WATER CONSUMPTION IN DENTAL PRACTICES: STUDY WATER USAGE PATTERNS IN DENTAL OFFICES, INCLUDING CONSUMPTION FOR PATIENT CARE, STERILIZATION, AND FACILITY MAINTENANCE. ASSESS STRATEGIES FOR REDUCING WATER WASTE AND IMPROVING EFFICIENCY, CONSIDERING BOTH ENVIRONMENTAL AND ECONOMIC IMPLICATIONS

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ABSTRACT: This study aimed to identify water usage practices in dental offices, compare their environmental and financial effects, and analyze measures that can be taken to minimize water wastage and enhance its conservation. The research was conducted to establish the areas where water is most consumed and develop realistic measures to help conservewater in dental practices. For this study, the research approach used was quantitative, and the data was collected using a cross-sectional survey, which was disseminated to 220 dental personnel, including dentists, dental hygienists, office managers, and dental assistants. The survey collected information on water use, environmental and socio-economic effects of water use, and water saving policies. Quantitative data was analyzed using frequencies and percentages and correlation and regression analysis to determine the relationship between the independent and dependent variables. The results also indicated a poor and insignificant relationship between water usage, water usage effects on the environment and the economy, and the measures that can be taken to curb the wastage of water and enhance conservation. Regression analysis found that water usage patterns and environmental and economic impact are not relevant determinants of the adoption of water-saving practices. The findings imply that other factors, like policies and legal frameworks within which the firms exist and internal policies, may be more significant in determining water efficiency practices. This work shows that encouraging water-saving measures in dental practices is not an easy task. Although knowledge of environmental and economic effects is significant, these factors alone have a relatively weak impact on implementing efficiency measures.

Keywords: Water usage, Dental practices, Environmental impact, Economic impact, Water efficiency, Water-saving strategies, Sustainability, Dental industry.

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INTRODUCTION

The water is categorized into two categories based on its chemical composition and microbial properties: the primary group consists of the "incoming amounts dental sections water," which is the water for drinking that is directly supplied to the tooth chair unit from the municipal water distribution system. The second group is the "wastewater," which encompasses every piece of waste generated by the dental unit (Fulford, 2020). Dental head units utilize water to cool and rinse the equipment used in dental procedures and wash the enamel of the teeth. This water is delivered to the cup filler material outlet, which patients utilize for oral cleaning, and to the bowl-rinse connection, which is used to clean the teeth using the dental chair device's spittoon. The dentist unit is furnished with a complex network of interconnecting narrow-bore (2-3 mm inner width) elastic-plastic tubing known as tooth unit that water lines. These water depths provide water to all dentist unit devices, cup-filler, and bowl-rinse fluid outlets (Kipfer, 2021).

The cleanliness of entering water is of significant importance as consumers and dental professionals constantly come into contact withwater and fumes produced by dental tools. Therefore, having evidence of elevated levels of microbial growth could constitute a health risk for practitioners and customers (Spagnolo, 2020). A multifaceted strategy has been proposed today to address these issues. The proposed strategy encompasses waterline drainage, autonomous water holding systems, the use of reduced or sanitized Water, embedded micro pore purification, recurring or constant chemical cleaning (using hydrogen peroxide hypochlorite and chlorine dioxide), and the implementation of anti-retraction valves in the body Among such devices, the "waterline filtration" are among those most frequently used. These sorts of filters have been developed for dental systems and feature micropore inline filtration that must be put on every water distribution line.

Water consumption is an essential requirement for every individual's existence. Regrettably, it is not alone our home electronics that are consuming valuable water resources (McAfee, 2019). Undoubtedly, food constitutes most of our concealed water consumption, accounting for most of our total water footprints. Producing meat consumes the highest quantity of water, followed by food processing and dairy products. For reference, producing a single pound of beef requires 15,000 liters of water, and individuals who consume meat consume approximately the equivalent of 15 bathtubs full of concealed water in their daily meals. For instance, a vegetarian eats approximately 8 bathtubs worth of concealed water. Whole foods, fruits, and vegetables are recommended for a nutritious diet and sustainable practices. However, it is ironic that, as reported by WRAP, eight out of the top 10 nations from which the UK imports its veggies and fruits were prone to droughts. In total, around 2700 liters of water are required to generate the food you consume, similar to taking 44 showers daily. Therefore, when we squandered food, we also squandered substantial quantities of water.

