

Quality of life for veterans and servicemembers with major traumatic limb loss from Vietnam and OIF/OEF conflicts

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Abstract—The goals of rehabilitation after major limb loss include not only functional restoration but also a return to a high quality of life (QOL). Few studies have identified which factors are associated with QOL in veterans and servicemembers with combat-associated major limb loss. We enrolled Vietnam and Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans and servicemembers in a national survey on prosthetic device use. In the Vietnam group, multivariate analysis found multiple limb loss (adjusted odds ratio [aOR] = 3.1, 95% confidence interval [CI] = 1.57–6.02) and satisfaction with current prostheses (aOR = 1.2, 95% CI = 1.05–1.38) are associated with better overall QOL, while a higher amputation impact rank (aOR = 0.66, 95% CI = 0.59–0.74) and depression (aOR = 0.21, 95% CI = 0.08–0.54) are associated with worse overall QOL. In the OIF/OEF group, three factors are significantly associated with worse overall QOL: combat-associated head injury (aOR = 0.78, 95% CI = 0.61–0.99), combat-associated injury to the non-amputated limb (aOR = 0.71, 95% CI = 0.57–0.88), and assistance needed in daily living (aOR = 0.12, 95% CI = 0.02–0.72). Improving satisfaction with prosthetic devices, improving mental health care, and treating other combat-associated injuries may significantly improve the overall QOL for these veterans and servicemembers.

Key words: amputation, combat injuries, limb loss, mental health, OIF/OEF, quality of life, prostheses, servicemembers, veterans, Vietnam.

INTRODUCTION

Technological advances, such as body armor, rapid casualty evacuation, and increased tourniquet use, have significantly decreased the number of lethal combat injuries in Operation Iraqi Freedom and Operation Enduring Freedom (OIF/OEF) in comparison with other modern wars [1–4]. There has been a corresponding increase in the number of nonlethal combat injuries [5]. The vast majority of nonlethal combat injuries are wounds to the limbs [6–7], and a sizable proportion of wounds to the limbs result in limb loss [8–9]. Identifying factors associated with quality of life (QOL) for veterans and servicemembers with combat-associated limb loss may provide critical information vital for their rehabilitation.

Abbreviations: aOR = adjusted odds ratio, CI = confidence interval, OEF = Operation Enduring Freedom, OIF = Operation Iraqi Freedom, PTSD = posttraumatic stress disorder, QOL = quality of life, SF-36 = 36-Item Short-Form Health Survey, WHOQOL-BREF = World Health Organization Quality of Life.

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Consensus opinion is that health-related QOL is a multidimensional construct, but consensus has not yet emerged regarding how QOL should best be measured. Multiple QOL dimensions can be measured and may include domains such as physical function, income, spirituality, psychosocial status, and pain [10]. QOL can also be measured as a global construct [11] using either multiple-item scales [12] or a single-item measure [13–17]. Multiple-item scales evaluate a number of factors that might be important aspects of global QOL, but may add to the survey length. Calibrated item banks and computerized adaptive testing have been used to limit the number of items while retaining validity [18–19].

We decided that a single-item measure of global QOL was appropriate and a minimally burdensome strategy for our exploratory survey. Single-item global QOL measures have been shown to provide reliable and valid assessments of QOL [13–14]. Common examples include the Uniscale [16], the Functional Assessment of Cancer Therapy/Functional Assessment in Chronic Illness Therapy scales [20–21], the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire [22], and the World Health Organization Quality of Life (WHOQOL-BREF) [23]. Further, one recent study assessing QOL in persons with non-combat-associated lower-limb loss using a single-item measure for global QOL identified seven significant predictors of QOL (depression, perceived prosthetic mobility, social support, comorbidity, prosthesis problems, age, and social activity participation) [15].

Prior research on QOL among veterans and servicemembers with combat-associated limb loss is limited [24–26]. Dougherty followed 23 Vietnam war veterans with bilateral transfemoral amputations for a mean of 25 years and compared them with a gender- and sex-matched controls but found few differences using standardized questionnaires on mental and physical health, except that those with limb loss had significantly lower physical functioning scores [25]. In another study reported by Dougherty, 72 Vietnam war veterans with transtibial amputations were followed for a mean of 28 years and compared with controls. Those with limb loss had a significantly increased use of psychological support services [26]. Hoaglund et al. followed 132 Korean and Vietnam war veterans with transtibial limb loss for a mean of 17 years and found an increase in pain but did not report on QOL [24].

The current study uses data collected from veterans and servicemembers with combat-associated major limb loss from the Vietnam war and OIF/OEF conflicts who

participated in the national Survey for Prosthetic Use [27] to identify factors associated with overall QOL and to determine how specific types of co-occurring combat injuries affect QOL.

METHODS

Survey Participants

Participants in this cross-sectional, descriptive survey are veterans and servicemembers from the Vietnam war and OIF/OEF conflicts with at least one combat-associated major traumatic amputation (excluding digit-only loss). We sent veterans and servicemembers with major limb loss that occurred during the Vietnam war (1961–1973) or OIF/OEF conflicts (2000–2008) an invitational letter to participate in a survey on prosthetic use. We invited all servicemembers with major limb loss from OIF/OEF and a selection of Vietnam war veterans to participate (all unilateral upper-limb loss, all multiple limb loss, and a subsample of unilateral lower-limb loss) to obtain a similar number to the total OIF/OEF invitees. Survey participants include 298 from the Vietnam war (65% response rate) and 283 from OIF/OEF (59% response rate). We surveyed participants during 2007 to 2008, and they took the survey by one of three methods (mail, telephone interview, or Website). A description of the detailed study methods and survey are provided elsewhere [28].

We based this survey on the conceptual framework provided by the Aday and Anderson model of healthcare utilization [29] and we modified it by Bradley et al. to include psychosocial factors [30]. This model posits that predisposing, need, enabling, perceived control, and knowledge factors determine healthcare use, outcomes, and costs. QOL is influenced in this model by predisposing, need, and enabling factors; knowledge and coping; and adjustment factors.

Survey Measures

Quality of Life and Health Status

We used a modified version of a commonly used single-item measure of global QOL for our study [23]. We also asked participants to rate their overall QOL: excellent, very good, good, fair, or poor. The concordance of responses to the QOL item was similar (61% agreement) to survey responses on the single-item self-rated health question from the 36-Item Short Form Health Survey (SF-36)

(kappa = 0.47) [12,31]. For this study, we compared those responding “better QOL” (excellent or very good) and “worse QOL” (fair or poor) with those responding “good QOL.” For logistic regression analyses, our goal was to distinguish participants with unequivocally high QOL from those with intermediate or low QOL; thus, we created a bivariate outcome QOL measure comparing “better QOL” (excellent or very good) with those with “worse QOL” (good, fair, or poor responses). We assessed self-rated health status using a validated single-item measure from the SF-36 [13,31].

Demographic Characteristics and Social Situation

Participants provided information on demographics (age, sex, and race) and current social situation (current marital status, whether or not participants have children, current employment status, current military status), as shown in **Table 1**. We collapsed response categories for race, current employment status, and current military status into a limited number of categories because of infrequent responses in some subcategories.

Comorbidities

Participants provided information on the presence or absence of 15 types of comorbidities (including arthritis, posttraumatic stress disorder [PTSD], depression, traumatic brain injury, stroke, diabetes, and migraines) and pain (including phantom pain, residual-limb pain, and chronic back pain).

