Derna Academy Journal for Applied Sciences

E-ISSN: 3006-3159

DAJAS

A Comparative Study Between Zinc Level and the Number of Neutrophils and Lymphocytes.

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Volume: 3 **Issue: 1** **Page Number: 39 - 47**

Keywords:
Immunodeficiency, Zinc deficiency, Immune cells, Neutrophil and Lymphocytes.

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Received: 20\11\2024
Accepted1: 05\12\2024
Published: 11\01\2025

DOI: https://doi.org/10.71147/hxy1dz86

ABSTRACT

Background: Zinc deficiency can weaken the immune response and increase the risk of infection, while adequate levels enhance the activity of immune cells and their ability to fight diseases. Objective: This work aims to study the effect of low zinc levels on the number of immune cells by comparing zinc levels with the numbers of some immune cells (neutrophils, lymphocytes). Materials and methods: Data were collected from 99 random individuals in Tarhuna Teaching Hospital, using a questionnaire, zinc analysis was performed, and a complete blood count (CBC) was examined. Results: The results found that 68.68% of the total cases were normal for zinc levels, while 23.23% were low, 72.73% have normal lymphocyte levels, while 7.07% have low levels, 56.57% have normal neutrophils levels, while 1.01% were low. Conclusion: According to the study results, it showed that in the cases with low zinc levels there were no suffering from low numbers of immune cells (Neutrophil, lymphocyte). Also, it has been showed that individuals with low zinc levels suffer from higher rates of fatigue and hair loss. In addition, low lymphocyte levels were associated with increased dry skin and frequent diarrhea, indicating weak immunity. Low neutrophil levels were not associated with these symptoms.

1. INTRODUCTION

Immunodeficiency is a condition in which the immune system cannot effectively fight off infections and diseases. This condition can be classified as either congenital (inherited) or acquired (Abbas, Lichtman, and Pillai, 2016). Immunodeficiency results from deficiencies or a complete absence of certain components in the immune system, including phagocytes, the complement system, and lymphocytes. There are two main types of immunodeficiency: primary and secondary.

Primary immunodeficiency arises from inherent deficiencies in components of the innate or adaptive immune systems. In contrast, secondary immunodeficiency is the result of various factors, such as steroid disorders, malnutrition, obesity, acquired immunodeficiency syndrome (AIDS), or other viral infections (Vaillant and Qurie, 2023). Malnutrition significantly contributes to secondary immunodeficiency. For instance, protein-energy malnutrition negatively affects cell-mediated immunity and the process of phagocytosis. Although individuals may still consume microorganisms, the ability of phagocytic cells to eliminate intracellular pathogens is compromised. Nutritional deficiencies are also associated with conditions such as cancer, burns, chronic kidney disease, multiple traumas, and ongoing infections (Rehman et al., 2017).

Zinc is an essential mineral vital for human health, particularly in synthesizing various enzymes and proteins. It plays a critical role in supporting the immune system, cellular growth, and wound healing (Wessels et al., 2020). Deficiencies in zinc and iron can severely impair immune function, leading to a decrease in delayed cutaneous hypersensitivity. Additionally, supplementation with certain vitamins—especially B6 and B12—along with selenium and copper, is vital for the normal functioning of the immune system (Rehman et al., 2017). The prevalence of zinc deficiency varies between developing and developed countries, with significantly higher rates reported in developing nations. This discrepancy is mainly due to differences in diet, income levels, and access to healthcare. Estimates suggest that between 17% and 30% of individuals in developing countries suffer from zinc deficiency (Lowe et al., 2024), while only 1% to 3% are affected in developed nations. This difference can be attributed to a more varied diet and better access to zinc-rich foods, such as dairy products and meat, in developed countries (Wessells and Brown, 2012). Zinc deficiency negatively impacts the immune system's effectiveness. As a key mineral involved in numerous biological processes, zinc enhances immune function by aiding in the production of antibodies, supporting the inflammatory response, and being essential for the creation and activation of immune cells, including T and B cells (Prasad, 2008; Baarz and Rink, 2022). A lack of zinc can reduce immune cell activity, making individuals more susceptible to illnesses and infections. It may also lead to inadequate immune responses against various pathogens, including bacteria and viruses (Maywald and Rink, 2022). Research indicates that zinc deficiency can diminish the body's overall resistance to infectious diseases, potentially increasing the risk of respiratory infections such as pneumonia and the common cold. Children and the elderly are particularly vulnerable to zinc deficiency due to their specific dietary needs and reduced capacity for nutrient absorption (Ibs and Rink, 2003).