It is important to note that while the ocean comprises around 75% of the Earth's surface, less than 3% of this is clean water, most of which is trapped in Antarctic ice caps and mountains. The quantity of freshwater differs throughout different regions, resulting in varying degrees of impact when this water is extracted (Gleick, 2018). What implications does this have for the natural environments near these groundwater sources of information? The extent of water deprivation and its consequences on marine organisms and adjoining soil ecosystems vary depending on factors such as the water source (underground water or ocean water) and the volume of water removed from a particular location. However, it is generally observed that water depletion harms aquatic organisms and the surrounding soil ecosystems. The consequences can encompass mortality and displacement of wildlife, depletion of habitats and biodiversity, salinization, soil deterioration, and poisoning of freshwater.

Water, also known as Paani, Jal, Tanni, L'eau, Wasser, or Acqua, is arguably the most universally recognized and commonly utilized term around the globe. Water requires no formal introduction, as its significance is universally recognized. Nevertheless, although water is an essential requirement for humans, this valuable asset is being squandered, contaminated, and diminishing. Each unit of water holds significant value, yet we persist in squandering it as if it were an abundant and costless natural resource. Nearly 98% of the Water on Earth is saline and unsuitable for human consumption. Of the total freshwater reserves, only 2% is available, with 1% being in the form of ice located in different places worldwide. Therefore, a mere 1% of the overall water reserves are accessible for our home and industrial utilization. Several cities in India and worldwide are experiencing severe water shortages. The problems are primarily caused by minimized rainfall, manufactured climate changes, decreasing groundwater supplies, growing populations, industrialization, and significant consumption of water owing to negligence by consumers and deteriorating systems of water supply. The significance of water in a nation's economic development should not be underestimated (Hoekstra, 2021).

The dental surgery units are provided with sterilized water from a third party. Pankrust et al. advocate using aseptic water in every surgical intervention. This study demonstrates that disinfected water is used in dental operating facilities (Lal B. R., 2018), The microbiological range of species is substantially greater in units of gingival or conservative dental treatment provided with ordinary distilled water. Research conducted by White and Rickard revealed no notable disparities between dental unit waterline (DUWL) systems that were filled with filtered water from the reservoir bottles and those filled with deionized water in operating areas.

Typically, water fountains and bottles are filled by hand with liquid (tap water, distilled water, or sterile water), which can become contaminated with bacteria from the skin, such as Staphylococcus epidermidis and S. aureus. Our finding may explain the higher isolation frequency of S. epidermidis in our investigation. Regular cleaning and disinfection of bottles is necessary to eliminate such occurrences. It is advisable to frequently sterilize reservoirs containers in an oven before refilling and reusing them (Nagarsenkar, 2021).

Nevertheless, no established norms or rules exist that explicitly pertain to the microbiological purity of water utilized in dental facilities. DUWLs are classified as medical equipment since they are designed to provide water for the efficient functioning of additional medical equipment, such as freezing and irrigating tools on a dental panel. Patients consume tiny quantities of water throughout treatment. Furthermore, the mist generated by dental appliances is breathed in (Yiek, 2021). It is imperative to engage in thorough sterilization of these orthodontic instruments. The dental unit is typically treated with chemicals such as hydrogen peroxide, silver ion gas peroxide, the chlorhexidine gluconate, potassium hypochlorite, per Acetic acid, acidic citric acid, a substance called glut chlorine dioxide, or chlorine oxide to minimize contaminate (Eliaz, 2019).

Research Objectives: To identify the key areas where water is most heavily utilized and to examine the specific water consumption practices in dental offices, focusing on patient care, sterilization processes, and facility maintenance.

- To assess the environmental footprint and economic costs associated with water consumption in dental offices, analyze the implications of current practices on the environment and operational expenses.
- To develop and recommend practical strategies for minimizing water waste in dental offices while maintaining high standards of care and hygiene, focusing on solutions that balance environmental sustainability with economic efficiency.

LITERATURE REVIEW

Overview of water usage in healthcare settings: Water is indispensable in dentists and serves several purposes, such as irrigating places of surgery and supplying cleansing during ultrasound instruments (Mayo, 2023). Over fifty years ago, scientific research first documented that the tubing used to carry water to dental equipment had a significant propensity to form biofilm, leading to patients being exposed to water with high levels of microbes. Biofilm can lead to infection in dental patients and exposes oral health professionals to aerosolized germs that might potentially cause sickness. The United States Organizations for the Control of Diseases (CDC) has established rules about the standard of water used in dental equipment, as it might not meet the necessary standards for medical treatments. The CDC advises that dental unit's waterways (DUWLs) should meet the same criteria for secure water for consumption as established by the US US Environmental Protection Agency (EPA), which is a maximum of 500 colony-forming cells (CFU) per centimeter. Significant progress has been achieved in comprehending the biofilm in dental unit waterlines (DUWL) and developing techniques to regulate and supervise water quality in dental (Gawish, 2019).

