Impact of Vitamin D Deficiency on Cognition in Patients with Multiple Sclerosis

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ABSTRACT

Low vitamin D status has been implicated in the etiology of multiple sclerosis. Evidences suggest that vitamin D may play a role in cognitive performance. Aim of work: Assessment of vitamin D level in patients with multiple sclerosis, the effect of multiple sclerosis on cognition, and the impact of vitamin D deficiency on cognition in multiple sclerosis patients. Subjects and Methods: A cross sectional study was conducted on 30 Egyptian patients with definite MS. They were divided into: group 1 (n=10) newly diagnosed on no treatment and group 2 (n=20) patients with MS for at least 2 years, this was further subdivided into: group 2A (n=10) patients receiving glucocorticoids and group 2B (n=10) patients receiving other disease modifying therapies. Patients were subjected to clinical evaluation, routine labs, serum vitamin D level, markers of calcium metabolism, Expanded Disability Status Scale (EDSS), Fatigue Severity Scale, and neuropsychological assessment. Results: Vitamin D deficiency was found in 87% of patients. No statistically significant correlation was found between cognitive function tests and vitamin D level, but a correlation was found between PTH level and performance on cognitive tests. (Egypt J. Neurol. Psychiat. Neurosurg., 2009, 46(1): 223-234)

INTRODUCTION

On the basis of comprehensive neuropsychological studies, there is now a consensus among investigators that 45 percent to 65 percent of MS patients suffer from some degree and form of cognitive difficulty.1

Cognitive impairment (CI) may develop at any time during the course of the disease in the presence or absence of neurological disability.2

Features of CI include bradyphrenia; impaired attention, concentration and abstract reasoning; reduced manual speed and dexterity; deficits in memory retrieval; and language deficits in both the relapsing-remitting and progressive forms of MS.3

A deranged calcium metabolism appears to be associated with impaired function in several tests of neuropsychological function.4

Aim of Work
1. Study the effect of multiple sclerosis and its treatment on cognition.
2. Study the effect of vitamin D deficiency on the cognitive performance in patients with multiple sclerosis.

SUBJECTS AND METHODS

Subjects
This is a cross-sectional study conducted on 30 Egyptian patients diagnosed with multiple sclerosis according to the International Panel on Diagnosis of Multiple Sclerosis “McDonald” criteria and its revision. All MS types were included. They were 19 female patients (63.3%) and 11 male patients (36.7%), their age ranged from 18 to 40 years with a mean of 28.9 years.

Those patients were divided into 2 groups:
1. Group 1: including 10 patients with newly diagnosed MS on no treatment.
2. Group 2: including 20 patients that had been diagnosed with MS for at least 2 years. This group was further subdivided into two subgroups:
Group 2A: 10 patients treated with glucocorticoids (without other disease modifying therapies) for at least 12 months.

Group 2B: 10 patients treated with other disease modifying therapies [cyclophosphamide (4 patients), azathioprine (4 patients), interferon β (1 patient) & mitoxantrone (1 patient)]; those patients did not receive steroids for the last 12 months.

Exclusion Criteria:
1. Age below 10 years or above 40 years.
2. Metabolic or endocrinal troubles and other medical conditions.
3. Smoking.

Methods
The patients were subjected to the following battery of assessment:

I. Clinical evaluation:
   a. History taking from patients including:
      - Total years of school attendance.
      - Cumulative dose of glucocorticoids.
      - Dose of Calcium Supplementation
   b. Full neurological examination

II. Laboratory Work-up:
   a. Serum vitamin D (25-Hydroxy-Cholecalciferol):
      Serum assays were performed in Bioscientia laboratory, Ingelheim, Germany using Chemiluminiscent Enzyme Immunoassay (CLIA) technique. The reference range ranged from 20 to 70 ng/ml. Patients with vitamin D level below 20 ng/ml were considered to have vitamin D deficiency.
   b. Markers of Calcium Metabolism including serum levels of total and ionized calcium; phosphorus; alkaline phosphatase; parathyroid hormone (PTH).

III. Rating Scales:
   a. Expanded Disability Status Scale (EDSS)7.

IV. Neuropsychological Scales:
   a. Paced Auditory Serial Addition Task (PASAT):
      This test is a serial-addition task used to assess working memory, divided attention, and information processing speed. The Gronwall version of PASAT with 3 seconds interstimulus interval was used in this study (61 items per trial)9 (Table 1).
   b. Faces Symbol Test (FST):
      This test measures attention and information processing speed. A series of nine faces, each paired with a symbol, is presented during the test at the top of the FST form10. Patients with major problems involving their dominant hand or their visual function are excluded. Table (2) shows the normative data for the FST11.

