DEPARTMENT OF THE AIR FORCE
711TH HUMAN PERFORMANCE WING (AFMC)
WRIGHT-PATTERSON AFB OHIO

27 Jan 2025

MEMORANDUM FOR AFGSC/SG

FROM: Epidemiology Consult Service Division
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SUBJECT: Missile Community Cancer Study Epidemiology Investigation Phase 1C Brief Report

SUMMARY:

An analysis of cancer mortality in the missile community (MC) did not identify statistically elevated mortality in the MC compared to the general U.S. population. Deaths in the MC from overall cancer, as well as non-Hodgkin lymphoma, lung and bronchus, prostate, and colon and rectum cancers were lower in the MC as compared to the general U.S. population. Furthermore, Phase 1C did not identify a statistically significant elevated mortality for non-Hodgkin Lymphoma nor any of the 13 other individual cancers in the missile community (MC) as compared to the non-missile community (non-MC). Those in the MC were less likely to die from lung and bronchus cancer, prostate cancer, and cancer overall as compared to the non-MC.

1. INTRODUCTION:

a. *Background:* The Phase 1C Brief Report builds upon knowledge from the Missile Community Cancer Study (MCCS) Epidemiology Study Brief Report dated 28 February 2024 (Phase 1A) and the MCCS Epidemiology Investigation Initial (Phase 1B) Results dated 12 September 2024. Therefore, please refer back to these documents for a comprehensive review of the background and purpose. This memorandum provides results from Phase 1C of the study using mortality rates derived from the National Death Index (NDI) – the comprehensive mortality database for the U.S.

b. *Study Personnel:*

(1) Lt Col Keith T. Beam, MD, MPH, Chief Preventive Medicine Consultant, USAFSAM/PHRR
(2) Mr. Gregory Wolff, MPH, Senior Epidemiologist, USAFSAM/PHR
(3) Mrs. Sarah Fryman-Wynkoop, MPH, CPH, Epidemiologist, USAFSAM/PHRR
(4) Mrs. Stefani Ruiz, MHS, Epidemiologist, USAFSAM/PHRR
(5) Mr. James Escobar, MPH, Biostatistician/Data Manager, USAFSAM/PHRR
(6) Ms. Alisa Simon, DrPH, MPH, Biostatistician/Data Manager, USAFSAM/PHRR
(7) Maj Amber F. Britt, DrPH, MPH, CPH, Chief Surveillance & Research Support Branch, USAFSAM/PHRR

2. METHODOLOGY:

a. *Parameters:*

(1) This portion of the multi-phased MCCS describes the cancer mortality in the missile community (MC) and compares it to the non-missile community (non-MC) and U.S. general population. A retrospective cohort study was employed to identify Active Duty (AD) Department of the Air Force (DAF) personnel with accession dates from 1 January 1976 - 31 December 2010. Ascertainment of cancer cases continued through 31 December 2020 allowing for a minimum 10-year follow-up period.

(2) This study was conducted as an occupational assessment of the MC to identify cancer deaths in this population and not to test a specific research hypothesis; therefore, the 711th Human Performance Wing Institutional Review Board (IRB) determined this effort to be non-human subjects research/public health practice (Protocol #FWR20240053N).

b. *Case Definition*:

(1) Cases of cancer mortality were defined according to the Surveillance, Epidemiology, and End Results (SEER) Program using the cause of death recode from 1969 and beyond (https://seer.cancer.gov/codrecode/1969_d03012018/index.html).

c. *Exclusion Criteria—these individuals were removed from all study analysis:*

(1) Individuals who had a cancer diagnosis preceding military service were excluded from the study cohort.

(2) Individuals with less than one year of military service were excluded from the study cohort. Standard occupational cancer incidence studies generally require a minimum of one year of exposure time.

(3) Air Force Personnel Center (AFPC) records younger than 17 (the minimum age for AD service) or older than 62 (the mandatory retirement age) were removed from the cohort, as these were likely transcription errors.

d. *Exposures:*

(1) Exposure Data: The cohort was identified from the AFPC database and included all AD DAF Service Members (SM) serving from 1 January 1976 - 31 December 2010. Each person was categorized by exposure status as defined by Duty Air Force Specialty Codes (DAFSC). These codes include but are not limited to missile operations officers, missile mechanics, missile systems security specialists (security forces), missile site cooks, and missile facility managers. The MC members were classified as exposed whereas the non-MC comprised the unexposed comparison group.

