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Traffic accident victims and polytrauma patients: injury patterns, outcome and their influencing factors

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Citation
Leijdesdorff, H. A. (2022, November 24). *Traffic accident victims and polytrauma patients: injury patterns, outcome and their influencing factors*. Retrieved from https://hdl.handle.net/1887/3487305

Version:	Publisher's Version
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Downloaded from:	https://hdl.handle.net/1887/3487305

Note: To cite this publication please use the final published version (if applicable).

7

Reduced Quality of Life, Fatigue, and Societal Participation After Polytrauma.

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International Surgery, 2018.

ABSTRACT

Background

This cross-sectional study analysed associations between and determinants for Health-Related Quality of Life (HRQoL), fatigue and societal participation in polytrauma patients.

Summary of Background Data

More polytrauma patients survive their injuries, often resulting in long-term disabilities. HRQoL is therefore an important outcome of trauma care. Fatigue and societal participation may be related to HRQoL. Also, their relation to severe injuries has not been studied to date.

Methods

283 polytrauma patients (ISS≥16) admitted to the Dutch level 1 Trauma Centre West were analysed. HRQoL was measured by the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores of the SF-36, fatigue by the Multidimensional Fatigue Inventory and societal participation by the Utrecht Scale for Evaluation of Rehabilitation-Participation. Age, gender, comorbidity, injury pattern, injury severity and time since trauma were analysed as potential determinants.

Results

122 patients (43%) responded after a median follow-up of 15 (10-23) months after polytrauma. 44% reported reduced physical health (PCS<45) and 47% reduced mental health (MCS<45). HRQoL was highly correlated with all fatigue and participation subscales. Severe head injury was associated with worse mental health. Female patients reported more general and mental fatigue and were less satisfied with their ability to perform daily activities. Patients with pre-existing comorbidity experienced worse physical health, more fatigue, and reduced societal participation.

Conclusions

One to two years after the trauma, polytrauma patients report reduced HRQoL, which is associated with more fatigue and reduced societal participation. Trauma rehabilitation strategies should focus on early recognition of reduced HRQoL, fatigue and societal participation and facilitate early intervention to improve these outcomes.

INTRODUCTION

Trauma is an important cause of death and contributes significantly to the global burden of disease. Trauma affects people of all ages and particularly the young, resulting in a considerable number of life years lost due to premature death and large numbers of years lived with disability[1]. The introduction of the Advanced Trauma Life Support (ATLS®) program, all-inclusive trauma systems and centralization of trauma care have gradually resulted in reduced trauma-related mortality in the Netherlands and many other countries[2]. Subsequently, an increasing number of trauma patients survive with long-term morbidity and often face severe and prolonged deficits in health-related quality of life (HRQoL). HRQoL has therefore become an increasingly important outcome measure to evaluate further enhancement of trauma care.

Long-term effects of major trauma on physical and mental health have been extensively reported[3-11]. Fatigue, another important aspect of well-being, has only been described after specific types of traumatic injuries such as traumatic brain injury[12, 13] and spinal cord injury[14-17]. In these patient groups, fatigue was associated with a negative impact on societal participation and resulted in restricted physical and social activities. Fatigue and reduced societal participation in multiple injured trauma patients after recovery have not been previously reported on and also their association with reduced HRQoL has not been described in the literature.

The objective of the study was to analyse these relations and to identify patient and injury characteristics associated with HRQoL, fatigue and societal participation in severely injured patients one to two years after the trauma.

MATERIALS AND METHODS

Study Design

In the regional trauma registry of the Dutch Trauma Centre West (DTCW) we identified all severely injured patients (Injury Severity Score [ISS] ≥16), who had been admitted to two level-I trauma centre locations of the DTCW, between July 2011 and July 2012. Minors (<18 years), deceased patients, patients with self-inflicted injuries, non-Dutch residents and patients who had been lost to follow-up after discharge from the hospital were excluded from the study. In April 2013, selected patients received a letter by mail to invite them to participate in a survey including questionnaires concerning HRQoL, fatigue and societal participation. Patients who did not respond were contacted by telephone and encouraged to participate and complete the questionnaires or, in case of

missing phone numbers, were sent reminders by mail to encourage participation. The institutional Medical Ethics Review Board approved the study (protocol no. P13.061).

Demographic and clinical data

Data retrieved from the trauma registry included gender, age, anatomic injury diagnoses and injury severity according to the Abbreviated Injury Scale (AIS) version 2005 update 2008[18], the initial Emergency Department Glasgow Coma Scale (GCS)[19] and mortality. Severe injury (AIS ≥ 3) was categorized using the anatomical regions defined in the AIS (head, face, neck thorax, abdomen, spine, extremities and external). The trauma patients were divided into two categories: polytrauma and severe polytrauma patients. Polytrauma was defined as an Injury Severity Score (ISS) ≥16), and severe polytrauma as ISS ≥ 25[20]. Data on pre-existing diseases were obtained from the Electronic Medical Records. Comorbidity was scored using the Charlson Comorbidity Index[21], which includes disorders defined according to the International Classification of Diseases 10 (ICD10). All data were documented directly after trauma or after discharge from the hospital.