The aim of the study:

This study aimed to:

- Determine the effect of low zinc levels on the immune system by comparing zinc levels with the numbers of some immune cells (neutrophils, lymphocytes).
- Understanding The extent to which symptoms fit with reduction of zinc level and immune cells count.

2. METHOD

Study area and sample size:

This study was conducted on 99 random samples in Tarhuna Teaching Hospital from 16/5/2024 to 27/6/2024.

Data collection:

Interrogation and investigations were conducted by using a questionnaire and analysis collected random samples to obtain clinical data.

Blood sample collection:

Blood samples were drawn from 99 random samples in two tubes (plain tube and EDTA containing tube).

Laboratory tests:

Zink level, lymphocyte count and Neutrophils count have been performed for each of participant individuals.

Statistical analysis:

The Statistical Package for Social Science version 20 (SPSS) software for biostatistics analysis was used to achieve valid and reliable results, P value < 0.05 were considered significant), the obtained data were presented as tables and figures.

3. RESULT

This study was conducted on 99 randomly selected volunteers (45males and 54 females) as shown in Figure 1

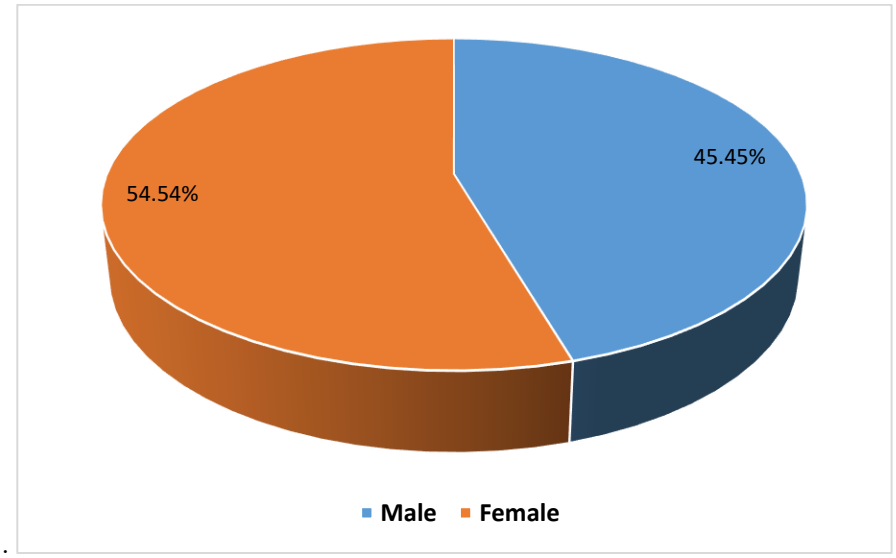

Figure 1: Distribution of study sample according to gender.

Regarding to age, cases from 21 to 30 years were the most represented in the sample at 44.44%; As the study sample is split into six age groups, as indicated in figure 2.

