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Veteran Status and Body Weight: A Longitudinal Fixed-Effects Approach

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Abstract About 10–12 % of young men (and increasingly, women) have served a term in the military. Yet, we know relatively little about the consequences of military service for the lives of those who serve. In this article, we provide estimates of the relationship between men's peacetime military service during the all-volunteer era (AVE) and body weight using longitudinal data on 6,304 men taken from the National Longitudinal Survey of 1979 (NLSY-79). Using fixed-effects estimators on up to 13 years of data and numerous controls for time-varying life-course characteristics linked to body weight, we find that veterans of active-duty military service have higher levels of BMI and obesity. We argue that eating habits learned during service, coupled with patterns of physical activity, lead to a situation whereby veterans making the transition to less active civilian lifestyles gain weight that is not lost over time.

Keywords Veteran status · Body weight · Fixed-effects

An often-ignored fact is that the military is the single largest employer of young men in the United States (Angrist 1998). Over recent decades about 10–12 % of young men (and increasingly, women) have served a term in the military. It remains the case, however, that we know relatively little about the consequences of military service for the lives of the young men and women who serve. This lack of information is most evident for the relationship between military service and

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important health-related behaviors. In this article, we provide estimates of the relationship between men's peacetime military service during the all-volunteer era (AVE) and body weight using data taken from the National Longitudinal Survey of 1979 (NLSY-79). Body weight, particularly obesity, is strongly related to multiple dimensions of poor health (Must et al. 1999; Thompson et al. 1999).

The link between veteran status and body weight is also interesting for theoretical reasons. As a near total institution, the ability of military service to impact attitudes and behaviors during the early adulthood years that may be related to health-related concerns is a sociologically intriguing question. Military service represents a structural variable that may act to flatten individual lifestyle differences affecting body weight (Christakis and Fowler 2007; Cockerham 2005; Smith and Christakis 2008). To what extent does time spent in an institution demanding relatively strict conformity, and with strong peer-group pressures, affect subsequent body weight in either a positive or negative direction? By focusing on peacetime service, we emphasize the relationship between military service itself apart from the impact of trauma and injury associated with combat. If military service can be shown to be related to body weight, it may be possible to draw lessons about public policy intended to address the growing epidemic of obesity in the United States (Mokdad et al. 2001).

Prior Literature

The small literature available that addresses the link between veteran status and body weight generally shows that veterans either do not differ from nonveterans (Almond et al. 2008; Wang et al. 2005) or are somewhat more likely to be overweight (Gizlice 2002; Koepsell et al. 2009). This finding is surprising given the careful screening of veterans into the military. Particularly relevant is the fact that military inductees are selected on the basis of body weight (in addition to other elements of physical health). In general, inductees must have a body mass index (BMI) between 19 and 25 (although exceptions down to 17.5 and up to 27.5 are possible).[1] Given evidence that childhood and early adult body weight is a good predictor of later-life body weight (Ferraro et al. 2003; Lee et al. 2010; Scharoun-Lee et al. 2009), one would expect that after military service veterans would not be as heavy as nonveterans.

One reason for this unexpected finding may be methodological. Most of the previous research is based on various rounds of the Behavioral Risk Factor Surveillance System. Even though the data are nationally representative, most researchers have simply compared age-adjusted BMI values between veterans and nonveterans. Thus, such research has failed to take into account the highly selective nature of military service, ignoring the fact that military inductees are not a random subset of the US population. In addition, such research has failed to take into account the fact that the post-military trajectories of veterans are different from those of nonveterans. Veterans have different trajectories of education, income,

[1] A BMI between 19 and 25 is generally considered to be normal (not underweight and not overweight).

mental health, childbearing, and marital status (Angrist 1998; Bryant et al. 1993; Lundquist 2004; Teachman 2007a, b; Whyman et al. 2011), all factors that have been linked to body weight (Sobal 1991; Umberson et al. 2009; Wardle et al. 2002).

Another methodological limitation of past research is that it has only considered body weight measured at a single point in time, ignoring trajectories of weight change. Individuals have different patterns of weight change that may make cross-sectional differences difficult to interpret (Kyle et al. 2006; Umberson et al. 2009). Veterans and nonveterans may gain or lose weight in unique patterns. Veterans may differ from nonveterans in lifestyle choices that affect their body weight (Cockerham 2005). For example, research has shown that veterans are less likely to be physically inactive than nonveterans (Gizlice 2002; Littman et al. 2009). Consistent physical activity may keep the BMI of veterans lower than would otherwise be the case. Yet, the extent to which these lifestyle differences between veterans and nonveterans is not constant across the life course may lead to different conclusions about differences in body weight.

Furthermore, past research has failed to consider that most veterans enlist at the stage of the lifecycle in which eating habits are often formed for the remainder of their lives. Studies have shown adolescence to be the most crucial time for the formation of eating habits. Nearly half of adult weight is gained during these ages, and failure to develop healthy eating habits potentially leads to obesity and can have long-term implications on adult health (Story et al. 2002). The extent to which military service affects patterns of eating and exercise, it may help to form a health lifestyle that has long-term implications for the health of veterans (Cockerham 2005). The sheer number of veterans makes this an important question to consider. In addition to numbers alone, though, the ability of the military, as an inclusive institution touching the lives of young men and women during a critical life-course stage, means that knowledge of the consequences such service may lead to the development of policy options to alter these outcomes.

We examine the linkage between veteran status and health using longitudinal data taken from the NLSY-79. We use fixed-effects estimators that allow control over all time-invariant factors linked to veteran status and body weight. We also employ a set of time-varying covariates that allow us to control for confounding factors that are not stable over time.

