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HEALTH RISKS OF SHIFT WORK FOR SERVICEMEN: PREVENTION AND REDUCTION STRATEGIES

VARDANYAN G.R.

Department of Organization and Tactics of the Medical Service, Military Medical Faculty,
YSMU after M. Heratsi, Yerevan, Armenia

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ABSTRACT

Shift work disrupts natural circadian rhythms, sleep-wake cycles, negatively impacting workers' psychosomatic health and overall quality of life.

Even in peaceful conditions, the nature of military service significantly differs from the daily routines and work activities of civilian population with a number of notable and significant features. Military service is always performed under stressful conditions, characterized by frequent deviations from standard work schedules, workloads and disruptions to normal daily rhythms, especially due to shift work. These stress factors have a negative effect on the working ability and health of servicemen. Moreover, this impact increases as the duration of military service extends. This situation is exacerbated among servicemen on combat duty due to constant stress and psychological strain.

Shift work is associated with sleep disturbances, depressive mood and anxiety, cognitive impairment, low quality of life and even suicidal thoughts, leading to increased safety risks. Shift work, sleep deprivation, and related fatigue endanger personal safety, task performance, and national security as well.

Shift work, sleep deprivation and daily rhythm disruptions lead to metabolic, cardiovascular, musculoskeletal system, mental, physical and functional cognitive disorders. Its impact on family and social life can result in psychological stress and psychosomatic disorders. Furthermore, it can negatively affect marital relations, fulfillment of parental responsibilities, and children's education.

Published articles provide considerably more data on the impacts of shift work on civilian workers than it does on servicemen.

Present study was conducted to demonstrate the detrimental effects of shift work on the psychosomatic health and life quality of workers with various professions, including military personnel. Various methods have been suggested to evaluate servicemen's suitability for work, to reduce professional errors, to ensure service safety and to mitigate the negative impact of shift work.

KEYWORDS: military service, circadian rhythm, occupational health, occupational risk, relative risk of mortality, working schedule, shift work, rotating shift schedule, quality of life, health-related quality of life, work ability, job performance, healthy aging, depression, accident.

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ADDRESS FOR CORRESPONDENCE:

Gor R. Vardanyan
Department of Organization and Tactics of the Medical Service
Military Medical Faculty, YSMU after M. Heratsi, 2 Koryun Street, Yerevan 0025, Armenia
Tel.: (+374 94) 11-81-82
E-mail: gorvardanyan43@gmail.com

INTRODUCTION

Even in peaceful conditions, the nature of military service significantly differs from the daily routines and work activities of civilian population with a number of notable and significant features. Thus, military service is always performed under stressful conditions, characterized by frequent deviations from standard work schedules, workloads and disruptions to normal daily rhythms, especially due to shift work. These stress factors have a negative effect on the working ability and health of servicemen. Therefore, understanding the mechanisms of shift work impact on the health of servicemen is necessary for assessing occupational risks, defining optimal work-rest schedules of servicemen, preventing diseases and preserving their working ability and combat readiness [Good C *et al.*, 2020].

The majority of the available literature on shift work impact focuses on the civilian sector. A large number of epidemiological and clinical studies have documented significant risk factors for human health, quality of life and well-being resulting from the organizational aspects of shift work. These factors range from disruptions to the circadian rhythm and sleep-wake cycles to various psychosomatic problems and disorders, which impact health, work efficiency and contribute to the deterioration of family and social life [Costa G, 1996; 2010; Selvi Y *et al.*, 2010; Chernikova E, 2015; Kozhevnikova V *et al.*, 2019; Tsvetkova E *et al.*, 2019; Good C *et al.*, 2020; Lim Y *et al.*, 2020 a, b; Frazier C, 2023].

MATERIAL AND METHODS

The negative effects of shift work on the civilian sector have been thoroughly studied and documented in the professional literature. A study analysis on day, night and rotating shift work and their impact on health-related quality of life among working women revealed that compared to a day-work control group, night work ($p=0.0202$) and rotating shifts ($p=0.0363$) led to a decrease in standardized health-related quality of life scores (EuroQol-5D) among schedule workers. This tendency persisted regardless of marital status, with married women experiencing decreased health-related quality of life when working night shifts [Kim W *et al.*, 2016].

