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Balancing Public Health and Governance: Exploring the Role of Social Governance and Health Policies in Shaping Community Well-being through Fluoride Consumption

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Abstract

Purpose: The study investigates the role of governance, particularly social governance (SG) and health policies (HP), in shaping the adoption and enforcement of fluoride-based dental products (ADD) and water fluoridation programs. Using Collaborative Governance Theory and the Health Policy Triangle Framework, the study explores how key stakeholders such as government bodies, healthcare professionals, and the public influence fluoride-related policies.

Methods: Survey data from high-fluoride regions in China and Pakistan were analyzed using structural equation modeling (SEM) to evaluate hypotheses.

Results: Results indicate that health policies, social governance, and stakeholder engagement significantly influence the adoption of fluoride-based products, improving community well-being (CWB) and promoting policy adoption and enforcement (PADD). Environmental governance (EG) moderates the relationship between fluoride product adoption and both CWB and PADD.

Conclusion: The findings offer insights into developing effective and equitable public health interventions for fluoride management.

Key-words: Fluoride Consumption, Health Policies, Social Governance, Environmental Governance, Community Well-being

1. INTRODUCTION

It is a well-accepted fact that fluoride has cariostatic properties. The strategies for the prevention of dental carries target population based interventions to guarantee constant and optimum fluoride exposure, which stabilize fluoride levels in the mouth at optimum levels and at negligible costs [1]. Fluoride's main demonstrated advantage to human health is in the fight against dental caries, an infection that attacks the enamel of the teeth. Fluoride gained a great deal of attention after the beginning of twentieth century especially concerning to its ability to combat caries when it exists in water [2]. Nonetheless, the application of public health policies concerning fluoride is different and depends on the state and foreign, national and international, institutional, knowledge and evidence embodied both domestically and internationally [3] WHO and other global health organizations endorse the use of fluorides as a potent anticaries agent despite the fact that dental caries remains a topical worldwide oral health problem [4]. Dental caries is the most prevalent non-communicable disease worldwide affecting human health and welfare through pain, infections, loss of teeth and reduced productivity. The programs to fluoridize water supplies with the view to preventing dental caries in larger population groups have been very effective in many countries [5]. However, such programs create debate most of the time. According to the critics the important issues arising with the use of water floridization include violation of the individual rights, the probability of overexposure leading to dental fluorosis and other questions concerning the prerogative right of the governments in implementing public measures for health [6]. These divergent perspectives raise issues on effective, efficient and completely transparent management and collaboration to ensure the identification of the common public health risks while addressing the interests of the society [7].

The purpose of this paper is to elaborate on the importance of public health governance in the course of health policies and practices across various societies as it plays the role of providing guidance on the formulation of health policies, their delivery and evaluation. Health interventions that are both scientifically sound and socially acceptable are therefore possible only through the participation of many stakeholders including the government and its sister departments, healthcare organizations, regulatory bodies, and the people. A clear example of such governance is the encouragement of fluoride intake through fluoridated water, fluoride containing oral products, and campaigns on oral health. It is well known that fluoride has potential in the prevention of dental caries especially in the regions with scarce resources for dental care [8]. However, the availability and regulation of fluoride differ considerably according to the political system, cultural perceptions, and facilities of health care.

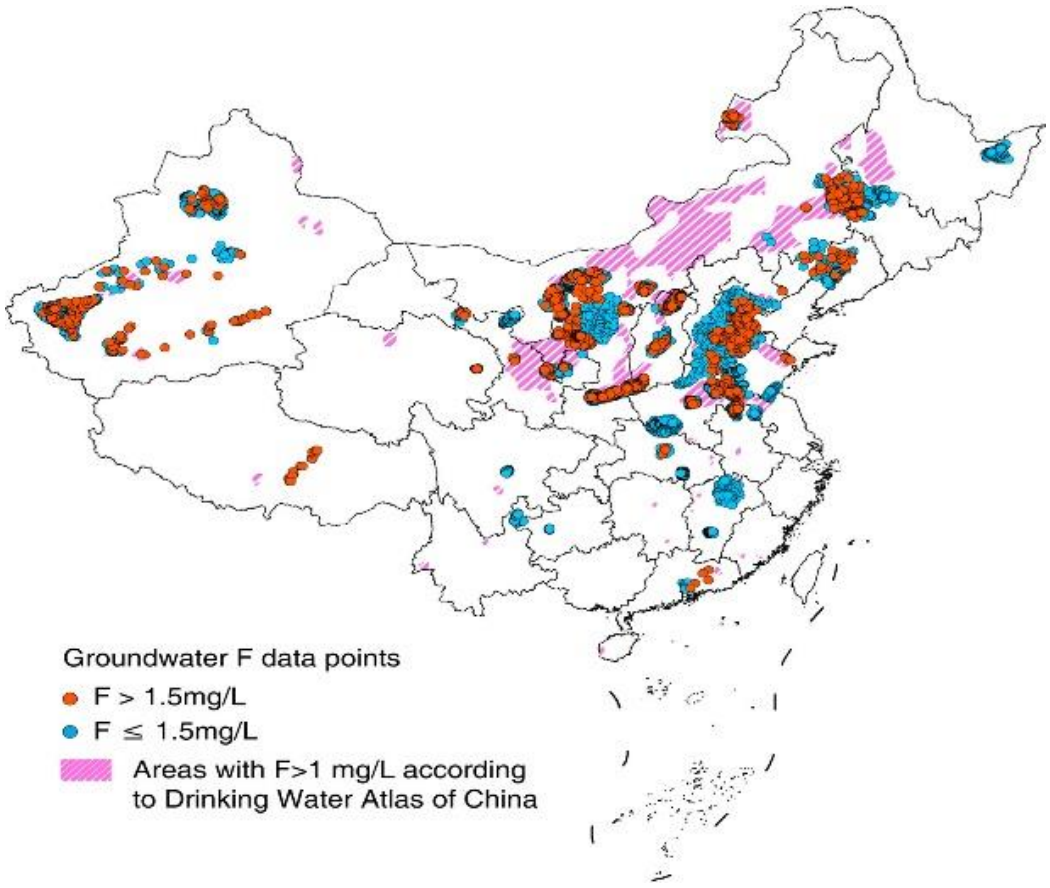

Figure 1: The geographical distribution of samples and occurrence of high F in groundwater of China based on Drink Water Atlas of China

Source: [9]

1.1 Social Governance: Definition and Importance

The term Social Governance is defined as the process of bringing stakeholders such as government, non-governmental organizations, health care facilities and other sectors of the society into taking part in solving sociological issues including health related ones [10]. New dimensions of governance are social governance which embraces the civil society, community engagement and partnership in policy making [4, 11]. This entails involvement of government, non-governmental organizations, community and other actors in the management of the country's resources [12]. In public health, social governance guarantees that, for instance, policies are relevant to the population's needs and are culturally permissible and sensitive. This paper emphasizes the importance of social governance in public health. It does this because it makes the policy makers answer to the populace because they have to explain policies to them and hence the policies gain credibility [13].

Also, through social governance the generation of knowledge and solutions is shared hence making it easier to come up with better and sustainable health solutions. Social governance fills the gap between the policy and practice by involving different stakeholders, thus making health initiatives meaningful and feasible [14]. Fluoride consumption is also an important policy area in which governance plays a crucial role in the implementation of such policies. Appropriate management measures ensure that fluoride polices are evidence based, nobody shall be endangered in the process of implementing the policies, and that the policies are not insensitive to the people's concerns [15]. On the other hand, weak governance refers to the enforcement of bad policies and this is a determinant of health inequality among the population especially the vulnerable population.

