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The Effect of Vitamin C Supplementation on Cognitive Function in Postmenopausal Women

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Abstract

During the menopause transition, a main symptom is cognitive decline and it has been shown that when hormone exposure increases, it is associated with cognitive decline. Recent studies have questioned the significance of vitamin exposure as a natural factor of improving cognitive health. This study aims to determine whether Vitamin C supplementation could be an easy, low-cost factor in delaying cognitive decline in postmenopausal women. The Mini Mental-State Examination (MMSE) was used to evaluate their cognitive levels before and after a time period of receiving Vitamin C supplementation. While the data did not show a significant increase in cognitive function, the qualitative data within subsections of the MMSE indicates a slight increase or no change in cognitive function. This shows to prove that Vitamin C supplementation could play an important role in preserving cognitive function during this aging period.

Introduction

Menopause is formally defined as the cessation of a female's menstrual cycle. It consists of a natural decline, followed by a fluctuation of reproductive hormones when a female reaches the age range of 40-60 years (Imtiaz et. al., 2017). Females have various reproductive hormones affecting their reproductive systems, such as estrogen and progesterone. Estrogen is the main hormone associated with the female reproductive organs and is responsible for the development of reproductive characteristics (Delgado et. al., 2023). During the menopause transition, a main symptom is cognitive decline. Cognitive function is formally defined as any mental processes involving symbolic operations such as perception, memory, speech, creation of imagery, and ability to learn new information (Espeland et. al., 2013). It has been shown that when hormone exposure increases, it is associated with cognitive decline (Fox et. al., 2018). More specifically, higher estrogen levels during the menopause transition is correlated with smaller brain volumes (de Lange et. al., 2020).

Recent studies have questioned the significance of vitamin exposure as a natural factor of improving cognitive health. Vitamin supplementation is the pharmaceutical category of nutrients to supplement an individual's diet. Recent studies have shown that vitamin supplementation can improve both physical and mental symptoms of menopause in females. 25-Hydroxyvitamin D [25(OH)-D] is a hormonally sensitive vitamin supplement that has been shown to relieve physiological menopause symptoms—specifically hot flashes, fatigue, and joint pain (Hakim et. al., 2022). Ascorbic Acid is a hormonally specific form of Vitamin C supplementation that when taken during a 12-week period, has highlighted significant improvements in cognitive function in postmenopausal females (Vijayakumar et. al., 2017). If Ascorbic Acid could be translated to any

over-the-counter Vitamin C supplementation, it could be treated as a convenient, low-cost alternative for postmenopausal females to delay cognitive declining symptoms they experience.

Purpose

The purpose of this study was to determine whether Vitamin C supplementation administered in postmenopausal women will delay cognitive decline. It was hypothesized that when postmenopausal women receive one Vitamin C supplement daily for a period of 4 weeks, they will experience a preservation in cognitive function.

Methodology

The criteria for this study were postmenopausal women with an age range of 45 to 60 years old. 14 participants were recruited for evaluation. In order to meet all requirements for analysis, participants completed a baseline questionnaire (**Figure 1**) and the Mini Mental-State Examination (MMSE) (**Figure 2**) before taking one tablet of Vitamin C per day for a period of 4 weeks, then completed the MMSE once more after the 4-week period.

An original baseline questionnaire was administered, which consisted of 4 questions. The survey inquired about the participants' age, ranging from 45 to 60 years (Question 1). It then inquired about the amount of time it has been since the participant experienced menopause in a number of years (Question 2). It was then asked whether the participant is already taking Vitamin C supplementation or not, and to specify which brand is used if the answer is yes to the previous question (Questions 3 & 4).

Before and after the 4-week period, participants were asked to complete the Mini Mental-State Examination (MMSE). The Exam tested for cognitive traits such as Orientation,

Registration, Attention and Calculation, Recall, and Language and Praxis (**Figure 3**). The test was scored on a scale of 0 to 30 points, with any score less than 24 being considered “Abnormal.” The score of each participant before and after the 4-week period was then considered for statistical analysis.

