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ORIGINAL ARTICLE

EFFECT OF COVID-19 ON THE NUTRITIONAL STATUS OF POLISH MILITARY FLYING PERSONNEL AND VITAMIN D SUPPLEMENTATION ON THE INCIDENCE OF DISEASE – A RETROSPECTIVE COHORT STUDY

Agata GAZDZIŃSKA[1], Magdalena KRZYŻANOWSKA[1], Paweł JAGIELSKI [2]

[1] Laboratory of Dietetics and Obesity Treatment, Department of Psychophysiological Measurements and Human Factor Research, Military Institute of Aviation Medicine, Warsaw, Poland

[2] Department of Nutrition and Drug Research, Faculty of Health Science, Jagiellonian University, Medical College, Cracow, Poland

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Author's address: A. Gaździńska, Military Institute of Aviation Medicine, Krasińskiego 54/56 Street, 01-755 Warsaw, Poland, e-mail: afrotena@gmail.com

Introduction: On 4 March 2020, the first case of coronavirus was detected in Poland, and on 20 March 2020, the Minister of Health declared a state of epidemic in the country, which entailed numerous changes in public life. The aim of this study was to assess the comparative nutritional status of Polish military flying personnel before and after two years of the COVID-19 pandemic and to examine the effect of vitamin D supplementation on the incidence of COVID-19.

Method: Measurements were obtained from all members of active military flight personnel in Poland who reported for mandatory annual anthropometric examinations at the Military Institute of Aviation Medicine in Warsaw. Nutritional status was assessed through anthropometric examinations and body composition analysis using the bioimpedance method. Overweight and obesity were assessed by Body Mass Index (with overweight defined as a BMI of 25-29.9 kg/m2 and obesity as a BMI ≥ 30 kg/m2) and body fat content, according to WHO criteria. Nutritional status surveys were conducted twice: in 2019 and in 2021. Subjects were asked about prior COVID-19 infection and vitamin D supplementation in the autumn-winter period, including the dosage and frequency of supplementation, if applicable.

Results: Analysis of the results showed that the pandemic had a significant adverse effect on the increase in such parameters of soldiers' nutritional status as body weight, BMI, and body fat ($p < 0.05$). In 2019, 54.3% of soldiers were found to be overweight, and 12% obese. There was no significant change in the percentage of overweight subjects during the pandemic period ($p > 0.05$). 15% of the subjects increased their body weight by more than 5%, while 7% decreased their body weight by more than 5% of their baseline weight.

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The largest percentage of soldiers (78%) maintained their baseline weight within ±5%. COVID-19 incidence was shown to have no significant effect on the nutritional status of military flying personnel ($p > 0.05$). Only 44% of the subjects declared that they supplemented with vitamin D during the autumn-winter period. It was shown that vitamin D supplementation had no significant effect on the incidence of COVID-19 in the study group ($p < 0.05$).

Conclusions: The first two years of COVID-19 pandemic adversely affected the nutritional status of military flying personnel. Therefore, regular self-monitoring of body weight is recommended to enable early therapeutic intervention and prevent excessive weight gain. No association was found between vitamin D supplementation and the incidence of COVID-19. More than half of the military flying personnel surveyed did not take vitamin D supplements at all, and only one-third were aware of the recommendations for supplementation with this vitamin, indicating a need for further education in this area.

Keywords: Covid-19, nutritional status, BMI, vitamin D, military flying personnel

INTRODUCTION

The novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes coronavirus disease (COVID-19), first appeared in December 2019 in Wuhan, China, and quickly spread worldwide. On 4 March 2020, the first case of coronavirus was detected in Poland, and on 20 March 2020, the Minister of Health declared a state of epidemic in the country. As of 21 January 2025, there were 6 770,134 cases of COVID-19 and nearly 120,870 related deaths in Poland. Re-infections were reported in 263,048 people [14]. The SARS-CoV-2 pandemic has led to changes in lifestyles, health status, and interpersonal relationships. The restrictions introduced (e.g. frequent hand washing, distancing, social isolation) were effective in limiting the transmission of SARS-CoV-2 infections, but at the same time caused depression and stress.

Stress is associated with higher energy intake, 'food cravings', unhealthy dietary patterns high in fat and sugar, and increased alcohol consumption, all of which can lead to weight gain and increased risk of obesity [2,42].

Social isolation disrupted daily routines. Increased sedentary behaviour and screen time, and limited food availability and choice also contributed to changes in dietary habits and weight gain [4].

Due to the restrictions and prohibitions introduced during the epidemic in the Republic of Poland, the Minister of Defence exempted all professional soldiers from the physical fitness test in 2020 and 2021 [29], which may have contributed to a decline in regular physical activity in this professional group over these two years.

