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The Impact of Adequate Selenium Intake on Severity Symptoms and Quality of Life among People with Allergic Rhinitis

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ABSTRACT

Background: Selenium (Se) deficiency leads to impairment of human immune function. Allergic Rhinitis (AR) is one of the most common immune-related diseases that affects the quality of life among patients. This study aims to investigate the effect of adequate Se intake on the severity of symptoms and quality of life among participants with AR**. Methods:** A total of 60 participants were recruited for the study and were divided into 2 groups; adequate Se intake (adSe) group and inadequate Se intake (InadSe) group based on nutritional suggestion calculated using a nutritional software package. All the participants were asked to complete the self-reported validated questionnaire on the severity of their symptoms and quality of life impairment for patients with AR. **Results:** The participants in InadSe group obtained significantly higher scores in almost all the aspects of the severity of symptoms and quality of life impairment compared with participants in adSe group (P<0.05). In addition, the amount of daily Se intake of the participants in this study was negatively correlated with the total scores of the questionnaires (P<0.05).**Conclusions**: The findings of this study indicated adequate Se intake, according to the recognized dietary guidelines, which tends to reduce the severity of symptoms and improve the quality of life among people with AR.

Introduction

Selenium (Se) is an essential trace element regarding human physiological functions. Long-term inadequate Se intake can lead to the development of several complications affecting the quality of life (Arthur and Brown, 2001). Many countries have reported the prevalence of inadequate Se intake amongst their populations, for example Spain (13.9%) (Navia *et al.*, 2014) and Ethiopia (36%) (Belay *et al.*, 2020). In Thailand, there is a lack of reported data regarding Se status within Thai population. A study revealed that 56% of children with HIV infection in Thailand had a degree of Se deficiency (Bunupuradah *et al.*, 2012). Se plays a critical role in human immunological functions (Filippini *et al.*, 2023). Therefore, for people at risk of immune impairment, there needs to be a focus on adequate Se intake (Kamer *et al.*, 2012).

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Allergic rhinitis (AR) is a chronic immunology-related disease that affects the quality of life and causes distress to the affected patients (Ozdoganoglu *et al.*, 2012). The reported global prevalence of AR is 10-60% (Savouré *et al.*, 2022). In Thailand, the estimated prevalence of AR is 37% (Bunjean *et al.*, 2012). Air pollution (i.e. particulate matter [PM2.5], vehicle and industrial emissions, etc.), wools, and pollens are examples of factors that stimulate severe symptoms of AR, such as sneezing, itchy nose, coryza or blocked nose, red and watery eyes, and cough (Mariani *et al.*, 2021). Hence, adequate trace element intake among people with AR should be of concern, particularly Se, which could minimize the severity of symptoms of AR by suppressing cytokine production (ie, Tumor necrosis factor alpha [TNF-α], Interleukin-1 beta [IL-1β], etc.) and cleavage of free radicals, as detailed *in vivo* studies (Hoffmann and Berry, 2008, Liu *et al.*, 2017). However, there is no established data on the effects of reduced Se intake below the nutritional standard (55 µg/day for adults) regarding the severity of symptoms and quality of life among people with AR. This study, therefore, aims to find out the impact of adequate Se intake on the severity of symptoms and the quality of life among people affected by AR in Thailand.

Materials and Methods

This cross-sectional study was conducted from April 1, 2023–November 30, 2023, involving people with AR living in Chonburi province, Thailand.

Questionnaires used in the study

Baseline questionnaire

This self-administered closed-ended questionnaire was developed to collect baseline and background data of the participants such as age, education level, sex, body mass index, and duration of diagnosed AR.

The 3-days food record questionnaire

The self-administered validated open-ended questionnaire (Yang *et al.*, 2010) was developed to assign the participants to record their food intake randomly 3 days a week. The participants had to record their food menus and the number of ingredients that consumed on 2 weekdays and 1 weekend day. Then, registered dietitians calculated their daily energy consumption and Se intake using nutritional software program (INMUCAL-Nutrients version 4.0, developed by the Institute of Nutrition, Mahidol University, Thailand) after their questionnaires were submitted. The participants with an estimated average Se intake below 55 µg were allocated to the inadequate Se intake group, while participants with an estimated average Se intake above 55 µg were allocated to the adequate Se intake group (Barchielli *et al.*, 2022).

