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Effect of Serum 25-Hydroxyvitamin D Level on Quality of Life in Allergic Rhinitis

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SUMMARY: *This study critically examines the influence of serum 25-hydroxyvitamin D [25(OH)D] levels on the health-related quality of life among Chinese adults diagnosed with allergic rhinitis. An observational research design incorporating structured questionnaires was employed to collect data. The investigation monitored the clinical status of individuals with confirmed allergic rhinitis and assessed how variations in serum 25(OH)D levels corresponded with changes in their health-related questionnaire. A total of 131 eligible participants who met the inclusion and exclusion criteria voluntarily completed the survey. The results indicate a moderate negative correlation between serum 25(OH)D levels and symptom severity, suggesting that higher vitamin D levels are associated with improved health-related quality of life outcomes. Participants with sufficient serum 25(OH)D levels reported reduced symptom burden compared with those exhibiting vitamin D deficiency. The study further demonstrates that approximately 17.6% of the variance in health-related quality of life can be predicted by serum 25(OH)D levels, underscoring the clinical significance of vitamin D status in allergic rhinitis management. Although the strength of association is moderate, the findings highlight the potential of optimising vitamin D levels to mitigate disease severity and enhance quality of life in affected individuals.*

KEYWORDS: *Serum 25(OH)D; Vitamin D; Allergic Rhinitis; Health-Related Quality of Life; Vitamin D Deficiency*

1 Introduction

Like other parts of the world, allergic rhinitis is one of the most chronic inflammatory airway disorders in China, accounting for significant public health challenges [1]. Although the issue has been witnessed in the society for a long time, in China it has gained dominance largely because of the significant lifestyle, social, and environmental changes that have taken place during the last two decades. In particular, increased environmental exposure, lifestyle changes, and rapid urbanisation are quoted as the three dominant reasons that contributed to the increase in the spreading of allergic rhinitis amongst children and adults across the country [2]. The seriousness of allergic rhinitis is evident from the figures quoted by [3], which state that the prevalence rate varies between 11% and 25%, while the perennial and seasonal forms of allergic rhinitis are substantially greater. The most common symptoms of allergic rhinitis include nasal congestion, sneezing, itching, rhinorrhoea and the like. Even though the disease is not life-threatening, nevertheless, the disease is associated with disruption of daily life and impairment

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of sleep quality, work productivity, and emotional wellbeing. Consequently, the intervention strategies often introduced to address the disease comprised improving the quality of life [4].

There are different studies that have been conducted to find out the root causes of the disease. A significant number of studies conducted in different parts of the world have linked allergic rhinitis with vitamin D deficiency as the core cause of the disease. According to [5], vitamin D is a fat-soluble secosteroid hormone, which is synthesised through sun exposure. The use of vitamin D has been gaining scientific attention due to its inherent immunomodulatory properties. Even though there are different properties developed, however, serum 25-hydroxyvitamin D [25(OH)D] is considered the most effective and trusty biomarker [6]. The core reason for the popularity and widespread adoption of Serum 25(OH)D is attributed to its dietary intake and the indigenous properties of the drug [7].

The use of Serum 25(OH)D is particularly suitable in the Chinese conditions, as most recently, studies conducted by [8] and [9] have found that a growing number of Chinese adults are witnessing health issues, including allergic rhinitis, because of dietary inadequacies, increased air pollution in the country, reduced opportunities for sun exposure, changing lifestyles, and ageing of the population. Considering the increased respiratory challenges that an overwhelming number of Chinese adults are witnessing, particularly in the form of asthma and chronic rhinosinusitis, researchers are taking particular interest in finding out the impact of using vitamin D and allergic diseases like allergic rhinitis [10]. In this regard, as per the assertions made by [11], the immunological mechanism between the use of vitamin D intake and allergic inflammation is plausible.