Health policies are important instruments by which governance structures transform public health (PH) agendas into manageable frameworks [16]. These policies guide action, provide funding, determine quality, and describe the roles of all the participants in public health activities. Within the fluoride intake framework, health policies contain the recommended amounts of fluoride in water, and supervise the fluoride levels. That is why it is important to understand that the process of formulation of health policies is not a simple process and includes players, their targets, functions, and authority. Hence, the need to engage all the stakeholders in policy making process in order to have scientific data, ethic and community views on the policies under consideration [17]. This approach makes it possible to develop coherent, equitable and relevant health policies for the current and future health problems and concerns [18].

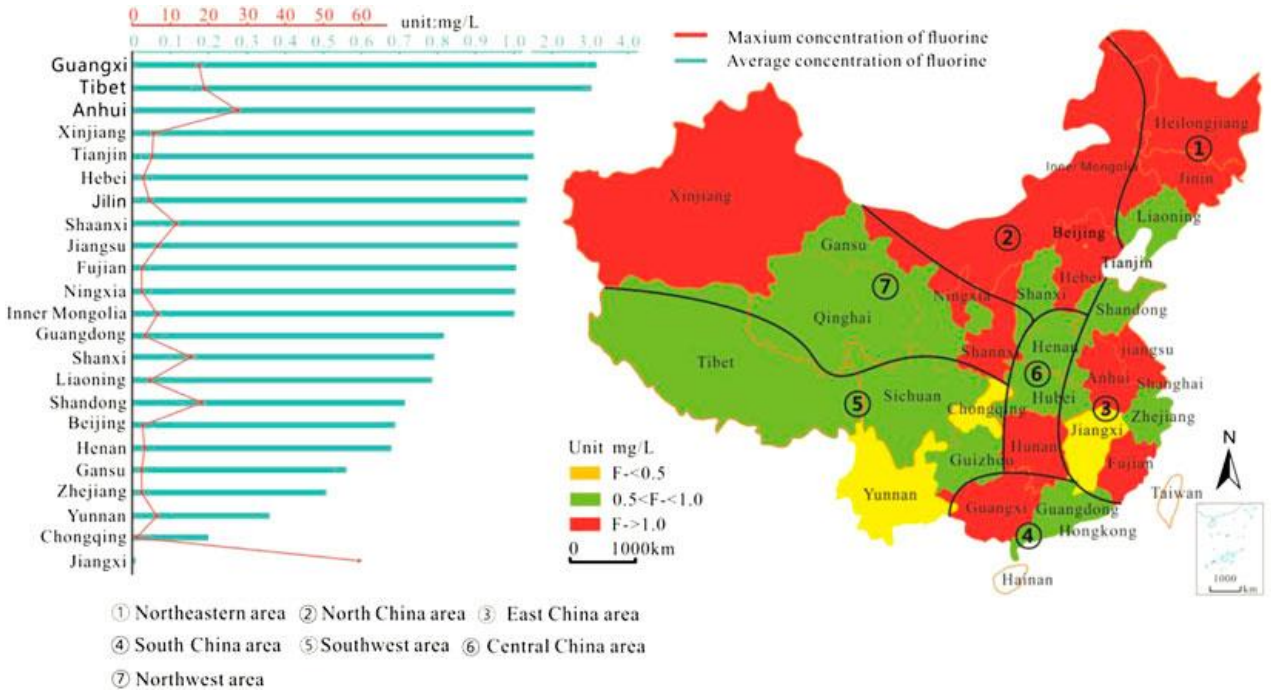

Figure 2: Average fluoride content in shallow groundwater in various provinces in China.

Source: [19]

This paper has also shown that governance plays a significant role in the policies surrounding the consumption of fluoride to enhance the health interventions' effectiveness and fairness. This paper has focused on how strong frameworks can help in formulating fluoride policies that are research informed, safe and which take into consideration the public's concerns [20]. Fluoride intake is widely accepted in many countries as a basic element of population-based oral health programs. Some of these countries include the United States of America, Australia and Canada and they have been supported by health officials and scientists. For example, Germany, Sweden, and Denmark have not embraced water fluoridation while at the same time endorsing the use of fluoride in forms such as toothpaste, and other dental gel products [21]. Such differences demonstrate that governance plays a crucial role in formulation, supervision and the social acceptability of health interventions. Fluoride concentrations in drinking water vary greatly in China and in most provinces, the fluoride concentrations of drinking water are still below the recommended level [22]. However, based on the 2nd National Oral Health Survey (NOHS), only seventeen percent of 12-year-olds and ten percent of 18-year-olds are using toothpaste that contains fluoride [23]; this has increased significantly in Beijing based on a recent study.

In this work, we plan to explore the impact of two major governance structures, namely social governance (SG) and health policies (HP), on the

adoption and implementation of fluoride-based dental products (ADD) and water fluoridation programs. The research will focus on how primary stakeholders like governments, health workers and secondary stakeholders like general public will affect policies on fluoride and its effects on health of communities. These objectives directly connect to our research questions: 1. How does the interaction between health policies (HP) and environmental governance (EG) collectively influence the adoption and effectiveness of fluoride-based dental products (ADD) in improving community well-being (CWB) 2: How do variations in environmental governance (EG) approaches affect the implementation of fluoride consumption policies, and what are the consequences for community well-being (CWB) in different socioeconomic contexts? 3: What are the key challenges in policy adoption and enforcement (PADD) regarding fluoride consumption, and how do stakeholder engagement and collaborative governance models enhance the effectiveness of these policies across diverse communities?

2. LITERATURE REVIEW

2.1 Collaborative Governance Theory and the Health Policy Triangle Framework

This paper argues that the management of fluoride intake has been a major area of interest in public health governance because of the significance of fluoride in oral health and the prevention of dental caries. There has been a considerable attempt in the formulation of the health policies (HPs) and environmental Consequently, these frameworks have been designed not only to regulate the water fluoridation process but also to serve as the means of ongoing public health evaluation.

The theoretical framework for this study is grounded in two primary theories: Ansell and Gash [24] explored the application of Collaborative Governance Theory and the Health Policy Triangle Framework. This paper presents the various lenses through which the governance systems or structures, policy-making processes, and stakeholders management influence the performance of the public health systems. Through the assessment of the fluoride intake, the role of governance in the formulation and administration of health care policies on dental health can be considered.

Collaborative Governance Theory has been developed as a dominant approach to explaining how people and organizations involved in society, for instance, public health concerns, work together to solve problems. Watt and Gilson [25] developed this theory of governance in public health where they assert that the role of government, non-government (EG) have been essential for ensuring that communities receive optimal fluoride levels while mitigating any associated risks, such as overexposure leading to fluorosis. These frameworks have been designed not only to regulate water fluoridation but also to establish monitoring systems for continuous public health evaluation.

The theoretical framework for this study is grounded in two primary theories: Collaborative Governance Theory and the Health Policy Triangle Framework [26]. These frameworks offer complementary perspectives on how governance structures, policy-making processes, and stakeholder engagement shape public health outcomes. By applying these theories to the case of fluoride consumption, we can gain a deeper understanding of how governance influences the development and implementation of public health policies aimed at improving dental health.

