EXAMINATION OF POST-SERVICE HEALTH-RELATED QUALITY OF LIFE AMONG RURAL AND URBAN MILITARY MEMBERS OF THE MILLENNIUM COHORT STUDY[*]

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ABSTRACT

Little information exists on the health-related quality of life (HRQL) of U.S. veterans based on rural (versus urban) status, especially those in younger age groups, and whether deployment influences this outcome. We addressed these questions in the Millennium Cohort Study, a prospective investigation of U.S. military personnel assessed first in 2001 and then subsequently every three years via self-administered questionnaires. Participants separated from the military at the time of the most recent survey were eligible (n = 10,738). HRQL was assessed using the SF-36V Physical Component Summary (PCS) and Mental Component Summary (MCS) scores. Rural status was assigned from zip codes using the Rural-Urban Commuting Area classification. The mean age of participants was 35 years (SD = 8.98). Compared with urban dwellers, rural residents reported significantly lower unadjusted mean PCS (49.80 vs. 50.42) and MCS (49.97 vs. 50.81) scores, but differences became nonsignificant after covariate adjustment. No interaction was seen between deployment and rural status. Rural status is not independently associated with HRQL among recent U.S. veterans.

Very limited knowledge exists on the demographics and health characteristics of rural veterans (Institute of Medicine 2010; Veterans' Rural Health Advisory Committee 2009), especially those who are younger and recently separated from service. Previous research has found rural veterans to have lower health-related quality of life (HRQL) scores, as measured by the Medical Outcomes Study Short Form 36-Item Health Survey for Veterans (SF-36V) Physical Component Summary (PCS) and Mental Component Summary (MCS) scores (Weeks et al. 2004), and a higher prevalence of physical disease co-morbidities, but lower rates of co-morbid mental health outcomes than urban-dwelling veterans (Wallace et al. 2006; Weeks et al. 2006; Weeks et al. 2008). Also, compared with urban veterans, rural veterans were older, male, white, and less likely to be employed (Weeks et al. 2004). This previous research has focused primarily on older veterans receiving Department of Veterans Affairs (VA) care and has used data collected before 2000.

Because many factors contribute to healthcare seeking, assessing differences in HRQL among veterans receiving VA healthcare may not provide unbiased estimates of HRQL for all urban and rural veterans. For example, access to care may be greater among urban veterans, and this may bias estimates of HRQL, as rural veterans may be less likely to access VA care unless they have more serious health conditions, which is generally associated with poorer HRQL. Evidence also suggests that there may be insignificant differences in HRQL among urban and rural-dwelling citizens, except among those aged 65 years or older who may have significantly poorer HRQL (Mainous 1995). Therefore, it is not known whether patterns are similar for population-based rural veterans irrespective of where they obtain healthcare, or for younger military personnel with significant combat deployment experience who have recently left military service.

Following the 1991 Gulf War, deployed military personnel reported poorer physical and mental HRQL compared with nondeployers (Proctor et al. 2001; Voelker et al. 2002). However, those deployed between 1998 and 2001 to Southwest Asia, Kosovo, and Bosnia reported slightly better HRQL than did nondeployers (T. Smith et al. 2007b). It is anticipated that among younger individuals, rural versus urban residence status may change prospectively from time of entry into the service, immediately post-service, and then later throughout their lifetime, and that changing residence status may reflect demographic differences (Brooks and Redlin 2009). Description and identification of recently separated rural veterans and a determination of whether post-service rural residence represents a significant predictor of less favorable HRQL could help target appropriate health care services or interventions.

The Millennium Cohort, the largest prospective study of U.S. military personnel, began enrollment in 2001 and has enrolled more than 150,000 participants composed of all services (Army, Air Force, Navy, Marines, and Coast Guard) and components (active duty, National Guard/Reserve) thereof (Gray et al. 2002; Ryan et al. 2007). By design, the Cohort is followed over time, even after separation from military service. To date, three panels have been enrolled, with two panels having completed at least one follow-up survey. Thus, the Millennium Cohort Study offers a unique opportunity to prospectively examine the differences in post-service physical and mental HRQL between rural and urban-dwelling participants.

This research has sought to examine and compare the post-service physical and mental HRQL of rural and urban military service members accounting for baseline (during service) functioning, determine whether having been deployed influences the HRQL of those rural dwellers differently (more adversely) than urban dwellers, and describe the rural–urban migration pattern for this cohort from time of entry into the service until recently separated from military service.

METHODS

Study Population

This study consists of Millennium Cohort participants from the 2001–2003 enrollment and 2004–2006 enrollment who completed a baseline questionnaire while in the service and at least one follow-up questionnaire (n = 80,524). Respondents were excluded if they remained in service at the time of their last completed questionnaire (n = 54,724); separated prior to the baseline assessment (n = 4,232); deployed prior to the baseline assessment (n = 9,841); or were missing information for zip code after separation (n = 51), MCS or PCS scores at baseline or follow-up (n = 332), or any covariate data (n = 606) at baseline or follow-up. After exclusions, the total study population was 10,738.