Reduced physical activity significantly contributed to weight gain among the Polish population. According to the Ipsos COVID 365+ survey conducted in the first quarter of 2021, as many as 42% of Poles gained an average of 5.7 kg in weight during the COVID-19 pandemic [20]. The survey, which involved a representative sample of 1,000 Polish residents, shows that one in two Poles is currently overweight or obese.

Obesity is considered a major civilization-related disease. Its high prevalence makes it a chronic social disease and a risk factor for numerous conditions, including hypertension, type 2 diabetes, ischemic heart disease, gallstones, and cancer [21,30,41].

Recent studies have also increasingly documented the increased risk of severe COVID-19 in obese patients and the high risk of mortality from SARS-CoV-2 infection in this group [7,40]. Severe acute respiratory syndrome coronavirus 2 penetrates human cells through direct binding with angiotensin-converting enzyme 2 receptors on the cell surface. Angiotensin-converting enzyme 2 expression in adipose tissue is higher than that in lung tissue, which means that adipose tissue may be vulnerable to COVID-19 infection [34].

A worrying phenomenon is the increasing prevalence of overweight and obesity, including in the military community. In addition to causing numerous health complications, overweight and obesity can also contribute to reduced combat capability. The results of studies systematically conducted in armies around the world, including in Poland, show an increase in the prevalence of overweight and obesity among both military students and soldiers [11,14,18,32,38].

Research conducted by the Military Institute of Aerospace Medicine in Warsaw within the framework of the National Health Programme

2016-2020, entitled “Conducting scientific and research activities and international cooperation, including the commissioning of a comprehensive study of the diet and nutritional status of professional soldiers and officers with the identification of risk factors for the development of obesity, with an assessment of physical activity, the level of nutritional knowledge and the prevalence of health inequalities in 2017 and 2020”, showed the prevalence of overweight in 49.3% and obesity in 17.3% of soldiers [12].

Many studies confirm the link between vitamin D deficiency and obesity, abdominal obesity, and metabolic syndrome, although there are also reports indicating no such link [22,24].

Studies are also looking for a link between blood levels of vitamin D and the risk of COVID-19 and the course of the disease. Common deficiencies of this vitamin are associated with health consequences—including increased morbidity and mortality from autoimmune diseases and cancers [17]. Nowadays, new properties of calcitriol are being highlighted, showing its preventive effect and the possibility of using it in supportive therapy for many diseases.

Vitamin D deficiency has long been linked to reduced immune function, which can lead to viral infection. Several studies have shown that vitamin D deficiency is associated with an increased risk of COVID-19 infection [1,8]. It has been suggested that vitamin D has a protective effect against COVID-19. Vitamin D has been shown to have immunomodulatory activity. Vitamin D [1,25-dihydroxyvitamin D; 1,25(OH)2D], interacting with its receptor (VDR) in immune cells, modulates the innate and acquired immune systems in response to invasion of bacterial and viral pathogens [16].

Adequate blood levels of vitamin D are also associated with a lower risk of complications in hospitalized COVID-19 patients [23]. It is believed that proper vitamin D levels may help mitigate adverse immunological sequelae (so-called cytokine storm) observed in patients with COVID-19.

A clinical study by Castillo et al. [6] showed that COVID-19 patients who were given vitamin D supplements experienced less severe symptoms.

Vitamin D deficiency affects up to 90 percent of Polish population. According to Polish recommendations, vitamin D should be supplemented by adults (19-65 years old) from September to May [33]. However, a study of 312 adults from Poland [5] found that only 15.7% followed this recommendation before the lockdown, and 13.5% during the lockdown. Overall, regardless of the time period, the use of dietary supplements in the study group was lower than suggested by market data referred to in a paper by Dziedziński et al., who reported that 72% of Poles took dietary supplements [8].

To date, relatively few studies have explored the role of vitamin D supplementation in coronavirus infection. However, recent studies suggest that vitamin D helps protect against infection with the SARS-CoV-2 virus and reduces the likelihood of developing serious symptoms [3,26].

To our knowledge, no one has yet studied the impact of the course of the COVID-19 pandemic on the nutritional status of military flying personnel and the effect of vitamin D supplementation on the incidence of COVID-19. Hence, the aim of this study was to comparatively assess the nutritional status of Polish flying personnel before and after two years of the pandemic and the frequency of vitamin D supplementation in this professional group.

MATERIAL AND METHODS

Measurements were obtained from all members of active military flight personnel in Poland who reported for mandatory annual anthropometric examinations to the Laboratory of Dietetics and Obesity Treatment at the Military Institute of Aviation Medicine in Warsaw, Poland, as part of their routine medical examinations. Nutritional status surveys were conducted twice: in 2019 and in 2021.

