Determination of the concentration of Aluminum and Zinc in adult teeth samples in Al-Najaf Governorate, Iraq

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A R T I C L E   I N F.

A B S T R A C T

The primary objective of this study was to assess the potential effects of aluminum (Al) and zinc (Zn) on oral health by determining their concentrations in adult teeth samples. Teeth of materials, such as implants and restorative products, often contain small amounts of metallic elements that can interact with the oral environment and impact a patient's health. To quantitatively analyze the concentrations of Al and Zn in teeth samples collected from adults, atomic absorption spectroscopy was used. The results showed the concentration of two metals: Aluminium (Al) and Zinc (Zn) in the teeth of 30 samples from the sample. It is evident from the data that Al and Zn concentrations differ between individuals according to age groups. The highest concentration of Aluminium was found in a 19-year old female with a concentration of 14.888 (ppm), while the highest concentration of zinc was found in a 54-year old male with a concentration of 59.458 (ppm). The lowest concentration of Aluminium was found in a 32-year male with a concentration of 1.735 (ppm), while the lowest concentration of zinc was found in a 52-year female with a concentration of 1.867 (ppm)**.**We conclude that the concentration of zinc in the dental samples was higher than that of Aluminium. This is because zinc plays an essential role in many body processes, including the formation of teeth and bones. It is a component of saliva that helps protect teeth from decay by reducing acids produced by bacteria in the mouth.

تحديد تركيز الألمنيوم والزنك في عينات أسنان البالغين في محافظة النجف /العراق

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الــخُـــلاصــة

الكلمات المفتاحية:

الهدف الأساسي من هذه الدراسة هو تقييم التأثيرات المحتملة للألمنيوم (Al) والزنك (Zn)

على صحة الفم من خلال تحديد تركيزاتها في عينات أسنان البالغين.

مواد الأسنان.

غالبًا ما تحتوي مواد الأسنان، مثل حشوات الاسنان ، على كميات صغيرة من العناصر المعدنية التي يمكن أن تتفاعل مع بيئة الفم وتؤثر على صحة المريض. للتحليل الكمي لتركيزات Al و Zn في عينات الأسنان التي تم جمعها من البالغين، تم استخدام مطيافية الامتصاص الذري(AAS). أظهرت النتائج تركيز معدنين هما الألومنيوم (Al) والزنك (Zn) في أسنان 30 عينة من العينة ويتضح من البيانات أن تراكيز الألمونيوم والزنك تختلف بين الأفراد حسب الفئات العمرية. وقد وجد أعلى تركيز للألمنيوم في أنثى بعمر 19 سنة بتركيز 14.888 (جزء من مليون)، بينما أعلى تركيز تم العثور على الزنك لدى رجل يبلغ من العمر 54 عاماً بتركيز 59.458 (جزء من مليون). أقل تركيز للألمنيوم وجد عند ذكر بعمر 32 سنة بتركيز 1.735 (جزء من مليون)، بينما أقل تركيز للزنك وجد عند أنثى بعمر 52 سنة بتركيز 1.867 (جزء من مليون). نستنتج أن تركيز الزنك في عينات الأسنان كان أعلى من تركيز الألمنيوم وذلك لأن الزنك يلعب دورًا أساسيًا في العديد من عمليات الجسم، بما في ذلك تكوين الأسنان والعظام وهو أحد مكونات اللعاب الذي يساعد على حماية الأسنان من التسوس عن طريق تقليل الأحماض التي تنتجها البكتيريا في الفم.

1. Introduction

Aluminum (Al) and Zinc (Zn) are two important metallic elements commonly found in teeth materials used in restorations and implants[1]. The release of these minerals into the oral cavity could have potential effects on oral health and overall wellness. However, limited research has been conducted to specifically evaluate Al and Zn concentration levels in adult teeth samples in Najaf Governorate, Iraq.

