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Original Article

# Comparison of vegan and non-vegan diets on memory and sleep quality

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SUMMARY

*Background and aims:* It is widely acknowledged that the quality of nutrition affects many aspects of physical and mental performance. A vegan diet is associated with superior cardiovascular and cerebrovascular conditions. Mediterranean diets (high fruit and vegetable content) are linked with reduced risk of neurodegenerative diseases and improved performance on cognitive. The aim of the present study was to evaluate the effects of diet on memory and sleep quality.

*Materials and methods:* Verbal memory and sleep quality were assessed in a cohort of 62 adults aged 40 and above. Using a modified Mediterranean Diet Adherence Screener, the participants were divided into the categories of vegan, vegetarian, pescatarian, omnivores with low meat/fish consumption, and omnivores with high meat/fish consumption. The California Verbal Learning Test was used to assess verbal learning memory, and the Pittsburg Sleep Quality Index was used to assess sleep quality.

*Results:* The diet group with the best performance was pescatarian ($M$ = 118.2), followed by vegetarian ($M$ = 117.6) and vegan ($M$ =116.0). The group with the lowest performance was omnivore high ($M$ = 104.7). Females performed better than males in every diet group except vegetarian. Analysis of variance showed a main effect of diet on delayed recall, $F(4, 57) = 2.823$, $P = .033$, $\eta p\ 2 = .165$. There was a significant difference among the diet groups on the delayed recall, where vegetarians had the highest scores (116.43) followed by pescatarians (116.20), vegans (115.21), omnivore lows (105.41) and lastly omnivore highs (99.43).

*Conclusions:* Diet was found to have a significant effect on memory but no significant effect on sleep quality. The sample size may have

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been insufficient to capture the effects of diet on sleep. To definitively establish the relationships between diet patterns and quality of cognitive functioning and sleep, further research is required. The results of this study cast doubt on the hypothesis that the consumption of animal products boosts memory performance.



## Introduction

Previous studies have indicated that the modern Western diet, high in animal fat and animal protein, is associated with raised incidences of obesity, diabetes, cardiovascular diseases, hypertension and cancer as well as mood and neurological disorders, [4,9,14,15,17]. Evidence also exists of a correlation between macronutrient intake and the quality of sleep, [12], and that reductions in sleep quality are related to lower cognitive functioning, [5]. Another study, [10], suggests that a vegan diet is associated with improvements in mood and neurological disorders, such as Alzheimer's disease. Studies on the effects of a Mediterranean diet, [16], indicate that it is associated with improved mood and cognitive processing speeds.

There are, however, a number of conflicting findings and the levels of statistical significance of some of the results referred to above are low due to small participant numbers, short study periods and diverse nutritional patterns, [7,11]. The possible implications of the effects of diet (i.e. cholesterol levels, attention and memory span and peacefulness) on the physical, mental and emotional health of the general population makes a controlled study of the effect of specific classified diets on defined sleep quality measures and on objectively measured memory performance highly relevant.

For the present pilot study, the independent variables are types of diet over the last five years in five classifications: vegan, vegetarian, pescatarian, omnivore-low and omnivore-high, as established by the Mediterranean Diet Adherence Screener, (MEDAS) questionnaire. The two dependent variables are sleep quality, self-reported on the Pittsburg Sleep Quality Index, (PSQI), and memory performance measured by the California Verbal Learning Test, 3rd Edition, (CVLT-3).

The main findings of the study are that adherence to a plant-based rather than a meat-based diet results in improved short-term verbal memory but has no effect on quality of sleep.

## Methods

### *Measures*

The primary measures used in the study were the California Verbal learning Test (CVLT) – 3rd Edition, the Mediterranean Diet Adherence Screener and the Pittsburg Sleep Quality Index.