Functional Capability and Need for Assistance

We categorized functional capability into three levels based on answers to questions about graded level of lower-limb functional capability: (1) nonambulatory (cannot walk, with or without assistance to transfer), (2) ambulatory (can walk, including household or community walkers), and (3) highly active (performs low- to high-impact recreational activities). We re-categorized need for assistance with daily activities as “needing no assistance” with daily activities or “needing any assistance” from another person with daily activities.

Prosthetic Devices

The survey also collected data on current prosthetic device and assistive device use, including the number, type, daily frequency of use, and satisfaction with current prostheses and services. We asked participants to rank their current satisfaction with their prostheses on a scale

ranging from 0 (not at all satisfied) to 10 (completely satisfied). We also asked survey participants to identify the types of prosthetic and assistive devices they might want to try in the next 3 years.

We asked participants to identify the number and type of prostheses they had received in the past (total for the first year postamputation and then total since that time). We collected data on the number of prostheses that wore out and the average replacement time by type of device. For prostheses that were discontinued due to dissatisfaction, we collected the number and type of device as well as the reasons why participants discontinued the prosthesis. Survey participants reported any prosthetic device receipt, regardless if received through military, Department of Veterans Affairs, or private sources. Survey participants also included prototype prosthetic devices received. Detailed descriptions of the types of prosthetic devices in current use, replaced, or stopped due to dissatisfaction are provided elsewhere for those with unilateral upper-limb loss [32], unilateral lower-limb loss [33], multiple limb loss [34], and satisfaction with services [35].

Combat-Associated Injuries

We asked participants to report the date and location of all amputations, number of associated surgeries, level of limb loss, and types of combat injuries. They reported the level of amputation as partial foot, ankle, transtibial, knee disarticulation, transfemoral, hip, transpelvic, partial hand, wrist, transradial, elbow disarticulation, transhumeral, shoulder, or forequarter. We grouped the types of limb loss into three categories: unilateral upper limb, unilateral lower limb, and multiple limb loss. We also created a survey question to determine how much participants’ amputation affects their current QOL. We defined this as the “amputation impact rank.” Survey participants rated the effect of their amputation on a scale of 0 (does not affect QOL at all) to 5 (moderately affects QOL) to 10 (strongly affects QOL). We interpreted higher values of the amputation impact rank as having more effect on current life. Although the survey did not specifically state whether the effect of their amputation was negative or positive, we queried a subsample of survey participants and all reported they interpreted the survey question to mean a negative effect on their life.

We asked survey participants if they sustained any of seven specific types of other combat injuries (besides their amputation): injury to limb(s) with no amputation, head injury, eye injury, hearing loss, chest injury, abdominal

Table 1.

Comparison of factors associated with overall quality of life (QOL) in Vietnam war and Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans and servicemembers with major combat-associated limb loss.

Subjects	Vietnam QOL (<i>n</i> = 297)			OIF/OEF QOL (<i>n</i> = 282)		
	Excellent or Very Good (%) (<i>n</i> = 100)	Good (%) (<i>n</i> = 116)	Fair or Poor (%) (<i>n</i> = 81)	Excellent or Very Good (%) (<i>n</i> = 135)	Good (%) (<i>n</i> = 104)	Fair or Poor (%) (<i>n</i> = 43)
Demographic						
Age (mean ± SD)	61.1 ± 3.0	60.6 ± 3.3	60.3 ± 2.5	29.1 ± 5.2	29.1 ± 6.4	29.6 ± 6.0
Sex						
Male	100 (100.0)	116 (100.0)	81 (100.0)	129 (47.2)	102 (37.4)	42 (15.4)
Female	0 (0.0)	0 (0.0)	0 (0.0)	6 (66.7)	2 (22.2)	1 (11.1)
Race						
Caucasian	86 (35.8)	91 (37.9)	63 (26.2)	104 (51.0)	77 (37.7)	23 (11.3)
Other	13 (23.2)	25 (44.6)	18 (32.1)*	29 (38.7)	26 (34.7)	20 (26.7)*
Lifestyle/Social Support						
Marital Status						
Married/Living Together	79 (35.9)	83 (37.7)	58 (26.4)	84 (49.7)	62 (36.7)	23 (13.6)
Other	19 (25.7)	33 (44.6)	22 (29.7)	47 (43.1)	42 (38.5)	20 (18.3)
Have Children (Yes)	85 (32.7)	104 (40.0)	71 (27.3)	64 (46.7)	52 (38.0)	21 (15.3)
Current Employment Status						
Employed/Student	83 (35.6)	91 (39.1)	59 (25.3)	110 (51.4)	76 (35.5)	28 (13.1)
Retired	17 (27.0)	25 (39.7)	21 (33.3)	22 (36.7)	25 (41.7)	13 (21.7)
Current Military Status						
Medical Discharge	78 (31.8)	95 (38.8)	72 (29.4)	69 (41.8)†	70 (42.4)	26 (15.8)†
Nonmedical Discharge	22 (42.3)	21 (40.4)	9 (17.3)	21 (75.0)	2 (7.1)	5 (17.9)
Active Duty	0 (0.0)	0 (0.0)	0 (0.0)	29 (50.0)	22 (37.9)	7 (12.1)
Rehabilitation	0 (0.0)	0 (0.0)	0 (0.0)	11 (45.8)	9 (37.5)	4 (16.7)
National Guard	0 (0.0)	0 (0.0)	0 (0.0)	5 (71.4)	1 (14.3)	1 (14.3)
Comorbidities						
Total No. of Comorbidities (mean ± SD)	3.6 ± 2.2*	5.1 ± 2.5	7.1 ± 2.6*	3.7 ± 2.3*	5.3 ± 2.3	6.3 ± 2.3*
Arthritis	52 (27.1)*	79 (41.1)	61 (31.8)	23 (31.5)	28 (38.4)	22 (30.1)*
Posttraumatic Stress Disorder	19 (17.0)*	45 (40.2)	48 (42.9)*	60 (36.1)*	70 (42.2)	36 (21.7)*
Depression	8 (11.0)*	27 (37.0)	38 (52.0)*	15 (22.1)*	29 (42.6)	24 (35.3)*
Traumatic Brain Injury	1 (10.0)	1 (10.0)	8 (80.0)*	35 (36.5)	38 (39.6)	23 (24.0)
Migraines	10 (29.4)	11 (32.3)	13 (28.2)	27 (43.6)	20 (32.3)	15 (24.2)*
Pain						
Phantom Pain	58 (27.0)*	86 (40.0)	71 (33.0)*	90 (42.1)*	89 (41.6)	35 (16.4)
Residual Limb Pain	38 (26.4)	54 (37.5)	52 (36.1)*	75 (42.1)	70 (39.3)	33 (18.5)
Chronic Back Pain	16 (14.8)*	44 (40.7)	48 (44.4)*	47 (39.5)*	50 (42.0)	22 (18.5)
Functional Capability						
Lower Limb Functional Capacity‡						
Nonambulatory	10 (33.3)	12 (40.0)	8 (26.7)	3 (50.0)	2 (33.3)	1 (16.7)
Ambulatory	37 (22.6)	75 (45.7)	52 (31.7)	44 (41.5)	44 (41.5)	18 (17.0)
Highly Active	32 (64.0)*	12 (24.0)	6 (12.0)	68 (60.2)	37 (32.7)	8 (7.1)
Needs Assistance§	8 (13.8)*	22 (37.9)	28 (48.3)*	21 (28.4)*	32 (43.2)	21 (28.4)*
Prosthetic Devices						
No. of Current Prosthetic Devices (mean ± SD)	1.4 ± 1.1	1.3 ± 1.1	1.3 ± 1.2	3.8 ± 3.3	3.3 ± 3.1	2.6 ± 2.3
Prosthesis Satisfaction¶ (mean ± SD)	7.8 ± 2.3*	6.8 ± 2.6	6.1 ± 2.8	8.1 ± 1.8*	7.3 ± 2.0	6.6 ± 2.4

**p* < 0.05 compared with "good" QOL within conflict group.

†*p* < 0.04 compared with nonmedical discharge.

