



Neurological disorders in vitamin B deficiencies: A review

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ABSTRACT

The neurological effects of vitamin B deficiency have been widely explored in current literature. Deficiency in vitamin B1 can cause impairments in memory and normal neurological function leading to the development of diseases such as Wernicke-Korsakoff syndrome, Alzheimer's, or dementia. Deficiency in vitamin B6 can cause painful developments of symptoms such as Tunnel syndrome. Deficiency in vitamin B12 can significantly cause deficits in physiological functions and Vitamin B12 status was found as a risk factor for neurological and cognitive impairments. This review paper aims to discuss the neurological effects of vitamin B1, B6, and B12 deficiency and how sufficient intake of Vitamin B1, B12, and B6 are very important for the maintenance of good neurological functioning, health, and prevention against risks of neurological diseases. Further research could be made into the impact of vitamin B supplementation in neurological diseases and their pathophysiological mechanisms.

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INTRODUCTION

Vitamin B deficiency leads to various neurological symptoms. The deficiency in vitamin B1 can predominantly cause high impairments in memory and symptoms linking to the ability of cognitive memory. Furthermore, it can cause the individual to develop neurological diseases such as Wernicke-Korsakoff syndrome, Alzheimer's, or dementia (1, 2, 3, 4). Deficiency in vitamin B6 can cause painful developments of symptoms such as Tunnel syndrome (5, 6). Deficiency in vitamin B12 can significantly cause deficits in physiological functions and Vitamin B12 status was found as a risk factor for neurological and cognitive impairments, especially in older people (7, 8). This review paper aims to discuss the neurological effects of vitamin B1, B6, and B12 deficiency.

Vitamin B1

Thiamine has been implicated in neurological problems, including delirium, and dementia.

Although a role for thiamine in neurological function has been known for long, we only have a limited understanding of its multiple actions (1). For the associations with Alzheimer's Disease (AD). Alzheimer's disease is defined by a progressive cognitive deterioration and neuropathological changes in the brain that consist of deposition of extracellular beta amyloid plaques and intracellular neurofibrillary tangles. Many other changes occur in the brains of patients that die with AD, including synaptic loss, changes in glucose metabolism, oxidative stress, reductions in thiamine-dependent processes, endosomal abnormalities, cholinergic dysfunction, lysosomal irregularities, and altered calcium dynamics, as well as changes in many other variables. Any one of the myriad of these pathologies could potentially lead to AD (1).

In a study by Ehsanian et al, the occurrence of vitamin B1 deficiency in the stroke population

admitted to acute inpatient rehabilitation was explored. The deficiency in vitamin B1 could lead to severe health consequences in patients including Beriberi, Wernicke-Korsakoff syndrome, or if in severe diagnosis it could lead to irreversible neurological damage. A subset of patients admitted to an acute rehabilitation hospital after an acute stroke was found to have low plasma levels of vitamin B1. This warrants further investigation given that there is potential for vitamin B1 deficiency to impair neural functions (2). In another study, Pourhassan *et al* investigated the association between thiamine levels and functional abilities. Whole blood thiamine levels and its link to the functional status of older hospitalized patients was explored and was found to be lower in patients with delirium and dementia compared to those without. Furthermore, higher thiamine levels were especially linked with functional recovery during hospitalization (3).

Thiamine deficiency has also been investigated in infancy. Thiamine deficiency among infants is very rare in developed countries, however it can occur mainly among breast-fed infants of mothers with insufficient thiamine intake or in cases of thiamine deficient total parenteral nutrition. The incidence of symptoms in infants with this condition is often very rapid and the fatality rate is high. A study by Mimouni *et al* shows that although the majority of infants vulnerable to thiamine deficiency did not exhibit any symptoms and their long term outcome was relatively benign, a small number displayed unfavorable outcomes. Moreover, those who were severely affected in the beginning and/or those who survived the acute phase of thiamine deficiency encephalopathy may suffer potential symptoms of severe disabling morbidity, Encephalopathy, language impairments, long-term neurodevelopmental, cardiac and orthopedic sequelae (4).

Vitamin B1 was the earliest nutritional component discovered to have associations with dementia. Throughout the previous century, research showed that thiamine deficiency is

associated with neurological issues, including cognitive impairments and encephalopathy. There are multiple similarities between classical thiamine deficiency and Alzheimer's disease, which both are associated with cognitive deficits and reductions in

glucose metabolism of the brain. The safety of thiamine and its analogues suggests that a carefully designed trial of thiamine analogues, should be conducted in patients Alzheimer's disease (1). Vitamin B1 deficiency has been linked to cognitive impairments for many decades. Nobel Prize-winning experiments in the 19th and 20th centuries associated with the discovery of thiamine discovered that a lack of thiamine in humans caused a common condition called beriberi. Beriberi is a condition that describes a deprivation in Vitamin B1 or Thiamine. Thiamine deficiency is majorly treated with a good diet and thiamine intake in the past. For example, early experiments in 1939 treated patients who suffered from Wernicke-Korsakoff Syndrome with a high-quality diet and a thiamine supplement and showed that subjects who received excess thiamine demonstrated a recovery approximately seven times as great as those that did not. These experiments initiated research to test the role of thiamine in memory in humans and animals. It has been shown that thiamine deficiency in humans produces many of the neurological consequences of beriberi (1).