(2) Exposures in the MC were further sub-categorized into more specific missile-related exposure groups: Launch Control Center (LCC), Missile Alert Facility (MAF), Launch Facility (LF) Underground, or Topside based on the SM ever having a corresponding DAFSC associated with these groups. The LCC is an underground capsule made of thick concrete and steel which uses giant shock isolators to protect the crew and sensitive electronics from nuclear attack. The MAF is a building above ground with a kitchen and sleeping quarters where missileers not on alert and other support personnel live while performing duties. The LF is the fenced-in secured area that sits on top

of the underground missile silo. The LF topside is the area above ground, whereas the LF underground is the location where the missile is housed and maintained. The exposure groups were not mutually exclusive, i.e., an individual could have had exposures in two or more exposure groups.

(3) AD DAF SM who never had any of the DAFSC codes that comprised the four missile exposure groups were categorized into the non-missile comparison group. SM could be categorized into more than one missile exposure group but could not be categorized into a missile exposure group and the non-missile exposure group.

(4) Cohort demographics (date of birth, sex, race, and rank) were derived from the AFPC database. Records missing any of these demographics were removed from analysis. Cohort data were merged with NDI data. For both cases and non-cases, an individual's demographic information from their last AFPC record was retained for final analysis.

e. *Data sources*:

(1) The National Cancer Institute's SEER data: Civilian case counts for each of the 14 cancer types and person-time denominators for each of the demographic buckets (age, race, sex, and year of death) from 1979-2020 were queried using the SEER*Stat software.

(2) NDI: A date of death variable was added to the cohort dataset from the Defense Suicide Prevention Office. This variable was used to help identify censorship dates if the death occurred through 31 December 2020. A person is censored at death, and they no longer contribute person-time at risk in the denominator. Mortality data were available from 1979-2020.

f. *Analysis Plan*:

(1) Internal Comparison: Cancer deaths in the MC were compared to the non-MC using a Poisson regression model to calculate mortality rate ratios (MRR). This modeled the relationship between exposure and mortality risk as a function of person-time. The 95% confidence intervals were calculated using the profile likelihood option, as this method provides more accurate interval estimates for parameters commonly encountered with Poisson-distributed data. The model controlled for relevant covariates (e.g., age, sex, race, rank) to isolate the exposure effect on mortality risk.

(2) External Comparison: Standardized mortality ratios (SMR) adjusted for age, sex, race, and year of death were generated for the MC as compared to the U.S. general population for each of the 14 individual cancers and the overall cancer mortality for the 14 cancers.

(3) For both the internal and external comparisons, the denominator was person-years. Person-time at risk began at the date of the first AFPC record when individuals entered the cohort and ended on the date of death, if the person died during the study time frame period, or the end of the study period, 31 December 2020.

(4) All data were managed and analyzed in SAS 9.4 and SAS Enterprise Guide 7.1 (Cary, NC).

4. RESULTS:

a. **Table 1.** The study included 64,930 individuals who served in the MC and 1,757,255 individuals who served in the non-MC, creating a total cohort of 1,822,184 individuals. Males accounted for 92.92% of the MC, compared to 84.10% of the non-MC. Age was calculated at death for the deceased, or at the end of the study period (31 December 2020) for those not deceased. Age distribution was found to be similar between both groups.

Officers made up 11.09% of the MC, compared to 12.50% of the non-MC. Most individuals in the cohort were white, with 84.41% in the MC and 80.25% in the non-MC. The second largest racial group was black, with 11.68% in the MC and 13.93% in the non-MC. See Table 1 below for additional demographic details.

