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VITAMIN STATUS OF LAW ENFORCEMENT OFFICERSUNDER THE INFLUENCE OF COMBAT STRESS

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Law enforcement officers with different levels of combat stress (men, residents of the Komi Republic, n=33, 32.0 (30.0–35.0) years old) were examined before (November) and after (March) trips to the combat zone. The control group included agents of the Ministry of emergency situations with a low level of stress (men, residents of the Komi Republic, 32.0 (30.0–35.0) years old). In total, law enforcement officers were shown to have a wide prevalence of vitamin deficiency: about 50% of persons had hypovitaminosis for vitamins A, E, about 35% — for vitamins B_1, B_2 and 24% — for vitamin C. A parallel study of the control group and law enforcement officers in November showed that initially there were more persons with reduced vitamin status in law enforcement officers, especially in the level of vitamins B_1 and E. In March, after the arrival of law enforcement officers from the combat zone, they found a significant decrease in the percentage of persons with hypovitaminosis for vitamins A, E, C and an increase vitamin B_1 deficiency. Changes vitamin status in the control group from November to March were not so significant.
Key words: marine medicine, vitamin status, combat stress, law enforcement officers.

Introduction. At present day law enforcement work is one of the most extreme professions. Official activities accompanied with high level of psychoemotional tension and real vital danger is often combined with extremely high physical loads that need hyperresponsiveness and endurance of a body [1, p. 47; 2, pp. 35-38; 3; pp. 68-73]. Usually adaptive human responces under the influence of such extreme factors are excessive and as a consequence, stress reaction is followed by adaptive as well as abnormal changes in the body [4, p. 200]. It has been established that work environment, influence of external and internal environmental factors of risk in officers of the Department of Internal Affairs promote development of somatic diseases as well as mental change [5, pp. 5–19; 6, pp.978-979].

The literature shows the essential role of vitamins especially, vitamin B complex and antioxidants, for prior functioning of nervous system (mental process, emotional state etc.), processes of power supply (including physical activity) and protection from free-radical oxidation of cells (in cardiovascular system, the brain etc.) [7, pp.3-108; 8, pp. 683-684; 9, pp. 3-92; 10, pp. 54-58]. For instance, it is shown that supplement of vitamin-mineral premix for health people may result in stress reducing, improvement of mental health, high spirits, improvement of cognitive functions [11, pp. 55-68] as well as health improvement after high-intensity physical activities [12, pp. 194]. Research of military personnel have shown the imbalance of micronutrients in the military including those who serve in the Arctic conditions. That research has established the essential role of complex approach with vitamin prophylaxis comprising vitamin-mineral premix supplement as well as correction of content of vitamins, macro and micronutrients in the diet [13, pp. 239-244; 14, pp. 5-11]. Thus, the article [15, pp. 66-70] states that even in compliance of planned ration with regulatory values of energy value, the content of vitamins within the blood of servicemen was below the recommended level: for antiscorbutic vitamin – 21.4% below, vitamin B_1 - 7.7% below, vitamin B_6 – 23% below, vitamin PP – 7.5% below.

Thus, extreme professional activities may certainly become risk factor vitamin deficiency states. In view of small number of publications on that subject, we set a goal to conduct the assessment of vitamin state and effect of combat stress with different level in law enforcement officers.

Materials and methods. The same law enforcement officers with different levels of combat stress (men, residents of the Komi Republic) were examined before (November) and after (March) trips to the combat zone in the Caucasus region (Table). All testers were on a standardized diet under medical surveillance. They took vitamin-mineral premix containing minimum one daily value of vitamin A and E and minimum 5 daily values of vitamins B_1 and B_2. Professional activity of law enforcement officers was related with different levels of combat stress. In this connection, all testers were divided into two groups: without increased combat stress (ICS) and with increased combat stress. The 1st group (without ICS) included medical workers, instructors, drivers, the 2nd group (with ICS) included servicemen with increased professional risk with real risk to life. Control group men, residents of the Komi Republic, intellectual workers who had been examined in the period from October to November and in March. The Table presents anthropometric characteristics of these groups.