‡Functional level groups: highly active (low- or high-impact activities and sports), ambulatory (household, community, uneven surfaces), nonambulatory (cannot walk). Data not collected for unilateral upper-limb participants.

§Needs assistance with activities of daily living.

¶Prosthesis satisfaction scale ranges from 0 (not at all satisfied with current prosthesis) to 10 (completely satisfied).

SD = standard deviation.

injury, and burns. We created a “combat injury impact rank” for this study to determine the degree to which specific combat injuries affect current QOL. Survey participants ranked each type of combat injury on a scale of 0 (does not affect QOL at all) to 5 (moderately affects QOL) to 10 (strongly affects QOL). For veterans and servicemembers reporting specific types of combat injuries, we calculated mean combat injury impact scores.

Statistical Analysis

We examined current data (demographic, health status, comorbidities, functional capability, and current prosthetic use) and retrospective data (combat injuries, type and number of prior prosthetic devices) for their association with current overall QOL using Stata 9.2 (StataCorp; College Station, Texas). For univariate analyses, we based statistical significance on chi-square (categorical data), Mann-Whitney U-test (ordinal data), Student’s *t*-test (continuous data), and Fisher’s exact test for cell sizes < 5. The level of significance is for a two-sided $p \leq 0.05$. We tested variables significant in univariate analyses in multivariate logistic regression models. To avoid overfitting the model, we added variables significant in univariate analyses using forward stepwise selection based on the log likelihood ratio and significance of the coefficient. We then compared the model with the previous model using the log likelihood ratio chi-square test. We kept variables in the model if their inclusion significantly improved model fit. We assessed interactions using the log likelihood ratio and the goodness of fit of the final model using the Hosmer-Lemeshow chi-square test statistic. A $p > 0.05$ indicates a well-fitted model [36–37]. The outcome of the logistic models is a bivariate variable using two groups of overall QOL data: better overall QOL compared with worse overall QOL. We fit type of limb loss as a dummy variable with unilateral lower limb as the comparison group and unilateral upper limb and multiple limb loss as independent variables.

RESULTS

Sample Description

A detailed description of the demographic characteristics of the Vietnam war and OIF/OEF groups with major limb loss is reported in another article in this issue [28]. These groups represent two distinct time periods in the recovery process. The Vietnam war group represents veterans who have had more time to adapt to their limb loss (an

average of 38.8 years postamputation), are older (mean age 61 years), and may be dealing with age-related and other chronic conditions. In contrast, the OIF/OEF group are servicemembers and veterans with relatively recent limb loss (average 3.0 years postamputation), are younger (mean age 29 years), and may be still dealing with healing and rehabilitation from combat injuries and their complications. Of the OIF/OEF group, 9 percent were still receiving rehabilitation services.

Of 298 participants from the Vietnam war group, 178 (59.7%) have unilateral lower-limb loss, 47 (15.8%) have unilateral upper-limb loss, and 73 (24.5%) have multiple limb loss (153 limbs). Of the 283 in the OIF/OEF group, 172 (60.8%) have unilateral lower-limb loss, 50 (17.7%) have unilateral upper-limb loss, and 61 (21.5%) have multiple limb loss (129 limbs).

Univariate Analysis of Overall Quality of Life

Overall, the Vietnam war group reported worse QOL than the OIF/OEF group. In the Vietnam war group, 297 of 298 self-reported their current overall QOL as excellent (33 [11.1%]), very good (67 [22.6%]), good (116 [39.1%]), fair (64 [21.5%]), or poor (17 [5.7%]). In the OIF/OEF group, 282 of 283 self-reported their current QOL as excellent (49 [17.4%]), very good (86 [30.5%]), good (104 [36.9%]), fair (39 [13.8%]), or poor (4 [1.4%]).

Type of Limb Loss

To identify whether type of limb loss is associated with overall QOL, we conducted analyses by type of limb loss separately for each group (**Figure 1**). Interestingly, multiple limb loss is associated with better QOL in both the Vietnam war and OIF/OEF groups. In the Vietnam war group, of participants with unilateral lower-limb loss, 26.4 percent report better QOL, 44.9 percent report good QOL, and 28.7 percent report worse QOL. In the Vietnam war group with unilateral upper-limb loss, significantly more report better QOL (40.4%); those with multiple limb loss (47.2%) also reported better QOL. In the OIF/OEF group with unilateral lower-limb loss, 50.3 percent report better QOL, 38.0 percent report good QOL, and 11.7 percent report worse QOL. For those in the OIF/OEF group with unilateral upper-limb loss, significantly more (30.0%) report worse QOL compared with unilateral lower-limb loss. We found no other significant differences by type of limb loss and QOL for OIF/OEF participants with multiple limb loss.

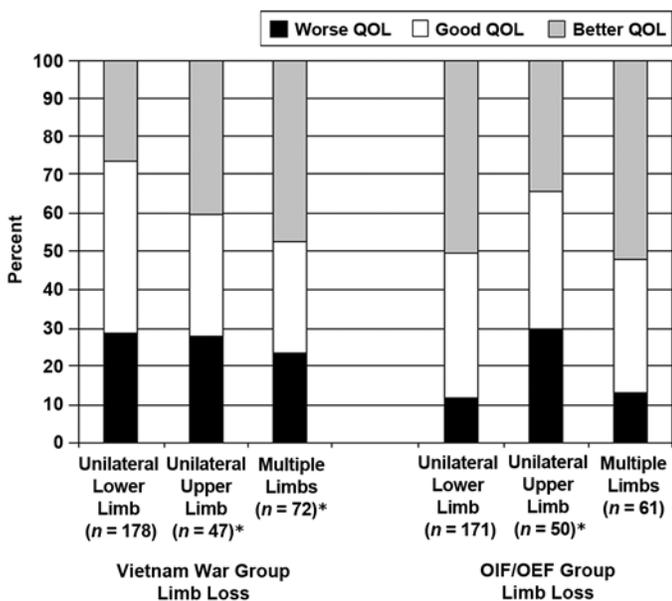


Figure 1.

Overall quality of life (QOL) by number of people with one of three types of combat-associated major limb loss for Vietnam war ($n = 297$) and Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF, $n = 282$) groups. * $p < 0.05$ compared with unilateral lower-limb loss.

Demographic Characteristics and Social Situation

In both groups, demographic (age, sex, and race) and current social situation (marital status, children, current employment status) variables are not associated with overall QOL (**Table 1**). Current military status is significantly associated with QOL in the OIF/OEF group but not in the Vietnam war group. Significantly fewer OIF/OEF participants with medical discharges report better QOL (42%) compared with those with nonmedical discharges (75%). We found no significant differences in the OIF/OEF group for QOL by those on Active Duty, National Guard duty, or in rehabilitation.