HRQoL, fatigue and societal participation

HRQoL was measured using the Short Form Health Survey (SF-36), a validated questionnaire including 36 items covering eight health domains: physical functioning, role limitations due to physical health problems, bodily pain, vitality, social functioning, role limitations due to emotional problems, general health, and emotional well-being [22]. The eight scales can be summarized into two scores: The Physical Component Summary (PCS) score and the Mental Component Summary (MCS) score. PCS and MCS scores range from 0 to 100 with higher scores reflecting better health. These scores are standardized to the general Dutch population by age and gender so that a score of 50 reflects the expected HRQoL of the Dutch population. Reduced HRQoL was defined as a score of 45 or lower since a difference of five points in PCS and MCS scores is considered clinically relevant [23].

Fatigue was measured using the Multidimensional Fatigue Inventory (MFI-20)[24]. This questionnaire evaluates five dimensions of fatigue: general fatigue, physical fatigue, mental fatigue, reduced motivation, and reduced activity. Scores on each scale vary from 4 to 20, with higher scores indicating higher levels of fatigue for each dimension.

Social participation was measured using the Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-P)[25]. This instrument measures three aspects of participation: frequency of leisure and societal activities, restriction in daily activities and satisfaction with the ability to perform daily activities. Scores range from 0 to 100, with higher scores indicating higher levels of participation.

Data Analysis

Characteristics of respondents and non-respondents, and patients with or without reduced HRQoL, were compared using the unpaired t-test for continuous data, and the Chi-square test for categorical data. The average PCS and MCS scores in our study group were compared with the reference score of 50 (standard deviation [SD] 10) for the general Dutch population using a one-sample t-test. Scores on the fatigue and societal participation scales were compared between patients with and without reduced HRQoL using an unpaired t-test. Furthermore, it was assessed whether patient- and injury characteristics (age, gender, presence of comorbidity, severe injury to the head, neck, trunk (thorax and abdomen), extremities and severe polytrauma) and length of follow-up since trauma were associated with HRQoL, societal participation and fatigue using linear regression analysis. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL), version 20. P-values < 0.05 were considered statistically significant.

RESULTS

Study group

Of the 372 identified polytrauma patients, 89 patients were excluded: 51 patients had died due to their injuries, 10 patients were minors, 9 patients had inflicted the injuries themselves, 2 patients were living abroad, and 17 patients were lost to follow-up. So, 283 met the inclusion criteria and were contacted for participation. Of these, 122 patients filled out the questionnaire (response rate of 43.1%). Respondents and non-respondents were comparable with respect to patient and injury characteristics, although respondents more often had severe injuries to the lower extremities (Table 1). The median follow-up of the respondents was 15.0 months (range 10-23).

Health-Related Quality of Life

The PCS and MCS scores could be computed for 114 patients (8 missing). Compared with the general Dutch population of the same gender and age, the polytrauma study group scored on average 4.2 PCS points (95% confidence interval [CI] 2.0-6.4) lower for physical health and 5.4 MCS points (95% CI 3.3-7.6) lower for mental health ($p<0.001$ for both comparisons). Fifty patients (43.9%) reported reduced physical health (PCS<45) and 53 patients (46.5%) reported reduced mental health (MCS<45).

Relation between reduced HRQoL and fatigue/societal participation

Polytrauma patients with reduced physical and/or mental health scored higher on all dimensions of the MFI-20 ($p<0.001$), indicating that they experienced more general, physical, and mental fatigue, and more reduced activity and reduced motivation than

polytrauma patients without reduced HRQoL (Table 2). Furthermore, polytrauma patients with reduced HRQoL scored lower on all USER-P subscales (p<0.001), indicating that they participated less frequently in social activities, were less satisfied with their societal participation and experienced more restrictions in their daily activities (Table 2).

Table 1. Demographics and clinical characteristics of polytrauma patients by study participation.