Table

General characteristic of control group and the examined law enforcement officers at the beginning of the trial

Indicator	Control	1st group (without ICS)	2nd group (with ICS)
Number of examined men, abs.	17	17	16
Age, years	32.0 (30.0–35.0)	36.0 (33.0–39.0)	35.0 (32.0–37.0)
Height, sm	172.0 (171.0–177.0)	177.0 (174.1–182.0)	177.0 (172.8–179.3)
Body weight, kg	76.0 (71.2–82.0)	91.0 (83.0–100.5)	81.0 (74.8–90.0)
Body mass index, kg/m^2	25.6 (23.7–27.3)	27.6 (25.8–31.4)	25.7 (24.4–28.3)
Bodyfat level, %	18.9 (16.7–21.6)	21.6 (17.7–25.3)	17.1 (14.8–21.0)

Note: the data is presented by median and interquartile interval within brackets (25–75th percentiles).

Sampling of venous blood, from median cubital vein of the testers was performed on an empty stomach using Greiner bio-one (Austria) one-time system. Concentration of vitamins A and E was assessed by fluorescence intensity of lipid extract in blood plasma [16. pp. 362-365; 17. pp. 46-47]; antiscorbutic vitamin level in blood – by method of visual titration against Til'mans reagent; supplying of the body with vitamins B_1 and B_2 – by activity increment of erythrocytic vitamin-dependent transketolase enzymes (TDP-effect) and glutathione reductase (FAD-effect) correspondingly [7. pp. 87-108; 17. pp. 19-30].

Before the study, the examined law enforcement officers gave an informed consent to participate in the trials. This study was approved by local Committee on Bioethics of Komi Institute of Physiology of scientific centre UrORAN, The trials were conducted through the programs of fundamental scientific research for 2017-2020 (No GR AAAA-A17-117012310157-7) and RAS Presidium for 2018–2020 No GR AAAA-A18–118012290367-6).

Statistical processing of the obtained data was carried out for non-parametric samples using Biostat software (v.4.03). Fischer angular transformation method was used in order to reveal significant differences between levels. Differences are defined as significant when level of significance $p<0.05$.

Results and discussion. The trial of law enforcement officers before the trip showed widespread distribution of vitamin deficiency states in the examined group for the most part (Figure 1).

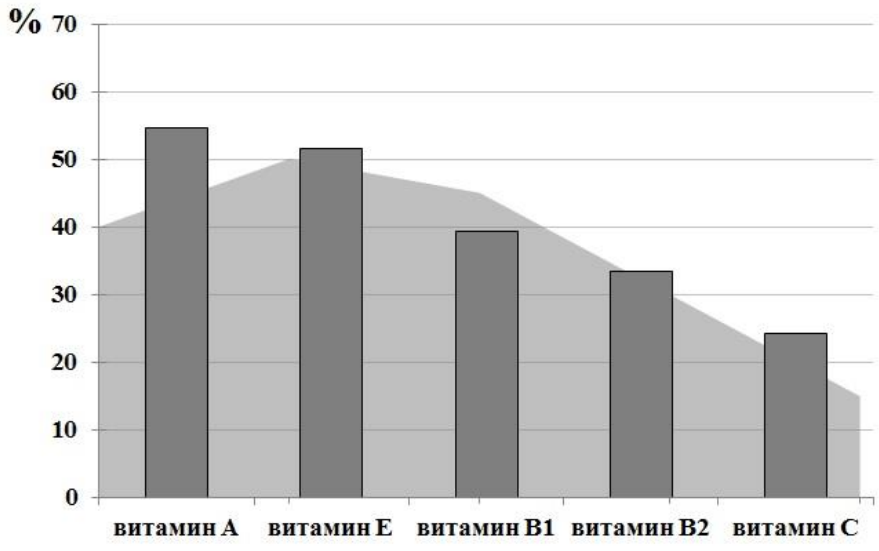

Рис.1. Распространенность витаминодефицитных состояний среди сотрудников правоохранительных органов до командировки (в % от общего числа обследованных).