Table 1. Normative data for PASAT Gronwall 3 seconds version.

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>16-29</th>
<th>30-49</th>
<th>50-69</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>47.4</td>
<td>10.1</td>
<td>43.4</td>
<td>10.2</td>
</tr>
</tbody>
</table>

Table (2): Normative data for the FST.

<table>
<thead>
<tr>
<th>&lt; 3.0 seconds per correct match</th>
<th>Cognitively normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 3.0 seconds per correct match</td>
<td>Likelihood of being cognitively impaired; further testing proposed</td>
</tr>
</tbody>
</table>

V. Magnetic Resonance Imaging of the brain

VI. Visual Evoked Potential (VEP) as a part of the McDonald criteria.

VII. Statistical Analysis:
Mann-Whitney U test was used for comparison when data was not normally distributed. As for the qualitative data, statistical differences and potential relations were assessed using Chi-
Square test. The one way of variance analysis (ANOVA) was used to assess statistical differences of quantitative data between study groups. Post Hoc Bonferroni test was used for multiple comparisons between study groups. Pearson correlation was used to test relation between study parameter. Correlation coefficient indicates the degree to which two measures are related. It does not indicate why they are related or that one variable causes the other. It ranges from -1 to +1 when = 0 means no relationship. Power: 95%.

RESULTS

Patients’ Characteristics

Thirty patients with definite MS were included. They were divided into group 1 which included 10 patients newly diagnosed with MS; group 2 included 20 patients that have been diagnosed with multiple sclerosis for at least 2 years; this group was further subdivided into group 2A which included 10 patients treated with glucocorticoids and group 2B which included 10 patients treated with other disease modifying therapies [cyclophosphamide (4 patients), azathioprine (4 patients), interferon B (1 patient) & mitoxantrone (1 patient)]. The distribution of age, gender, type of MS, duration of illness, EDSS, FSS, and the results of VEP in the study groups can be shown in table (3).

Vitamin D (25-Hydroxy-Cholecalciferol)

The mean level of vitamin D in the whole study group was 11.6±5.1 and vitamin D deficiency was encountered in 87.6% of all patients. All the newly diagnosed patients (group 1) and all those with PPMS experienced vitamin D deficiency. The mean level and the status of vitamin D in the different study groups and MS types are shown in figure (1) and tables (4) and (5).

Cognitive Function Tests

In study groups

There was no statistically significant difference between study groups as regards cognitive tests scores as shown in table (6).

Table (7) and figures (2), (3) and (4) show the degree of affection of cognitive function tests in the 3 study groups, there were no statistically significant difference between the 3 groups as regards the degree of affection of the cognitive function tests.

In MS types

Table (8) shows the scores of the cognitive function tests in MS types, there was no statistically significant difference in the scores of cognitive function tests between the MS types.

Correlation between Cognitive Function Tests and Age

No statistically significant correlation was found between cognitive function tests and age.

Correlation between Cognitive Function Tests and Total Years of School Attendance

A statistically significant positive correlation was found between PASAT score and total years of school attendance as shown in figure (5).

Correlation between Cognitive Function Tests and Vitamin D (25-Hydroxy-Cholecalciferol) level

No statistically significant correlation was found between cognitive function tests and vitamin D level.

Correlation between Cognitive Function Tests and Markers of Calcium Metabolism

A statistically significant negative correlation was found between PST 90 and parathyroid hormone in group 1, FST 90 and alkaline phosphatase in group 2A, FST T and alkaline phosphatase in group 2A as shown in figure (6). Whereas no statistically significant correlation existed between any of the cognitive function tests and other markers of calcium metabolism including total and ionized calcium, phosphorous, or alkaline phosphatase in any of the study groups.

Correlation between Cognitive Function Tests and Cumulative Dose of Calcium Supplementation

No statistically significant correlation was found between cognitive function tests and cumulative dose of calcium supplementation.

Correlation between Cognitive Function Tests and Duration of Illness in Months
No statistically significant correlation was found between cognitive function tests and duration of illness in months.