The use of teeth materials containing Al and Zn has become increasingly popular in modern dentistry due to their desirable properties such as durability and biocompatibility[2]. However, concerns have been raised about the long-term effects of these minerals on oral health, as well as their potential systemic effect through ingestion or absorption. Examining the Al-Najaf Governorate in central Iraq reveals a significant portion of its population grappling with diverse oral health issues. Evaluating the levels of aluminum (Al) and zinc (Zn) concentrations in teeth samples

from this area holds utmost importance. It not only aids in gauging potential health hazards linked to dental materials but also offers valuable insights for oral healthcare professionals and policymakers. This study aims to determine the concentration of Al and Zn compound in adult teeth samples taken from patients in Najaf province. Through the use of analytical techniques such as atomic absorption spectroscopy, the research aims to provide quantitative data on the presence and distribution of Al and Zn in teeth materials and oral tissues[3]. Overall, this investigation seeks to fill the knowledge gap regarding Al and Zn concentration levels in adult teeth samples in Najaf Governorate, Iraq, and their potential effects on oral health, thus contributing to the advancement of evidence-based teeth care practices in the region[4].

2. The relationship of Aluminum and Zinc to teeth

Aluminum and zinc are two elements that can have an impact on teeth, although their effects differ.

1. Aluminum: It is not considered an essential element for teeth health, and excessive exposure to aluminum can have adverse effects[5]. High levels of aluminum exposure have been associated with enamel erosion, which can lead to teeth sensitivity and increased risk of cavities. However, it's important to note that aluminum is not typically present in significant amounts in drinking water or commonly consumed foods, so the risk of aluminum-related teeth issues is generally low[6].

2. Zinc: It is an essential trace element that plays a crucial role in maintaining oral health. It is involved in various enzymatic reactions and contributes to the formation and maintenance of teeth enamel[7]. Zinc deficiency can lead to delayed teeth eruption, enamel defects, and impaired immune function, which can increase the risk of oral infections. Adequate zinc intake through a balanced diet or supplements can help support healthy teeth and gums[8].

   It's worth mentioning that both aluminum and zinc can be found in oral care products like teeth paste.

3. Materials and methods

Teeth samples were gathered from individuals aged 17 to 70 years at the Specialty Teeth Center in Najaf, Iraq. Additional teeth samples were acquired from donors at the same center and carefully organized for subsequent analysis. These samples were collected under hygienic conditions and appropriately labeled. A total of thirty teeth samples were collected from both healthy males and females. These samples were then placed in special tubes containing formalin compound to preserve their biological characteristics.

After that, the teeth samples underwent a process where they were washed with distilled water and dried before being ground into powder using specialized grinders or ceramic mortar. Atomic Absorption Spectroscopy (AAS) was then used to determine the concentration of Zinc and Aluminum in the teeth samples.

4. Statistical analysis

All calculations were performed using statistical software (SPSS for Windows version 20, SPSS Inc., Chicago, IL, USA), and the results were reported as means and standard deviations, along with the corresponding minimum and maximum values[9]. To assess the statistical significance of the data, mean error, Levine test, and P values were computed. A P value less than 0.05 indicates statistical significance, while a P value greater than 0.05 implies no statistical significance. The outcomes of these statistical analyses

5. Results and Discussion

Thirty teeth samples were collected from healthy men and women with an average age of (17-70) years, then the concentrations of aluminum and zinc were measured in the dental samples using atomic absorption spectrometry, and the obtained results are shown in the Table(1).

Table (1): Shows the concentration of elements (Al and Zn) in teeth samples.

