Short communication

Cervical cancer screening compliance among active duty service members in the US military

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ABSTRACT

Previous research suggests active duty service members (ADSM) experience higher rates of human papilloma virus infection and cervical dysplasia, which puts them at greater risk for cervical cancer. The current study examined crude rates and correlates of cervical cancer screening compliance in 2003–2015 among screening-eligible ADSM in the Millennium Cohort Study (MCS). Data were drawn from the MCS, Defense Manpower Data Center, and Military Health System Data Repository. Screening eligibility and compliance were calculated each year and initial analyses examined crude rates of compliance. Generalized estimating equations were calculated to determine whether sociodemographic, military, and mental/behavioral health covariates were associated with cervical cancer screening compliance. A majority of participants were 21–29 years old (79.4%), non-Hispanic White (60.6%), and enlisted (82.2%). Crude rates of cervical cancer screening compliance increased from 2003 (61.2%) to 2010 (83.1%), and then declined from 2010 to 2015 (59.8%). Older ADSM and those who had a history of deployment had lower odds of screening compliance. ADSM in the Air Force and those in healthcare occupations had higher odds of screening compliance. Study findings suggest that cervical cancer screening compliance is declining among ADSM. Interventions to improve screening should target groups with lower screening compliance.

1. Introduction

It is estimated that nearly all sexually active individuals in the US general population will have a human papillomavirus (HPV) infection at least once during their lifetime. (Chesson et al., 2014) HPV is the primary cause of cervical cancer and precancer (also known as cervical dysplasia). (Chesson et al., 2014; U.S. Preventive Services Task Force. Final Recommendation: Cervical Cancer Screening., 2018) Although the rate of genital HPV infection among active duty service members (ADSM) has generally declined since 2010, it remains the second most commonly diagnosed sexually transmitted infection, with an incidence rate of 16.0 and 191.3 per 10,000 person-years among males and females, respectively. (Stahlman et al., 2019) Furthermore, the rate of genital HPV infection has increased among female ADSM aged 30 years and older since 2013. (Stahlman et al., 2019)

Alarmingly, HPV infection, as well as HPV-related cervical dysplasia, are more common among ADSM than in the general US population, putting ADSM at an even greater risk for cervical cancer. (Agan et al., 2013 Feb; Daly et al., 2018) There is very limited information regarding why HPV and cervical dysplasia are more common among ADSM; however, researchers have speculated that ADSM may be more likely to engage in risk-taking, which may influence STI incidence. (Agan et al., 2013 Feb) Other researchers have suggested that rates may be higher among ADSM due to greater access to STI testing among military populations. (Stahlman et al., 2019) Regardless, cervical cancer may lead to medical separation (discharge from service) among ADSM. Moreover, in addition to cervical cancer, HPV-related cervical dysplasia may hinder readiness and delay deployment. (Office of the Assistant Secretary of Defense for Health Affairs, 2015) To protect the health and readiness of ADSM, the Department of Defense has issued policy to support regular

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cervical cancer screening for screening-eligible service members per US Preventive Services Task Force (USPSTF) recommendations (which also apply for the general US population). (U.S. Preventive Services Task Force. Final Recommendation: Cervical Cancer Screening., 2018; Office of the Secretary, 2010) The USPSTF recommends screening by cervical cytology (Pap smear) every 3 years for women aged 21–29 years, and, for those aged 30–65 years, the screening interval can be extended to every 5 years with either HPV testing alone or in combination with cervical cytology. (U.S. Preventive Services Task Force. Final Recommendation: Cervical Cancer Screening., 2018)

Given the threat of HPV infection, cervical dysplasia, and cervical cancer to the health and mission readiness of ADSM, the current study aimed to examine compliance with cervical cancer screening guidelines over time among ADSM. The current study also examined correlates of cervical cancer screening compliance to inform future policies, practices, and interventions to improve screening uptake among ADSM.