Comorbidities

In both groups, an association exists between QOL and mean number of current comorbidities. Higher number of comorbidities is significantly associated with worse overall QOL (**Table 1**). The mean number of comorbidities in the Vietnam war group is significantly higher in the worse QOL group (7.1 ± 2.6) than the good QOL group (5.1 ± 2.5 , $p < 0.001$). The mean number of comorbidities in the OIF/OEF group is also significantly higher (6.3 ± 2.3) in the worse QOL group than the good QOL group (5.3 ± 2.3 , $p = 0.01$). The mean number of comorbidities is signifi-

cantly fewer for those reporting better QOL in both the Vietnam war group (3.6 ± 2.2 , $p < 0.001$) and OIF/OEF group (3.7 ± 2.3 , $p < 0.001$). All data presented as mean \pm standard deviation unless otherwise noted. When we examined specific types of comorbidities, we found several types were associated with current QOL within each group (**Table 1**). In the Vietnam war group, we found worse QOL significantly associated with PTSD (42.9%), depression (52.0%), and traumatic brain injury (80.0%). In the OIF/OEF group, we found worse QOL significantly more frequent in those reporting arthritis (30.0%), PTSD (21.7%), depression (35.3%), and migraines (24.2%). In the Vietnam war group, we found three types of pain also significantly associated with worse QOL: phantom pain (33.0%), residual-limb pain (36.1%), and chronic back pain (44.4%), while pain was not associated with worse QOL in the OIF/OEF group.

Functional Capability and Need for Assistance

We found lower-limb functional capability not associated with QOL in either group (**Table 1**). We found the only significant difference in the Vietnam war group who reported being highly active (64.0% reported better QOL compared with 24.0% who reported only good QOL). For the OIF/OEF group, we found no significant association between lower-limb functional level and QOL. In contrast, we found a significant association between overall QOL and needing assistance with activities of daily living in both groups. Of the Vietnam war group participants who need assistance with daily activities, 48.3 percent report worse QOL compared with 37.9 percent reporting good QOL ($p = 0.01$). Of the OIF/OEF group who require assistance, most (43.2%) report only good QOL and significantly fewer (28.4%) report better QOL ($p = 0.04$).

Prosthetic Devices

We found no statistically significant associations between overall QOL and the number of current prosthetic devices (**Table 1**). We found no significant association between overall QOL and the number of prosthetic devices ever received or the type (myoelectric, electronic, body-powered, cosmetic, sports leg, etc.) of prostheses (data not shown). In both the Vietnam war and OIF/OEF groups, veterans and servicemembers who report better overall QOL also report higher satisfaction scores with their current prosthetic devices than do veterans and servicemembers with worse overall QOL (**Table 1**).

Combat-Associated Injuries

The incident responsible for combat-associated limb loss typically results in multiple other types of combat-associated injuries. **Figure 2** shows these other types of combat-associated injuries. The most frequent types of other combat injury in the Vietnam war group include hearing loss (47%) and injuries to the nonamputated limb(s) (33%). The most frequent in the OIF/OEF group included hearing loss (48%), injuries to the nonamputated limb(s) (45%), and injuries to the head (34%). The OIF/OEF group reported significantly more injuries to the nonamputated limb(s) ($p = 0.01$), head ($p < 0.001$), and burns ($p = 0.04$) than did the Vietnam war group (**Figure 2**). In the Vietnam war group, we found the mean number of combat injuries (excluding amputation) was significantly higher (3.7 ± 2.4 , $p < 0.01$) in those reporting worse QOL than in those reporting good (2.7 ± 1.7) or better (2.8 ± 1.9) QOL. In contrast, in the OIF/OEF group, those reporting better QOL had significantly more combat injuries (3.1 ± 1.7 , $p = 0.02$) than those with good QOL (3.6 ± 1.9). For those in the OIF/OEF group with worse QOL, we found the mean number of combat injuries (4.3 ± 2.2) not significantly different from those reporting good QOL.

We also examined combat injuries by the type of limb loss (**Table 2**) to determine if the types of combat injuries changed by conflict. Nearly one-third of the Vietnam war group reported injuries to the nonamputated limb(s), but we found no difference by type of limb loss group. Injury to the other nonamputated limb(s) occurs more frequently

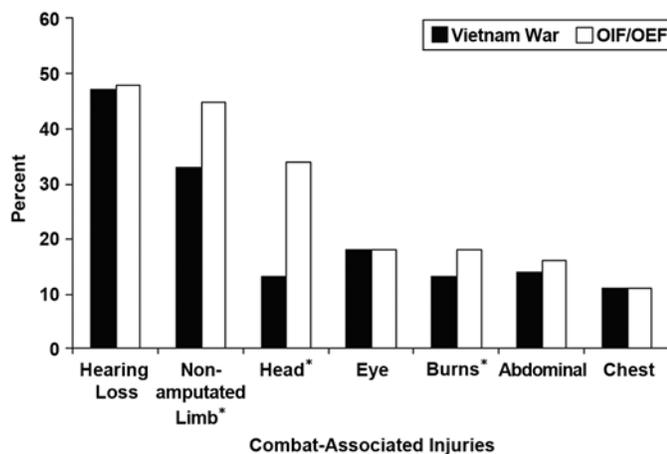


Figure 2.

Other types of combat-associated injuries associated with major limb loss in Vietnam war and Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) groups. * $p < 0.05$.

in the OIF/OEF group than in the Vietnam war group. Of the OIF/OEF group, 50.6 percent with unilateral lower-limb loss and 42.6 percent with multiple limb loss report injuries to nonamputated lower limbs ($p < 0.01$). We found head injuries were significantly more frequent across all limb-loss groups in the OIF/OEF group (29.6%–46.0%) than in the Vietnam group (10.1%–22.2%). Hearing loss is significantly more frequent in the OIF/OEF group with unilateral upper-limb loss (62.0%) than the Vietnam war group (34.0%).

We assessed the effect of combat injuries on current life for the Vietnam war group (**Figure 3**) and the OIF/OEF group (**Figure 4**). In the Vietnam war group, those with unilateral lower-limb loss reported their amputation had the highest effect on current life (amputation impact rank = 7.5 ± 2.7 , $p < 0.05$) compared with unilateral upper-limb loss (7.0 ± 3.0) or multiple limb loss (7.1 ± 3.1). In the Vietnam war group, we found other types of combat injuries also associated with a higher impact rank depending on the type of limb loss. For those with unilateral lower-limb loss in the Vietnam war group, we found the highest effect for injury to the nonamputated lower limb (mean combat injury rank = 5.4 ± 3.1); for those with unilateral upper limb loss, eye injuries were highest (7 ± 3.4); and for those with multiple limb loss, hearing loss had the highest effect (5.7 ± 2.4). In the OIF/OEF group (**Figure 4**), amputation has the highest effect for those with unilateral upper-limb loss (mean impact rank = 8.1 ± 2.3 , $p < 0.05$) compared with unilateral lower-limb loss (6.8 ± 2.6) or multiple limb loss (7.9 ± 2.7). In the OIF/OEF group, injury to the nonamputated limb had the greatest effect on current life for all three limb loss groups: unilateral lower limb (mean impact rank = 5.0 ± 3.4), unilateral upper-limb (5 ± 3.5), and multiple limb loss (5.9 ± 3.5).

