ASSESSMENT OF THE PREVALENCE OF CARDIOVASCULAR RISK FACTORS AND ASSOCIATED HEALTH THREATS AMONG SOLDIERS OF NATO MEMBER STATES

Ocena rozpowszechnienia czynników ryzyka sercowo-naczyniowego i związanych z nimi zagrożeń zdrowotnych wśród żołnierzy państw Sojuszu Północnoatlantyckiego

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Abstract

Cardiovascular diseases pose a significant health threat also to professional soldiers, who theoretically should present with better health due to rigorous medical requirements and lifestyle. In reality, the rates of overweight, hypertension, and lipid disorders among military personnel of NATO member states are alarmingly high, which may negatively impact their combat capability and operational readiness. The aim of this paper was to assess the prevalence of classical cardiovascular risk factors among NATO soldiers and to analyze their potential impact on health and operational performance. The literature review included original papers published in the PubMed database between 2019 and 2024. Based on the selection criteria, only studies evaluating classical cardiovascular risk factors such as overweight, obesity, hypertension, hyperlipidemia, and smoking, in active-duty NATO soldiers were considered. The data were subjected to a comparative analysis across different armed forces of NATO member states. The review findings indicate a high prevalence of cardiovascular risk factors among NATO soldiers, with significant differences between individual countries. The results highlight the need for modern preventive strategies to minimize cardiovascular risk in the NATO military population.

Streszczenie

Choroby układu sercowo-naczyniowego stanowią istotne zagrożenie zdrowotne nawet dla żołnierzy zawodowych, którzy teoretycznie powinni cechować się lepszym stanem zdrowia dzięki rygorystycznym wymogom medycznym i trybowi życia. W rzeczywistości jednak wskaźniki nadwagi, nadciśnienia i zaburzeń lipidowych wśród personelu wojskowego państw NATO są alarmująco wysokie, co może negatywnie wpływać na zdolność bojową i gotowość operacyjną. Celem niniejszego artykułu jest ocena rozpowszechnienia klasycznych czynników ryzyka sercowo-naczyniowego wśród żołnierzy NATO oraz analiza ich potencjalnego wpływu na zdrowie i wydajność operacyjną. Przegląd literatury obejmował analizę badań oryginalnych opublikowanych w bazie PubMed w latach 2019–2024. Selekcji dokonano na podstawie kryteriów obejmujących wyłącznie badania dotyczące czynnych żołnierzy NATO, oceniające klasyczne czynniki ryzyka sercowo-naczyniowego, takie jak nadwaga, otyłość, nadciśnienie tętnicze, hiperlipidemia i palenie tytoniu. Dane poddano analizie porównawczej między różnymi armiami państw członkowskich Sojuszu. Wyniki przeglądu wskazują na wysoką częstość występowania czynników ryzyka sercowo-naczyniowego wśród żołnierzy NATO, z istotnymi różnicami między poszczególnymi krajami, oraz na konieczność wdrożenia nowoczesnych strategii profilaktycznych w celu minimalizacji ryzyka sercowo-naczyniowego w tej populacji.

Keywords: cardiovascular diseases (CVD); health prevention; CVD risk factors; soldiers' health; NATO forces

Słowa kluczowe: choroby sercowo-naczyniowe (CVD); profilaktyka zdrowotna; czynniki ryzyka CVD; zdrowie żołnierzy; wojsko NATO

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Introduction

Cardiovascular diseases (CVDs) pose a significant challenge also in individuals undergoing rigorous health screening, such as professional soldiers. Paradoxically, despite mandatory regular medical check-ups, military personnel exhibit a disturbingly high prevalence of classical CVD risk factors. Similarly unexpected findings have been obtained for various military forces around the world. Only in Poland, 58% of soldiers > 50 years of age are overweight, and 45% have hypertension (HT), with up to 60% presenting with abnormal LDL cholesterol levels [1]. Similar trends are observed globally: the proportion of U.S. soldiers with optimal blood pressure (30%) is nearly half that of the civilian population (55%) [2].

These statistics are particularly relevant in the context of the specific conditions of military service. Stress, which is responsible for a 63% increase in the soldiers' risk of CVDs, is associated with an irregular lifestyle. Indeed, up to 33% of Polish soldiers over 40 years report a sedentary lifestyle. Furthermore, cultural and organizational factors, such as a diet high in saturated fats and easy access to stimulants, give rise to a unique combination of health risks.