2. Methods

The current study protocol was approved by the Naval Health Research Center Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects. Study participants (n = 34,141) were drawn from the Millennium Cohort Study (MCS). The MCS is a prospective cohort of over 200,000 current and former military service members and is the largest study of military service members in the United States. (Chesbrough et al., 2002) The current study aimed to provide estimates of cervical cancer screening among ADSM enrolled in the MCS in 2003–2015. Female ADSM were considered eligible for screening in a given year if they were between the ages of 21 and 62 years on the last day of the year, were considered active duty (i.e., at least 9 months in full-time US military service) for the concurrent year and 2 years before, had not had a hysterectomy in the current or any prior year, and had not separated from the military that year or any prior year. The upper age limit for the sample was 62 to ensure that a participant had three years of history from when monitoring was initiated. While participants had to be considered active duty per the aforementioned definition above to be included in the current study, we note that participants may have since left military service. ADSM missing data on education level, race/ethnicity, or occupation (n = 63) were excluded from analyses.

ADSM were considered compliant with screening recommendations in 2003–2015 if they had a medical report of a Pap smear in the year of assessment or prior 2 calendar years. To account for changes in USPSTF recommendations in 2012, ADSM were also considered compliant with screening recommendations in 2013–2015 if they had completed Pap/HPV co-testing within the previous 5 years or had Pap smear in the year of assessment or 2 prior calendar years. (U.S. Preventive Services Task Force. Final Recommendation: Cervical Cancer Screening., 2018) Co-testing was considered to have occurred if a Pap smear and HPV testing occurred within 4 days of each other, although most (>99%) occurred on the same day.

2.1. Data analyses

Screening eligibility and compliance were calculated each year. Initial analyses examined crude rates of compliance among screening-eligible ADSM. After crude compliance rates were determined, generalized estimating equations (GEEs) were calculated to examine whether sociodemographic, military, and mental/behavioral health covariates (drawn from MCS surveys and Defense Manpower Data Center [DMDC] data) were associated with cervical cancer screening compliance. Multiple covariance structures were tested to ensure proper model fit. Given that the MCS surveys are spaced approximately 3 years apart, most covariates were considered indicators of history (i.e., once a participant endorsed depression on any survey, they were considered to have a history of depression from the year of that survey forward). Covariates

from the MCS survey included marital status, education level, depression, panic/anxiety, and problematic alcohol use. Depression, panic/anxiety, and problematic alcohol use variables were measured with Patient Health Questionnaire scales. (Spitzer et al., 1999) The DMDC is a large data center, serving under the Office of the Secretary of Defense, that collects and organizes military personnel and beneficiary data for the Department of Defense. These data are used for a variety of purposes and administrative needs, including health research. (Defense Manpower Data Center, Defense Manpower Data Center; Fagan et al., 2011) DMDC data were used for demographic covariates, including age, race/ethnicity, branch of service, pay grade, history of deployment, and military occupation. Date of birth was used to calculate age at the end of each year and ADSM were categorized into three age categories: 21–29 years, 30–39 years, and 40 years of age and older. In the analysis, demographic covariates were treated as fixed. To prevent removal of observations with missing data (which occurred in less than 3% of any given variable), dummy codes indicating missingness were included.

3. Results

3.1. Sample characteristics

Table 1 presents the sociodemographic and military characteristics

Table 1
Characteristics of US active duty service member study sample (n = 34,141).

Characteristics	n	%
Age at baseline, years		
21–29	27,111	79.4
30–39	5,545	16.2
40+	1,485	4.4
Race/ethnicity		
White, non-Hispanic	20,682	60.6
Black, non-Hispanic	6,549	19.2
Other	6,910	20.2
Branch of service		
Army	11,992	35.1
Navy	7,159	21.0
Marine Corps	1,612	4.7
Air Force	12,609	36.9
Coast Guard	769	2.3
Pay grade		
Enlisted	28,056	82.2
Officer	6,085	17.8
Occupation		
Other occupation	27,141	79.5
Healthcare specialist	7,000	20.5
Ever deployed		
No	12,471	36.5
Yes	21,670	63.5
Marital status at baseline		
Never married	13,416	39.3
Married/divorced/separated/widowed	20,722	60.7
Education at baseline		
Some college or less	25,798	75.6
Bachelor's degree or higher	8,343	24.4
Depression (ever)		
No	25,841	75.7
Yes	8,180	24.0
Unknown	120	0.4
Panic/anxiety (ever)		
No	29,992	87.9
Yes	3,955	11.6
Unknown	194	0.6
Problematic alcohol use (ever)		
No	29,884	87.5
Yes	3,748	11.0
Unknown	509	1.5
Smoking (ever)		
No	20,479	60.0
Yes	12,952	37.9
Unknown	710	2.1