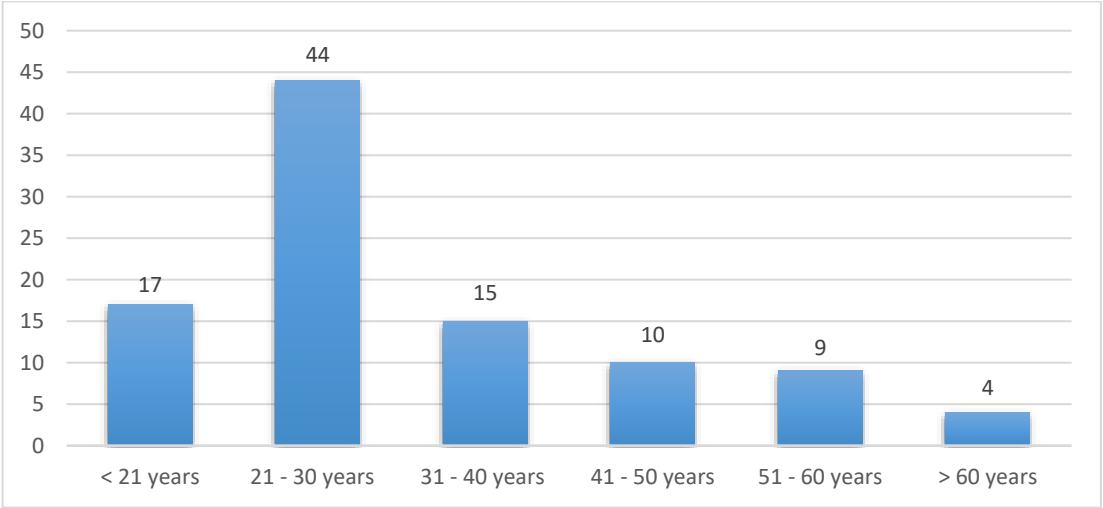

Figure 2: Distribution of Study Sample by Age.

The results of current study indicate that the majority of individuals (68.68%) have normal zinc levels in their blood, while 31.32% have abnormal levels (23.23% low and 8.08 high levels), as demonstrated in the figure 3.

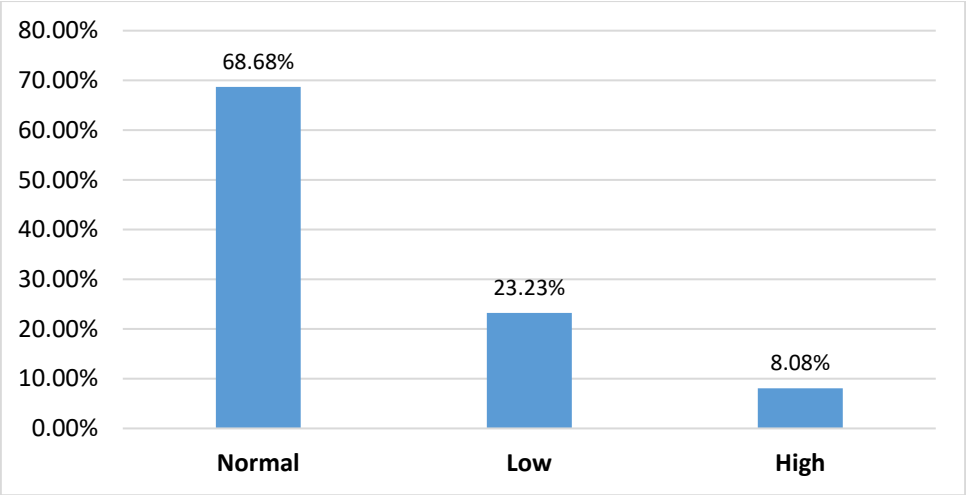

Figure 3: The distribution of measured zinc levels (normal, low, and high) in mg/dl.

The results indicate that the majority of individuals (72.73%) have normal lymphocyte count, while 27.27% have abnormal levels, as figure 4 shows that.