No. Sample	Age (year)	Gender	Smoking	Concentrations(ppm) Al	Zn
1	21	Male	smoker	6.554	26.490
2	29	Male	non-smoker	4.736	34.256
3	45	Male	non-smoker	6.713	28.521
4	25	Male	smoker	2.844	24.877
5	42	Male	non-smoker	7.132	41.566
6	44	female	smoker	5.988	25.899
7	29	Male	non-smoker	8.080	23.914
8	42	Female	non-smoker	8.657	34.824
9	46	Female	non-smoker	7.497	35.811
10	60	Male	non-smoker	8.328	31.487
11	50	Male	non-smoker	9.906	28.223
12	43	Female	non-smoker	5.796	24.974
13	60	Male	smoker	5.664	31.003
14	42	Male	non-smoker	3.977	24.567
15	40	Male	smoker	4.398	26.972
16	39	Male	smoker	8.913	34.508
17	27	Male	non-smoker	6.517	23.588
18	28	Male	smoker	6.702	29.500
19	40	Male	non-smoker	8.634	33.645
20	19	Female	smoker	14.888	49.338
21	17	Female	smoker	12.007	34.132
22	70	Female	non-smoker	4.154	19.900
23	32	Male	smoker	1.735	26.513
24	52	Female	smoker	4.235	1.867
25	34	Female	non-smoker	4.588	25.774
26	35	Male	non-smoker	7.606	25.835
27	24	Female	smoker	4.596	24.001
28	45	Female	smoker	10.925	28.945
29	32	Male	non-smoker	7.214	36.955
30	45	Male	smoker	3.482	59.458

The presented data illustrates variations in the concentrations of Aluminium (Al) and Zinc (Zn) within the teeth of a diverse group of 30 individuals, spanning different ages and genders. Notably, distinct differences in the individual levels of Al and Zn concentrations are evident.The content of Aluminum ranges from 1.735 (ppm) to 14.888 (ppm), with an average of 6.029 (ppm). ON the other hand, Zn concentration ragged from range from 19.900 (ppm) to 59.458 (ppm), with an average of 30.119 (ppm), As in Figure(1).

A 19-year female had the greatest Aluminum content, 14.888 (ppm), whereas a 35-year man had the highest Zinc concentration, 59.458 (ppm). A32-year man had the lowest Aluminum content of 1.735 (ppm), and a 52-year male had the lowest zinc concentration of 1.867 (ppm) female.

In terms of gender differences, there is no discernible trend in Aluminum and Zinc concentrations between males and females. In both genders, both minerals have a wide range of concentrations.
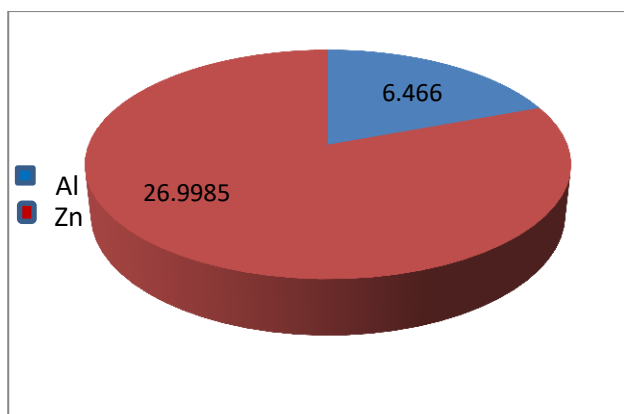
Figure(1): Aluminum and Zinc concentrations were compared based on the gender of the teeth samples.

Table (2): presents the correlation coefficients between the age of subjects and the concentrations of Aluminium and Zinc in 30 teeth samples obtained from healthy individuals.

Correlations		age(year)	Al	Zn
age(year)	Pearson Correlation	1	-0.153-	-0.123-
	Sig. (2-tailed)		0.345	0.449
Al	Pearson Correlation	-0.153-	1	0.288
	Sig. (2-tailed)	0.345		0.072
Zn	Pearson Correlation	-0.123-	0.288	1
	Sig. (2-tailed)	0.449	0.072	
	N	30	30	30

According to the Table(2),there are relationships between age (in years) and the variables Al and Zn. Furthermore, there is a relationship between the variables Al and Zn. The Pearson correlation coefficient between age and Al is -0.153, with a significance value (Sig.) of 0.345, suggesting that the observed relationship is not statistically significant. For both age and Al, the sample size (N) is 30.