According to the study, pollution of dental facilities, water, and machinery is a significant issue in contemporary dentistry. Contrarily, as per the prevailing rules of the Dia and the US Centers during Prevention and Control of Disease (CDC), the permissible level of water contamination for dental procedures should not exceed 500 CFU/mL (Monteiro, 2018). The water samples taken from the invasive, gum disease, and traditional dental units at the Scientific Dental Polyclinic in Wroclaw showed a microbiological contaminant significantly higher than the acceptable threshold of 500 CFU/mL. Just 46% of the water test sites from the dentistry unit did not surpass the specified limit for microbial counts. Based solely on ADA rules, just 29% of dental workplaces complied with the rules and regulations. The concentration of bacteria, including S. warneri, S. pasteuri, R. picketti, S. epidermidis, and B. pumilus, surpassed 10,000 CFU/mL, representing the predominant bacteria detected in the analyzed water samples. These bacteria have an opportunity to cause disease in humans, particularly when present in high numbers. Potential adverse effects of these substances include the development of osteoarthritis in irritation, irritation of the eyes or ears in individuals without pre-existing conditions, and the additional presence of bacteria in the bloodstream (Błaszczyk, 2022).

The problem of microbial contaminants in dental unit waterways was initially documented in 1963 by Blake's studies. Subsequent investigations have extensively described the impurity of dental unit waterways throughout orthodontic treatments and explored methods to eradicate biofilm and microbes through physical processes (filtration) and chemical approaches (hydrogen peroxide solution, chlorexidine lactic acid, sodium chlorine dioxide).

The initial recorded instance of illness associated with tainted dental wastewater occurred in 1987 (Craun, 2018). Two individuals in this instance were identified with afterwards diseases. The bacteria obtained from the site of the wound illnesses were identified as the bacterium Pseudomonas, the same pathogen found in the dentist unit's water supply. An initial case of mortality linked to dental water poisoning was reported in Italy, where an elder woman was admitted to hospital and subsequently succumbed of pneumonia caused by Legionnaires' disease. The patient's lack of physical activity prior to falling ill allowed us to deduce that her contact with saliva occurred throughout a dentist visit (Amato, 2020).

Since 2003, the CDC has advised that all dentistry units utilize methods to deliver treatments groundwater that meets hydration requirements ($\leq$ 500 CFU/mL of heterotrophic in nature freshwater bacteria) for outpatient operations.The CDC emphasized that relying solely on standalone dams, often known as water-bottle infrastructure, is inadequate and must be supplemented with commercialized items and equipment that enhance the standard of the fluid used for regular dental procedures. The Center for Disease Control advises seeking guidance from the dental unit maker and the good or device responsible for preventing biofilm to determine the suitable techniques for maintaining dental water purity and tracking it (Wen, 2020).

Sterilization and Water Use: Before disinfecting and sterilizing dental equipment, washing is crucial(Fulford & Stankiewicz, 2023). This technique includes thoroughly cleansing every surface of dental tools to eliminate bloodstream, microorganisms, and particles, and ready the equipment for the dentistry sterilizing procedure. Equipment maintenance is often carried out using water or chemicals. As previously mentioned, it is necessary to cleanse dental equipment that has been stained with blood and other debris before disinfection. OSAP advises every dental office to have a dedicated area specifically designated for decontaminating hazardous dental tools. It is important to promptly submerge the devices in water or detergents after use to avoid blood and detritus from hardening. Dental hygiene technicians should don thick gloves when cleaning equipment to minimize the risk of unintended harm and the spread of infections. Ultrasonic equipment can also be utilized for enhanced washing.

Another method of cleaning, in place of ultrasonic cleaning, is by hand cleaning the instrument using non or brushed stainless steel bristles with a light or low-pH surgery solution (Nemitz, 2022).Before sterilization, it is essential to thoroughly wash the device with disinfected water with minimal contamination levels to remove any residual cleaning agent. Employ only purified water with low contamination levels

Facility Maintenance and Water Consumption: The UN's understanding of the fundamental human right of sanitation and water access has undergone significant revisions to incorporate all essential components necessary for establishing an agreement for maintaining facilities (Winkler, 2019). She referred to a general observation 15 and the prior Special Rapporteur's annual reports on the rights of humanity obligations for access to adequate potable and sanitary water. Based on the findings of the rapid evaluations of water used for drinking conditions (RADWQ) conducted around the entire nation, there is a significant issue with the nutritional value of water. Radon pollution is far more prevalent than previously believed. Furthermore, most of the analyzed water sources were found to be tainted with intestinal coliforms or able to tolerate bacteria, as reported by the WHO and UNICEF in 2010. The presence of geographic discrepancies across the Caribbean, Central, and Pacific zones, together with gender prejudice and inequality among the affluent and the impoverished, are matters that are worrying for rights defenders activists.