	Total (*n*=283)	Respondents (*n*=122)	Non-respondents (*n*=161)	*P*
Male, n (%)	192 (67.8)	81 (66.4)	111 (68.9)	0.65
Age in years, mean (SD)	56.2 (21.1)	57.9 (19.2)	55.0 (22.4)	0.24
CCI, mean (SD)	0.5 (0.9)	0.4 (0.8)	0.5 (1.0)	0.35
ISS, mean (SD)	22.2 (7.3)	21.6 (6.2)	22.6 (8.1)	0.25
Number of severe injuries, mean (SD)	1.9 (1.1)	1.9 (1.2)	1.9 (1.1)	0.96
Severe injury (AIS ≥3), n (%)				
Head/Face	175 (61.8)	71 (58.2)	104 (64.6)	0.27
Thorax	96 (33.9)	40 (32.8)	56 (34.8)	0.73
Abdomen	19 (6.7)	9 (7.4)	10 (6.2)	0.70
Spine	30 (10.6)	12 (9.8)	18 (11.2)	0.72
Upper extremities	18 (6.4)	8 (6.6)	10 (6.2)	0.91
Lower extremities	37 (13.1)	22 (18.0)	15 (9.3)	0.03
External	7 (2.5)	3 (2.5)	4 (2.5)	1.00
GCS[l], mean (SD)	13.1 (3.3)	13.4 (3.1)	13.0 (3.5)	0.42

SD: standard deviation; CCI: Charlson Comorbidity Index; ISS: Injury Severity score; AIS: Abbreviated Injury Scale.
[l]GCS: Glasgow Coma Scale

Table 2. Associations between reduced health-related quality of life and fatigue and societal participation after polytrauma.

Dimension	PCS < 45 (*n* = 50)	PCS ≥ 45 (*n* = 64)	*P*	MCS < 45 (*n* = 53)	MCS ≥ 45 (*n* = 61)	*P*
General Fatigue	14.8 (3.9)	8.4 (4.2)	<0.001	14.5 (3.7)	8.3 (4.4)	<0.001
Physical Fatigue	15.4 (3.7)	7.8 (3.8)	<0.001	14.3 (4.4)	8.4 (4.6)	<0.001
Reduced Activity	13.8 (3.9)	8.2 (3.9)	<0.001	13.5 (4.2)	8.2 (3.7)	<0.001
Reduced Motivation	12.4 (4.3)	7.9 (3.8)	<0.001	12.9 (3.9)	7.2 (3.3)	<0.001
Mental Fatigue	11.8 (5.3)	8.2 (4.5)	<0.001	12.8 (4.7)	7.2 (3.9)	<0.001
USER-P Frequency	23.8 (13.2)	38.3 (10.7)	<0.001	25.2 (13.4)	37.5 (11.7)	<0.001
USER-P Restriction	64.1 (21.1)	96.2 (7.6)	<0.001	72.5 (23.3)	92.3 (14.9)	<0.001
USER-P Satisfaction	57.9 (19.4)	84.8 (14.6)	<0.001	58.2 (17.8)	86.9 (14.1)	<0.001

All results are presented as mean scores (standard deviation).
General Fatigue, Physical Fatigue, Reduced Activity, Reduced Motivation and Mental Fatigue are the five scales of the Multidimensional Fatigue Inventory (MFI-20).
USER-P Frequency (measuring the frequency of leisure and societal activities), USER-P Restriction (measuring restriction in daily activities) and USER-P Satisfaction (measuring satisfaction with the ability to perform daily activities) are the three scales of the Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-P).
The Physical Component Summary (PCS) score and Mental Component Summary (MCS) score are summary measures that are based on the scores of the eight scales of the Short Form Health Survey (SF-36).

Determinants of HRQoL

Pre-existing comorbidity was associated with worse physical health (on average 12.9 points lower PCS scores, 95% CI 7.9-17.9; p<0.001) (Table 3). Severe head injury was associated with worse mental health (on average 6.8 points lower MCS scores, 95% CI 0.6-13.1; p=0.03). PCS and MCS scores were not associated with severe injury to the trunk or to the extremities, severe polytrauma and time since the trauma. The models explained 25.6% and 8.0% of the variance in PCS and MCS scores.

Table 3. Associations between patient and injury characteristics* and health-related quality of life in polytrauma patients, assessed by linear regression analysis.

Characteristic	PCS	MCS
Presence of comorbidity	**-12.9 (-17.9; -7.9)**	-0.9 (-6.1;4.3)
Severe injury† to the		
Head	2.8 (-3.2;8.9)	**-6.8 (-13.1; -0.6)**
Neck, thorax, abdomen or spine	-0.5 (-6.3;5.4)	-2.6 (-8.6;3.5)
Extremities	-4.5 (-10.0;1.0)	-2.1 (-7.8;3.6)
Severe polytrauma‡	-1.6 (-7.2;4.0)	-0.1 (-5.9;5.7)
Time since trauma, per month increase	0.1 (-0.6;0.7)	0.4 (-0.2;1.0)