The results of a cross-sectional study, examining the impact of night shift work on nurses' health

and work performance, revealed that the majority of nurses (68%) expressed dissatisfaction with night shift work. They reported various health issues, such as insomnia (27.9%), muscle tension (24.6%), constant fatigue (16.4%) and back pain (12.3%). Moreover, night shift work was found to affect nurses' work performance, with workload increasing by 39.3%, fatigue by 30.3% and concentration decreasing by 15.6%. The gender (standardized odds ratio (OR) = 1.94; 95% confidence interval (CI): 1.06-3.57), educational level (OR = 2.36; 95% CI: 1.21-4.60) and marital status (OR = 2.08; 95% CI: 1.09-3.98) of the studied were found to be significantly associated with nurses' feelings about night shift work.

Another cohort study investigated the correlation between night shift work and the risk of developing coronary heart disease among nurses. It was confirmed that a longer duration of night shift work is associated with a statistically significant increase in the risk of coronary heart disease. The incidence rate (IR) per 100,000 person-years was 435.1 for less than 5 years of night shift work (hazard ratio (HR), 1.02; 95% CI, 0.97-1.08), 525.7 for 5 to 9 years of rotating night shift work (HR, 1.12; 95% CI, 1.02-1.22), and 596.9 for 10 years or more of rotating night shift work (HR, 1.18; 95% CI, 1.10-1.26; $p<.001$ for trend), compared to an IR of 425.5 for women who have never worked rotating night shifts [Vetter C *et al.*, 2016; Dires T *et al.*, 2023].

A cross-sectional study conducted in 2019 examined the quality of life among night shift workers in Saudi Arabia, assessing the impact of health-care workers' work schedules on various aspects of psychosocial and physical health, drug use and sleep quality. Day shift workers reported higher levels of satisfaction with work and quality of life compared to night shift workers, with mean scores of 3.82 (standard deviation (SD) =0.93) and 3.48 (SD=1.04), respectively ($p=0.007$). Additionally, the study revealed that the negative impact of night shift work on social life was greater compared to day shift work, with mean scores of 3.95 (SD=1.11) and 3.61 (SD=1.25), respectively ($p<0.030$). Similarly, family quality of life was more adversely affected by night shift work compared to day shift work, with mean scores of 3.92 (SD=1.10) and 3.50 (SD=1.21), respectively ($p<0.006$) [Qanash S *et al.*, 2019].

A 24-year cohort study conducted among nurses in the United States examined the relationship between night shift work and healthy aging. Following 24 years of follow-up, 3695 out of 46,318 nurses (8.0%, mean (SD) age at baseline, 55.4 [6.1] years) were classified as having reached healthy aging. It has been confirmed that with longer duration of night shift work, the probability of healthy aging decreases significantly. Odds ratios were 0.96 (95% CI, 0.89-1.03) for 1 to 5 years, 0.92 (95% CI, 0.79-1.07) for 6 to 9 years, and 0.79 (95% CI, 0.69-0.91) for longer durations of night shift work ($p=0.001$) [Shi H et al., 2022].

Servicemen engaged in shift work are also affected by similar professional factors. Metabolic, cardiovascular, musculoskeletal system and cognitive function disruptions lead to significant mental and physical disorders, that are often the result of shift work, inadequate sleep and disruptions in daily rhythm.

Sleep deprivation and related fatigue endanger personal safety, task performance and national security as well. Chronic lack of sleep not only leads to common sleep disorders such as insomnia, obstructive sleep apnea and parasomnia, but also contributes to other physiological and psychological diagnoses, including post-traumatic disorders, cardiovascular diseases and dementia. The probability of inattention, professional errors and mortality among servicemen increases as a result of these factors [Good C et al., 2020].

In 2008, a data analysis from the USA "Sleep in America" poll, conducted among a sample of 1,000 workers, revealed that 21% had a threefold increased risk of drowsy driving accidents due to night work (95% CI = 1.27-6.0), which further increased fourfold (95% CI = 1.15-16.48) for those experiencing shift work sleep disturbances. This was associated with an exacerbation of cardiovascular and other chronic diseases. Among US police officers, the relative risk (OR) for all-cause mortality was 1.20 (95% CI = 1.14-1.26), for cardiovascular disease was 1.10 (95% CI = 1.02-1.19) and for atherosclerotic diseases slightly higher than for non-shift workers, 1.20 (95% CI = 1.14-1.26). Mortality level from all malignancies was also slightly increased (OR = 1.32; 95% CI = 1.19-1.46). A greater increase is observed among police officers who entered service under the age of

25 and had a long service record [Bukhtiyarov I, Rubtsov M, 2016; Good C et al., 2020].