**Correlation between Cognitive Function Tests and FSS**

A statistically significant negative correlation was found between FST 90 and FSS in whole study population, FST 90 and FSS in group 2B and between FST T and FSS in group 2B as shown in table (9) and figure (7).

**Correlation between Cognitive Function Tests and Cumulative Dose of Multiple Sclerosis Treatment**

No statistically significant correlation was found between cognitive function tests and cumulative dose of multiple sclerosis treatment.

![Mean Vitamin D in ng/ml](image)

**Fig. (1):** Vitamin D level in MS types.

### Table 3. Patients' characteristics & VEP in study groups.

<table>
<thead>
<tr>
<th>Patients' Group</th>
<th>Group 1 (n= 10)</th>
<th>Group 2A (n= 10)</th>
<th>Group 2B (n= 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs) Mean±SD</td>
<td>27.43±4.85</td>
<td>29.97±7.22</td>
<td>29.97±7.22</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>6 (60%)</td>
<td>7 (70%)</td>
<td>6 (60%)</td>
</tr>
<tr>
<td>Males</td>
<td>4 (40%)</td>
<td>3 (30%)</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>Type of MS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RRMS</td>
<td>6 (60%)</td>
<td>6 (60%)</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>SPMS</td>
<td>0 (0%)</td>
<td>3 (30%)</td>
<td>6 (60%)</td>
</tr>
<tr>
<td>PPMS</td>
<td>4 (40%)</td>
<td>1 (10%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Duration of Illness (months) (Mean±SD)</td>
<td>34.90±15.61</td>
<td>95.60±26.49</td>
<td>80.80±56.59</td>
</tr>
<tr>
<td>EDSS</td>
<td>3.45 ± 1.91</td>
<td>3.25 ± 2.60</td>
<td>5 ± 1.9</td>
</tr>
<tr>
<td>FSS</td>
<td>3.27 ± 1.28</td>
<td>4.74 ± 1.78</td>
<td>4.86 ± 1.59</td>
</tr>
<tr>
<td>VEP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td>9 (90%)</td>
<td>6 (60%)</td>
<td>6 (60%)</td>
</tr>
<tr>
<td>Normal</td>
<td>1 (1%)</td>
<td>4 (40%)</td>
<td>4 (40%)</td>
</tr>
</tbody>
</table>
Table 4. Mean level and status of vitamin D in study groups.

<table>
<thead>
<tr>
<th>Vitamin D</th>
<th>Group 1 (n=10)</th>
<th>Group 2A (n=10)</th>
<th>Group 2B (n=10)</th>
<th>Whole Study Population (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Level (ng/ml)</td>
<td>10.3±4.15</td>
<td>9.78±4.75</td>
<td>13.8±6.67</td>
<td>11.59±5.14</td>
</tr>
<tr>
<td>Deficiency</td>
<td>10 (100%)</td>
<td>9 (90%)</td>
<td>7 (70%)</td>
<td>26 (86.7%)</td>
</tr>
<tr>
<td>Normal</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
<td>3 (30%)</td>
<td>4 (13.3%)</td>
</tr>
</tbody>
</table>

Table 5. Vitamin D status in different MS types.

<table>
<thead>
<tr>
<th>Vitamin D</th>
<th>RRMS (n=15)</th>
<th>PPMS (n=6)</th>
<th>SPMS (n=9)</th>
<th>Total (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficiency</td>
<td>14 (93.3%)</td>
<td>6 (100%)</td>
<td>6 (66.7%)</td>
<td>26 (86.7%)</td>
</tr>
<tr>
<td>Normal</td>
<td>1 (6.7%)</td>
<td>0 (0%)</td>
<td>3 (33.3%)</td>
<td>4 (13.3%)</td>
</tr>
</tbody>
</table>

Table 6. Cognitive tests scores in study groups.

<table>
<thead>
<tr>
<th>Cognitive Function Tests</th>
<th>Group 1 (n=10)</th>
<th>Group 2A (n=10)</th>
<th>Group 2B (n=10)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASAT</td>
<td>32.4±10.35</td>
<td>26.9±8.33</td>
<td>33±14.01</td>
<td>0.42</td>
</tr>
<tr>
<td>FST 90</td>
<td>7.34±3.29</td>
<td>6.1±1.79</td>
<td>5.74±4.69</td>
<td>0.57</td>
</tr>
<tr>
<td>FST T</td>
<td>9.65±4.92</td>
<td>8.8±2.79</td>
<td>11.54±15.72</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Table 7. Cognitive function tests in study groups.