### *California Verbal Learning Test 3 (CVLT-3)*

The CVLT-3, standard form, was used to measure memory performance. Participants were given word lists to memorize and recall was tested after a timed delay. Raw scores were standardized for age. For the current study the key outcome measure was total recall. Raw scores from the correct recall tests were scaled using tables to standardise for age. This results in a standardised score with mean for the population of 100 and a SD of around 15. The raw score for the Y/N recognition discrimination was also scaled used the tables, giving a scaled score from 1 to 19. Higher scores indicate better memory performance. The mean standard score is 100 with a standard deviation of 15.

*Mediterranean diet adherence (MEDAS)*

The Mediterranean Diet Adherence Screener consists of 14 questions on food and drink consumption. For the present study an amended scoring system was used to categorize individuals to one of the five specified dietary groups. Participants were considered to be in a given category if their dietary habits had not changed in at least 6 months. A respondent was categorised as 'vegan' if they self-reported as such and replied that they did not eat meat products, dairy products or seafood. The 'vegetarian' category included respondents who self-reported as such and who did not eat meat products or seafood). 'Pescatarians' were individuals who did not eat meat products but did eat seafood. Individuals who ate meat, fish or other animal products were divided into two groups according to the level of consumption of such products that they consumed. 'Omnivore – low animal-product consumption' participants were those who reported eating fewer than 3 servings of meat products per day (where on serving is 2–3 ounces), three or fewer servings of dairy products a day (one serving is 1 tablespoon) and 3 or fewer servings per week of seafood (one serving is 2–3 ounces of fish or 3 ounces of shellfish). 'Omnivore – high animal-product consumption' participants were those that consumed more than 3 servings a day of meat, more than 3 servings a day of dairy products, more than 3 servings a week of seafood, or a combination of 1–3 servings per day of meat plus 1–3 servings per day of dairy products. Animal products include red and white meat, fish and shellfish, milk, cream, butter and margarine, cheese and eggs. It has been assumed that omnivores had followed their chosen diet for life.

*Pittsburg sleep quality questionnaire (PSQI)*

The Pittsburg Sleep Quality Questionnaire assesses sleep quality and disturbances over the previous month. It contains a list of 19 questions giving scores for sleep quality, latency, duration and efficiency and also disturbances, use of medications and dysfunctions during daytime activities. A list of 19 questions results in scores for 7 components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, disturbances of sleep, use of sleep medication and dysfunction during daytime activities.

Each of the seven components is scored from 0 (no difficulty) to 3 (severe difficulty), and these are combined into an overall score ranging from 0 to 21, where higher scores represent worse sleep quality. If the total score is equal to or lower than 5 then the sleep quality is considered as "good". If it was higher than 5 then it is considered "bad".

## Data collection

Once informed consent had been given by the participant and they had been given instructions to be focused as much as possible, the experimenter started the questionnaire booklet. This consisted of the CVLT-3 test followed by the MEDAS and PSQI questionnaires. The delayed components of the CVLT-3 were completed after the questionnaires. The entire procedure took between 40 and 60 minutes to complete.

The study was approved by the Ethics Committee of Birkbeck, University of London.

## Statistical analysis

Analyses were performed using IBM SPSS Version 25. The main hypothesis concerning the effect of diet on memory was assessed using ANCOVA with dietary group as the independent variable and the memory score as the dependent variable with sleep quality as the covariate.

## Results

All participants were adults aged between 40 and 77 years of age. All were fluent English speakers, with English as their first or second language. There were 62 participants, 33 male and 29 female. Using

the diet questionnaire, each participant was placed in one of the five dietary categories as shown in Table 1.

**Table 1**
Number of participants by diet group

| OMN-H | OMN-L | PESC | Veget | Vegan | Grand total |
|---|---|---|---|---|---|
| 14 | 17 | 10 | 7 | 14 | 62 |

Table 2 shows the mean memory score for each diet group and the overall mean. Figure 1 shows the differences between the individual group scores and the overall mean. The statistical analysis confirmed that there was a marginally significant effect of diet on short-delay only if there was no other independent or confounding variables taken into the statistical analyses. When an ANCOVA test was run with Gender added as the covariate, the significance of the diet was lost.