of the study sample as well as baseline values of the covariates that were included in the GEE models. The majority of participants were aged 21–29 years (79.4%), non-Hispanic White (60.6%), had married (60.7%), and had less than a Bachelor's degree (75.6%). In addition, the majority of participants were enlisted (i.e. service members who serve under commissioned officers and warrant officers; 82.2%) and had a history of deployment (63.5%). Approximately 36.9% of the sample were in the Air Force, 35.1% Army, 21.0% Navy, 4.7% Marine Corps, and 2.3% Coast Guard.

3.2. Crude estimates of cervical cancer screening compliance

Compliance rose from the beginning of monitoring in 2003 (61.2%) to a high of 83.1% in 2010. Compliance then declined to a low of 59.8% in 2015. The number of eligible women followed a similar pattern, with a low in 2003 (n = 6,113) to a high in 2011 (n = 13,481), which declined through 2015 (n = 8,663).

3.3. Associations between Sociodemographic, Military, and Mental/ Behavioral covariates and compliance

Three different PROC GEE correlation structures were examined: compound symmetry, first-order autoregressive, and unstructured. The quasilikelihood under the independence model criterion (QIC) was lower (indicating better model fit) for the autoregressive (QIC = 160,078) and unstructured (QIC = 160,061) models relative to the compound symmetry model (QIC = 160,099). Estimates between autoregressive and unstructured models were nearly identical (year estimates differed in the thousandths place). Such close similarities in model fit and fixed effect estimates indicate the model was properly specified using either the autoregressive or unstructured models. Therefore, the results from the autoregressive model are presented because the fixed effect estimates were nearly identical, additional information can be gleaned from the autoregressive coefficient, and estimates are robust to misfit. (Ballinger, 2004)

The autoregressive coefficient was 0.55, indicating a strong correlation between compliance one year and the next year within a given women. This was largely expected because one encounter with Pap smear or co-testing would result in multiple years of screening compliance. Patterns of change over time mirrored that of the crude compliance, such that compliance was lowest at the beginning and end of the study. Similar to crude results, GEE models identified the peak of compliance in 2010.

Table 2 presents the unadjusted and adjusted odds ratios from the GEE analysis. The dummy codes indicating missingness were not significant with the exception of missing marital status, and thus are not presented. Older age was associated with decreased odds of compliance (ages 30–39 vs 21–29 years, adjusted odds ratio [aOR] = 0.89, 95% confidence interval [95% CI] = 0.86–0.93; ages 40 and older vs 21–29 years, aOR = 0.88, 95% CI = 0.82–0.94). ADSM in the Army (aOR = 0.68, 95% CI = 0.65–0.71), Navy (aOR = 0.40, 95% CI = 0.38–0.42), and Marine Corps (aOR = 0.45, 95% CI = 0.41–0.50) were all less likely to be compliant compared with Air Force personnel. ADSM in healthcare roles (e.g. officer healthcare providers such as doctors and nurses as well as enlisted healthcare providers including medics and corpsmen) were more likely to be compliant with cervical cancer screening guidelines than ADSM in other occupations (aOR = 1.11, 95% CI = 1.05–1.16), whereas ADSM who had deployed (aOR = 0.85, 95% CI = 0.82–0.88) were less likely to meet screening compliance guidelines.