After determining the projected amount of liquid consumption, evaluate the quantity that is used to the quantity required for optimal facility functioning (Capodaglio, 2019). Consult system manuals for service and maintenance, exercises, or additional pertinent material to ascertain the suitable flow rate for the machinery. Nevertheless, the standard of subsoil is generally poor in most cases. Many of the country's people depend on water for hazardous and contaminated consumption. Economically disadvantaged individuals are especially susceptible and allocate a significant portion of their earnings toward purchasingwater for basic sustenance. The Pakistan Institute of Research in Water Management conducted a comprehensive water safety surveillance programme and discovered that the number of bacteria found Report Phrase in Islamabad, Rawalpindi, Lahore, and Faisalabad varied from 45 to fifty percent in the years 2005-2006 (Sohail, 2020).

The global water scarcity is widely recognized as a significant issue. Furthermore, the detrimental consequences of the environment would only worsen the problem (Omer, 2020). The majority of traditional dentistry institutions had inadequate water usage policies. Green medicine is a progressive method of doing dental treatments that prioritizes ecological sustainability and efficiency by reducing waste, preserving both energy and water, and eliminating contamination through advanced technology and techniques. Across the globe, Eco-dental offices utilize the latest advances in their instruments, including dryness dental vacuum machines, fast cycle automation cleaning instruments, washers/thermal disinfectors, and Eco sanitizer. In addition, the installation of faucets with low flows and water-efficient bathrooms will be beneficial. This method dramatically decreases total water usage and also has a beneficial effect on the surroundings by minimizing the quantity of effluent. Moreover, this alternative will significantly reduce energy usage, minimizing its detrimental environmental impact. Nevertheless, limited research has been conducted on evaluating the influence of Eco dentistry clinics on preserving Water (Martin, 2021).

Environment implications of high-water usage: Ensuring the accessibility of water and promoting its appropriate consumption are crucial difficulties in transforming the water supply sector and handling environmental demands. There is a common argument that, because water supplies are limited, government agencies should not provide it to everyone for free but instead charge a fee for its accessibility (Cech, 2018). However, implementing price as an appetite control strategy may provide additional issues for towns. Communities lacking the financial means to access water will face the risk of both poverty and diseases caused by water, in along with engaging in civil disobedience.

Maintaining the safe functioning of a dental facility requires adequate water supply, which should be achieved through ecologically responsible methods. Doctors who earned a greater annual salary were also more inclined to employ a receptionist, conduct microbiological examinations to assess the drinking water quality of their equipment, utilize an ongoing supply of water framework, and adhere to more stringent guidelines for maintaining the water cleanliness of their equipment. In general, dentists with fewer years of experience and older have a higher level of knowledge about the quality of water law, with a percentage of 27.6%. On the other hand, dentist who have more expertise and are older have a lower level of knowledge, ranging from 13.2% to 17.5%. Gender, job experience, degree of education, and dental office features are crucial determinants of water ecological responsibility, waterline hygiene, and maintenance of machinery in dentistry. Dental organisations should promote knowledge of the cleanliness of the water and the environment while also engaging in continuous education while utilizing protocols and methods that are environmentally friendly (Shellard, 2022).

Liu et al. proposed that earlier research neglected biodiversity assessment in water primarily because they focused on measuring blue-colored water (flow) capabilities and overlooked the evaluation of green water (storage) resources. Another crucial consideration is that the potential cost of blue drinking water is substantially greater than that of green water (Pasanen, 2019). Unlike blue water, green waters are stationary in space and generally accessible on land for plants. However, they can be transferred to a blue water pool because they build up aquifers through extensive percolation. However, the primary objective of the shortage of water footprints technique is to measure and assess the effects of water usage instead ofexplicitly addressing water shortages. While numerous studies have examined the limited supply of surface-level or groundwater, prior studies, aside from a few instances, seldom considered the water requirements of crops and the availability of green water supplies in a single study. Recent research has consistently recognized environmentally friendly water as a significant concern that must be handled in future evaluations regarding water scarcity (Tzanakakis, 2020).