Multivariate Analysis of Overall Quality of Life

As many of these variables may be correlated with QOL or one another, we used logistic regression to estimate the effect of these variables on QOL (**Table 3**). In the Vietnam war group, multivariate analysis found multiple limb loss (adjusted odds ratio [aOR] = 3.07, 95% confidence interval [CI] = 1.57–6.02) and satisfaction with current prostheses (aOR = 1.20, 95% CI = 1.05–1.38) were associated with better QOL, while a higher amputation impact rank (aOR = 0.66, 95% CI = 0.59–0.74) and depression (aOR = 0.21, 95% CI = 0.08–0.54) were associated with worse overall QOL. In the OIF/OEF group, after adjusting for the type of limb loss, we found three

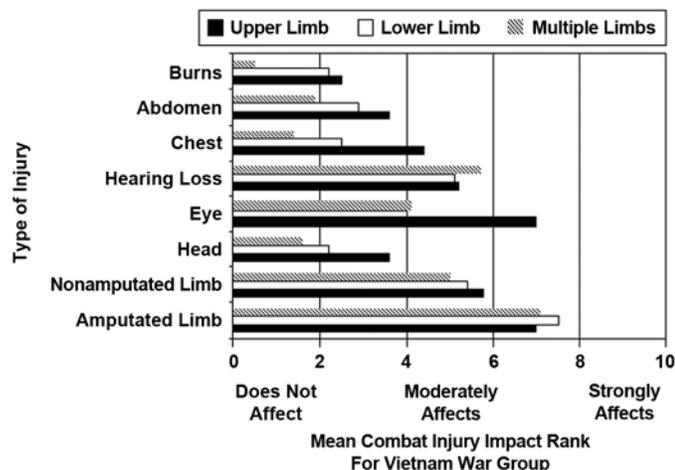
Table 2.

Frequency of types of combat-associated injuries by type of limb loss in Vietnam war and Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans and servicemembers with major combat-associated limb loss.

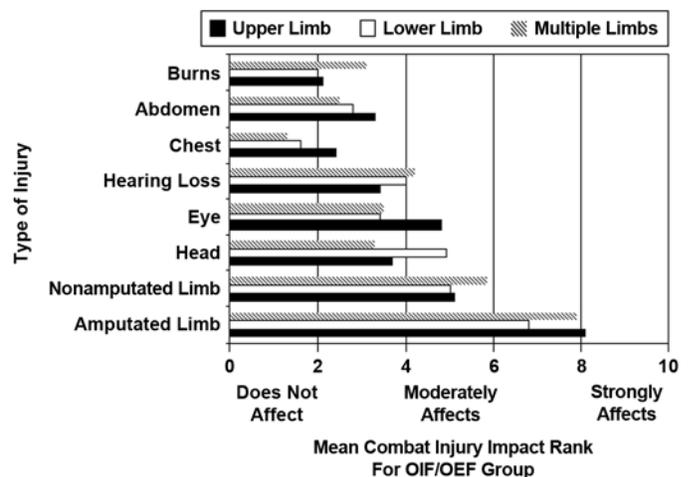
Type of Limb Loss	Frequency (%) by Type of Combat-Associated Injury							
	Amputated Limb	Injuries to Nonamputated Limb(s)	Head	Eye	Hearing Loss	Chest	Abdominal	Burns
Vietnam (n = 297)								
Unilateral Lower Limb	178 (100.0)	66 (37.1)	18 (10.1)	25 (14.0)	89 (50.0)	17 (9.6)	19 (10.7)	17 (9.6)
Unilateral Upper Limb	47 (100.0)	13 (27.6)	5 (10.6)	8 (17.0)	16 (34.0)	5 (10.6)	9 (19.1)	6 (12.8)
Multiple Limb(s)*	153 (100.0)	41 (26.8)	34 (22.2)	42 (27.5)	69 (45.1)	22 (14.3)	26 (17.0)	25 (16.3)
Total Limbs	378 (100.0)	120 (32.0)	57 (15.0)	75 (20.0)	174 (46.0)	44 (12.0)	54 (14.3)	48 (13.0)
OIF/OEF (n = 282)								
Unilateral Lower Limb	172 (100.0)	87 (50.6) [†]	51 (29.6) [†]	19 (11.0)	77 (44.8)	14 (8.1)	24 (13.9)	26 (15.1)
Unilateral Upper Limb	50 (100.0)	16 (32.0)	23 (46.0) [†]	8 (16.0)	31 (62.0)*	10 (20.0)	9 (18.0)	12 (24.0)
Multiple Limb(s)*	129 (100.0)	55 (42.6) [†]	46 (35.7) [†]	32 (24.8)	54 (41.9)	15 (11.6)	22 (17.0)	25 (19.4)
Total Limbs	351 (100.0)	158 (45.0)	120 (34.2)	59 (17.0)	162 (46.0)	39 (11.0)	55 (16.0)	63 (18.0)

*Multiple limbs include Vietnam war (378 limbs) and OIF/OEF (351 limbs) veterans and servicemembers.

[†] $p < 0.05$ compared with other group within limb-loss category.

**Figure 3.**

Mean combat injury impact rank by type of limb loss for each type of combat-associated injury in veterans with major combat-associated limb loss from Vietnam war group.

**Figure 4.**

Mean combat injury impact rank by type of limb loss for each type of combat-associated injury in veterans and servicemembers with major combat-associated limb loss from Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) group.

factors significantly associated with worse overall QOL : combat-associated head injury (aOR = 0.78, 95% CI = 0.61–0.99), combat-associated injury impact rank to the nonamputated limb (aOR = 0.71, 95% CI = 0.57–0.88), and needing assistance with activities of daily living

(aOR = 0.12, 95% CI = 0.02–0.72). We found no significant interactions between variables in either model, and no other variables examined in the univariate analysis improved the model fit.

Table 3.

Multivariate analysis of variables associated with better overall quality of life (QOL) in Vietnam war and Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans and servicemembers with major combat-associated limb loss.

Variable	Vietnam (<i>n</i> = 297)			OIF/OEF (<i>n</i> = 282)		
	aOR	95% CI	<i>p</i> -Value	aOR	95% CI	<i>p</i> -Value
Multiple Limb Loss*	3.07	1.57–6.02	0.001	0.28	0.06–1.31	0.11 [†]
Prosthetic Satisfaction Score [‡]	1.20	1.05–1.38	0.008	—	—	—
Amputation Impact Rank [§]	0.66	0.59–0.74	<0.001	—	—	—
Depression	0.21	0.08–0.54	0.001	—	—	—
Head Injury	—	—	—	0.78	0.61–0.99	0.05
Combat Injury Impact Rank for Nonamputated Limb [¶]	—	—	—	0.71	0.57–0.88	0.002
Needs Assistance**	—	—	—	0.12	0.02–0.72	0.02
Unilateral Upper Limb	2.21	0.83–5.87	0.11 [†]	0.67	0.98–4.58	0.68 [†]

Note: — = variable not included in model, goodness of fit for Vietnam war model ($\chi^2 = 130.3$, 139 degrees of freedom, $p = 0.69$) and for OIF/OEF model ($\chi^2 = 62.5$, 51 degrees of freedom, $p = 0.13$).

*Compared with unilateral lower limb, multiple limbs include Vietnam war (378 limbs) and OIF/OEF (351 limbs) veterans and servicemembers.

[†]Adjusted for in model.

[‡]Prosthetic satisfaction rank ranges from 0 (not at all satisfied) to 10 (completely satisfied).

[§]Amputation impact rank ranges from 0 (limb loss does not affect QOL today) to 10 (strongly affects) and is specific for effect of amputated limb(s) only.