Table 1. Characteristics of missile community and non-missile community by demographics [count (column %)] from 1 January 1976 – 31 December 2020

	Missile Community	Non-missile Community	Total
Total	64,930*	1,757,255*	1,822,184
Sex			
Male	60,330 (92.92)	1,477,929 (84.10)	1,538,258 (84.42)
Female	4,600 (7.08)	279,326 (15.90)	283,926 (15.58)
Age ŦŦ			
17-19	229 (0.35)	15,238 (0.87)	15,467 (0.85)
20-24	10,513 (16.19)	282,124 (16.05)	292,637 (16.06)
25-29	5,328 (8.21)	161,812 (9.21)	167,140 (9.17)
30-34	3,460 (5.33)	135,807 (7.73)	139,267 (7.64)
35-39	4,312 (6.64)	141,705 (8.06)	146,017 (8.01)
40-44	4,264 (6.57)	125,183 (7.12)	129,447 (7.10)
45-49	4,623 (7.12)	116,192 (6.61)	120,815 (6.63)
50-54	5,683 (8.75)	138,355 (7.87)	144,037 (7.90)
55-59	8,085 (12.45)	174,571 (9.93)	182,656 (10.02)
60-64	7,654 (11.79)	169,155 (9.63)	176,809 (9.70)
65-69	5,232 (8.06)	115,817 (6.59)	121,049 (6.64)
70-74	3,047 (4.69)	80,496 (4.58)	83,543 (4.58)
75-79	1,691 (2.60)	55,074 (3.13)	56,765 (3.12)
80-84	657 (1.01)	32,949 (1.88)	33,606 (1.84)
85+	152 (0.23)	12,777 (0.73)	12,929 (0.71)
Rank			
Officer	7,202 (11.09)	219,708 (12.50)	226,910 (12.45)
Enlisted	57,728 (88.91)	1,537,546 (87.50)	1,595,274 (87.55)
Race			
White	54,806 (84.41)	1,410,271 (80.25)	1,465,076 (80.40)
Black	7,582 (11.68)	244,872 (13.93)	252,454 (13.85)
Other	2,542 (3.91)	102,112 (5.81)	104,654 (5.74)
Avg Person-time	32.29	32.06	32.07

* Individuals were excluded from analysis if they did not have at least 1 year in service. Unique individuals only.

ŦŦAge is either age at death for cancer deaths or age at end of study time period for those not deceased (31 December 2020).

b. **Table 2.** A total of 37,100 cancer deaths were recorded during the study period, with 1,145 (3.09%) in the MC and 35,955 (96.91%) in the non-MC (Table 2). The proportion of male cancer deaths was higher in the MC (97.29%) compared to the non-MC (91.37%), consistent with the demographic predominance of males in the MC.

Table 2. Cancer deaths among missile and non-missile communities by demographics [count (column %)], 1 January 1979 – 31 December 2020

	Missile Community Deaths	Non-Missile Community Deaths	Total
Total	1,145 (3.09%)	35,955 (96.91%)	37,100
Sex			
Male	1,114 (97.29%)	32,852 (91.37%)	33,966 (91.55%)
Female	31 (2.71%)	3,103 (8.63%)	3,143 (8.47%)
Age at death			
17-19	0 (0.00%)	0 (0.00%)	0 (0.00%)
20-24	2 (0.17%)	96 (0.27%)	98 (0.26%)
25-29	7 (0.61%)	265 (0.74%)	272 (0.73%)
30-34	22 (1.92%)	438 (1.22%)	460 (1.24%)
35-39	34 (2.97%)	798 (2.22%)	832 (2.24%)
40-44	58 (5.07%)	1,318 (3.67%)	1,376 (3.71%)
45-49	102 (8.91%)	2,582 (7.18%)	2,684 (7.23%)
50-54	145 (12.66%)	4,038 (11.23%)	4,183 (11.27%)
55-59	195 (17.03%)	5,563 (15.47%)	5,758 (15.52%)
60-64	199 (17.38%)	5,939 (16.52%)	6,138 (16.54%)
65-69	161 (14.06%)	5,348 (14.87%)	5,509 (14.85%)
70-74	111 (9.69%)	4,299 (11.96%)	4,410 (11.89%)
75-79	76 (6.64%)	3,196 (8.89%)	3,272 (8.82%)
80-84	26 (2.27%)	1,529 (4.25%)	1,555 (4.19%)
85+	7 (0.61%)	546 (1.52%)	553 (1.49%)
Rank			
Officer	163 (14.24%)	5,712 (15.89%)	5,875 (15.84%)
Enlisted	982 (85.76%)	30,243 (84.11%)	31,225 (84.16%)
Race			
White	1,013 (88.47%)	30,566 (85.01%)	31,579 (85.12%)
Black	118 (10.31%)	4,735 (13.17%)	4,853 (13.08%)
Other	14 (1.22%)	654 (1.82%)	668 (1.80%)