Theoretical Framework

We outline three general paths through which military service may affect body weight. First, men may be selected for military service according to preexisting factors linked to body weight that distinguish veterans from nonveterans irrespective of their service. Second, military service itself may alter health practices directly in ways that may be related to the long-term relationship with body weight. Third, military service may lead to changes in post-service health-related characteristics and behaviors that in turn affect body weight at a subsequent point in the life course.

Selectivity

As indicated earlier, military service during the AVE has not occurred randomly. Even if men were assigned randomly to risk of service (as they were after implementation of the draft lottery during the Vietnam era), they would not be randomly sorted into military service because of restrictions placed on the health and mental functioning of recruits. The issue is confounded during the AVE because recruits likely self-select into the military based on other characteristics such as attitudes and values that might be related to behaviors affecting body weight (e.g., attitudes toward physical exercise and conditioning). Research dealing with the relationship between military service and health must, therefore, explicitly deal with the effects of selectivity. Again, prior research has failed to account for the potential effects of selectivity on the relationship between veteran status and body weight.

To account for selectivity, we make use of fixed-effects estimators and a natural experiment available in the NLSY-79 data to control for differences between veterans and nonveterans on preexisting characteristics likely to affect health. These controls are extremely important because without them it is difficult, if not impossible, to attach any association between military service and weight to military service itself and not to a set of preexisting conditions that tap underlying health conditions or health-related beliefs and behaviors linked to weight. Failure to implement controls for selectivity, therefore, runs the risk of generating biased estimates of the relationship between military service and body weight.

The fixed-effects approach operates using each veteran as his own control via multiple observations. The natural experiment follows by comparing active-duty veterans to reserve-duty veterans. Both the groups of veterans are subject to identical pre-service screens for enlistment. Yet, over the period covered by this study, reserve-duty veterans did not spend time on active duty outside an annual 2-week training regime. Thus, reserve-duty veterans were not subject to the rigors of exercising a military occupation on a daily basis, did not experience the disruptions of multiple moves between duty stations, and otherwise led an average civilian life. Accordingly, if there is something about military service that affects body weight, beyond selectivity, veterans of active-duty service should have body weights that differ from men who served in the reserves.

Military Service as an Agent Directly Impacting Health

In addition to selecting men according to preexisting conditions that may be related to body weight, military service may act directly to alter the health-related behaviors of young men. Here, the timing of military service in the life course is important to note. For the most part, men serve in the military in their late teens and early twenties, ages during which habits surrounding health-related behaviors such as tobacco and alcohol use, as well as eating are being formed. Because the military removes men from their familiar surroundings and encompasses them in a near total institution, there is the opportunity for military service to have major impact on numerous behaviors. As a number of authors have noted, social context (e.g., weight composition of social networks, neighborhood availability of outlets selling healthy foods) affects the likelihood of obesity beyond the effects of individual-level characteristics (Boardman et al. 2005; Inagami et al. 2006; Smith and Christakis 2008). A number of alternatives are possible.

First, norms of physical fitness, hygiene, and, exercise associated with military service may affect body weight, both in the short term and in the long term through the development of lifelong habits linked to physical activity (LaVerda et al. 2006). Indeed, veterans are generally more physically active than nonveterans (Gizlice 2002; Littman et al. 2009). Second, military recruits are also provided easily accessible and high-quality health care at no cost that reduces the risk of illness that may increase the risk of a sedentary lifestyle. Military personnel are also required to maintain a certain level of physical fitness and meet stringent BMI requirements. Early preventive care and cautions about weight gain may delay or prevent the onset of subsequent weight gain. Third, military service removes many men from negative social environments that might negatively influence personal behaviors related to stable and optimal body weight (e.g., social networks built around poor eating habits or sedentary activities). A consideration of these factors leads to the following hypothesis: Hypothesis 1—active-duty military service leads to lower body weight when compared to nonveterans.

On the other hand, military service may have offsetting negative effects on the habits of recruits. Despite the emphasis on physical fitness, previous research has demonstrated that military service is linked to increased consumption of alcohol and tobacco products. Bray et al. (1991, p. 868) report that "[m]ilitary personnel are, in general, less likely to use drugs than civilians but are more likely to drink and drink heavily and to smoke and smoke heavily." Other researchers have reported similar findings (Lau et al. 1990; Klevens et al. 1995; Kroutil et al. 1994; McKinney et al. 1997). The greater reliance of military personnel on alcohol and tobacco is consistent with Cockerham's (2005) notion of the development of a health lifestyle that may be attributable to the macho culture of military service, the stress of fulfilling demanding and dangerous occupations, often while deployed, and the fact that alcohol and tobacco products during much of the AVE were subsidized for on-base purchase. Greater use of these substances may also be due to the stage in the lifecycle most typical of those in the military, as college students have also been shown to drink and smoke heavily (Johnston et al. 2006). Rates of tobacco and alcohol use remain elevated among veterans long after their service, suggesting the pervasive effects of military service itself.