Collaborative Governance Theory has emerged as a prominent framework for understanding how complex societal issues, such as public health challenges, are addressed through the cooperation of multiple stakeholders [27]. Developed by Ansell and Gash [24], this theory posits that effective governance in public health requires the collaboration of government agencies, non-governmental organizations (NGOs), private sector actors, and local communities. The theory holds that public health problems that cannot be solved through governmental action must be solved through collaboration based on decentralization, participation, and trust. The present analysis of the fluoride consumption may be complemented with the use of Collaborative Governance Theory as it identifies the means through which stakeholders participate in the formulation of policies that are meant to enhance oral health. For instance, one of the roles of governments is to come up with and put into effect health care systems and such systems must be informed by research. On the same note, NGOs and health care workers participate in lobbying for uptake of fluoride

containing dental products and creating awareness on the advantages and disadvantages of fluoride [28].

However, as the theory of Collaborative Governance narrows it down, social governance mechanisms assist in the realization of public health interventions accordingly. Social governance means the ways by which society coordinates and controls the solutions to social problems including health. In the context of Collaborative Governance Theory also underlines the significance of trust between the stakeholders. Trust is crucial in order to achieve collaboration and guarantee that public health policies will be supported by the community [29]. For instance, in the case of IFFCO it is believed that the collaborative governance frameworks are useful in promoting cooperation and trust among stakeholders in order to achieve fluoride related public health interventions. The Health Policy Triangle Framework that was devised by Walt, Shiffman [30] offers a tool for the assessment of the formation and delivery of health policies. Social governance refers to the processes and institutions through which society organizes itself to manage public issues, including health. In the case of fluoride consumption, social governance involves the coordination of government agencies, healthcare providers, and civil society organizations to promote the safe and effective use of fluoride-based dental products and water fluoridation programs. Collaborative Governance Theory also emphasizes the importance of building mutual trust between stakeholders. Trust is essential for fostering cooperation and ensuring that public health policies are accepted by the community. In the case of fluoride consumption, building trust may involve addressing public concerns about the safety of fluoride, providing transparent information about the benefits and risks of fluoride use, and ensuring that policies are implemented in a way that minimizes potential health risks. By fostering collaboration and trust between stakeholders, collaborative governance frameworks can help to ensure the successful implementation of fluoride-related public health interventions.

The Health Policy Triangle Framework, developed by O'Brien, Sinnott [31], provides a systematic approach to analyzing the development and implementation of health policies. The framework consists of four components: These are content, context, process and actors. All these elements have significant implications to the formulation of the health policies and the way health interventions are promulgated and implemented. This tool – the Health Policy Triangle Framework is very effective in understanding the management of fluoride consumption because it encompasses all the elements which can be used in analyzing why certain policies are implemented and upheld. The substance of fluoride-related policies is formed based on the research on the positive impact of fluoride on dental health and the negative impact, including dental fluorosis. The environment in which these policies are conceived spans the political discourse on subject liberties, the issue of people's confidence in the government agencies, and the financial considerations of the fluoridation programs.

The process of policy development also plays a big role in identifying how fluoride-related health policies are formulated and implemented. Health Policy Triangle Framework recognizes the role of decision making in policy formulation and implementation as the critical elements of the health policy process. For example during the formulation of fluoride consumption policies, government departments, health facilities and civil society may sit down and come up with policies that are scientifically and politically reasonable. The framework also depicts the part played by actors in policy processes, whether human or corporate. It is possible to see from this paper how different actors manage consumption of fluoride and thereby gain a clearer picture of the process of formulation and implementation of public health policies.

Similarly, the Health Policy Triangle Framework also embraces the context in implementation of health policies. In the case of the intake of fluoride, it has been seen that political climate, economic conditions and the attitude of the general population towards. For instance, where people have confidence in their government institutions, fluoridization programs would not be bitterly disputed by the public. However, where there is a lot of backlash against the government involvement in health, the policies on fluoride may meet more resistance (Kamel, 2019) In this case of the fluoride consumption policies, the Health Policy Triangle Framework can be used in

identifying the context of the policy and hence, result in a general analysis of the policy making process.

Two theoretical frameworks through which the proposed research will make sense of the relationship between governance structures and fluoride-related health policies include the Collaborative Governance Theory and the Health Policy Triangle Framework. These are Collaborative Governance Theory which deals with stakeholders, trust and collaboration and the Health Policy Triangle Framework which is a theoretical framework. This paper argues that fluoride consumption exposes how theories governing health, policymaking, and stakeholder management drive attainment of health objectives.

Combining such theory as Collaborative Governance Theory and the Health Policy Triangle Framework makes it easy to understand the part that governance plays in determining health impacts especially in the case of fluoride intake. These theories therefore support the principles of stakeholder involvement, trust, and contextualized policy in the design of viable and non-bias public health policies and program. Good policies call for good governance structures that support clear and answerable decision-making processes and participation of If governance structures enhance collaboration, and consider social, political and cultural environment, then there will be a more effective response to public health issues thus enhancing the wellbeing of the community. On the other hand, weak governance results in negative impact on health inequalities and deters the health interventions. This paper also finds that the management of the right to health in relation to fluoride consumption demonstrates the importance of governance in the balance between the individual and societal health goals and underscores the importance of governance in enhancing the well-being of the population.

3. MODEL AND HYPOTHESES

3.1 Research Model

We suggest our model of research, grounded in Collaborative Governance Theory and the Health Policy Triangle Framework. This conceptual model had health policies, social governance, and Stakeholder engagement as independent variables with Adoption of Fluoride-Based Dental Products (ADD) as mediator variable and the dependent variables being Community well-being and Policy Adoption and Enforcement (PADD). Additionally, it is proposed that Environmental Governance moderates the relationship between Adoption of Fluoride-Based Dental Products (ADD) and Community well-being and Policy Adoption and Enforcement (PADD).

3.2 Hypotheses

The relationship between public health and governance is a very important aspect that is not very easy to understand. The use of fluoridated water, and fluoride containing dental products are examples of such public health interventions which have to be balanced to some extent. Fluoride is significant in the prevention of dental caries; however, the mass use of fluoride has brought controversies concerning public health ethic, community self-governance, and governmental responsibility. Social governance and health policies are the major determinants of how these challenges affecting the uptake, implementation, and acceptance of fluoride-related interventions are addressed. The public, policy makers and societies must be involved in a decision-making process that may encourage the fluoridation of water in the society with the view of enhancing the oral health of citizens. The social governance, health policies and other stakeholders influence the use of fluoro-based products and the implementation of fluoride policies and in the process impact the health of the population.

It is thus important that health policies should be a reference document in promoting the health of the population through disease prevention. Many reviews have confirmed that understandable and logically sequential health policies enable the attainment of favourable health results via the provision of interventions. For example, Lawes-Wickwar, Ghio [32] explain that policy clarity can greatly affect the attitude of the population towards some public health interventions like vaccination or use of health products. This linkage is particularly relevant in oral health care where policies supporting the use of fluoride containing dental products may enhance their use and hence reduce oral diseases [33]. Hence, this study proposes the following hypothesis:

H1: *Health policies significantly influence the adoption of fluoride-based dental products.*

Social governance deals with the way society is managed or facilitated in order to ensure its health and other wellbeing. Good social order in

cooperation with the community will lead to the effectiveness of public health measures, for instance, the use of dental products that are intended to enhance the health of teeth and mouth [34]. The present study indicates that societies that have effective governance structures are in a better position to adopt preventive health care [35]. Perception and adherence of the public to the health guidelines and measures can as well be shaped by social governance. Hence, this study proposes the following hypothesis:

H2: *Social governance significantly influences the adoption of fluoride-based dental products*.

