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# A cohort study of body mass index changes among U.S. Air Force personnel during the COVID-19 pandemic

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## Abstract

**Background** The impact of the COVID-19 pandemic period continues to be felt, including a resulting increase in prevalence and rates of individuals with obesity within the Unites States, which had already been trending upward prior to the pandemic. This study aims to identify changes in body mass index (BMI) among the active-duty U.S. Air Force (USAF) personnel prior to and during the pandemic.

**Materials and Methods** We conducted a retrospective cohort study of USAF active-duty personnel. BMI data points were sourced from the Military Health System Data Repository and included a measure from each period: pre- (September 1, 2018 – February 28, 2020), early (March 1, 2020 – September 30, 2020), and late pandemic (October 1, 2020 – September 30, 2022). Pregnant women delivering during or one year prior to the study periods were excluded. Statistical analysis included percent change, the Stuart-Maxwell test for marginal homogeneity, and ANOVA comparing mean BMI with post-hoc mean comparisons. Additionally, the percentage change toward obese BMI was stratified by rank and occupation.

**Results** We identified a cohort of 111,392 active-duty USAF personnel. The overall increase in prevalence of USAF personnel with obesity over the entire study period was 44.1%. The prevalence of USAF personnel with obesity among our cohort increased by 11.6% from the pre-pandemic period to the early pandemic period (18% pre-pandemic; 20.8% early pandemic) with a 29.1% increase in prevalence from the early to late pandemic periods (20.8% early pandemic; 26.9% late pandemic). USAF aircrew members progressed to having a BMI of obese at lower rates over the same periods increasing by 7.8%, 21.3%, and 30.7%, respectively. The most prominent changes were observed among females, personnel between the ages 20 and 24, of American Indian or Alaska Native race, and in junior enlisted ranks.

**Conclusions** Our analysis indicates that like the other service branches of the U.S. military, the Air Force experienced an increase in active-duty personnel with obesity during the COVID-19 pandemic period. This indicates increases in rates of service members with obesity across the U.S. armed forces, which is likely to result in decreased force readiness.

**Keywords** Body Mass Index, Military Medicine, Obesity, COVID-19, Overweight, Military personnel

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## Background

Though the federal COVID-19 public health emergency declaration ended in May of 2023, ramifications from the COVID-19 pandemic period continue to be felt globally. The lockdown measures and subsequent lifestyle modifications put in place during the pandemic by federal and state agencies, while necessary to minimize the spread of illness, have had long lasting impacts. These include a resulting increase in prevalence and rates of obesity within the Unites States (U.S.), which had already been trending upward prior to the pandemic [1]. U.S. military service members were not immune to this trend; during the pandemic, the Department of Defense (DoD) also enacted a series of public health protection measures, limiting access to dining and fitness facilities for service members. Previous studies have indicated increases in body mass index (BMI) among Army, Navy, and Marine Corps personnel during the COVID-19 pandemic [2, 3].

Increases in BMI among active-duty service members impacts the fitness and force readiness of the U.S. military. Obesity and overweight are associated with several health consequences for service members, including increased odds of endocrine and metabolic disorders, cancer, nervous system diseases, circulatory system diseases, musculoskeletal diseases, and mental and behavioral disorders [4]. Obesity associated conditions contribute to increased health care utilization among active-duty service members with higher BMI compared to those who meet height and weight standards and account for an estimated 658,000 lost duty days annually [5, 6, 7]. The DoD spends an estimated $1.5 billion annually on health costs related to obesity associated conditions and replacing personnel that are separated from service due to obesity [7]. Replacing separated personnel is also a challenge due to increases in the prevalence of obesity within the U.S. According to the Centers for Disease Control and Prevention (CDC), only 40% of young adults aged 17–24 are eligible to serve in the military due to BMI and physical activity criteria [7]. This was supported by another study by Webber et al. that indicated only 34.3% of the military-aged population in the U.S. met the BMI and physical fitness eligibility criteria to enlist [8]. The rigorous height and weight and physical activity standards of the U.S. military, though necessary for force readiness, have contributed to declines in military enlistment and inability to meet recruitment goals in recent years [9]. The health consequences to our service members combined with the monetary and personnel costs associated with overweight and obesity may present a significant threat to military readiness [2, 3].