Moreover, structures are acknowledged as one of the primary consumers of freshwater supply. Excessive water consumption during the building and operation process depletes water supplies and leads to significant ecological effects. The primary reason is the energy consumption associated with the water cycles in constructed areas, which encompasses treating and distributing raw water, its utilization within structures, and the subsequent sewage purification. Furthermore, the influence of water usage differs greatly among nations and regions, mostly due to variations in water consumption patterns (Mannan, 2020). For instance, numerous nations employ traditional water purification methods, while others depend on sophisticated evaporation techniques.

Despite the growing worldwide water constraint, the potential effects of water usage in the construction and operation of structures have been overlooked. Over the past few years, there has been a growing global problem of water scarcity, accompanied by a rise in the amount of water consumed per person each year, as well as escalating expenses for water delivery and treatment of waste. This has resulted in a disparity between the availability of water and those who are looking for it. The disparity and ecological considerations have emphasized the significance of implementing efficient methods for managing water in the construction industry (Fei, 2021).

The prevailing public opinion on preserving water differs among families. Prior studies have explored the potential impact of schooling, age, financial standing, and bill-paying status on public water-saving attitudes. The reasons for efforts to conserve water might differ among individuals and can sometimes appear obscure even to the person themselves. Indeed, Tijs et al. (2017) discovered that individuals saw monetary rewards as somewhat more attractive than environmental motivations. Nevertheless, they showed that ecological arguments were more efficacious (Koop, 2019). This disconnection offers an advantage to activists and politicians who aim to motivate changes in conduct, and we should contemplate utilizing environmentalist arguments for forthcoming conservation campaigns. Higher levels of training and earnings tend to be associated with lesser consciousness of water preservation due to more liquid-consuming devices. Therefore, focusing efforts to save water on closing the knowledge gap among these groups might prove most effective (Conde, 2019).

Behavioral and Operational Strategies for Reducing Water Waste: Dental unit effluent encompasses all liquid waste generated by an orthodontic unit, including water from the inhalation engine and the bowl-rinse wastewater outflow. In Italy, orthodontic unit wastewater and drainpipes are immediately linked to urban drainage systems using certain city approvals (Battersby, 2023). The dental unit effluent is classified as residential wastewater, meaning it originates from the metabolism of people and household operations and is, therefore, appropriate for disposal into the urban drainage systems following the law.

Research on preserving trees in Beijing is crucial because woods enhance the watersheds' integrity, mitigate flooding by absorbing precipitation, and sustain stable watersheds. Additionally, forests contribute to moisture-rich grounds for the agricultural sector, hence lowering the requirement for additional irrigated (Kaur, 2020). Reusing wastewater is a preservation solution with several promising approaches. Reusing Water decreases the need for new water in situations when it is overly utilized for various purposes. Pilot projects worldwide have demonstrated potential for successful expansion in various applications, such as agriculture reuse (irrigating crops), urban reuse (providing water to serve public sanitation, protection from fire, and surroundings watering), manufacturing utilize (such as cooling power stations, manufacturing of steel, and oil enhancing), and augmenting existing water supplies (enhancing the replenishment of groundwater and stream the baseflow). Consequently, this has stimulated a significantly elevated benchmark for the purification of sewage, as delineated in the Clean Water Act of 1970 and analogous regulations worldwide. Additional prevalent methods include the collection of rainfall and the use of water-efficient equipment (Wanjiru, 2018).

According to Marinoski et al. (2018), the most effective way to save water is to implement strategies that focus on increasing drinkable water money saved, reducing sewage, and minimizing the adverse environmental effects by lowering energy costs associated with sewage treatment. Traditionally, the oversight of wastewater treatment plants has evolved from primarily addressing hygiene issues in the first decades of the 20th century to focusing on preventing drowning in lakes and rivers and promoting nutrients recovery/recycling in the preceding decade. Nevertheless, numerous cities in countries that are developing continue to face the issue of contaminated water resources as a result of the dumping of waste from homes and factories into reservoirs of Water (Xia, 2018).

Hence, it is imperative to establish an efficient and enduring system for managing sewage, which should commence at the individual household scale and primarily relies on human involvement (Masi, 2018), Particularly concerning the level of tolerance on reusing of materials obtained from garbage. Nhapi and Gijzen propose three methods for an effective waste water management framework. Firstly, they suggest minimizing production of wastewater by significantly reducing water consumption as well as waste the next. Secondly, they recommend directly treating and reusing water and nutrients to the lowest attainable level, such as on-site application. Lastly, they propose intervening to improve the their own purification capability of bodies of water that receive sewage.