Vitamin B6

A case report 'Food for thought' by Milly Ryan Harshman & Walid Aldoori investigates the association between Carpal Tunnel Syndrome and vitamin B6. The report looks specifically on a 42-year-old woman with carpal tunnel syndrome who claimed that she used vitamin B6 supplements to relieve her symptoms. Despite the effectiveness of vitamin B6 being controversial, it is often used as a conservative and adjunct therapy in treatment of carpal tunnel syndrome. Scientifically, Vitamin B6 intake at less than 200 mg daily is not likely to cause any adverse effects, however patients should be monitored regularly for changes in symptoms--- particularly if they have taken dosage for over long periods. Evaluating its effects on the body, Vitamin B6 is involved in several metabolic pathways of neural function; ie Neurotransmitter synthesis, Amino acid metabolism, sphingolipid synthesis and breakdown; thus it associates with Tunnel syndrome (5).

A study by Bernstein and Dinesen suggested that vitamin B6 supplementation substantially improved pain scores despite electrophysiologic data showing only mild improvement. Thus it supports the theory

that vitamin B6 raises pain thresholds. In another study, Ellis et al. discovered that in at least 7 patients, a primary deficiency of vitamin B6 was linked to Tunnel Syndrome. In a case study, Folkers and colleagues determined that 2 mg/d of vitamin B6 improved patients' clinical condition, but that 100 mg of vitamin B6 daily for a longer period allowed patients to avoid hand surgery (6). The report also gives useful information on the recommended daily intake of vitamin B6. It claims that The recommended daily intake of vitamin B6 is 2 mg or less for all age, sex, and lifestage groups, and the upper limit has been set at 100 mg/d. Patients taking up to 200 mg/d of vitamin B6 are unlikely to suffer adverse health effects from supplementation. For patients who notice an improvement in their Tunnel syndrome symptoms, physicians can recommend a gradual reduction in dose after about 3 months' therapy at the higher dose. Patients taking vitamin B6 in amounts greater than 200 mg/d, especially if their intake approaches the level of 500 mg/d, should be monitored closely for signs of sensory neuropathy. Patients taking high doses of vitamin B6 who present with nerve problems accompanied by depression, fatigue, impaired memory, irritability, headaches, difficulty walking, or bloating should be evaluated for vitamin B6 toxicity (6). Moreover the review also gives information on Vitamin B6 or Pyridoxine's association with neural conditions as well. Pyridoxine has been known as an essential cofactor in the production of neurotransmitters. For this reason, it has been considered a therapeutic adjunct in a variety of conditions with known or suspected neurotransmitter abnormalities. Among these conditions are seizures, Parkinson's disease, depression, chronic pain, headache, behavioral abnormalities of adults and children, and peripheral neuropathies (6).

Vitamin B12

Vitamin B12 has a vital role in the physiological functioning of the nervous system. A study by Kwok et al. investigates Vitamin B12 supplementation in elderly people with diabetes and its effects on their cognitive abilities. The study trial found out that Vitamin B12 supplementation in older diabetic patients with borderline vitamin B status did not prevent cognitive decline despite severe reduction in serum MMA and homocysteine over a 27-month period (Kwok). In another similar study by Dangour

et al., the benefits of vitamin B12 supplementation on neurologic and cognitive function in moderately vitamin B12-deficient older people were investigated. Vitamin B12 status was found as a risk factor for neurological and cognitive impairments, especially in older people. The study found out that the results of the trial do not support the hypothesis that the correction of moderate vitamin B12 deficiency (in the absence of anemia, neurologic and cognitive signs or symptoms) has beneficial effects on neurological or cognitive function in later life (7).

In another study by Seal et al, the effects of small doses of oral cyanocobalamin supplements in elder patients with low or borderline serum vitamin B12 concentrations but no other evidence of pernicious anemia were investigated. The results show that Cyanocobalamin supplementation of 50 g but not 10 g daily produced a significant increase in serum vitamin B12 (8).

Conclusion

In conclusion, sufficient intake of Vitamin B1, B12, and B6 are very important for the maintenance of good neurological functioning, health, and prevention against risks of neurological diseases. These three types of vitamin B have evident associations with neurological functions. Further research could be made into the impact of vitamin B supplementation in neurological diseases and their pathophysiological mechanisms.

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