Data are presented as regression coefficients with their 95% confidence interval. Statistically significant regression coefficients (p<0.05) are presented in bold.
The Physical Component Summary (PCS) score and Mental Component Summary (MCS) score are summary measures that are based on the scores of the eight scales of the Short Form Health Survey (SF-36).
* Not including age and gender, since PCS and MCS scores are standardized by these characteristics
† Abbreviated Injury Score ≥ 3
‡ Injury Severity Score ≥ 25

Determinants of fatigue

Female patients reported more general fatigue (on average 2.3 points higher scores, 95% CI 0.3-4.4; p=0.03) and more mental fatigue (on average 2.3 points higher scores, 95% CI 0.1-4.5; p=0.04) than male patients (Table 4). Patients with comorbidity had higher scores on most fatigue subscales indicating more general fatigue (5.0 points higher scores, 95% CI 2.7-7.4; p<0.001), more physical fatigue (4.8 points higher scores, 95% CI 2.3-7.3; p<0.001), more reduced activity (3.3 points higher scores, 95% CI 1.0-5.6; p=0.006), more reduced motivation (2.3 points higher scores, 95% CI 0.1-4.6; p=0.006). Age, severe polytrauma, location of severe injury and time since trauma were not associated with any of the domains of fatigue (Table 4). The percentage of variance explained by the models ranged from 10.7% for mental fatigue to 22.0% for general fatigue.

Determinants of societal participation

Gender and the presence of comorbidity were associated with some dimensions of societal participation (Table 5).

Table 4. Associations between patient and injury characteristics and fatigue in polytrauma patients, assessed by linear regression analysis.

Characteristic	General Fatigue	Physical Fatigue	Reduced Activity	Reduced Motivation	Mental Fatigue
Age, per year increase	-0.03 (-0.08;0.02)	0.01 (-0.04;0.07)	0.01 (-0.05;0.06)	0.01 (-0.04;0.06)	-0.03 (-0.09;0.03)
Female gender	**2.3 (0.3;4.4)**	1.9 (-0.4;4.1)	1.5 (-0.5;3.6)	1.2 (-0.8;3.2)	**2.3 (0.1;4.5)**
Presence of comorbidity	**5.0 (2.7;7.4)**	**4.8 (2.3;7.3)**	**3.3 (1.0;5.6)**	**2.3 (0.1;4.6)**	2.1 (-0.4;4.5)
Severe injury* to the					
Head	-0.6 (-3.1;2.0)	-0.9 (-3.7;1.8)	0.4 (-2.1;3.0)	0.7 (-1.8;3.2)	1.2 (-1.6;3.9)
Neck, thorax, abdomen or spine	0.7 (-1.8;3.1)	0.3 (-2.3;2.9)	-0.5 (-3.0;1.9)	-0.8 (-3.2;1.6)	0.7 (-1.9;3.2)
Extremities	1.0 (-1.3;3.4)	1.3 (-1.3;3.8)	0.8 (-1.5;3.1)	1.1 (-1.2;3.4)	0.6 (-1.9;3.1)
Severe polytrauma†	0.6 (-1.8;3.0)	1.0 (-1.3;3.8)	1.8 (-0.6;4.1)	1.7 (-0.6;4.0)	1.2 (-1.3;3.7)
Time since trauma, per month increase	-0.02 (-0.28;0.25)	-0.1 (-1.6;3.5)	-0.03 (-0.29;0.23)	-0.1 (-0.4;0.1)	-0.09 (-0.36;0.19)

Data are presented as regression coefficients with their 95% confidence interval. Statistically significant regression coefficients ($p<0.05$) are presented in bold. Fatigue was measured using the Multidimensional Fatigue Inventory (MFI-20).
* Abbreviated Injury Score ≥ 3
† Injury Severity Score ≥ 25

Table 5. Associations between patient and injury characteristics and social participation in polytrauma patients, assessed by linear regression analysis.

Characteristic	USER-P Frequency	USER-P Restrictions	USER-P Satisfaction
Age, per year increase	-0.1 (-0.2;0.1)	0.0 (-0.3;0.2)	-0.03 (-0.27;0.22)
Female gender	-0.2 (-5.9;5.5)	**-13.5 (-22.8;-4.2)**	-6.7 (-15.9;2.5)
Presence of comorbidity	-5.3 (-11.9;1.3)	**-21.0 (-31.6;-10.3)**	**-14.9 (-25.7;-4.0)**
Severe injury* to the			
Head	-2.5 (-9.5;4.5)	-2.4 (-14.0;9.3)	-9.3 (-20.3;1.8)
Neck, thorax, abdomen or spine	0.5 (-6.2;7.3)	-9.1 (-20.1;1.9)	-2.9 (-13.5;7.8)
Extremities	-2.9 (-9.4;3.5)	-4.5 (-15.7;6.7)	-5.5 (-16.0;5.0)
Severe polytrauma†	-3.1 (-9.6;3.5)	5.2 (-6.3;16.6)	1.5 (-9.1;12.1)
Time since trauma, per month increase	0.6 (-0.1;1.4)	0.2 (-1.0;1.3)	0.6 (-0.6;1.7)