The same arguments may be made for linking military service to eating habits that may be tied to body weight. During their military service, veterans may learn poor eating habits that are detrimental to preserving a healthy body weight. In a longitudinal study of college students, another institution composed mostly of adolescents (and approximately the age of most military inductees), individuals dramatically increased their intake of unhealthy foods (Lau et al. 1990). Part of this relationship may be explained by the communal setting in which meals in both the first year of college and the military are taken. Mess halls introduce individuals to a setting where food is abundant and where meals are often taken at the same place and time of day, a practice that conditions people to eat beyond capacity regardless of nutritional need (Rogers 1999). Moreover, the available food is often high in calories and carbohydrates, including rations used during field deployments (e.g., MREs). Previous research has shown that food environments are related to body weight (Cummins and Macintyre 2006; Drewnowski 2004; Inagami et al. 2006). During active-duty service when rigorous physical activity is often the norm, and fitness standards must be met, such a diet may not be related to weight gain. After discharge, however, physical activity regimens often change with many men adopting a much less active lifestyle. As Smith et al. (2009) suggest, the transition from war-time active-duty service to civilian life is often accompanied by subsequent weight gain as a result of eating habits acquired in the service that do not match reduced activity levels after return to civilian life.

In the case of peacetime service where issues of stress, trauma, and food insecurity are less likely to play a role in determining body weight, it is likely the case that military service serves as a structural or social context within which eating (as well as drinking and smoking) lifestyles are generated (Cockerham 2005).[2] Once formed during adolescence and early adulthood, these health lifestyles continue to have consequences throughout the life course. Considering the case of eating and diet, the following hypothesis follows: Hypothesis 2—active-duty military service leads to higher body weight when compared to nonveterans.

Military Service and Subsequent Life-Course Events

Past research has linked socioeconomic status to body weight (Pampel et al. 2010; Sobal 1991; Umberson et al. 2009; Wardle et al. 2002). Individuals with lower attainments are generally more likely to suffer overweight and obesity. The extent to which military service affects socioeconomic attainment would, therefore, imply subsequent links to body weight.

Available research suggests that, unlike veterans from previous eras, veterans of the AVE do not enjoy a subsequent income premium. Bryant and Wilhite (1990) found a negative relationship between military service in the AVE era and subsequent wages in the civilian labor market. Bryant et al. (1993) and Teachman and Tedrow (2007) find a small wage premium for Black and Hispanic AVE veterans and a wage deficit for White AVE veterans. Angrist (1998) also finds a small wage premium for nonwhite AVE veterans and a wage deficit for white AVE veterans, as well as slightly higher employment rates for all veterans relative to comparable nonveterans. Although less well researched, levels of education are also affected by military service during the AVE. Several researchers have shown that active-duty veterans of the AVE receive less education than comparable nonveterans (Cohen et al. 1995; Teachman 2007a).

Another possible link between military service and health runs through marital status. A body of literature has linked marriage and marital transitions to body weight (Sobal et al. 2003; Umberson et al. 2009). In particular, marriage is associated with weight gain and divorce is linked to weight loss. Relevant to this

[2] Of course, the issue of stress is relative. Members of the active-duty military are still likely subject to more stress than nonveterans. For example, changing duty stations every 2–3 years can be stressful on military families.

point, military service has been linked to the risk of both marriage and divorce. Active-duty military service during the AVE appears to spur marriage and slow divorce, particularly for black men (although these relationships are greatest during active service, veterans remain more likely to be married than are nonveterans) (Lundquist 2004, 2006; Teachman 2007b). These differences in marital status, as well as other life-course transitions lead to the following hypothesis: Hypothesis 3—the reason active-duty military service may be linked to higher body weight is due to life-course differences in employment, income, education, and marital status.

Decay in the Relationship Between Active-Duty Military Service and Body Weight

It is also possible that the relationship between military service and body weight might vary according to age. Specifically, it may be the case that the relationship between veteran status and body weight wanes with time since military service. Even though active-duty military service can be a strong influence in the lives of young men, it is possible that lessons learned erode with the passage of time and exposure to different contexts. For example, there is evidence that the relationship between military service and educational attainment weakens the longer veterans have been out of the military (Teachman 2007a). This possibility leads to the following hypothesis: the relationship between active-duty military service and body weight will decline with time since discharge.

Data and Methods

We use 13 waves of data taken from the NLSY-79, which is a nationally representative sample of 12,686 men and women age 14–22 in 1979. The response rate in 1979 was 76 %. Participants were followed annually through 1994 and biennially thereafter. By 2004, the last year of data that we consider, 80 % of eligible respondents from the 1979 survey remained in the study.[3] We use data collected on self-reported weight for men at least 18 years of age in 13 different years (1981, 1982, 1985, 1986, 1989, 1990, 1992, 1994, 1996, 1998, 2000, 2002, and 2004). Because relatively few women entered the military during the years covered by these data, we focus solely on men. We note, however, that the experiences of women in the military (e.g., experiences of physical and sexual assault, greater discrepancy between military requirements and gender-specific work roles) may lead women to react differently with respect to their military service and health outcomes. Men interviewed all 13 years contribute 13 observations to the database, while men interviewed 12 of the 13 years contribute 12 observations to the database, and so on. In total, 6,304 men contributed at least

[3] By eligible, we mean respondents who were not in portions of the NLSY study that were dropped in previous years due to budget cuts. After 1984, the NLSY dropped 1,079 respondents that had formed a supplemental sample of men and women serving in the US military. After 1990, the NLSY dropped 3,652 respondents who had formed a supplemental sample of economically disadvantaged, nonblack/nonHispanic respondents.

one observation to the database (6207 men contributed at least two intervals), yielding a pooled sample of 54,872 observations. It should be noted that the NLSY study constitutes a sample of households and that a number of households contributed more than one sample member. Our analyses control for the clustered nature of these data.

