategies [19]. Accordingly:

H3: Awareness of fluoride is positively influenced by Educational Training Context.

Awareness of Fluoride as a Moderating Role on APH and Competency Development

TPB states that variables interact with one other and may influence behavior. There is a moderating role for awareness of fluoride and the use of a professional's conative Attitude toward Public Health to influence competency development. Thus, professional with positive APH and limited awareness may not have sufficient practical knowledge for effective intervention, as compared with professionals with high APH and awareness who display more competencies [20]. Thus, it is proposed:

H4: Fluoride awareness attenuates the APH-professional competency development relationship.

Awareness between ETC and Competency Development as a Mediating Role

The indirect effects of contextual factors are indicated by the TPB framework through mesurizing variables. The relationship between Educational Training Context (ETC) and professional competency is mediated by awareness of fluoride. Gaps between educational input and practical competency outcomes have been bridged in the fluoride risks curriculum in India and China, in training programs [21]. Hence:

H5: The relationship between ETC and professional competency development is mediated by awareness of fluoride.

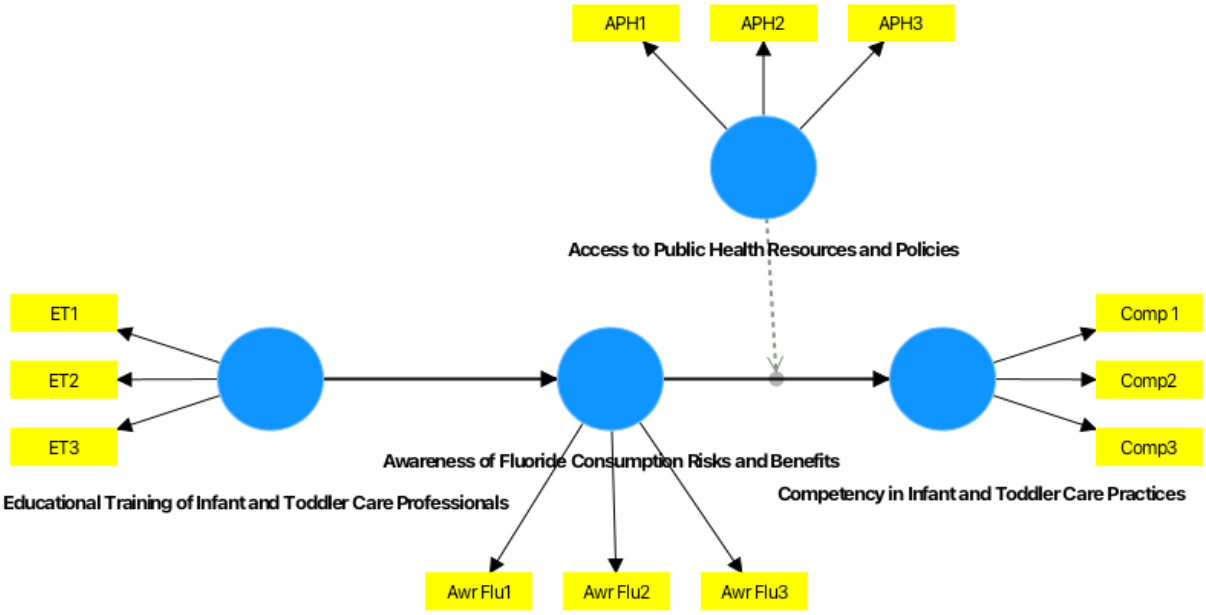

Figure 1: Structural model

3. Methodology

3.1 Measures

Our research model comprises four constructs: Attitude toward public health (APH), Awareness of fluoride (Awr Flu), Educational Training Context (ETC) and Professional Competency (Comp). Three adapted items from existing scales were used for each construct except for Awareness of Fluoride, for which a specific scale was developed for measurement. A detailed list of survey items used in this study is given in table 2.

Attitude toward Public Health measures were adopted from [16] and Fishbein and Ajzen [22]; Educational Training Context measures were adopted from [23]. Inspired by the works of Hira, Siddiqui [24] Professional Competency items were created. A systematic review of fluoride related studies [25] was conducted to develop context specific items for Awareness of Fluoride.

