Trends in Metabolic Disorder in U.S. Army Aviators, 2016–2018

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INTRODUCTION:	Recent epidemiological studies of U.S. Army aviators have suggested higher than anticipated rates of hyperlipidemia and metabolic disorder. The goal of this study was to determine whether this finding has persisted in 2016–2018 and to subsequently determine whether this trend is genuine and warrants further evaluation.
METHODS:	Data were requested from the U.S. Army Aeromedical Electronic Resource Office (AERO) and retrieved from the publicly available Defense Medical Surveillance System (DMSS) utilizing similar inclusion/exclusion criteria, where possible, as the earlier studies. For each year 2016–2018, incidence rates (per 1000 person years) for hyperlipidemia and metabolic syndrome were retrieved from DMSS, while percentages of aviators with these conditions were retrieved from AERO. The DMSS incidence rates were also age stratified. No formal analyses were conducted.
RESULTS:	Results from DMSS showed overall rates of hyperlipidemia ranging from 3.18 to 6.83 per 1000 person-years and for metabolic syndrome from 0.16 to 0.69 per 1000 person-years. The age stratified rates increased proportionally with age. AERO data showed a range of 0.8–1.5% of aviators had hyperlipidemia and for metabolic syndrome this ranged from 0.31 to 0.45%. These rates are broadly comparable to the previous studies' findings.
DISCUSSION:	This study's findings suggest no continued increase in hyperlipidemia or metabolic disorder in aviators. While the exact cause is unknown, one could speculate a number of sources such as preferences in testing or encouragement from specific commanders or flight surgeons.
KEYWORDS :	aircrew, aviator, medical diagnoses, epidemiology.

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wo recent, independent studies have analyzed data from two separate sources of U.S. Army aviators' medical and health information and point to an increased rate of hyperlipidemia and metabolic syndrome in rotary wing/tiltrotor pilots. Metabolic syndrome is defined in U.S. Army aeromedical policy as having three or more of the following: raised blood pressure, elevated fasting blood sugar, low serum high density lipoprotein cholesterol, raised serum triglycerides, or truncal obesity.⁴

The first study⁶ was completed in response to the reporting requests of Section 750 (Study on Health of Helicopter and Tiltrotor Pilots) of the Conference Report to accompany S. 2943, Fiscal Year 2017 National Defense Authorization Act. A task force was formed, consisting of representatives from aeromedical research organizations and the Armed Forces Health Surveillance Branch, to assess potential links between the operation of helicopter and tiltrotor aircraft and acute and chronic medical conditions experienced by such pilots. A three-phase strategy was formulated: Phase I involved a review of the published

literature of the potential health effects of piloting helicopter or tiltrotor aircraft (led by the U.S. Army Aeromedical Research Laboratory); Phase II consisted of an epidemiological study to compare the health of career helicopter pilots and tiltrotor pilots to a suitable control population (led by the Armed Forces Health Surveillance Branch); and Phase III integrated the results of the epidemiology study and literature review and formulated conclusions and recommendations.

The Phase II epidemiological study was of a retrospective cohort design and examined health data from the Defense Medical Surveillance System (DMSS) on an "exposed group"

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(helicopter and tiltrotor pilots, minimum of 1000 flying hours) compared to two "non-exposed" groups (nonpilot maintenance officers and fixed wing pilots). Maintenance officers were selected due to the expected similarity of demographic and exposure characteristics as the exposed cohort, with the exception of being pilots. However, it was expanded to include signals, intelligence, transportation, automotive maintenance, and quartermaster corps officers due to the dearth of nonpilot maintenance officers in the Army. The cohort was identified by using selected primary military occupation specialty (PMOS) codes from DMSS. The second "non-exposed" cohort of fixed wing pilots was selected due to the similar potential reporting bias and health status as the exposed group and was also identified using specific PMOS codes. All exposed and unexposed groups were restricted to active duty personnel who were less than 40 yr of age at the time of entry into the cohort and had served any time between January 1998 and December 2015. Subjects were followed from entry into the cohort of interest until they left service, left the active component, had an incident diagnosis for the condition of interest, or December 31, 2017 (whichever came first). Those who had a condition of interest diagnosed prior to entering a cohort were excluded.