International comparisons indicate that Polish soldiers occupy a middle-of-the-pack position, with obesity and HT rates comparable to those observed in the United States, but significantly lower than those reported in developing countries. However, this relative optimism is tempered by a troubling trend of changes. Between 2007 and 2014, the number of CVD cases increased by 38% among U.S. soldiers, indicating that conventional prevention models are becoming ineffective against contemporary health threats. It is worth emphasizing that a modern military relies on highly trained specialists, whose preparation for service requires substantial investment of time and resources. Maintaining their full operational capacity constitutes a major challenge. Therefore, preventive measures are justified not only from a medical standpoint but also from the point of view of efficient resource utilization, which directly impacts the effectiveness and combat readiness of the armed forces. The aim of this paper was not only to enhance understanding of CVD epidemiology in NATO military populations, but also to provide a basis for revising the criteria for assessing combat capability in the context of long-term health risks. Combining an epidemiological perspective with an analysis of the specific conditions of military service may help develop innovative CVD prevention strategies tailored to the dynamically evolving requirements of modern armed forces. These actions are not only fully justified, but also play a key role in maintaining high combat efficiency and constitute a long-term investment in the health of military personnel of NATO countries.

Methods

This literature review included papers selected from the PubMed database using the following criteria: publications dated 2019 or later, original papers on active-duty soldiers from NATO countries, and studies addressing classical CVD risk factors. Our approach allowed for collecting up-to-date and reliable data for investigating issues related to CVD prevention in the population of interest.

The methods we employed allowed us for collecting relevant information on the cardiovascular health among military personnel. PubMed was selected as the primary data source due to its high quality and peer-reviewed content. The five-year time limit for the analysed research was aimed to ensure the inclusion of up-to-date data reflecting the latest trends in CVD diagnosis and prevention among NATO soldiers.

Restricting the review to original papers provided direct insight into empirical findings and minimized the risk of bias associated with secondary analyses. Limiting the study population to active NATO service members ensured a homogeneous sample and enabled comparison of results across Alliance countries. Focusing on classical CV risk factors allowed for a comprehensive assessment of the primary health determinants in this professional group. The adopted methodology enabled the collection of research data necessary for developing effective preventive strategies tailored to the unique needs and challenges faced by armed forces personnel.

Results

After limiting the search to publications from the past five years, the PubMed database yielded six studies on the prevalence of CV risk factors among NATO soldiers, including two conducted in Poland. The key findings from these papers are presented in Table 1.

A recent study conducted by the Military Institute of Aviation Medicine in Warsaw included anthropometric measurements, body composition analysis, and laboratory tests in 200 young male air personnel of the Polish Armed Forces [3]. Of these, 36.5% individuals had a normal body weight by BMI. However, when body composition analysis and body fat percentage were taken into account, the proportion of individuals with normal parameters increased to 47.5%. The study demonstrated a significant correlation between the prevalence of overweight and obesity (defined based on both BMI and body fat percentage) and abnormal metabolic findings. In the obese group, abnormal total cholesterol was found in 54% and 58% of soldiers using BMI and BIA (bioelectrical impedance analysis), respectively, while abnormal HOMA-IR (Homeostatic Model Assessment of Insulin Resistance) was found in 57.1% and 51.6% of individuals assessed by BMI and BIA, respectively.

As reported in a paper published in 2022, soldiers of the French Armed Forces have a lower prevalence of obesity and fewer CV risk factors than the general French population [4]. These conclusions were based on a study conducted among 1,589 soldiers, 86.4% of whom were men. In addition to anthropometric measurements, the study incorporated blood pressure, biochemical parameters, and a lifestyle questionnaire. The mean BMI was 25.4, comparable to that of the

Table 1. Summary of original studies on the prevalence of CV risk factors among NATO soldiers