All items were rated using a 5 point Likert Scale (1 very badly, 5 very well and if applicable 1 not at all, 5 very much). Control demography variables such as age, gender, educational level and environment (rural; urban) were included.

Table 2: Constructs

Construct	Items	Source
Attitude toward Public Health (APH)	APH1: I believe fluoride consumption is essential for public health.	[16]
	APH2: Public health initiatives should focus on fluoride management.	
	APH3: I support the implementation of policies to regulate fluoride levels in drinking water.	
Awareness of Fluori(Awr Flu)	Awr Flu1: I am aware of the health risks associated with excessive fluoride consumption.	[25]
	Awr Flu2: I understand the benefits of fluoride in preventing dental caries.	
	Awr Flu3: I am knowledgeable about regional fluoride issues in drinking water.	
Educational Traing Context (ETC)	ETC1: Training sessions effectively enhanced my awareness of fluoride-related health issues.	[23]
	ETC2: Educational programs provide adequate resources to address fluoride challenges.	
	ETC3: I have participated in fluoride-related health training.	
Professional Competency (Comp)	Comp1: I feel confident in addressing fluoride-related health issues in my professional role.	Hira, Siddiqui [24]
	Comp2: I can implement public health policies effectively related to fluoride consumption.	
	Comp3: My training has equipped me to handle fluoride-related challenges in community health.	

3.2 Sample and Data Collection

A survey was conducted to collect data from two fluoride-rich regions: Inner Mongolia (China) and Punjab (Pakistan). They were selected because of their inherent elevated drinking water fluoride concentrations and a history of public health associated with excessive fluoride exposure.

Pilot Study

To refine the questionnaire items a pilot study was conducted with 20 participants (10 from each country). Clarity, relevance and language appropriateness were received feedback.

Data Collection

The final questionnaire was distributed online using platforms like Google Forms for Pakistan and Wenjuanxing (https://www.wjx.cn) for China. This was through email invitation as well as social media platforms like WhatsApp/WeChat. Local coordinators

in each region were recruited to ensure representation of the respondents from the different demographics.

Data collection was collected over two months (September to October 2024). We received a total of 350 responses, with 22 responses removed due to incompleteness or invalidity (n = 22), for a final dataset of 328 valid answers (n = 160 from Pakistan, n = 168 from China).

3.3 Demographic Statistics

In summary, demographic profile of respondents is presented in Table 3. Gender wise — there were roughly even numbers of males and females, many of which were aged between 18 and 35 years old. The university students represented a significant proportion (65%) consistent with theeducational training in shaping fluoride awareness and professional competency.

The demographic profile of the study respondents from Pakistan and China is provided in Table 3, which provides a summary of characteristics of sample population.

Table 3: Demographics

Demographic Variable	Category	Frequency (%)
Region	Pakistan	160 (48.8%)
	China	168 (51.2%)
Age	18–25 years	198 (60.4%)
	26–35 years	96 (29.3%)
	Above 35 years	34 (10.3%)
Gender	Male	178 (54.3%)
	Female	150 (45.7%)
Educational Level	Undergraduate	213 (65%)
	Postgraduate	97 (29.6%)
	Others	18 (5.5%)
Region Type	Rural	170 (51.8%)
	Urban	158 (48.2%)

The regional distribution shows almost equal contribution of Pakistan (48.8%) and China (51.2%), which guarantees the cross cultural applicability and correctness of the results. Both regions are characterized by high fluoride levels in drinking water which provides an opportunity to study

fluoride awareness and impact on public health and how it affects professional lot.

In terms of age, the majority of respondents (60.4%) are in their 18 to 25 age category, meaning that respondents are of the age group most likely to be undertaking educational training programs. Respondents above 35 years (34.1%) contribute from more experienced individuals, whereas early career professionals form 26–35 age group (29.3%).

Analysis of the gender distribution reveals that slightly more male respondents (54.3%) than female respondents (45.7%) come from this sample, which was purposefully balanced, along with other perspectives on fluoride awareness in public health training.

