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Comparison of pre-injury recalled Health Status (HS) data of trauma patients and HS of the general population

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ABSTRACT

Purpose: Significant differences exist between retrospectively collected pre-injury Health Status (HS) of trauma patients and the HS of the general population. Compared to the general population, the trauma population includes a larger proportion of individuals with a low level of socio-economic status. The aim was to compare retrospectively collected pre-injury HS with HS of a sample of Dutch individuals not only adjusted for age and gender, but also for educational level.
Methods: Within three months post-trauma, pre-injury HS (n = 2987) was collected by using the EuroQol-five-dimension-3-level (EQ-5D-3L) questionnaire. Data were abstracted from the Brabant Injury Outcome Surveillance. The reference cohort (n = 1839) included a sample of the Dutch general population. Multiple regression was used to compare HS of both cohorts.
Results: A higher recalled pre-injury EQ-5D-3L score of the injury cohort was reported compared to the HS of the reference cohort after adjustment for age ($\beta = 0.014$ [95% CI: 0.001,0.027] for males and $\beta = 0.018$ [95% CI: −0.001, 0.036] for females). After adjustment for age and educational level, the Beta showed a ≥10% increasement: males; unadjusted $\beta = 0.006$ [95% CI: −0.007, 0.019] to $\beta = 0.014$ [95% CI: 0.001, 0.027] after age adjustment to $\beta = 0.020$ [95% CI: 0.007, 0.033] after adjustment for age and educational level, females; unadjusted $\beta = -0.018$ [95% CI: −0.035, −0.001] to $\beta = 0.018$ [95% CI: −0.001, 0.036] after age adjustments to $\beta = 0.025$ [95% CI: 0.007, 0.043] after adjustments for age and educational level. After adjustment for age, gender and educational level, the injury cohort reported prior to the trauma less problems on the 'pain/discomfort' (OR = 0.522 [95% CI: 0.454, 0.602]) and the 'anxiety/depression' (OR = 0.745 [95% CI: 0.619, 0.897]) dimensions, as compared to the reference cohort. In contrast, the injury cohort reported significantly more problems on the 'self-care' dimension (OR = 1.497 [95% CI: 0.1.112, 2.016]) prior to the trauma.
Conclusions: Injured patients report better recalled pre-injury HS compared to the HS of the reference cohort. After adjustment for educational level, the difference in HS between the injury cohort and the reference cohort increases, underlining that other confounders might also influence HS.

Background

To produce valid estimates of the health impact and the decrease of functioning after trauma, information on patients functioning prior to the trauma is crucial [1–4]. For instance, pre-existing disability is highly related to problems with mobility and pain post-trauma [5]. Therefore, knowledge about the change from pre-injury to post-injury Health Status (HS) is important in order to derive population estimates of the impact of a trauma [6]. However, insight into this change requires a HS norm. In trauma research there are two dominant approaches to assess the HS norm that is used to measure change in HS.

The first approach uses pre-injury HS as a norm. In this approach pre-injury HS is mostly assessed retrospectively, even though it is well-known that retrospectively collected data can be distorted due to recall bias or response shift [6]. Recall bias appears when people remember their former state as better or worse than

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it actually was [7]. Response shift occurs when, aggravated by a life event such as a trauma, people do not maintain a consistent internal scale for their responses over time [8]. Subsequently, patients' perception of HS might change after a trauma [9]. Both recall bias and response shift are presumed to lead to a systematic overestimation of the HS prior to the trauma [6].

In the second approach, HS of the general population is used as a norm to measure change in HS [10–13]. An advantage of this approach is that it is fairly easy to obtain general population norms by country, age and gender category. However, the question is if HS of the general population is representative of the pre-injury HS of the trauma population. Several studies found significant differences between retrospectively collected pre-injury HS data of trauma patients and the HS of the general population, even after adjustment for age and gender [6,12,14–17]. Trauma patients tend to be less healthy compared to the general population [6] implying that the trauma population is not a representative sample of the general population.