Using specified ICD-9 codes, 31 acute and chronic medical conditions were selected for evaluation based on data on the top 10 diagnoses, top 10 medical reasons for waivers, conditions resulting in permanent grounding among helicopter pilots (from the second study referenced in this paper), and from literature reviews. These included musculo-skeletal injuries, mental health conditions, metabolic conditions, and respiratory outcomes. Each outcome was analyzed separately and person-time was calculated as the time of entry into a cohort to a censoring event. For all 31 health outcomes incidence rates (per 1000 person-years) were generated for each of the exposed and unexposed cohorts. Incidence rate ratios (IRRs) were also calculated to compare the exposed cohort to each of the unexposed groups. Poisson regression analysis was used to calculate adjusted IRRs and corresponding 95% confidence intervals.

The main headline findings were that highly screened and monitored military helicopter pilots had a lower risk of 25 out of the 31 outcomes investigated compared to nonpilot officers (e.g., 11% less likely to have hearing loss and 86% less likely to have a major depressive disorder) and there was no difference in risk for 5 outcomes. When compared to the fixed wing cohort, helicopter/tiltrotor pilots had a similar risk for 26 (out of 30) outcomes, a lower risk of allergic rhinitis, and a 26% higher risk of low back pain. Furthermore, two health outcomes were of particular interest and pertinence to this paper. Firstly, the exposed group had a statistically significant higher risk of metabolic syndrome (adjusted IRR 5.71) compared to nonpilot officers. Secondly, the exposed cohort had a 21% increased risk of hyperlipidemia and over seven times the risk of metabolic syndrome compared to the fixed wing cohort. The results of interest are summarized in Table I.

On the basis of these results, the study concluded that there was an apparent excess risk of metabolic syndrome and hyperlipidemia in the helicopter/tiltrotor cohort, mirroring results from an independent second study (outlined below). However, it was suggested that this excess risk was a spurious finding and may represent detection bias due to increased screening for these conditions during the study period or might be associated with one service over another, i.e., heightened screening in Army aviation only. Specifically, the paper commented as follows: "One factor that could dominate the analysis is a dramatically heightened search within Army aviation for cardiac risk factors, including elevated serum lipids, body weight, etc., that apparently occurred during the study period [Personal communication, J. McGhee, May 2018]. As U.S. Army helicopter pilots comprise 75% of the exposed cohort, an aggressive Army policy to discover and diagnose elements of metabolic syndrome could affect the results of the analysis. This enhanced detection due to increased screening is a well-known source of error in epidemiological studies." Nonetheless, a recommendation was made to investigate these findings further and determine if helicopter and tiltrotor pilots are truly at a higher risk of metabolic syndrome and hyperlipidemia or if these findings are the result of increased screening.

The second study,² a retrospective epidemiological review undertaken by the U.S. Army Aeromedical Research Laboratory, examined 10 yr of health data (June 2005 through June 2015) using the U.S. Army Aeromedical Electronic Resource Office (AERO), a system of computerized management of aviator medical records, managed by the U.S. Army Aeromedical Activity (USAAMA) at Fort Rucker, AL. AERO was interrogated in order to determine the most prevalent conditions in U.S. Army aviators (active duty, National Guard, and Reservists) and associations between these diagnoses and granting of aeromedical waivers or permanent suspension. The retrieved data were examined in terms of raw ICD-9 diagnostic codes allowing identification of the 10 most prevalent conditions. The top five were lumbago (4.7% of aviators), hypertension (4.4%), hearing loss (4.0%), and, of interest to this paper, hyperlipidemia (3.9%) and metabolic syndrome (3.4%).

In addition to specific clinical diagnoses, a further variable was created by grouping the ICD-9 codes into 23 systems-based categories, two of which are pertinent to this paper: disorder of blood fats and metabolic disorder. Analysis of the data revealed that hyperlipidemia was the fourth most prevalent diagnosis overall and the fifth most common condition concurrent to a waiver. Additionally, metabolic disease featured in the top 10 diagnostic categories concurrent to a waiver (3.8% of aviators) or permanent suspension (3.6% of aviators). However, it was not possible to determine from AERO whether the hyperlipidemia or metabolic syndrome diagnosis was the reason for the waiver/suspension or purely a concurrent issue to a separate waiving/suspending medical problem. The fact that U.S. Army aeromedical policy,^{4,5} at the time, did not necessarily require a waiver for either of these conditions makes it highly improbable that these were the waiving/suspending conditions in themselves.