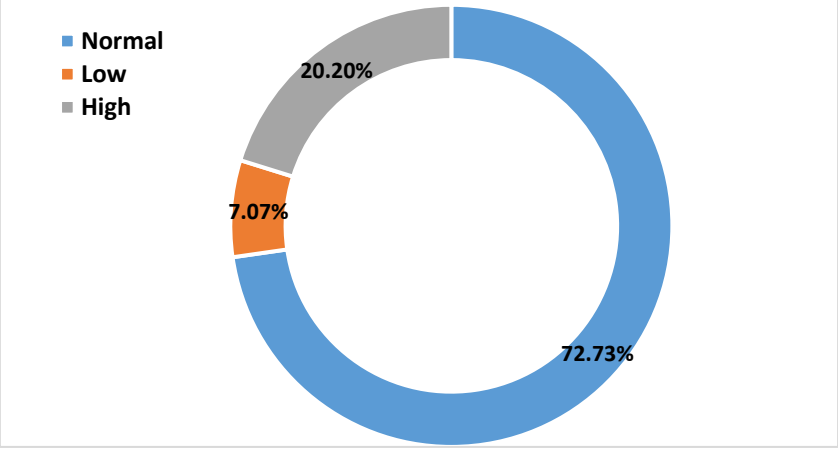

Figure 4: Proportion of Lymphocyte results.

On regard to Neutrophils, the findings indicated that more than half of the individuals (56.57%) have normal neutrophils levels, while 43.43% have abnormal levels, as illustrate in figure 5.

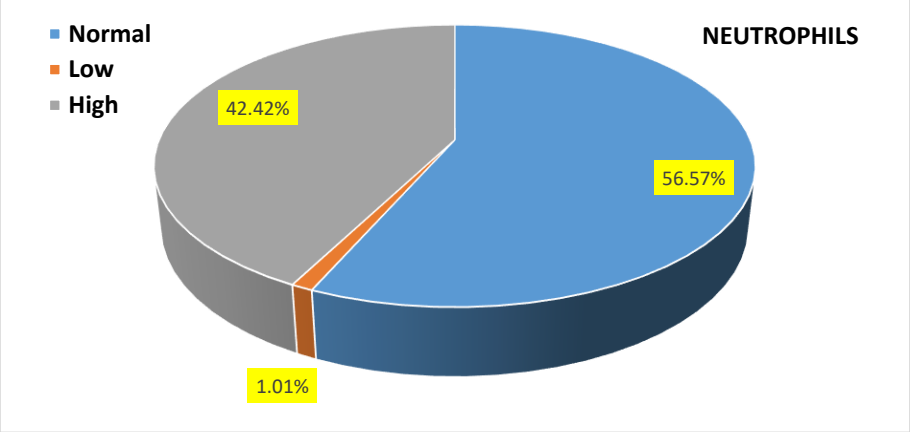

Figure 5: the distribution of neutrophils levels among study sample.

Based on the table 1, 69.12% of individuals with normal zinc levels also have normal lymphocyte levels. 10.29% of individuals with normal zinc levels have low lymphocyte counts, 20.59% of individuals with normal zinc levels have high lymphocyte counts. 82.61% of individuals with below-normal zinc levels have normal lymphocyte counts, while 17.39% has high lymphocyte count, however no cases were observed of individuals with below-normal zinc levels. On the other hand, 75.0% of cases with more than the normal of zinc level has normal lymphocyte count, while 25.0 % of individuals have high lymphocyte count. A chi-square test was conducted to determine if there is a statistically significant relationship between zinc levels and lymphocyte counts. The p-value was 0.432. Although the distribution differences between groups appear substantial (especially for individuals with below-normal zinc levels, where all cases had normal lymphocyte counts), the p-value of 0.432 indicates that this relationship is not statistically significant at the conventional confidence level (typically 0.05). In other words, the null hypothesis cannot be rejected, which states that there is no true relationship between zinc levels and lymphocyte counts.

Table 1: Crosstabulation between ZINC levels in mg/dl and LYMPHOCYTES levels.