This study was approved by the Institutional Review Board of the Naval Health Research Center, and the research was performed in agreement with all applicable federal regulations governing the protection of human subjects in research (protocol NHRC.2000.0007).

Measures

Physical and mental HRQL was investigated using the MCS and PCS scores from the SF-36V, which evaluates physical functioning, physical health problems, bodily pain, general health, vitality, social functioning, psychological distress, and

psychological well-being (Kazis et al. 2004a; Kazis et al. 2004b; Kazis et al. 2004c; Ware, Kosinski, and Gandek 2005; Ware and Sherbourne 1992), by asking about the self-appraised effect of somatic ("physical") and emotional ("mental") health problems on basic components of day-to-day functioning (e.g., accomplishing less than usual). MCS and PCS scores have normative values with a mean of 50 and standard deviation of 10 for comparison with other U.S. populations, with higher summary scores reflecting a more favorable health status (Ware and Kosinski 2001; Ware, Kosinski, and Keller 1994).

The Millennium Cohort provided zip code data for the address of residence at the time of follow-up survey completion for each separated participant (Welch et al. 2009). All zip codes were categorized as rural or urban based on the Rural-Urban Commuting Area (RUCA) classification system. The RUCA system applies the standard U.S. Census Bureau Urbanized Area and Urban Cluster definitions to distinguish various levels of the continuum from highly rural/isolated to urban settings. Specifically, we used the 2-tier classification system issued by the University of Washington Rural Health Research Center (Washington State Department of Health 2006).

The Defense Manpower Data Center (DMDC) provided additional data on demographics and military characteristics of Cohort participants. Data included sex, birth year, race/ethnicity, education, marital status, branch of service, service component, military pay grade, military occupation, zip code at time of entry into military service, and deployment experience in support of the operations in Iraq and Afghanistan from 2001 to 2008.

Participants were defined as deployers if they had at least one deployment in support of operations in Iraq or Afghanistan between baseline and the date of separation. Deployers were further classified as deployed with or without combat experiences based on affirmative self-report on any follow-up questionnaire to personally witnessing or being exposed in the past three years to a person's death due to war or disaster, physical abuse, dead or decomposing bodies, maimed soldiers or civilians, or prisoners of war or refugees. Also, the length of service (years) was calculated as the time from basic active service date to the date of separation from service.

Several post-service covariates were included. Education and marital status were obtained from DMDC. Participants were categorized as having a civilian occupation if they affirmatively endorsed having a civilian occupation at the time of survey completion. Nonsmokers, past smokers, and current smokers were identified using survey items addressing lifetime smoking of at least 100 cigarettes

(5 packs), a successful attempt to quit smoking, and cigarette use in the past year. An aggregate variable was computed to indicate the presence of any mental health symptoms or provider-diagnosed condition, which included posttraumatic stress disorder (PTSD), depression, panic or other anxiety symptoms, or alcohol-related problems. A positive PTSD symptom screen was assessed using the sensitive measure of PTSD symptoms from the PTSD Checklist-Civilian Version (PCL-C) (Weathers et al. 1993). These criteria are based on the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (American Psychiatric Association 1994; Blanchard et al. 1996; Brewin 2005; Hoge et al. 2004; Weathers et al. 1993; Wright et al. 2002). Depression symptoms were assessed through responses on the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire's (PHQ) (Spitzer et al. 1999; Spitzer et al. 2000; Spitzer et al. 1994) 9-item depression module to measure self-reported symptoms (Kroenke and Spitzer 2002; Spitzer et al. 2000; Spitzer et al. 1994). Panic or other anxiety disorder and alcohol-related problems were also assessed using the PHQ (Spitzer et al. 1999; Spitzer et al. 1994). Self-reported provider diagnoses were determined based on a participant's self-report to the following question: "Has your doctor or other health professional told you in the last three years that you have any of the following conditions?". The 41 conditions listed in the questionnaire were collapsed into the following five categories: no conditions, cancer, illness (other than cancer), mental disorder, and other conditions (such as gallstones, hernia, or vertigo). Participants were then categorized by the number of diagnoses. The days hospitalized and days unable to work because of illness or injury in the past three years were assessed based on responses to items covering this information in the questionnaire. Length of time since separation from military service was computed as the time difference between the follow-up survey completion date and recorded date of separation. Lastly, rural versus urban status categories at time of entry into the service were computed using zip codes obtained for residential address at time of entry to the service obtained from electronic personnel files.