c. **Table 3.** Lung and bronchus cancer was the most common cause of cancer death in both communities, accounting for 36.07% of deaths in the MC and 39.39% in the non-MC (Table 3). This was followed by colon and rectum cancer (MC: 14.41%, non-MC: 13.02%) and pancreatic cancer (MC: 11.97%, non-MC: 10.64%).

Table 3. Cancer deaths [count (column %)] by cancer type and exposure status (missile community versus non-missile community) from 1 January 1979 – 31 December 2020

	Missile Community (N=64,930)	Non-missile Community (N=1,757,254)	Total
Total Cancer Deaths	1,145 (1.76%)	35,955 (2.05%)	37,100
Breast (Male and Female)	17 (1.48%)	1,110 (3.09%)	1,127 (3.04%)
Colon and Rectum	165 (14.41%)	4,680 (13.02%)	4,845 (13.06%)
Hodgkin Lymphoma	9 (0.79%)	222 (0.62%)	231 (0.62%)
Kidney and Renal Pelvis	61 (5.33%)	1707 (4.75%)	1768 (4.77%)
Leukemia	85 (7.42%)	2,294 (6.38%)	2,379 (6.41%)
Lung and Bronchus	413 (36.07%)	14,161 (39.39%)	14,574 (39.28%)
Melanoma of the Skin	69 (6.03%)	1,446 (4.02%)	1,515 (4.08%)
Non-Hodgkin Lymphoma	66 (5.76%)	2,096 (5.83%)	2,162 (5.83%)
Ovarian	5 (0.44%)	236 (0.66%)	241 (0.65%)
Pancreatic	137 (11.97%)	3,824 (10.64%)	3,961 (10.68%)
Prostate	63 (5.5%)	2,671 (7.43%)	2,734 (7.37%)
Testicular	4 (0.35%)	138 (0.38%)	142 (0.38%)
Thyroid	7 (0.61%)	133 (0.37%)	140 (0.38%)
Urinary Bladder	44 (3.84%)	1,237 (3.44%)	1,281 (3.45%)

d. **Table 4.** In the MC, lung and bronchus cancer accounts for the largest number of cancer deaths across all exposure categories (LCC: 34.81%; MAF: 35.01%; LF Topside: 36.86%; LF Underground: 36.04%). Colon and rectum cancer deaths (ranging from 13.28%-15.72%) and pancreatic cancer deaths (ranging from 10.55%-12.92%) were the next most frequent deaths from cancer in each exposure group.

NOTE: Individuals may have been included in multiple exposure locations in Table 4, i.e. the exposures are not mutually exclusive. For example, an individual who dies from cancer could have been included in both the MAF and LCC exposure groups. Therefore, the sum of cancer deaths by row will be higher than Table 3 or Table 5.

Table 4. Cancer deaths among missile community [count (column %)] by exposure group, from 1 January 1979 – 31 December 2020