Severity symptoms and quality of life questionnaire impairment

The validated self-respondence 5-level scale questionnaire, adapted from a previous study (Okubo *et al.*, 2017), was used to ask the participants about their quality-of-life impairment, the severity of symptoms, and emotional status. Examples of questions on the severity of symptoms used in the questionnaire included “In the past 1-2 weeks, which level of coryza symptoms have you experienced” and “In the past 1-2 weeks, which level of sneezing symptoms have you experienced”. The rating scales and scoring method are 0=no symptoms, 1=mild, 2=moderate, 3=severe, and 4=extremely severe. The classification of severity scores was adapted from one study (Brown, 2019, Okuda, 2001). Average scores in ranges between 0.00-1.00 were considered mild, 1.01-2.00, moderate, 2.01-3.00, severe, and 3.01-4.00 was considered the most severe. Examples of questions on the quality-of-life impairment used in the questionnaire included “In the past 1-2 weeks, which level of AR symptoms reduced productivity at work/home” and “In the past 1-2 weeks, which level of AR symptoms led to limitation of outdoor life”. The rating scales and scoring method were 0=no, 1=Yes, slightly, 2=Yes, moderately, 3=Yes, severe, and 4=Yes, extremely severe. Again, average scores in the range between 0.00-1.00 was considered slight, 1.01-2.00 , moderate, 2.01-3.00 , severe, and 3.01-4.00 was considered very severe

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(Brown, 2019, Okuda, 2001).

All questionnaires were reviewed and proof-read by experts in dietetics and experts in immunological diseases. After revising the questionnaires, according to the experts' comments, the questionnaires and study protocol were sent to the Burapha University Institutional Review Board (BUU-IRB) for ethical approval (approval no. IRB1-071/2566)

Participants

After enrollment, a total of 60 participants were recruited for the study. Participants were sampled by quota into the inadequate Se intake group (n=30) and adequate Se intake group (n=30) according to their average daily Se intake. The inclusion criteria included ages between 18-60, being diagnosed as having AR, and able to read and write Thai. The exclusion criteria included participants who suffered from communicable diseases and oral problems that affected chewing and swallowing, receiving dietary supplements or herbal supplements, those were pregnant or lactating, who had mental problems, and who could not complete any of the questionnaires, and could participate throughout the period of the study.

Study procedures

The public relation aspect of the study was performed via social media. Participants were invited to a room at the Faculty of Allied Health Sciences, Burapha University, Chonburi province, Thailand, and were asked to sign the informed consent before participating in the study. After that, baseline data were collected using the questionnaire. Next, participants were given knowledge of the Thai food exchange and were trained on how to count the portion sizes of food consumed in several food categories using the food models. Once completed, participants were assigned to record their food intake in the same week of the study, and fill in the 3-days food record questionnaire. Participants were asked to record their consumed food and the amount of each ingredient (portion size or gram estimation) over 2-week days and 1 weekend day. After that, the completed 3-day food record questionnaire was submitted to the dietitians by the following week. The 3-day average of energy intake and Se intake were calculated and the participants who had Se intake of below average, less than 55 µg per day, were allocated to the inadequate Se intake group (InadSe), while participants who had an average Se intake of 55 µg or above, were sampled into the adequate Se intake group (AdSe). Finally, all the participants were asked to complete severity symptoms and quality of life impairment questionnaire. Participants self-rated the scale in the questionnaire. The rated scores in the questionnaire were collected and the results were interpreted.

Data analysis

The percentage of sex and education level of the participants were recorded, and the data on BMI, energy intake (kcal), energy distribution, daily Se intake, and the scores of severity symptoms and quality of life impairment questionnaire were reported as mean±standard deviation (SD). The logistic regression analysis and independent t-test were used to compare the odd ratio, confident interval, and mean differences between groups, while percentages of data on sex and education level were reported and were tested for the percentage difference between the groups using Pearson's chi square test. In addition, the Pearson correlation coefficient was used to investigate the correlation between the amount of Se intake and the scores relating to the severity of symptoms and quality of life impairment among the participants. Statistical analysis was performed using the statistical software package, Predictive Analytics Software Statistics (SPSS Inc, Chicago, Il), version 25.0. The significant difference was deemed at P-value<0.05.