Statistical Analyses

    Descriptive and univariate analyses were conducted to examine unadjusted associations of study outcomes with demographic, occupational, and behavioral risk factors. Multivariate regression modeling was performed to investigate the difference between post-service functional health and post-service rural status. Multiple models (M1–M7) were explored by first adjusting for demographic covariates, then baseline component scores, then military characteristics, and finally

the full model including post-service covariates. The covariates entered into the models included biologically and military service-relevant factors considered in the literature to be related to the outcomes of interest. Collinearity was tested in each model, with a variance inflation factor of 4, or greater, indicating multicollinearity. When tested, the combat deployment and multiple deployment variables were collinear, so only the combat deployment variable was included in the multivariable regression analyses. When comparing model-adjusted PCS and MCS means, Tukey's method (Tukey 1994) was used to adjust for multiple comparisons. The differential impact of rural status on HRQL by deployment was examined by including the product interaction term (rural vs. urban status multiplied by deployment (non-deployed vs. deployed with and without combat)) in the full models (M7) for both MCS and PCS.

Additionally, we assessed whether there were changes between rural/urban status at time of service entry and status after separation from service. However, DMDC data for zip code information at the time of service entry was only available for enlisted personnel, so this comparison was restricted to enlisted personnel. Statistical analyses were performed using SAS software (SAS Institute, Inc., Cary, NC, version 9.2, 2002).

RESULTS

Of the 10,738 Cohort participants with complete demographic and questionnaire data, 16.8 percent were categorized as rural, while 83.2 percent were categorized as urban dwellers post-service (Table 1). Overall, the average age was 35 years (SD = 8.98), 70.7 percent were male, and 22 percent had a previous Operation Iraqi Freedom/Enduring Freedom deployment. The rural group compared with the urban was significantly younger (rural, mean = 34 years; [SD = 9.33]; urban, mean = 35 years; [SD = 8.91]; F-statistic = 3.73, $p < 0.001$), and male (rural n = 1,322 [73.8 percent]; urban n = 6,270 [70.1 percent]; χ^2 = 9.79; p = 0.002). The rural group also included higher proportions of persons who were non-Hispanic white, enlisted, and current smokers, as well as persons with greater self-reported mental health conditions than the urban group.

Table 2 reports the unadjusted means for the MCS and PCS scores by rural status. Overall, compared with urban residents, rural dwellers reported less favorable mental (F-statistic = 3.02, p = 0.003) and physical (F-statistic = 2.68, p = 0.007) HRQL, with the urban group scores slightly higher than the U.S. population mean of 50 and scores for the rural group just under 50. Rural men and women compared with urban-dwelling residents reported significantly less

TABLE 1.   CHARACTERISTICS OF MILLENNIUM COHORT PARTICIPANTS NO
           LONGER IN THE SERVICE

| | URBAN | | RURAL | |
| | N=8,946 | | N=1,792 | |
CHARACTERISTICS	N	%	N	%
At baseline[*]				
Sex				
Male.	6,270	70.1	1,322	73.8
Female.	2,676	29.9	470	26.2
Birth year				
Pre-1960.	2,160	24.1	351	19.6
1960–1969.	3,797	42.4	759	42.4
1970–1979.	2,326	26.0	494	27.6
1980+.	663	7.4	188	10.5
Race/ethnicity				
Non-Hispanic White.	5,905	66.0	1,453	81.1
Non-Hispanic Black.	1,345	15.0	124	6.9
Asian/Pacific Islander.	894	10.0	112	6.3
Hispanic.	599	6.7	64	3.6
Other.	203	2.3	39	2.2
Education				
High school or less.	4,499	50.3	1,085	60.5
Some college/bachelor's degree.	3,294	36.8	573	32.0
Advanced degree.	1,153	12.9	134	7.5
Marital status				
Never married.	2,517	28.1	504	28.1
Married.	5,933	66.3	1,189	66.4
Other.	496	5.5	99	5.5

TABLE 1. CHARACTERISTICS OF MILLENNIUM COHORT PARTICIPANTS NO LONGER IN THE SERVICE (*CONTINUED*)

| | URBAN | | RURAL | |
| | N=8,946 | | N=1,792 | |
CHARACTERISTICS	N	%	N	%
Service branch				
Army..............................	4,153	46.4	897	50.1
Air Force.	2,243	25.1	363	20.3
Navy/Coast Guard.	2,030	22.7	418	23.3
Marine Corps........................	520	5.8	114	6.4
Service component				
Reserve/National Guard.	1,694	18.9	420	23.4
Active duty.........................	7,252	81.1	1,372	76.6
Military pay grade				
Enlisted............................	6,955	77.7	1,520	84.8
Officer.............................	1,991	22.3	272	15.2
Military occupation				
Combat specialist....................	1,652	18.5	366	20.4
Electrical repair.....................	923	10.3	145	8.1
Communication/intelligence..........	782	8.7	146	8.1
Health care specialists.	1,029	11.5	159	8.9
Other technical and allied specialists. ...	244	2.7	58	3.2
Functional support.	1,901	21.2	289	16.1
Electrical/mechanical equipment repair.	1,126	12.6	319	17.8
Craft workers........................	245	2.7	52	2.9
Service and supply...................	756	8.5	188	10.5
Students, trainees, and other..........	288	3.2	70	3.9