The study group consisted of 300 men (only 7 female military flying personnel reported for medical examinations during this period, and were therefore excluded from further analyses). The group included 27% pilots of highly manoeuvrable aircraft, 24% transport pilots, 21% helicopter pilots, 27% cabin crew (technicians, navigators, operators, gunners), and 1% highly-manoeuvrable aircrafts candidate pilots. The mean age was 38.47 ± 6.84 years (24–57 years).

Nutritional status was assessed by anthropometric measurements of height and weight. Body Mass Index (BMI) was calculated.

Body composition was measured using the bioelectrical impedance method with the Inbody 370 analyser (InBody, Tokyo, Japan). Overweight and obesity were assessed by BMI (with overweight defined as a BMI of 25-29.9 kg/m2 and obesity as a BMI ≥ 30 kg/m2) and body fat content, according to World Health Organisation (WHO) criteria [10,28].

Body height was measured to the nearest 1 mm using a Harpenden Anthropometer (Holtain Ltd, Crosswell, Crymych, Pembs, UK), with the subject standing upright without shoes. Body weight and body composition were assessed following an overnight fast.

Handgrip strength (HGS) was measured using a SAEHAN DHD-1 hydraulic medical hand dynamometer (Glanford Electronics Ltd., Scunthorpe, UK). Measurements were performed in a standing position, with the arm lowered alongside the body and the elbow fully extended.

Three trials were conducted for each hand, with short rest periods between attempts to allow for muscle relaxation. Grip strength was measured in kilograms, and the average of the results obtained for each hand was used for analysis. The results were compared with reference values for the adult Caucasian population, where the average handgrip strength for men is 49 kg for the dominant hand and 47 kg for the non-dominant hand [25]. All evaluations were conducted in the morning. Participants were instructed to avoid any physically strenuous activity for at least three days prior to the examination. They were also asked to empty their bladders before testing and wore only underwear during measurements.

During anthropometric measurements, a short history was taken regarding the incidence of COVID-19 (a positive PCR test result was considered confirmation of infection) and vitamin D supplementation in the autumn-winter period of 2019-2021. If supplementation was reported, participants were asked about the frequency and dose of vitamin D intake. Medical records were reviewed to collect information on age, marital status, type of flight crew, flight history, and smoking status.

Ethics

The Institutional Review Board of the Military Institute of Aviation Medicine in Warsaw, Poland, retrospectively approved the use of the results for statistical analyses (Decision No. 8/2021 of 11 August 2021). All procedures were performed in accordance with the ethical standards set out in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. All participants signed an informed consent form.

Statistics

Descriptive statistics were calculated, including mean, standard deviation, median, and the first and third quartiles (Q1–Q3). The Shapiro-Wilk test was used to check the normality of distribution of quantitative variables. The Wilcoxon test or the McNemar's test was used to test for the differences between the two groups (2019 and 2021 participants) for the quantitative or ordinal variables analysed. Chi-square test was used to test for differences between aircraft type and participants' BMI categories. Statistical analyses were performed using PS IMAGO PRO 10 (IBM SPSS Statistics 29, Armonk, NY, USA). The level of statistical significance was set as $\alpha < 0.05$.

RESULTS

The average age of the subjects was 36.4 ± 6.8 years. The majority were married (77%), 18% were single, 4% were divorced, and 1% were widowers. 79% of the subjects declared that they did not smoke. A positive PCR test was reported by 35% of the subjects. Less than half (44.0%) reported taking vitamin D supplements during autumn and winter. The majority of soldiers taking supplements reported taking a vitamin D dose of 2000 IU (Fig. 1.). More than 70% of those taking vitamin D supplements did so daily (Fig. 2.). Only 34% of soldiers reported being aware of the recommendations for vitamin D supplementation. Vitamin D intake had no significant effect on the incidence of COVID-19 in the study group ($p > 0.05$).