AV offers a recurring process and a comprehensive strategy for managing sewage. Macrophytes, also absorb vitamins and minerals, which can be utilized as fodder for cattle or fish whenever collected. The waste product can also serve for agricultural applications such as fertilizer (Kurniawan, 2021). Multiple underwater plant genera can serve as microorganisms in MAV devices. Furthermore, the process of treating sewage eliminates harmful microorganisms and generates biological methane and nutrient-rich manure that can be used in farming operations. This study is founded on the correlation among handling waste and ecology. Water treatment is a component of the initiatives aimed at reducing water wastage, alleviating strain on rivers and lakes, and establishing a means for generating renewable power.

While there has already been significant studies on the treatment of waste water, its relationship to environmental sustainability has yet to be sufficiently explored (Sanneh, 2018). The majority of the current research has mostly concentrated on the many methodologies of sewage treatment, with no emphasis on longevity. The preceding research have explored several typical strategies for wastewater treatment, including chemical processing, mechanical treatment, the utilization of biological living things, and treatment of sludge. Prior research has also investigated fundamental procedures involved in the purification of sewage, such as screenings and pumps (beginning treatments), the initial treatment, subsequent treatment, cleaning, and treating sludge.Nevertheless, the procedures involved in sewage treatment are primarily determined by what is being done. According to Libhaber et al., the emphasis on sustainable guarantees a enough supply of water that is safe to fulfill the requirements of current residents without jeopardizing the potential of subsequent generations to access the exact same resource. Despite the abundance that water has as an environmental asset, it's availability is consistently limited (Schyns, 2019).

RESEARCH METHODOLOGY

Research Design: This research used a quantitative approach to the study of the research questions as this allows for analyzing the relationships between the variables. Self-administered questionnaires were used to gather data from participants which provided a good picture of the existing dental offices' practices and beliefs regarding water consumption and conservation measures. The questions were mainly closed-ended to generate quantitative data, and there was also one closed-ended question to extend the information received from the respondents.

Population and Sample Size: The sample for this study was taken from professionals working in dental practices, such as dentists, dental hygienists, managers, and dental assistants. The participants were chosen because of their direct involvement in dental activities during their daily practice. As such, they would better understand water usage and conservation measures. To obtain statistically reliable results and enable comparison between subgroups, it was decided to conduct the survey among 220 respondents. The participants for the study were chosen using a convenience sampling technique, and participants were selected to participate in the survey depending on their availability.

Data Collection: The sample was recruited through an online survey disseminated through email lists and professional social media groups. The questionnaire was developed to capture the use of water, attitude and awareness of environmental and fiscal effects, and water conservation methods. The questionnaire used in the survey was based on closed questions: Likert scale and demographic questions were used to obtain comprehensive information about the respondents. The survey was conducted for one month to obtain many responses and increase the validity of the data collected.

Data Analysis: The data collected from the survey was analyzed using statistical software for both descriptive and inferential analysis. Descriptive statistics were employed to portray the respondents' socio-demographic profile and give a brief idea of the measures of central tendency and dispersion of the major study variables. Correlation analysis was applied to determine the various coefficients between water usage patterns and environmental and economic consequences, as well as measures adopted to address water wastage and enhance the overall efficiency of water usage. Moreover, multiple regression analysis was also used to test the hypothesis and establish the extent to which the independent variables can predict the dependent variable and the factors that may affect the uptake of water conservation measures.

RESULTS AND ANALYSIS

This part of the present research work presents the findings and discussion of the data collected in the study, and the emphasis is on the interconnections between the identified variables that concern water use behaviors, the economic and environmental implications of water use, and water conservation and management. Descriptive statistics, correlation, and regression analysis are used to examine the findings and establish the strength and significance of these relationships. This section will also seek to determine the patterns, evaluate the possibilities of the independent variables and determine the factors that may affect the implementation of efficient water management strategies in the dental sector.

Table 4.1: Demographic information of respondents.

Variables	Frequency	Percent
Dentist	52	23.6
Dental Hygienist	47	21.4
Office Manager	61	27.7
Dental Assistant	60	27.3
Less than 1 year	52	23.6
1-5 years	48	21.8
6-10 years	49	22.3
More than 10 years	71	32.3
Solo practice	54	24.5
2-4 practitioners	59	26.8
5-10 practitioners	50	22.7
More than 10 practitioners	57	25.9
Urban	67	30.5
Suburban	51	23.2
Rural	47	21.4
Other	55	25.0
Total	**220**	**100.0**

The profile of the participants is quite diverse based on their position in the dental practice, experience, size of the practice, and geographical location in the country. Of the participants, the Office Managers and the Dental Assistants were observed to form the largest category of respondents, with 26. The Dentists and Dental Hygienists are 7% and 27%, respectively, second and third with 23. 6% and 21. 4% respectively. As for experience, as much as 32. 3% of the respondents have more than 10 years of experience, proving a stable workforce; 23. 6% of the respondents have less than a year of work experience. The number of dental practitioners in the practices also differ; the most common being 2-4 practitioners (26. 8%), followed by single-handed practices (24. 5%), and those with 10 or more practitioners (25. 9%). The total dental practices are mostly urban (30. 5%), with a good distribution from suburban (23. 2%) and rural (21. 4%) practices, and a quarter of the remaining were classified as 'Other' (25%). This diverse demographic distribution gives a good picture of the dental workforce and practice settings giving a broad experience and environment within the dental field.