TABLE 1. CHARACTERISTICS OF MILLENNIUM COHORT PARTICIPANTS NO LONGER IN THE SERVICE (*CONTINUED*)

| | URBAN | | RURAL | |
| | N=8,946 | | N=1,792 | |
CHARACTERISTICS	N	%	N	%
Length of service (years)				
0 to 3	179	2.0	50	2.8
>3 to 8	1,904	21.3	424	23.7
>8 to 15	1,361	15.2	274	15.3
>15	5,502	61.5	1,044	58.3
Deployment[†]				
Non-deployed	6,986	78.1	1,397	78.0
Deployed without combat	1,098	12.3	214	11.9
Deployed with combat	862	9.6	181	10.1
Number of deployments[†]				
Non-deployed	6,986	78.1	1,397	78.0
1 deployment	1,544	17.3	317	17.7
2 or more deployments	416	4.7	78	4.4
Mental component score				
>75th percentile	2,185	24.4	501	28.0
>50th to 75th percentile	2,243	25.1	446	24.9
>25th to 50th percentile	2,267	25.3	419	23.4
0 to 25th percentile	2,251	25.2	426	23.8
Physical component score				
>75th percentile	2,220	24.8	462	25.8
>50th to 75th percentile	2,184	24.4	508	28.3
>25th to 50th percentile	2,269	25.4	404	22.5
0 to 25th percentile	2,273	25.4	418	23.3

TABLE 1. CHARACTERISTICS OF MILLENNIUM COHORT PARTICIPANTS NO LONGER IN THE SERVICE (*CONTINUED*)

| | URBAN | | RURAL | |
| | N=8,946 | | N=1,792 | |
CHARACTERISTICS	N	%	N	%
After separation				
Education				
High school or less.	1,116	12.5	354	19.8
Some college/bachelor's degree.	6,057	67.7	1,209	67.5
Advanced degree.	1,773	19.8	229	12.8
Marital status				
Never married.	1,348	15.1	256	14.3
Married.	6,342	70.9	1,281	71.5
Other.	1,256	14.0	255	14.2
Civilian occupation				
No.	1,679	18.8	390	21.8
Yes.	7,267	81.2	1,402	78.2
Smoking status				
Nonsmoker.	4,914	54.9	856	47.8
Past smoker.	2,652	29.6	581	32.4
Current smoker.	1,380	15.4	355	19.8
Mental health disorder/problems[§]				
No.	7,202	80.5	1,394	77.8
Yes.	1,744	19.5	398	22.2
Self-reported provider-diagnosis[¶]				
No diagnosis.	3,105	34.7	611	34.1
1 diagnosis.	3,866	43.2	752	42.0
2 or more diagnoses.	1,975	22.1	429	23.9

TABLE 1.　CHARACTERISTICS OF MILLENNIUM COHORT PARTICIPANTS NO LONGER IN THE SERVICE (*CONTINUED*)

| | URBAN | | RURAL | |
| | N=8,946 | | N=1,792 | |
CHARACTERISTICS	N	%	N	%
Days hospitalized due to illness or injury				
None.	6,925	77.4	1,339	74.7
1 day.	641	7.2	134	7.5
2–5 days.	851	9.5	189	10.5
6–10 days.	262	2.9	67	3.7
11–15 days.	98	1.1	21	1.2
16–20 days.	50	0.6	9	0.5
21 days or more.	119	1.3	33	1.8
Days unable to work or perform usual activities due to illness or injury				
None.	3,351	37.5	648	36.2
1 day.	464	5.2	101	5.6
2–5 days.	2,071	23.2	379	21.1
6–10 days.	1,026	11.5	212	11.8
11–15 days.	510	5.7	102	5.7
16–20 days.	285	3.2	62	3.5
21 days or more.	1,239	13.8	288	16.1
Length of time since separation (years)[#]				
0 to 1.	2,277	25.5	390	21.8
>1 to 3.	5,317	59.4	1,107	61.8
>3 to 5.	1,050	11.7	231	12.9
>5.	302	3.4	64	3.6

NOTE: [*]Characteristics for participants while in military service. [†]Deployment was assessed as ever deployed between baseline and date of separation. [‡]Characteristics for participants after separation from military service. [§]Includes posttraumatic stress disorder, depression, panic, anxiety, and alcohol-related problems. [¶]Self-reported provider-diagnosis includes a count of the number of disease categories (cancer, illness, mental disorder, and other) endorsed. [#]Years from date of separation from service to post-service survey completion date.

favorable MCS; rural men, but not rural women, reported significantly less favorable PCS.

Although the rural compared with the urban group reported significantly less favorable HRQL, after adjusting for sex and birth year (M1) and following a series of multiple linear multivariate regression models (M2–M7), no significant differences between rural and urban groups on MCS and PCS were found after adjusting for variables of interest in the final model (M7).

The difference between mean MCS by urban/rural status became nonsignificant after adjustment for sex and birth year and baseline MCS. The difference between mean PCS between groups became nonsignificant after adjustment for sex and birth year, baseline PCS, service branch, service component, military pay grade and length of service, deployment status, post-service education, marital status, and smoking status. No significant interaction was observed between deployment and rural status for either HRQL outcome (MCS, F-statistic = 0.07, p = 0.933; PCS, F-statistic = 0.73, p = 0.482).