Wuerdeman et al. and Janvrin et al. both identified changes in body mass index (BMI) among Army, Navy, and Marine Corps service members as a result of the COVID-19 pandemic [2, 3]. This study aims to identify changes in BMI among the active-duty U.S. Air Force (USAF) personnel over the course of the pandemic to gain additional understanding of the impact that the COVID-19 pandemic has had on the health, fitness, and readiness of the U.S. military. Results from this study will allow for comparison of the impact of the COVID-19 pandemic lockdown and social distancing measures across U.S. military service branches on military readiness.

## Methods

The methods for this study have been previously described in Wuerdeman et al. and Janvrin et al. [2, 3] We have adapted these methods for the Air Force population to allow comparison between these service branches, though we have refined the time periods associated with the pandemic to better reflect our current understanding of the COVID-19 pandemic timeline. We conducted a retrospective cohort study of all active-duty US Air Force personnel using data from the Military Health System Data Repository (MDR); a central repository of healthcare data for Military Health System (MHS) beneficiaries who received care at military treatment facilities (MTFs), with limited tracking of care in civilian markets using their TRICARE benefit. Only USAF active-duty personnel aged 17 and older with a recorded BMI in the pre-pandemic, early pandemic, and late pandemic periods were included. The pre-pandemic period was defined as September 1, 2018 to February 28, 2020; the early pandemic period was defined as March 1, 2020 to September 30, 2020; and the late pandemic period was defined as October 1, 2020 to September 30, 2022. We excluded reserve and National Guard personnel due to their inconsistent access to care within the MHS. Women with a pregnancy or delivery in the year prior to the study or at any time during the study were excluded from analysis. ICD-10 diagnostic codes were used to identify pregnancies and deliveries (Z33-Z34, Z3A, Z36-Z39, O00-O9A). USAF service status was confirmed during the pre-pandemic period; if any personnel transitioned to the US Space Force during the later years of our study, they would be officially considered "guardians," but remained in the USAF cohort for this analysis. [2, 3]

We calculated BMI from height and weight metrics reported in the MDR, expressed as $kg/m^2$. We then categorized BMI as follows: Underweight (below 18.5 $kg/m^2$), healthy weight (18.5–24.9 $kg/m^2$), overweight (25.0–29.9 $kg/m^2$), and obese (30.0 $kg/m^2$ and above). Implausible BMI calculations identified as outliers by the interquartile method were then removed if higher or lower than three standard deviations from the mean. For USAF personnel with multiple BMI measurements in an observed period (pre-, early-, and late-pandemic), the most recent BMI measurement was preferentially as

temporally representative of DoD COVID-19 mitigation efforts [2, 3]. Due to the availability of necessary height and weight data, BMI was only calculated from in-person encounters at MTFs [2, 3].

Study analyses included descriptive statistics on pre-pandemic patient demographics (sex, age, race, rank, and military occupation), ANOVAs adjusted by all patient demographics to evaluate differences in mean BMI over the study period and between each pandemic period, Stuart-Maxwell test for marginal homogeneity to evaluate differences in paired BMI category distributions across the study period and between each pandemic period, and percent change of obesity between the pandemic periods, stratified by patient demographics. Military occupation was categorized as pilots or navigators, aircrew, "other", and missing to allow for focused analyses on "flying" occupations as personnel in those roles have stringent body composition criteria compared to all other USAF occupations. All analyses were performed using SAS 9.4 and statistical significance was set a priori at $\alpha = 0.05$. This study was reviewed and found exempt by the Uniformed Services University Institutional Review Board [2, 3].

## Results

We identified an initial cohort of 123,500 active-duty USAF personnel. However, 12,108 individuals were then excluded due to either outlying BMI values or due to meeting our pregnancy exclusion criteria. This resulted in a final cohort of 111,392 USAF personnel (Fig. 1). Comprehensive demographics are detailed in Table 1. The majority of our final cohort consisted of personnel who were male (77.5%), identified as White (72.8%), were between the ages of 25 to 29 years (25.6%), and were in a junior enlisted (E1-E4) rank (39.4%).