Data are presented as regression coefficients with their 95% confidence interval. Statistically significant regression coefficients ($p<0.05$) are presented in bold.
USER-P Frequency (measuring the frequency of leisure and societal activities), USER-P Restriction (measuring restriction in daily activities) and USER-P Satisfaction (measuring satisfaction with the ability to perform daily activities) are the three scales of the Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-P).
*Abbreviated Injury Score ≥ 3
† Injury Severity Score ≥ 25

Female patients reported more restrictions in social participation than male patients with on average 13.5 points lower scores (95% CI 4.2-22.8; p=0.005). Compared to patients without comorbidity, the patients with comorbidity experienced more restrictions in social participation (scores on average 21.0 points lower, 95% CI 10.3-31.6;

p<0.0001) as well as less satisfaction with social participation (scores on average 14.9 points lower, 95% 4.0-25.7; p=0.008). Age, severe polytrauma, location of severe injury and time since trauma were not associated with any of the dimensions of societal participation. The percentage of variance explained by the models was 12.4% for frequency of leisure and societal activities, 28.7% for restrictions in daily activities, and 17.4% for satisfaction with the ability to perform daily activities.

DISCUSSION

The aim of this study was to analyse HRQoL, fatigue and societal participation after polytrauma in relation to specific patient and injury characteristics.

One to two years after being severely injured, almost half of the participants in our study reported reduced physical and/or mental health compared to the general Dutch population of the same age and gender. Reduced HRQoL was strongly associated with increased fatigue and reduced societal participation. Within this group of polytrauma patients, the injury severity and location of severe injuries were not associated with HRQoL, fatigue and societal participation, except that mental health was worse in patients who had suffered severe head injury. Female patients and patients with comorbidity were found to be at risk for decreased HRQoL, more fatigue and lower societal participation.

HRQoL, Fatigue and Societal Participation

Although the mean PCS and MCS scores of the polytrauma patients were statistically lower compared to those of the general Dutch population of similar age and gender, the clinical significance of these differences on a group level was marginal (respectively 4.2 and 5.4 on average). Differences found with the general population in overall HRQoL are in concordance with earlier studies in different countries, for instance in Denmark[3], Sweden[4], Norway[5], Germany[6] and the Netherlands[11]. But, considering the fact that more than half of the patients in our study did not report reduced HRQoL together with the marginal clinical significant difference in PCS and MCS, it seems that many polytrauma patients in contrast to the previous stated studies recover fully from their injuries.

Our study showed that both reduced physical health and reduced mental health were strongly associated with all dimensions of fatigue and societal participation. Fatigue is often found in patients with various chronic diseases and is perceived by patients to have a major impact on their quality of life[26]. The results of this study confirm our assumption that reduced HRQoL, and fatigue have a large impact on the ability

of polytrauma patients to participate in social activities. Although not measured in our study, it is also known from other studies that up to 30% of polytrauma patients in working ages are unable to return to work after recovery of their injuries[6,7,27]. It is important to recognize that, beside physical disabilities, psychological factors such as depressive symptoms and posttraumatic stress disorder (PTSD) are common in trauma patients. These psychological factors can limit societal participation and prevent a return to work[28-31]. Physicians should be aware of these symptoms so that psychological intervention can be started early if needed[32].

Determinants of HRQoL, fatigue and societal participation

There is a vast body of literature describing various determinants of reduced HRQoL after polytrauma. Several studies have identified demographic determinants such as age[4, 33-36], gender[11,27], educational level[11,36], social economic status[35], living with a partner[11,35]; clinical determinants such as pre-existing comorbidity [9,11,33,34]; and injury-related determinants such as injury severity[11,27,33-35] and injury location[15,33,35-38]. In this study, we focused on injury severity, the anatomical site of the injuries, and basic patient characteristics (gender, age, pre-existing comorbidity) as potential determinants because the socioeconomic status and educational level at the time of the hospital admission were not available in the analysed data.

Only pre-existing comorbidity was identified as a determinant for worse physical health, and only severe head injury was a determinant for worse mental health. Both determinants were associated with a clinically relevant decrease in scores of 7 and 13 points, respectively. The fact that varying determinants of HRQoL are found in the present and previous studies, indicates that influences on HRQoL after trauma are multifactorial and that most probably many of the determinants of reduced HRQoL are correlated. In previous studies, the length of the patient's follow-up since trauma also differed between one and five years, which may explain some of the variations in determinants found in the literature.