Shift work is associated with sleep disturbances, depressive mood and anxiety, cognitive impairment, low quality of life and even suicidal thoughts, leading to increased safety risks for professionals such as healthcare workers, first responders and manufacturing specialists, etc. In a large cohort study of US police officers, at least 40.4% of 4,957 respondents reported a sleep disorder, with 33.6% diagnosed with obstructive sleep apnea, 6.5% with moderate to severe insomnia, and 5.4% with shift work disorder. Furthermore, a 10% increase in the number of night shifts was found to increase the frequency of suicidal thoughts among police officers with post-traumatic stress disorder by 13% (OR = 1.13; 95% CI = 1.00-1.22) [Bukhtiyarov I et al., 2016; Brown J et al., 2020].

The most common health consequences caused by shift work stress are depression and accidents. Servicemen involved in shift work are exposed to stress and high psychological tension, which can affect their work efficiency.

Thus, the impact of shift work on occupational burnout, depression, anxiety and stress levels among service personnel was examined using the Depression, Anxiety and Stress Scale-21 to measure depression, anxiety and stress. Apparently, the study indicates a significant correlation between shift work and occupational burnout. Particularly vulnerable groups comprise individuals over 45 years old and those with more than 20 years of work experience [Gerber M et al., 2010; Sartang A et al., 2017].

At the same time, it should be noted that the analysis of the shift work impact on occupational health still requires additional studies.

Thus, a study involving 695 active Portuguese adults aged 18-73 demonstrated statistically significant differences ($p<0.05$) for all indicators between shift workers and those with regular rhythms, i.e., emotional burnout syndrome ($p=0.024$), work engagement ($p<0.001$), work self-development ($p<0.001$), depression symptoms ($p<0.001$) and anxiety symptoms ($p<0.001$). This testifies that the participants showed lower scores in work engagement and effectiveness, and higher scores in exhaustion, depression and anxiety.

It can be concluded that non-standard working hours (shift work) negatively impact workers' oc-

cupational health, increase anxiety and depression levels, contribute to burnout and decrease perceptions of work engagement and self-efficacy [Pereira H et al., 2021]. An analysis of 7 longitudinal studies examining the correlation between shift work and mental health revealed that shift work was linked to a higher risk of negative mental health outcomes (Effect Size = 1.28; 95% Confidence Interval (CI) = 1.02, 1.62; I² = 70.6%), particularly depressive symptoms (Effect Size = 1.33; 95% CI = 1.02, 1.74; I² = 31.5%). Regarding gender, female shift workers appeared to be more vulnerable, showing more pronounced depressive symptoms compared to non-shift workers (OR = 1.73; 95% CI = 1.39, 2.14) [Torquati L et al., 2019].

The impact of shift work on employees' working ability, general well-being, health and sleep was analyzed. Workers often complain of irritability, nervousness and anxiety as a result of stressful working conditions and greater challenges in managing family and social life.

It was revealed that shift and overtime work disrupt normal circadian rhythms, metabolism and hormonal balance, resulting in reduced recovery periods between shifts and an increased risk of burnout. These disruptions can lead to the development of cardiovascular, gastrointestinal, excretory, nervous system and oncological diseases. There are data concerning the correlation between sleep disorders and metabolic abnormalities, particularly obesity.

Shift workers showed a markedly higher incidence of hypertension compared to standard shift workers (34.4% vs. 27.4%, respectively, $p < 0.01$). Furthermore, significant differences were observed in the prevalence of abdominal obesity (69.2% vs. 19.3%, respectively, $p < 0.001$) and carbohydrate metabolism disorders (19.0% vs. 10.6%, respectively, $p < 0.001$) between the shift and standard work schedule groups [Costa G, 2010; Jerieva I et al., 2012; Chernikova E, 2015].

High work productivity depends on workers' mental and physical performance which can change significantly under conditions of night shift work. Studies on male night shift workers have shown reduced activity, lack of adaptive mechanisms for autonomic regulation and signs of autonomic dysfunction syndrome.

Heart rate variability analysis is commonly used for early detection of autonomic nervous system

functional disorders, diagnosing an autonomic dysfunction syndrome in 20.4% of night shift workers.