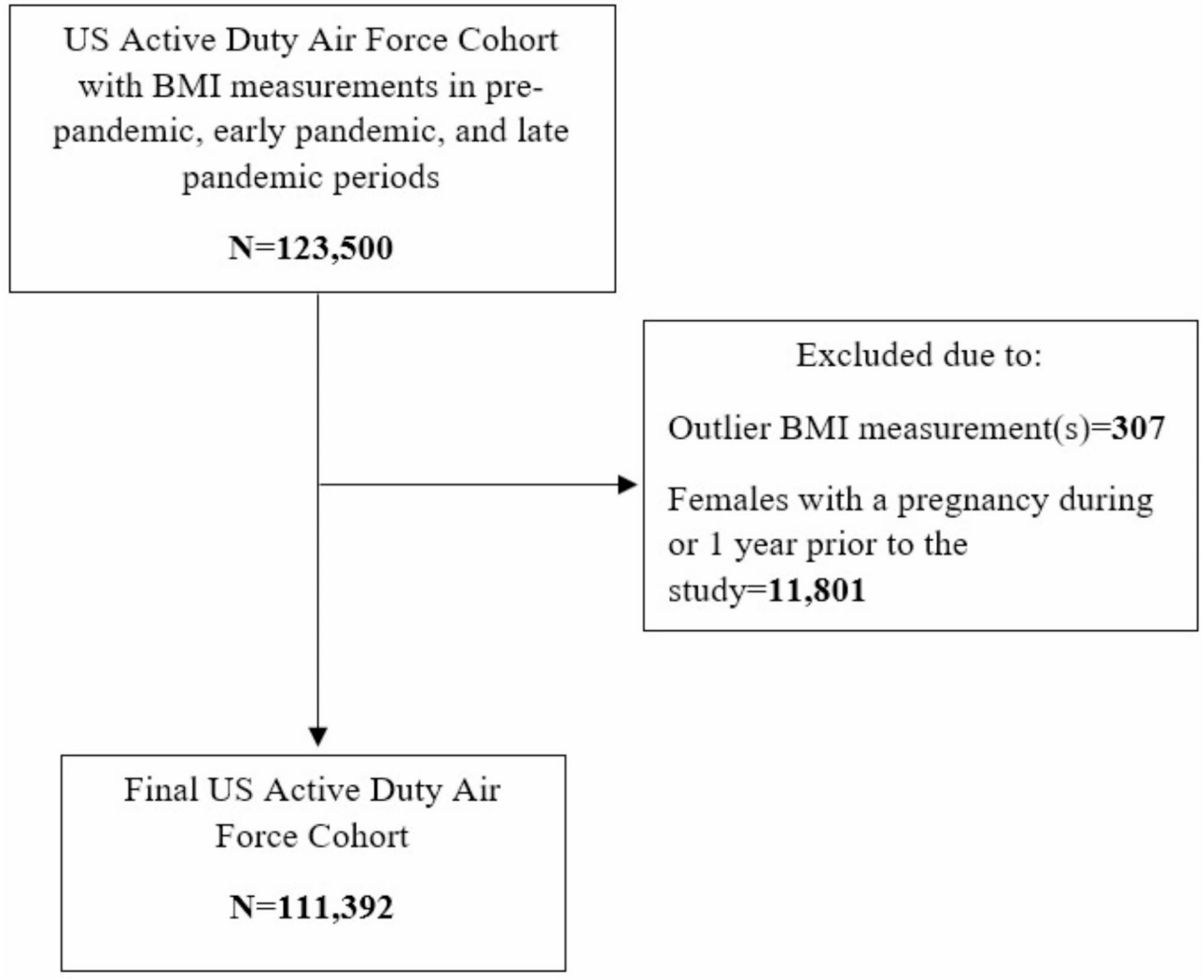


**Fig. 1** CONSORT Diagram of USAF Cohort. A CONSORT diagram illustrating application of the inclusion and exclusion criteria to the starting population to determine the final study population. Abbreviations: BMI = body mass index, USAF = U.S. Air Force