Примечание: серая область за столбцами указывает на частоту встречаемости (%) лиц с гиповитаминозами среди всего обследованного населения Европейского Севера [15, 16].

Figure 1. Prevalence of vitamin deficiency among law enforcement officers before the trip (in % of total number of examined persons).
Note: grey area behind the columns indicates the hypovitaminosis frequency rate in the whole examined population of European North [15,16].

Columns: Vitamin A, vitamin E, vitamin B1, vitamin B2, vitamin C.

Most number of hypovitaminosis was revealed for fat-soluble vitamins A and E: part of deficiency exceeded 50% of total number of examined. Slightly less number of hypovitaminosis was revealed for water-soluble vitamins B_1 and B_2 (39 and 33% correspondingly). The most favorable situation was revealed for supplement of the body with vitamin C as only 24% of examined showed low level of the vitamin. On the whole, the total picture of vitamin status in law enforcement officers was similar to the data earlier obtained during the study of residents of the North Севера [18. pp. 27-30; 19. pp. 64-67] nevertheless, the rate of hypovitaminosis in law enforcement officers was higher for almost all vitamins. The same sort of situation was observed in the group of military who served in Saint Petersburg and in the Arctic Region [14. pp. 5-11]. Thus, the majority of examined servicemen in these groups (80-100%) had deficiency in vitamins E and B_2, the supplement of the examined with vitamins B_1 and A was a little better (17–86%), generally. The most favorable situation was revealed for concentration of vitamins C and D within the blood of the servicemen (no more than 14% of surveyed servicemen).
Parallel study of law enforcement officers and the control group (identical in age, weight-height characteristics and professional activity) in November showed that already in the beginning of the study, the number of law enforcement officers with reduced vitamin supplement was more than that in the control group and hereby the most significant difference was in the level of vitamins B_1 and E (Figure 2).

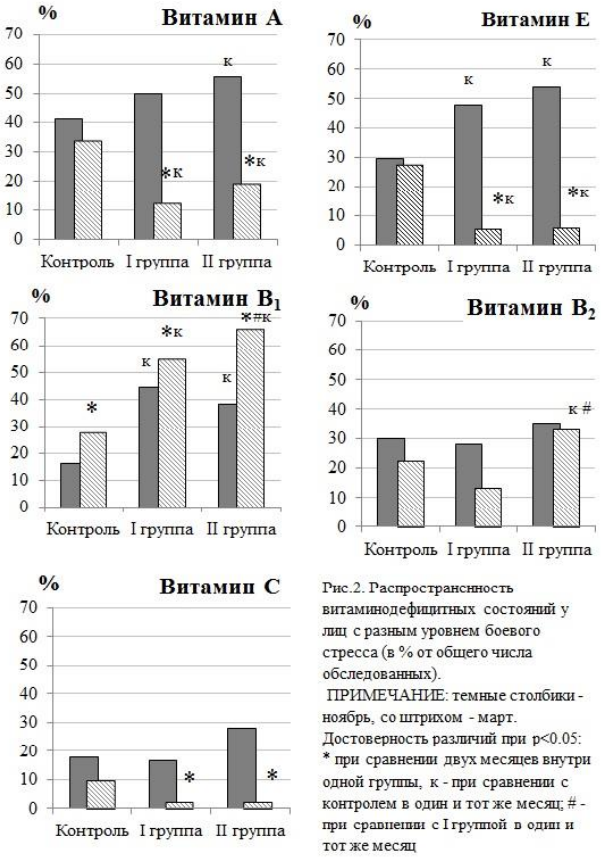

Рис.2. Распространенность витаминодефицитных состояний у лиц с разным уровнем боевого стресса (в % от общего числа обследованных).
ПРИМЕЧАНИЕ: темные столбики - ноябрь, со штрихом - март. Достоверность различий при $p<0.05$: * при сравнении двух месяцев внутри одной группы, к - при сравнении с контролем в один и тот же месяц; # - при сравнении с I группой в один и тот же месяц

Vitamin A, vitamin E, vitamin B1, vitamin B2, vitamin C.