When evaluating the change in residence between entry into the service and post-separation from service among the enlisted group, we found that 71.5 percent of the group did not change categories (8.5 percent stayed rural, 63.0 percent stayed urban), 9.0 percent changed from urban at time of entry into the service to rural post-service, and 19.5 percent changed from rural to urban.

DISCUSSION

These findings are notable for the small magnitude differences observed in HRQL between rural and urban veterans who have recently separated from the U.S. military. In unadjusted analyses, small differences were seen in MCS and PCS by rural versus urban residence, which exceeded the threshold for statistical significance. After adjustment for relevant confounding factors, the magnitude of these differences diminished and was no longer statistically significant. Having experienced a deployment, whether or not combat exposure occurred, did not appear to modify the lack of association between HRQL measures and rural versus urban status.

Most prior research, which has documented significantly poorer HRQL among rural compared with urban veterans (Wallace et al. 2006; Weeks et al. 2004), has focused on those receiving VA healthcare and therefore included older persons (in their 60s) who served in the military several decades ago and earlier. In those studies, mean MCS and PCS scores were approximately 5 percent and 15 percent

TABLE 2. UNADJUSTED MCS AND PCS SCORES FOR SEPARATED MILLENNIUM COHORT STUDY PARTICIPANTS BY RURAL STATUS (N = 10,738)

	MCS				PCS			
	URBAN		RURAL		URBAN		RURAL	
	N = 8,946		N = 1,792		N = 8,946		N = 1,792	
CHARACTERISTICS	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)
Baseline[*]	50.81	(10.61)	49.97	(11.53)[b]	50.42	(8.96)	49.80	(9.10)[b]
Sex								
Male.	51.64	(10.04)	50.86	(11.13)[a]	50.75	(8.61)	49.82	(8.93)[c]
Female.	48.87	(11.61)	47.44	(12.25)[a]	49.65	(9.71)	49.73	(9.59)
Birth year								
Pre-1960.	53.04	(9.56)	53.78	(9.73)	50.15	(8.99)	49.03	(8.66)[a]
1960–1969.	51.77	(10.17)	51.09	(10.71)	49.71	(9.01)	49.22	(9.00)
1970–1979.	48.29	(11.11)	47.55	(12.25)	51.68	(8.70)	50.94	(9.38)
1980 +.	46.89	(11.67)	44.65	(12.64)[a]	51.03	(9.01)	50.58	(9.31)
Race/ethnicity								
Non-Hispanic White.	50.71	(10.52)	49.79	(11.51)[b]	50.60	(8.77)	49.80	(9.23)[b]
Non-Hispanic Black.	51.27	(11.13)	50.68	(12.57)	49.23	(9.46)	49.48	(8.48)
Asian/Pacific Islander.	52.43	(8.93)	52.96	(9.54)	51.43	(8.39)	50.73	(8.19)
Hispanic.	48.92	(11.88)	50.46	(10.30)	49.96	(10.03)	50.03	(7.94)
Other.	49.08	(11.42)	44.91	(14.11)[a]	50.06	(9.67)	47.96	(10.50)
Service branch								
Army.	49.77	(11.06)	49.41	(11.88)	49.78	(9.30)	49.72	(9.01)
Air Force.	52.40	(9.66)	51.72	(10.98)	50.69	(8.98)	50.04	(9.09)
Navy/Coast Guard.	51.38	(10.17)	49.92	(11.16)[b]	51.21	(8.34)	50.03	(8.73)[b]
Marine Corps.	49.98	(11.50)	48.99	(11.43)	51.34	(8.16)	48.82	(11.09)[b]

TABLE 2. UNADJUSTED MCS AND PCS SCORES FOR SEPARATED MILLENNIUM COHORT STUDY PARTICIPANTS BY RURAL STATUS (N = 10,738) (CONTINUED)