In summary, both these retrospective epidemiological studies suggest that hyperlipidemia and metabolic disease are prevalent diagnoses in military rotary wing pilots, despite the fact that they looked at two slightly different populations and drew

				95%	Cls
OUTCOME	EXPOSED GROUP (INCIDENCE RATE)	NONPILOT OFFICERS (INCIDENCE RATE)	ADJUSTED IRR	LOWER	UPPER
Metabolic Syndrome	0.43	0.09	5.71	2.89	11.28
				95%	Cls
	EXPOSED GROUP (INCIDENCE RATE)	FIXED WING PILOTS (INCIDENCE RATE)	ADJUSTED IRR	LOWER	UPPER
Metabolic Syndrome	0.43	0.02	7.46	1.73	32.20
Hyperlipidemia	4.05	3.24	1.21	1.02	1.44

Table I. Incidence Rates for Metabolic Syndrome and Hyperlipidemia in Helicopter/Tiltrotor Pilots, Non-Pilot Officers, and Fixed Wing Pilots.

data from two different, yet not entirely independent, sources. Additionally, it appears that these diagnoses are a common coexisting condition to a medical waiver or suspension and could be related to factors limiting the operationally available aviator pool.

In line with the recommendations made in the first study, the purpose of this follow-on work was to evaluate whether these higher than anticipated reported rates in hyperlipidemia and metabolic disorder in rotary wing aviators has continued beyond 2015 and whether it requires further evaluation and attention in the military aviation/aeromedical community, such as changes to policy or health protection strategies.

METHODS

Prior to beginning this study, it was reviewed and approved by the U.S. Army Aeromedical Research Laboratory's Regulatory Compliance Office. Data were retrieved from both the DMSS and AERO databases in order to provide some parity on data collection and analysis with the previous studies and allow meaningful comparisons between the data sets. Using DMSS, the search criteria attempted to mirror those of the first study as closely as possible, namely active duty personnel only with the same PMOS code [0203 (helicopter pilots)], under 40 yr of age, and only including the first encounter for each condition. Limiting the search to those with a minimum of 1000 flight hours was not possible as this information was not available. Additionally, data from nonpilots or fixed wing pilots was not included as the required comparator was aviator data from the previous two studies. Only data from 2016 through 2018 were sought, using the appropriate ICD-10 codes [E78.2 (mixed hyperlipidemia); E78.4 (other hyperlipidemia); E78.5 (hyperlipidemia; unspecified); E88.81 (metabolic syndrome)] in order to understand any more recent trends in these conditions of interest.

The AERO search, which included active duty, National Guard, and Reserve personnel, was conducted at the USAAMA using the same ICD-10 codes, but was unable to limit the search to only those under 40 yr of age or with more than 1000 flight hours due to resource constraints. Nonetheless, the search criteria closely mirrored those used in the previous study of AERO data.

For each year 2016–2018, incidence rates (per 1000 personyears) for hyperlipidemia and metabolic syndrome were retrieved from DMSS, while percentages of aviators with these conditions were retrieved from AERO, in line with the previous studies. Additionally, to allow some more in-depth analysis, the DMSS incidence rates were age stratified, although this was not possible with AERO and was not done with the previous studies. No formal analyses were conducted.

RESULTS

Overall, rates were fairly low from both sources. The DMSS and AERO data are summarized in **Table II**. In order to provide a cursory estimate of rates in aviators against those of nonaviators, USAAMA undertook an age-stratified search for rates of hyperlipidemia and metabolic syndrome combined in helicopter pilots against ground/naval arms and psychologists, covering 2016 and 2017. Although not a direct comparator in terms of data search criteria, it showed that helicopter pilots have no worse rates for these conditions compared to the other two PMOS codes.

Table II.	Overall and Age-Stratified Yearly Inc	idence Rates for Hyperlipidemia
and Meta	abolic Syndrome by Data Source.	