**Table 2**
Memory scores by diet group

| OMN-H | OMN-L | PESC | Veget | Vegan | Grand total |
|---|---|---|---|---|---|
| 104.7 | 109.5 | 118.2 | 117.6 | 116.0 | 112.2 |

Figure 1 shows the effect of diet on verbal memory.

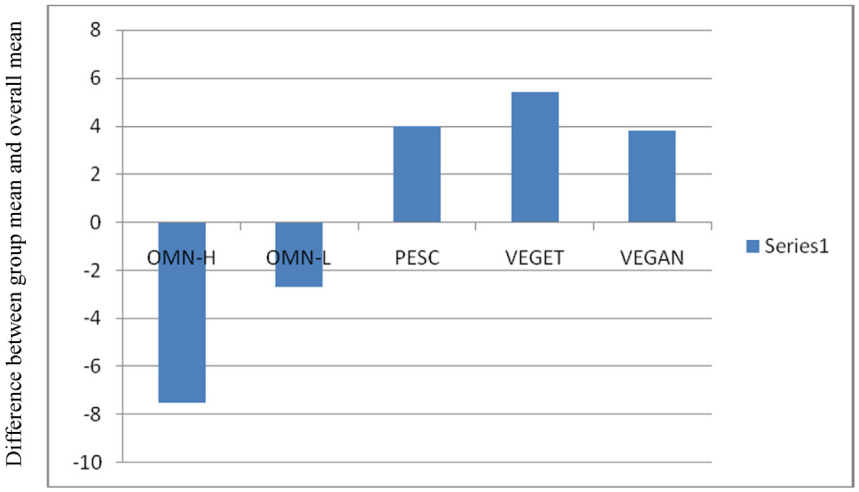


**Figure 1.** The effect of diet group on the difference between individual diet group mean and overall mean for verbal memory.

Table 3 shows the mean scores for sleep quality for the individual diet groups together with the overall mean. Higher scores signify lower sleep quality.

**Table 3**
Mean scores for sleep quality

| OMN-H | OMN-L | Pesc | Veget | Vegan | Grand total |
|---|---|---|---|---|---|
| 5.6 | 4.3 | 4.9 | 7.1 | 4.6 | 5.1 |

Figure 2 shows the differences between the individual group mean scores and the overall mean score – with positive differences indicating better sleep quality. The statistical analysis confirmed that there was no significant effect of diet on sleep quality. According to the PSQI guide, a score of 5 or more indicates a poor sleep pattern.