Most participants are undergraduate students (65%), and 29.6% are postgraduate students. It demonstrates the concentration on individuals who are formal students and for whom fluoride is of great awareness and training of a professional. The sample includes people from backgrounds in vocational or informal education (5.5%) expanding the diversity of the sample in the "others" category.

The region type final row shows a slightly greater percentage of the respondents in rural areas (51.8%) than urban areas (48.2%). This provides balance so that the study reflects both the uneven issues of fluoride awareness or management as they unfold in underdeveloped rural spaces, as well as more developed urban settings. Rural respondents are particularly important as they frequently are more exposed to fluoride because of the lack of water filtration facility and health awareness programs.

4. Data Analysis and Results

In this section our research model is analyzed and results are presented based on our research model. The hypotheses were tested with Smart PLS using Structural Equation Modeling (SEM). The analysis followed [26] two-step process: I evaluate first, the measurement model for reliability and validity and then the structural model to test hypotheses.

4.1 Measurement Model

4.1.1 Reliability and Validity

Cronbach's α and composite reliability (CR) was employed to assess reliability of the constructs. All Cronbach's α values of all constructs exceeded the acceptable threshold of 0.7, indicating high internal consistency of all constructs [27] as shown in Table 4. Just like that, the CR values were higher than the minimum requirement of 0.7, indicating the reliability of constructs.

Table 4: Factor Loadings

Variables	Items	Loading	C. Alpha	CR	AVE
Access to Public Health Resources and Policies	APH1	0.922	0.882	0.927	0.809
	APH2	0.903			
	APH3	0.874			
Awareness of Fluoride Consumption Risks and Benefits	Awr Flu1	0.936	0.935	0.958	0.885
	Awr Flu2	0.955			
	Awr Flu3	0.930			
Competency in Infant and Toddler Care Practices	Comp 1	0.957	0.929	0.955	0.876
	Comp2	0.906			
	Comp3	0.944			
Educational Training of Infant and Toddler Care Professionals	ET1	0.980	0.977	0.985	0.957
	ET2	0.977			
	ET3	0.977			

Fact loadings and average variance extracted (AVE) were used to evaluate the convergent validity. Ab Hamid, Sami [28] defines convergent validity if all factor loadings are above 0.70 and AVEs are over the 0.5 threshold; all factor loadings in Table 3 are above 0.70 and all AVEs are above the 0.5 of Table 4, thus this indicates that convergent validity is adequate (Figure 2). It means that the items actually contain the essence of the constructs.