Results

The percentage of female sex in the InadSe group was significantly higher than the AdSe group (P<0.05). Other background characteristics of the participants in this study revealed no significant differences. Regarding the daily Se intake, this was significantly higher in the AdSe group (134.08 ug/d) compared to the InadSe group (50.28 ug/d, P<0.05, **Table 1**).

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Table 1. Background characteristics of the participants in this study

Characteristics	AdSe group (n=30)	InadSe group (n=30)	P-value[a]
Sex			
Male	15 (50.00)[b]	5 (16.66)	<0.05
Female	15 (50.00)	25 (83.34)	
Education level			
Secondary school degree	0 (0.00)	2 (6.67)	
High school diploma	4 (13.33)	6 (20.00)	0.15
Bachelor's degree	26 (86.67)	20 (66.67)	
Master's degree	0 (0.00)	2 (6.67)	
Age (y)	29.30 ± 10.14[c]	28.70 ± 8.64	0.86
Body mass index (kg/m^2)	23.34 ± 5.53	21.40 ± 3.56	0.11
Length of AR diagnosed (y)	7.60 ± 6.54	8.86 ± 7.62	0.49
Daily Se intake (µg)	134.08 ± 45.51	50.28 ± 5.43	<0.05

[a]: Obtained by Chi-square test for qualitative variables and independent two sample test for quantitative variables; [b]: n (%); [c]: Mean±SD; ***AdSe****: adequate Se intake group;* ***InadSe****: Inadequate Se intake group.*

There were significantly higher scores in almost all aspects of severity symptoms in the InadSe group compared to the AdSe group, such as sneezing, blocked nose, itchy nose, itchy eyes, and watery eyes (P<0.05). Furthermore, the sum of the total score from part 1 questionnaire on the severity symptoms of participants in the InadSe group (11.43 points) was significantly higher than those of the AdSe group (6.83 points) at P<0.05. From the past 2 questionnaires on quality-of-life impairment, almost all aspects of sub-questions scores regarding quality-of-life impairment were significantly higher in the InadSe group compared with AdSe group (P<0.05) except for hesitation in visiting friends or relatives, frustration, and irritability. In addition, the sum of the total score on the quality-of-life impairment of participants in InadSe group (25.26 points) was significantly higher than the AdSe group (12.66 points) at P<0.05. As to the question on the general state (including symptoms, life, and emotion) in the past 1-2 weeks, the participants in the InadSe group obtained significantly higher scores (2.43 points) compared with participants in the AdSe group (1.33 points) in P<0.05. Moreover, the sum of the total score from all 3 parts of the questionnaire revealed that participants in the InadSe group obtained 39.13 points (from the total score of 96 points), which was significantly higher than the participants in the AdSe group (20.83 points) at P<0.05, **Table 2**).

In addition, **Figure 1** shows the significant negative correlation between the amount of daily Se intake and the total score on the severity of symptoms and quality of life impairment questionnaire regarding the participants in this study (P<0.05).

As to the dietary habits of the participants, the results revealed there were no significant differences in kcal intake and %kcal from carbohydrates and fat between the 2 groups of the participants, the exception being that %kcal from fat and %kcal from protein consumed by the participants in AdSe group were significantly higher than the participants in InadSe group for protein (P<0.05) and significantly higher than the participants in InadSe group for fat (P<0.05, **Table 3**).

Discussion

Selenium is an essential trace element in human physiology, especially the immune system. The findings of this study revealed that the participants in InadSe group ingested less than the suggested amount of daily Se, recognized as 55 ug/d for adults (Wang *et al.*, 2023). However, most of the participants in InadSe group were females who are often more concerned about their dietary habits (Alhazmi and Aziz, 2020, Alkazemi, 2018). Regarding the severity of symptoms, participants in AdSe group showed less severe symptoms relating to AR when compared with InadSe group.