DATA SOURCE & YEAR	AGE RANGE	HYPERLIPIDEMIA	METABOLIC SYNDROME
DMSS; 2016	<20	0	0
	20-24	0	0
	25-29	1.29	0
	30-34	6.11	0
	35-39	13.91	0.52
	Overall	6.83	0.16
AERO	Overall	0.97 [†]	0.45 [†]
DMSS; 2017	<20	0	0
	20-24	0	0
	25-29	1.36	0
	30-34	2.60	0.52
	35-39	10.07	1.59
	Overall	4.47	0.69
AERO	Overall	0.80 [†]	0.31 ⁺
DMSS; 2018	<20	0	0
	20-24	0	0
	25-29	0	0
	30-34	3.94*	0
	35-39	5.75*	0.52*
	Overall	3.18*	0.17*
AERO	Overall	1.50 ⁺	0.35 ⁺

* DMSS was unable to provide total aviator numbers for 2018 so the denominator used to calculate incidence rates was an average of the 2016 and 2017 aviator numbers. This was deemed an appropriate approximation when the absolute counts for these conditions were small.

[†] AERO was only able to provide absolute counts for each of these conditions.

Percentages were calculated using the total number of flight physicals on AERO, for each year, as the denominator.

DISCUSSION

Previous reports have suggested higher than anticipated rates in hyperlipidemia and metabolic disorder in U.S. Army aviators, particularly when compared with fixed wing pilots or nonpilot officers. This raised the question of whether there was something specific in the helicopter pilot community that needed further analysis to determine if this was an ongoing phenomenon or an increasing trend. The first study suggested that the apparent uptick in cases may reflect an information bias, specifically increased screening by the aeromedical community during the study period. Discussions with USAAMA revealed that, although there was no formal aeromedical policy change during these periods, there was a USAAMA-directed push to increase screening for these conditions around 2007–2008. This may well account for the trends observed.

The findings from this study do not support a continued or increasing trend in the years 2016–2018. Although the DMSS figures suggest an uptick in the incidence of hyperlipidemia in 2016, this observation does not continue into 2017 and 2018. In fact, the figures trend downwards below that seen in the first study, albeit the differences are marginal. Similarly, as can be seen in Table II, the overall DMSS rates of metabolic syndrome are lower in 2016 and 2018 than that observed in the first study, with a marginal increase in 2017.

However, the DMSS and AERO data for this study includes aviators with less than 1000 flying hours, so will invariably capture more young individuals who have a lower likelihood of having either of these conditions and who have had less occupational exposure, an association that the initial study was designed to assess. Whether this erroneously reduces the apparent rates for 2016–2018 by inflating the denominator or should have captured more cases and raised the rates is open to conjecture. Nonetheless, the overall figures show rates that are comparable to those expected from a general U.S. population as well as those associated with normal aging.^{1,3}

When considering the AERO figures, they illustrate that the rates for both hyperlipidemia and metabolic syndrome, from 2016 through 2018, are lower than that reported in the second study (2005–2015), particularly for metabolic syndrome. As neither of these data sets excluded individuals based on flight hours or age, they could be considered more comparable than the DMSS data sets and would tend to verify the assertion that there is no continuing trend of concern for these conditions in helicopter pilots.

This study is limited in that it assumes the databases to be accurate and that there has been no miscoding of data when entered into DMSS or AERO. Furthermore, AERO is unable to distinguish between Army helicopter and fixed wing aviators and many helicopter pilots transition to fixed wing during their flying careers, making a distinction between the two on health grounds more challenging. A further limitation is that the search criteria for this study did not fully match those from the previous reports. The lack of flight hours information in DMSS and AERO did not allow those with less than 1000 h to be excluded and this may have skewed the figures either up or down. It is also acknowledged that the DMSS incidence rates for 2018 are an approximation based on a reasonable estimate of the denominator (mean of 2016 and 2017 aviator numbers). However, as the absolute counts are not large this was deemed acceptable.

In conclusion, the results of this brief review of recent hyperlipidemia and metabolic disorder rates do not suggest that rotary wing pilots are at increased risk for developing dyslipidemia compared to the other military occupations cited in this paper, the U.S. Armed Forces more generally,⁷ or the wider civilian population, and that further evaluation or exploration by the aeromedical community is not necessary.

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