However, [12] have pointed out that at the international front, there are studies that failed to establish the desired link, as mixed results have also been stressed by [13]. Although at the international level there is significant research undertaken in the field, the analysis of existing literature could reveal that there is very limited literature pertaining to the association of vitamin D intake with allergic rhinitis. According to [14], there are different factors that affect such an association and should thus be considered, which include air pollution, regional sun exposure, genetic practices and dietary practices. As these factors are significantly different in China than what has been witnessed in other parts of the world, there is a need for the region-specific research that could clearly demonstrate the relations between vitamin D intake and allergic rhinitis. This research has been organised with the aim to critically analyse the impact of serum 25-hydroxyvitamin D [25(OH)D] level on quality of life in allergic rhinitis. The research critically analyses the relations between 25(OH)D and health-related quality of life witnessed in the Chinese market amongst the adult population.

2 Materials and Methods

2.1 Research Strategy

The research strategy that has been adopted in this study could be termed observation design, as it aimed to analyse the impact of serum 25(OH)D level on quality of life in allergic rhinitis amongst the adult Chinese population. The study observed the conditions of patients who have reportedly suffered from allergic rhinitis and analysed how such patients have reacted to serum 25(OH)D level, noting changes in the quality of life of each of the participants of the research. The study has been conducted in the otorhinolaryngology and allergy unit of the outpatient clinic of Hebei, China. For the sake of this study, data collection and analysis have taken place, as data has been collected over a period of 12 months, from Feb 1, 2024, to March 31, 2025. The period of time has been selected, as it includes both sunny and low sunlight periods, pointing towards natural variations in the vitamin D.

2.2 Population and Sample

The participants of the study have been carefully selected for this observational-based study. The sampling procedure that has been used in the study could be categorised as purposive sampling, as the participants fulfilling the inclusion criteria have been selected, while others have been ignored. The core inclusion criteria include individuals of Chinese origin, aged 18 years or older, clinically diagnosed with allergic rhinitis for at least one year, and willing to participate in this study. As the study has clinical significance, exclusion criteria have also been used in this study, whereas certain individuals who fulfilled the above criteria have still been excluded from the study. The major exclusion criteria of the study include individuals who have taken corticosteroids in the last four-month period, have taken vitamin D supplements in the last three months, are patients suffering from chronic kidney, liver, or malignant diseases, are pregnant or breastfeeding mothers, and are individuals who have declined blood sampling. To ensure that a sufficient sample has been selected so that reliable and valid findings are presented, the findings of the study are based on the data collected from a total of 131 participants.

2.3 Data Collection Procedure

As the data collection involved extended interactions, a proper plan for the data collection has been followed throughout the study. The potential participants of the study have been approached in the Otorhinolaryngology and Allergy unit of the outpatient clinic of Hebei, China. The researcher first ensured inclusion and exclusion criteria, and after due fulfilment, informed consent was ensured in the study. First, the participants were asked to fill out a questionnaire that could be referred to as a quality of life questionnaire. Second, demographic and clinical information has been obtained from the participants of the study, which includes sex, smoking status, BMI, allergic rhinitis duration, and classification in terms of seasonal and perennial status. After this, venous blood sampling was obtained, whereas a certified local laboratory confirmed the serum 25 (OH) level.

2.4 Data Analysis and Measurement Tools

The primary independent variable that in this study has been Serum 25 (OH) D level, for which the standardised ECLIA tool has been utilised. The reported results have been measured in terms of nanograms per millilitre (ng/ml). Mainly, there were three different categories established in this study for the sake of classification. Participants who were having > 20 ng/ml were thus classified as ‘Deficient’, while participants whose serum 25 (OH) D was in the range of 20 to 30 ng/ml were classified as ‘Insufficient’. Contrary to these two categories, participants whose report states a serum 25 (OH) D level of > 30 ng/ml were classified as ‘Sufficient’. On the other hand, quality of life has been the core dependent variable in the present study, whereas a 28-item Likert scale questionnaire divided into 7 major categories has been adopted in this study, for which a 7-point Likert scale has been adopted in this study. The point 0 in the scale denotes no impairment, while the point 6 in the scale denotes severe impairment; thus, a higher score denotes a poorer quality of life. For the sake of analysing the demographic data, a statistical analysis process has been adopted in this study, as means and standard deviations were computed along with frequencies and percentages. On the other hand, an inferential statistical tool like Pearson correlation analysis has been conducted with the aim of analysing the linear relations between serum 24 (OH) D and quality of life score. The following formula has been adopted for Pearson correlation analysis:

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \cdot \sum(Y_i - \bar{Y})^2}}$$

In the above formula, Xi denotes serum 25(OH)D, Yi denotes the questionnaire score of the participant of the study, $\bar{X}$ denotes mean serum 25(OH)D, $\bar{Y}$ denotes the mean score of the questionnaire, and r denotes the range, which varies from –1 to +1.