Figure 1: Baseline Questionnaire

1. How old are you?

2. How many years has it been since you have experienced menopause?

3. Do you currently take Vitamin C supplementation?
 - Yes
 - No

4. If yes, what brand supplement do you use?

Figure 2: Mini Mental-State Examination (MMSE) Interpretation

Method	Score	Interpretation
Single Cutoff	<24	Abnormal
Range	<21 >25	Increased odds of Dementia Decreased odds of Dementia
Education	21 <23 <24	Abnormal for 8th grade education Abnormal for high school education Abnormal for college education
Severity	24-30	No cognitive impairment

	18-23 0-17	Mild cognitive impairment Severe cognitive impairment
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Figure 3: MMSE Categories

Category	Point Value
Orientation	10 points
Registration	3 points
Attention and Calculation	5 points
Recall	3 points
Language and Praxis	9 points

Results

There were 14 participants in total, one that was excluded because of incomplete data regarding the Mini Mental-State Examination (MMSE). Of the total 14 participants, 28.57% reported that they currently take Vitamin C Supplementation already (n=4). This subgroup was composed of 1 individual who takes Nature’s Bounty, 3 that take Nature Made, and 1 that takes Spring Valley.

Before the 4-week period in the MMSE, in both the Orientation and Registration section, all participants received full credit. In the Attention and Calculation section, 47% received full credit (5 points), 40% received 3 points, and 13% received 2 points. In the Recall section, 53% received full credit (3 points), 33% received 2 points, and 14% received 1 point. In the Language and Praxis section, 47% received full credit (9 points), 13% received 8 points, 20% received 7 points, and 20% received 6 points.

After the 4-week period in the MMSE, the Orientation and Registration section both had no change in score in any participants and stayed full credit. In the Attention and Calculation

section, 57% received full credit, 29% received 3 points, and 14% received 2 points. In the Recall section, 64% received full credit, 29% received 2 points, and 7% received 1 point. In the Language and Praxis section, 64% received full credit, 21% received 8 points, 15% received 7 points, and no participants received 6 points.

Figure 4: Original Questionnaire Data

	n=	% of total responses
Total	14	100
<50 years	3	21.43%
>50 years	11	78.57%
1-5 years since menopause	8	57.14%
6-12 years since menopause	6	42.86%
Currently taking supplementation	4	28.57%

Figure 5: Attention and Calculation MMSE (Pre 4-Week Period)

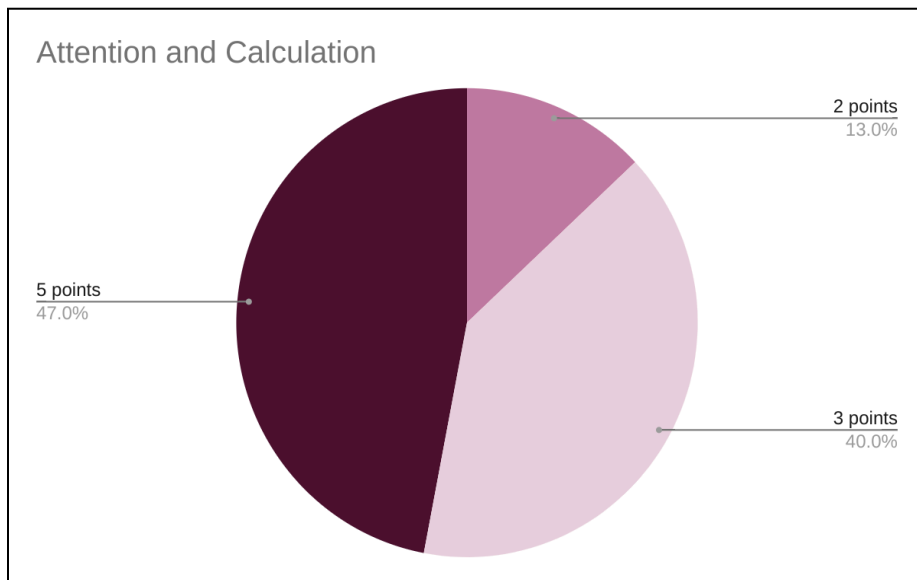


Figure 6: Recall MMSE (Pre 4-Week Period)