[¶]Combat injury impact rank for nonamputated limb ranges from 0 (does not affect QOL today) to 10 (strongly affects).

**Needs assistance with activities of daily living.

aOR = adjusted odds ratio, CI = confidence interval.

DISCUSSION

Improving QOL for veterans and servicemembers with combat-associated limb loss is an important goal for rehabilitation care. The current study used an adapted version of the WHOQOL-BREF single-item measure because it has been shown to be valid in persons with a number of health conditions, including traumatic spinal cord injury, that can present similar challenges to those associated with traumatic limb loss [38]. Predictors of this single-item QOL measure are useful in identifying how healthcare may be improved for veterans and servicemembers with limb loss.

The current study identified specific factors associated with overall QOL for two distinct groups of veterans and servicemembers from the Vietnam war and OIF/OEF conflicts. The advantage of assessing these different groups is that we can compare QOL at two different times in the post limb-loss lives of veterans and servicemembers with combat injuries. As expected, the Vietnam war group is both older and has experienced a much longer time interval between limb loss and the survey. The Vietnam war group has had more time to adapt to their limb loss and to improve their coping skills but has also had time to develop comorbidities and other age-related health problems. For the Vietnam war group, better overall QOL was reported by

persons with multiple limb loss and those who report greater satisfaction with their current prostheses. Self-reported overall QOL was significantly worse in the Vietnam war participants who report their amputation has a greater effect on their life and those who report depression. An unexpected finding was the better QOL reported by those with multiple limb loss compared with those with unilateral lower-limb loss. Survey participants with multiple limb loss often experience more severe combat injuries, but they also reported a shift in life priorities and were thankful to be alive. The Vietnam war group has had nearly 38 years to adapt and develop coping skills. This improvement in QOL was not apparent in the OIF/OEF group with multiple limb loss, but they have had an average of only 3 years to develop coping skills. In another survey of people with limb loss, participants with bilateral limb loss more frequently reported that they considered something good had happened to their life (character building, more appreciation for life, developing coping abilities) as a result of their amputations [39]. Taken together, these findings suggest that reported QOL of survivors of catastrophic injuries may shift as they gain new perspectives on life priorities and develop improved coping skills as a result of their injuries. This “response shift” has been described in other studies of disability and needs to be further explored [40]. Individuals may also change how they appraise their QOL

over time as life priorities shift [41]. We found the QOL of OIF/OEF participants was not significantly associated with pain, while in the Vietnam war participants, we found pain was associated with QOL. Response shift may explain why OIF/OEF servicemembers with recent limb loss (who are involved in acute rehabilitation and recovery issues) may view pain with less priority. Vietnam war participants (who are older and have more comorbidities) may view pain as a higher priority as they are no longer focused on the strenuous rehabilitation process.

In the Vietnam war group, we found satisfaction with current prostheses was associated with slightly better QOL, but no other measure of prosthetic device use or specific satisfaction measure associated with QOL. This finding may indicate that issues other than prosthetic device problems play an important role in determining overall QOL in older veterans. When asked about the overall effect their amputation had on their QOL, those in the Vietnam war group with worse QOL reported their amputation had a greater effect. Our survey did not reveal the specific effects of amputation on QOL. We found prosthetic use by number or type, number of surgeries, most comorbidities, and family support were not associated with QOL. Depression was the only factor we found associated with worse QOL in the Vietnam war group, which is not surprising. Asano et al. reported that depression accounted for 30 percent of the variance in QOL in his study of 415 people with lower-limb loss [15].

The OIF/OEF group is earlier in their recovery and adaptation process. For this group, we found worse overall QOL was associated with combat-associated head injury, a greater effect of the injury to the nonamputated limb, and need for assistance with activities of daily living. These factors are more proximal to the time of amputation and may reflect that the OIF/OEF group is still in the process of developing coping skills. Differences may also reflect changes in types of combat injuries and early medical care received [42–43]. It is also interesting to observe that not all combat-associated injuries have the same effect on a person's life with limb loss. In contrast to the Vietnam war group, the OIF/OEF servicemembers did not report that their amputation affected their QOL as strongly as other factors. Significant variables associated with QOL in the two groups reflect variables that have high priority at the time. As the veteran ages, other variables have greater effect on their current QOL, such as satisfaction with their prosthetic devices and other comorbidities. These other injuries should not be neglected in the care and management of patients with limb loss. As we did not collect

information on the severity of the combat injuries and their effect on QOL, future studies could collect this data and evaluate the association between the severity of combat injuries and overall QOL later in life.

These findings expand our understanding of combat-related limb loss. Prior studies have found that, in comparison with matched controls, veterans from the Vietnam and Korean war conflicts with combat-associated limb loss report lower physical and physical role functioning [25], more pain [24], and increased use of psychological support services [26]. While we found these associations in the univariate analysis of our survey data, after controlling for other variables, lower function and pain were not associated with QOL.

QOL in people with noncombat limb loss (due to injury or disease) has also been reported. Our results are generally consistent with findings reported in non-combat-associated limb loss, but there are important differences. Consistent with the results of the current study, these studies demonstrate that age, depression, perceived prosthetic mobility problems, and comorbidity are associated with worse QOL [15]. Social support and social functioning have been associated with better QOL [15,44–45]. We did not directly measure social support, but employment status and family support were not associated with better or worse QOL in either group. Another study demonstrated that physical role functioning and pain [46] were also associated with overall QOL in those with noncombat traumatic amputations. These differences may reflect differences between civilian and military medical and rehabilitation care or differences in etiology (isolated trauma vs congenital or dysvascular disease) resulting in a different clinical experience than combat-associated limb loss, which typically results in complex blast injuries and significant tissue destruction [3,5–6,24].

The strengths of our study include use of a standard survey for two distinctly different combat groups (Vietnam war and OIF/OEF). In addition, the use of three modes of survey administration (mail, telephone interview, or Web site) achieved a good response rate in both Vietnam war (65%) and OIF/OEF (59%) groups. The preferred survey response method differed by group, as 65 percent of veterans from the Vietnam war group preferred the mail-out/mail-back method, whereas only 26.5 percent of the OIF/OEF group selected this option. Significantly more OIF/OEF servicemembers took the survey on our Web site (40%) or by telephone interview (33%) than Vietnam war veterans (23% and 12%, respectively, $p < 0.001$). While some other studies have reported differences in survey responses depending

upon the mode of administration [47–48], other studies have found no effect by mode of administration [49–50]. We did not find that the mode of administration significantly influenced the responses of survey participants.

Study limitations include potential bias because of exclusion of veterans and servicemembers who did not choose to participate in the survey, recall bias, and the cross-sectional design of the survey. While this survey is unique in obtaining a relatively high follow-up rate, those who were not located or who refused to participate could have a substantially different experience of limb loss. QOL has been shown to change over time, perhaps due to changes in life situations and to transient mood states [51], and reticence to report negative experiences may present additional biases to the measurement of self-reported QOL. Prospective and longitudinal studies would be useful to evaluate causality of factors associated with QOL in those with combat-related limb loss. We also recommend collecting data on the severity of combat-associated injuries and social support to see what future effect these factors have on QOL. In addition, prospective studies could evaluate if shifting from one category of QOL to another has clinical relevance or affects the recovery of veterans and servicemembers with limb loss.