**Table 1** Demographic distributions of Air Force Cohort, *N* = 111,392

| | ***n*** **(% of Cohort)** |
|---|---|
| **Gender** | |
| Female | 25,122 (22.55) |
| Male | 86,270 (77.45) |
| **Age Group** | |
| < 20 | 475 (0.43) |
| 20–24 | 22,899 (20.56) |
| 25–29 | 28,560 (25.64) |
| 30–34 | 22,110 (19.85) |
| 35–39 | 19,861 (17.83) |
| 40–44 | 11,577 (10.39) |
| 45–49 | 4095 (3.68) |
| 50+ | 1815 (1.63) |
| **Race** | |
| White | 81,053 (72.76) |
| Black | 17,486 (15.70) |
| Asian/Pacific Islander | 6030 (5.41) |
| American Indian/Alaska Native | 812 (0.73) |
| Other | 6011 (5.40) |
| **Rank Group** | |
| Junior Enlisted (E1-E4) | 43,837 (39.35) |
| Senior Enlisted (E5+) | 41,101 (36.90) |
| Junior Officer (O1-O4) | 20,249 (18.18) |
| Senior Officer (O5+) | 4795 (4.30) |
| Other | 1410 (1.27) |
| **Occupation** | |
| Pilots/Navigators | 6097 (5.47) |
| Aircrew | 4150 (3.73) |
| Other | 98,197 (88.15) |
| Missing | 2948 (2.65) |

Differences in the mean BMI change was assessed using adjusted ANOVA (Supplemental Tables 1–3) and found to be statistically significant over the full study period (pre-pandemic to late pandemic), [$F(20, 108{,}423) = 180.75$, $p < 0.0001$; and between each pandemic period (pre- to early pandemic, $F(20, 108{,}423) = 190.22$, $p < 0.0001$; early to late pandemic, $F(20{,}108{,}423) = 44.54$, $p < 0.0001$). All models were adjusted by age, gender, race, rank, and occupation, and all were individually significant and considered to be predictors of BMI change, except for occupation with mean BMI change from the pre- to early pandemic periods.

Cohort BMI category changes between each pandemic period are visually depicted in the Sankey Diagram (Fig. 2). These changes were statistically assessed using the Stuart-Maxwell test for marginal homogeneity and found to be statistically significant ($p < 0.0001$) between each paired comparison, confirming a significant change in proportions across BMI categories. The prevalence of personnel with underweight in the pre-, early and late periods was 0.53%, 0.55%, and 0.43%; the prevalence of personnel with healthy weight during these same time periods was 32.6%, 30.9%, and 26.1%; the prevalence of personnel with overweight during these time periods was 48.1%, 47.7%, and 46.5%; and the prevalence of personnel with obesity during these time periods was 18.7%, 20.8% and 26.9%. These changes in personnel with obesity represent a percent change increase by 11.6% from the pre- to early pandemic periods, 29.1% from the early to late pandemic periods, and 44.1% over the entire study period (Tables 2 and 3).

Overall percentage change from any non-obese category to the obese category was further analyzed by gender, age, race, rank, and occupation (Table 4). The most prominent changes were observed among females, between the ages 20 and 24, those of American Indian or Alaska Native race, and in a Junior Enlisted rank. Among females, USAF personnel with obesity increased by 17% (pre- to early pandemic), 38% (early to late pandemic), and 62% (pre- to late pandemic), while personnel with obesity in males increased by 10%, 27%, and 40%, respectively. USAF personnel with obesity among ages 20 to 24 years increased by 43% (pre- to early pandemic), 56% (early to late pandemic), and 123% (pre- to late pandemic). By race, personnel with obesity among American Indian and Alaska Natives increased by 17% (pre- to early pandemic), 39% (early to late pandemic), and 63% (pre- to late pandemic). USAF personnel with obesity among junior enlisted personnel increased by 27% (pre- to early pandemic), 46% (early to late pandemic), and 86% (pre- to late pandemic), respectively. By occupation, pilots and navigators along with those designated aircrew had similar observed increased changes in personnel with obesity, but these changes were lower compared to all other personnel in which personnel with obesity increased by 12% (pre- to early pandemic), 30% (early to late pandemic), and 45% (pre- to late pandemic).