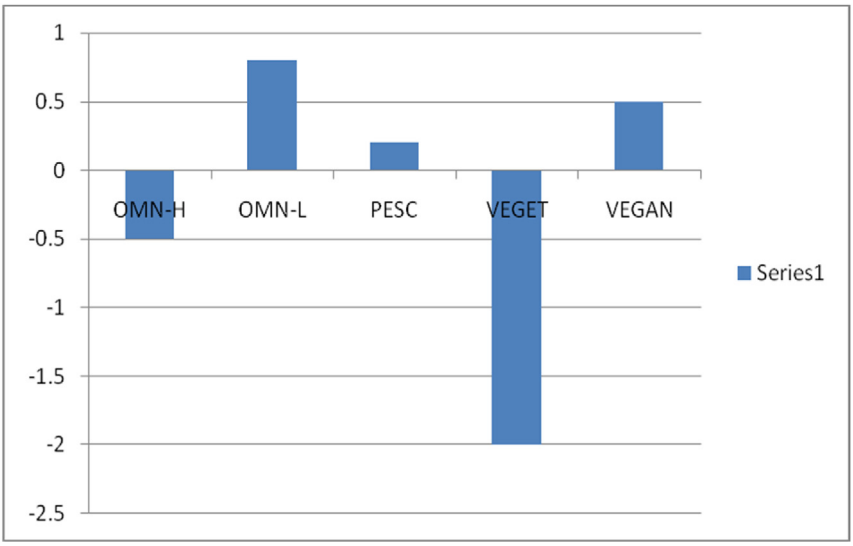


**Figure 2.** The effect of diet group on the difference between diet group mean and overall mean for sleep quality.

## Discussion

The rates of cognitive disorders that impact the memory are increasing globally, and it is also increasingly recognized that diet related pathological processes such as atherosclerosis [1] and inflammation [8] impact cerebrovascular health leading to cognitive deficiencies. There is limited evidence that feeding on a plant-based diet, (which is high in dietary fiber and vitamins), can lead to functional protection or even improvement in human cognition. In this cross-sectional observational pilot study, the association between diet and verbal learning memory was evaluated. Consistent with most earlier findings. it was found that there was a significant effect on short-delay memory, with plant-based diets showing improved performance relative to the animal-based diets when diet was the only independent variable and no confounding variable is taken into account utilizing ANOVA (Analyses of Variance). However, when confounding variables (i.e. gender, sleep quality and education level) were added to the statistical analyses using ANCOVA (Analyses of Covariance), the significance of the effect was lost. There is literature suggesting that diet plays a role in sleeping patterns, such as the duration, quality and the latency of sleep. Food containing high carbohydrate; hence rich in tryptophan, a protein that is the precursor of sleep hormone Melatonin, are known to be sleep-promoting, (Binks *et al.*, 2020). However in this study, a one-way ANOVA showed no significant effect of diet on sleep quality. Future research can investigate not only the quality but also the latency and the duration of sleep in relation to food that are rich in not only carbohydrates but also animal-based macronutrients in contrast to plant-based ones. Last but not least, a chi-squared test showed that females in the sample showed significantly better verbal learning memory performances than the males in overall verbal learning memory, which is short-delay, long delay and recognition.

This could be due to diet preferences where females are more inclined to become vegans than males, [2]. Alternatively, it could be due to neuroanatomical differences that affect verbal capacity positively [3]. The cortical speech processing centres - Broca's and Wernicke's areas - are larger in females than in males, (Harasty *et al.*, 1997). Also, the commissural fibers in the corpus callosum linking

the left and right hemispheres are larger, so that females use both hemispheres much more than males who predominantly use only the left hemisphere, [13].

Current pilot study had limitations as it had a small sample size and the confounding variables were so strong that they have decreased the significance of the independent variables that are the types of different diet types. In order to eliminate the effects of covariates, in this case the strongest was by far the gender, same gender groups could be compared instead of binary experimentation. As indicated above, females have an advantage in verbal memory which derails the study's objective. Research recruiting only female or male participants comparing various diet types are recommended, hence the difference of the memory capacity could be attributed massively to the diet, if not solely.

Lastly, research on vegans have had its limitations as the vegan population has been the minority among population however in the last couple of years the quantity of vegan people have massively increased [6] which would provide a promising database for the upcoming vegan diet research.

## Conclusion

This pilot study has found that there is a significant effect of gender favoring females over males in overall memory and a marginally significant effect of diet on short-term memory, with plant-based diets showing superior performance to animal-based diets. No significant effect of diet on sleep quality was found. The results suggest that a similar study with a much larger sample size would make a major contribution to resolving the scientific uncertainties regarding the effects of diet on memory and other neural mechanisms.

## Data availability

All data generated or analyzed during this study are included in the supplementary information files.

## Ethical statement

Participants gave written informed consent before the experiment. The procedures were approved by the Department of Psychological Sciences Research Ethics Committee at Birkbeck, University of London. All procedures were in accordance with the principles of the Declaration of Helsinki. Written informed consent for the publication of anonymized data for academic purposes was obtained from all participants.

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## Declaration of competing interest

There were no conflicts of interest in the performance of the study.

## Additional information

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