Cognitive function assessments revealed that 34.9% of studied individuals showed short-term memory stability and reduced long-term memory, indicative of fatigue development. Among two-thirds of workers with over 10 years of service, autonomic regulation disorders become chronic and are clinically manifested as autonomic dysfunction syndrome [Ivashova Yu et al., 2018; Ustinova O et al., 2019].

Under long-term stressful working conditions, operators experience fatigue and increased tension due to the influence of low-intensity factors and the demands of their work, occurring during both day and night shifts. This type of work regimen disrupts their normal circadian rhythm, leading not only to reduced work capacity and concentration, but also to the development of metabolic disorders, cardiovascular diseases and oncological conditions [Kalyada T et al., 2018].

Mealtimes play an important role in regulating both physiological and social aspects of human life. According to the literature data, although shift workers don't significantly change the overall amount of energy they consume, they do change the timing, frequency and sometimes composition of their food intake. Food is often taken cold and for a short period of time. Digestive issues after sleep are frequently reported among shift workers (ranging from 20% to 75%, compared to 10% to 25% among regular workers. These issues are linked to meal timing disruptions, functional gastrointestinal (such as stomach, bile and pancreas secretions, enzyme activity and intestinal motility) disorders, fluctuations in production of hunger and satiety hormones and increasing rate of food intake.

Functional gastrointestinal disorders can present in various ways: diarrhea, more commonly constipation, digestive difficulties, meteorism, and in severe cases, gastroduodenitis, peptic ulcer, irritable bowel syndrome, and etc. Recent studies in Japan on gastric ulcers have revealed a twofold increased relative risk among shift workers compared to regular workers (2.38% vs. 1.03% for peptic ulcer and 1.37% vs. 0.69% for duodenal ulcer). Numerous studies have also highlighted a higher prevalence of metabolic disorders such as overweight and obesity, as well as elevated blood

triglyceride and total cholesterol levels among shift workers.

Some studies have reported impaired glucose tolerance, increased nocturnal insulin resistance and a higher, nearly doubled prevalence of type 2 diabetes among shift workers, a risk that seems to rise along with seniority.

Shift work can also impact the detoxification processes occurring in the liver.

There are data indicating a direct correlation between shift work and coronary heart disease. Thus, according to the literature data, shift workers have, on average, a 40% higher risk of coronary heart disease compared to regular workers. The increased prevalence of cigarette smoking among shift workers, as well as metabolic disorders resulting from changes in diet and meal timing contribute to this.

Recent studies have also highlighted the significance of elevated levels of inflammatory mediators, along with other independent risk factors such as homocysteine and fibrinogen, as well as an increase in the frequency of arrhythmias and ventricular extrasystoles among shift workers.

A study investigated an association between risk factors for metabolic disorders, immune cell counts and night shift work with its various characteristics, including frequency, duration and sequence of shifts.

Night shift workers had higher body mass index and waist circumference, as well as increased immune cell counts compared to non-shift workers. This was more pronounced with an increasing frequency of monthly night shifts (frequency ≥ 5 : body mass index: 0.81 kg/m^2 (95% CI = 0.43-1.10), waist circumference: 1.58 cm (95% CI = 0.34-1.71), leukocytes: $0.19 \times 10^9 \text{ cells/L}$ (95% CI = 0.04-0.34 $\times 10^9$), in case of frequent night shift work with a smaller interval (> 3 : body mass index: 0.92 kg/m^2 : 95% CI = 0.41-0.43), waist circumference: 1.85 cm (95% CI = 0.45-3.24), and leukocytes: $0.32 \times 10^9 \text{ cells/L}$ (95% CI = 0.09-0.55 $\times 10^9$)).

According to some authors, occupational exposure to high noise levels and night shift work is associated with the risk of coronary heart disease. In particular, the risk of coronary heart disease in men was HR 1.10 (95% CI 1.05 to 1.14), and in women, HR 1.25 (95% CI 1.17 to 1.34) [Costa G, 2010;

Peplonska B et al., 2014; Shan Z et al., 2018; Tsvetkova E et al., 2019; Streng A et al., 2022; Eng A et al., 2023; Jankowiak S et al., 2024].

Shift work has been shown to increase insulin resistance, blood pressure and postprandial triglyceride levels after food intake, thereby increasing the risk of cardiovascular diseases by 1.6 times in men and 3.0 times in women aged 45-55. "The Night Shift Work, Genetic Risk and Hypertension" cohort study found that night shift workers had a higher risk of developing hypertension that increased with the frequency of night shifts (p trend < 0.001) and genetic predisposition to hypertension [Mosendane T et al., 2008; Dzherieva I et al., 2012; Chernikova E, 2015; Vishnevskaya N et al., 2017; Wong R et al., 2023].