Country/group	Poland (pilots)	France	Germany (pilots)	Czech Republic	Poland (MILSCORE)	USA
Year of publication	2023	2022	2020	2020	2020	2019
N (number of participants)	200	1589	1957	659	6440	263 430
Males %	100	86,4	98,3	87,4	97	85,32
Females %	0	13,6	1,7	12,6	3	14,68
Mean age	37,8	35,7	41,9	43,8 (M) / 45 (K)	34,9	ND
Mean BMI	26,7	26,7	25,6	27,1 (M) / 23,9 (K)	ND	ND
Overweight (%)	46,0 (BMI) 37 (BIA)	38,7	54,3	ND	54,6	48,2
Obesity (%)	17,5 (BMI) 15,5 (BIA)	10,0	4,4	ND	14,1	18,3
Nicotine dependence (%)	10,5	ND	25,2	ND	46,2	19,9
Known HT (%)	ND	2,0	0,3	ND	13,7	5,0
Known DM (%)	ND	1,0	0,2	ND	1,0	1,7
Mean SBP (mmHg)	ND	ND	120	ND	134,7	ND
Mean DBP (mmHg)	ND	ND	80	ND	83,1	ND
Normal BP (%)	ND	ND	ND	ND	32,2	30,3
Elevated BP (%)	ND	ND	ND	ND	16	64,7
Hypertension (%)	ND	ND	ND	ND	51,8	5
LDL (mg/dL)	109,1	ND	132	ND	128,3	ND
HDL (mg/dL)	55,3	ND	54	ND	52,7	ND
Triglycerides (mg/dL)	138,5	ND	102	ND	152	ND

ND – no data; BMI – body mass index; BIA – bioelectrical impedance analysis; HT – hypertension

general French population. However, obesity affected 10% of the military cohort, as opposed to 15% in the civilian population. The percentage of individuals with abnormal body weight increased with age. Furthermore, the prevalence of HT and diabetes mellitus (DM) among French Army soldiers was significantly lower than that in the general population (2% vs 17.6% for HT and 1% vs 5.8% for DM, respectively).

The Institute of Aerospace Medicine in Cologne published their aviation medicine studies conducted among German military pilots during two periods: 2007–2009 and 2016–2018 [5]. To facilitate comparison with other military forces, only 2016–2018 results have been included in Table 1. Both study cohorts underwent anthropometric and blood pressure measurements, and laboratory workup, as well as were assessed for the risk of coronary events using the PROCAM score, originally developed for the German population. Both studies included a total of 1,717 pilots. When comparing the results from the two periods, the number of pilots decreased (from 3,396 to 1,957), while the mean age (from 36.7 to 41.9 years), all cholesterol fractions, BMI, and CV risk assessed using the PROCAM algorithm increased. It should be emphasized that this tool is used exclusively to assess the risk of acute coronary events, incorporating age, lipid levels, smoking status, DM, family history, and systolic blood pressure. The authors reported low rates of HT (0.3%) and DM (0.2%) among pilots, lower than those observed in the general population. They further emphasized that the increased risk of coronary events (13.9% at a CVD RISK threshold of ≥5%, indicating a 5% risk of a coronary event within 10 years, and 4.9% at a threshold of ≥10%), was solely due to age differences, as the risk assessed using the age-adjusted PROCAM score was identical in both groups.

Researchers from the Faculty of Military Health Sciences University of Defence presented the results of mandatory periodic medical check-ups conducted among soldiers of a selected elite unit of the Czech Army [6]. The health status of 659 soldiers (87.4% of men) was compared with health findings from a civilian cohort of similar size and demographic structure. In addition to anthropometric measurements, laboratory tests and lifestyle surveys were also performed. Analysis by gender revealed significant differences. In both age categories, female soldiers had a mean BMI within the normal range (23.9 and 24.7, respectively), whereas the BMI values of female civilians ranged between 27 and 27.7. A similar trend was observed for biochemical findings, with more favourable values observed in female soldiers. However, a reverse trend was seen in the male group, both for BMI and biochemical findings. Furthermore, abnormal body weight was significantly correlated with increasing age among the men.

The largest cohort of NATO soldiers in Europe was included in a study conducted by a research team from the Military Institute of Medicine in Warsaw [1]. The MIL-SCORE study was a comprehensive epidemiological analysis of CV risk factors in the population of the Polish armed forces. The study involved 6,440

soldiers, with men accounting for 97%. The study protocol included a multidimensional health assessment consisting of a detailed medical interview focused on chronic conditions, family history, and behavioural health determinants; a comprehensive physical examination with anthropometric measurements; and a laboratory panel. The obtained data indicated a high prevalence of modifiable CV risk factors, whose occurrence was significantly correlated with age. Of particular concern was the high percentage of smokers (46.2%). Combined with abnormal body weight (only 31.3% of participants had a normal BMI) and lipid disorders (elevated LDL cholesterol in 59% of soldiers), this gave rise to an unfavourable cardiometabolic risk profile. Suboptimal blood pressure control, with only 32% of participants exhibiting values within the reference range, was an additional risk factor. Cardiovascular risk was stratified using POL-SCORE, validated for the Polish population, yielding high risk in 7.9% (≥5% and <10% risk of a CV event within 10 years) and very high risk in 0.4% (≥10%) of participants.

