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The Trace Elements of Drinking Water and Longevity Phenomenon

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The narrative review explores how the level of trace element intake and its retention influence life expectancy and centenarian longevity of the blue zones (longevity hot spots) in Mayang, China in comparison to Ikaria Island. Both Mayang City in China and Ikaria Island have the greatest population of centenarians. Since the beginning of time, mankind has been interested in eternal life, and the answer may exist in these longevity hot spots like Mayang, China and Ikaria Island. Empires and civilizations were built on the promise of a 'forever life,' and many fundamental questions provided a basis to explore the trace elements of drinking water and the longevity phenomenon. Such fundamental questions derived from 'what warranties our existence,''what are we made of and 'can we live forever' which contribute to the quest for longevity. Though much is known about how some people reach old age compared to those who die relatively young, there is a need to further understand beyond 'Nature vs. Nurture.' Since genetics is not the only factor contributing to a long life, there must be other factors such as trace elements that allow humans to become centenarians. Collective results from different studies with a focus on water toxicity levels, nutrient intake, and centenarians' hair and urine may help determine the common denominator for the phenomenon of longevity, which may significantly contribute to the body of literature.

Keywords: Trace elements; drinking water; longevity; phenomenon metals; toxicity; oxidative stress; hemostasis.

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1. INTRODUCTION

This narrative review analyzes qualitative and quantitative research to understand the association between water composition, nutrients, and longevity. The fountain of youth is yet to be found which makes research about trace elements of water and longevity interesting. Though old fables narrate, little do we know that the answer may be right in front of us about the benefits of trace elements in drinking water. Metals consumed in the diet as well as in water create a heightened level of concern. Some people think that metals digested are beneficial, while others foresee the ingestion as metal toxicity. Though research shows that everything does not have to be a right or wrong correlation, there is a census that metals have a significant role in oxidative stress and homeostasis of the body's metabolism as it ages [1,2,3]. Therefore, this narrative review is essential to explore the level of trace element intake and its retention influence on life expectancy and centenarian longevity.

The human body cannot independently make trace minerals [4,5,6]. Minerals must be introduced to organisms via diet and water to ensure an appropriate balance which may be key to achieving longevity. Toxic heavy metals such as lead, mercury, arsenic, and even cadmium are needed in small quantities for different processes in the human body [1,6,3]. Some unknown elements, along with other essential metals like magnesium, nickel, and selenium play a role in the progression of diseases and preservation of functioning mechanisms in all ages. Research shows that it is important to understand how elements' nutritional status in metals connect with age-related diseases and the survival probability of how these trace elements benefit the human body [7,5,6,3]. Therefore, this narrative review is essential to analyze how the level of trace element intake and its retention influences life expectancy and centenarian longevity.

2. LITERATURE REVIEW

Since the beginning of time, fighting for survival and the purpose of it has been a mission to thrive and adapt. Even the greatest civilizations in history were dependent on the availability of fundamental demands like water for their prosperity and fertility. Civilizations have shown that there is a connection between landscape and people's development [5]. The great Egyptian civilization's achievements would not have been possible without the Nile River. Even though the Nile River is surrounded by desert, there are different environmental advantages like ideal soil for fruit trees and vegetation around the river shore that allows the prevalence of the bank's ecosystem. Historically, the Nile River flooded for half of the year leaving behind a deposit of a rich, brown layer of silt that was suitable for growing grains and even cotton after the six months of flooding. The Nile River was the life and health-giving source of water for drinking, cooking, and washing for every Egyptian which makes the area a great source of knowledge when considering the longevity of life and what makes us reach old age [4]. However, other factors, such as organ damaging bacteria and parasites, shortened the population's life expectancy which may have competed with the benefits that trace elements of drinking water may have contributed.