## Discussion

We identified a cohort of 111,392 active-duty USAF personnel. The overall increase in prevalence of personnel with obesity over the entire study period was 44.1%. The prevalence of personnel with obesity among our cohort increased by 11.6% from the pre-pandemic period to the early pandemic period (18% pre-pandemic; 20.8% early pandemic), with an even larger 29.1% increase in prevalence from the early to late pandemic periods (20.8% early pandemic; 26.9% late pandemic). The most prominent changes were observed among females, between the ages 20 and 24, those of American Indian or Alaska Native race, and in a junior enlisted rank. Our analysis indicates that this cohort is demographically representative of the USAF active-duty population [10].

The changes in BMI observed in the USAF cohort align with previously published studies on the U.S. Army, Navy, and Marine Corps, which taken together indicate

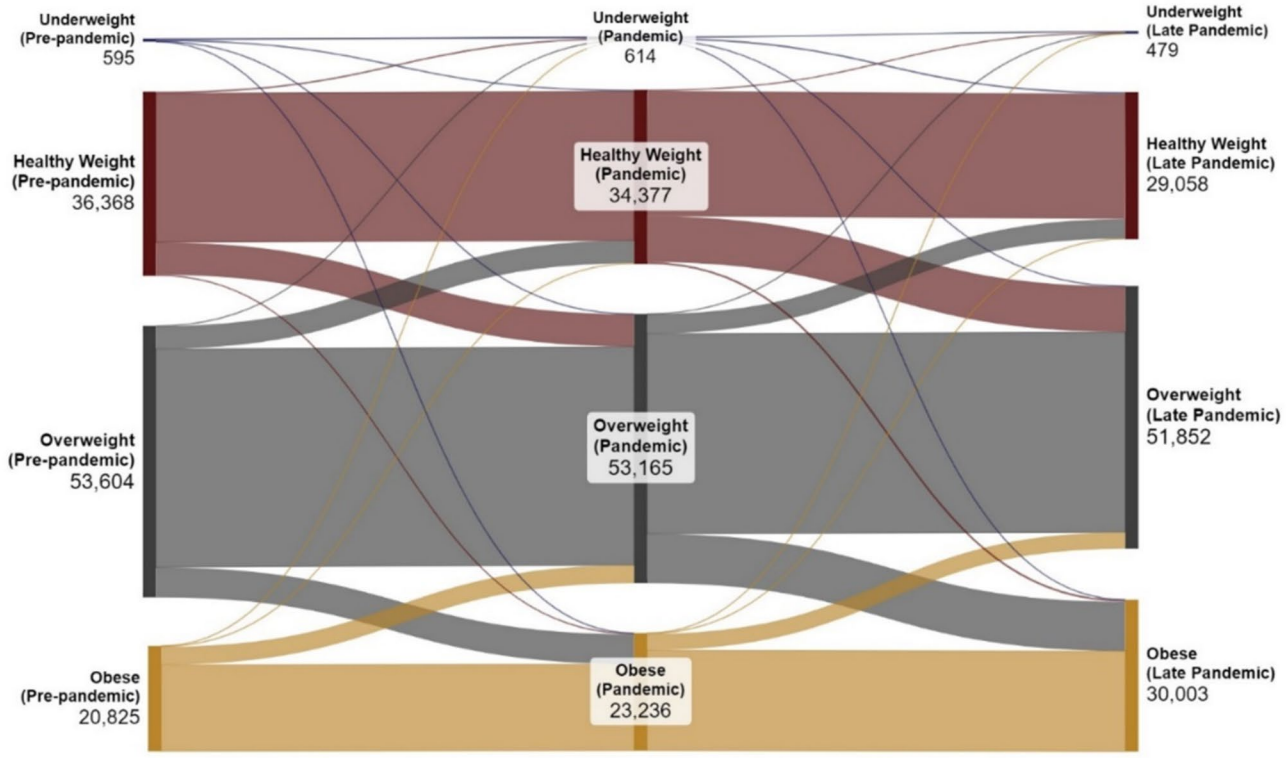


**Fig. 2** Sankey diagram of changes in BMI category distributions among Airmen by pandemic period. Illustrates changes in BMI category from the pre-pandemic BMI to the early pandemic BMI to the late pandemic among the Air Force cohort. This diagram illustrates the movement between BMI categories during the three time periods, with the bands on the left indicating the pre-pandemic BMI category of cohort members by color, the bands in the middle reflecting the early pandemic BMI category of cohort, and the bands on the right indicating the late pandemic BMI category of cohort members Note: Distribution changes over the full study period (pre- to early to late pandemic) and between each pandemic period (pre- to early; early to late) were statistically significant ($p < 0.0001$) as indicated by the Stuart-Maxwell test for marginal homogeneity

**Table 2** Comparison of Air Force Cohort BMI category prior to and during COVID-19 Pandemic*

| BMI Category Change by Pandemic Period | | | | | | |
|---|---|---|---|---|---|---|
| **BMI Category** | **Pre to Early** | | **Early to Late** | | **Pre to Late** | |
| | **Absolute Change** | **Change (%)** | **Absolute Change** | **Change (%)** | **Absolute Change** | **Change (%)** |
| **Underweight** | 19 | 3.2 | -135 | -22.0 | -116 | -19.5 |
| **Healthy weight** | -1991 | -5.5 | -5319 | -15.5 | -7310 | -20.1 |
| **Overweight** | -439 | -0.8 | -1313 | -2.5 | -1752 | -3.3 |
| **Obese** | 2411 | 11.6 | 6767 | 29.1 | 9178 | 44.1 |