	MCS				PCS			
	URBAN		RURAL		URBAN		RURAL	
	N = 8,946		N = 1,792		N = 8,946		N = 1,792	
Characteristics	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Service component								
Reserve/National Guard.	49.10	(11.44)	48.58	(12.34)	51.21	(9.17)	50.97	(8.90)
Active duty.	51.21	(10.37)	50.39	(11.25)[b]	50.24	(8.91)	49.44	(9.14)[b]
Military pay grade								
Enlisted.	50.15	(10.95)	49.24	(11.83)[b]	50.04	(9.08)	49.55	(9.20)
Officer.	53.10	(8.96)	54.05	(8.67)	51.76	(8.40)	51.17	(8.44)
Military occupation								
Combat specialist.	51.69	(9.88)	50.58	(11.50)	51.24	(8.62)	50.58	(8.80)
Electrical repair.	50.60	(10.36)	49.96	(11.06)	50.91	(8.61)	50.14	(8.98)
Communication/intelligence.	50.81	(10.35)	49.74	(11.29)	50.19	(9.13)	50.73	(8.66)
Health care specialists.	50.66	(10.54)	50.85	(10.29)	50.72	(9.10)	50.46	(8.55)
Other technical & allied specialists.	50.04	(11.15)	50.35	(10.98)	50.80	(9.27)	49.44	(8.93)
Functional support.	51.02	(10.80)	49.12	(12.46)[b]	49.98	(9.02)	48.91	(9.51)
Electrical/mechanical.	50.65	(10.99)	50.20	(11.40)	49.91	(8.99)	49.34	(8.94)
Craft workers.	50.90	(10.75)	51.20	(10.14)	49.89	(8.47)	50.17	(8.39)
Service and supply.	49.81	(11.38)	49.91	(11.90)	49.32	(9.54)	49.01	(9.65)
Trainees, and other.	49.40	(10.59)	46.55	(12.66)	51.68	(8.65)	49.49	(10.91)
Length of service (years)								
0 to 3.	46.75	(11.72)	46.00	(13.20)	48.90	(10.59)	49.52	(10.07)
>3 to 8.	47.93	(11.45)	45.96	(12.66)[b]	51.49	(8.83)	50.86	(9.34)
>8 to 15.	48.30	(11.31)	48.61	(11.35)	51.22	(9.31)	50.75	(9.50)
>15.	52.56	(9.68)	52.14	(10.45)	49.91	(8.82)	49.13	(8.79)[b]

TABLE 2.   UNADJUSTED MCS AND PCS SCORES FOR SEPARATED MILLENNIUM COHORT STUDY PARTICIPANTS BY RURAL STATUS (N = 10,738) (CONTINUED)

	MCS				PCS			
	URBAN		RURAL		URBAN		RURAL	
	N = 8,946		N = 1,792		N = 8,946		N = 1,792	
CHARACTERISTICS	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)
Deployment[+]								
Non-deployed.................	51.06	(10.48)	50.41	(11.34)[a]	50.38	(9.09)	49.86	(9.20)
Deployed without combat.........	51.58	(9.52)	49.82	(10.91)[a]	51.77	(7.60)	50.12	(8.50)[b]
Deployed with combat.	47.78	(12.38)	46.72	(13.14)	49.05	(9.30)	48.94	(9.06)
Baseline component score[‡]								
>75th percentile.................	56.14	(7.72)	55.55	(9.03)	54.87	(6.54)	54.41	(6.76)
>50th to 75th percentile..........	53.70	(7.97)	53.42	(8.57)	52.87	(6.82)	52.03	(7.95)[a]
>25th to 50th percentile..........	50.10	(9.21)	49.70	(9.96)	49.88	(7.94)	49.92	(7.88)
0 to 25th percentile..............	43.05	(12.16)	42.56	(12.88)	43.90	(10.06)	43.55	(9.71)
After separation[§]								
Education								
High school or less.	49.84	(10.77)	47.91	(12.25)[b]	50.76	(8.96)	49.81	(9.47)
Some college/bachelor's degree. ..	50.39	(10.89)	49.77	(11.56)	49.92	(9.11)	49.55	(9.18)
Advanced degree................	52.84	(9.21)	54.15	(8.95)[a]	51.93	(8.28)	51.09	(7.96)
Marital status								
Never married.	48.58	(11.31)	46.92	(12.30)[a]	51.64	(8.93)	51.59	(9.12)
Married......................	51.88	(9.95)	51.27	(10.68)[a]	50.28	(50.28)	49.51	(8.99)[b]
Other........................	47.79	(12.04)	46.48	(13.47)	49.84	(9.52)	49.48	(9.48)
Civilian occupation								
No.	47.29	(12.97)	46.04	(14.05)	47.31	(11.50)	47.02	(11.11)
Yes...........................	51.62	(9.81)	51.06	(10.48)	51.14	(8.10)	50.57	(8.30)[a]

TABLE 2. Unadjusted MCS and PCS Scores for Separated Millennium Cohort Study Participants by Rural Status (N = 10,738) (Continued)