Similarly, the Pearson correlation coefficient between age and zinc is -0.123, with a significance value (Sig.) of 0.449, indicating that the observed link is also not statistically significant. Both age and zinc have a sample size (N) of 30. The Pearson's correlation coefficient between Al and Zn, on the other hand, is 0.288, and the significance value (Sig.) is 0.072, which is close to the usual significance value The significance threshold represents a potentially moderately substantial relationship. However, At the conventional significance level, it is not statistically significant. Aluminum (Al) and Zinc (Zn) both have a sample size (N) of 30 people. The findings suggest a possible link between Al and Zn, however it falls short of statistical significance at 0.05.

In conclusion, the data show a little negative relationship between age and both Al and Zn, but this connection is not statistically significant. Furthermore, Al and Zn have a slight positive correlation that is not statistically significant.

Table (3): Describes the correlation coefficient between smoking status and aluminum and zinc amounts in 30 healthy persons' teeth samples, which were evaluated using the SPSS statistical tool.

Correlations		Smoking	Al	Zn
Smoking	Pearson Correlation	1	-0.191-	0.080
	Sig. (2-tailed)		0.237	0.623
Al	Pearson Correlation	-0.191	1	0.288
	Sig. (2-tailed)	0.237		0.072
Zn	Pearson Correlation	0.080	0.288	1
	Sig. (2-tailed)	0.623	0.072	
	N	30	30	30

According to the Table (3) provided, the correlation coefficient between smoking and Al is -0.191 (in both directions), indicating a slight negative relationship between the two variables. This relationship has a p-value of 0.237 (two-tailed), which exceeds the conventional significance threshold of 0.05, making it statistically insignificant. Regarding smoking and zinc, the correlation coefficient is 0.080, implying a very weak positive relationship between the two variables. The associated p-value is 0.623 (two-tailed), indicating that this association is not statistically significant. On the other hand, the correlation coefficient between Al and Zn is 0.288, demonstrating an average positive relationship between the two variables. This correlation has a p-value of 0.072 (two-tailed), making it marginally significant but not statistically significant at the conventional level.

To summarize, based on the provided data, there is no significant relationship between smoking and either Al or Zn. However, there appears to be a moderate positive correlation between Al and Zn, which is marginally significant but not statistically significant at the usual significance level. To summarize, there is no substantial association between smoking and Al or Zn based on the facts supplied. However, Al and Zn appear to have a moderately favorable association.

Table(4): Represent the correlation coefficient between gender and aluminum and zinc amounts in 30 healthy people's teeth using the statistical application SPSS..

| Correlations		Gender	Al	Zn
		Gender	Al	Zn
Gender	Pearson Correlation	1	0.193	0.007
	Sig. (2-tailed)		0.233	0.965
Al	Pearson Correlation	0.193	1	0.288
	Sig. (2-tailed)	0.233		0.072
Zn	Pearson Correlation	0.007	0.288	1
	Sig. (2-tailed)	0.965	0.072	
	N	30	30	30

A correlation analysis between three variables is shown in the table(4) gender, Al (Aluminum), and Zinc (Zn). Each correlation is accompanied by Pearson correlation coefficients, p-values (significance), and sample size (N) for the analyses.

The correlation between gender and Al yields a value of 0.193, indicating a minor positive connection. However, the p-value for this association is 0.233 (two-tailed), which surpasses the standard significance criterion of 0.05. Consequently, the association is not statistically significant at the customary significance level. Similarly, the correlation between gender and zinc results in a value of 0.007, representing a very weak positive relationship between the two variables, almost close to zero. The p-value for this relationship is 0.965 (two-tailed), suggesting that the observed link is not statistically significant.