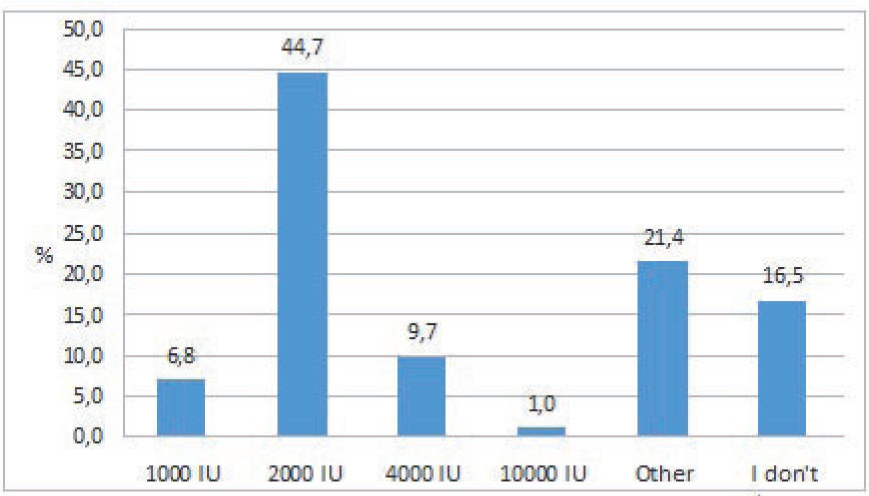

Fig. 1. Percentage distribution of vitamin D doses used by military flying personnel.

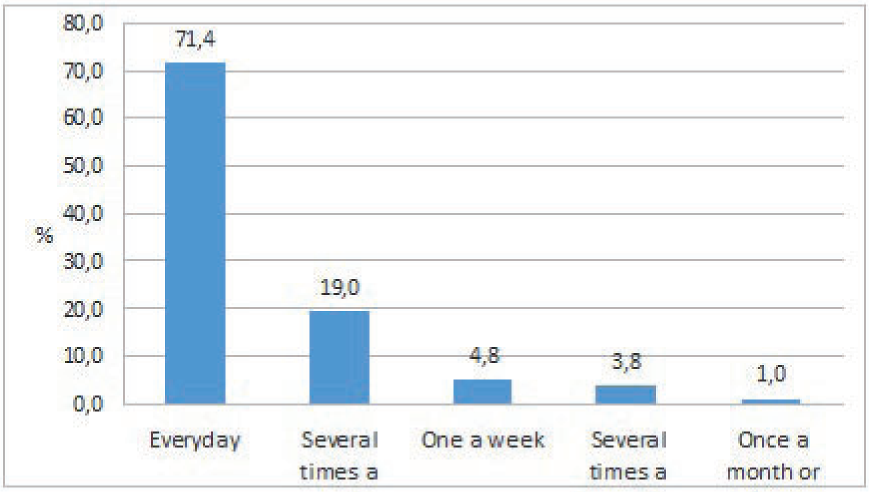

Fig. 2. Frequency of vitamin D supplementation by military flying personnel in the autumn and winter periods – during the COVID-19 pandemic.

Table 1. Summary of anthropometric parameters and body composition of military flying personnel in 2019 and 2021.

Variable	2019	2021	Delta	Wilcoxon test p
	N = 300	**N = 300**	**N = 300**	
	X (SD)	**X (SD)**	**X (SD)**	
	Me (Q1 – Q3)	**Me (Q1 – Q3)**	**Me (Q1 – Q3)**	
Height (cm)	178.3 (6,1)	178.3 (6,1)	0 (1.0)	0.6858
	178 (174.3-183)	178 (174.3-183)	0 (0-0)	
Weight (kg)	83.8 (11.0)	84.4 (11.4)	0.5 (4.0)	**0.0047**
	82.9 (76.5-90.7)	82.8 (76.8-90.5)	0.6 (-1.8-2.8)	
BMI	26.3 (3.0)	26.5 (3.2)	0.2 (1.3)	**0.0023**
	25.9 (24.4-28.2)	26 (24.4-28.1)	0.2 (-0.6-0.9)	
BFM (kg)	16.8 (6.5)	17.2 (6.8)	0.4 (3.2)	**0.0018**
	15.5 (12.7-20.2)	16.6 (12.4-20.2)	0.4 (-1.3-2.1)	
FFM (kg)	67.0 (7.6)	67.1 (7.5)	0.1 (2.2)	0.3783
	66.4 (62.1-71.8)	66.8 (62.3-71.7)	0 (-1.2-1.4)	
SMM (kg)	38.3 (4.5)	38.3 (4.5)	0.0 (1.3)	0.4996
	37.9 (35.3-41.2)	38.1 (35.4-41.1)	0.0 (-0.8-0.8)	
TBW (L)	49.2 (5.5)	49.2 (5.5)	0.1 (1.6)	0.3050
	48.7 (45.5-52.5)	49 (45.6-52.6)	0 (-0.9-1.0)	
BMR (kcal)	1818,1 (163.2)	1820,2 (163.0)	2.0 (46.5)	0.3998
	1803.5 (1710.5-1921)	1811.5(1715.5-1919)	1.0 (-26.01-30.0)	
HGS – right hand (kg)	56.8 (8.7)	56.1 (8.8)	- 0.5 (7.5)	**0.0412**
	56 (51-62)	56 (50-60)	-1 (-5-3)	
HGS – left hand (kg)	54.3 (8.2)	54.3 (8.3)	0.1 (6.6)	0.7029
	54 (48-59.5)	54 (49-59)	0 (-4-3)	

TBW – Total Body Water, BFM – Body Fat Mass, SLM – Soft Lean Mass, FFM – Fat Free Mass, SMM - Skeletal Muscle Mass, PBF – Percent Body Fat, BMR – Basal Metabolic Rate, HGS – Handgrip strength, for Wilcoxon test result, bold values denote statistical significance at the $p < 0.05$ level.