Water is essential for the body,which may have a promising connection to the longevity of life. Bacteria and parasites in water or other sources have the propensity to harm the body. For instance, historically, Schistosoma worms entered a human hostthrough the feet and legsto lay eggs in the bloodstream affecting the host's organs and making them susceptible to other diseases [4]. During earlier civilizations, life expectancy did not surpass 40 years of age which may be associated with the quality of trace elements in the water. According to the bone analysis of the Egyptians in burial sites, research found that the bones had a significant iron (Fe) deficiency causing anemia, whereby, iron deficiency is diagnosed by markers on the roof of the eye sockets or small holes on the top of the skull [4]. Even the wealthiest of the ancient Egyptians suffered from mineral deprivation due to their low dietary intake or blood-sucking parasites. Research further showed that their bones, especially the long bones, were frequently injured, such as having femoral fractures [4] such fractures likely resulted from compromised bone density due to a lack of sufficient trace elements. In addition tobarbaric treatment and different diseases such as toxicity from animal droppings, cooking and eating rodents, or traumatic punishment consisting of blows to the body, Egyptians suffered from unclean water, nutrients, and mineral deficiency that may have contributed to their poor life expectancy.

Egyptian drinking water may have been an important source of trace elements intake into

the body, but the poor quality of water may have had the greatest impact on people's health and short longevity. According to the Environmental Protection Agency, when measuring water quality, there are seven important factors to consider: pH, ammonia levels, bacteria in relation to nitrite and nitrate (autotrophic and heterotrophic), temperature, oxygen concentration, alkalinity, and source [7]. These factors fluctuate depending on geographic location, season, and population type (industrialized or rural) and may yield relevant information about longevity.

Groundwater is the main source of water in many longevity areas of the world. The water environment is the most basic, active, and broad influential factor in sustaining life. For example, great sources are the superannuated spring that supplies the residents of Dujiangyan City in China's Sichuan province, the densely vegetated Aba Forest, and the East Coast as well as the South [7]. Water from Abu Dhabi's glacier is the world's oldest water and has a smaller molecular group consisting of low deuterium, high dissolved oxygen, and a variety of life that meets the needs of human nutrition and health standards for drinking water [7]. In analyzing the distribution of these water sources, it is imperative to consider that when water travels within the soil plaques, the concentration of metals and heavy particles increases in the solution. Therefore, it is beneficial for this narrative review to evaluate how the level of trace element intake and its retention influence life expectancy and centenarian longevity.

Research shows that a case study was conducted on the effects of drinking water quality on the health and longevity of people in Mayang, Hunan Province, China, which focused on trace elements associated with longevity, health benefits, and diseases like cancer [6]. Research, was also conducted on the quality of trace elements in drinking water on Ikaria Island. Outcomes of the research conducted on residents of Mayang, China and Ikaria Island revealed the greatest population of centenarians [4,1,6,8,9]. The research showed interesting information about trace elements and the body’s inability to produce them independently. The research elaborated on the fact that trace elements cannot be manufactured by the human body itself wherein they are derived from the natural environment in which water is a major source of trace elements for the growth of biological organisms [6]. Without a doubt, water sources have an impact on our health and may be a major component of longevity as well as a propensity for disease. For example, areas with a high incidence of gastric cancer had an increased concentration of Cu, Fe, Sr, Ti, and V in the water compared with the areas of low incidence while places with a low occurrence of gastric cancer had a high concentration of Se and Zn in water [6]. Hence, research exploring the level of trace intake and its retention influence on life expectancy and centenarian longevity is important to enhance the literature.