Measures

Our primary dependent variable is BMI calculated as weight in kilograms divided by height in meters squared. Even though BMI measured in a clinical setting would be preferred to reduce the likelihood of measurement error, we base our analysis on the available self-reported height and weight. We note that if measurement error is consistent across time for an individual, our use of fixed-effects estimators will nullify such error (e.g., measurement error will cancel in difference scores). Height is measured as the tallest self-report registered in the 1981, 1982, and 1985 survey rounds. Weight is based on self-reports registered in the 13 NLSY rounds listed earlier, yielding 13 values of BMI. We also ascertain whether respondents are overweight (BMI $\geq$ 25) or obese (BMI $\geq$ 30). Overweight and obese are dummy variables coded 1 if the condition applies, 0 otherwise. Military service is measured by a set of four dummy variables in each of the 13 years included in the analysis; currently serving on active duty, currently serving on reserve duty, veteran of active duty and veteran of reserve duty. For each dummy variable, a value of 1 indicates that the characteristic applies, 0 otherwise. The omitted category in each case consists of nonveterans. As indicated earlier, reserve-duty veterans constitute a sort of natural experiment for the relationship between active-duty military service and body weight.

It is also the case that veterans of active duty are the same individuals who at an earlier point were actively serving in the military. Thus, a comparison of active-duty service members with veterans of active duty constitutes a sort of before–after control function. Again, if there is something about active-duty service that affects body weight beyond selectivity, veterans of active duty should differ from men who are currently serving on active duty.

We include a number of controls for time-varying characteristics that may impact body weight and which may not be captured by the fixed-effects estimators. Two variables measure marital status at each interval; a dummy variable indicating whether the respondent was married, and a dummy variable indicating whether the respondent was cohabiting. The omitted category is not living with a partner. In each case, respondents are coded 1 if the characteristic applies, 0 otherwise. We also include time-varying variables indicating, at each interval, highest level of schooling achieved, natural logarithm of family income, natural logarithm of weeks employed in current job, natural logarithm of cumulative number of weeks of civilian labor market experience, number of children living in the household, and age in years. Two dummy variables indicate whether the respondent was enrolled in school as of May in any interval and whether the respondent suffered a health limitation in that interval that limited either the amount or type of work (in each case coded 1 if the characteristic applies, 0 otherwise). Finally, we included a set of dummy variables indicating industry in which the respondent was employed in each interval. We used five dummy variables: manufacturing, transportation/utilities/communication, wholesale/retail trade, no industry reported, or agriculture/forestry/fisheries/mining/construction. The omitted category was business/financial/real estate/insurance. Again, for each dummy variable a value of 1 is coded if the characteristic applies, 0 otherwise.

Descriptive statistics for the sample used are shown in Table 1 for five groups of respondents: nonveterans, respondents currently serving on active duty, respondents currently serving on reserve duty, veterans of active-duty service, and reserve-duty veterans.[4] The values shown refer to the sample of observations for each of these groups. Nonveterans represent 81.1 % of the observations, respondents serving on active duty 5.1 %, respondents serving on reserve duty 1.0 %, active-duty veterans 9.1 %, and reserve-duty veterans 3.5 %. The mean BMI is lowest for respondents serving on active duty and highest for veterans of reserve duty. Both active- and reserve-duty veterans are heavier than men currently serving in the military and slightly heavier than nonveterans. Men serving on active duty are the least likely to be either overweight or obese. Reserve-duty veterans are the most likely to be either overweight or obese, followed by nonveterans and veterans of active duty. Nonveterans and both active- and reserve-duty veterans are more likely to be overweight or obese when compared to men currently serving in the military. The differences are particularly large for obesity. Active-duty veterans are 4.3 times more likely to be obese than men currently serving on active- and reserve-duty veterans are 2.9 times more likely to be obese than men currently serving on reserve duty. Nonveterans are 4.5 times more likely to be obese than men serving on active duty and 2.7 times more likely to be obese than men serving on reserve duty.

Statistical Model

We use a fixed-effects estimator to examine the relationship between the covariates and the body weight. The fixed-effects model we estimate, following Allison (1994), is of the following general form:

$$\mathrm{BMI}_{iht} = u_1 \mathrm{Age}_{iht} + u_2 \mathrm{Age}^2_{iht} + \delta_1 \mathrm{X}_{iht} + \gamma W_{iht} + \alpha_i + \tau_h + \varepsilon_{iht}$$

where BMI represents the BMI for individual i from household h at time t.[5] The 13 values of t correspond to the 13 survey rounds covered in our analysis. The value of i for a given t depends upon the number of respondents who contribute an observation at that value of t. The value of h depends on the number of households who contribute an observation at that value of t. Age_{iht} indicates the age of the respondent at time t (and is used to account for change in BMI associated with aging); X_{iht} represents a time-varying dummy variable indicating whether respondent i from household h is a veteran (either active- or reserve-duty veteran); W_{iht}

[4] Care should be made in interpreting these descriptive statistics because they do not take into account differences on variables such as age that can strongly impact body weight.

[5] As noted earlier, the NLSY-79 data were collected from all age-relevant individuals in a sample of households. Thus, multiple respondents occur for some households. The fixed-effects procedure we use also accounts for clustering associated with multiple respondents occurring in some households.