Statistically significant Stuart Maxwell test for marginal homogeneity, $p < 0.0001$

Negative or positive indicating direction of change, number and %

An overview of BMI category by the pre-to-early, early-to-late, and pre-to-late pandemic periods, the absolute changes and percentage shift amongst the BMI categories, and the result from the Stuart-Maxwell test for homogeneity

**Table 3** Comparison of Air Force Cohort BMI during pre-pandemic and late pandemic time periods

| Pre-pandemic vs. Late Pandemic Cohort BMI Comparison*, $N = 111,392$ | | | | | |
|---|---|---|---|---|---|
| **Pre-pandemic BMI** | **Late Pandemic BMI** | | | | |
| | **Underweight** ***n*** **(% of total)** | **Healthy** ***n*** **(% of total)** | **Overweight** ***n*** **(% of total)** | **Obese** ***n*** **(% of total)** | **Total** |
| **Underweight** | 145 (24) | 331 (56) | 77 (13) | 42 (7) | 595 |
| **Healthy** | 272 (1) | 24,635 (72) | 10,881 (26) | 580 (1) | 36,368 |
| **Overweight** | 47 (0) | 3935 (7) | 37,948 (71) | 11,674 (22) | 53,604 |
| **Obese** | 15 (0) | 157 (26) | 2946 (47) | 17,707 (27) | 20,825 |

*Statistically significant Stuart-Maxwell test for marginal homogeneity, $p < 0.0001$

An overview of BMI category for the Air Force cohort from the pre-pandemic period to the late pandemic period

**Table 4** Percent change in obesity among USAF cohort by pre-pandemic demographics, *N* = 111,392

| | Pre to Early Pandemic % Change | Early to Late Pandemic % Change | Total Study Period % Change |
|---|---|---|---|
| **Total** | 12% | 29% | 44% |
| **Gender** | | | |
| Female | 17% | 38% | 62% |
| Male | 10% | 27% | 40% |
| **Age Group** | | | |
| 20–24 | 43% | 56% | 123% |
| 25–29 | 19% | 34% | 59% |
| 30–34 | 8% | 27% | 37% |
| 35–39 | 4% | 22% | 27% |
| 40–44 | 5% | 21% | 26% |
| 45–49 | 3% | 22% | 26% |
| 50 and older | 7% | 16% | 25% |
| **Race** | | | |
| White | 11% | 31% | 46% |
| Black | 10% | 25% | 38% |
| Asian/Pacific Islander | 14% | 26% | 43% |
| American Indian/Alaska Native | 17% | 39% | 63% |
| Other | 15% | 26% | 44% |
| **Rank** | | | |
| Junior Enlisted (E1-E4) | 27% | 46% | 86% |
| Senior Enlisted (E5+) | 6% | 22% | 29% |
| Junior Officer (O1-O4) | 9% | 27% | 38% |
| Senior Officer (O5+) | 5% | 16% | 21% |
| Other | 38% | 55% | 113% |
| **Occupation** | | | |
| Pilots/Navigators | 8% | 21% | 31% |
| Aircrew | 8% | 23% | 33% |
| Other | 12% | 30% | 45% |
| Missing | 38% | 51% | 108% |