Although persistent fatigue is a frequent complaint after traumatic head injury[12,13,39] and spinal cord injury[14,17], determinants of fatigue in the general polytrauma population have not previously been described. Fatigue is a multidimensional concept which was studied using the MFI-20 which measures fatigue on five subscales. These five include general fatigue which refers to daily functioning, physical functional fatigue which refers to physical tiredness, mental fatigue which refers to cognitive symptoms of fatigue, reduced motivation which refers to the lack of motivation to start any activity, and reduced activity[24]. We found that scores on all subscales of the MFI were equally high for polytrauma patients with severe injury to the head, trunk (including neck,

thorax, abdomen and spine) or extremities. Unfortunately, in our study, there were only twelve patients with severe spinal injury, which was a too small number to be studied as a separate group. Similarly, to injury location, fatigue scores also did not relate to the overall injury severity level (ISS). From these results, we tentatively conclude that fatigue is equally present in all types of polytrauma patients, irrespective of injury severity and anatomical injury site. Pre-existing comorbidity was found to be a determinant of most aspects of fatigue except for mental fatigue.

The female patients in our polytrauma population scored on average respectively 2.3 points higher than the male patients on both the subscales for general and mental fatigue, which is in line with a previous study conducted by Cantor[13]. The effect seems to be clinically meaningful and is similar to that described in patients with cancer-related fatigue[40]. General fatigue relates to general remarks made by a person concerning his or her functioning, while the MFI-20 mental subscale reflects fatigue related to "mental ability to do things" and "mental condition" that causes a feeling of decreased ability to manage daily activities. Female patients are known to report significantly worse long-term well-being after major trauma than male patients[11, 27]. They are at risk for worse functional and psychological outcomes, independent of age, injury severity and trauma mechanism[41]. The underlying mechanism is not well understood, although psychological factors may play a role, as female patients seem to be more susceptible to depression and post-traumatic stress after major trauma than male patients[42]. This may explain why the female patients in our study reported more general fatigue and mental fatigue. The female patients also seemed to score more fatigue on the other three subscales (physical fatigue, reduced motivation and reduced activity), but these effects were not as large and not statistically significant.

Societal participation other than return to work has rarely been studied as an outcome measure after trauma. In the present study, societal participation was measured using the Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-Participation). This instrument measures both objective participation (the frequency of leisure and societal activities) and subjective participation (experienced restriction in daily activities and satisfaction with the ability to perform daily activities). Patients with pre-existing comorbidity experienced more restrictions in social participation due to their condition and were also less satisfied with their level of social participation. Female patients did not report less participation in leisure and social activities than male patients, but they did feel notably more restricted in participating in daily activities. The explanation for these seemingly contradictory results for the objective and subjective levels of social participation is not clear and can only be speculated upon. As women are more at risk for psychological morbidity than men after severe trauma[42], the perception of being

able to participate after recovering from their injuries may be more adversely affected in females than in male patients[42]. This assumption is strengthened by the fact that the female patients also seemed to feel less satisfied with their ability to participate socially, although this finding was not statistically significant.

LIMITATIONS

This study has several limitations. First, the study had a cross-sectional design so causal relationships could not be established. Moreover, the actual levels of HRQoL, fatigue and societal participation of the patients before their injuries were not measured so changes from baseline could not be taken into account.

Second, the response rate in our study was low, which may have resulted in a bias. The questionnaire sent to the polytrauma population was lengthy because it included specific instruments for measuring HRQoL, as well as fatigue and societal participation. Therefore, the length of the used questionnaire could not be shortened, which may have discouraged study participation, especially in specific subgroups such as patients struggling with fatigue after polytrauma and patients with cognitive limitations after severe head injury. Also, the order of the instruments within the questionnaire was not randomized. Although selection and information bias cannot be ruled out entirely, our study group of polytrauma patients seemed representative since the respondents and non-respondents were comparable regarding patient and injury characteristics, which renders the risk of bias to be low.

Third, it can be assumed that the time elapsed between trauma and participation in our survey was relatively short i.e., between 10 and 23 months. However, the length of follow-up since trauma did not have a measurable effect on any of the outcomes in the study. Also, it has been demonstrated that after one year of follow-up hardly any improvement in functioning is seen, so one year seems sufficient to gain insight into HRQoL after severe injuries[5,21].

Last, although every effort was made to code injuries accurately in our regional trauma registry, a possible selection bias might have been introduced concerning the interpretation of injury pattern and injury outcome; therefore, influencing the AIS and ISS coding.

CONCLUSIONS

Between one and two years after the trauma, nearly half of all polytrauma patients still suffer from a reduced HRQoL, which is associated with more fatigue and reduced societal participation. It can be assumed that female polytrauma patients and patients with comorbidities have higher risks for reduced HRQoL, more fatigue and lower societal participation compared to other polytrauma patients.