Table 1 Descriptive statistics for variables used in examining the link between veteran status and body weight

Variable	Nonveterans		Current active duty		Current reserve duty		Active-duty veterans		Reserve-duty veterans	
	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Body mass index	25.6	4.5	24.4	2.8	24.6	3.1	25.7	4.8	26.1	4.0
Overweight	49.9		42.3		44.8		51.5		57.0	
Obese	13.9		3.1		5.2		13.2		15.3	
Age	27.2		24.2		24.3	4.4	28.8	5.4	30.1	5.1
Cohabiting	7.3		2.1		5.4		9.1		8.4	
Married	38.1		46.0		34.0		42.8		53.1	
Highest grade completed	12.4	2.5	12.5	1.4	12.6	1.9	12.5	1.4	12.8	2.0
Family income/1,000	23.3	52.1	14.7	25.3	21.9	32.3	20.6	42.7	23.5	51.3
Job tenure in weeks	191.3	205.4	14.1	45.2	136.3	174.7	148.0	165.8	177.2	186.6
Labor market experience in weeks	356.4	244.3	69.39	79.4	242	195.0	278.6	208.7	361.7	210.7
Enrolled in school	13.9		11.2		16.8		8.7		6.9	
Number of children	0.6	1.0	0.6	0.9	0.5	0.9	0.7	1.1	1.0	1.2
Health limitation	3.7		2.2		2.4		4.2		3.2	
Industry										
Ag./forestry/fisheries/mining/construction	16.2		0.8		8.0		14.6		13.9	
Manufacturing	12.6		0.5		14.6		13.2		10.4	
Transportation/utilities/communication	7.0		0.3		9.1		9.2		9.7	
Wholesale and retail trade	18.6		2.3		14.6		14.6		14.3	
Business/finance/real estate/insurance	34.7		2.7		30.0		39.1		36.3	
None	10.9		93.4		9.3		9.3		15.4	
Number of intervals	44,620		2,770		553		4,995		1,934	
Number of men	5,053		965		179		1,081		344	

The number of men reported exceeds 6304 (the number of unique respondents) because some men served in both the reserves and on active duty. The number of men reporting that they are veterans of active- or reserve-duty exceeds the number of men who report being active- or reserve-duty because some men were already veterans at the beginning of data collection

represents a vector of time-varying characteristics of respondents, both nonveterans and veterans, that correspond to control variables; u_1, u_2, δ_1, and γ are coefficients or vectors of coefficients, α_i represents unobserved and constant person-specific differences across respondents that affect schooling, τ_h represents unobserved and constant household-specific differences across households that affect schooling, and ε_{iht} is a residual error term. This model is estimated using PROC GENMOD in SAS. We also estimate this model using overweight and obesity as dependent variables. Because these are dichotomous measures, we use PROC LOGISTIC with the STRATA option to obtain fixed-effects estimates.

The model does not include any fixed (nonchanging) characteristics of respondents or households because coefficients are estimated using a fixed-effects procedure. As a consequence, the effects of any constant person-specific characteristics such as race are absorbed within the person-specific factors, α_i, and the effects of any constant household-specific characteristics are absorbed within the household-specific factors, τ_h. Thus, although covariates such as race do not appear in the model, their effects on the dependent variable are controlled. Heuristically, one can imagine that the fixed-effects model is estimated by including two sets of dummy variables—one set corresponding to each of the respondents (e.g., the α_i correspond to $i - 1$ dummy variables for the individual respondents) and a second set of dummy variables corresponding to each of the households (e.g., the τ_h correspond to $h - 1$ dummy variables for each of the households).

The value of the fixed-effects procedure is that in controlling for all person-specific factors, it controls for potential sources of spuriousness associated with entry into the military and body weight. Transitory sources of spuriousness (those associated with unobserved changes in characteristics linked to military service) are not controlled in fixed-effects models. Yet the model does include a number of important time-varying characteristics of individuals that should help alleviate this issue (i.e., marital status, education, income, job tenure, cumulative labor market experience, school enrollment, children, health limitations, and industry). In addition, the comparison between veterans of active duty and men currently serving on active- or reserve-duty and veterans of reserve duty helps to control for unobserved aspects of military service that may affect body weight beyond fixed characteristics of selectivity.

Multivariate Results

We begin the analysis by conducting a least-squares analysis of the pooled database where the models use multiple observations for each respondent. These results are shown as the first two models in Table 2. We use a GEE estimator to adjust standard errors of the estimated coefficients for the fact that observations across time are clustered within respondents who are also clustered within households. Although clustering is taken into account, the resulting coefficient estimates do not control for unobserved, time-constant factors linked to the included covariates and BMI. Model 1 indicates the coefficient for veteran status net of age but not the time-varying life-course variables that might explain the relationship. The coefficients for military status indicate their effect relative to the omitted category, which is a nonveteran. The results indicate that men currently serving on active duty have a BMI that is lower than nonveterans. The same is true of veterans of active duty, although the

Table 2 Multivariate regression results examining the relationship between veteran status and BMI

Variable	GEE estimates		Fixed-effect estimates	
	Model 1	Model 2	Model 3	Model 4
Active duty	−0.504**	−0.280*	0.480**	0.228**
Reserve duty	−0.279	−0.286	−0.011	−0.152
Veteran of active duty	−0.265*	−0.165	0.732**	0.490**
Veteran of reserve duty	−0.074	−0.149	0.091	−0.119
Nonveteran (omitted category)	–	–	–	–
Cohabiting		0.023		0.272**
Married		0.289**		0.411**
Not married or cohabiting (omitted category)		–		–
Highest grade completed		−0.092**		−0.012
Log of family income		−0.001		−0.002
Log of tenure on current job		0.006		−0.039**
Log of cumulative labor market experience		0.231**		0.322**
Enrolled in school		−0.227**		−0.095**
Not enrolled in school (omitted category)		–		–
Number of children		0.098*		0.031**
Health limitation		0.065		−0.051
No health limitation (omitted category)		–		–
Industry				
Ag./forestry/fisheries/mining/construction		−0.200*		−0.089**
Manufacturing		−0.141		−0.079**
Transportation/utilities/communication		0.436**		0.017
Wholesale and retail trade		−0.054		−0.096**
Business/finance/real estate/insurance (omitted category)		–		–
None		0.155		0.039
Age	0.248**	0.202**	0.272**	0.214**
Intercept	18.858**	19.904**		