Additionally, regression analysis has been conducted in the study, for which the following formula has been used for the computation:

$$Y=\beta\ 0+\beta 1\ X$$

In the above formula, Y denotes the questionnaire score, X denotes Serum 25(OH) D, β_0 denotes the intercept, and β_1 X denotes the regression coefficient.

3 Results

3.1 Baseline Characteristics of the Participants of the Study

The baseline characteristics of the participants of the study have been categorised in the following Table 1:

Table 1: Baseline Characteristics of the Participants of the Study

Description	Variable	Number	Percentage
Gender	Male	68	51.9%
	Female	63	48.1%
Age	18 to 29	47	35.9%
	30 to 44	53	40.5%
	45 to 60	31	23.7%
BMI Category	Underweight (<18.5)	11	8.4%
	Normal (18.6 to 23.9)	73	55.7%
	Overweight (24 to 27.9)	32	24.4%
	Obese (>28)	15	11.5%
Vitamin D Status	Deficient (< 20 ng/ml)	52	39.7%
	Insufficient (21 to 29 ng/ml)	48	36.6%
	Sufficient (> 30 ng/ml)	31	23.7%
Allergic Rhinitis Duration	< 1 Year	28	21.4%
	1-3 years	56	42.7%
	> 3 Years	47	35.9%
Comorbid Allergic Conditions	None	84	64.1%
	Allergic Asthma	19	14.5%
	Atopic dermatitis	11	8.4%
	Food allergy	17	13.0%
Seasonal of Analysis	Spring	44	33.6%
	Summer	21	16.0%
	Autumn	26	19.8%
	Winter	40	30.5%

From the analysis of Table 1, it is very pertinent to note that the participants of the study shared a diverse range of characteristics, which in turn adds to the validity and reliability of the study. In terms of age groups, the participants in the age bracket 30 to 44 years emerged as the largest group, as about 40% of the participants were in the age bracket, followed by individuals who were in the age bracket 18 to 29 years, as this age group had about 36% of the participation. On the other hand, about 24% of the participants of the study were in the age group 45 to 60 years.

Additionally, in terms of gender, about 52% of the participants of the study are male, while about 48% of the participants of the study are female patients who were suffering allergic rhinitis. Furthermore, the weight of the patient plays a crucial role in the allergic rhinitis, which has been measured in terms of BMI. In this regard, patients with a BMI of less than 18.5 were about 8% of the total participants of the study. On the other hand, about 56% of the participants of the study had a normal BMI, as they had a BMI of 18.5 to 23.9. Additionally, about 24% of the participants of the study were categorised as overweight, as they had a BMI of 24 to 27.9. Furthermore, about 12% of the participants of the study were obese, as they had a BMI of > 28.

In addition, in terms of 'Vitamin D Status', the participants of the study were also sharing diverse statuses, as about 40% of the participants have reported being vitamin D deficient, as they were having Serum 25 (OH) D of > 20 ng/ml, thus categorised as 'Deficient'. Furthermore, about 58% of the total participants were having Serum 25 (OH) D in the range of 20 to 30 ng/ml and thus classified as having 'Insufficient' Serum 25 (OH) D. Contrary to these two categories, about 37% of the participants reported a serum 25 (OH) D level of > 30 ng/ml and could be thus classified as having 'sufficient' serum 25 (OH) D.

In terms of the duration that the participants of the study have been suffering from allergic rhinitis, three main categories have been identified in the study. Participants that had been suffering from the disease for less than a year were about 21% of the total participants of the study. On the other hand, about 43% of the total participants of the study had been suffering from allergic rhinitis for a period of 1 to 3 years, while those suffering from the disease for more than 3 years were about 36% of the total participants of the study. This in turn dictates that the findings of the study are based on the patients who have been suffering from allergic rhinitis for diverse periods of time.