The quality of trace elements in water may show a connection to life expectancy and longevity. Research shows that even though Fe and Sr concentration is elevated in places with a high incidence of gastric cancer, those elements are also increased in other locations with very high longevity rates. The daily intake of Ca, Cu, Fe, Se, and Sr rich waters (weak alkalinity) had an extremely significant positive relationship with the centenarian index of 100/80% and 100/90%.Perhaps the positive relationship was linked to the presence of Se (Selenium) which is an antioxidant that prevents excessive peroxide damage and cancer or the mixed-match combination of the different elements [6]. Literature shows that Se (Selenium) is known to protect blood vessels. Since Se (Selenium) is beneficial for blood vessels, research shows that it is an anti-cancer element because it has an impact on the immune system and can directly kill tumor cells [6]. Therefore, studying centenaries is very important to determine what can potentially increase longevity. Not only is the intake of the different trace elements important, but also the excretion and clearance are essential.

Research showed that essential outcome measures of trace elements must consider water hydrochemistry types and analysis of drinking water and groundwater. There are great influences placed on studies that focused on various pH values, inorganic indexes such as but not limited to (K^+, Na^+, Ca^{2+}, Mg^{2+}, Cl^-, I^-, F^-, SO_4^{2-}, HCO_3^-, NH_4^+, NO_3^-, NO_2^-) total dissolved solids [TDS], total hardness [TH], total Fe [TFe], Cu, Pb, Zn, Mn, Cr^{6+}, Cd, Hg, As, Se, Br, Li, Sr, H_2SiO_3 and free CO_2 [5,1,6]. Few studies have been conducted that analyzed the relationship between concentrations of elements in drinking water and longevity. However, the correlation coefficients between concentrations of macro and microelements in drinking water and longevity index with inclusivity and high

range comparison of different groups were compared (e.g., women, men, elderly, and young candidates) [4,1,2,8]. Since there are limited studies on trace elements of drinking water in correlation with longevity, this narrative review is beneficial to reduce the knowledge gap.

There may be a connection between longevity and the trace element of drinking water. As we age, our organs suffer overloads and decay which can cause retention of water [5,2]. Poor filtering of the kidneys can cause major health issues. Data suggests that the accumulation of several heavy metals can potentially represent a risk factor for human life extension [4,6]. Excessive urinary excretion of metals (Cu and Cr) might result in low-level exposure in vivo and contribute to longevity [1]. Therefore, having a urinary analysis is necessary to assess trace elements in drinking water that are effective and ineffective for the longevity of a centenarian.

The centenarian prevalence is the proportion of centenarians per 100,000 inhabitants which will be explored in this narrative review. The proportion of centenarians will be considered because it reflects longevity in a total population within a given area and enables comparisons with other areas. The longevity index will be reviewed to understand the calculation of the ratio of the population greater than 90 years to the population over 65 years which will be calculated, when applicable, to reflect the relative elderly population ratio. The longevity index will be represented to show the continuity of longevity and the centenarian prevalence. The longevity index will be explored to assess the longevity phenomenon and the structure of the population. The research focused on the available data on the longevity areas of Mayang, China and Blue zones (longevity hot spots) and Ikaria Island to whether there is a correlation between trace elements of drinking water and longevity.

3. DESIGN AND METHODS

The design and method consisted of a narrative review that explored how the level of trace element intake and its retention influence life expectancy and centenarian longevity. A literature review was conducted by using Saint James School of Medicine Library Resources as well as the FIU article system. Thesearch was performed by using the PubMed and EMBASE databases using text words “aged”, “80and over,”“Mayang, China,” “Ikaria Island,”“drinking water,”“groundwater,” “longevity,” “longevity regions,” “trace elements,” “water,” “toxicity,” “centenarians,” “nature vs.nurture,”“nutrients” with the use of the Boolean Operator "AND" the term water quality. The inclusion criteria consisted of 1) Peer-reviewed sources; 2) relevant articles in the last 25 years;3) articles published in the English language only; 4) males and females who achieved centenarian; and 5) centenarians residing in different Mayang, China and Ikaria Island.

