



Review Article

Role of nutritional supplements in military personnel: a review article



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ABSTRACT

Introduction: Military personnel need to use nutritional supplements to increase physical and mental efficiency and protect against occupational injuries. However, Information is limited about the effectiveness and efficiency of nutritional supplements related to military personnel needs. The aim of this study is to review the studies in the field of nutritional supplements required for the military personnel.

Methods: In this review study, articles related to nutritional supplements needed to protect against intense noise, improve trauma and enhance physical and mental function in military personnel were reviewed. The articles were extracted from the databases of PubMed, Scopus, Web of Sciences and Persian databases as the SID and Magiran between 1993 and 2018.

Results: The results of the review showed that supplementation of magnesium and vitamin B12 to protect against abnormal sounds, supplementation of glutamine and omega-3 in trauma, supplementation of beta-alanine in physical activity and caffeine in mental function can be beneficial.

Conclusion: Nutritional supplements can be useful for military personnel from different aspects. However, the supplements discussed in this article only cover a small part of the supplements required by the military. In addition, although evidence suggests the potential benefits of nutritional supplements to military personnel, but this subject is still controversial and requires further studies.

Introduction

Military personnel are always faced with many physical and mental challenges. Fitness, mental alertness and readiness to be exposed to stressful situations are the job requirements of the armed forces. In addition, due to their occupational nature, military personnel have always suffered physical damage, such as trauma and hearing impairment resulting from high-frequency sounds (1). Physical activity has always been proposed to improve the

health status. However, studies show that, unlike moderate physical activity, severe physical activity can endanger the health of individuals, weaken the immune system, and increase inflammatory factors and physical damage (2, 3). Similarly, many military personnel are subject to intense physical activity and its consequences. In this case, studies have shown that many nutritional supplements can prevent the side effects of intense physical activities (4). Many soldiers tend to use nutritional supplements due to increased nutritional needs and to increase physical and mental efficiency and reduce occupational injuries. A study showed that more than half of US

military troops use nutritional supplements (5). On the other hand, food industries related to nutritional supplements are on the rise, and a major part of people's awareness of the efficacy of supplements comes from advertising through these industries. Food industry advertisements are mainly focused on expanding business rather than spreading health. On the other hand, the consumption of unnecessary nutritional supplements can cause side effects and interfere with other drugs. Recently, a meta-analysis study revealed that some supplements used to enhance physical functioning, contrary to claims, not only do not enhance physical performance, but can also cause side effects (6). Therefore, despite the importance of nutritional supplements in various aspects, information on the effectiveness and efficiency of nutritional supplements related to the needs of military personnel is limited. Therefore, the present study reviews published articles about the effects of nutritional supplements on some military personnel needs (protection against abusive sounds, trauma, physical and mental function enhancement).

Methods

This article was written as a narrative review. The authors initially identified the needs and problems of military personnel according to their occupational nature. In the next step, the articles, related to the effect of nutritional supplements on preventing and improving the clinical, mental and physical condition of military personnel, were assessed. To this end, interventional studies that examined the effect of nutritional supplements on improvement of hearing loss, caused by exposure to high frequency sounds, trauma, mental and physical performance were analyzed. The articles were obtained from the scientific databases such as Scopus, Web of Sciences, PubMed, and Persian databases, such as Magiran and SID, published in 1993 to 2018. Search for articles was carried out by keywords including "Magnesium" AND "Hearing loss", "Magnesium" AND "Tinnitus", "Magnesium" AND "Noise exposure", "B12" AND "Hearing loss", "B12" AND "Tinnitus", "B12" AND "Noise exposure", "Omega-3" AND "Trauma", "DHA" AND "Trauma", "EPA" AND "Trauma", "Glutamin" AND "Trauma", "Beta-alanine" AND "Physical performance", "Caffeine" AND "Mental performance" combined with "Military personnel and soldier". All authors (four) participated in the extraction of papers. The inclusion criteria were: the studies related to military personnel, clinical trials, the studies on nutritional supplements and improving clinical conditions (hearing loss and trauma), physical and mental capabilities of military

personnel. The exclusion criteria were: repeated studies, studies with unsuitable design and poor quality, cross sectional studies, nonhuman interventional studies, studies on populations unrelated to military personnel, studies on other nutritional supplements, studies on the effects of nutritional supplements on military personnel, in terms of aspects other than that of this study.