Figure 2. Prevalence of vitamin deficiency among persons with different level of combat stress (in % of total number of examined persons).

Note: dark columns indicate November, diagonal-hatching columns – March. Difference significance with $p<0.05$: * when comparing two months in one group, k – when comparing with control in the same month, #- when comparing with the 1st group in the same month.

After arrival of law enforcement officers from combat zone, in almost four months after the first trials, the significant changes were revealed in the level of supplying the body with vitamins. Thus, significant reducing in number of law enforcement officers with hypovitaminosis for fat-soluble vitamins A and E ($p<0.05$) and antiscorbutic vitamin ($p<0.05$). When comprising these groups with control, it may be noted that despite the less number of officers with hypovitaminosis in the beginning, the last group showed almost no changes in vitamin status for the same period. But in our opinion, the positive tendency of vitamin status in law enforcement officers before and after the trip may be related with balanceness of intake and supplying of vitamins in the body including the additional supplement of vitamin complex and, probably, lower demand in antioxidant vitamins - due to lower activation of lipid exchange in the south polar region comprising with the north region [20. pp. 27].

The contrary situation was created for supplement of the body with vitamin B_1. Thus, in the beginning, the law enforcement officers revealed higher frequency of deficiency for vitamin B_1 than control group. After the arrival from the trip, all examined groups showed similar tendency of increasing the number of men with hypovitaminosis comparing with November ($p<0.05$). It is evident that intake of vitamin-mineral complex in 1st and 2nd groups with different level of ICS was not sufficient to supply the body needs in vitamin B_1 in that period that may be related with strenuous exercises and general psychoemotional stress in combat zone. That is not to deny the effect of dietary factor (intake of this vitamin with food) as almost all vitamins are essential and hereby, repository of water-soluble vitamins is no more than 2-6 weeks [9. pp. 21]. Although, we didn't have such information under the project.

The assessment of level of vitamin B_1 didn't reveal significant differences in levels in November and March within all groups but it may be noted that the control and the 1st groups showed more clearly defined tendency to reducing of number of men with hypovitaminosis than the 2nd group with ICS.

Polyvitaminosis (that is deficiency of three and more vitamins) in the beginning of the trial was found in almost 30% of enrolled men in all groups. After the trip, the quantity of law enforcement officers with polyvitaminosis heavily declined (in 5 times) in relation to the data obtained in the trial before the trip that is primarily connected with the improvement of supplying the body with four of five examined vitamins. At the same time, this level didn't change significantly in control group (25%).

It is known that vitamins as essential micronutrients, play a key role in some important functions of the human body. Vitamin C is essential for metabolism of proteins, carbohydrates and lipids. B vitamins such as vitamin B_1 and B_2 are co-factors of vitamin-dependent enzymes necessary for prior functioning of processes of energy supply and nervous system. Fat-soluble vitamins E and A as well as vitamins B_2 and C are the components of antioxidant system [7. pp. 3-99. 9. pp. 18]. And thus, basing on obtained results it may be assumed that staying in relatively comfortable natural climatic conditions (comparing with the conditions of the North) and centralized system of nutrition as well as undergoing a course of vitaminrophylaxis at that moment of time contribute greatly to normalization of the level of antioxidant vitamins. But, at the same time, the rate of supplying of the body with vitamin B_1 became worse and the rate of supplying of the body with vitamin B_2 didn't change. In our opinion, the level of B-vitamins didn't change under supplement of vitamin-mineral complex primarily due to their high demand under strenuous exercises and long-term psychoemotional stress in battle conditions [21. pp. 75-76]. In that situation the effect of dietary factor on vitamin status is reputed to be less likely as insufficient intaking of this vitamin with food could be compensated with supplement of vitamin complex. It is worth saying that in view of specificities of contingent examined in the study we couldn't assess the effect of all causes affecting vitamin supplying to a full extent. Therefore our explanations are only hypothesis.