There were 50 articles identified that consisted of quantitative and qualitative studies. Of the 50 articles, 41 were excluded by abstract screening because the articles were unrelated to the focus of this narrative review. The remaining nine were reviewed to ensure that the literature focused on how the level of trace element intake and its retention influence life expectancy and centenarian longevity. Nine articles yielded data that was tabulated to create tables that were reflective of the retrieved information. Efforts were made to expand the search for other articles with relevant data by reviewing the reference lists of the selected nine articles. There were no additional applicable data. The final inclusion of articles in this narrative review was nine which were selected based on the relevance of information about the level of trace element intake and its retention influence on life expectancy and centenarian longevity.

4. RESULTS

The results of this narrative study focused on trace elements of drinking water and longevity phenomenon. The longevity of individuals living in a region in the Western part of Hunan Province in China (Mayang, China) and Ikaria Island was explored due to historically having the greatest populations of centenarians. The results revealed various trace elements of drinking water and longevity. The following figures and tables provide relevant data to support the benefits of identifying the trace elements of drinking water and longevity phenomenon.

The results in the area in Fig. 1 are known for having a significant amount ofcentenarians [1,6]. Fig. 1 provides the region (Mayang, China) with a source of pH of the water asweak alkaline (pH7.2) and almost blood pH (7.35-7.45). The region is proven to contribute to health and well-being especially in the elderly by maintaining soft blood vessels (avoiding hardening of the vessel walls), low blood pressure, and normal pulse.

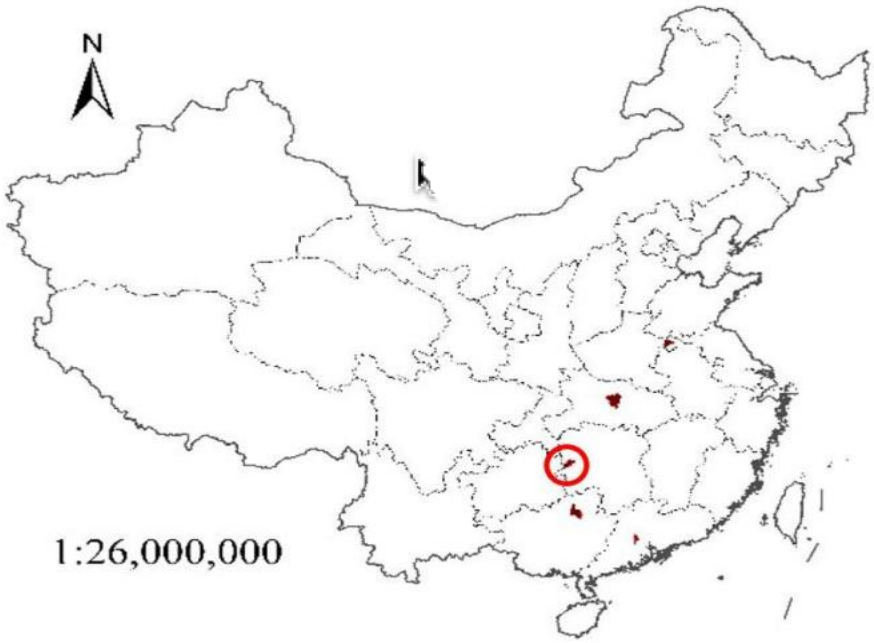

Fig. 1. Map of Mayang County, Northwest of Huaihua City, Western part of Hunan Province in China

Note. Fig. 1 adapted from Lu & Yuan [6]

Table 1. Binomial logistic regression analysis of DCEs

Elements	Odds ratio	95% CI	Significance (p-value)
Cr	3.097	1.243-7.716	0.015
Mn	2.663	1.127-6.293	0.026
Cu	3.439	1.518-7.792	0.003
Zn	3.305	1.416-7.714	0.006
Tl	0.076	0.019-0.296	<0.001
Constant	0.823		

Note. Table 1 is adapted from Li, Hu, Lin, Yang, Zhou, et al. [1]

The data from the region may yield results that provide answers to the race elements of drinking water and longevity.