4. Discussion

Overall, our findings indicate subpar cervical cancer screening compliance across all military service branches, with concerning recent declines in cervical cancer screening uptake among ADSM. Unfortunately, there is very limited information to explain why cervical cancer

Table 2
Factors associated with US ADSM cervical cancer screening compliance (n = 34,141).

Factors	Unadjusted OR [95% CI]	Adjusted OR [95% CI]
Age (ref = 21–29 years)		
30–39	0.94 [0.91, 0.97]	0.89 [0.86, 0.93]
40+	0.90 [0.85, 0.95]	0.88 [0.82, 0.94]
Race/ethnicity (ref = non-Hispanic White)		
Non-Hispanic Black	0.97 [0.92, 1.01]	1.01 [0.96, 1.06]
Other race/ethnicity	0.86 [0.82, 0.9]	0.97 [0.92, 1.02]
Marital status		
Married	1.08 [1.04, 1.12]	1.01 [0.97, 1.05]
Education level		
Bachelor's degree or higher	1 [0.97, 1.05]	1.03 [0.96, 1.10]
Mental/behavioral health		
Ever depression	0.98 [0.93, 1.03]	1.03 [0.98, 1.09]
Ever panic/anxiety	0.88 [0.81, 0.95]	0.95 [0.87, 1.03]
Ever problematic alcohol use	0.84 [0.78, 0.89]	0.98 [0.91, 1.04]
Ever smoker	0.95 [0.92, 0.99]	0.96 [0.92, 1.00]
Deployment status		
Ever deployed	0.88 [0.85, 0.91]	0.85 [0.82, 0.88]
Service branch (ref = Air Force)		
Army	0.67 [0.64, 0.70]	0.68 [0.65, 0.71]
Navy[a]	0.41 [0.39, 0.43]	0.40 [0.38, 0.42]
Marine Corps	0.47 [0.43, 0.51]	0.45 [0.41, 0.50]
Pay grade		
Enlisted	1.00 [0.96, 1.05]	1.00 [0.93, 1.09]
Occupation		
Healthcare specialist	1.15 [1.10, 1.20]	1.11 [1.05, 1.16]

ADSM, active duty service member; CI, confidence interval; OR, odds ratio.
[a] For inferential analyses, Coast Guard was combined with Navy.

screening compliance has been declining recently among ADSM, although we note that cervical cancer screening also declined in the overall US population during a similar time period. (Hall et al., 2018) Moreover, we observed that the number of screening-eligible women fluctuated in a similar way, with fewer eligible women during the years with lower screening compliance; however, more research is needed to ascertain whether there is any association between number of screening-eligible individuals and screening compliance. These compliance rates are especially alarming given that ASDM have universal access to healthcare, and thus, in theory, should have universal access to screening. (Hutchinson et all., 2016) The DoD has set forth policy to support ADSM compliance with USPSTF recommendations for cervical cancer screening. (U.S. Preventive Services Task Force. Final Recommendation: Cervical Cancer Screening., 2018; Office of the Secretary, 2010) However, our results suggest that these policies may not be adequately enforced among ADSM, and that interventions and changes to practice may be needed to encourage screening compliance.

Our results revealed several correlates associated with lower screening uptake, including age, history of deployment, and service branch. Older ADSM were less likely to comply with cervical cancer screening guidelines. This finding mirrors results from a previous Centers for Disease Control and Prevention study within the US civilian population, which found that women were less likely to be compliant with cervical cancer screening guidelines as they get older. (White et al., 2017) Older women may believe they are less at risk for HPV infection and thus less likely to get cervical cancer. However, the incidence rate of cervical cancer among older women does not decline until age 85 years. (White et al., 2017) Thus, our findings suggest that interventions may be necessary to educate older ADSM regarding their risk for cervical cancer and the necessity of continued adherence to screening guidelines as they age.

Additionally, ADSM who had deployed were less likely to be compliant with cervical cancer screening guidelines, suggesting that history of deployment may interfere with screening uptake. Certainly, screening may not be available at all deployment locations and within

austere settings. More research is needed to better understand potential associations between deployment and cervical cancer screening compliance.