ZINC mg/dl * LYMPHOCYTES Crosstabulation					
		LYMPHOCYTES			**Total**
		Normal	**Low**	**High**	
ZINC mg/dl	**Normal**	47(69.12%)	7(10.29%)	14(20.59%)	68
	Low	19(82.61%)	0	4(17.39%)	23
	High	6(75%)	0	2(25%)	8
Total		72(72.73%)	7(7.07%)	20(20.20%)	99

Crosstabulation between zinc level and lymphocyte count as shown in the table 2 according to the gender represents females, 71.43 % with normal zinc levels have normal lymphocyte, while 11.43 % have less than lymphocyte levels. Among those with normal zinc levels, 17.14% have normal lymphocyte levels. However, 86.7 % of low zinc Level have normal lymphocyte, while 13.3 % have high lymphocyte and no cases have low lymphocyte count. On the other hand, for males, 66.66% with normal zinc have normal lymphocyte, and 9.1% of normal zinc have less than lymphocyte. While 75.0% of less than zinc levels have normal lymphocyte count and 25.0% have high lymphocyte count. As with females, all males with below-normal zinc levels had normal lymphocyte levels.
Regarding the statistical results for males a p-value was 0.881 and females: a p-value was 0.598. This indicates no statistically significant difference between zinc levels and lymphocyte levels in females and males.

Table 2: Crosstabulation between ZINC levels in mg/dl and LYMPHOCYTES levels according to the gender.

ZINC mg/dl * LYMPHOCYTES * Gender Crosstabulation						
Gender			**LYMPHOCYTES**			**Total**
			Normal	**Low**	**High**	
Female	ZINC mg/dl	Normal	25(71.43%)	4(11.43%)	6(17.14%)	35
		Low	13(68.67%)	0	2(13.33%)	15
		High	3(75%)	0	1(25%)	4
	Total		41(75.93%)	4(7.41%)	9(16.66%)	54
Male	ZINC mg/dl	Normal	22(66.66%)	3(9.10%)	8(24.24%)	33
		Low	6(75%)	0	2(25%)	8
		High	3(75%)	0	1(25%)	4
	Total		31(68.89%)	3(6.67%)	11(24.44%)	45

The data represented in the table 3 shows the distribution of zinc levels and neutrophil levels among different groups: it clear that individuals with normal zinc levels: 58.82% have normal neutrophil levels, while 1.5%have below-normal neutrophil levels. While individuals with below-normal zinc levels: 47.83%have normal neutrophil levels, and no one has below-normal neutrophil levels. Statistical analysis: p-value was 0.816 which indicates no statistically significant difference between zinc levels and neutrophil levels.

Table 3: Crosstabulation between ZINC levels in mg/dl and NEUTROPHILS levels according to the gender.

ZINC mg/dl * NEUTROPHILS Crosstabulation					
		NEUTROPHILS			Total
		Normal	Low	High	
ZINC mg/dl	Normal	40(85.82%)	1(1.47%)	27(39.71%)	68
	Low	11(47.83%)	0	12(52.17%)	23
	High	5(62.50%)	0	3(37.50%)	8
Total		56(56.57%)	1(1.01%)	42(42.42%)	99

"The data represented in the table 4 reflects the distribution of zinc levels and neutrophil levels among males and females:

- Females: 51.43%of females with normal zinc levels have normal neutrophil levels, while 2.86% have below-normal neutrophil levels. Among females with below-normal zinc levels, 40.0%have normal neutrophil levels and 60.0% have high neutrophil levels.
- Males: All males, regardless of whether their zinc levels are normal or below-normal, there is no cases has low neutrophil levels.

Statistical analysis for male p value with 0.268. Also, in females with p-value 0.267 indicates no statistically significant difference between zinc levels and neutrophil levels in females and males.

Table 4: Crosstabulation between ZINC levels in mg/dl and NEUTROPHILS levels according to the gender.