Table 4.2: Descriptive Statistics.

	Mean	Std. Deviation	N
Water Usage Patterns	14.5682	2.52655	220
Environmental and Economic Impact	12.4455	2.38942	220
Strategies for Reducing Water Waste and Improving Efficiency	12.6227	2.54609	220

The descriptive statistics for the survey responses provide insights into three key areas: the use of water, the social/ economic effects, and the ways of minimizing wastage of water resources. The mean scores show that the respondents gave the highest ranking for the component of water usage patterns (M=14. 57), which means that the participants were very aware of this aspect of water resources management. The environmental and economic impact was also rated slightly less concerning or understood with a mean score of 12. 45. Strategies for water conservation and water use efficiency also got a moderate average score with a mean of 12. 62. The standard deviations are also quite comparable for the three areas, with a range of 2. 39 to 2.

55, which means there is a rather stable degree of variability in the respondents' answers. This means that, although there is some discrepancy in the understanding of these issues, the respondents' views are quite convergent concerning the significance and effects of these factors.

Table 4.3: Correlations.

		Water Usage Patterns	Environmental and Economic Impact	Strategies for Reducing Water Waste and Improving Efficiency
Water Usage Patterns	Pearson Correlation	1	.056	-.054
	Sig. (2-tailed)		.407	.427
	N	220	220	220
Environmental and Economic Impact	Pearson Correlation	.056	1	.044
	Sig. (2-tailed)	.407		.521
	N	220	220	220
Strategies for Reducing Water Waste and Improving Efficiency	Pearson Correlation	-.054	.044	1
	Sig. (2-tailed)	.427	.521	
	N	220	220	220

The correlations between the water usage patterns, the environmental and economic effects, and the strategies to prevent wastage of water and enhance water use are low and are not statistically significant. The Pearson correlation coefficients are all below 0. 3 and close to zero, implying the absence of linear relation. More precisely, the relationship between water consumption and its implications for the environment and the economy is not strong (r = . 056, p = . 407), implying no relationship exists. Likewise, the relationship between water usage behavior and water conservation and optimization methods is also negative and weak (r = -. 054) with p-value of . 427, hence also indicating the absence of a relationship. Last of all, the relationship between environmental and economic consequences and measures for water conservation and optimization is weakly positive (r = 0. 044) and statistically insignificant (p = 0. 521). These results indicate that the variables are not very much related to each other in this dataset and fluctuations in one of the variables are not related to those in the other variables.

Table 4. 4: Regression analysis of Water Usage Patterns and Strategies for Reducing Water Waste and Improving Efficiency.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.054[a]	.003	-.002	2.54822

a. Predictors: (Constant), Water Usage Patterns

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.114	1	4.114	.634	.427[b]
	Residual	1415.572	218	6.493		
	Total	1419.686	219			

a. Dependent Variable: Strategies for Reducing Water Waste and Improving Efficiency

b. Predictors: (Constant), Water Usage Patterns

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	13.413	1.008		13.312	.000
	Water Usage Patterns	-.054	.068	-.054	-.796	.427

a. Dependent Variable: Strategies for Reducing Water Waste and Improving Efficiency

A regression analysis was used to determine the correlation between water usage patterns (independent variable) and the ways and means of minimizing water wastage and enhancing efficiency (dependent variable). The model summary shows that the correlation between these variables is rather weak, given that the R is 0. 054.

The R Square of 0. 003 indicates that only 0. 3% of the total variance in the strategies that can be adopted to minimize water wastage and enhance water use efficiency is associated with water usage patterns. The adjusted R-Square is -. 002; thus, the model does not explain the variability in the data.

This is further confirmed by the ANOVA table highlighting that the regression model is statistically insignificant with an F-value of . 634 and a p-value of . 427, which means that water usage patterns do not have a bearing on the strategies that can be used to reduce wastage of water and increase its efficiency.

The table of coefficients gives further information. For the variable for water usage patterns, the unstandardized coefficient is -. 054, which means that with a unit increase in water usage patterns, there is a slight decrease of . 054 in the strategies for reducing water waste and improving efficiency but this is not significant, (p = . 427). The constant (13. 413) indicates the dependent variable's expected value at the independent variable's zero level; this is also not very meaningful since all the coefficients are not statistically significant.