RESULTS

The study found that the prevalence of arterial hypertension among shift workers increases due to instability of the work schedule, additional workload, reduced rest time, work intensity and circadian misalignment. The assessment of daily cortisol dynamics revealed that 40% of workers have increased cortisol levels in the evening. Pronounced hemostasis disorders were observed, characterized by an increased rate of thrombus formation, spontaneous thrombosis and elevated activity of coagulation factor VIII [Kozhevnikova V et al., 2019].

In 2007, the International Agency for Research on Cancer classified shift work as "probably carcinogenic to humans" (group 2A), based on "limited evidence for the carcinogenicity of shift work among humans". While the focus is primarily on breast cancer, there are also publications on endometrial, prostate, colon cancer and non-Hodgkin lymphoma.

The menstrual cycle is the most known monthly hormonal rhythm and can be disrupted among women working shifts. Women working shifts (nurses, flight attendants, industrial workers) often experience menstrual irregularities, a higher frequency of premenstrual syndrome and menstrual cramps, and according to some studies, even an increased risk of miscarriage and fetal malformations, including preterm birth and low birth weight.

Shift work also has a significant impact on family and social life, resulting in psychological stress and psychosomatic disorders. Shift workers often face difficulties in balancing work and social com-

mitments, as most family and social activities are scheduled during the day. This can adversely affect marital relationships, fulfillment of parental responsibilities, children's education, as well as the associated health issues, such as sleep problems, chronic fatigue and psychosomatic complaints.

As can be seen, numerous pathological conditions are directly associated with shift work or can be potential contraindications for shift work. When evaluating someone's suitability for work, it's crucial to thoroughly assess any restrictions, temporary limitations or complete prohibitions they may have. This involves considering the severity of these conditions and implementing appropriate preventive measures [Costa G, 2010; Bukhtiyarov I et al., 2016].

CONCLUSION

Further studies are necessary to understand the impact of shift work on the health-related quality of life among servicemen.

Therefore, depending on work organization, specific situations, the type and severity of the disorder, as well as possible interactions with other pathologies, the above-mentioned diseases can be considered relative or absolute contraindications to shift work. Further studies are necessary due to other dangerous and unfavorable factors specific to military service.

To reduce professional errors in evaluating the suitability of servicemen and ensure the safety of service, it's crucial to consider additional conditions that may negatively affect well-being, health and work ability. These may include age over 50, chronic respiratory diseases, type 2 diabetes, female hormonal dysfunctions, and others.

When evaluating suitability for shift work, it's important to consider the following:

- Shift schedules can be quite different, and their impact on health can vary significantly,
- Health and well-being may be affected not only

by shift work itself but also by other occupational risk factors,

- Many health disorders may develop in mild forms without significantly affecting the worker's psychophysical work ability.

During advanced medical examinations conducted as part of servicemen's healthcare, clinical studies may be enhanced with laboratory and instrumental tests, as well as additional examinations of specialists, in particular, investigation of sleep disorders, ECG readings, blood glucose and insulin levels, hormonal assessments (such as cortisol, melatonin and thyroid hormones), consultations with cardiologists, endocrinologists and psychologists.

For female service members, in addition to the abovementioned studies and specialist examinations, it is also necessary to schedule a consultation with a gynecologist.

The Depression, Anxiety and Stress Scale-21 can serve as a tool for selecting shift workers, assessing their mental health and psychological well-being.

According to literary sources, regulating work schedules plays a preventive role in extending the duration of work ability, combat readiness and professional suitability for both shift workers and servicemen. These schedules should adhere to ergonomic standards aimed at reducing stress and mitigating the negative effects of shift work on health and well-being, in particular:

- Limiting night work as much as possible,
- Avoiding a large number of consecutive night shifts,
- Preferring a fast rotating (every 3 days) shift schedule,
- Defining the shift duration in accordance with psychophysical requirements,
- Determining number of days sufficient for rest between shifts,
- Keeping the shift schedule as regular as possible.

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Address for correspondence:

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Republic of Armenia

Phones:

(+37410) 582532 YSMU

(+37493 588697 Editor-in-Chief

Fax: (+37410) 582532

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Phone: (+374 10) 62 76 12,
E-mail: las.print@yahoo.com

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