An explanation for this finding may be that, compared to the general population, the trauma population includes a larger proportion of individuals with a low level of socio-economic status (SES) (e.g. educational level) [1,18] and SES in its turn is highly associated with HS [19]. For example, high educational level is associated with lower levels of emotional distress (e.g. depression, anxiety or anger), lower physical distress (e.g. pain) and a lower prevalence of comorbid conditions [19]. As far as we known, no study has been conducted comparing retrospectively assessed pre-injury HS and HS of the general population after adjustment for age, gender and SES. Therefore, The aim was to compare retrospectively collected pre-injury HS with HS of a sample of Dutch individuals not only stratified by age and gender, but also by educational level.

Materials and methods

Design and setting

A comparative study was conducted including a cohort of injured patients and a sample of Dutch individuals adjusted for age, gender and educational level that functioned as a reference cohort.

Participants

Injury cohort

For the injury cohort, data was used from the Brabant Injury Outcome Surveillance (BIOS). The BIOS was approved by the Medical Ethics Committee Brabant, the Netherlands (project number NL50258.028.14). The study protocol is published elsewhere [20]. The BIOS is a large prospective observational follow-up cohort study in which HS, psychosocial, functional outcome and costs after trauma will be assessed during two years of follow-up. The BIOS was conducted in all ten hospitals of the Dutch Noord-Brabant region.

In the BIOS, adult injured patients aged 18 and older who were admitted to an Intensive Care Unit or a ward after presentation on the emergency department (ED), and who survived to hospital discharge were eligible for inclusion. All types of trauma were included, regardless of the intent or severity. Patients were included between August 2015 and November 2016. Patients with a pathological fracture, insufficient knowledge of the Dutch language or with no permanent address of residence were excluded. For eligible patients it was possible to enter in the study at different time points, i.e. one week (T1), one month (T2), three months (T3), six months (T4) or one year (T5) post-trauma. For this study, a sub cohort of the BIOS was used (see Fig. 1). To minimise recall bias, we used pre-injury HS data that was completed within three months post-trauma. Questionnaires completed by proxy informants were excluded. All patients gave informed consent prior to participation. Patients did not receive compensation for participation.

Reference cohort

Retrospectively collected pre-injury HS was compared with HS of a reference cohort. For the reference cohort, we made use of the data of the Longitudinal Internet Studies for the Social sciences (LISS) panel administered by CentERdata (Tilburg University, the Netherlands). The LISS-panel is a representative sample of the Dutch population who participate in monthly internet surveys. This panel is based on a true probability sample of households