	MCS				PCS			
	URBAN		RURAL		URBAN		RURAL	
	N = 8,946		N = 1,792		N = 8,946		N = 1,792	
CHARACTERISTICS	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)
Smoking status								
Nonsmoker........................	51.74	(10.03)	50.92	(10.95)[a]	51.08	(8.64)	50.37	(8.98)[a]
Past smoker.	50.57	(10.68)	49.88	(11.50)	50.06	(9.05)	49.69	(8.73)
Current smoker.	47.96	(11.88)	47.81	(12.64)	48.79	(9.67)	48.61	(9.87)
Any mental health[¶]								
No	53.76	(7.31)	53.48	(7.62)	51.22	(8.24)	50.50	(8.51)[b]
Yes...........................	38.64	(13.13)	37.66	(14.18)	47.15	(10.90)	47.34	(10.57)
Self-reported provider-diagnosis[#]								
No diagnosis...................	53.61	(7.90)	53.15	(8.70)	54.13	(6.36)	53.18	(7.22)[b]
1 diagnosis.	52.54	(8.83)	51.46	(9.97)[b]	50.13	(8.38)	49.41	(8.53)[a]
2 or more diagnoses.	43.02	(13.43)	42.81	(14.30)	45.18	(10.67)	45.66	(10.54)
Days hospitalized due to illness or injury								
None	51.72	(9.81)	50.75	(10.80)[b]	51.78	(7.97)	51.29	(8.08)[a]
1 day	49.95	(10.91)	49.50	(11.20)	48.53	(9.11)	45.82	(9.66)[b]
2–5 days	48.21	(12.28)	48.17	(13.11)	45.60	(10.42)	46.78	(10.13)
6–10 days	45.72	(13.05)	46.60	(13.76)	43.79	(11.33)	44.69	(10.63)
11–15 days	46.32	(12.48)	44.93	(14.23)	41.86	(11.34)	44.74	(9.92)
16–20 days	41.49	(13.65)	45.40	(16.42)	44.26	(9.73)	41.02	(13.01)
21 days or more	40.00	(15.57)	41.63	(16.95)	40.55	(11.56)	38.66	(12.20)

TABLE 2.   UNADJUSTED MCS AND PCS SCORES FOR SEPARATED MILLENNIUM COHORT STUDY PARTICIPANTS BY RURAL STATUS (N = 10,738) (CONTINUED)

	MCS				PCS			
	URBAN		RURAL		URBAN		RURAL	
	N = 8,946		N = 1,792		N = 8,946		N = 1,792	
CHARACTERISTICS	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)
Days unable to work or perform usual activities due to illness or injury								
None	53.34	(8.64)	52.22	(9.61)[b]	53.83	(6.32)	53.54	(6.61)
1 day	52.34	(8.74)	53.02	(8.17)	53.41	(6.58)	53.68	(5.52)
2–5 days	51.83	(9.12)	51.45	(8.17)	51.58	(7.29)	51.12	(7.48)
6–10 days	49.62	(10.54)	49.53	(10.34)	49.25	(8.54)	48.69	(7.74)
11–15 days	48.06	(11.62)	48.25	(13.13)	48.02	(8.72)	46.58	(8.29)
16–20 days	47.12	(11.75)	45.78	(13.67)	45.41	(9.71)	44.54	(10.50)
21 days or more	44.65	(14.12)	43.69	(14.69)	41.28	(11.14)	41.36	(11.41)
Length of time since separation (years)[**]								
0 to 1	50.78	(10.61)	49.40	(11.84)[a]	50.27	(9.17)	48.63	(9.63)[b]
>1 to 3	50.93	(10.56)	50.54	(11.23)	50.52	(8.80)	50.24	(8.87)
>3 to 5	50.24	(10.86)	48.44	(12.23)[a]	50.11	(9.23)	49.66	(8.99)
>5	50.79	(10.60)	49.05	(11.79)	50.96	(9.27)	49.76	(9.68)

NOTE: MCS, Mental Component Summary; PCS, Physical Component Summary; SD, standard deviation. [*]Characteristics for participants while in the service. [†]Deployment was assessed as ever deployed between baseline and date of separation. [‡]Baseline MCS or PCS score, in quartiles, for each respective model. [§]Characteristics for participants after separation from the service. [¶]Includes posttraumatic stress disorder, depression, panic, anxiety, and alcohol-related problems. [#]Self-reported provider-diagnosis categories include no disease, cancer, illness (other than cancer), mental disorder, and other conditions. [**]Years from date of separation to survey completion date. For comparisons made between rural and urban groups: [a]$p < .05$, [b]$p < .01$, [c]$p < .001$.

TABLE 3. ADJUSTED MENTAL COMPONENT SUMMARY (MCS) AND PHYSICAL COMPONENT SUMMARY (PCS) SCORES FOR SEPARATED MILLENNIUM COHORT STUDY PARTICIPANTS (N = 10,738)

	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
MCS							
Residence status							
Urban	49.70[a]	50.22[a]	49.95[a]	48.98[a]	48.15[a]	47.26[a]	45.02[a]
Rural	49.05[b]	49.85[a]	49.69[a]	48.71[a]	47.92[a]	47.13[a]	44.90[a]
PCS							
Residence status							
Urban	50.44[a]	50.50[a]	50.97[a]	50.43[a]	50.34[a]	49.58[a]	49.13[a]
Rural	49.69[b]	50.02[b]	50.52[b]	49.97[b]	49.94[a]	49.27[a]	48.83[a]

NOTE: M1: adjusted for sex and birth year. M2: adjusted for M1 characteristics as well as baseline MCS or PCS for each respective model. M3: adjusted for M2 characteristics as well as service branch, service component, military pay grade, and length of service. M4: adjusted for M3 characteristics as well as deployment status. M5: adjusted for M4 characteristics as well as post-service education, marital status, and smoking status. M6: adjusted for M5 characteristics as well as post-service civilian occupation. M7: adjusted for M6 characteristics as well as any reported mental health diagnoses/disorders post-service. [a,b]Letters that are different indicate statistically significant differences ($p < 0.05$) of adjusted means. Same letters indicate no statistically significant differences in means. Tukey's method was used to adjust for multiple comparisons.