A detailed summary of the results of anthropometric tests and body composition measurements of military flying personnel conducted in 2019 and 2021 is presented in Table 1. Analysis of the results showed that the COVID-19 pandemic had no significant effect on most of the nutritional status parameters studied in military flying personnel. However, there was a significant increase in body weight ($p = 0.0047$), BMI ($p = 0.0023$) and body fat (% and kg) ($p < 0.01$), and a decrease in HGS – right hand ($p = 0.0412$).

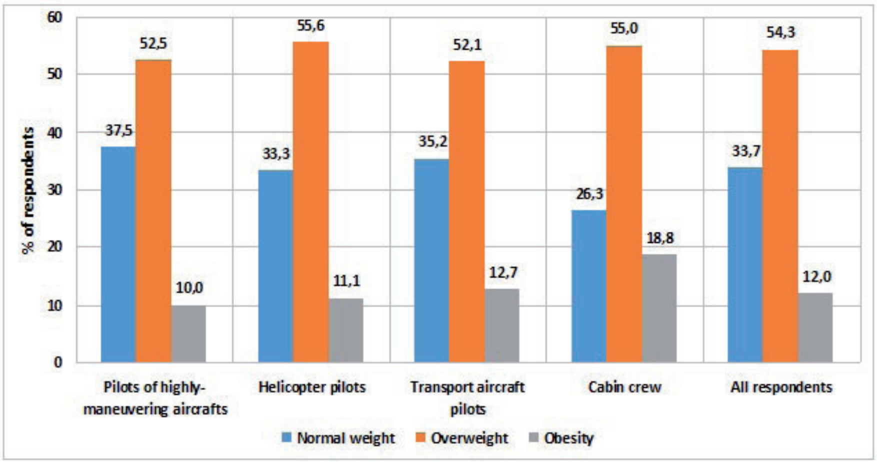

Fig. 3. Prevalence of overweight and obesity in military flying personnel by aircraft type (chi-square test; p = 0.607).

Table 2. Interpretation of nutritional assessment based on Body Mass Index (BMI) of the whole study group in 2019 and in 2021.

Nutritional status	2019	2021	p-value
Normal weight N (%)	101 (33.7)	100 (33.3)	
Overweight N (%)	163 (54.3)	161 (53.7)	0.6558
Obesity N (%)	36 (12.0)	39 (13.0)	

N – sample size, p-value for McNemar's test

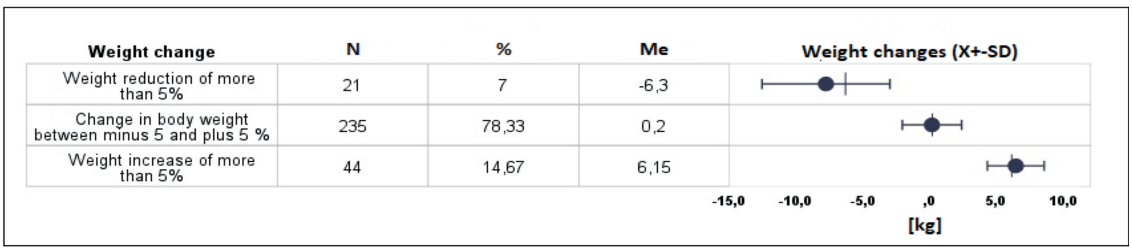

Fig. 4. Changes in body mass of military flight personnel between 2019 and 2021.
N – sample size, Me – median, X – mean, SD – standard deviation

The results of the survey show that in 2019, 54.3% of military flying personnel were classified as overweight, and 12.0% as obese (Table 2.). Excess body weight was most prevalent among flight attendants (Fig. 3.), although the differences were not statistically significant (p > 0.05). During the pandemic period, there was no significant change in the proportion of overweight and obese military flying personnel (p > 0.05). From March 2019 to December 2021, the proportion of soldiers with normal body weight decreased by 0.4%, and the number of those diagnosed with obesity increased by 1 % (Table 2).