<table>
<thead>
<tr>
<th>Cognitive Function Tests</th>
<th>MS Patients</th>
<th>Group 1 (n=10)</th>
<th>Group 2A (n=10)</th>
<th>Group 2B (n=10)</th>
<th>Total (n=30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASAT</td>
<td>Affected</td>
<td>7 (70%)</td>
<td>9 (90%)</td>
<td>6 (60%)</td>
<td>22 (73.3%)</td>
<td>0.303</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>3 (30%)</td>
<td>1 (10%)</td>
<td>4 (40%)</td>
<td>8 (26.7%)</td>
<td></td>
</tr>
<tr>
<td>FST 90</td>
<td>Affected</td>
<td>10 (100%)</td>
<td>10 (100%)</td>
<td>9 (90%)</td>
<td>29 (96.7%)</td>
<td>0.355</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
<td>1 (3.3%)</td>
<td></td>
</tr>
<tr>
<td>FST T</td>
<td>Affected</td>
<td>10 (100%)</td>
<td>10 (100%)</td>
<td>10 (100%)</td>
<td>30 (100%)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
</tbody>
</table>
Fig. (2): PASAT in study groups.

Fig. (3): FST 90 in study groups.

Fig. (4): FST T in study groups.
Table 8. The scores of cognitive function tests in MS types.

<table>
<thead>
<tr>
<th>Cognitive Function Tests</th>
<th>RRMS (n=15)</th>
<th>PPMS (n=6)</th>
<th>SPMS (n=9)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASAT</td>
<td>29.87±10.09</td>
<td>33.5±10.78</td>
<td>30.44±13.77</td>
<td>0.74</td>
</tr>
<tr>
<td>FST 90</td>
<td>6.38±3.02</td>
<td>8.72±4.95</td>
<td>4.76±1.34</td>
<td>0.13</td>
</tr>
<tr>
<td>FST T</td>
<td>8.53±4.64</td>
<td>16.75±17.9</td>
<td>7.49±2.51</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Fig. (5): Correlation between PASAT score and total years of school attendance.

Fig. (6): Correlation between FST 90 and parathyroid hormone in group 1.
Table 9. Correlation between cognitive function tests and FSS.

<table>
<thead>
<tr>
<th>Cognitive Function Tests</th>
<th>Whole Study Population (n=30)</th>
<th>Group 1 (n=10)</th>
<th>Group 2A (n=10)</th>
<th>Group 2B (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FSS</td>
<td>FSS</td>
<td>FSS</td>
<td>FSS</td>
</tr>
<tr>
<td>PASAT</td>
<td>0.22</td>
<td>0.25</td>
<td>0.12</td>
<td>0.74</td>
</tr>
<tr>
<td>FST 90</td>
<td>-0.40</td>
<td>0.03*</td>
<td>-0.08</td>
<td>0.82</td>
</tr>
<tr>
<td>FST T</td>
<td>-0.3</td>
<td>0.12</td>
<td>0.06</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Fig. (7): Correlation between 90 and FSS in whole study population.

DISCUSSION

In this study the prevalence of vitamin D deficiency (less than 20 ng/ml) among MS patients was 86.7%. The mean vitamin D level in this study groups was 11.59±5.14 ng/ml.

Though evidence suggests vitamin D may play a role in cognitive performance\textsuperscript{12}; yet, in this study no statistically significant correlation was found between cognitive function tests and vitamin D level. This is in agreement with Jorde et al.\textsuperscript{4}, who didn’t find a statistically significant correlation between the performance in several neuropsychological tests and serum levels of vitamin D. On the contrary, Wilkins et al.\textsuperscript{12} found that vitamin D deficiency was associated with worse performance on the “Short Blessed Test” (SBT) and higher “Clinical Dementia Rating” (CDR) in the
vitamin D-deficient group, and Rondanelli et al.\textsuperscript{13}, found a significant negative correlation between dietary intake of vitamin D and poor performance on cognitive tests. The absence of correlation between vitamin D level and the performance in cognitive function tests inspite of high prevalence of vitamin D deficiency in this study could be attributed to the choice of cognitive tests as the cognitive tests chosen in this study were sensitive to MS but they may not reveal cognitive domains affected in vitamin D deficiency.