Contrasts	Chi-square		*F*-value	
Veteran active duty versus veteran reserves	0.35	0.00	15.58**	14.27**
Veteran active duty versus currently active	2.64	0.45	12.50**	11.69**
Veteran active duty versus current reserves	0.00	0.19	21.14**	16.02**

* $p < 0.10$; ** $p < 0.05$

coefficient is smaller. As indicated by the contrasts presented at the bottom of the table, however, there is no statistically significant difference between the coefficient for being an active-duty veteran and any of the other coefficients measuring the relationship between military service and body weight. In Model 2, after introducing controls for the time-varying covariates, the coefficients for currently serving on active duty and being a veteran of active duty decline, and the coefficient for being an active-duty veteran is no longer significant. Again, as indicated by the contrasts at the bottom of the table, there is no statistically significant difference between the coefficient for being a veteran of active duty and the other coefficients for military service. These results are consistent with results generated by prior research on the topic (Almond et al. 2008; Wang et al. 2005).

The next two models, Models 3 and 4, are the fixed-effects estimators for BMI. In these models, all time-constant characteristics of respondents are controlled (e.g., race, family background), and these factors are allowed to be correlated with the included covariates. Thus, these models are able to control for unobserved characteristics linked to the likelihood of selection into the military and BMI. The results from these models differ substantially from those in Models 1 and 2, indicating strong effects of the unobserved variables. The coefficients in Model 3 show that when not accounting for the effects of the time-varying control variables both serving on active duty and being a veteran of active duty are positively linked to BMI, with the coefficient for being a veteran of active duty being much larger (0.732 versus 0.480). The coefficient for being a veteran of active duty is larger than each of the other coefficients measuring military service and these differences are all statistically significant, as indicated by the contrasts shown at the bottom of the table.

Model 4 includes the effect of the time-varying control variables. The positive coefficient for active-duty service remains (both current service and being a veteran), although somewhat diminished. In addition, the coefficient for being a veteran of active-duty service continues to be about twice the size the coefficient for current active-duty service. The contrasts at the bottom of the table show a statistically significant difference between the coefficient for being an active-duty veteran and all other indicators of military. These differences provide further evidence that there is something about active-duty service beyond selectivity that positively affects body weight after leaving the military.

These findings are consistent with hypothesis 2 and not hypotheses 1 and 3. That is, the relationship between veteran status and body weight is positive, not negative, and this relationship cannot be explained by differences in marital status, education, school enrollment, children, income, labor market experiences, health limitations, industry, and age.

The results shown in Table 2 refer to weight change anywhere along the weight continuum. Thus, it is not necessarily the case that the additional weight associated with being an active-duty veteran will have a negative influence on health. To address weight change in a different fashion, Table 3 provides ordinary logistic and fixed-effects logistic regression analyses of the odds of being overweight (BMI $\geq$ 25) or being obese (BMI $\geq$ 30). The coefficients shown represent the effect of each variable on the log of the odds of either overweight or obesity. Effects on odds can be calculated as $(e^{b} - 1) * 100$.

Following the logic used in Table 2, Models 1 and 2 present ordinary logistic regression coefficients for the effects of the covariates on overweight. Models 5 and 6 present ordinary logistic regression coefficients for the effects of the covariates on obesity. We discuss the ordinary logistic results first. According to Models 1 and 5, veterans of active duty are less likely to be overweight, whereas men currently serving on active- or reserve-duty are less likely to be obese. The coefficient for

Table 3 Multivariate logistic regression results examining the relationship between veteran status and overweight and obese (logit coefficients)

Variable	Overweight				Obese			
	Ordinary logistic		Fixed-effects logistic		Ordinary logistic		Fixed-effects logistic	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Active duty	0.006	0.121	0.391**	0.017	−1.364**	−1.217**	−0.326	−0.701*
Reserve duty	0.155	0.152	0.326	0.086	−0.684**	−0.690**	−0.597	−0.779*
Veteran of active duty	−0.133**	−0.080	0.612**	0.262	−0.130	−0.066	1.381**	1.159**
Veteran of reserve duty	0.018	−0.011	0.417*	0.122	0.028	0.014	0.201	−0.198
Nonveteran (omitted category)	–	–	–	–	–	–	–	–
Cohabiting		0.059		0.279**		0.007		0.480**
Married		0.254**		0.685**		0.067		0.731**
Not married or cohabiting (omitted category)		–		–		–		–
Highest grade completed		−0.035**		0.062**		−0.075**		−0.053
Log of family income		0.004		0.004		−0.002		−0.007
Log of tenure on current job		−0.001		−0.049**		0.005		−0.018
Log of cumulative labor market experience		0.122**		0.373**		0.152**		0.274**
Enrolled in school		−0.133**		−0.161**		−0.209**		−0.087
Not enrolled in school (omitted category)		–		–		–		–
Number of children		0.014		0.002		0.079**		0.174**
Health limitation		−0.048		−0.049		0.200**		0.004