Note: Table results does not include those in the "under 20 years" age group due to cell counts of 10 or fewer and to protect the anonymity of USAF Airmen

an increasing trend of BMI among U.S. active-duty military personnel. The prevalence of the USAF cohort with obesity during the late pandemic period (26.9%) is lower than that of the Navy cohort (29.1%), but higher than that of the Army (23.2%) and Marine Corps (12.6%) cohorts [2, 3]. This represented a 44% increase in personnel with obesity among the Air Force cohort, an increase of 27% among the Army cohort, and increase of 16.5% among the Navy cohort, and an increase of 51% among the Marine Corps cohort [2, 3]. These studies taken together indicate significant increases in BMI across all U.S. military service branches. Additionally, these increases in USAF personnel with obesity among each of the cohorts are higher than the increase in individuals with obesity among the U.S. general population in 2020 (3%) [11].

Across the U.S. Army, Navy, Marine Corps, and Air Force cohorts, junior enlisted and female service members experienced the highest increases in BMI. The junior enlisted population is generally required to live in military dormitory housing and is to a greater extent dependent on base facilities, i.e., fitness and dining facilities that were affected by the public health protection measures, which may have facilitated a disproportionate increase in obesity [12]. In the U.S. general population there is no reported significant difference in the prevalence of individuals with obesity between men and women, though the age-adjusted prevalence of individuals with severe obesity was higher among women [13].

While previous studies of the U.S. Army, Navy, and Marine Corps have examined trends in obesity using two time periods, prior to and during the COVID-19 pandemic, this study further refined those time periods to reflect changes that occurred during the pandemic and the lifting of public health protection measures that limited movement, which for active-duty U.S. service members included disruption in access to dining and fitness facilities. The addition of the late pandemic period allowed us to examine any changes in BMI trends as these facilities reopened. Our findings suggest that these public health protection measures are only contributing factors to an overall trend of increased BMI among USAF personnel, as the prevalence of personnel with obesity among the USAF cohort increased only 2.1% from the pre-pandemic to the early pandemic period and an additional 6.1% from the early to late pandemic periods. Studies among the U.S. general population indicate that potential risk factors associated with weight gain during the pandemic include having a pre-pandemic BMI of overweight or obese, psychological distress, solitary drinking, use of meal delivery services, and increased online leisure time [14, 15]. One study of COVID-19 pandemic weight gain among U.S. Navy personnel found that participants perceived the COVID-19 pandemic as heightening their stress and that it interfered with their engagement in health and fitness behaviors, such as healthy eating and exercise, with the authors concluding that it is possible this perceived pandemic stress may have interfered with their ability to manage their weight [16].

Our analysis also compared trends in BMI by occupation within the Air Force cohort, as aircrew have more stringent accession and currency standards compared to those of the general USAF population. All acute or chronic conditions are assessed in context of continued flying status with determination made on need for a flying waiver. Additionally, aircrew have physical requirements that exceed those of other AFSCs (Air Force Specialty Code), including aircraft egress training, land and water-based survival, aeromedical evacuation duties, and physiologic requirements [17]. Our analysis indicates that while USAF personnel with obesity increased among

the entire USAF cohort, the percent change of personnel with obesity among pilots/navigators and other aircrew was lower than that of the general USAF active-duty population. While this does reflect the more stringent standards that aircrew are subject to, given the demands of these military aviation AFSCs the increased prevalence of personnel with obesity could result in a decrease in aircrew eligible personnel.