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The results could be explained by the effectiveness of Se in promoting anti-inflammatory functions. Previous studies pointed out that Se combined with vitamin E is beneficial in suppressing immune signaling and lowering inflammatory cytokines such as nuclear factor erythroid 2-related factor 2 (Nrf2), TNF-alpha, interleukin (IL)-6, IL-8, and IL-10, which can alleviate AR symptoms (Ansar, 2016, Jiang *et al.*, 2021). The organic form of Se, Se combined with protein, is more efficiently used in the human body compared with the inorganic form. Selenomethionine and Selenocystein are examples of common organic forms of Se found in natural meat and fish (Sele *et al.*, 2018, Singhato *et al.*, 2023, Singhato *et al.*, 2022) that the human body can utilize to metabolize glutathione peroxidase (GPX), 15 kDa selenoprotein F (SELENOF), selenoproteins K and S, and thioredoxin reductases, all of which reduce oxidative stress and improve mitochondrial functions in endoplasmic reticulum of the cells (Genchi *et al.*, 2023, Kieliszek, 2019). Therefore, the participants in AdSe group potentially received these benefits from the adequate amount of daily Se intake to reduce the severity of their symptoms. The quality-of-life impairment scores of the participants in AdSe group were also lower than InadSe group. These results were in line with previous studies that indicated minimizing of the severity of symptoms of patients' underlying diseases, especially allergic rhinitis, with and without comorbid asthma, is related to increased physical activity of the participants, allowing them to have a better quality of life when compared to participants suffering from severe symptoms (Moitra *et al.*, 2023)

Interestingly, the differences in dietary intake of the participants revealed that not only was %kcal from protein in the AdSe group higher than InadSe group, but also the %kcal from fat in the AdSe group was lower than InadSe group. This could be the reason for the difference in the amount of daily Se intake between the 2 groups because the food sources rich in Se included meat, eggs, fish (both freshwater and marine fish), and poultry (Bakaloudi *et al.*, 2021, Hu *et al.*, 2021). Therefore, people who are at risk of inadequate Se intake have reduced protein intake, as noted in vegetarians, those suffering from oral problems, and gastrointestinal system dysfunction (Corsello *et al.*, 2020, Jayasinghe *et al.*, 2022, Zhang *et al.*, 2019).

The limitations of this study included not investigating the biomarkers of Se status in the body, such as serum Se, selenoprotein P, and GPX (Müller *et al.*, 2020). Hence, future study is suggested to determine these Se biomarkers in the body as well as long-term monitoring of health outcomes and the quality of life among larger groups of participants. In conclusion, adequate Se intake, according to the recognized dietary guideline, is effective and can be correlated to a reduction of the severity of symptoms and improvement of quality of life among participants.

Conclusions

This study revealed the importance of adequate Se intake in people suffering from AR, that can minimize their symptoms and improve their quality of life. In conclusion, participants with adequate Se intake, according to the RDA, had less severe symptoms and a better quality of life compared with the participants with inadequate Se intake.

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Table 2. Severity symptoms and quality of life impairment scores.