During the COVID-19 pandemic, 14.7% (n = 44) of the subjects increased their body weight by more than 5% of their baseline weight over the two-year period (Fig. 4.). In contrast, 7.0% (n = 21) reduced their body weight by more than 5% of their baseline weight. The largest percentage of soldiers (78.3%; n = 235) maintained their baseline weight within ±5%. A detailed summary of the change in body weight in each group of military flying personnel by diagnosed overweight and obesity between 2019 and 2021 is shown in Fig. 5, which shows the clear flow of people between the groups. It was observed that the group of soldiers who lost more than 5% of their baseline weight in 2021 had the highest BMI (indicating overweight) compared to the group of soldiers whose weight increased or remained within ±5% of their baseline weight (Fig. 6).

It was found that contracting COVID-19 had no significant effect on the nutritional status of military flying personnel (p > 0.05).

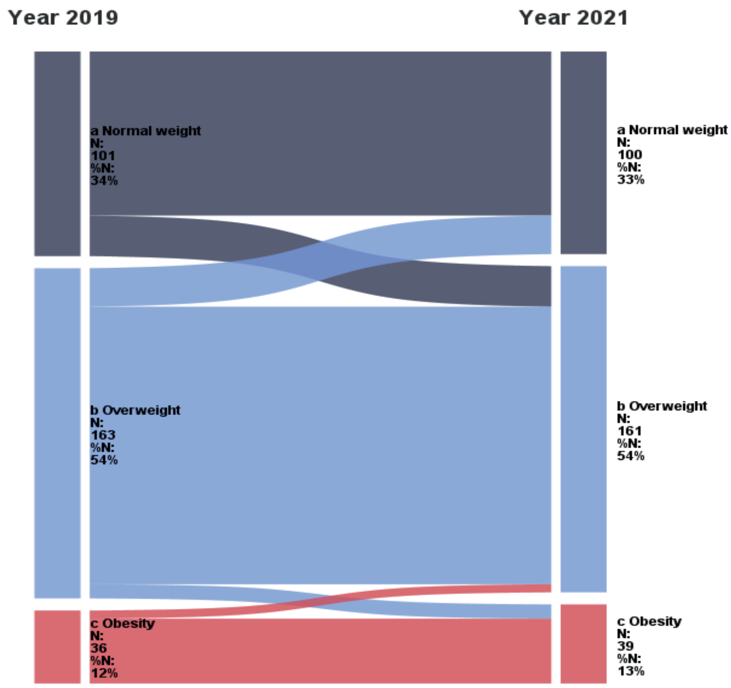

Fig. 5. Changes in BMI of military flying personnel between 2019 and 2021.
N – sample size

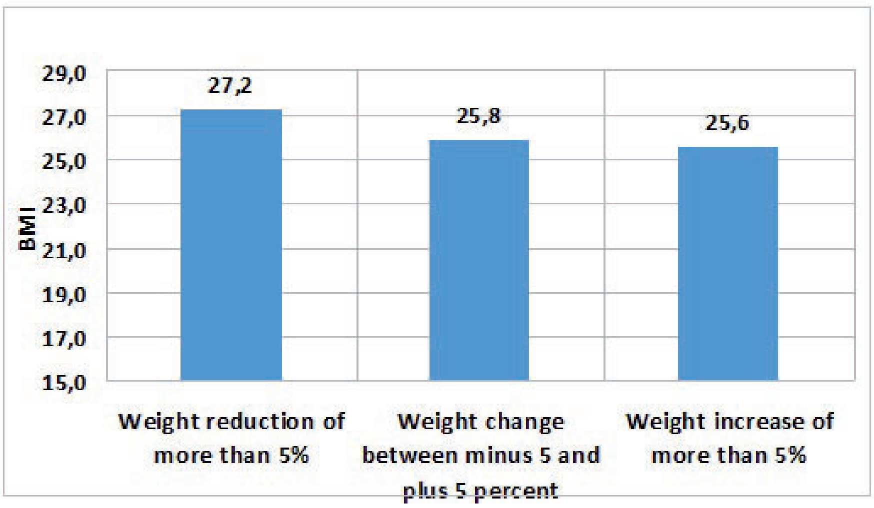

Fig. 6. Average BMI in groups of military flying personnel divided by weight change during the Covid-19 pandemic.