As previously discussed in Janvrin et al. [3] there has been concern about the validity of BMI as a measure to assess the impact of overweight and obesity within a military population as it is thought that using BMI may result in an overrepresentation of obesity due to an expected higher level of musculature among service members as a result of their occupation [18, 19]. However, the literature indicates that BMI is actually more likely to underreport overweight and obesity among service members, with one study concluding that although Army soldiers with overweight and obesity had additional lean body mass, it was accompanied by a disproportionate increase in additional body fat [20]. Another study found that standard cutoffs for obesity significantly underestimated excess body fat among both active-duty and retired U.S. Navy Sailors [21]. This notion can result in delays in medically necessary care; Clutter et al. found that only a fraction of service members that meet prediabetes screening criteria by BMI are being screened [22]. Because of this, our analysis of obesity and overweight among USAF personnel in our cohort may actually underestimate true prevalence rather than overestimate it [3, 18, 19]. However, it is important to note that BMI does not directly assess body fat, and it is ultimately excess body fat that negatively impacts health, fitness, and readiness.

This study has several limitations. As a retrospective cohort study, this study is unable to demonstrate causality. This study is a study of BMI changes and does not take additional body composition measurements into consideration, such as waist circumference, skinfold measures, or body fat percentage. This can lead to misclassification of overly muscular individuals. It is also possible that during the COVID-19 pandemic some service members may have either gained or maintained more muscle mass due to reduced aerobic fitness demands, which our analysis would be unable to capture [23, 24]. We also acknowledge that there are additional weight factors that affect weight changes, including, but not limited to, lifestyle, physical activity, dietary changes, but we are unable to assess these factors using health care claims data. Additionally, USAF personnel included in our study needed to have a BMI measure from each period in order to be included. Because of this, individuals without an MHS encounter would not be captured, however, all active-duty service members are required to receive an annual physical so the impact of this on our study results should be limited. The MDR data used in this study may not be a representative medical history and is limited in its ability to indicate potential medical causes for weight gain outside of pregnancy. Our analysis also did not consider injury status, which could result in weight gain. Despite these limitations, this study is a large representative cohort of USAF personnel.

## Conclusions

Our analysis indicates that, like the other service branches of the U.S. military, the Air Force experienced an increase in rates of personnel with obesity among its active-duty personnel over the COVID-19 pandemic period. Unlike previous studies, this study was able to assess three time periods to get a better understanding of overall trends of BMI prior to and during the COVID-19 pandemic period. This indicates increases in service members with obesity across the U.S. armed forces, which is likely to result in decreased fitness and force readiness. Stratified analysis by aircrew occupation demonstrated a reduced progression to a BMI of obese suggesting a protective effect related to a more stringent entrance requirements and/or physically rigorous Air Force specialty. Interventions promoting healthy lifestyles among military personnel, with emphasis on nutrition education, exercise, sleep, and stress management are needed [2, 3].

### Abbreviations

| | |
|---|---|
| AFSC | Air Force Specialty Code |
| AI/AN | American Indian/Alaskan Native |
| BMI | Body Mass Index |
| CDC | Centers for Disease Control and Prevention |
| CONSORT | Consolidated Standards of Reporting Trials |
| DoD | United States Department of Defense |
| MHS | Military Health System |
| MDR | Military Health System Data Repository |
| MTF | Military treatment facility |
| PI | Pacific Islander |
| U.S. | United States |
| USAF | United States Air Force |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-21808-2.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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None.

### Author contributions

Authors JM, AB, and TPK conceived and designed the study. AB acquired and analyzed the data. JM, AB, MLJ, and TPK interpreted the data and drafted the manuscript. All authors critically reviewed and revised the manuscript and approved of its submission.

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**Data availability**
The data that support the findings of this study are available from the United States Defense Health Agency. Restrictions apply to the availability of these data, which were used under Federal Data User Agreements for the current study, and so are not publicly available.

## Declarations

**Ethics approval and consent to participate**
All experimental protocols related to this study were approved by the Uniformed Services University of the Health Sciences Institutional Review Board. All methods were carried out in accordance with the relevant guidelines and regulations. Informed consent was waived for this study by the Uniformed Services University of the Health Sciences Institutional Review Board.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

**Disclaimer**
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