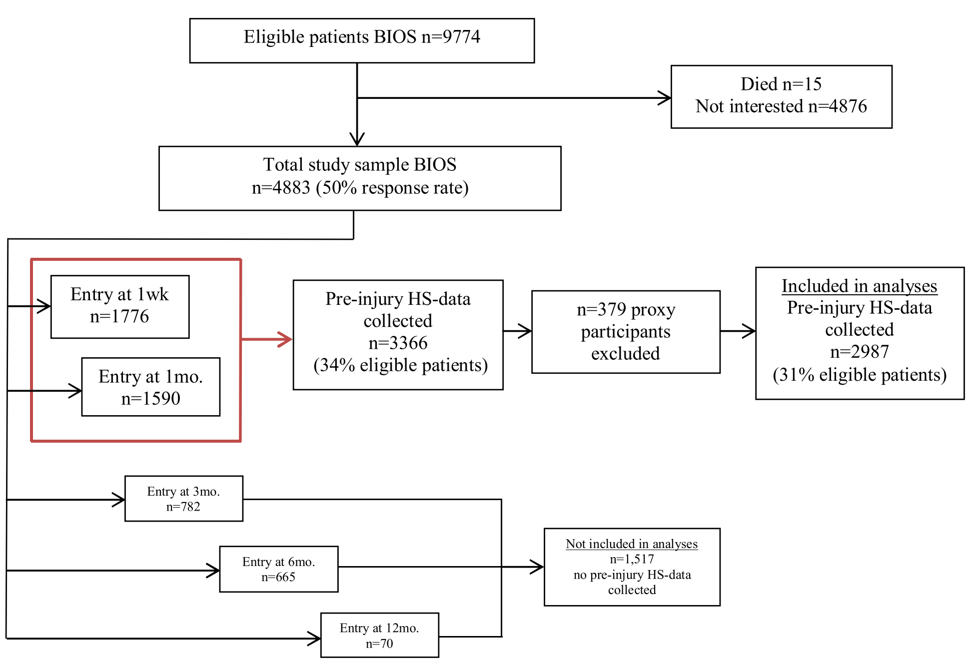

Fig. 1. Flow chart of patient inclusion throughout the Brabant Injury Outcome Surveillance.
Abbreviations: BIOS; Brabant Injury Outcome Surveillance: HS; health status.

drawn from the population register [21]. For the composition of the reference cohort, similar gender and age distributions as presented in the Dutch trauma population [22] were used. The trauma population is an ageing population. Therefore, we oversampled patients aged 65 or older in the LISS-panel. Since younger people generally show low inclusion rates in surveys, younger participants were oversampled as well to increase the response rate. Participants completed the HS-data in January 2016 and received an incentive for completing the questionnaire.

Educational level

Educational level as collected in the injury and reference cohort was subdivided into low, middle or high as suggested by Statistics Netherlands [23]. Participants with no diploma, primary education or preparatory secondary vocational education were considered to have a low educational level. Middle educational level included participants who completed university preparatory education, senior general secondary education or senior secondary vocational education and training. Participants who completed university of applied science (associate degree) or an academic degree were considered to have high educational level.

Data collection

Demographic characteristics of the injury and reference cohort were extracted from the self-reported questionnaire and included age, gender and educational level (i.e. degree, diploma or certificate of highest education).

Outcome measures

To determine (pre-injury) HS, the EuroQol-five-dimension-3-level (EQ-5D-3L) [24] was completed by all participants. The EQ-5D-3L is a self-reported questionnaire and consists of five questions and the EuroQol Visual Analogue Scale (EQ-VAS). In the EQ-5D-3L, health is defined along five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each item can be scored as 'no problems', 'moderate problems' or 'severe problems'. For the injury cohort, the recall period of the EQ-5D-3L was one day prior to the injury, for the reference cohort the recall period was 'today'. From the individual dimensions, a scoring algorithm can be calculated by which each health status description can be formatted into a summary score. This summary score ranges from 0 for death and 1 for full health [24]. The EQ-VAS records participant's self-rated health on a vertical visual analogue scale with two endpoints, i.e. 'the best health you can imagine' (score 100) and 'the worst health you can imagine' (score 0) [24].

Data analysis

All analyses were conducted using SPSS V.24 (Statistical Package for Social Sciences, Chicago, Illinois, USA). Statistical test results were considered significant at a level of $p < 0.05$. Categorical variables were presented as frequencies (percentages), and continuous variables as mean with standard deviation (SD) or median with 25th and 75th percentiles, as appropriate.

The injury and reference cohort were stratified by age, gender and educational level. For this, six age categories (i.e. 18–34, 35–44, 45–54, 55–64 65–74 and 75 years or older) were created. Descriptive statistics were used to compare the different strata.

For the injury and reference cohort, multiple linear regression analyses were used to explain the relationship between (pre-injury) HS and age, gender and educational level (low educational level as reference group) for both the EQ-5D-3L summary score and the EQ-VAS.