ZINC mg/dl * NEUTROPHILS * Gender Crosstabulation						
Gender			NEUTROPHILS			Total
			Normal	Low	High	
Female	ZINC mg/dl	Normal	18(51.43%)	1(2.86%)	16(45.71%)	35
		Low	6(40%)	0	9(60%)	15
		High	4(100%)	0%	0	4
	Total		28(51.85%)	1(1.85%)	25(46.30%)	54
Male	ZINC mg/dl	Normal	22(66.67%)	0	11(33.33%)	33
		Low	5(62.50%)	0	3(37.50%)	8
		High	1(25%)	0	3(75%)	4
	Total		28(62.22%)	0	17(37.78%)	45

- As shown in the table 5, The data indicates a correlation between various symptoms and levels of zinc, lymphocytes, and neutrophils in the body. Individuals are categorized based on their levels of zinc, lymphocytes, and neutrophils as either 'normal' or 'below normal', with percentages of people experiencing symptoms such as loss of smell, general fatigue, vision problems, loss of appetite, dry skin, frequent diarrhea, and hair loss.
- Normal Zinc Levels: Are associated with fewer cases of dry skin and hair loss compared to below-normal zinc levels. Individuals with below-normal zinc levels show higher percentages of general fatigue and hair loss, which may suggest an impact of zinc deficiency on these symptoms.
- Lymphocytes: Individuals with below-normal levels of lymphocytes experience higher rates of dry skin and frequent diarrhea, which may indicate an effect on the immune system.
- Neutrophils: Individuals with below-normal levels of neutrophils do not exhibit any of the mentioned symptoms, suggesting that these individuals may have more stable health regarding these symptoms or that the available samples are too small to show clear associations.

There may be a relationship between zinc deficiency and certain symptoms, such as general fatigue and hair loss, and there may also be an effect on the immune system as indicated by the correlation between lymphocyte levels and dry skin and frequent diarrhea.

Table 5: The data indicates a correlation between various symptoms and levels of zinc, lymphocytes, and neutrophils in the body.

		Zinc mg/dl		lymphocytes		neutrophils	
		Normal	Low	Normal	Low	Normal	Low
Weak sense of smell	No	94.1%	95.7%	94.4%	85.7%	96.4%	100%
	Yes	5.9%	4.3%	5.6%	14.3%	3.6%	0.0%
General body fatigue	No	42.6%	26.1%	37.5%	42.9%	44.6%	100%
	Yes	57.4%	73.9%	62.5%	57.1%	55.4%	0.0%
Weakness and unsteady vision	No	66.2%	73.9%	66.7%	71.4%	69.6%	100%
	Yes	33.8%	26.1%	33.3%	28.6%	30.4%	0.0%
Persistent loss of appetite	No	70.6%	78.3%	68.1%	85.7%	75.0%	100%
	Yes	29.4%	21.7%	31.9%	14.3%	25.0%	0.0%
Dry skin	No	55.9%	43.5%	52.8%	28.6%	57.1%	100%
	Yes	44.1%	65.5%	47.2%	71.4%	42.9%	0.0%
Frequent diarrhea	No	85.3%	91.3%	90.3%	57.1%	87.5%	100%
	Yes	14.7%	8.7%	9.7%	42.9%	12.5%	0.0%
Hair loss	No	51.5%	34.8%	48.6%	75.1%	50.0%	100%
	Yes	48.5%	65.2%	51.4%	42.9%	50.0%	0.0%

4. DISCUSSION

In our study, 99 random cases were collected to examine zinc levels and compare them with immune cell levels. The results indicate that the majority of individuals (68.68%) have normal zinc levels, while 31.32% experience abnormal levels which showed 23.23% low zinc level and 8.08 high zinc level. These findings are consistent with a study published in the International Journal of Molecular Sciences (2023), which showed that blood zinc levels are often normal among the majority of the population, although a small percentage suffers from abnormal levels (Hara et al, 2023).