Further data has been collected from the participants of the study about comorbid allergic conditions. In this regard, about 64% of the total participants of the study did not have any comorbid allergic conditions; however, about 15% of the total participants of the study have been suffering from allergic asthma. Furthermore, about 9% of the total participants reported that they have developed atopic dermatitis, while a further 13% of the total participants of the study have been suffering from food allergies. The analysis of these figures in turn dictates that about one-third of the participants suffering from allergic rhinitis have developed a range of allergic conditions over time.

In order to eradicate the seasonal impact on data, data in this study has been collected over a period of one year, which represents different seasons. In this regard, about 34% of the analysis has been conducted in the spring season, while 16% of the assessment has been conducted in summer. Furthermore, about 20% of the total patients have been assessed in the autumn season, while 30% of the total patients suffering from allergic rhinitis have been analysed during the winter season. The diverse seasons ensured in this study point towards a more valid data collection, as allergic rhinitis is significantly affected by the seasonal factors.

3.2 Correlations and Regression Analysis

The correlations and regression values have been computed, analysed and summarised in the following Table 2:

Table 2: Correlations and Regression Analysis

Analysis Type	Computation	Value
Pearson Correlation Analysis	r	-0.42
	p-value	< 0.001
Linear Regression Model Analysis	Equation	4.85 - 0.086 x 25 (OH)D
	β coefficient	-0.086
	Standard Error	0.020
	t-Value	-4.33
	p-value	< 0.001
	R^2	0.176
	Adjusted R^2	0.170

From the analysis of the above Table 2, it is pertinent to note that the Pearson correlation analysis exhibited in the form of r is -0.42, which exhibits moderate negative correlations between serum 25 (OH) D level and quality of life in allergic rhinitis. The negative correlation is statistically significant, which is evident from the analysis of the p-value, which has been calculated as < 0.001. This in turn dictates that the participants suffering allergic rhinitis symptoms who have been using Serum 25 (OH) D have been showing lesser symptom severity as compared to patients who have not been taking Serum 25 (OH) D, thus exhibiting a better quality of life with a higher vitamin D level.

Further analysis of the relations between serum 25(OH)D level and quality of life in allergic rhinitis could be gained from the analysis of the linear regression model. As per the analysis, the equation shows that the patients who are taking higher vitamins – D; such higher intake – have been predicting their quality of life score. This could be confirmed with the β coefficient that has been measured at -0.086, which stressed the negative relations between the independent variable and dependent variable of the study. Furthermore, from the analysis of the t-value exhibited in the above Table 2, it is pertinent to note that the value -4.33 exhibits that Vitamin D is a significant predictor of the changes that the participants of the study have been witnessing in the form of quality of life. The p-value, which is <0.001, also showcases the strong significance of the relations. Additionally, the R^2 value calculated and exhibited in the above Table 2 could translate to about 17.6% variance in the quality of life that could be explained through the vitamin D intake of the participant of the study. The following Figure 1 exhibits the scatter plot with the regression line.

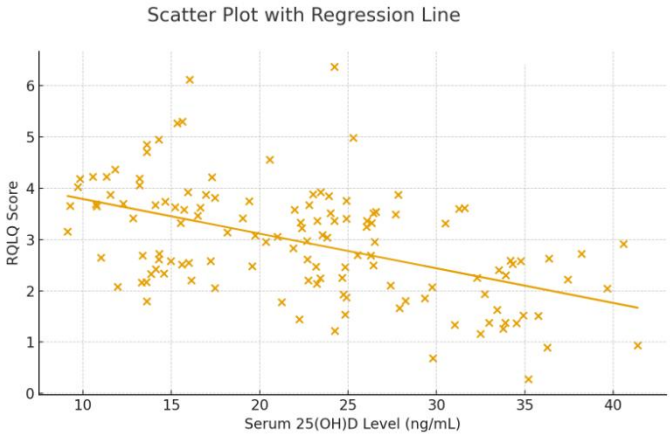

Figure 1: Scatter Plot with Regression Line

3.3 Health-Related Quality of Life Score and Vitamin D Status

The relationship between health-related quality of life and the vitamin D status have been summarised in the following Table 3:

Table 3: Health-Related Quality of Life Score and Vitamin D Status

Vitamin D Category	n	Min	Max	Median	Mean	SD
Deficient	52	1.40	5.60	3.40	3.38	0.98
Insufficient	48	1.20	4.90	2.85	2.87	0.91
Sufficient	31	0.60	3.80	1.80	1.92	0.82
Total Sample	131	0.60	5.60	2.70	2.78	1.12

As per the values exhibited in the above Table 3, it is pertinent to note that the participants of the study who are deficient in using vitamin D are showing the highest mean of quality of life, which points towards a higher symptom of allergic rhinitis. On the other hand, the participants of the study who have been taking insufficient vitamin D exhibit clear decreasing quality of life trends in the table, exhibiting that the symptoms that they witnessed in the form of allergic rhinitis are lesser than the deficient category participants of the study. Furthermore, Table 3 also exhibits that the participants of the study who are taking sufficient vitamin D have the lowest quality of life, exhibiting that they are currently witnessing the lowest symptoms of allergic rhinitis. The trends witnessed within the study are more consistent, which could also be confirmed from the median values, which have been exhibited in the following Figure 2:

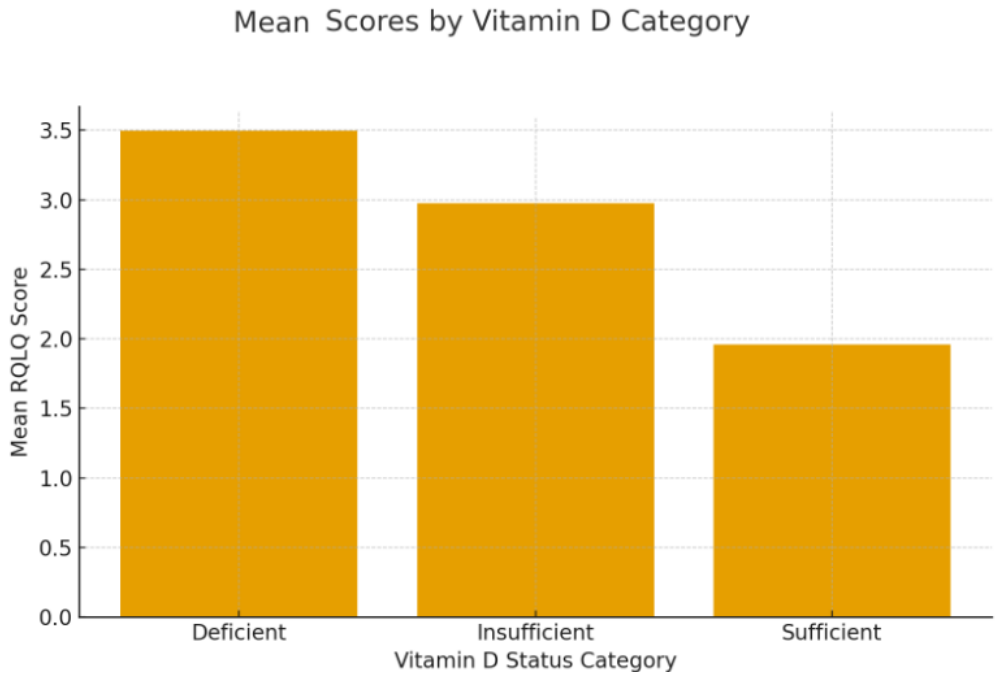

Figure 2: Mean Score by Vitamin D Category

From the analysis of Figure 2, it is evident that the media value for deficient participants was 3.40, which dropped down to 2.85 in the case of insufficient vitamin D participants and further dropped down to 1.80 in the case of sufficient vitamin D participants of the study.