Results

In obtaining articles, they were first reviewed based on the title related to the objectives of the present study. After reviewing the abstract, if having eligibility, the text of the article was analyzed. Thus, in the first phase, 510 articles were identified that were potentially related to the study objective. After reviewing the abstract and the text of the articles, a total of 16 articles with the clinical trial type were included in this study and the information related to the objective of the present study was extracted. These articles were in English.

Protection against high frequency sounds

The armed forces are always exposed to high-frequency sounds, including explosions and firing bullets. Long-term exposure to high-frequency sounds reduces hearing ability and can affect the vigilance and operational readiness of the soldiers. In many countries, an outbreak of 15 to 23 percent of hearing loss has been reported among the militaries, and its prevalence is increasing (8, 7). Researches in this area show that nutrients can protect auditory from the hearing damage caused by noise. Magnesium is one of the nutrients that can play a protective role in this case. In a clinical trial, the effect of administration of 122 mg of magnesium supplement (for 12 days) on hearing loss in healthy subjects was investigated. The subjects were exposed to 90 dB white noise for 90 min. The results of the study indicated that the group receiving magnesium supplementation suffer significantly less hearing loss than that of placebo group. The hearing loss more than 20 dB in the placebo group was reported significantly higher than that of the magnesium group (28% vs. 12%) (9). In a clinical trial, 300 healthy people were exposed to severe and frequent noise caused by military training for 2 months. Patients were prescribed magnesium aspartate supplement or placebo. The results of the study showed that the hearing loss in the placebo group was significantly higher than the magnesium supplement group.

Table1. Clinical studies for supplemental effects in military personnel

Parameter	Author	Year	Study type, participants	Supplementary	Results
Protection against high frequency sounds	Attias et al. (9)	2004	Clinical trial, healthy subjects	Magnesium, 122mg, 12day	Reduction in noise-induced temporary threshold shift
	Attias et al. (10)	1994	Clinical trial, healthy subjects exposures to high levels of impulse noises	Magnesium, 167mg,m 2month	Reduces in permanent hearing loss induced by noise exposure
	Quaranta et al. (14)	2004	Clinical trial, healthy subjects with noise-induced temporary threshold shift	B12, 1mg/7days and 5mg/1day	Reduces in temporary threshold shift
	Singh et al. (40)	2016	Clinical trial, patients of chronic tinnitus	B12, 1ml, 6 weeks	Improvement in tinnitus severity and visual analog scale (VAS)
Trauma	Chuntrasakul et al. (21)	2003	Clinical trial, trauma patients	dietary arginine, glutamine and omega-3 fatty acids (fish oil) supplementation	Improvement in serum total protein and triglyceride, shorten ICU stay and wean-off respirator day
	Oliver et al. (41)	2016	Clinical trial, American football athletes	DHA, 2, 4, 6 gram/d.	Reduces in serum NFL (Biomarker of Head Trauma) coincident
	Matsumura et al. (42)	2017	Clinical trial, accident survivors	Omega-3 PUFAs (1470 mg DHA and 147mg EPA per day) for 10 day	Reduces in heart rate
	Sun et al. (43)	2013	Clinical trial, patients with severe burn injury	Glutamine combined with ulinastatin, 0.3 gr/kg, 10day	Increase in nitrogen balance, decrease in serum levels of D-lactate, DAO, LPS, TNF- α , and IL-6 and the incidence of burn sepsis. improve in wound healing rate and total hospital stay days
	Guo et al. (44)	2007	Clinical trial, burn patients	Glutamine enriched enteral feeding. 10 days	Increase in prealbumin, IgM, IGA, percentage of CD4+
	Peng et al. (45)	2006	Clinical trial, severely burned patients	Glutamine. 0.5gr/kg. 10 days	Improve in neutrophil phagocytosis index (NPI), CD4/CD8 ratio and IL-2. Reduce in wound healing and hospital stay days
Improve mental performance	de Andrade et al. (30)	2017	Clinical trial, highly-trained athletes	Beta-alanine, 6.4gr/day. 4 weeks	Improve in the number of throws per set and the total number of throws. Increase in the lactate response to exercise
	Hoffman et al. (31)	2015	Clinical trial, Soldiers	Beta-alanine, 6gr/day. 30days	Increase in muscle carnosine content, improve in physical and cognitive performance
	Hoffman et al. (32)	2014	Clinical trial, soldiers from an elite combat unit	Beta-alanine, 6gr/day. 28 days	Enhance power performance, marksmanship and target engagement speed
Improve mental performance	Lieberman et al. (36)	2002	Clinical trial, Navy Sea-Air-Land trainees exposure to 72 h of sleep deprivation	Caffeine supplement, 200, 300mg	Improve in visual vigilance, choice reaction time, repeated acquisition, self-reported fatigue and sleepiness.
	Kamimori et al. (37)	2015	Clinical trial, Soldiers during three successive nights of sustained wakefulness followed by 4-h afternoon sleep periods	Caffeine supplement, 800mg, 5 day	Improve cognitive function during overnight periods
	Batéjat et al. (46)	2006	Clinical trial, healthy male with 6-h prophylactic sleep period with zolpidem followed by a 18-h continuous work period	Caffeine supplement, 200mg	Improve cognitive performance and alertness