Results from Table 1 show the binomial logistic regression analysis of trace elements that are known to be essential for human health. Urinary ionic analysis reveals a new relationship between minerals and longevity in a Chinese population [1,6]. The trace elements are identifiable in the selected longevity population's urine which showed increased quantities, especially Cr and Cu. Trace elements of Cr and Cu are crucial for a variety of metabolic processes in aging which are necessary for inflammatory and oxidative processes. An imbalance of Cr or Cu can lead to damage to cells and tissues suggesting that accumulation, as well as excretion of a variety of heavy metals, might be a potential risk factor for life extension or contribution to longevity.

The data from Table 2 shows the water analysis results and national WHO guidelines values. The results in Table 2 provide a national standard in comparison to the water quality in Mayang, China. Table 2 also provides the WHO guidelines values in relation to the water quality in values in Mayang, China. An interesting fact revealed in Table 2 is that the pH is 7.21 in Mayang, China, the pH for the national standard is 6.5-8.5, and the pH value for the WHO guideline values is 6.5-9.5. The pH level including the other trace elements outlined in Table 2 is relevant to understanding the trace elements of drinking water and longevity. The data in Table 2 is relevant because residents of Mayang, China have a population of centenarians which may

Table 2. The water quality in Mayang, China

	Mayang	National standard		WHO guideline values	
		Value	CR (%)	Value	CR (%)
pH	7.21	6.5-8.5	100	6.5-9.5	100
F (mg/L)	0.072		—	≤1.5	100
Ba (mg/L)	0.196	≤0.7	100		—
Cd (mg/L)	ND	≤0.005	100	≤0.003	100
Co (mg/L)	ND	≤1	100		—
Cr (mg/L)	ND	≤0.05	100	≤0.05	100
Cu (mg/L)	0.018	≤1	100	≤2	100
Fe (mg/L)	0.074	≤0.3	93.33	≤2	100
Mn (mg/L)	ND	≤0.1	100	≤0.4	100
Mo(mg/L)	ND	≤0.07	100	≤0.07	100
Na (mg/L)	15.70	≤200	100	≤200	100
Ni (mg/L)	0.004	≤0.02	100	≤0.07	100
Pb(mg/L)	ND	≤0.01	100	≤0.01	100
Se (ug/L)	0.872	≤10	100	≤10	100
Zn(mg/L)	0.009	≤1	100	≤3	100

Note: ND denotes "not detected"; CR denotes "compliance rate".
Note: Table 2 is adapted from Lu & Yuan [6]

Table 3. Daily element intake from drinking water for the residents in Mayang, China

Element	Daily intake amount	National average daily intake from beverage and water
Ba(mg)	0.37	0.064
Ca(mg)	134.21	30.8
Cr(ug)	-	3.2
Cu(mg)	0.04	0.01
Fe(mg)	0.11	0.1
K(mg)	8.78	10.2
Mg(mg)	31.96	16.3
Mn(mg)	-	0.18
Mo (ug)	-	3
P (mg)	0.08	3
Sr(mg)	1.13	0.18
Zn (mg)	0.007	0.18
Se(ug)	1.77	0.5

Note: Table 3 is adapted from Lu & Yuan [6]

provide answers to the longevity phenomenon [4,1,6,3].

The data from Table 3 shows the daily element intake from drinking water for the residents in Mayang, China. The data shows that high-quality water, as well as the environment, are important factors for the emergence of a large number of centenarians [6]. The data provides the daily intake amount in comparison to the national average daily intake from beverages and water. Such correlation is essential to recognize the importance of identifying relevant trace elements of drinking water that result in longevity.

The results of Table 4 show the correlation coefficient between the concentration of elements in drinking water and different population indices. The data shows the concentration in water for various trace elements. The correlations present the trace elements' concentration levels of 80/60%, 90/60%, 100/80%, and 100/90%. Such relevant data provides pertinent proof to determine that high concentration values of Mg, Sr, and Se are closely related to longevity.