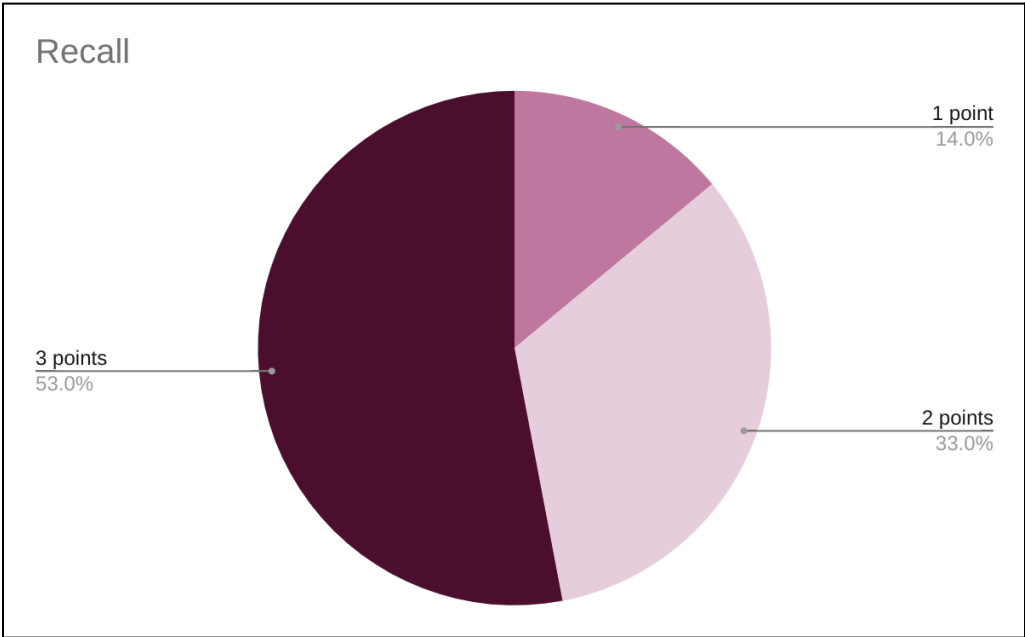


Figure 7: Language and Praxis MMSE (Pre 4-Week Period)

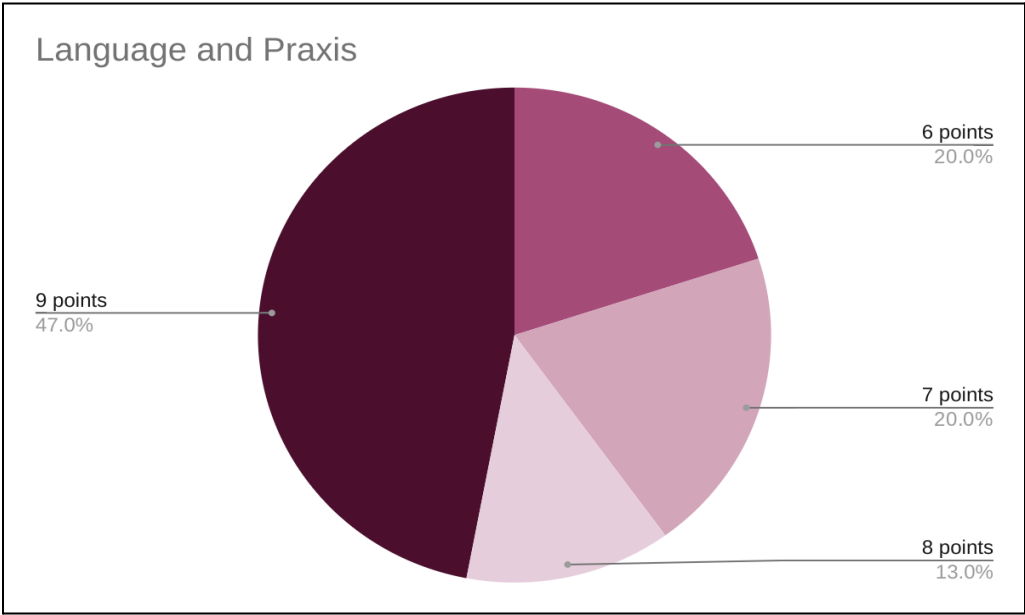


Figure 8: Attention and Calculation MMSE (Post 4-Week Period)