Conclusion. Generally, the widespread distribution of vitamin-deficient states was represented. Frequency of hypovitaminosis for vitamins A and E was 55 and 51% correspondingly, for vitamins B_1 and B_2 – 33 and 39% correspondingly.

References

1. Сидоров П.И.. Ксенофонтов А.М.. Беликов И.И.. Новикова И.А. Динамика психического состояния сотрудников органов внутренних дел в зоне боевых действий // *Экология человека*. 2007. № 10. С. 44–48. [Sidorov P.I.. Ksenofontov A.M.. Belikov I.I.. Novikova I.A. Dinamika psihicheskogo sostoyaniya sotrudnikov organov vnutrennih del v zone boevyh dejstvij. *Ehkologiya cheloveka*. 2007. No 10. pp. 44–48 (In Russ.)].

2. Исхаков Э.Р.. Биккинина Г.М. Интенсивность производственной нагрузки и напряженность труда как факторы риска служебной деятельности сотрудников Органов внутренних дел // *Медицина труда и промышленная экология*. 2010. № 6. С. 32–38. [Iskhakov Eh.R.. Bikkinina G.M. Intensivnost' proizvodstvennoj nagruzki i napryazhennost' truda kak faktory riska sluzhebnoj deyatel'nosti sotrudnikov organov vnutrennih del. *Medicina truda i promyshlennaya ehkologiya*. 2010. No 6. pp. 32–38 (In Russ.)].

3. Ичитковкина Е.Г.. Злоказова М.В. Клинико-диагностические аспекты боевой психической травматизации полицейских спецподразделений // *Медицинский вестник МВД.* 2013. № 1. С. 68–73. [Ichitkovkina E.G.. Zlokazova M.V. Kliniko-diagnosticheskie aspekty boevoj psihicheskoj travmatizacii policejskih specpodrazdelenij. *Medicinskij vestnik MVD*. 2013. No 1. pp. 68–73 (In Russ.)].

4. Смекалкина Л.В.. Шевцов С.А. Клинико-диагностические аспекты последствий боевого стресса // *Вестник новых медицинских технологий*. 2007. Т. 14. № 2. С. 199–200. [Smekalkina L.V.. Shevcov S.A. Kliniko-diagnosticheskie aspekty posledstvij boevogo stressa. *Vestnik novyh medicinskih tekhnologij*. 2007. Vol. 14. No 2. pp. 199–200 (In Russ.)].