	Launch Control Center (LCC)* N=30,107	**Missile Alert Facility (MAF)*** N=52,743	**Launch Facility (LF) Topside*** N=47,221	**Launch Facility (LF) Underground*** N=20,680
Total Cancer Deaths	655 (2.16%)	774 (1.46%)	738 (1.56%)	455 (2.20%)
Breast (Male and Female)	10 (1.53%)	10 (1.29%)	6 (0.81%)	6 (1.32%)
Colon and Rectum	87 (13.28%)	114 (14.73%)	116 (15.72%)	69 (15.16%)
Hodgkin Lymphoma	8 (1.22%)	6 (0.78%)	8 (1.08%)	7 (1.54%)
Kidney and Renal Pelvis	31 (4.73%)	44 (5.68%)	39 (5.28%)	18 (3.96%)
Leukemia	53 (8.09%)	56 (7.24%)	55 (7.45%)	41 (9.01%)
Lung and Bronchus	228 (34.81%)	271 (35.01%)	272 (36.86%)	164 (36.04%)
Melanoma of the Skin	45 (6.87%)	51 (6.59%)	44 (5.96%)	30 (6.59%)
Non-Hodgkin Lymphoma	35 (5.34%)	45 (5.81%)	48 (6.5%)	26 (5.71%)
Ovarian	4 (0.61%)	1 (0.13%)	1 (0.14%)	0 (0%)
Pancreatic	79 (12.06%)	100 (12.92%)	84 (11.38%)	48 (10.55%)
Prostate	44 (6.72%)	42 (5.43%)	35 (4.74%)	28 (6.15%)
Testicular	3 (0.46%)	3 (0.39%)	2 (0.27%)	1 (0.22%)
Thyroid	4 (0.61%)	6 (0.78%)	4 (0.54%)	1 (0.22%)
Urinary Bladder	24 (3.66%)	25 (3.23%)	24 (3.25%)	16 (3.52%)

* Categories are not mutually exclusive. Missileers have overlapping exposures.

e. **Table 5** SEER data from 1979-2020 were used to compare the MC to U.S. civilians of the same age, sex, race, year of death categories (Table 5). The MC had a significantly lower overall cancer mortality (SMR = 0.78, 95% CI: 0.74-0.83, $p < 0.001$). Specifically, NHL cancer mortality (SMR = 0.77, 95% CI: 0.59-0.98, $p = 0.03$, lung and bronchus cancer mortality (SMR = 0.68, 95% CI: 0.61-0.74, $p < 0.001$), colon and rectum cancer mortality (SMR = 0.79, 95% CI: 0.67-0.92, $p < 0.001$), and prostate cancer mortality (SMR = 0.65 95% CI: 0.50-0.84, $p < 0.001$) were significantly lower compared to the U.S. general population.

Table 5. Standardized Mortality Ratios (SMRs) by cancer type among the missile community, compared to U.S. civilians using SEER Research database from 1 January 1979 – 31 December 2020

Cancer Type	Observed Deaths	Expected Deaths	SMR	95% CI Lower	95% CI Upper	p-value
All 14 types	**1145**	**1460**	**0.78**	**0.74**	**0.83**	**<0.001**
Male and Female Breast	17	17	1.01	0.59	1.62	1.02
Colon and Rectum	**165**	**209**	**0.79**	**0.67**	**0.92**	**<0.001**
Hodgkin Lymphoma	9	12	0.77	0.35	1.47	0.55
Kidney and Renal Pelvis	61	70	0.87	0.67	1.12	0.31
Leukemia	85	88	0.96	0.77	1.19	0.78
Lung and Bronchus	**413**	**611**	**0.68**	**0.61**	**0.74**	**<0.001**
Melanoma of the Skin	69	55	1.25	0.97	1.58	0.08
Non-Hodgkin Lymphoma	**66**	**86**	**0.77**	**0.59**	**0.98**	**0.03**
Ovarian	5	3	1.48	0.48	3.46	0.50
Pancreatic	137	151	0.91	0.76	1.07	0.28
Prostate	**63**	**96**	**0.65**	**0.50**	**0.84**	**<0.001**
Testicular	7	8	0.86	0.35	1.77	0.86
Thyroid	4	6	0.68	0.19	1.75	0.61
Urinary Bladder	44	48	0.92	0.67	1.24	0.66

* Bolded text indicates significant at alpha level 0.05.

Table 6. A significantly lower overall cancer mortality rate was observed in the MC compared to the non-MC after adjusting for age, race, sex, and rank (MRR = 0.83, 95% CI: 0.78-0.88, p < 0.001). This trend was consistent for both males (MRR = 0.83, 95% CI: 0.78-0.88, p < 0.001) and females (MRR = 0.65, 95% CI: 0.46-0.93, p = 0.02).