Stakeholder involvement in public health decision making increases accountability, credibility and thus, creates a good foundation for health interventions [36]. Health care professionals, local authorities and the communities remain valuable in the promotion of healthy products for example fluoride containing dental products [37]. In addition, studies show that the involvement of the stakeholders in the design and implementation of these policies enhance acceptability of new health care trends [38]. Based on this understanding, the following hypothesis is proposed:

H3: *Stakeholder Engagement (SE) positively influences the Adoption of Fluoride-Based Dental Products (ADD).*

The use of fluoride-based products is as one of the most effective ways of enhancing oral health. Several research studies have established that fluoride in dental care, including through toothpaste or fluoridated water, greatly lowers the number of dental caries and other diseases, thereby improving the health of communities [1]. Here, as dental health improves, so does the general health, and, therefore, public health [39]. Based on these findings, the following hypothesis is proposed:

H4: *Adoption of Fluoride-Based Dental Products (ADD) positively influences Community Well-Being (CWB).*

Public health policies may be beneficial only if they are supported by most people who need to implement them in their practice. With regard to fluoride containing dental products, population use may contribute to the enhancement and compliance with relevant policies. Research has also shown that once positive health products are integrated into the market, the government becomes cautious and enforces laws to promote the continued and proper utilization of such products [40]. Thus, the following hypothesis is formulated:

H5: *Adoption of Fluoride-Based Dental Products (ADD) positively influences Policy Adoption and Enforcement (PADD).*

3.3 Moderation Hypotheses

Environmental governance defined as the frameworks that define the relationship between the state and society in relation to the environment also moderates public health measures. Literature shows that environmental governance influences the effectiveness of health interventions most especially within areas that are concerning the environmental effects of health products [41]. Good governance is linked to environmentally friendly and sustainable practices and could lead to increased consumption of health products like the fluoride containing dental products. Accordingly, the following hypotheses are proposed:

H6a: *Environmental Governance (EG) moderates the relationship between Adoption of Fluoride-Based Dental Products (ADD) and Community Well-Being (CWB), such that the positive effect of ADD on CWB is stronger under higher levels of Environmental Governance.*

H6b: *Environmental Governance (EG) moderates the relationship between Adoption of Fluoride-Based Dental Products (ADD) and Policy Adoption and Enforcement (PADD), such that the positive effect of ADD on PADD is stronger under higher levels of Environmental Governance.*

This set of hypotheses is a useful conceptual device for moving towards a grounded understanding of Collaborative Governance Theory and the Health Policy Triangle Framework. This process evaluation model helps to understand how various scales of determinants influenced the fluoride management interventions outcomes and thereby is useful for policy makers, public health workers and community leaders to enhance the success rates of this type of intervention approach. All of these different types of factors need to be taken into consideration so that a better strategy can be developed for how best to duplicate and continue the fluoride programs at the national level. The detail diagramitic view of hypotheses are given below in Figure 3

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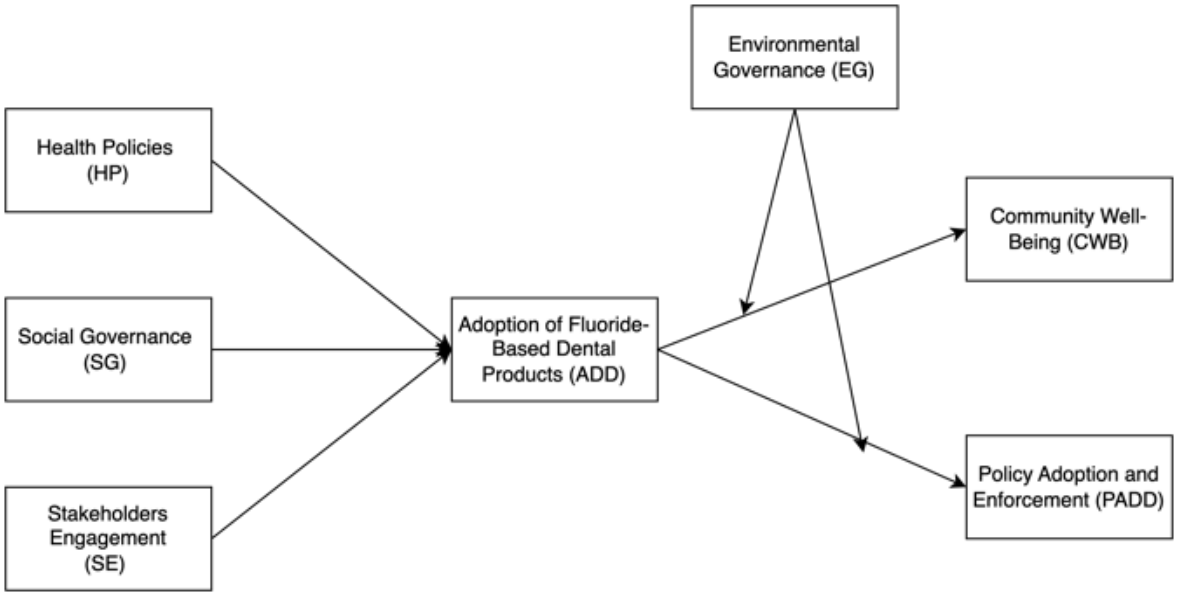

Figure 3: Path model

4. METHODOLOGY

4.1 Measures

The conceptual research model underlying this study included seven key constructs: Health Policies, Stakeholder Engagement, Social Governance, Adoption of Fluoride-Based Dental Products (ADD), Community Well-Being, Policy Adoption and Enforcement, and Environmental Governance. The content validity was achieved by using several items for each of the constructs that were used in the study and which were borrowed from validated scales and questionnaires used earlier. All survey items are provided in Table 1 below. Consequently, we used scales to measure health policy impact, stakeholder engagement, and social stewardship since they are essential and have been previously used. In addition, scales were employed to capture the level of fluoride-based dental product use, perceived general health, and regulation of fluoride policies.

The health policies scale was adopted from the items that were validated by Lawes-Wickwar, Ghio [32]. Stakeholder engagement items were adapted from [37] for the purposes of this study with relation to public health interventions. Social governance was measured with items derived from [34], and it concerned the ways in which community systems enhance. The adoption of fluoride containing dental products was assessed through newly included items formulated according to the recommendations of [39, 40]. Community well-being was measured using scales developed by [40] to focus on the health status of the community. Items for the policy adoption and enforcement were prepared for this study based on [40] and regulation. Environmental governance was measured using items adapted from previous study by [41], in this case, the focus was made on the extent to which environmental policy influence health.