5. Тарабрина Н.В. Основные итоги и перспективные направления исследований посттравматического стресса // *Психол. журн*. 2003. Т. 24. № 4. С. 5–19. [Tarabrina N.V. Osnovnye itogi i perspektivnye napravleniya issledovanij posttravmaticheskogo stressa. *Psihol. zhurn*.. 2003. Vol. 24. No 4. pp. 5–19 (In Russ.)].
6. Vila B. Impact of long work hours on police officers and the communities they serve // *Am. J. Ind. Med*. 2006. Vol. 49. No 11. P. 972–980.
7. *Теоретические и клинические аспекты науки о питании* / под ред. М.Н. Волгарева. М: Типография ХОЗУ Миннефтепрома. 1987. 217 с. [*Teoreticheskie i klinicheskie aspekty nauki o pitanii*. pod red. M.N. Volgareva. Moscow: Tipografiya HOZU Minnefteproma. 1987. 217 p. (In Russ.)].
8. Maughan R.J. Role of micronutrients in sport and physical activity // *British Medical Bulletin.* 1999. No 3. P. 683–690.
9. Спиричев В.Б.. Шатнюк Л.Н.. Позняковский В.М. Обогащение пищевых продуктов витаминами и минеральными веществами. Наука и технология. Новосибирск: Сиб. Унив. Изд-во. 2004. 548 с. [Spirichev V.B.. Shatnyuk L.N.. Poznyakovskij V.M. Obogashchenie pishchevyh produktov vitaminami i mineral'nymi veshchestvami. *Nauka i tekhnologiya*. Novosibirsk: Sibirskoe Universitetskoe Izdatel'stvo. 2004. 548 p. (In Russ.)].
10.Мартынов Н.А.. Потолицына Н.Н.. Володин В.В.. Есева Т.В.. Бойко Е.Р. Витаминный статус лыжников-гонщиков высокой квалификации в течение годового тренировочного цикла // *Вестник спортивной науки*. 2014. № 4. С. 54–58. [Martynov N.A.. Potolicyna N.N.. Volodin V.V.. Eseva T.V.. Bojko E.R. Vitaminnyj status lyzhnikov-gonshchikov vysokoj kvalifikacii v techenie godovogo trenirovochnogo cikla. *Vestnik sportivnoj nauki*. 2014. No 4. pp. 54–58 (In Russ.)].
11.Kennedy DO. Veasey R. Watson A. Dodd F. Jones E. Maggini S. Haskell CF. Effects of high-dose B vitamin complex with vitamin C and minerals on subjective mood and performance in healthy males // *Psychopharmacology (Berl.).* 2010. Vol. 211. No 1. P. 55–68.
12.Rawson E.S.. Miles M.P.. Larson-Meyer D.E. Dietary Supplements for Health. Adaptation. and Recovery in Athletes // *Int. J. Sport. Nutr. Exerc. Metab*. 2018. No 18. P. 1–33.
13.Андриянов А.И.. Кириченко Н.Н.. Субботина Т.И.. Ивченко Е.В.. Кравченко Е.В.. Сметанин А.Л.. Лазаренко Л.П. Витаминный статус военнослужащих и его коррекция // *Вестник Российской военно-медицинской академии*. 2016. № 3 (55). С. 239–244. [Andriyanov A.I.. Kirichenko N.N.. Subbotina T.I.. Ivchenko E.V.. Kravchenko E.V.. Smetanin A.L.. Lazarenko L.P. Vitaminnyj status voennosluzhashchih i ego korrekciya. *Vestnik Rossijskoj voenno-medicinskoj akademii*. 2016. No 3 (55). pp. 239–244 (In Russ.)].
14.Сметанин А.Л.. Андриянов А.И.. Белозеров Е.С.. Субботина Т.И.. Ивченко Е.В.. Кириченко Н.Н.. Кривцов А.В.. Щукина Н.А.. Коновалова И.А. Оценка витаминно-минерального статуса военнослужащих. проходящих службу на Крайнем Севере и в Санкт-Петербурге // *Профилактическая и клиническая медицина.* 2015. № 4 (57). С. 5–11. [Smetanin A.L.. Andriyanov A.I.. Belozerov E.S.. Subbotina T.I.. Ivchenko E.V.. Kirichenko N.N.. Krivcov A.V.. Shchukina N.A.. Konovalova I.A. Ocenka vitaminno-mineral'nogo statusa voennosluzhashchih. prohodyashchih sluzhbu na Krajnem Severe i v Sanct-Peterburge. *Profilakticheskaya i klinicheskaya medicina*. 2015. No 4 (57). S. 5–11 (In Russ.)].
15.Кузнецов С.М.. Макаров П.П.. Трунов Я.И. *Современные медицинские проблемы совершенствования питания военнослужащих Вооруженных сил Российской Федерации* // Сб. научн. статей по материалам межвузовской науч.-практ. конф. 29 мая 2014 г. «Продовольственное обеспечение Вооруженных сил Российской Федерации на современном этапе: проблемы и пути их решения». СПб.: ВАМТО. 2014. С. 66–70. [Kuznecov S.M.. Makarov P.P.. Trunov Ya.I. *Sovremennye medicinskie problemy sovershenstvovaniya pitaniya voennosluzhashchih Vooruzhennyh sil Rossijskoj Federacii*. Sb. nauchn. statej po materialam mezhvuzovskoj nauch.-prakt. konf. 29 maya 2014 g. «Prodovol'stvennoe obespechenie Vooruzhennyh sil Rossijskoj Federacii na sovremennom ehtape: problemy i puti ih resheniya». Saint Petersburg: Izdatel'stvo VAMTO. 2014. pp. 66–70 (In Russ.)].
16.Чернулкенс Р.Ч.. Грибаускас П.С. Одновременное флуорометрическое определение концентрации витаминов А и Е в сыворотке крови // *Лабораторное дело*. 1984. № 6. С. 362–365. [Chernulkens R.Ch..