On the contrary in this study a correlation was found between PTH level and performance in cognitive tests. Although the PTH level was within the reference range a statistically significant negative correlation was found between PTH level and performance in Faces Symbol Test at 90 seconds (FST 90) in newly diagnosed patients (Group 1). Previous studies reported correlations between hyperparathyroidism and performance in cognitive function tests. Jorde et al.\textsuperscript{3} in their study on neuropsychological function in subjects with secondary hyperparathyroidism (SHPT) not due to renal failure, found that for 10 of the 13 neuropsychological tests performed, a high serum PTH was associated with an unfavorable result. Also, Chou et al.\textsuperscript{14} noticed a significant improvement in cognitive performance as assessed by CDR and MMSE in 39 patients with secondary hyperparathyroidism after they undergone parathyroidectomy. Similar findings were found in patients with primary hyperparathyroidism using the Stroop tests\textsuperscript{22}. To our knowledge no previous studies questioned the relation between PTH and neuropsychological performance in MS patients.

The fact that this correlation was found in group 1 (newly diagnosed MS patients who received no treatment) reflects that the relation between parathyroid hormone and cognitive function is independent of treatment effect.

Cognitive impairment occurs in 43–65\% of patients with an established form of multiple sclerosis\textsuperscript{16}. As regards the performance in cognitive function tests in this study; in PASAT, 73.3\% of the study population had an abnormal test score, and in FST 90, 96.7\% had an abnormal test score, as for FST T all the study population (100\%) had an abnormal test score.

Previous studies found that (24%-64\%) of patients with MS were cognitively impaired when examined by PASAT\textsuperscript{10,17,21}. While Scherer et al.\textsuperscript{10}, estimated that 40.7\% out of MS patients were cognitively impaired using the FST. Descriptincies found between this study and previous studies as regards degree of cognitive impairment could be attributed to lower level of education of patients recruited in this study, the effect of education on performance in these tests couldn’t be ignored, this is supported by the highly statistically significant positive correlation between total years of school attendance and performance on PASAT, such correlation was missing with the FST which makes sense since the PASAT requires some arithmetic abilities, while the FST depends on facial recognition.

In the current study, no statistically significant correlation was found between duration of illness in months and cognitive function tests. The influence of disease duration on cognitive functioning in MS remains controversial, with investigations of natural history frequently confounded by small sample sizes, inadequate control for practice effects, high drop-out rates, and brief retest intervals\textsuperscript{22,24}.

It is reported that prevalence of moderate and severe cognitive impairment doubles over a 4-year follow-up of new diagnosed MS patients\textsuperscript{25}. Over a sufficiently long follow-up period cognitive dysfunction is likely to emerge and progress. Great variation exists between longitudinal studies in the clinical variables of participants, length of follow-up, and neuropsychological methods, making it difficult to compare results. These methodological issues appear to be contributing to the conflicting data, and a consensus is yet to be achieved regarding the evolution of cognitive impairment in MS. Furthermore, it is likely that the natural history of MS can no longer be accurately investigated, as most MS patients now receive disease-modifying drugs\textsuperscript{24}.

Ninety percent of MS patients complain of abnormal fatigue during the course of disease\textsuperscript{25,26}. This problem strongly affects patients’ ability to work and their quality of life. Many patients report that fatigue lowers their cognitive performance\textsuperscript{27}. In this study a statistically significant negative correlation was found between fatigue as assessed by Fatigue Severity Scale (FSS) and Faces Symbol
Test at 90 seconds in whole study population, between FSS and FST 90 in group 2B and between FSS and FST T in group 2B. Previous studies reported a negative impact of fatigue on cognition\(^\text{28,29,30}\). Fatigue does not affect particular cognitive domains, but rather it acts to limit the overall capacity of individuals with MS to sustain mental activity\(^3\). Compounding the problem of cognition in MS patients, individuals who are already experiencing some degree of cognitive decline, may be particularly susceptible to additional cognitive dysfunction from medications\(^3\). In particular, corticosteroids, baclofen, benzodiazepines, and neuroleptic drugs used by individuals with MS may have a negative impact on cognitive functioning\(^33,34\).