Table 3 continued

Variable	Overweight				Obese			
	Ordinary logistic		Fixed-effects logistic		Ordinary logistic		Fixed-effects logistic	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
No health limitation (omitted category)		–		–		–		–
Industry								
Ag./forestry/fisheries/ mining/construction		−0.006		−0.046		−0.302**		−0.153
Manufacturing		−0.015		−0.016**		−0.102		−0.158
Transportation/utilities/ communication		0.241**		−0.042		0.024		0.028
Wholesale and retail trade		−0.057		−0.169**		−0.046		−0.081
Business/finance/real estate/insurance (omitted category)		–		–		–		–
None		0.075		−0.090		0.111		0.162
Age	0.115**	0.090**	0.364**	0.284**	0.102**	0.081**	0.334**	0.282**
Intercept	−3.126**	−2.793**			−4.730**	−4.068**		
Contrasts	Chi-square		Chi-square		Chi-square		Chi-square	
Veteran active duty versus veteran reserves	1.12	0.22	0.30	0.10	0.74	0.19	3.29*	4.02**
Veteran active duty versus currently active	2.65	4.65**	2.00	2.53	63.18**	47.04**	27.31**	28.24**
Veteran active duty versus current reserves	3.77	2.39	0.73	0.23	6.22**	7.80**	9.70**	8.70**

* $p < 0.10$; ** $p < 0.05$

being a veteran of active duty on overweight becomes nonsignificant, however, after adding the additional control variables to the model (Model 2). The contrasts presented at the bottom of the table indicate that for overweight in only one case is the coefficient for being a veteran of active duty significantly different from the coefficients for the other measures of military service (the comparison to current active-duty service in Model 2). With respect to obesity (Models 5 and 6), men serving on either active- or reserve-duty are less likely to be obese, with the relationship being much stronger for men serving on active duty. The contrasts show that the coefficients for being a veteran of active duty are different from those for currently serving on active duty or in the reserves. Moreover, these differences are statistically significant, showing that veterans of active-duty service are more likely to be obese than men currently serving.

The situation again changes substantially when the fixed-effects estimators are considered, particularly for obesity, further indicating the presence of strong, but unobserved, factors linked to both military service and body weight. In Model 3, all types of military service are positively linked to an increased risk of being overweight with the exception of current reserve-duty service. However, these coefficients become nonsignificant when the control variables are added in Model 4. In addition, the contrasts shown at the bottom of the table do not show significant differences between the coefficients for being a veteran of active duty and the other measures of military service. Thus, the higher body weight of veterans of active duty indicated by the results for BMI in Table 2 do not reflect a greater likelihood of being simply overweight.

When considering obesity, Model 7 shows that veterans of active duty are more likely to be obese than nonveterans. The contrasts at the bottom of the table indicate that the differences between the coefficient for veterans of active-duty service and those for other measures of military service are all statistically significant. When the time-varying life-course variables are included (Model 8), the difference between veterans of active duty and other service members remains. Service personnel currently on active or reserve duty are significantly less likely than nonveterans to be obese, whereas veterans of active duty continue to be more likely to be obese. Once again, the differences between the coefficient for active-duty veterans and those for other types of service are all statistically significant, as indicated by the contrasts at the bottom of the table. These results indicate that the higher BMI values for active-duty veterans shown in Table 2 translate into a significantly higher risk of being obese.

Finally, we tested whether the effect of military changes with age. We conducted this test by creating interaction terms between veteran status and current age of the respondent and replicated the models shown in Tables 2 and 3. None of these interaction terms reached statistical significance (results not shown), providing no evidence that the effects of prior military service decay with time. Thus, hypothesis 4 is not supported.

Discussion

Our analysis indicates that veteran status is related to body weight. In particular, being a veteran of active-duty service appears to be linked to greater body weight and increased odds of being obese. At least some previous research has found that veteran status is not closely linked to body weight (Almond et al. 2008; Wang et al. 2005). However, the lack of association in prior studies may result from methodological flaws and data limitations. In particular, the use of cross-sectional data without strong controls for selectivity, as used in previous research, makes it difficult to untangle the effects of military service itself from a number of other factors that may be operating to influence both body weight and likelihood of serving in the military. Indeed, our results indicate that the positive effects of prior active-duty service on bodyweight are either not evident or are less substantial when using regression models that do not control for unmeasured characteristics.

The use of fixed-effects estimators allows us to control for all time-constant factors that might influence both military service and body weight. These unobserved factors are important to consider. When fixed-effects estimators are used, the effect of being a veteran of active-duty service becomes statistically significant and strongly positive for both BMI and obesity. These results indicate that service members are selected according to characteristics linked to body weight. Without considering these unobserved factors, it appears that military service is neutral with respect to weight. When their effects are considered, however, active-duty veterans are heavier than would appear to be the case if they had not served in the military. When it comes to obesity, the results from Model 8 in Table 3 indicate that veterans of active-duty service are three times ($e^{1.159} = 3.19$) more likely to be obese than nonveterans. They are six times more likely to be obese than men currently serving on active duty ($e^{1.159-(-0.701)} = 6.42$), nearly seven times more likely to be obese than men currently serving on reserve duty ($e^{1.159-(-0.779)} = 6.94$), and about four times more likely to be obese than veterans of reserve duty ($e^{1.159-(0.198)} = 3.88$). These figures are important to consider given the well-defined consequences of obesity for a variety of health outcomes (Bray 2004; Ferraro and Kelley-Moore 2003; Must et al. 1999; Thompson et al. 1999).