Lung and bronchus cancer mortality (MRR = 0.74, 95% CI: 0.67-0.82, p < 0.001) and prostate cancer mortality (MRR = 0.67, 95% CI: 0.52-0.86, p < 0.001) were significantly lower in the MC. No cancer types showed significantly higher mortality rates in the MC compared to the non-MC.

Table 6. Cancer deaths, by type, of missile career field compared to non-missile career field* from 1 January 1979 - 31 December 2020 (MRR = Mortality Rate Ratio) (SE = Standard Error)

Cancer Type	MRR	SE	95% CI, lower	95% CI, upper	p-value
All 14 types (Male and Female)	**0.83**	**1.03**	**0.78**	**0.88**	**< 0.001**
All 12 types (Female)	**0.65**	**1.20**	**0.46**	**0.93**	**0.02**
All 13 types (Male)	**0.83**	**1.03**	**0.78**	**0.88**	**< 0.001**
Breast (Male and Female)	0.86	1.28	0.54	1.39	0.55
Breast (Female)	0.66	1.35	0.36	1.19	0.17
Colon and Rectum	0.90	1.08	0.77	1.05	0.18
Hodgkin Lymphoma	1.15	1.41	0.59	2.24	0.68
Kidney and Renal Pelvis	0.89	1.14	0.69	1.15	0.37
Leukemia	0.94	1.12	0.76	1.17	0.57
Lung and Bronchus	**0.74**	**1.05**	**0.67**	**0.82**	**< 0.001**
Melanoma of the Skin	1.20	1.13	0.94	1.53	0.13
Non-Hodgkin Lymphoma	0.80	1.13	0.63	1.02	0.07
Ovarian (Female)	1.37	1.57	0.56	3.33	0.49
Pancreatic	0.93	1.09	0.79	1.11	0.43
Prostate (Male)	**0.67**	**1.14**	**0.52**	**0.86**	**< 0.001**
Testicular (Male)	1.69	1.47	0.79	3.61	0.18
Thyroid	0.75	1.66	0.28	2.03	0.57
Urinary Bladder	0.93	1.17	0.69	1.26	0.64

* Multiple Poisson regression adjusted for age, race, sex, and rank.
** Bolded text indicates significant at alpha level 0.05.

5. DISCUSSION:

The MCCS is the most comprehensive investigation into cancer mortality rates in the MC. The MC did not have statistically significant increased SMRs when compared to the U.S. civilian population for overall cancer and across 14 of the site-specific cancers that were investigated (Table 5). Although male and female breast, melanoma of the skin, and ovarian cancers do have SMR above 1, they are not statistically significant and therefore, there is no meaningful difference in the rates between these two groups. NHL, lung and bronchus, colon and rectum, prostate, and cancer overall had statistically significantly lower mortality. Colon and rectum cancers have been linked to physical inactivity, being overweight, and inadequate fruit and vegetable consumption in high-income countries. Thus, the lower

mortality rates of these cancers might be reflective of the healthier lifestyles and physical fitness requirements of military service.

When compared to their military peers, the MC had statistically significant lower mortality rate ratios with overall cancer, lung and bronchus, and prostate (Table 6). All other cancers had statistically similar mortality rate ratios for the MC when compared to the non-MC.

6. STRENGTHS & LIMITATIONS:

a. Strengths:

(1) The inclusion of an internal comparison i.e., the non-MC, is a significant strength of this study. This internal comparison uses two military populations that are more similar to each other with regards to fitness standards, overall health, and access to healthcare, and reduces the impact of the healthy soldier effect (HSE).

(2) The inclusion of all members of the MC (including maintainers, security forces, food services, etc.) over the large study timeframe created a comprehensive cohort large enough to ensure adequate statistical power to uncover any association with cancer mortality, should one exist.

(3) Two study epidemiologists performed independent, parallel analysis of the data—starting with the same datasets and then comparing outcomes after coding the statistical software to clean the data. Their analysis yielded similar case counts and results, yielding high internal validity. As such, there is confidence the results are accurate and representative of the true nature of the associations.