In this study no statistically significant correlation was found between the cumulative dose of steroids and performance in neuropsychological tests. Special emphasis is drawn on potential cognitive drawback of corticosteroids. Based on their known anti-inflammatory, anti-edematous and immunosuppressive characteristics, corticosteroids are among the first and the most frequently immunosuppressive drugs used in the treatment of MS. Neuro-psychological impairment including psychosis and dementia like syndromes has been reported to occur following long-lasting high dose steroid therapy\(^3\). The ultrahigh dose corticosteroids (through their psychotropic effects) induce worsening of neuropsychological deficits known to occur in early stages of MS\(^36\). In most cases, steroid induced deficits are reversible; in a few instances however they may also persist for weeks or months\(^37,38\).

Investigations on healthy individuals showed that even the lowest doses of steroids may induce significant deficits of cognitive functions, mainly involving declarative memory\(^39,40\). Impairments of working memory and of alertness\(^41\) have been reported as well. Investigating MS patients during and after a relapse under treatment with methylprednisolone, Patzold et al.\(^42\) reported improved cognitive performance operationalised by PASAT (Paced Auditory Serial Addition Test).

No statistically significant correlation was found between the cumulative dose of azathioprine and cyclophosphamide and cognitive function tests. A single trial has studied the effects of immunosuppressive treatments on cognitive function in progressive MS patients. A significant improvement in global cognitive efficiency, encoding abilities, planning abilities and inhibition was detected after treatment with cyclophosphamide combined with methylprednisolone for 12 months\(^43\).

**REFERENCES**


[Abstract]

المخصص العربي
تأثير فيتامين د على الإدراك في مرضى التصلب المتعدد

يعاني 45% من مرضى التصلب المتعدد من صعوبات في الأداء الإدراكي والمعرفي، وتنتشر الدلائل أن فتق فيتامين د قد يلعب دورًا في هذه الصعوبات. تهدف هذه الدراسة إلى دراسة مستوى فيتامين د في مرضى التصلب المتعدد ودور فتق فيتامين د في صعوبات الأداء الإدراكي والمعرفي لمرضى التصلب المتعدد، كما تهدف إلى دراسة أن مرض التصلب المتعدد على كلية العظام وعظام المريض. أجريت هذه الدراسة على ثلاثين مريضًا مصابًا بمرض التصلب المتعدد.

تم تقسيم المرضى إلى مجموعتين: مجموعة 1؛ وشملت على مرصد على عشرة مرضى تم تشخيصهم حديثًا ولم يلقوا علاجًا في حين أشتملت مجموعة 2 على عشرة مرضى تم تشخيصهم بالمرض لمدة لا تقل عن سنتين، وقسمت المجموعة إلى مجموعتين: مجموعة 2ا؛ وشملت عشرة مرضى تم علاجهم بعد إجراء الجلوكوكورتيكويد، ومجموعة 2ب؛ وشملت عشرة مرضى تم علاجهم بعد إجراء الجلوكوكورتيكويد.

وقد خضع هؤلاء المرضى لتقسيم عدديًا وفحوصات أتممتهم على تحليلات روسيوية، وتم فيتامين د في الدم، دلالات.
أي الكابلوم، كما تم تقسيمهم باستخدام مقياس حالة الإعاقة الموسوع (EDSS)، اختبار الجمع الموالي (PASAT) والحوار والوجوه (FST)، وقد تم تم تحليل النتائج التالية:

- تقلص نسبة نسبة فيتامين D في مرضى التصلب المتعدد 86.7%.
- أشارت الدراسات المعرفية والإدراكية أن النتائج الأتية:
- أظهرت اختبار جمع الموالي (PASAT) 73.3% من المرضى في اختبار القدرة الموالية السعوية الموالية.
- أظهرت اختبار الحلف الموالي 96.7% من المرضى في اختبار الحوار الموالي ونسبة 90% (FST T).
- لا يوجد ارتباط بين نتائج الدراسات المعرفية والإدراكية ومستوى فيتامين D في الدم.
- وجود ارتباط سببي بين الإدمان في اختبار الحوار الموالي ونسبة 90% (FST T) وهرمون البلاستري في مجموعات.
- لا يوجد ارتباط بين نتائج الدراسات المعرفية والإدراكية وعمر المريض.
- وجود ارتباط سببي بين نسبة اختبار الحوار الموالي ونسبة 90% (FST T) والوجه (كم تبين من مقياس شدة الوجه).
لا يوجد ارتباط بين الأداء في الاختبارات المعرفية والإدراكية والجرعة التراكيمية لمركبات الجلوكوكورتيكون أو ألتازوثيرامين أو السيكلوفوساميد.