Table 1: Survey Items		
Construct	Items	Ref
Health Policies (HP)	HP1: The government has effective health policies for promoting fluoride-based products.	[26]
	HP2: Health policies encourage fluoride use for dental care.	
	HP3: Fluoride-based health guidelines are enforced.	
	HP4: Public health campaigns promote fluoride in dental care.	
Social Governance (SG)	SG1: Social policies prioritize dental health and fluoride use.	[34]
	SG2: health programs effectively incorporate fluoride-based dental products.	
	SG3: Community social programs encourage fluoride adoption.	
Stakeholder Engagement (SE)	SE1: Dental associations are actively engaged in promoting fluoride-based products.	[37]
	SE2: Stakeholder collaborations encourage fluoride adoption.	
	SE3: Public stakeholders support the use of fluoride-based dental products.	
	SE4: Businesses promote fluoride use through CSR initiatives.	
Environmental Governance (EG)	EG1: Environmental policies consider the effects of fluoride in the water supply.	[41]
	EG2: Environmental regulations encourage sustainable fluoride use.	
	EG3: Fluoride adoption complies with environmental standards.	
	EG4: Awareness campaigns address the environmental impact of fluoride use.	
Adoption of Fluoride-Based Dental Products (ADD)	ADD1: The community adopts fluoride-based products due to health benefits.	[39]
	ADD2: Public dental clinics prefer fluoride-based dental products.	
	ADD3: Fluoride-based products are commonly used in public dental care.	
	ADD4: Awareness of fluoride benefits has increased adoption rates.	
Community Well-Being (CWB)	CEB1: Fluoride adoption has improved dental health in the community.	[40]
	CWB2: Fluoride-based dental care is seen as beneficial by the public.	
	CWB3: Fluoride use reduces the incidence of dental diseases in the community.	
	CWB4: Public confidence in fluoride-based dental products has increased over time.	
Policy Adoption and Enforcement (PADD)	PADD1: Fluoride dental policies are widely adopted and enforced.	[40]
	PADD2: Policy enforcement ensures widespread access to fluoride products.	
	PADD3: Policy adoption has increased fluoride use in community dental care.	

After the pilot testing, items with factor loading of less than 0.70 were dropped, and CFA was conducted with high average variance extracted (Smallest AVE is 0.72) and composite reliability (Smallest CR is 0.84). The last items showed acceptable levels of convergent validity as well as acceptable internal consistency. The findings show that all the items were measured on 5-Likert scale responses with labels from 1 (strongly disagree) to 5 (strongly agree).

4.2 Sample and Data Collection

This study has been conducted in regions with relatively high levels of fluoride in both China and Pakistan, a quantitative survey questionnaire was proposed to survey people, particularly health professionals, policy makers, and citizens. Fluorosis sites in China, with high levels of fluoride in groundwater were selected: The cities of Inner Mongolian and Shannxi province; Yunnan and parts of Shandong provinces. Punjab and Sindh provinces in Pakistan were chosen as the areas where similar fluoride problems are also observed.

The online survey method was employed, and questionnaires were given in Chinese. The initial study was then carried out with a sample of 20 participants from Shanxi Province of China for the main survey. The subjects were citizens of the study area, and the feedback they provided in the questionnaire was used to fine-tune the measurement items. The last version of the questionnaire was given to a larger group of high-fluoride administrative and health officials (Table 2). The data collection was done in two months from the month of January to March 2024 to ensure that the respondents have enough time to respond This led to gathering a good amount of data, with 389 respondents in the study. To test the stated hypotheses and to assess the overall fitness of our research model, we used structural equation modeling (SEM). This way it will be possible to

find the factors that may influence the ability of fluoride management programs in China and Pakistan to reach their full potential. The information gathered from this study will be useful in helping health planners and administrators,

The characteristics of the participants in the final analysis are presented in Table 2. The age of the majority of the respondents fell between 25 and 50 years. Out of the respondents 45% were males and 55% were females. Those that have resided in areas with high fluoride levels for the past 10 years were 60% of the sample size. Seventy percent of the surveyed population had at least secondary education, and 65% knew about the local public health policies.

Table 2: Demographics

Category	Percentage
Age (25-50 years)	76%
Male	45%
Female	55%
Lived in high-fluoride areas >10 years	60%
Secondary education or higher	70%
Aware of local public health policies	65%

5. DATA ANALYSIS AND RESULTS

To validate the research model developed in this paper, we conducted structural equation modeling (SEM). To test the reliability and validity of the model as suggested by [42] we first examined the measurement model. Consequently, the research hypotheses were analyzed by assessing the structural model. The present study used Smart PLS Version 4 for data analysis.

5.1 Measurement Model

5.1.1 Reliability and Validity

The current study assessed the reliability of the current study using Cronbach's α and composite reliabilities (CR) as highlighted in Table 3 below; all the CR and α values exceeded the recommended level of 0.7 by and [43]. It was also found that the loading of each item ranged from 0.742 to 0.910, this show that each construct is reliable. The convergent validity was examined by employing the standardized loading of items and the average variance explained (AVE). In Table 3 all values of indicator loadings were higher than 0.70, and the values of AVE for each construct were above 0.50 which indicated a good convergent validity. The composite reliability ranged from 0.849 and 0.907. The average variance extracted (AVE) was between 0.592 and 0.774, which showed a good convergent validity that was confirmed. (See Figures 4-7)

Table 3: Construct Reliability and Validity

Constructs	Items	Landings	Cronbach's alpha	CR	AVE
Adoption of Fluoride-Based Dental Products (ADD)	Add1	0.803	0.861	0.867	0.592
	Add2	0.765			
	Add3	0.799			
	Add4	0.845			
	Add5	0.742			
Community Well-Being (CWB)	CWB1	0.874	0.866	0.874	0.655
	CWB2	0.880			
	CWB3	0.804			
	CWB4	0.853			
Environmental Governance (EG)	EG1	0.792	0.839	0.849	0.606
	EG2	0.810			
	EG3	0.789			
	EG4	0.733			
	EG5	0.767			
Health Policies (HP)	HP1	0.859	0.846	0.853	0.622
	HP2	0.809			
	HP3	0.786			
	HP4	0.838			
Policy Adoption and Enforcement (PADD)	PAdd1	0.881	0.903	0.907	0.774
	PAdd2	0.848			
	PAdd3	0.880			
	PAdd4	0.910			
Stakeholders Engagement (SE)	SE1	0.796	0.854	0.862	0.630
	SE2	0.779			
	SE3	0.798			
	SE4	0.808			
	SE5	0.788			
Social Governance (SG)	SG1	0.864	0.861	0.876	0.648
	SG2	0.904			
	SG3	0.868			