In addition, there was a reverse correlation between hearing loss and magnesium levels of red blood cells (10). Magnesium can reduce the permeability of calcium in the ciliated cells in the internal ear and prevent them from calcium deposition (11). On the other hand, the deficiency of magnesium can lead to increased glutamate release and excessive stimulation of NMDA receptors in the auditory nerve (12). Vitamin B12 is also another nutrient that can have protective effect against hearing loss caused by high frequency sounds. A study reported that armed forces suffering from vitamin B12 deficiency are more vulnerable to hearing loss, resulting from noise (13). In a clinical trial, healthy volunteers were injected with vitamin B12 or placebo. After injection, the participants were exposed to 112 dB noise for 10 min and then the hearing threshold of both groups was evaluated. The results of the study showed that vitamin B12 could significantly improve the hearing threshold against abnormal sounds compared with placebo (14). The role of vitamin B12 in stabilizing neuronal activity can be one of the mechanisms of its effect in this case.

Trauma

Trauma is one of the main problems in militaries. With the spread of war in many parts of the world, the spread of trauma among the militaries has expanded. Epidemiologic study of trauma in Iranian soldiers shows that 30% of the patients in the garrison health services suffer from trauma (15). Many soldiers in war zones are traumatized when they are exposed to dehydration, food constraints, energy depletion and psychological stress, which can disrupt the trauma recovery process. On the other hand, the researchers suggested that some nutrients can have an effective role in the trauma. Therefore, the effects of diet and dietary supplements that can strengthen the immune system and maintain reparative traumatic activities are of particular importance to the military. Omega-3 is one of the most important nutrients in the trauma. Omega-3 fatty acids can reduce metabolic responses, prevent muscle tissue loss, prevent oxidative damage, and modulate inflammatory responses. Omega-3 fatty acids reduce inflammation through the alteration in cell membrane phospholipids and changes in the expression of inflammatory genes (16). Clinical studies have reported that the prescription of fish oil to patients in critical condition can reduce the release of inflammatory cytokines and the production of acute phase proteins (17). Norouzi Javidan et al. examined anti-inflammatory effects of omega-3 on people with spinal cord injury in a clinical trial. The results of the study showed that omega-3

administration could have protective effects on neurons in acute phase conditions (18). In a study carried out by Matsuoka et al., the use of omega-3 was suggested as a novel approach to the treatment of "post-traumatic stress" (19). Prescribing a formulation containing omega-3 via enteral feeding can have beneficial effects on patients admitted after the trauma. Weimann et al. indicated that the administration of omega-3 in patients with severe trauma can result in a significant reduction in systemic inflammatory responses and acute-phase proteins (20). A clinical trial showed that the administration of omega-3 in patients with trauma can reduce the hospitalization time (21). Glutamine can be effective in treating trauma through direct impact on the immune system. Given that trauma treatment depends on protein metabolism and the prevention of infection, nutrients that stimulate the immune system can accelerate the process of recovery of the trauma. Studies have shown that administration of glutamine in patients with trauma has positive effect on the immune system (22). In this regard, the results of a clinical trial showed that administration of glutamine by oral gavage for 4 weeks in patients with severe burn can reduce the infection of blood and ulcers (23). Lorenz et al. examined the effect of glutamine supplementation administered by oral gavage on immune function, wound healing and hospitalization time in multiple traumatic patients. Their results showed that the total number of lymphocytes, killer T cells and plasma levels of interleukin-12 in patients receiving glutamine supplementation faster reach normal level compared to that in the placebo group. The researchers suggested that glutamine supplementation could improve the immune system, accelerate wound healing, and shorten hospitalization time (24). In addition, it has been suggested that glutamine can also be effective in wound healing through the synthesis of collagen, the formation of new blood vessels and fibrous tissues. Hydroxyproline is one of the products of glutamine metabolism that is essential for collagen production. The repair of damaged skin depends on the build-up of collagen. The glutamine supplementation helps to increase the content of the hydroxyproline and builds collagen in the wound area (25). In a clinical trial, Blass et al. examined the effect of glutamine supplementation along with antioxidants on wound healing in people with trauma. The results of the study showed that glutamine supplementation along with antioxidants for two weeks can further improve the wounds compared to placebo (26). The results of the study carried out by Wong et al. showed that the supplementation of a mixture of amino acids, including glutamine, arginine

and beta-hydroxybutyrate, for two weeks can improve damaged tissues and repair the wound caused by subcutaneous wounds (27).