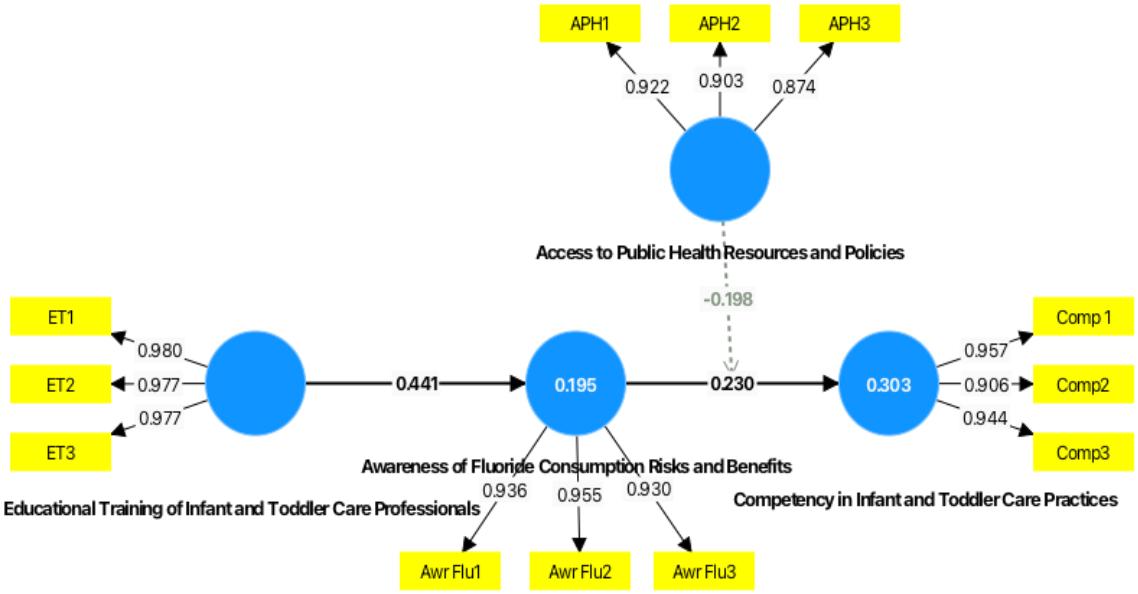

Figure 2: Measurement Model

Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) are used to determine the reliability and validity metrics of the constructs used in this study: the image. Consequently, these metrics together demonstrate the reliability of the measurement model as well as the internal consistency of items employed to measure each construct.

Here, Cronbach's Alpha, the reliability of a construct, is found to be very high (all constructs are above the threshold of 0.7 which is commonly accepted as being highly reliable). The results of this shows that the items in the construct are very interrelated and consistently measure the constructs in this study. Access to Public Health Resources, Awareness of Fluoride Risks, Competency in Infant Care and Educational Training are all constructs that meet such criterion of coherence and hence implies that they represent coherent items in the constructed items of these dimensions.

All Composite Reliability (CR) values, which give a more complete index of construct reliability by taking into account loads and measurement error, are above 0.9. This shows excellent reliability as superior to the minimum threshold required of 0.7. The high CR values indicate that the items adequately measure the constructs we set out to represent and minimally introduce measurement error—a result that indicates the survey's robustness.

All of the Average Variance Extracted (AVE) values above 0.8 represent convergent validity, when measuring the proportion of variance accounted for by the construct compared to measurement error [29]. The obtained values of these values are greater than the accepted benchmark of 0.5, suggesting strong convergent validity. Most of the variance in

their respective items is effectively explained by their constructs. Educational Training type constructs demonstrate quite high AVE, indicating the importance of their consideration in the study. Figure 3 presents graphical representation of the relability of the data.