Gribauskas P.S. Odnovremennoe fluorometricheskoe opredelenie koncentracii vitaminov A i E v syvorotke krovi. *Laboratornoe delo*. 1984. No 6. pp. 362–365 (In Russ.)].
17.Спиричев В.Б.. Коденцова В.М.. Вржесинская О.А.. Бекетова Н.А. Методы оценки витаминной обеспеченности населения: учебно-методическое пособие. М.. 2001. 68 с. [Spirichev V.B.. Kodencova V.M.. Vrzhesinskaya O.A.. Beketova N.A. *Metody ocenki vitaminnoj obespechennosti naseleniya*: uchebno-metodicheskoe posobie. Moscow. 2001. 68 p. (In Russ.)].
18.Бойко Е.Р.. Потолицына Н.Н.. Нильсен О. Обеспеченность тиамином и рибофлавином жителей Архангельска // *Вопросы питания*. 2005. Т. 74. № 1. С. 27–30. [Bojko E.R.. Potolicyna N.N.. Nil'sen O. Obespechennost' tiaminom i riboflavinom zhitelej Arhangel'ska. *Voprosy pitaniya*. 2005. Vol. 74. No 1. pp. 27–30 (In Russ.)].
19.Бойко Е.Р.. Потолицына Н.Н.. Бойко С.Г.. Ларина В.Е.. Зеленов В.А. Обеспеченность населения Севера жирорастворимыми витаминами // *Вопросы питания.* 2008. № 3. С. 64–67. [Bojko E.R.. Potolicyna N.N.. Bojko S.G.. Larina V.E.. Zelenov V.A. Obespechennost' naseleniya Severa zhirorastvorimymi vitaminami. *Voprosy pitaniya*. 2008. No 3. pp. 64-67 (In Russ.)].
20.Бичкаева Ф.А.. Кокоев Т.И.. Джиоева Ц.Г.. Джабиева З.А.. Волкова Н.И.. Третьякова Т.В.. Власова О.С. Содержание в сыворотке крови аполипопротеинов А. В и параметры обмена липидов у жителей приполярных регионов севера и южных регионов Кавказа // *Клиническая лабораторная диагностика*. 2013. № 1. С. 25–27. [Bichkaeva F.A.. Kokoev T.I.. Dzhioeva C.G.. Dzhabieva Z.A.. Volkova N.I.. Tret'yakova T.V.. Vlasova O.S. Soderzhanie v syvorotke krovi apolipoproteinov A. V i parametry obmena lipidov u zhitelej pripolyarnyh regionov severa i yuzhnyh regionov Kavkaza. *Klinicheskaya laboratornaya diagnostika*. 2013. No 1. pp. 25–27 (In Russ.)].
21.Михайлов В.Г.. Варлачев А.В.. Чумаков Н.В. Исследование эффективности применения витаминно-минерально-аминокислотного комплекса для коррекции физической работоспособности лиц опасных профессий // Воен.-мед. журн. 2012. № 4. С. 75–76. [Mihajlov V.G.. Varlachev A.V.. Chumakov N.V. Issledovanie ehffektivnosti primeneniya vitaminno-mineral'no-aminokislotnogo kompleksa dlya korrekcii fizicheskoj rabotosposobnosti lic opasnyh professij. *Voen.-med. zhurn*.. 2012. No 4. pp. 75–76 (In Russ.)].

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