Reinforcing physical function

Militaries always seek to increase muscle mass and improve physical strength and endurance. To increase muscle mass, adequate protein intake is needed. The protein requirement for military personnel is higher than normal people, which is estimated to be 1.1-1.4 g / kg / day (28). For this reason, the demand for protein supplements is common among military personnel. A recent survey of prevalence of protein supplements among military personnel was reported as 34% (29). Beta-alanine is one of the protein supplements that has been studied in militaries. Beta-alanine is a non-proteinogenic amino acid that, in combination with histidine, produces carnosine. Carnosine plays the role of buffer in the muscles. As a result of increased physical activity, increasing lactate concentration in the muscles leads to muscle fatigue. Carnosine acts as a buffer to neutralize lactate and reduce muscle fatigue. Therefore, beta-alanine can decrease muscle fatigue by increasing the concentration of carnosine in the muscles. The results of a clinical trial showed that the administration of β -alanine supplementation for 4 weeks can increase the performance of athletes by reducing lactate and acidosis in the muscles (30). In a clinical trial, trained soldiers were supplemented with β -alanine or placebo for one month. The results of the study showed that beta-alanine supplementation compared to placebo could significantly increase muscle carnosine concentration and significantly decrease muscle fatigue. In addition, there was a significant difference between cognitive function between β -Alanine and placebo groups (31). In another study, beta-alanine supplements were tested on soldiers for 4 weeks. The results of the study showed that supplemental beta-alanine can improve physical function, accuracy in shooting and speed of operation. Improvement of cognitive function after taking beta-alanine is achieved by increasing the level of carnosine in the brain (32).

Reinforcing mental performance

Armed forces experience a variety of unpredictable stresses repeatedly. Occupational stress can affect the physical and mental performance of individuals. In order to prevent weakening mental function and to increase mental capacity in stressful situations, the tendency to use nutritional supplements that can strengthen mental function has expanded. Caffeine is one of the cases that can stimulate the mental functioning through stimulation of the central

nervous system, and the prevalence of high caffeine consumption in the armed forces has been reported. A study showed that roughly 12 percent of Australian soldiers in the Middle East used caffeine-containing supplements between 2001 and 2009 (33). A survey carried out on US Air Force staff showed that 84 percent of staff consumes caffeine-containing products (34). In a study, the effects of caffeine on marine forces that were under stress and sleep disorder were investigated. The results of this study showed that supplementation of caffeine compared with placebo could significantly increase the accuracy and speed of shooting (35). In another study, effect of caffeine supplementation was tested on sea troops under stressful conditions and three days of sleep deprivation. The results of the study showed that insomnia can have a negative effect on cognitive function, and caffeine can modify the effects of insomnia and stress. Caffeine supplementation (200 and 300 mg) significantly improves visual acuity, selective reaction time, fatigue, alertness and reaction time (36). In the study carried out by Kamimori et al., the effect of caffeine on the cognitive performance of military personnel, who have had limitations in sleeping for three days was studied. The results of the study showed that administering 800 mg of caffeine supplementation after drowsiness can improve the diagnosis of events, increase the number and speed of responses to stimuli. The researchers suggested that, when enough sleep conditions are not provided throughout the day, supplemental caffeine can be a good stimulus to maintain cognitive function (37). In addition to enhancing mental function, caffeine can also be effective in improving physical and clinical performance in military personnel (39, 38).

Conclusion

The result of reviewing articles showed that nutritional supplements could be useful for military personnel from different aspects. However, the supplements discussed in this article only cover a small fraction of the supplements required by the military. Although evidence suggests the potential benefits of nutritional supplements to military personnel, this issue is still controversial and requires further studies. Further research can lead to the provision of specific nutritional formulas for military personnel, based on potential stressors.

Ethical disclosure

Before performing the research, it was explained to the participants. An informed consent was obtained from all participants included in the study.

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Authors' contribution

All the authors have accepted responsibility for the entire content of this study.

Conflict of interest

The authors declare that they have no conflict of interest.

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