The data in Table 5 shows the trace elements from a Greek island which is located to the west in the Aegean Sea, which is referred to as Ikaria Island. The data in Table 5 is showing that there is a difference in trace elements of drinking waterin this region as compared to that of the world. The different trace elements in drinking

water may provide pertinent information about the longevity phenomenon. The following data was extracted from Geothermal Systems and Energy Resources from Turkey and Greece [9]. Pliocene tourmaline rhyolite dykes from Ikaria Island in the Aegean back-arc region show the composition of water dykes analyzed by XRF [8]. Trace elements of Sr, Rb, and Mg show that there may be a relation between these minerals and longevity. The results in Table 5 are relevant because Ikaria Island has one of the greatest populations of centenarians in the world.

Table 4. The correlation coefficient between the concentration of elements in drinking water and different population indices

Concentrations in water	80/60%	90/60%	100/80%	100/90%
Ba	0.334	0.296	0.436	0.329
Ca	0.079	-0.050	0.471	0.494
Cu	0.290	0.468	-0.314	-0.420
Fe	0.329	0.271	0.292	0.273
K	0.105	-0.292	0.361	0.491
Mg	-0.204	-0.166	**0.710****	**0.717****
Ni	0.322	-0.153	-0.168	0.062
Pb	-0.013	-0.052	-0.227	-0.253
Sr	-0.344	-0.411	**0.643***	**0.749****
Se	-0.006	-0.169	**0.717****	**0.731****

*Note: ** Indicates a significant correlation at p = 0.01 level; * Indicates a significant correlation at p = 0.01 level*
Note. Table 4 is adapted from Lu & Yuan [6]

Table 5. Representative chemical analysis of the Ikaria Island rhyolitic dykes (Major Elements in wt %), Trace Element in PPM

	XRF		LA-ICP-MS
SiO_2	73.15	Rb	219
TiO_2	0.2	Sr	140
Al_2O_3	13.88	Y	47
Fe_2O_3	1.37	Zr	65
MnO	0.03	Nb	12.3
MgO	0.32	Ba	355
CaO	1.42	La	16.1
Na_2O	3.46	Ce	30.6
K_2O	3.92	Pr	3.58
P_2O_5	0.06	Na	13.0
LOI	0.7	Sm	3.23
Sum	98.50	Bu	0.437
		Gd	3.30
	XRF	Tb	0.615
Sc	3	Dy	5.03
V	10	Ho	1.41
Cr	11	Er	4.94
Co	20	Tm	0.850
Ni	4	Yb	5.04
Cu	1	Lu	0.857
Zam	26	Hr	2.29
Ga	17	Ta	2.18
		Pb	65
		Th	18.2
		U	6.80
TIMS			
$^{87}Sr/^{86}Sr$	0.708440±10		
$^{143}Nd/^{144}Nd$	0.512235±10		

Note. Table 5 is adapted from Baltatzis, Kostopoulos, Godelitsas, Zachariadis, & Papanikolaou [8]

Table 6. Final cluster centers

Cluster	pH	EC	NO_3	SO_4	HCO_3	Cl	SiO_2	Ca	K	Na	Mg
1	6.73	44812	0.1	2627	171	19134	23	1257	373	10630	838
2	7.36	3354	4.5	162	133	950	20	108	24	633	66

Parameters in mg/L, EC in µS/cm

The data in Table 6 provides information about the final cluster centers. The cluster centers provide parameters to show the variation of existing trace elements. A comparison is made for the cluster centers to show the trace elements and the pH comparison with other locations. The data in Table 6 is significant to refer to the specific trace elements to identify whether there is a correlation with longevity. The data from Table 6 may help explain the specific trace elements within the drinking water, which may contribute to advancement in recognizing the longevity phenomenon.

Table 6 is adapted from Baltatzis, Kostopoulos, Godelitsas, Zachariadis, & Papanikolaou [8].