(4) USAFSAM consulted with industry experts including epidemiologists and biostatisticians from the University of Cincinnati and Wright State University. Their independent evaluation of the methodology, analysis, result interpretation, and study limitations ensured a robust evaluation that aligned with other occupational study practices.

(5) Utilization of the NDI provides a reliable and thorough source of mortality data. The comprehensive nature of this data source allows for detailed investigation of various cancer types.

b. Limitations:

(1) This is a retrospective cohort study; thus, it is limited to the availability of historical data. Incomplete data in the NDI can lead to missed matches. Death certificates often have classification errors—meaning that they may not report cancer as the cause of death. Furthermore, death certificates are often completed by a third party who did not have a direct clinical relationship with the decedent. Misclassifying can lead to either underestimating or overestimating cancer mortality rates.

(2) The study design precluded the comparison of sub-exposures (LCC, MAF, LF topside, LF underground) to each other because many individuals were in multiple exposure groups.

(3) Additionally, establishing a causal relationship between exposure, such as career field and cancer, was not a realistic goal of this study. This retrospective cohort study was designed to determine if there was a relative difference in cancer mortality between two populations rather than search for causation. Identifying causation for disease conditions with long latency (i.e., conditions that take years to decades to develop after exposure) is next to impossible with descriptive epidemiology. This is due to several factors including the retrospective nature of these studies,

unavailable data about numerous individual lifestyle choices (smoking, alcohol usage, body mass index, diet, etc.) that confound the relationships being evaluated, genetic predisposition to cancer, and non-occupational exposures. The study's retrospective nature also limits an analysis of changes in cancer risk due to advancement in technology, medical care, or changes in exposure levels. Furthermore, time in occupation was not investigated but could be a major influence on cancer development, and any subsequent mortality, should a causal relationship exist.

(4) It is well known that members of the military have better access to care, are generally healthier than civilians, and require more health screenings to complete their jobs. This is known as the HSE. The relationship between the duration of military service and the HSE is complex and varies based on several factors, including the length of service, deployment history, and the individual's overall health status. This analysis does not consider the length of service or attempt to adjust for the HSE.

(5) The nature of the data obtained from AFPC gives an annual "snapshot" of an individual's service that is taken in September of each year. Individuals with < 1 year of service (and thus exposure time) were excluded from the analysis. However, for a large number of individuals with only a single AFPC record, it was unable to be determined if they had served for <12 months or between 12-23 months. While the number of persons excluded was large, the effect on study findings is likely to be minimal as these individuals would have the least amount of exposure to the MC.

(6) Competing risks occur when individuals in a cohort can experience multiple potential outcomes that prevent the occurrence of the primary event of interest—in this case, death from cancer. If an individual dies from an unrelated cause (e.g., a car accident), they can no longer die from cancer, which complicates the interpretation of cancer mortality rates. In other words, it's impossible to know if they would have developed and died from cancer had they not been first afflicted by the motor vehicle accident death. Not accounting for competing risks means that the estimated cancer mortality may be artificially low. This would be the case if the MC died from accidents before cancer became a factor; the observed cancer mortality would not be reflective of the real risk of cancer in the cohort.

7. CONCLUSION:

During Phase 1C, there was no statistically significant elevation in cancer mortality within the MC as compared to the non-MC or general U.S. population. Four cancers (NHL, lung and bronchus, colon and rectum, and prostate) and cancer overall had statistically significantly lower mortality than the general U.S population. For the comparison to the non-MC, the MC had statistically significant lower mortality rate ratios with cancer overall, lung and bronchus, and prostate. All other cancers studied were statistically similar in the MC as compared to the general U.S. population and to the non-MC.

These findings conclude the mortality investigation from USAFSAM, but the study team will continue the assessment of cancer incidence using the Virtual Pooled Registry (Phase 2). Further investigation into specific subgroups, exposures, and potential confounders may provide deeper insights into the complex relationship between service in the MC and cancer risk. Additionally, efforts to promote health and wellness initiatives tailored to the unique needs of the MC remain crucial in mitigating overall health risks, including cancer, within this community.

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