We also controlled for a number of time-varying characteristics known to be associated with body weight (e.g., marital status, education, income, industry, labor market experience, children, and health limitations) and find that they cannot explain the positive effect of active-duty service on BMI, overweight, and obesity. Moreover, there is a consistently positive difference between veterans of active-duty service and other measures of military service, suggesting that unobserved time-constant and time-varying characteristics linked to military service may not be the source of the higher body weight of active-duty veterans. Subsequent research, however, should pay attention to a wider range of time-varying processes that may link active-duty veteran status to BMI. For example, military service has been linked to greater use of alcohol and tobacco products but inconsistent recording of these behaviors in the NLSY-79 precludes their consideration. The extent to which they are linked to body weight argues for their inclusion. Other candidates for closer scrutiny include better information about physical and emotional demands placed on veterans by the jobs that they hold, information that is more specific than simple controls for industry or occupation; better information about overall patterns of physical activity and exercise; changes in diet; and variation in use and knowledge of health information.

Assuming that unmeasured time-varying covariates are not the source of the higher BMI values for veterans of active duty, the exact nature of active-duty service itself that leads to increased body weight cannot be ascertained from the data at hand. We can speculate on the nature of this relationship, though. Men currently serving on active duty have BMI values greater than nonveterans, and this is likely due to their greater muscle mass. The results for obesity indicate that men on active duty are much less likely than nonveterans to be obese. It is possible, therefore, that eating habits learned in an environment of plentiful and inexpensive nourishment, but with concurrent physical fitness standards, may operate to increase body weight after military service ends and physical demands return to civilian levels. A variety of research has indicated that physical activity associated with occupation is related to body weight, with more active occupations linked to lower body weight (Bockerman et al. 2008; King et al. 2001; Lakdawalla and Phillipson 2009; Larsson et al. 2004; Mummery et al. 2005), as would be the case with serving on active duty in the military. Yet, there is evidence that high levels of physical activity at an earlier point in time, unless sustained, do not protect against weight gain in the long term (Williamson et al. 1993). Moreover, it appears that only more vigorous levels of consistent physical activity are related to lower body weight over time (Jakicic 2002). Thus, it is possible that lower levels of post-military physical activity, coupled with eating habits generated during service, result in higher than expected body weight. As suggested earlier, to better specify the impact of active-duty military service on body weight will require longitudinal data that couples indicators of military service to longer-term changes in nutrition and physical exercise. Subsequent research should pay attention to the manner in which military service leads to changes in nutrition and exercise, particularly in reference to levels experienced during service.

Information is also needed about the link between military service and body weight among female veterans. The number of women serving in the military has increased considerably since the early 1980s when most of the NLSY-79 respondents served. The extent to which the relationship between nutrition, physical activity, and body weight varies according to sex (Frank et al. 2009), suggests that military service may impact the subsequent body weight of women differently than men. Women also experience military service differently than men (e.g., greater likelihood of experiencing physical and sexual harassment) (Simon 2001).

It should also be noted that the results in our analysis pertain to a cohort of men who mostly entered the military between 1980 and 1990. The relationship between military service and body weight may differ for men who entered either before or after this period. In particular, the effects of military service post-9/11 with significant risk of multiple deployments to a war zone may alter any association between service and BMI. Our results are also limited by the small size of reserve-duty veterans in the NLSY sample as well as by the fact that the nature of reserve-duty service changed considerably after 9/11.

More generally, the results shown in this article speak to the potential effect of a near total institution on an important health-related outcome. The relationship between being a veteran of active duty and BMI is positive and does not appear to decay with time, at least not within the ages considered in this analysis. The impact of military service is critical because it is intense and occurs during a portion of the life course when life-long habits are being formed. Other research has shown that active-duty military service is tied to smoking and alcohol habits even many years after discharge (Bray et al. 1991; Klevens et al. 1995; Kroutil et al. 1994; McKinney et al. 1997). BMI can now be added to this list. Overall, the results, combined with prior research, point to the potential for military service to have long-term effects on the health of veterans. Indeed, Teachman (2010) has found that veterans at age 40 have lower self-reported health than would be otherwise expected given selectivity on health characteristics. In part, these results may be due to the greater likelihood of obesity among active-duty veterans. Our results are consistent with the notion of the development of a health lifestyle as expressed by Cockerham (2005). As such, the impact of a near total institution experienced during adolescence and early adulthood gains theoretical weight for its potential to alter the health trajectories of young Americans.

There is also the potential for these results to generate policy changes in the military that may reduce the likelihood that service will lead to overweight and obesity. Without a better specified model of the process by which military service is linked to weight gain, policy prescriptions should be made with caution. That being said, however, a likely candidate includes cultural changes within the military with respect to eating habits linked with greater emphasis on healthier nourishment. Similar efforts have been made by the military to help reduce the burden of increased alcohol and tobacco consumption while on active duty (Ames and Cunradi 2004; Bondurant and Wedge 2009)

Conclusion

Using data taken from the 1979 NLSY, our results suggest that veterans of active duty are heavier than comparable nonveterans. Using BMI, overweight, and obesity as indicators of body weight, and controlling for unobserved selection factors, veterans of active-duty military service are heavier than they might otherwise be. Controls for time-varying characteristics of respondents do not eliminate this relationship, indicating that military service itself is somehow linked to the higher than expected body weight of veterans. Moreover, this relationship appears to hold as veterans age. Although direct measurement of the factors experienced during active-duty military service is not possible using the data at hand, we suggest that eating habits learned during service, coupled with patterns of physical activity, lead to a situation whereby veterans making the transition to less active civilian lifestyles gain weight. The fact that substantial numbers of men, and increasingly women, experience a spell of military service indicates the importance of this near total institution for the health of young Americans.

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