Our findings also revealed significant differences in cervical cancer screening compliance by service branch. ADSM in the Air Force exhibited the highest rates of screening compliance compared with the other service branches. The Air Force has a more sophisticated tracking system for preventive health vaccinations and screenings, which may partially account for higher screening uptake in this branch. (U.S. Department of the Air Force. Human Papillomavirus Vaccination Policy., 2007) However, more research is needed to better understand the unique context of each service branch and how service branch-associated factors relate to cervical cancer screening opportunity and uptake.

5. Limitations

While our study sought to examine correlates of cervical cancer screening compliance among ADSM, we were unable to examine all potentially significant correlates of cervical cancer screening. For example, prior studies have suggested that sexual history and body mass index may be associated with cervical cancer screening compliance. (Cyrus-David et al., 2002; Fagan et al., 2016) Additionally, prior studies within other universal care settings have indicated that difficulties scheduling appointments/interference with work, discomfort with the cervical cancer screening procedure, and limited health literacy may contribute substantially to cervical cancer screening noncompliance. (Aasbø et al., 2019; Östensson et al., 2015) These factors may also impact screening uptake among ADSM, and should be examined in future studies of cervical cancer screening in military populations.

Additionally, we were unable to examine some of the correlates in the current study with a high degree of granularity. For example, we did not have information regarding the timing of deployment, such that direct associations between being deployed and cervical cancer screening compliance could be examined. Future studies should examine these correlates with greater detail to better understand how they may relate to cervical cancer screening compliance among ADSM.

Our findings should also be interpreted in light of other recent cervical cancer screening studies among ADSM. For example, another very similar study of cervical cancer screening compliance among ADSM yielded substantially different findings. Pope et al. (Pope et al., 2021) found that ethnic minority ADSM were more likely to have screened for cervical cancer than were non-Hispanic White ADSM, while our current study did not find any significant differences in screening compliance by race/ethnicity. (Pope et al., 2021) Moreover, Pope et al. (Pope et al., 2021) found that cervical cancer screening was higher in the Navy than any of the other service branches, which directly contradicts our findings. (Pope et al., 2021)

We believe that methodological differences may account for the differences in our findings and the findings of Pope et al. (Pope et al., 2021). In the study by Pope and colleagues, any service member who had a Pap smear performed within the adjacent years of their index Pap smear was automatically eliminated from the their analysis. (Pope et al., 2021) While this approach may have eliminated service members who were receiving follow up testing due to abnormal screenings, it may also have eliminated service members who were receiving regular screenings more frequently than the current USPSTF guidelines. (U.S. Preventive Services Task Force. Final Recommendation: Cervical Cancer Screening., 2018) Prior studies have suggested that many women may have continued to receive annual cervical cancer screening even after the USPSTF widened the screening interval. (Sirovich and Welch, 2004; Silver et al., 2018) Thus, these methodological differences may have resulted in lower than actual screening compliance in Pope et al. (Pope et al., 2021) and higher than actual screening compliance in the current study, as well as differences in associations between sociodemographic and military characteristics and screening compliance.

6. Conclusion and directions for future research

Taken together, our findings indicate that cervical cancer screening compliance is inadequate among ADSM overall, especially given that ADSM have universal access to medical care. Our findings also indicate that age, history of deployment, and service branch may be important correlates of screening compliance among ADSM. However, to fully address the issue of low screening compliance, it is essential that researchers, clinicians, policymakers, and military leadership have a clear perspective on which service members are experiencing barriers to screening so that appropriate interventions can be developed. Thus, future research should clarify and extend the current study by examining associations between sociodemographic factors, service branch, deployment-related factors, and cervical cancer screening compliance among all ADSM. In addition to resolving discrepancies between the current study and Pope et al. (Pope et al., 2021), such initiatives would expand on our findings by in-depth examination of several of these variables and would further contribute to the development of policies, practices, and interventions to enhance cervical cancer screening compliance among ADSM.

7. Disclaimer

CRediT authorship contribution statement

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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