CONCLUSIONS

In summary, these findings have important and direct implications for clinical care and research. The current study suggests resources must be devoted to promote the psychosocial adjustment of veterans and servicemembers with combat-associated limb loss, including the provision of appropriate educational, employment, and recreational options. Regarding clinical care, rehabilitation efforts must not only focus on functional restoration but must also regard as critical the need to address subtle aspects of adjusting to life with limb loss and prothesis use and encourage veterans and servicemembers to become active members of their treatment teams.

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REFERENCES

1. Stansbury LG, Lalliss SJ, Branstetter JG, Bagg MR, Holcomb JB. Amputations in U.S. military personnel in the current conflicts in Afghanistan and Iraq. *J Orthop Trauma*. 2008;22(1):43–46. [PMID: 18176164] DOI:10.1097/BOT.0b013e31815b35aa
2. Eastridge BJ, Jenkins D, Flaherty S, Schiller H, Holcomb JB. Trauma system development in a theater of war: Experiences from Operation Iraqi Freedom and Operation Enduring Freedom. *J Trauma*. 2006;61(6):1366–73. [PMID: 17159678] DOI:10.1097/01.ta.0000245894.78941.90
3. Kauvar DS, Wolf SE, Wade CE, Cancio LC, Renz EM, Holcomb JB. Burns sustained in combat explosions in Operations Iraqi and Enduring Freedom (OIF/OEF explosion burns). *Burns*. 2006;32(7):853–57. [PMID: 16899341] DOI:10.1016/j.burns.2006.03.008
4. Blood CG, Puyana JC, Pitlyk PJ, Hoyt DB, Bjerke HS, Fridman J, Walker GJ, Zouris JM, Zhang J. An assessment of the potential for reducing future combat deaths through medical technologies and training. *J Trauma*. 2002;56(6):1160–65. [PMID: 12478044] DOI:10.1097/00005373-200212000-00021
5. Holcomb JB, McMullin NR, Pearse L, Caruso J, Wade CE, Oetjen-Gerdes L, Champion HR, Lawnick M, Farr W, Rodriguez S, Butler FK. Causes of death in U.S. Special Operations Forces in the global war on terrorism: 2001–2004. *Ann Surg*. 2007;245(6):986–91. [PMID: 17522526] DOI:10.1097/01.sla.0000259433.03754.98
6. Clouse WD, Rasmussen TE, Perlstein J, Sutherland MJ, Peck MA, Eliason JL, Jazrevic S, Jenkins DH. Upper extremity vascular injury: A current in-theater wartime

- report from Operation Iraqi Freedom. *Ann Vasc Surg.* 2006;20(4):429–34. [PMID: 16799853] DOI:10.1007/s10016-006-9090-3
7. Owens BD, Kragh J F Jr, Macaitis J, Svoboda SJ, Wenke JC. Characterization of extremity wounds in Operation Iraqi Freedom and Operation Enduring Freedom. *J Orthop Trauma.* 2007;21(4):254–57. [PMID: 17414553] DOI:10.1097/BOT.0b013e31802f78fb
 8. Livingston RD Jr. Orthopedic management of wartime trauma patients. *Mil Med.* 1985;150(2):72–76. [PMID: 3919337]
 9. Champion HR, Bellamy RF, Roberts CP, Leppaniemi A. A profile of combat injury. *J Trauma.* 2003;54(5 Suppl):S13–19. [PMID: 12768096]
 10. Zidarov D, Swaine B, Gauthier-Gagnon C. Quality of life of persons with lower-limb amputation during rehabilitation and at 3-month follow-up. *Arch Phys Med Rehabil.* 2009;90(4):634–45. [PMID: 19345780] DOI:10.1016/j.apmr.2008.11.003
 11. Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life. A conceptual model of patient outcomes. *JAMA.* 1995;273(1):59–65. [PMID: 7996652] DOI:10.1001/jama.273.1.59
 12. Ware JE. SF-36 Health Survey: Manual and interpretation guide. Lincoln (RI): Quality Metric Inc; 2000.
 13. DeSalvo KB, Fan VS, McDonnell MB, Fihn SD. Predicting mortality and healthcare utilization with a single question. *Health Serv Res.* 2005;40(4):1234–46. [PMID: 16033502] DOI:10.1111/j.1475-6773.2005.00404.x
 14. Ferrans CE. Differences in what quality-of-life instruments measure. *J Natl Cancer Inst Monogr.* 2007;(37):22–26. [PMID: 17951227] DOI:10.1093/jncimonographs/lgm008
 15. Asano M, Rushton P, Miller WC, Deathe BA. Predictors of quality of life among individuals who have a lower limb amputation. *Prosthet Orthot Int.* 2008;32(2):231–43. [PMID: 18569891] DOI:10.1080/03093640802024955
 16. Buchanan DR, O'Mara AM, Kelaghan JW, Minasian LM. Quality-of-life assessment in the symptom management trials of the National Cancer Institute-supported Community Clinical Oncology Program. *J Clin Oncol.* 2005;23(3):591–98. [PMID: 15659506] DOI:10.1200/JCO.2005.12.181
 17. Sloan JA, Loprinzi CL, Kuross SA, Miser AW, O'Fallon JR, Mahoney MR, Heid IM, Bretscher ME, Vaught NL. Randomized comparison of four tools measuring overall quality of life in patients with advanced cancer. *J Clin Oncol.* 1998;16(11):3662–73. [PMID: 9817289]
 18. Reeve BB, Hays RD, Bjorner JB, Cook KF, Crane PK, Teresi JA, Thissen D, Revicki DA, Weiss DJ, Hambleton RK, Liu H, Gershon R, Reise SP, Lai JS, Cella D; PROMIS Cooperative Group. Psychometric evaluation and calibration of health-related quality of life item banks: Plans for the Patient-Reported Outcomes Measurement Information System (PROMIS). *Med Care.* 2007;45(5 Suppl 1):S22–31. [PMID: 17443115]
 19. Lai JS, Cella D, Chang CH, Bode RK, Heinemann AW. Item banking to improve, shorten and computerize self-reported fatigue: An illustration of steps to create a core item bank from the FACIT-Fatigue Scale. *Qual Life Res.* 2003;12(5):485–501. [PMID: 13677494] DOI:10.1023/A:1025014509626
 20. Cella DF, Bonomi AE, Lloyd SR, Tulsky DS, Kaplan E, Bonomi P. Reliability and validity of the Functional Assessment of Cancer Therapy-Lung (FACT-L) quality of life instrument. *Lung Cancer.* 1995;12(3):199–220. [PMID: 7655830] DOI:10.1016/0169-5002(95)00450-F
 21. Cella DF, Tulsky DS, Gray G, Sarafian B, Linn E, Bonomi A, Silberman M, Yellen SB, Winicour P, Brannon J. The Functional Assessment of Cancer Therapy scale: Development and validation of the general measure. *J Clin Oncol.* 1993;11(3):570–79. [PMID: 8445433]
 22. Aaronson NK, Ahmedzai S, Bergman B, Bullinger M, Cull A, Duez NJ, Flechtner H, Fleishman SB, De Haes JC. The European Organization for Research and Treatment of Cancer QLQ-C30: A quality-of-life instrument for use in international clinical trials in oncology. *J Natl Cancer Inst.* 1993;85(5):365–76. [PMID: 8433390] DOI:10.1093/jnci/85.5.365
 23. Development of the World Health Organization WHOQOL-BREF quality of life assessment. The WH OQOL Group. *Psychol Med.* 1998;28(3):551–58. [PMID: 9626712] DOI:10.1017/S0033291798006667
 24. Hoaglund FT, Jergesen HE, Wilson L, Lamoreux LW, Roberts R. Evaluation of problems and needs of veteran lower-limb amputees in the San Francisco Bay Area during the period 1977–1980. *J Rehabil Res Dev.* 1983;20(1):57–71. [PMID: 6887067]
 25. Dougherty PJ. Long-term follow-up study of bilateral above-the-knee amputees from the Vietnam war. *J Bone Joint Surg Am.* 1999;81(10):1384–90. [PMID: 10535588]
 26. Dougherty PJ. Transtibial amputees from the Vietnam war. Twenty-eight-year follow-up. *J Bone Joint Surg Am.* 2001;83-A(3):383–89. [PMID: 11263642]
 27. Reiber GE. Impact of the DoD paradigm shift on VA amputee prosthetic care. Washington (DC): Department of Veterans Affairs Health Services Research and Development Service; 2006–9.
 28. Reiber GE, McFarland LV, Hubbard S, Maynard C, Blough DK, Gambel JM, Smith DG. Servicemembers and veterans with major traumatic limb loss from Vietnam war and OIF/OEF conflicts: Survey methods, participants, and summary findings. *J Rehabil Res Dev.* 2010;47(4):275–98.