Despite the previously stated limitations, this study underlines the importance of early identification of polytrauma patients at risk for suboptimal physical and/or mental recovery. Increased awareness of signs and symptoms, both in-hospital and after discharge, of reduced HRQoL, fatigue and societal participation after polytrauma can help achieve improved guidance by clinicians and rehabilitation specialists.

REFERENCES

1. Peden M, McGee K, and Krug E (Eds). Injury: A leading cause of the global burden of disease, 2000. 2002. Geneva, World Health Organization.
2. Kortbeek JB, Al Turki SA, Ali J, Antoine JA, Bouillon B, Brasel K, et al. Advanced trauma life support, 8th edition, the evidence for change. J Trauma Acute Care Surg. 2008;64(6):1638–50.
3. Overgaard M, Høyer CB, Christensen EF. Long-term survival and health-related quality of life 6 to 9 years after trauma. J Trauma Acute Care Surg. 2011;71(2):435–41.
4. Sluys K, Häggmark T, Iselius L. Outcome and quality of life 5 years after major trauma. J Trauma Acute Care Surg. 2005;59(1):223–32.
5. Soberg HL, Bautz-Holter E, Roise O, Finset A. Long-term multidimensional functional consequences of severe multiple injuries two years after trauma: a prospective longitudinal cohort study. J Trauma Acute Care Surg. 2007;62(2):461–70.
6. Kaske S, Lefering R, Trentzsch H, Driessen A, Bouillon B, Maegele M, et al. Quality of life two years after severe trauma: A single centre evaluation. Injury. 2014 ;45 Suppl 3:S100–5.
7. Gabbe BJ, Simpson PM, Harrison JE, Lyons, RA, Ameratunga S, Ponsford J, et al. Return to work and functional outcomes after major trauma. Ann Surg. 2016;263(4):623–32.
8. Kenardy J, Heron-Delaney M, Warren J, Brown E. The effect of mental health on long-term health-related quality of life following a road traffic crash: Results from the UQ SuPPORT study. Arch Phys Med Rehabil. 2015 Mar;96(3):410-7.
9. Alghnam S, Wegener ST, Bhalla K, Colantuoni E, Castillo R. Long-term outcomes of individuals injured in motor vehicle crashes: A population-based study. Injury 2015;46(8):1503–8.
10. Innocenti F, Del Taglia B, Coppa A, Trausi F, Conti A, Zanobetti M, et al. Quality of life after mild to moderate trauma. Injury. 2014;46(5):902–8.
11. Ringburg AN, Polinder S, van Ierland MCP, Steyerberg EW, van Lieshout EMM, Patka P, et al. Prevalence and prognostic factors of disability after major trauma. J Trauma Acute Care Surg. 2011;70(4):916–22.
12. Mollayeva T, Kendzerska T, Mollayeva S, Shapiro CM, Colantonio A, Cassidy JD. A systematic review of fatigue in patients with traumatic brain injury: The course, predictors and consequences. Neurosci Biobehav Rev. 2014;47C:684–716.
13. Cantor JB, Ashman T, Gordon W, Ginsberg A, Engmann C, Egan M, et al. Fatigue after traumatic brain injury and its impact on participation and quality of life. J Head Trauma Rehabil. 2008;23(1):41–51.
14. Craig A, Tran Y, Wijesuriya N, Middleton J. Fatigue and tiredness in people with spinal cord injury. J Psychosom Res. 2012;73(3):205–10.
15. Moghimian M, Kashani F, Cheraghi MA, Mohammadnejad E. Quality of life and related factors among people with spinal cord injuries in Tehran, Iran. Arch Trauma Res. 2015;4(3):e19280.
16. Barclay L, McDonald R, Lentin P. Social and community participation following spinal cord injury. Int J Rehabil Res. 2015;38(1):1–19.
17. Wijesuriya N, Tran Y, Middleton J, Craig A. Impact of fatigue on the health-related quality of life in persons with spinal cord injury. Arch Phys Med Rehabil. 2012;93(2):319–24.
18. Gennarelli TA and Wodzin E (Eds). Abbreviated Injury Scale 2005 - Update 2008. 2008. Barrington, IL, Association for the Advancement of Automotive Medicine.
19. Teasdale G, Jennett B. Assessment of coma and impaired consciousness: A practical scale. Lancet. 1974;81–4.