Conversely, the correlation coefficient between Al and Zn is 0.288, demonstrating a reasonably strong relationship between the two variables. However, the p-value for this association is 0.072 (two-tailed), indicating that it is marginally significant but does not reach statistical significance at the usual level, As in figures(3) ,(4)

In conclusion, based on the presented data, there is no significant relationship between gender and either Al or Zn. Nonetheless, Al and Zn appear to have a reasonably positive relationship.
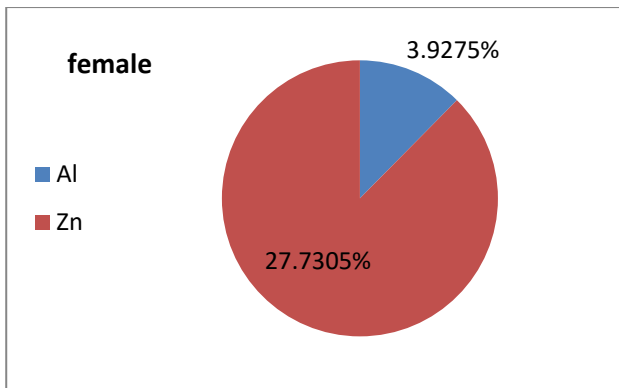
Figure (3): Comparison between the concentration of Aluminum and Zinc and samples of female teeth.
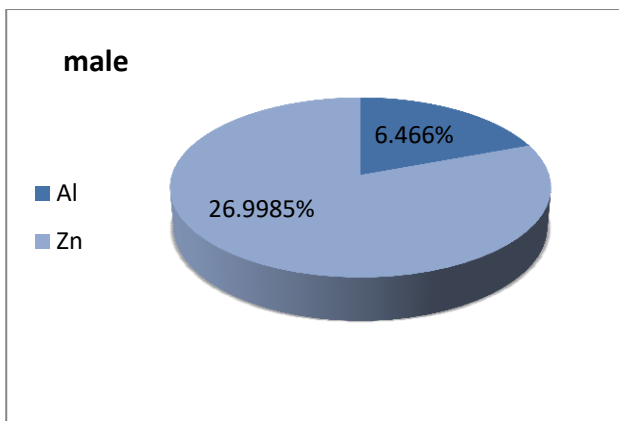
Figure (4): Comparison between the concentration of Aluminum and Zinc and samples of male teeth.

6. Conclusions

In the conclusive analysis of this study, our primary objective was to ascertain the levels of aluminum and zinc concentrations in samples of adult dentition. These samples underwent preparation and were subjected to analysis using atomic absorption spectroscopy.

The study's outcomes revealed the presence of both aluminum and zinc within the teeth samples, indicating their presence within the oral cavity. Importantly, the concentrations of aluminum and zinc exhibited variations among the samples, pointing towards individual disparities in exposure or physiological factors.

Notably, the findings related to aluminum emphasize the significance of monitoring its levels in teeth samples due to its association with enamel erosion and potential risks to dental health when exposed excessively. There is a need for further investigations to comprehensively understand the sources and impacts of aluminum exposure in the oral environment.

Conversely, zinc, being an essential trace element, was also detected in the teeth samples. Maintaining adequate zinc levels is crucial for oral health, as zinc deficiency has been linked to enamel defects and compromised immune function. Monitoring zinc levels in teeth samples can contribute to a better grasp of its importance in oral health and potential therapeutic applications.

Moreover, we observed variations in mineral concentrations among individuals, highlighting the possibility of differences in oral health, dietary habits, or environmental exposures. Analyzing the concentrations of aluminum and zinc in adult teeth samples enhances our understanding of the long-term effects of dental materials on oral health. The findings from this study can serve as a solid foundation for future research endeavors, exploring potential health risks or benefits associated with the presence of these metals in the oral environment.

7. Recommendation

1-Taking more teeth samples for each governorate of Iraq.

2. Other studies of teeth samples using other techniques.

3. Use teeth replacement bone to determine the concentration of Radon and heavy metals.

4. The sample size should be increased to improve the accuracy of the study.

5.Performed the determination of aluminum and zinc concentrations in adult dental samples using inductively coupled plasma mass spectrometry

(ICP-MS).ICP-MS is the most sensitive and accurate method to measure the concentration of metals in biological samples. It is also the most widely used method for measuring aluminum and zinc concentration in teeth.

6- Collect dental samples from healthy adult teeth, clean them to remove any surface debris, then use a dental drill to remove the enamel.

Grind the ivory into a powder using a mortar and pestle.

8. Reference

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