29. Aday LA, Anderson R. A framework for the study of access to medical care. *Health Serv Res.* 1974;9(3):208–20. [PMID: 4436074]
30. Bradley EH, McGraw SA, Curry L, Buckser A, King KL, Kasl SV, Andersen R. Expanding the Andersen model: The role of psychosocial factors in long-term care use. *Health Serv Res.* 2002;37(5):1221–42. [PMID: 121479494] DOI:10.1111/1475-6773.01053
31. Ware JE, Kosinski M. SF-36 physical and mental health summary scales: A manual for users of version 1. Lincoln (RI): Quality Metric Inc; 2001.
32. McFarland LV, Hubbard Winkler SL, Heinemann AW, Jones M, Esquenazi A. Unilateral upper-limb loss: Satisfaction and prosthetic-device use in veterans and servicemembers from Vietnam and OIF/OEF conflicts. *J Rehabil Res Dev.* 2010;47(4):299–317.
33. Gailey R, McFarland LV, Cooper RA, Czerniecki J, Gambel JM, Hubbard S, Maynard C, Smith DG, Reiber GE. Unilateral lower-limb loss: Prosthetic device use and functional outcomes in servicemembers from Vietnam war and OIF/OEF conflicts. *J Rehabil Res Dev.* 2010;47(4):317–32.
34. Dougherty PJ, McFarland LV, Smith DG, Esquenazi A, Blake DJ, Reiber GE. Multiple traumatic limb loss: A comparison of Vietnam veterans to OIF/OEF servicemembers. *J Rehabil Res Dev.* 2010;47(4):333–48.
35. Berke GM, Ferguson J, Milani JR, Hattingh J, McDowell M, Nguyen V, Reiber GE. Comparison of satisfaction with current prosthetic care in veterans and servicemembers from Vietnam and OIF/OEF conflicts with traumatic limb loss. *J Rehabil Res Dev.* 2010;47(4):361–72.
36. Colak C, Colak MC, Orman MN. [The comparison of logistic regression model selection methods for the prediction of coronary artery disease]. *Anadolu Kardiyol Der g.* 2007;7(1):6–11. Turkish. [PMID: 17347067]
37. Ash AS, Schwartz M. Evaluating the performance of risk-adjustment methods: Dichotomous measures. In: Iezzoni LI, editor. *Risk adjustment for measuring health care outcomes.* Ann Arbor (MI): Health Administration Press; 1994. p. 313–46.
38. Jang Y, Hsieh CL, Wang YH, Wu YH. A validity study of the WHOQOL-BREF assessment in persons with traumatic spinal cord injury. *Arch Phys Med Rehabil.* 2004;85(11):1890–95. [PMID: 15520987] DOI:10.1016/j.apmr.2004.02.032
39. Gallagher P, MacLachlan M. Positive meaning in amputation and thoughts about the amputated limb. *Prosthet Orthot Int.* 2000;24(3):196–204. [PMID: 11195354] DOI:10.1080/03093640008726548
40. Schwartz CE, Andresen EM, Nosek MA, Krahn GL; RRTC Expert Panel on Health Status Measurement. Response shift theory: Important implications for measuring quality of life in people with disability. *Arch Phys Med Rehabil.* 2007;88(4):529–36. [PMID: 17398257] DOI:10.1016/j.apmr.2006.12.032
41. Rapkin BD, Schwartz CE. Toward a theoretical model of quality-of-life appraisal: Implications of findings from studies of response shift. *Health Qual Life Outcomes.* 2004;2:14. [PMID: 15023229] DOI:10.1186/1477-7525-2-14
42. Pasquina PF, Bryant PR, Huang ME, Roberts TL, Nelson VS, Flood KM. Advances in amputee care. *Arch Phys Med Rehabil.* 2006;87(3 Suppl 1):S34–45. [PMID: 16500191] DOI:10.1016/j.apmr.2005.11.026
43. Friedemann-Sánchez G, Sayer NA, Pickett T. Provider perspectives on rehabilitation of patients with polytrauma. *Arch Phys Med Rehabil.* 2008;89(1):171–78. [PMID: 18164350] DOI:10.1016/j.apmr.2007.10.017
44. Lerner RK, Esterhai JL Jr, Polomano RC, Cheatle MD, Heppenstall RB. Quality of life assessment of patients with post-traumatic fracture nonunion, chronic refractory osteomyelitis, and lower-extremity amputation. *Clin Orthop Relat Res.* 1993;(295):28–36. [PMID: 8403662]
45. Dunn DS. Well-being following amputation: Salutary effects of positive meaning, optimism, and control. *Rehabil Psychol.* 1996;41(4):285–302. DOI:10.1037/0090-5550.41.4.285
46. Smith DG, Horn P, Malchow D, Boone DA, Reiber GE, Hansen ST Jr. Prosthetic history, prosthetic charges, and functional outcome of the isolated, traumatic below-knee amputee. *J Trauma.* 1995;38(1):44–47. [PMID: 7745656] DOI:10.1097/00005373-199501000-00013
47. Molina JA, Lim GH, Seow E, Heng BH. Effects of survey mode on results of a patient satisfaction survey at the observation unit of an acute care hospital in Singapore. *Ann Acad Med Singapore.* 2009;38(6):487–87. [PMID: 19565098]
48. Walsh EG, Khatutsky G. Mode of administration effects on disability measures in a sample of frail beneficiaries. *Gerontologist.* 2007;47(6):838–44. [PMID: 18192637]
49. Ritter P, Lorig K, Laurent D, Matthews K. Internet versus mailed questionnaires: A randomized comparison. *J Med Internet Res.* 2004;6(3):e29. [PMID: 15471755] DOI:10.2196/jmir.6.3.e29
50. Salaffi F, Gasparini S, Grassi W. The use of computer touch-screen technology for the collection of patient-reported outcome data in rheumatoid arthritis: Comparison with standardized paper questionnaires. *Clin Exp Rheumatol.* 2009;27(3):459–68. [PMID: 19604439]
51. Mochizuki Y, Omura K, Matsushima E. [Changing trend over time of psychological states and quality of life of oral cancer patients with surgery]. *Ko kubyo Gakkai Zasshi.* 2009;76(1):16–24. Japanese. [PMID: 19378776]

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