DISCUSSION

This study focused on a comparative assessment of the nutritional status of military flying personnel before and after two years of the COVID-19 pandemic, as well as the effect of vitamin D supplementation on the incidence of COVID-19. The results showed that the pandemic had a significant adverse effect on several indicators of soldiers' nutritional status, including increases in body weight, BMI, and body fat content ($p < 0.05$), and a decrease in HGS in the right hand. In 2019, 54.3% of surveyed military flying personnel were classified as overweight, and 12.0% as obese. During the COVID-19 pandemic, there was no significant change ($p > 0.05$) in the percentage of overweight individuals in the surveyed group. However, there was a 0.4% decrease in the percentage of soldiers with normal weight, a 0.6% decrease in the percentage of overweight soldiers, and a 1% increase in the percentage of those diagnosed with obesity. 15% of the subjects increased their body weight by more than 5%, while 7% of the subjects decreased their body weight by more than 5% of their baseline weight. The largest percentage of soldiers (78.0%) maintained their baseline weight within ±5%. The occurrence of COVID-19 infection did not significantly affect the nutritional status of the soldiers ($p > 0.05$). Only 44.0% of the subjects declared using vitamin D supplementation during autumn and winter. Vitamin D supplementation had no significant effect on the incidence of COVID-19 in the group of soldiers surveyed ($p > 0.05$).

A study by Stiegmann et al. [37], which assessed trends in the prevalence of overweight, obesity, and diabetes among all active U.S. military service members, including those in the Navy, Air Force, and Marine Corps, from 2018 to 2021, i.e. before and after the start of the COVID-19 pandemic, found, in contrast to their own study, an increase in the prevalence of obesity among active service members from 16.1% to 18.8%. Considering both obesity and overweight, the prevalence increased from 65.5% in 2018 to 67.3% in 2021.

In Nour and Altintaş [27], a systematic review of 40 studies with a total population of 5,681,813 people from 22 countries to determine the determinants of obesity during the 2019-2023 coronavirus disease (COVID-19) pandemic showed that sedentary lifestyles, unhealthy dietary habits, reduced sleep, high stress, depression, anxiety, lowered mood, age, male gender, educational status, minority background, and Internet and social media addiction were identified as risk factors for obesity during the COVID-19 pandemic. All studies included in the review reported weight changes during the pandemic, with the mean weight gain ranging from 0.04 (SD = 1.18) to 2.8 (SD = 3.7). In our study, we found a similar mean weight gain of 0.6 kg in military flying personnel.

A cross-sectional online survey of Polish adults (n = 1097) published by Sidor and Rzymski [35], conducted during a nationwide quarantine to assess whether dietary and consumer habits were affected under these conditions, found that almost 30% of overweight and more than 18% of obese individuals experienced weight gain (mean ± SD 3.0 ± 1.6 kg) and weight loss (-2.9 ± 1.5 kg), respectively. Overweight, obese, and elderly subjects (aged 36 –45 and over 4) were more likely to gain weight, while underweight subjects were more likely to lose weight. Increased BMI was associated with less frequent consumption of vegetables, fruit, and legumes during quarantine, and greater consumption of meat, dairy products, and fast food.

An online questionnaire survey conducted by Błaszczyk-Bębenek, et al. [5] also showed a change in body weight during quarantine among Polish adults (n = 312, aged 41.12 ± 13.05). Statistically significant differences in nutritional status based on BMI (Δ 0.27 ± 1.61 kg/m2were found before (24.98 ± 4.33 kg/m2) and during (25.28 ± 4.44 kg/m2; $p < 0.0001$) the pandemic. During this period, 45.86% of the subjects gained weight, 32.41% remained the same, and 21.72% lost weight. However, this study covered a relatively short period (from 29 April to 19 May 2020), during which the strictest restrictions on leaving home and moving around were in place.

Our survey found that less than half of soldiers (44%) supplemented with vitamin D during autumn and winter, with 71% taking it daily. Given that maintaining adequate vitamin D levels year-round is difficult in north/central-western Europe without supplementation, and that deficiency remains widespread, this is a very worrisome phenomenon.

Studies confirm the predominantly seasonal nature of vitamin D deficiency in various military populations. For example, in a prospective study of 220 Finnish military recruits, serum 25-(OH) D3 levels were measured across a year, with the prevalence of deficiency rising from 0.9% to 38.9% in winter [39].

It is worth mentioning the results of another study conducted on a group of 756 Finnish conscripts who started a 6-month military training in the summer (July) [19]. The study population was a homogeneous group in terms of age, physical activity, nutrition, clothing, residence, and sun exposure. The percentage of subjects with low vitamin D concentrations (< 40 nmol/l) was 3.6%. Although such low blood 25(OH)D concentrations were present in a minority of subjects, this group had significantly ($p = 0.004$) more days away absent due to physician-confirmed respiratory infections (median: 4; quartile 1 –quartile 3: 2 –6) compared to control subjects (2; 0–4; n 628; incidence rate ratio 1.63; 95% CI: 1.15, 2.24). These individuals were 1.6 times more likely to miss military service due to respiratory tract infections. The observed relationship, given the low percentage of soldiers supplementing with vitamin D (44%) identified in our study, appears to be an important finding in the context of supporting immune system function and reducing susceptibility to respiratory tract infections among soldiers.