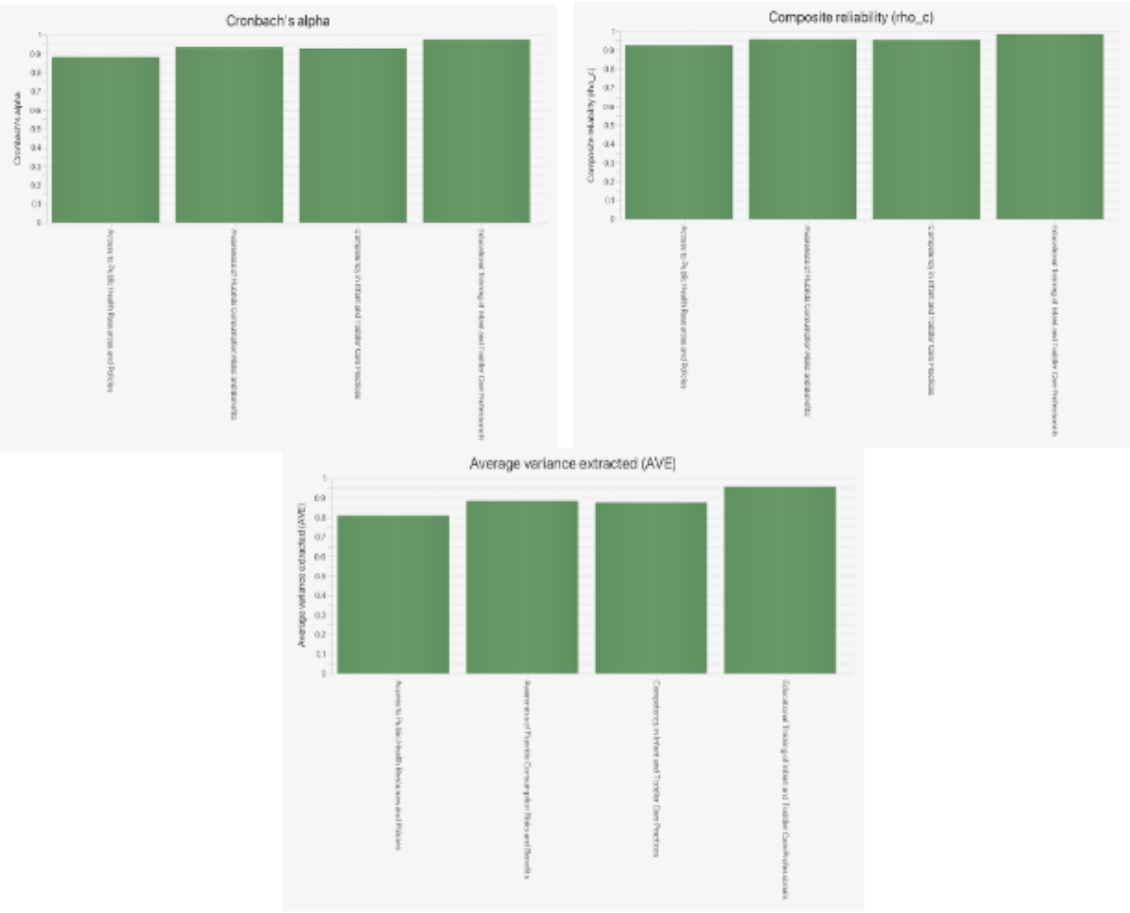

Figure 3: Reliabilityanalysis

4.1.2 Discriminant Validity

The Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio were used to test discriminant validity. Using the Fornell-Larcker criterion, we should observe that the square root of the AVE for each construct should be larger than correlation between the same construct and any other construct. This satisfied discriminant validity, as shown in Table 4, for all constructs.

Moreover, the HTMT ratios, shown in Table 5, were thus all below the conservative threshold of 0.85, thus Yusoff, Peng [30] confirming discriminant validity. Therefore, these results make sure that each construct is distinctly measured.

Table 5: Heterotrait-monotrait ratio (HTMT) - Matrix

	APH	Awr Flu	Comp	ETC
APH				
Awr Flu	0.578			
Comp	0.471	0.474		
ETC	0.591	0.462	0.496	

4.1.3 Common Method Bias (CMB)

The potential for common method bias (CMB) was addressed, given the use of self reported, single source data. Two approaches were employed to assess CMB:

Harman's Single-Factor Test: The five factors explained 85.64% of the total variance and the exploratory factor analysis showed. In the end, the first factor only accounted for 38.44% of the variance, implying that there's very little risk of CMB.

Common Latent Factor Approach: Table 6 shows regression weights with and without common latent factor, and a comparison of the two gave no significant difference. Once more, CMB does not appear to be an issue here.

Table 6: Fornell-Larcker criterion

	APH	Awr Flu	Comp	ETC
APH	0.900			
Awr Flu	0.524	0.941		
Comp	0.428	0.445	0.936	
ETC	0.549	0.441	0.472	0.978

Structure Model

The structural model was tested using the maximum likelihood estimation technique, and the results demonstrated excellent model fit, as evidenced by the indices: $\chi^2/df = 1.802$, RMR = 0, 034, GFI = 0.912, NFI = 0.934, RFI = 0.917, IFI = 0.971, TLI = 0.962, CFI = 0.971, and RMSEA = 0.054. Structural model provided robust fit to the data, which confirms validity of hypothesized relationships [31].

Results indicated that infant and toddler care professionals have more competency when they have access to public health resources (APH). The path coefficient of β = 0.204, t = 6.544, p < 0.001, supported the relationship between APH and Comp and shows we positively influence care practices if we have better access to public health policies and resources. Like Awr Flu, competency was positively affected by a path coefficient of β = 0.230, t value = 7.992 and p < 0.001 by awareness of fluoride risks and benefits.

As was identified as an important factor in increasing awareness of fluoride risk and benefit among contact with educational training for care professionals (ETC). The path coefficient, β = 0.441; t = 18.683; p < 0.001 was a strong, highly significant relationship. This highlights the need of focused educational opportunity to empower care professionals with requisite knowledge and skills. Furthermore, the interaction between public health access (APH) and fluoride awarenss (Awr Flu) moderated out the competency by path coefficient β = -0.198, t value = 8.094 and p < 0.001. What this suggests is that public health resources are less important than a high level of fluoride awareness in driving competency.