5. DISCUSSION

The data analysis and results from Fig. 1 and Table 1 through Table 6 provide insight into details of the tests performed in the different regions' drinking water. The data showed weak alkaline properties and suggestive high quality of the drinking water. Data from Table 1 through Table 6 showed sample characteristics that matched with the populations' characteristics which consisted of residents of advanced agecentenarians. According to data from Table 1 through Table 6, the intake of Cu, Fe, Ca, Se, and Sr was higher than normal in these longevity areas compared to the national average. The 100/80% and 100/90% centenarian index had another similitude whereby they had an increased intake of Mg, Sr, and Se. The results of this study, along with additional literature, revealed that magnesium is used in hundreds of biochemical reactions in our body to maintain muscles, nerves, immune system, steady heart rate, and bone integrity while helping with glucose levels [4,1,2,3]. Strontium is under calcium (Ca) in the periodic table and therefore, has a very similar composition. The Tables (Table 1 through Table 6) show a strong presence of strontium which is a key trace element that is vital in bone formation because it slows the breakdown of old bones which may be key to longevity. According to research, strontium is essential for women with osteoporosis because the body is unable to absorb it and thus, stores it for later use [3].

The data in Fig. 1 showed the pH of the water was alkaline (pH7.2) which is almost similar to blood pH (7.35-7.45). Research shows that the values were beneficial for the elderly in the regions which may contribute to their longevity. The correlation of the values to longevity may have contributed to the well-being of the elderly in Mayang, China, whereby the alkaline water and blood pH may help in maintaining soft blood vessels (avoiding hardening of the vessel walls), low blood pressure, and normal pulse [6]. The data in Table 1 through Table 4 showed that Mayang, China had a greater calculated intake of daily metals than the national average intake of Ca, Cu, Fe, Se, and Sr. Such data is relevant to understand how trace elements are essential for the human body. For instance, Table 1 shows essential binomial logistic regression analysis of trace elements that are beneficial for the human body. Based on the data, it is reasonable to conclude that there is a strong correlation between trace elements and longevity in the Chinese population. Data from the table with existing literature shows that Cr and Cu are essential for the body. An imbalance of the Cr and Cu trace elements can lead to damage to cells and tissues, which leads to the accumulation and excretion of heavy metals that may cause potential risk factors for life extension or decreased longevity [6,3].

The results from Table 1 through Table 6 show the existence of selenium as a trace element in drinking water. Selenium is essential in many proteins and enzymes (selenoproteins) for the synthesis of DNA and cell protection against infections. Selenium is significant for the thyroid hormones and even in reproduction. Thus, calcium (Ca) and iron (Fe) have a direct impact on human health. The data in Table 1 through Table 6 shows the same results of Ca and Fe since the concentration of those two metals is present in high quantities in the drinking water of Mayang, China, and Ikaria Island. The data in Table 1 to Table 6 shows that there was a concentration of metals, specific calcium. According to the literature, there was a low incidence of rectal cancer, gastric cancer, breast cancer, and acute myocardial injury in the

regions [6]. Table 1 through Table 6 revealed an important finding in the amount of iron (Fe). The presence of iron is necessary because, without iron, there is a failure of many major metabolic processes and as a consequence, there can be a development of anemia and chronic diarrhea. Furthermore, iron deficiency can cause an increase in gastrointestinal loss of trace elements which may impact longevity.

In a comparison analysis, data in Table 2 and Table 5 show similar trace elements though the drinking water is from different regions Mayang, China (Table 2) and Ikaria Island (Table 5). Both regions have the greatest populations of centenarians in the world. The daily intake of trace elements from water for residents in Mayang, China (Table 2) compared to residents in Ikaria rhyolitic dykes (Table 5) provides unique findings that may be associated with the longevity phenomenon for those regions. The correlation coefficient proves that Mg, Sr, and Se in drinking water have an extremely significant positive relation with two centenarian indexes: 100/80% and 100/90% which are significant findings [4,6,9]. There was a weak negative correlation between the two longevity indexes 80/60% and 90/60% which shows some similar specific trace elements [4,6,9]. Even the specific budding of two or more elements may be the reason why these individuals have a much extended lifespan.