4 Discussions

4.1 Vitamin D Deficiency and Allergic Rhinitis

This study confirmed that the Chinese patients who participated in the study and have been suffering from allergic rhinitis were having serum 25(OH)D deficiency that causes the disease. As per the results compiled in the study, about 39.7% of the participants of the study were classified as vitamin D deficient patients, while 36.6% of the participants of the study had insufficient vitamin D intake compared to the desired level. Only 23.7% of the total participants of the study were having a sufficient level of serum 25(OH)D. Although there could be different reasons behind the significant deficiency that the Chinese population has been witnessing, a core reason in this regard could be the increased air pollution due to increasing industrialisation in the country, indoor lifestyle patterns, and limited sunlight exposure, particularly in the winter season. From the results of the study, it is evident that deficiency of serum 25(OH)D amongst the allergic rhinitis patients has due importance, and bringing changes in the level could help in modifying disease severity. The findings of the current study are in line with the findings of [15] and [16], who have also found positive relations between serum 25 OH(D) and allergic rhinitis.

4.2 Vitamin D Status and Health-Related Quality of Life

This study found moderate negative interrelations between serum 25(OH)D and health-related quality of life, as the overall r value computed is -0.42 and the p-value is < 0.001. These values have different implications for the health practitioners in the Chinese market. The findings of the study imply that patients who have a higher level of serum 25(OH)D are witnessing fewer or less severe symptoms of allergic rhinitis, which in turn has been improving their daily functioning, leading to a better quality of life. On the other hand, patients who have lower serum 25(OH)D are witnessing more symptoms of allergic rhinitis, which in turn have been affecting their quality of life. The study found that there are stepwise relations between vitamin D, as participants classified as deficient in vitamin D were having a health-related quality of life score of 3.38, while the participants who were having insufficient vitamin intake were having a quality of life score of 2.87, while participants who were having sufficient vitamin D intake were having a quality of life score of 1.92. From the findings of the current study, it is thus pertinent to note that the increased vitamin D level corresponds to clinical improvement in the severity of sleep quality, sneezing, nasal congestion, and emotional functioning of participants suffering from allergic rhinitis. The findings of the study stand in line with the findings of [17].

4.3 Vitamin D is a Significant Predictor of Health-Related Quality of Life

From the correlations and regression analysis exhibited in the study, it is pertinent to note that serum 25(OH)D significantly predicts the quality of life. In this regard, the equation and the p-value, which stands for <0.001, exhibit that about 17.6% of the changes witnessed in the form of quality of life of the participants of the study could be effectively predicted with the changes in their vitamin D level. From these findings, it could be inferred that quality of life factors could be effectively improved through sufficient focus on the vitamin D level. However, in terms of magnitude of impact, the study noted the moderate relations, which dictate that a noticeable reduction in allergic rhinitis could be noted in different circumstances. The findings of this study thus stand in line with the findings of [18] and [19], who have also found such moderate relations.

5 Conclusion

This research critically analysed the impact of serum 25(OH)D level on health-related quality of life in allergic rhinitis amongst Chinese adults. The findings of the research are based on observation research coupled with questionnaire design, which have been used for the sake of data collection. The study observed the conditions of patients who have reportedly suffered from allergic rhinitis and analysed how such patients have reacted to serum 25(OH)D level, noting changes in the quality of life of each of the participants of the research. The findings are based on data collected from a total of 131 patients who have expressed willingness to participate in the study and who fulfil the inclusion and exclusion criteria. As per the core findings of the study, moderate negative correlations between serum 25 (OH) D level and quality of life in allergic rhinitis have been noted. Participants suffering allergic rhinitis symptoms who have been using Serum 25 (OH) D have been showing lesser symptom severity as compared to patients who have not been taking Serum 25 (OH) D, thus exhibiting a better quality of life with a higher vitamin D level. The study confirms that deficiency of serum 25(OH)D amongst the allergic rhinitis patients has due importance, and bringing changes in the level could help in modifying disease severity. In this regard, about 17.6% of the changes witnessed in the form of health-related quality of life of the participants of the study could be effectively predicted with the changes in their vitamin D level. From these findings, it could be inferred that quality of life factors could be effectively improved through sufficient focus on the vitamin D level. However, in terms of magnitude of impact, the study noted the moderate relations, which dictate that a noticeable reduction in allergic rhinitis could be noted in different circumstances.

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