The largest prospective comparative study on CVDs, comparing a population of active U.S. soldiers with civilian controls, was conducted and published by a team of U.S. researchers [2]. The study included a cohort of 263,430 active duty army personnel aged 17–64 years, undergoing standard periodic check-ups, with men accounting for 85.32%. A representative civilian group characterised by a different demographic distribution was used for comparative analysis. The military population consisted mainly of younger age groups: 56% in the age range 17–29 years, 29% aged 30–39 years, 12.6% aged 40–49 years, and 1.28% aged > 50 years. The age structure of the control group differed markedly, with 30% of participants aged 17–29 years, 20% aged 30–39 years, 19% aged 40–49 years, 31% aged > 50 years; and with evenly distributed gender groups (50% women and 50% men). Risk factor analysis revealed a significantly lower prevalence of DM (1.7% vs. 5.7%) and nicotine dependence (19.9% vs. 22.5%) in the military cohort. The more favourable anthropometric profile of military personnel was reflected in significantly lower rates of obesity, defined based on standard BMI criteria (18% vs. 33.6%). Excess body weight was observed in 48.2% of soldiers and 32.3% of civilians, while normal BMI was found in 33.5% and 34.1% of the subjects, respectively. Blood pressure findings were particularly noteworthy. Despite comparable HT rates in both groups (5.0% vs. 5.4%), a significantly higher percentage of soldiers (64.7% vs 40%) had blood pressure classified as high-normal. Also, the positive correlation between elevated blood pressure and the frequency of exposure to combat deployment in the military group was a noteworthy finding.

Discussion

This systematic comparative analysis of studies on CV risk factors in NATO military populations delivered a comprehensive picture of the health status of military personnel while simultaneously revealing the complexity of research issues within this specific professional group. It further demonstrated that methodological heterogeneity and demographic diversity within the study populations, although preventing direct comparison of results, allow for the identification of key health trends and challenges. This in turn offers a meaningful contribution to the development of preventive strategies and the optimisation of healthcare systems within the field of military medicine.

Analysing the age and gender structure of soldiers, several significant correlations can be identified. The U.S. Army is comprised of the youngest population; the combined proportion of individuals in the 17–29 and 30–39 age ranges is 85% [2]. For comparison, the mean age in the elite unit of the Czech Armed Forces is much higher, with nearly 44 years for men and 45 years for women [6]. The U.S. Army also stands out in terms of gender structure, with women accounting for 14.68% of its personnel [2], and male predominance among military pilots. Systematic analysis of the available research indicates widespread anthropometric abnormalities, manifested as overweight and obesity, affecting both the general population and military personnel. Particularly valuable conclusions arise from research conducted by the Military Institute of Aviation Medicine, which revealed significant diagnostic limitations of standard tools used to assess nutritional status [3]. Conventional BMI, which is based solely on weight relative to the square of a person's height, has limited specificity in populations characterized by a high proportion of muscle tissue, which can result in misclassification of metabolic risk. The introduction of advanced tools for body composition analysis, which enable precise assessment of body fat percentage, provides significantly more accurate diagnostic data and should become the standard for evaluating the health status of military personnel.

A comparative assessment of the anthropometric profiles of the study populations revealed significant differences between the individual armies. The most favourable anthropometric parameters were observed in the French Armed Forces, which were characterized by the highest percentage of soldiers with a healthy body weight. In contrast to other military units, the U.S. Army had the highest obesity rate. Conversely, particularly low obesity rates were observed in a selected group of German military pilots [2, 4, 5].

Not all studies included comprehensive data on smoking and the prevalence of clinically confirmed HT and DM. The highest smoking rates were reported in the MIL-SCORE study, with cigarette smokers accounting for 46.2% of respondents. By comparison, smoking rates were estimated at 19.9% for the U.S. Army, 25.2% for German pilots, and 10.5% for Polish pilots [1–3, 5]. The high percentage of smokers in the MIL-SCORE group may substantially increase the risk of CVD, further underscoring the need for intensive preventive measures.

Comparative evaluation of the prevalence of hypertension revealed significant intergroup heterogeneity. The MIL-SCORE study reported the highest rates of HT, reaching 13.7% of the study population, a value considerably higher than that observed in the U.S. (5.0%) and French cohort (2.0%, with a median age of

35.7 years). Particularly low HT rates were found in the group of German military pilots (0.3%) [1, 2, 4, 5]. The observed disparities may be due to multiple factors, including varying levels of physical activity, differences in behavioural patterns, and specific medical selection criteria used across individual military formations.