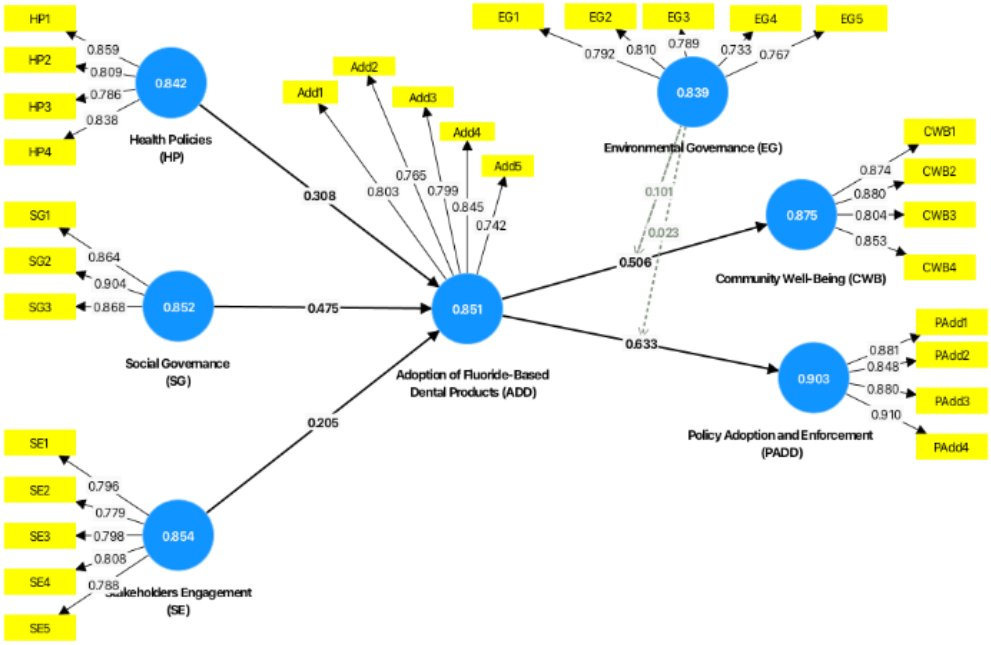

Figure 4: Measurement Model

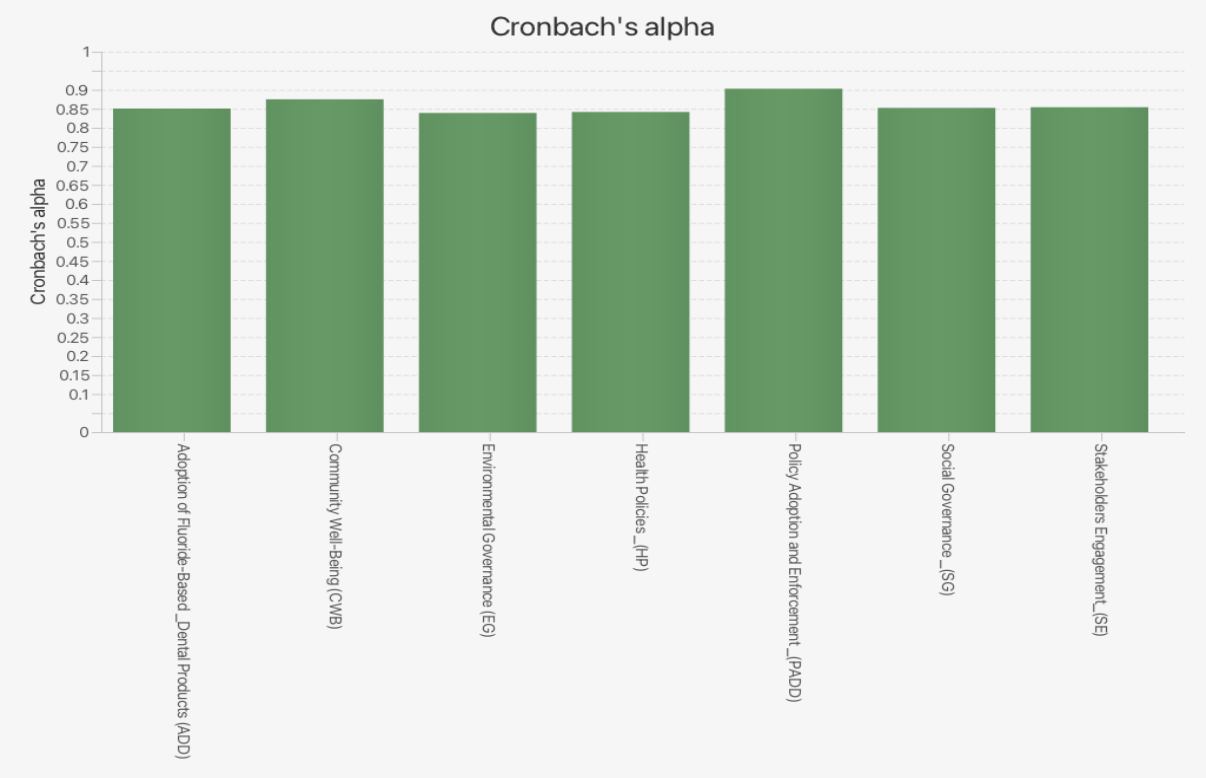

Figure 5: Graphical representation of Cronbach's Alpha

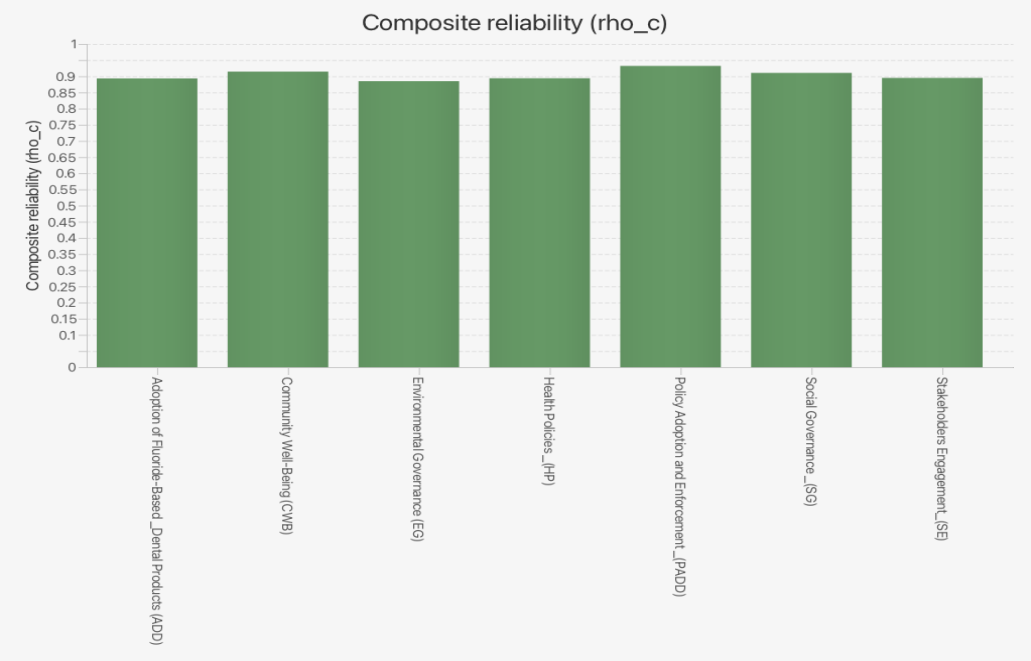

Figure 6: Graphical representation of Composit reliability (CR)

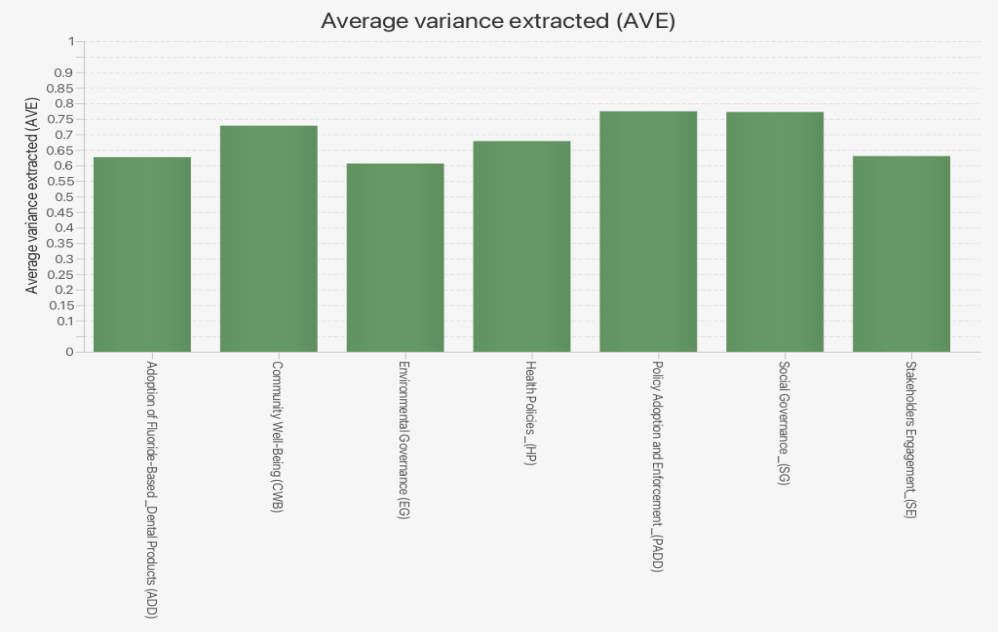

Figure 7: Graphical representation of Average VarianExtracted (AVE)

The external reliability of the constructs was assessed using the Fornell and Larcker technique and the Heterotrait-Monotrait (HTMT) ratio of correlations. Interestingly, Fornell and Larcker [44] suggested that the correlation coefficients should be below the square roots of the AVE. For HTMT, the correlation score was set and documented to be below 0.90. We have provided the HTMT values in Table 4 and Fornell and Larcker in Table 5. The adequate discriminant reliability coefficients were obtained for the total model and for each subgroup (health officials and administration staff). Consequently, there were no signs of the homological problem during the estimation of external validity.