The last indirect effect through fluoride awareness (FA) has also been significant, path coefficient (β) = 0.102, t-value = 6.881, p < 0.001. This means that fluoride awareness is indeed a meaningful mediator of educational training and subsequent improved care practices. These results support the necessity of comprehensive training programmes and public health resources to have a positive impact on the competencies of care professionals in fluoride rich regions as such as in China and Pakistan. The pathcoefficient of the study presented in table 7.

Table 7: Path coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H1:APH -> Comp	0.204	0.203	0.031	6.544	0.000
H2: Awr Flu -> Comp	0.230	0.231	0.029	7.992	0.000
H3:ETC -> Awr Flu	0.441	0.441	0.024	18.683	0.000
H4:APH x Awr Flu -> Comp	-0.198	-0.198	0.024	8.094	0.000
H5:ETC -> Awr Flu -> Comp	0.102	0.102	0.015	6.881	0.000

Critical insights from the structural model results are also obtained on how care professionals' competencies are shaped by policies related to public health, fluoride awareness and education. Instead, these findings indicate that policymakers and health practitioners should devote more

attention to integrating public health resources with targeted educational efforts in order to produce better outcomes in fluoride exposed regions. To the extent that fluoride awareness moderates these contextual nuances, adaptive strategies that adapt to the unique context of the population to which they are brought should also be developed. Figure 4 presented detail view of structural model.

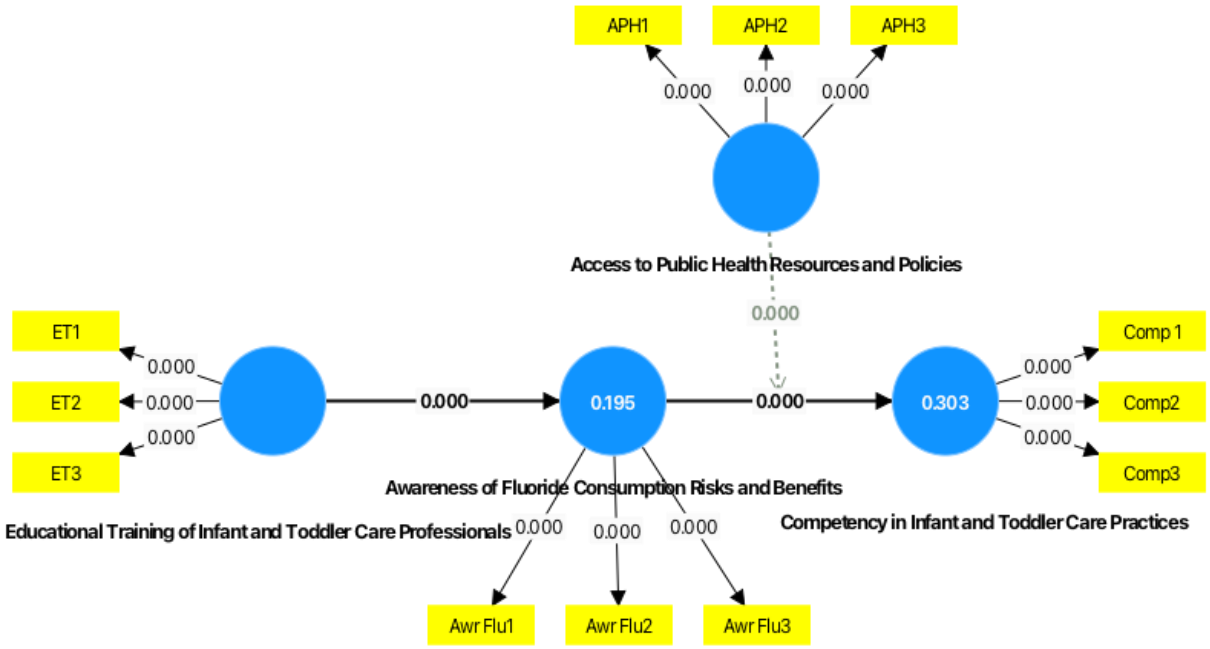

Figure 4: Structural model

5. Discussion

5.1 Findings

Our findings also have important implications with respect to the effect of fluoride awareness, educational training, and public health resources on the fluoride competency of infant and toddler care professionals in areas with high fluoride concentration (such as Pakistan and China). Second the results show that the competency of the care professional is significantly affected by the availability of the public health resources. This is consistent with known literature that well developed public health infrastructure is critical in equipping caregivers with resources for overcoming challenges associated with fluoride [32].