Data revealed from Table 1 through Table 5 show that high-quality water, as well as the environment, are important factors for the emergence of a large number of centenarians [6]. Even though the magma under Ikaria's dykes is slightly acidic, there is an elevated pH in the island center. The data shows a slight difference in pH and mineral concentrations in the water. However, the pH on Ikaria Island is almost similar to the pH in Mayang, China which may be the basis for the longevity in both regions. Interestingly, the data in Table 2 and Table 5 illustrate the presence of a great variety of trace elements as well as an elevated concentration which may be the reason the regions have the greatest population of centenarians. While it is frequently argued that genes are the most important factor in longevity, some may agree that the environment is key to growing old and potentially becoming a centenarian.

The data shows that factors associated with hair, urine, and intake of trace elements from the water in these areas had great significance in the elderly. The trace elements of Mg, Sr, and Se seemed to be the elements with the most benefits that had the greatest concentration and co-occurrence. The right combination of metal supplementation according to an individual's age and metabolism may hold the key to discovering the formula to slow down our expiration date. Thus, cluster centers as revealed in Table 6 may yield promising efforts to identify specific trace elements that contribute to becoming a centenarian. Therefore, this narrative review was essential to explore the trace elements of drinking water and the longevity phenomenon.

6. RECOMMENDATION FOR FUTURE RESEARCH

There is a significant need for future research to be conducted to identify trace elements of drinking water that correlate with longevity. Research is needed to explore how trace elements in drinking water have similarities and differences for other regions in the world compared to Myang, China and Ikaria Island. There is a need to assess the specific trace element required to promote and maintain the continuation of cellular and tissue function to sustain the longevity of life. Future research on trace elements in correlation with health associations to delay health ailments would be essential. Though many studies have focused on longevity, genomics, aging of sociology, and health status in the lifestyle of the geriatric population, few studies have concentrated on the association between longevity and trace elements in food, which should be explored. Future research identifying a correlation between trace elements and concentration of them that help prevent the likelihood of breast, colon, lung, or prostate cancer may yield interesting findings. Though it is a known fact that brain neurons do not regenerate, groundbreaking future research on trace elements that help regenerate neurons will set a new precedence in the medical field. While this narrative review was important to enhance knowledge about the trace elements of drinking water and the longevity phenomenon, future research is needed to expand the body of literature.

7. LIMITATIONS OF RESEARCH

The trace elements of drinking water and the longevity phenomenon is essential to understand the possibility of a correlation. Though there

seems to be a correlation between trace elements of drinking water and longevity phenomenon, continued research is needed. Though this narrative research contributes to the body of literature, there are limitations. There was a lack of comparison to multiple regions worldwide to make a definitive conclusion that specific trace elements will guarantee longevity. A limitation existed with directly analyzing the trace elements to assess the values to make a correlation with centenarians. Though this narrative review had some limitations, the research contributes to the literature to conclude that trace elements of drinking water may correlate with longevity.

8. CONCLUSION

The narrative review explored trace elements of drinking water and the longevity phenomenon. Since the dawn of civilization, humans have evolved and adjusted to their surroundings and environmental factors had an impact on their genetics as well as survival. There may be a significant positive association between trace elements in drinking water and becoming a centenarian. Recognizing the benefits of trace elements may be essential. Therefore, great consideration should be geared toward the following:

1) Alkalinized water with essential in-ground minerals, not chemically enhanced;
2) Organic nutritious grains, proteins, and fruits; and
3) Intake of Mg, Sr, and Se in high concentrations (supplements or dietary intake).

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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