Table 4: HTMT Ratios

	ADD	CWB	EG	HP	PADD	SG	SE
Adoption of Fluoride-Based _Dental Products (ADD)							
Community Well-Being (CWB)	0.800						
Environmental Governance (EG)	0.856	0.755					
Health Policies _(HP)	0.869	0.765	0.749				
Policy Adoption and Enforcement _(PADD)	0.780	0.753	0.745	0.892			
Social Governance _(SG)	0.7523	0.749	0.733	0.781	0.861		
Stakeholders Engagement_(SE)	0.740	0.732	0.828	0.661	0.822	0.628	
Environmental Governance (EG) x Adoption of Fluoride-Based _Dental Products (ADD)	0.382	0.411	0.310	0.286	0.395	0.377	0.250

According to [45], discriminant validity is claimed if all the correlations between any two constructs are less than the square root of AVE of each of the constructs in question. As presented in Table 5, square roots of the AVE for all constructs were higher than the corresponding correlations between the constructs. Furthermore, the correlations of the current study showed sufficient discriminant validity.

Table 5: Fornell and Larker Criterian

	ADD	CWB	EG	HP	PADD	SG	SE
Adoption of Fluoride-Based Dental Products (ADD)	0.792						
Community Well-Being (CWB)	0.742	0.853					
Environmental Governance (EG)	0.694	0.666	0.779				
Health Policies (HP)	0.739	0.662	0.649	0.824			
Policy Adoption and Enforcement (PADD)	0.927	0.867	0.858	0.781	0.880		
Social Governance (SG)	0.790	0.666	0.642	0.662	0.843	0.879	
Stakeholders Engagement_(SE)	0.640	0.642	0.706	0.573	0.731	0.546	0.794

In addition, the values of variance inflation factor (VIF) were also checked to check for multicollinearity between the constructs. The VIF values obtained are between 1.499 to 2.955 which is less than the suggested VIF of 10 (REF). Therefore, multicollinearity is not a problem in this study.

Second, the structural model is proposed to be estimated on the data collected for the validated measures. Hypothesized model fit indices were estimated by using SmartPLS version 4. The obtained values are also in agreement with the recommended values. RMSEA is 0.049, which is less than 0.10 recommended by scholars. The CMIN/DF of the model is 2.770 and this is also within the acceptable range. Furthermore, IFI is 0.854, TLI is 0.914, and CFI is 0.926 and all these aregreater than the advised values of 0.90. Therefore, the results indicate that the model is adequate.

Furthermore, since all the questions of the survey were filled in by the same participant, the common method variance was assessed by Harman's one-factor test. Common method bias is likely to be a problem in the test if a single factor explains more than half the variance (Harman, 1976). The analyses reveal that no factor is able to explain the variance in a dominant manner whereby the most explanatory factor explains 36.9% of the variance. Other symptoms of CMB are high coefficients of inter-relationship of the variables (CORR > 0.90).

The inter-construct correlation matrix points to an absence of the very high correlation in the sample used. Therefore, common method bias is not a threat in this study as indicated in the table 4-5.

5.2 Structural Model

To this end, the structural model-related hypotheses were tested in the overall model with the help of SmartPLS 3.0 as suggested in Section 3. In the next section, the results emerging from the overall model are elaborated.

5.2.1 Overall Model

All hypothesis of this study stated in the structural model are significant and are supported in the overall model. The results indicate that Health policies (HP) have a strong positive effect on adoption of fluoride basd dental products (H1: It was 0.308 ($t = 2.47$, $df = 71$; $\beta = 0.308$, $p < 0.05$), which is in accordance with previous studies and as some previous studies also indicated. Then, the hypothesis can be accepted as valid. Social Governance (SG) has a positive significant impact on adoption of fluoride based dental products (H2: $\beta = 0.475$, $p < 0.05$). Moreover, Stakeholder Engagement (SE) has a positive significant effect on adoption of fluoride based dental products (H3: $\beta = 0.205$, $p < 0.05$). Adoption of fluoride based dental products has a significant effect on Community Well-being (H4: The findings show that the level of knowledge about fluoride based dental products has a positive and significant correlation with Policy adoption and enforcement (H4: $\beta = 0.506$, $p < 0.05$) and Adoption of fluoride based dental products also has a significant influence on Policy adoption and enforcement (H5: $\beta = 0.633$, $p < 0.05$). Moreover, the Environmental Governance (EG) is also found to mediate the relationship. Environmental Governance significantly moderate the relationship a) between Adoption of Fluoride-Based Dental Products (ADD) and Community Well-Being (CWB), (H6a: Environmental Governance moderated the ADD – CWB relationship ($\beta = 0.101$, $p < 0.05$), indicating that the positive effect of ADD on CWB was higher at higher levels of Environmental Governance. And Environmental Governance significantly moderate the relationship b) between Adoption of Fluoride-Based Dental Products (ADD) and Policy Adoption and Enforcement (PADD), (H6b: The result of the analysis shows that the positive effect of ADD on PADD is moderated by the level of Environmental governance. For this reason, we accept the verification of the assumed model (Fig. 7). Further detailed hypothesis is presented in Table 6.