Variable	AdSe group (n=30)	InadSe group (n=30)	Odd ratio	95% CI	P-value[a]
Severity symptoms					
Coryza	1.36(0.96)[b]	1.83(1.05)	0.71	(0.12, 3.99)	0.07
Sneezing	1.36(0.92)	2.10(1.05)	1.41	(0.12, 15.78)	<0.05
Blocked nose	1.53(1.00)	2.13(1.07)	0.64	(0.08, 4.88)	0.03
Itchy nose	1.06(0.90)	2.00(1.01)	1.25	(0.23, 6.65)	<0.05
Itchy eyes	0.80(1.06)	1.66(1.02)	3.20	(0.75, 13.65)	<0.05
Watery eyes	0.70(0.87)	1.70(1.05)	2.40	(0.55, 10.32)	<0.05
Total scores	6.83(4.06)	11.43(3.90)	1.31	(1.13, 1.52)	<0.05
Quality of life impairment					
Reduced productivity at work/home	0.73(0.82)	1.63(1.03)	2.86	(0.69, 11.82)	<0.05
Poor mental concentration	0.86(0.93)	1.66(0.95)	3.50	(0.76, 16.11)	<0.05
Reduce thinking power	0.60(0.81)	1.40(1.16)	0.75	(0.18, 3.10)	<0.05
Impaired reading Book/newspaper	0.53(0.81)	1.73(1.04)	4.75	(1.05, 21.36)	<0.05
Reduced memory loss	0.40(0.67)	1.50(1.10)	2.18	(0.51, 9.22)	<0.05
Limitation of outdoor life	0.93(1.08)	1.73(0.90)	9.62	(1.69, 54.78)	<0.05
Limitation of going out	0.90(1.02)	1.63(1.06)	1.45	(0.33, 6.34)	<0.05
Hesitation to visit friends or relatives	1.10(1.12)	1.00(0.94)	1.95	(0.57, 6.58)	0.71
Reduced contact with friends or others by telephone or conversation	0.73(0.86)	1.46(0.81)	4.16	(1.00, 17.30)	<0.05
Not an easy person to be around	0.23(0.43)	1.56(1.16)	2.05	(0.50, 8.34)	<0.05
Impaired sleeping	1.26(1.22)	2.13 (1.40)	0.91	(0.16, 5.04)	<0.05
Tiredness	1.23(1.19)	2.16(0.91)	8.09	(1.69, 38.59)	<0.05
Fatigue	1.20(1.18)	1.83(1.23)	1.04	(0.21, 5.09)	0.04
Frustration	0.93(1.01)	1.36(1.03)	2.88	(0.79, 10.57)	0.10
Imitability	0.33(0.60)	0.53(0.68)	2.15	(0.65, 7.11)	0.23
Depression	0.26(0.44)	0.80(0.88)	2.53	(0.82, 7.83)	<0.05
Unhappiness	0.36(0.71)	1.10(0.92)	9.37	(2.10, 41.62)	<0.05
Total score	12.66(10.46	25.26(9.28)	1.12	(1.05, 1.19)	<0.05
General state (including symptoms, life and emotion) in the past 1-2 weeks	1.33(0.75)	2.43(0.93)	4.54	(2.02, 10.18)	<0.05
Overall scores from 3 parts	20.83(13.05)	39.13(12.51)	1.10	(1.05, 1.15)	<0.05

*[a]: Obtained by independent two sample test; [b]: Mean (SD); **AdSe**: adequate Se intake group; **InadSe**: Inadequate Se intake group; Total score in each sub-question = 4.0; Total score of part 1 = 24; Total score of part 2 = 68; Total score from all the 3 parts = 96.*

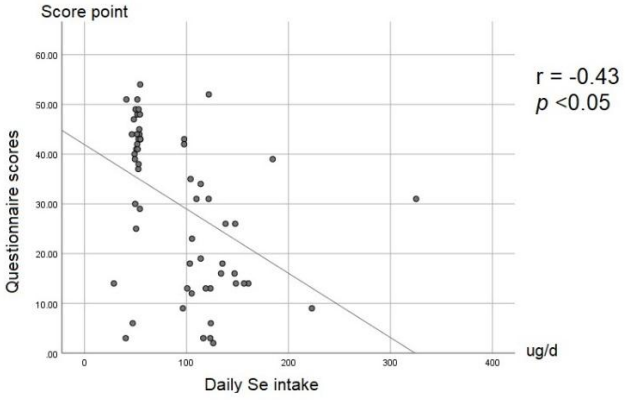

Figure 1. Correlation between of Se intake and scores of the severity of symptoms and quality of life mpairment.

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Table 3. Dietary intake of the participants.

Variable	AdSe group (n=30)	InadSe group (n=30)	*p* value[a]
Total energy in kcal	2,079 .13(331.56)[b]	1,976.93(337.37)	0.24
%kcal from carbohydrate	57.43(5.49)	56.06(6.05)	0.36
%kcal from protein	16.46(4.93)	11.83(3.86)	<0.05
%kcal from fat	26.10 (6.42)	32.10 (6.83)	<0.05

*[a]: Obtained by independent two sample test; [b]: Mean (SD); **AdSe**: adequate Se intake group; **InadSe**: Inadequate Se intake group.*

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Authors' contributions

T Tiyawisutsri, N Suwanpanyakul, W Kongkasri, and K Thongsri collected the data. A Singhato conceptualized the study design and wrote the manuscript, and R Timothy Callaghan proof read the English writing of the manuscript.

Conflict of Interest

The authors declared no conflict of interests.

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