lower, respectively, than those reported in this study. Our analyses within a large cohort of personnel separated from service generally within the past one to three years and younger individuals (averaging 35 years of age) found no significant differences in HRQL between rural and urban groups after adjusting for covariate differences. We do note several statistically different ($p < 0.05$) demographic and descriptive characteristics between rural and urban groups (see Table 2), where differences were quite modest (generally less than 1 point). It is important to comment that what is statistically significant may not always translate into meaningful differences in biological or clinical terms (Todd 1996). Some evidence supports the assertion that differences in MCS and PCS scores somewhere between 2.5 (Kazis et al. 2004b; Kazis et al. 1999) and 5 points (Ware 1993) are clinically or socially meaningful. However, from a population-based public health perspective, even a small magnitude shift in the group distribution toward poorer HRQL (thus detecting subtle population shifts) may be widely relevant. Even when modest in size for an individual participant, if negative health outcomes are sufficiently pervasive, functionally relevant, and potentially preventable or treatable, they hold

significant implications for public policy. Of interest, we found that the mean unadjusted and adjusted MCS and PCS scores for the rural group were lower than U.S. population norms. Also, the MCS and PCS scores are lower compared with baseline scores observed in the overall Millennium Cohort population at baseline (52.8 and 53.4, respectively, (T. Smith et al. 2007b). As our study focused on persons who had separated from service, most likely the lower scores reflect a less healthy and somewhat older population than the active duty Millennium Cohort Study population at baseline. Ongoing studies seek to better understand important differences in Millennium Cohort participants that are no longer in service compared with those who are still serving in the U.S. military.

Certain limitations should be considered when interpreting these study findings. The Millennium Cohort represents a stratified sample of U.S. service members who were serving as of October 1, 2000, and results may differ from those obtained from a random, or complete, sample of the U.S. military. Furthermore, response to initial invitation and to the follow-up invitation was incomplete. However, previous analyses have shown that participants in the Millennium Cohort well represent the U.S. military (Riddle et al. 2007; B. Smith et al. 2007b; T. Smith 2009), prior health did not influence response rates (Wells et al. 2008), and questionnaire data are reliable (B. Smith et al. 2007a; B. Smith et al. 2007b; T. Smith et al. 2007a).

This study utilized RUCA to classify participants as either "rural" or "urban." To do so, the 33 RUCA codes were collapsed into the 2-tier rural and urban categories, which may have allowed for some misclassification of individual participant rural/urban status (Berke et al. 2009). However, should this have occurred, this misclassification was likely nondifferential in nature. It is also possible that rural status differences in HRQL may have been evident with the more granular categorization of the rural-urban continuum (such as with the 4-tier or higher RUCA or VA classification systems). When rendering rural versus urban categorizations for the time of entry into the service, we used the same 2006 RUCA zip code crosswalk employed for post-service status. It is possible that the rural/urban designations may have changed over time, such that an area categorized as rural 15–20 years ago may be considered urban in 2006. If this were the case, then the observed proportion (almost 20 percent) that migrated from rural to urban status may reflect a misclassification due to RUCA coding version and not necessarily the actual portion that migrated to an urban residential area post-service. Finally, while the SF-36V has been used extensively in clinical care settings, MCS and PCS scores are estimated based on an individual's self-reported

assessment of functioning, which may be less accurate than if mental and physical HRQL had been assessed by a clinician.

Several strengths deserve discussion. This study is based upon a population-based sample of current and recent U.S. military service members, making results representative of those who have served in both the active duty and Guard/Reserve components, and independent of health care-seeking behavior. The prospective design allowed incorporation of baseline (during-service characteristics) and follow-up (post-separation from military service) data to account for time-varying covariates and accurate temporal assessment for differences in MCS and PCS scores with respect to rural/urban categorization. The relatively large sample size permitted adequate power to meet study objectives. Finally, self-reported information was collected with little bias regarding awareness of the hypotheses to be tested concerning the specific exposures and outcomes of interest and in a way that ensured participants that individual-level data were not to be revealed, promoting open and honest questionnaire response.

In conclusion, we found no evidence for an association between rural or urban residence and HRQL among recent U.S. veterans. Furthermore, deployment experience did not alter the association between these outcomes and rural or urban residence in military personnel separated from service within the previous five years. While these results do not find that rural veterans recently separated from military service currently may require special interventions aimed at achieving the same HRQL as urban veterans, it has been noted that the differential effect of residency on HRQL is of a slowly progressing nature (Mainous 1995). Therefore, as previous research of older populations has documented significant HRQL differences between rural and urban veterans, future analyses of lifetime disability course among Cohort participants will allow for a better understanding of progression of health differences between rural and urban dwellers over time.

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