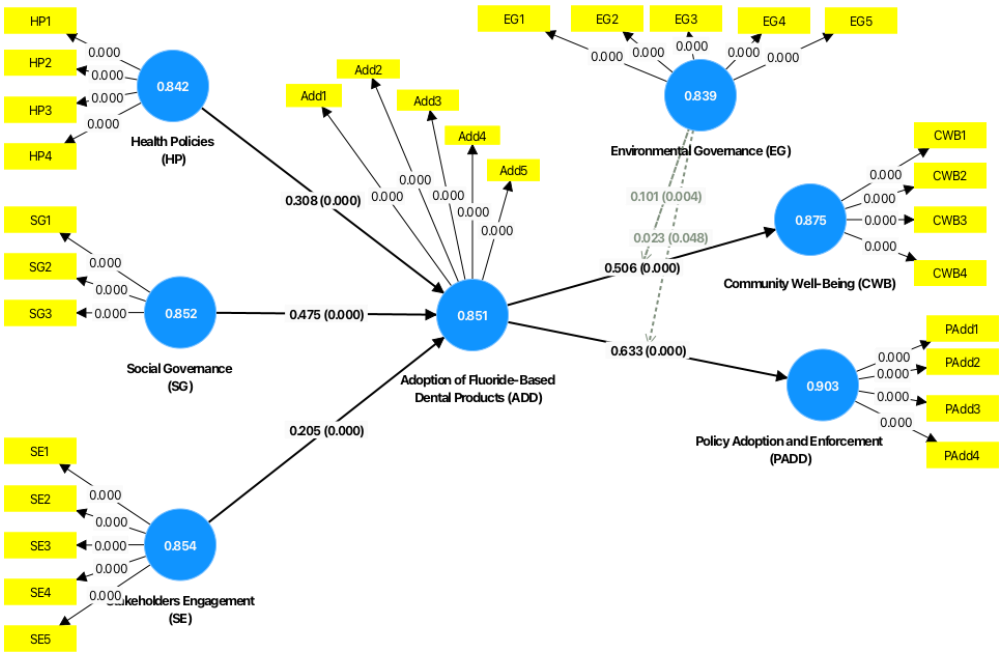

Figure 7: Path coeficients

Table 6: Path coeficiente

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Adoption of Fluoride-Based _Dental Products (ADD) -> Community Well-Being (CWB)	0.506	0.501	0.065	7.778	0.000
Adoption of Fluoride-Based _Dental Products (ADD) -> Policy Adoption and Enforcement _(PADD)	0.633	0.632	0.026	24.684	0.000
Environmental Governance (EG) -> Community Well-Being (CWB)	0.277	0.283	0.062	4.469	0.000
Environmental Governance (EG) -> Policy Adoption and Enforcement _(PADD)	0.409	0.411	0.025	16.320	0.000
Health Policies _(HP) -> Adoption of Fluoride-Based _Dental Products (ADD)	0.308	0.309	0.047	6.572	0.000
Social Governance _(SG) -> Adoption of Fluoride-Based _Dental Products (ADD)	0.475	0.470	0.055	8.674	0.000
Stakeholders Engagement_(SE) -> Adoption of Fluoride-Based _Dental Products (ADD)	0.205	0.210	0.052	3.940	0.000
Environmental Governance (EG) x Adoption of Fluoride-Based _Dental Products (ADD) -> Community Well-Being (CWB)	0.101	0.099	0.036	2.843	0.004
Environmental Governance (EG) x Adoption of Fluoride-Based _Dental Products (ADD) -> Policy Adoption and Enforcement _(PADD)	0.023	0.022	0.012	1.982	0.048

7. DISCUSSION AND CONCLUSIONS

The present study examines the co-evolution of health policies (HP) and environmental governance (EG) in determining the utilization of fluoride-based dental products (ADD) and their implications for community well-being (CWB). Health policies guide the administration, promotion and usage of fluoride products in order to achieve the best possible results and make them readily available to the populace. Coherent health policies help to navigate both the decision-makers and the population on the most effective and safe ways to use fluoride containing dental items. For instance, the levels of fluoride in water fluoridation programmes are described in health policies as well as the manufacturing and supply of dental products containing fluoride such as toothpaste.

While environmental governance ensures that fluoride programs are not only socially and economically efficient but are also environmentally and health efficient. This is also good environmental management because it also prevents cases of fluorosis that are caused by high levels of fluoride in drinking water. It also promote environmentally friendly production and distribution of fluoride products and solution. This way, environmental governance protects the welfare of societies, and encourages the wise use of fluorides.

Health policies and environmental governance systems should therefore be well coordinated as they provide an enabling governance structure for the use of fluoride based dental products. Here the community governance is applied in a way that the fluoride interventions not only address the dental health issue but also the environment and the health of the people. It also leads to improved CWB through the reduction of dental caries through treating the populations in the regions with no access to dental treatment.

The study also shows that environmental governance complexity is likely to affect the effectiveness of fluoride consumption policies and thus the CWB in different socioeconomic settings. Where there are institutions that can enforce environmental policies in a region, then policies on fluoride consumption are likely to be more efficient. For example, in the United States and Australia, the two high income countries that have also good environmental policies, water fluoridation is well organized hence better oral health of the population.

However, in low and middle income countries where environmental governance may be less robust the fluoridation of policies can be problematic. Some of the barriers include; inadequate assessment of the fluoride concentration in water, lack of strong legal framework, and equally poor health systems that cannot support the use of the products. Therefore residents of these areas will be at high risk of developing fluorosis or dental caries due to right exposure to fluoride.

This paper also finds that the socioeconomic setting has an important bearing on the success of the fluoride policies. Fluoride based dental products are more easily marketed and used in the richer areas owing to health care, mass media and education. [46] On the other hand low density income area will lack these resources therefore uptake of fluoride will be low and dental health poor. This means that the differences in the environmental governance can only compound the health inequalities in the population particularly those in the bottom of society and thus there is need to put in place and implement good health standards that include environmental and social health.

Several important barriers in the promotion and implementation of fluoride consumption policies (PADD) are discussed in the study. These challenges include community opposition to fluoride interventions especially where fluoride use is a contentious issue; inadequate resources for surveillance and compliance; and variation in compliance power among the regions. In societies with a low level of confidence in governmental agencies, policy adoption may be a difficult process because people can perceive fluoride policies as invasion of their rights or may have negative perceptions about adverse effects such as fluorosis.

This paper identifies that stakeholder engagement is a key factor in overcoming these challenges. This paper has argued that there is a need for active stakeholder participation in the policy-making process with regard to fluoride programmes to enhance the trust of the healthcare professionals, local authorities, NGOs, and the public. Co-governance structures—defined as those in which two or more actors are involved in decision making—offer great promise for increasing policy adoption and implementation. These models increase the believability of the fluoride programs and increase the possibility of the communities accepting the programmes since they are critical for the success of the programs.

Hence, in acultural and even stratified societies, collaborative governance makes sure that fluoridation policies are suitable for the locality and do not offend culture. For instance, when there are many controversies with regard to water fluoridation, it could be useful to bring those who make decisions and the stakeholders into a discussion with the professionals on fluoride. Collaborative governance also entail formulation of policies for certain problems and requirements of different communities and comes up with better ways of implementing public health interventions.

Finally, it is argued that stakeholder engagement and collaborative governance models enhance the fluoride policies through enhancing the participation in the public health governance. These models guarantee the scientific rationale for fluoride interventions while taking into account social realities and, thus, enhancing policy uptake, implementation, and population health.

6.1 Theoretical and Practical Implications

This work adds value to the literature on public health governance by applying the Collaborative Governance Theory and the Health Policy Triangle Framework within the context of fluoride consumption. Through these theories, this research aims to show how various stakeholders' cooperation and policy-making that is informed by context can produce better and more socially just health interventions. The results of this study suggest that additional research is needed on organized fluoride policies based on principles of transparency, stakeholder participation, and evidence to guarantee the evidence-based and socially acceptable fluoride policies.

From a policy perspective, this work offers significant recommendations for policy-makers and healthcare managers. It underlines the need to involve many stakeholders in the implementation of fluoride-based health endeavours. Health policies should be comprehensible, systematically organized, and with considerations of the stakeholders to support the use of fluoride based dental products by the public. The problem is that there is no environmental governance in the policy

framework of public health interventions, which makes these interventions less efficient and unsustainable.

6.2 Limitations and Future Research Directions

Nonetheless, the present study has some drawbacks. First, the data was collected from high fluoride areas of China and Pakistan and as such the results cannot be generalized to other areas. Second, because the data is cross-sectional, it is quite challenging to determine the way the variables are related, that is, whether one is causing the other. Future work can fill these gaps by doing cross-sectional studies in different places and by comparing the effects of other governance mechanisms on fluoride ingestion strategies. On the same note, more research has to be carried out to establish the impacts of environmental governance on the interventions of public health.

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