In terms of metabolic disorders, the highest prevalence of DM was reported for the U.S. military population (1.7%). Lower rates were observed in the MIL-SCORE study group and among French military personnel (1.0% in both populations). The lowest prevalence of DM was found in the cohort of German military pilots (0.2%) [1, 2, 4, 5]. As in the case of HT, the intergroup differences in the prevalence of DM may result from a combination of demographic factors and the specific conditions of military service, including different medical qualification criteria and varying health monitoring protocols.

Cardiovascular risk factors can significantly affect combat capabilities of soldiers. Individuals with HT, hyperlipidaemia, or excess body weight are at increased risk of CV events when exposed to high stress and intense physical exertion. A very high CVD risk, defined as the probability of a CV event within the next 10 years greater than the ≥10% threshold (according to the Pol-SCORE scale), was identified in 0.4% of Polish soldiers participating in the MIL-SCORE study, while high risk (≥5% and <10%) was found in nearly 8% of the assessed military personnel. German researchers estimated the risk of coronary events among military pilots using the PROCAM score developed for the German population. A high risk (>10% probability of an event within 10 years) was identified in 4.9% of pilots, while a moderate risk (5–10% probability within 10 years) was found in 13.9% of the study population.

Highly specialized military units, such as the Air Force, apply stringent qualification criteria and continuous medical monitoring protocols, which effectively exclude individuals with certain health conditions from active duty. This approach, employed by both the Polish and German Air Forces, results in significantly lower rates of chronic conditions, including HT, DM, and obesity, compared with other military units. These findings highlight the importance of regular health monitoring and targeted preventive strategies within the military population.

Conclusions

This review of original research on the health of NATO soldiers showed that, despite rigorous physical demands, regular medical check-ups, and systematic health screening, military personnel are not immune to CV risk factors and cardiovascular diseases. Comparative analyses revealed significant differences between individual armies, resulting not only from demographic characteristics, but also from the specific nature and intensity of military service.

As evidenced in international comparisons, the health status of Polish soldiers appears less favourable than that of personnel in other NATO armies. Our troops present with the highest rates of smoking, hypertension, and multiple metabolic abnormalities, including lipid disorders. Obesity, which is one of the most significant CVD risk factors, is also more prevalent in the Polish Armed Forces than in most of the analysed military populations, being second only to the U.S. Army. It is worth noting that the overall CVD risk assessed in the MIL-SCORE study indicates that nearly 8% of Polish soldiers are at high risk of cardiovascular events (≥5% and <10%), despite their relatively young mean age (34.9 years).

These data indicate the need for more effective preventive programmes for the Polish Army, encompassing not only systematic monitoring of soldiers' health, but also intensified health education efforts. Of particular importance are comprehensive initiatives aimed at reducing smoking, promoting regular physical activity, and encouraging dietary modifications consistent with evidence-based healthy eating principles. Although NATO soldiers generally present with better health parameters compared with the civilian population, the substantial differences observed between individual armies highlight the need to tailor preventive strategies to the specific health profiles and operational demands of each military group. Long-term cardiovascular disease prevention initiatives encompassing health education, risk-factor reduction, and the promotion of healthy lifestyle behaviours should constitute a fundamental component of the health strategy implemented within the armed forces.

Conclusions and recommendations

- The increased prevalence of hypertension among Polish and U.S. soldiers underscores the need to intensify preventive measures and ensure systematic blood pressure monitoring in these populations.
- Dyslipidaemia and metabolic disorders, particularly among Polish soldiers, necessitate the implementation of more effective preventive strategies, including targeted dietary interventions and the promotion of regular physical activity.
- The high prevalence of smoking, particularly among Polish soldiers, constitutes a major cardiovascular risk factor and should prompt intensive preventive measures, including comprehensive anti-smoking campaigns and smoking cessation support programmes.
- The low incidence of diabetes among NATO soldiers may be attributed to rigorous health standards and systematic medical screening, which contribute to early detection of metabolic abnormalities and the exclusion of high-risk individuals from active duty. However, noticeable differences in fasting glucose levels across the analysed populations suggest that factors such as diet, lifestyle, physical activity, and the specific medical selection criteria used across different armies may significantly influence the metabolic status of soldiers. Therefore, further research is needed to clarify the mechanisms underlying these disparities and to help develop more personalised and effective preventive strategies.

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