If the study focuses on the impact of lymphocyte levels on health, the large proportion of people with normal levels suggests that most participants do not have obvious issues with this parameter. However, the comparison between zinc and lymphocyte levels among different groups, indicating that 69.1% of individuals with normal zinc levels also had normal lymphocyte levels, while 10.3% had low lymphocyte counts and 20.6% had high lymphocyte counts. Additionally, 82.6% of individuals with low zinc levels had normal lymphocyte levels, whereas 17.4% had high lymphocyte counts. However, no individuals have low lymphocyte in the case of low zinc level. These results suggest a lack of a strong relationship between blood zinc levels and lymphocyte counts, which is inconsistent with a study conducted in Molecular Nutrition & Food Research. This discrepancy may be due to sample size or demographic characteristics of the participants. Nevertheless, a study published in the British Journal of Nutrition that aligns with our current study found no strong relationship between zinc levels and lymphocyte counts in healthy adults. Considering these studies, it can be said that the effect of zinc on lymphocytes may be more pronounced in individuals with significant zinc deficiency, while it may not show a substantial effect in those with normal levels (Bonham et al, 2003). Despite the variation in zinc levels between genders, the statistical analysis shows no strong or significant relationship between zinc levels and lymphocyte levels for either males or females. Further studies or a larger data analysis may be necessary to better understand the relationship between these variables.

Although there is no strong relationship between zinc levels and lymphocyte counts for both genders, zinc deficiency was more prevalent among females than males. Results showed that 86.7% of women with low zinc levels had normal lymphocyte levels, while 13.3% had elevated levels, indicating zinc deficiency in this group. In contrast, males showed a lower rate of zinc deficiency, with 75% of men with low zinc levels having normal lymphocyte levels and 25% having elevated levels, aligning with a study published in the British Medical Journal (Prasad, 2003).

Regarding to the distribution of zinc and neutrophil levels across different groups. Among individuals with normal zinc levels, 58.8% had normal neutrophil levels, while 1.5% had lower-than-normal levels. For those with low zinc levels, 47.8% had normal neutrophil levels, and no individuals had lower-than-normal neutrophil levels.

These results indicate no statistically significant relationship between zinc and neutrophil levels, either in the general sample or in separate analyses for males and females. This finding contradicts Hasegawa's study, which suggests zinc benefits neutrophil function. It can be concluded that zinc's effect on neutrophils may be indirect, or that neutrophil regulation depends on other factors, such as general health or the balance of other minerals (Hasegawa et al, 2000). The large proportion of people with normal levels suggests that most participants do not have obvious issues related to neutrophils. However, attention should be given to the significant proportion with abnormal levels, as this condition may be associated with specific health issues. It is essential to study the factors leading to abnormal neutrophil levels and examine their impact on overall health

The results indicate an association between zinc levels, lymphocytes, neutrophils, and various symptoms. Individuals with low zinc levels experience higher rates of general fatigue and hair loss, suggesting that zinc deficiency may impact these symptoms. Additionally, low lymphocyte levels are linked to increased skin dryness and frequent diarrhea, indicating potential immune weakness. On the other hand, low neutrophil levels were not associated with these symptoms. This aligns with a study conducted in Germany. (Wessels, Maywald and Rink, 2017).

5. CONCLUSION

1The study showed that zinc levels are often normal and a small percentage suffer from abnormal levels.

.2The study showed that there is no relationship between zinc levels and lymphocytes, whether in the general sample or in separate analyses for both males and females.

3. The study showed that there is no relationship between zinc levels and neutrophils, whether in the general sample or in separate analyses for both males and females.

.4The study showed that zinc deficiency is associated with various symptoms such as general fatigue, hair loss, dry skin and frequent diarrhea.

Recommendations:

Based on the results of this study, we strongly recommend the following:

1. Conduct new research with a larger sample size to determine the effect of zinc levels on immune cell levels.
2. Routine zinc analysis is highly recommended.

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