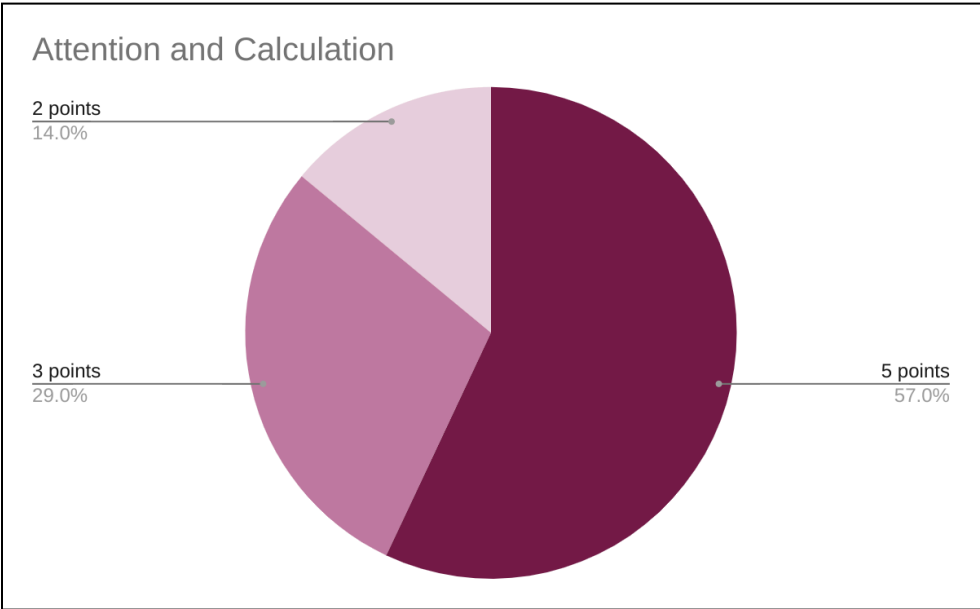


Figure 9: Recall MMSE (Post 4-Week Period)

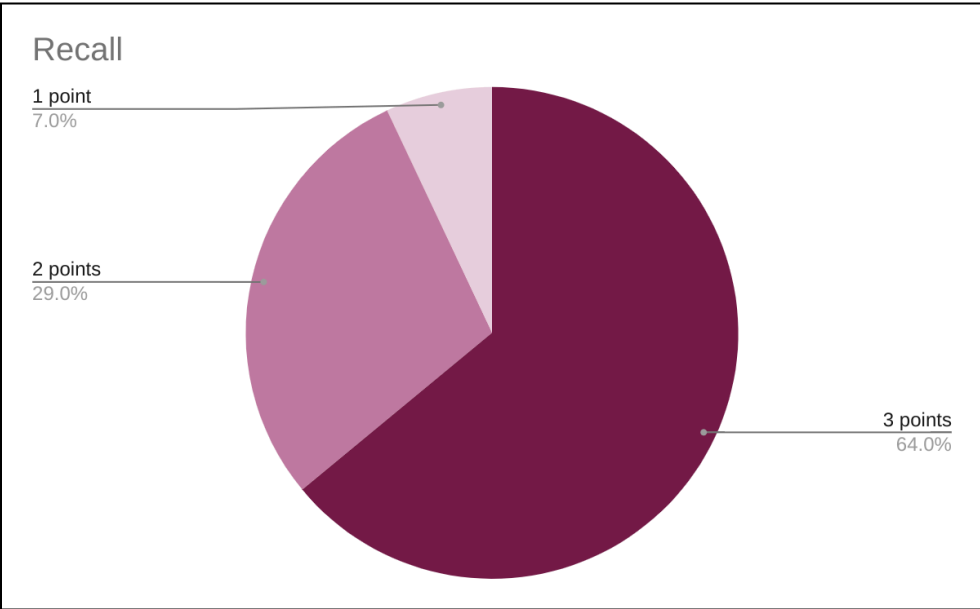
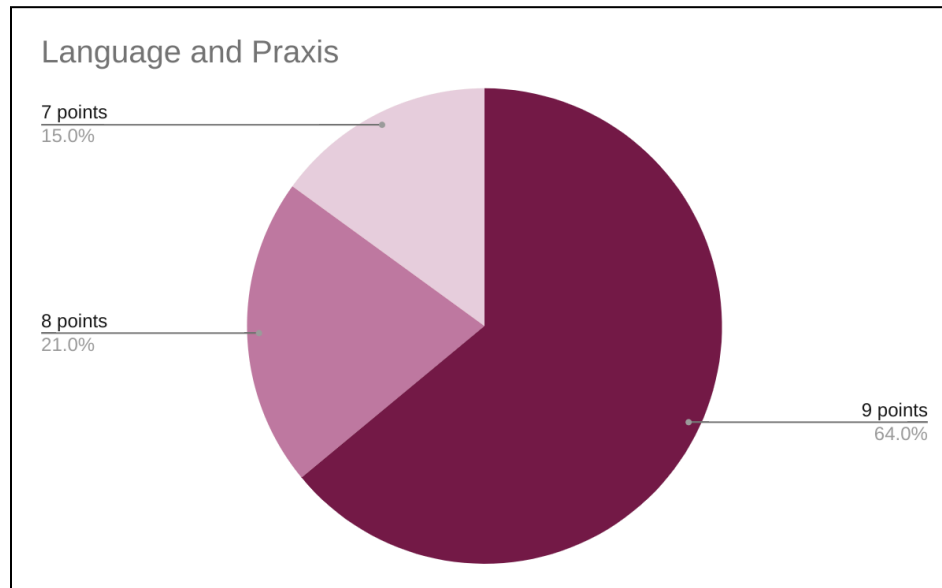