Table 4.5: Regression analysis of Environmental and Economic Impact and Strategies for Reducing Water Waste and Improving Efficiency.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.044[a]	.002	-.003	2.54951

a. Predictors: (Constant), Environmental and Economic Impact

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2.688	1	2.688	.414	.521[b]
	Residual	1416.998	218	6.500		
	Total	1419.686	219			

a. Dependent Variable: Strategies for Reducing Water Waste and Improving Efficiency
b. Predictors: (Constant), Environmental and Economic Impact

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	12.046	.914		13.184	.000
	Environmental and Economic Impact	.046	.072	.044	.643	.521

a. Dependent Variable: Strategies for Reducing Water Waste and Improving Efficiency

The regression analysis was conducted to determine the correspondence between the environmental and economic effects of water usage (independent variable) and measures to prevent water wastage and enhance efficiency (dependent variable). The model summary shows this to be a very poor relationship with an R of . 044. The R Square value of . 002 indicates that only 0. 2% of the variability in strategies for water conservation and water use efficiency can be attributed to environmental and economic factors. The Adjusted R Square of the model is negative at -0. 003 which suggests that the model is not a good fit to the data.

The ANOVA table also shows the regression model is not statistically relevant (F = . 414, p = . 521). This means that measures to reduce water wastage and enhance efficiency have little to do with the environmental or economic context.

The coefficients table shows the unstandardized coefficient for environmental and economic impact. 046, showing that for every one unit increase in the environmental and economic impact score there is a . 046 increase in the score of strategies for reducing water waste and improving efficiency. Nevertheless, this relationship was not statistically significant (P = 0. 521). The standardised constant 12. 046 is the value of the dependent variable for the case where the independent variable is zero. However, this value is not particularly helpful given that the model is not statistically significant.

DISCUSSION

The results of this research can help dental practitioners and policymakers understand the current water consumption practices and their effects on the environment and, financial costs and gains and how best to address water wastage and enhance water conservation. Unfortunately, the correlation tests indicated that these factors had a rather low correlation with the use of water-saving measures in the dental sector; this implies that other factors might affect the uptake of these measures. These findings align with some of the earlier work but point to directions for future inquiry.

For example, in a study conducted by (Leung, 2022), dental practitioners revealed a good level of understanding of environmental issues but this knowledge is not reflected in their water conservation practice. This follows the weak positive relationship seen in our research between environmental and economic footprint and measures for water conservation and enhanced utilization.(Valizadeh, 2021) also noted that institutional rules and standards are stronger determinants of water conservation behaviours than people's knowledge or attitude towards water conservation or environmental issues; this could be why the variables used in this study had low predictive value.

Furthermore, the research evidence points to the fact that water use behaviour is not the only determinant of the uptake of efficiency measures. This is in tandem with the work done by (Abu-Bakar, 2021)which supports the claim that besides understanding water usage, the actual adoption of water use efficiency measures depends on various elements, including cost, technology, and pressures. Hence, it seems that a more complex view, which would consider factors such as organizational culture, legal requirements, and financial stimuli, may be helpful for the encouragement of water-saving practices in dental surgeries.

Although this study adds value to the knowledge of water usage and efficiency measures in the dental sector, the low and essentially non-existent correlations and the low R-squared values of the analysed variables indicate that more research should be conducted. Subsequent studies should include other factors to explain the intention to use water-saving measures in dental clinics, including policy, technological, and economic factors. Thus, the broadened scope may contribute to identifying most promising interventions and advancing evidence-based practices within the field.

Conclusion: This research aimed to establish the link between water usage in dentistry, the environment, and the economy, as well as the possible ways of minimizing wastage and enhancing the efficiency of water usage in dental surgeries. The data analysis established that these variables had low and insignificant relationships; this shows that water usage behavior and beliefs about the effects of water usage on the environment and the economy are poor predictors of the uptake of water conservation measures in dental surgeries. These findings suggest that there may be other factors that are likely to include institutional factors such as policies, economic factors such as incentives, and technological factors that may influence efficiency practices.

Despite the findings of this study, which add value to the current literature on the issues surrounding sustainable water use in dentistry, the study also establishes the need for future research. Appreciating the conditions within which these practices are being seen, such as legal frameworks and company culture, will be vital in formulating better practices. Education is likely not enough to encourage water conservation practices in dental practices; instead, support for water conservation must be provided through a combination of measures that facilitate the implementation of the desired behaviours.

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