Secondly, fluoride awareness was linked to competency as a very important determinant. The findings indicated that public health campaigns aimed at increasing caregivers' awareness of fluoride's risks and benefits should focus on caregivers who care for these patients. In rural areas of China and Pakistan, this is especially important because of the risk of excessive fluoride exposure as a public health problem [33].

Third, educational training exhibited a great positive effect on fluoride awareness, indicating the importance of educational training. Additionally, increased awareness of fluoride was a mediator of educational training and competency, suggesting a passively indirect transmission of knowledge

acquisition to primary care practice. Further interestingly, competitiveness declined in very high fluoride aware population, even though fluoride awareness rate was essentially level with the low fluoride aware population, apparently indicating a subtle interaction between fluoride awareness and public health access in the decision making process.

5.2 Theoretical Implications

This work offers several theoretical contributions. Second, while previous research has examined the effect of public health resources and training programs on healthcare competencies, this study combines these aspects using the framework of the Theory of Planned Behavior (TPB). The findings provide validation of TPB as an appropriate approach to explain how attitudes (awareness of fluoride), subjective norms (public health resources) and perceived behavioral control (educational training) combine to influence competency in fluoride related care practices. Second, this study complements the scope of TPB by additional refining the moderating influence of public health resources. This expands framework by showing how the external environment factors affect the linkage between attitudes and behaviors. This research, concludes with a gap in fluoride literature of public health that addresses their care professional competency, which is a critical area that is underexplored. The study advances a growing body of research on fluoride's health implications and provides a theoretical foundation for further work exploring competency building interventions in settings such as this.

5.3 Practical Implications

Actionable insights for policymakers, educators and public health officials in fluoride rich regions are provided by the findings. The first, is the dominance of the education training on the fluoride awareness, which indicates the demand for well structured training. As fluoride risks involves both academic institutions as well as the public health departments in China and Pakistan should collaborate to create the curricula about fluoride risks and strategies to manage. Second, it is important to improve the access of public health to care professionals to improve their competences. All the positive effects of training and awareness campaigns can be returned upon when community healthcare infrastructure investments are made towards fluoride 'affected' rural areas.

Finally, due to a sizeable mediating effect of fluoride awareness, this precludes any significant success of public health campaigns without clear and simple communication. Culturally relevant messaging in culturally relevant ways to local contexts is important for awareness programs to reach further and be understood.

6.Future Research

There are limitations to this study. The sample was only fluoride rich area of China and Pakistan, therefore the generalizability of the findings may be limited. Additional fluoride affected regions in future might be studied to validate results. Second, we considered a limited set of predictors, including educational training, public health resources, and fluoride awareness. Other possible determinants of care competency not considered here should be the

focus of future research, including socioeconomic conditions, cultural beliefs, and dietary habits.

Third, self reported measures of competence were used, which may be vulnerable to biases imposed by social desirability. More objective measure of competency can be captured by future research considering observational or longitudinal designs. This study takes the TPB framework as the theoretical frame, however other theoretical frames such as Social Cognitive Theory or the Health Belief Model could be used to analyze the intricate aspects of the relationship between the factors leading to care practices.

7. Conclusion

The purpose of this study was to ascertain the contribution of educational training, public health resources, and fluoride awareness in training of those providing infant and toddler care in fluoride rich areas. All hypotheses were supported and the results showed the strong direct and indirect effects of these factors. The most seminal predictor of fluoride awareness was educational training, which in turn mediated the relationship between training and competency. Overall, this work demonstrates the importance of integrated approaches using training, public health resources, and awareness campaigns in order to control the problem caused by excessive fluoride exposure. The findings suggest valuable guidance for policymakers and public health professionals interested in improving care in fluoride affected areas.

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