Researchers from the University of Ljubljana, Slovenia, suggest that it would be prudent to supplement vitamin D in subpopulations at risk of vitamin D deficiency and adverse COVID-19 outcomes, as well as in those already infected with SARS-CoV-2, in order to achieve optimal 25(OH)D3 concentrations as quickly as possible [36].

In the US veteran population, supplementation with vitamin D2 and D3 was associated with a 28% and 20% reduction in COVID-19 infection, respectively [(D3 hazard ratio (HR) = 0.80, [95% CI 0.77, 0.83]), D2 HR = 0.72, [95% CI 0.65, 0.79]]. Similarly, mortality within 30 days of COVID-19 infection was 33% lower for vitamin D3 and 25% lower for D2 (D3 HR = 0.67, [95% CI 0.59, 0.75]; D2 HR = 0.75, [95% CI 0.55, 1.04]). It was also found that, after accounting for blood vitamin D levels, veterans who received higher doses of vitamin D benefited more from supplementation than veterans who received lower doses. The most substantial reduction in in COVID-19 infections after supplementation was observed among veterans with blood vitamin D levels between 0 and 19 ng/ml. Black veterans reported a greater reduction in COVID-19 risk with supplementation than white veterans [1]. According to the authors of the cited study, vitamin D—being safe, widely available and inexpensive—may help reduce the severity of the COVID-19 pandemic.

Parsons et al. [31] reviewed 700 studies examining the evidence for vitamin D supplementation in military populations for the prevention of acute respiratory tract infections (ARTI), including SARS-CoV-2 infection, and consequently COVID-19 disease. The review confirmed that vitamin D deficiency is commonly observed in military cohorts and may influence the risk of acute respiratory tract infection in this group. However, the interventional studies in the cited systematic review provided conflicting evidence, probably due to considerable heterogeneity in dosing regimens and baseline vitamin D levels. Several of the RCTs presented in this systematic review showed that vitamin D supplementation did not reduce the risk of ARTI. However, the authors emphasise that further studies are needed to determine the effect of vitamin D supplementation on asymptomatic/mildly symptomatic SARS-CoV-2 infection, the broader clinical course of COVID-19, and the associated risk of transmission.

Grant et al. [15] also identified several lines of evidence supporting the role for vitamin D in reducing the risk of COVID-19. These include the fact that the outbreak occurred during winter, when 25-hydroxyvitamin D (25(OH)D) levels are lowest; that case rates were lower in the southern hemisphere during late summer; that vitamin D deficiency has been found to contribute to acute respiratory distress syndrome; and that case fatality rates increase with age and chronic comorbidities, both of which are associated with lower 25(OH)D levels. To reduce infection risk, the authors recommend that people at risk for influenza and/or COVID-19 consider taking 10,000 IU/d of vitamin D3 for several weeks to rapidly raise 25(OH)D levels, followed by 5,000 IU/d. The target 25(OH)D levels should be above 40–60 ng/ml (100–150 nmol/l). Higher doses of vitamin D3 may be beneficial in treating individuals already infected with COVID-19.

Our study found no association between vitamin D supplementation and the incidence of COVID-19. A notable limitation of this finding is that the concentration of this vitamin in the soldier's blood was not measured, so we cannot determine the actual vitamin D status of soldiers who did or did not supplement with vitamin D.

CONCLUSIONS

The first two years of the COVID-19 pandemic had an adverse effect on the nutritional status of military flying personnel. Therefore, regular self-monitoring of body weight is recommended to enable timely therapeutic intervention and prevent excessive weight gain. No association was found between vitamin D supplementation and the incidence of COVID-19. More than half of the military flying personnel surveyed did not supplement with vitamin D at all, and only one-third were aware of the recommendations in this regard. This highlights the need for further education in this area.

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COMPLIANCE WITH ETHICAL STANDARDS

Statement of Informed Consent: Informed consent was obtained from all individual participants included in the study.

Ethical Approval: All procedures were conducted in accordance with the ethical standards of the institutional research committee of the Military Institute of Aviation Medicine School and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

AUTHORS' DECLARATION

Study Design: Agata Gaździńska. **Data Collection:** Agata Gaździńska, Magdalena Krzyżanowska. **Manuscript preparation:** Agata Gaździńska, Magdalena Krzyżanowska, Paweł Jagielski. The Authors declare that there is no conflict of interest.

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