20. Baker SP, O'Neill B, Haddon Jr W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma Acute Care Surg. 1974;14(3):187.
21. Charlson M, Pompei P. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis. 1987;40(5):373–83.
22. Aaronson NK, Muller M, Cohen PD, Essink-Bot M, Fekkes M, Sanderman R, et al. Translation, validation, and norming of the Dutch language version of the SF-36 Health Survey in community and chronic disease populations. J Clin Epidemiol. 1998;51(11):1055–68.
23. Ware JE, Koskinski M, and Keller SD. SF-36 physical and mental health summary scales: A user's manual 2nd ed. 1994. Boston MA, The Health Institute.
24. Smets EM, Garssen B, Bonke B, De Haes JC. The Multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. J Psychosom Res. 1995;39(3):315–25.
25. Post MWM, van der Zee CH, Hennink J, Schafrat CG, Visser-Meily JM, Berdenis van Berlekom S. Validity of the Utrecht Scale for Evaluation of Rehabilitation-Participation. Disabil Rehabil. 2012;34(6):478–85.
26. Swain MG. Fatigue in chronic disease. Clin Sci (Lond). 2000;99(1):1–8.
27. Vles WJ, Steyerberg EW, Essink-Bot M-L, van Beeck EF, Meeuwis JD, Leenen LPH. Prevalence and determinants of disabilities and return to work after major Trauma. J Trauma Acute Care Surg. 2005;58(1):126–35.
28. O'Donnell ML, Creamer M, Elliott P, Atkin C, Kossmann T. Determinants of quality of life and role-related disability after injury: impact of acute psychological responses. J Trauma Acute Care Surg. 2005;59(6):1328–34; discussion 1334–5.
29. Tøien K, Skogstad L, Ekeberg Ø, Myhren H, Schou Bredal I. Prevalence and predictors of return to work in hospitalised trauma patients during the first year after discharge: a prospective cohort study. Injury. 2012;43(9):1606–13.
30. Haagsma JA, Ringburg AN, Van Lieshout E, Patka P, Schipper IB, Polinder S. Prevalence rate, predictors and long-term course of probable posttraumatic stress disorder after major trauma: a prospective cohort study. BMC Psychiatry. 2012 Dec 27;12:236.
31. Haagsma JA, Scholten AC, Andriessen TM, Vos PE, Van Beeck EF, Polinder S. Impact of depression and posttraumatic stress disorder on functional outcome and health-related quality of life of patients with mild traumatic brain injury. J Neurotrauma. 2015 Jun 1;32(11):853-62.
32. O'Donnell ML, Bryant RA, Creamer M, Carty J. Mental health following traumatic injury: Toward a health system model of early psychological intervention. Clin Psychol Rev. 2008;28(3):387–406.
33. Harris IA, Young JM, Rae H, Jalaludin BB, Solomon MJ. Predictors of general health after major trauma. J Trauma Acute Care Surg. 2008;64(4):969–74.
34. Rainer TH, Yeung JHH, Cheung SKC, Yuen YKY, Poon WS, Ho HF, et al. Assessment of quality of life and functional outcome in patients sustaining moderate and major trauma: A multicentre, prospective cohort study. Injury. 2014;45(5):902–9.
35. Janssen C, Ommen O, Neugebauer E, Lefering R, Pfaff H. Predicting health-related quality of life of severely injured patients: Sociodemographic, economic, trauma, and hospital stay-related determinants. Eur J Trauma Emerg Surg. 2008;34(3):277–86.
36. Holtslag HR, van Beeck EF, Lindeman E, Leenen LPH. Determinants of long-term functional consequences after major trauma. J Trauma Acute Care Surg. 2007;62(4):919–27.

37. Sluys KP, Shults J, Richmond TS. Health related quality of life and return to work after minor extremity injuries: A longitudinal study comparing upper versus lower extremity injuries. Injury. 2016 Apr;47(4):824-31.
38. Son MAC, Vries J, Roukema JA, Gosens T, Verhofstad MHJ, Den Oudsten BL. The course of health status and (health-related) quality of life following fracture of the lower extremity: A 6-month follow-up study. Qual Life Res A. 2016 May;25(5):1285-94
39. Cantor JB, Ashman T, Bushnik T, Cai X, Farrell-Carnahan L, Gumber S, et al. Systematic Review of Interventions for Fatigue After Traumatic Brain Injury: A NIDRR Traumatic Brain Injury Model Systems Study. J Head Trauma Rehabil. 2014;29(6):490–7.
40. Purcell A, Fleming J, Bennett S, Burmeister B, Haines T. Determining the minimal clinically important difference criteria for the multidimensional fatigue inventory in a radiotherapy population. Support Care Cancer. 2010;18(3):307–15.
41. Holbrook TL, Hoyt DB, Anderson JP. The importance of gender on outcome after major trauma: functional and psychologic outcomes in women versus men. J Trauma Acute Care Surg.. 2001 Feb;50(2):270–3.
42. Holbrook TL, Hoyt DB, Stein MB, Sieber WJ. Gender differences in long-term posttraumatic stress disorder outcomes after major trauma: women are at higher risk of adverse outcomes than men. J Trauma Acute Care Surg. 2002;53(5):882–8.