Figure 10: Language and Praxis MMSE (Post-4 Week Period)



The Mini Mental-State Examination (MMSE) scores consistently increased in each participant before and after the 4-week period, as well as the Attention & Calculation, Recall, and Language & Praxis sections. The results do show a positive correlation between the time period after 4 weeks and the MMSE score in all aspects.

As a whole, the results indicate that though there was an increase in MMSE scores after the 4-week period, there was not a significant difference, so the null hypothesis was retained. ($p=0.134$). Since the Orientation and Registration score sections of the MMSE remained identical, there was not a significant relationship between performance in those aspects. Attention & Recall ($p=0.230$) and Recall ($p=0.386$) also did not have a significant difference in scoring before and after the 4-week period. The only section within the MMSE that showed a significant change in cognition was Language & Praxis ($p=0.030$). Language & Praxis contained a large increase in point value in each individual before and after the 4-week period and rejected the null hypothesis.

Figure 11: Mini Mental-State Exam (MMSE) Score Changes

	Pre 4-Week Period Mean ± SD	Post 4-Week Period Mean ± SD	p-value
Orientation	10	10	n/a
Registration	3	3	n/a
Attention & Calculation	3.643 ± 1.277	4 ± 1.24	0.230
Recall	2.5 ± 0.65	2.571 ± 0.646	0.386
Language & Praxis	7.714 ± 1.267	8.5 ± 0.76	0.030
Total	26.857 ± 3.085	28.071 ± 2.556	0.134

Discussion

Though there was mostly no statistical significance to the change in MMSE scores, there was a consistent increase in all aspects of the study before and after the 4-week period. In all participants, the total MMSE score was within the parameters of “normal” cognitive function (>23). The MMSE is a cognitive assessment where a lower score would indicate a higher risk for Dementia later in life. None of the participants within this study exhibited a risk solely based on score, but many individuals were not at a perfect level of function.

The results imply that women who have already taken Vitamin C supplementation in the past have better cognitive performance. The individuals who indicated they took Vitamin C supplementation before the time period of the study had higher scores in the MMSE both before and after the 4-week period. Since they have had more exposure than the allotted period of time given, they most likely are subject to a stronger delay in cognitive decline than those who only started supplementation after the first MMSE.

The small sample size and relatively short time period allotted to take Vitamin C supplementation limits the generalizability of these results. If more time was available for a supplementation period in these participants, there is a higher chance that MMSE scores would be higher in a more statistically significant sense. Furthermore, if there was a larger sample size of participants, the results of this study could be adopted to a larger population of postmenopausal women. The tablet intake was also solely the responsibility of the participants in the study and was not counted during the 4-week period, so there is a possibility that not every tablet was taken on time or at all.

Conclusion

The hypothesis was partially supported. When postmenopausal women received Vitamin C Supplementation for a period of 4 weeks, their cognitive function was preserved. Each individual's Mini Mental State Examination (MMSE) score either increased or remained the same. There was no decline in cognitive function.

It can therefore be concluded that Vitamin C is a helpful, low-cost alternative to more expensive medications in delaying menopause-related cognitive decline. It should be noted that it should only be used as a preventative measure and not a treatment at this time. It is not shown that Vitamin C Supplementation improves cognitive function in any way, and it only slightly slows down the aging process of the brain. In terms of postmenopausal cognitive decline that is not at risk for Dementia, vitamin supplementation can be an effective way to relieve physical and cognitive symptoms for longer periods of time.

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