For the regression analyses of the EQ-5D-3L summary score and the EQ-VAS, variables were divided into three blocks. To compare the injury and reference cohort, type of cohort was entered in block 1 (i.e. unadjusted model). In block 2, adjustments were made for age. In block 3, educational level was added to the variable of block 2. Age was entered as a continuous variable and educational level was entered as a dummy variable. Data were presented with unstandardized Beta's (β's) and the 95% Confidence Intervals (95% CI's), representing the difference in HS in the injury cohort relative to the reference cohort.

Logistic regression analyses were performed in which score options of each dimension of the EQ-5D-3L were dichotomized into 0='no problems', and 1='moderate problems'/'severe problems'. Here, no statistically significant interaction terms were identified between gender and educational level (low educational level as reference group) (mobility p-value = 0.995 (for middle educational level) and p-value = 0.735 (for high educational level), self-care p-value = 0.387 (for middle educational level) and p-value = 0.601 (for high educational level), daily activities p-value = 0.992 (for middle educational level) and p-value = 0.189 (for high educational level), pain/discomfort p-value = 0.876 (for middle educational level) and p-value = 0.076 (for high educational level), anxiety p-value = 0.806 (for middle educational level) and p-value = 0.609 (for high educational level)). Variables were divided into three blocks. Type of cohort was entered in block 1 (i.e. unadjusted model). In block 2, adjustments were made for gender and age. In block 3, educational level was added to the variables of block 2. For the logistic regression, Beta's, Odds Ratio's (ORs) and 95% CI's were reported.

Besides the comparison of the injury and reference cohort, we examined the confounding effect of educational level on the (pre-injury) EQ-5D-3L summary score and EQ-VAS. If the Beta changes $\geq$10% after adjustment for educational level in the regression analyses, educational level was considered to be a confounding variable [25].

Results

General characteristics of the participants

Injury cohort – During the study period, 9774 patients were eligible for the BIOS (see Fig. 1). In total, 4883 (50% response rate) participated in the BIOS of which 2987 (31% of all eligible patients) completed the pre-injury HS-data within three months post-trauma. The median time of completing the pre-injury HS was 11 days (interquartile range 6–30). Comparisons of responders and non-responders showed that the group of responders included a larger proportion of males (46% vs 53%) and that responders were younger compared to the non-responders (mean 62 years vs 66 years). Regarding to the injuy-related characteristics, responders were more likely to have a traffic accident, a work-related injury or a sport injury. Responders were less likely to have a self-inflicted injury. Furthermore, responders with an Injury Severity Score (ISS) of 4–8 or $\geq$16 showed the highest response rate (36.8% and 34.0%, respectively) whereas those with an ISS 9–15 showed the lowest response rate (28.6%). Participants who were admitted $\leq$2 days or 3–7 days showed the highest response rate (31.9% and 34.7%, respectively) compared to those with 8–14 or $\geq$15 days of hospitalization (25.6% and 19.8%, respectively). In total, 33.2% of the patients that were admitted to an Intensive Care Unit participated into the study (see Table 1).

Reference cohort – For the reference cohort, 2262 participants were invited of whom 1839 participated (response rate 81.3%). Comparison of responders and non-responders showed that responders were older (mean 51 years vs. 39 years) (see Table 1).

The injury cohort included a higher percentage of males (53% vs. 47%), and patients had a higher mean age (62 years vs. 51 years)

Table 1
Demographic and injury-related characteristics of the responders and non-responders of the injury cohort and demographic characteristics of the reference cohort.

	Injury cohort		Reference cohort	
	Responders (n = 2987)	Non-responders (n = 6787)	Responders (n = 1839)	Non-responders (n = 423)
Males	n = 1593 (53%)	n = 3143 (46%)	n = 859 (47%)	n = 175 (41%)
Mean age (yrs.)	62 (SD 18)	66 (SD 22)	51 (SD 19)	39 (SD 18)
18–24	n = 133 (4.5%)	n = 484 (7.1%)	n = 227 (12%)	n = 105 (25%)
25–44	n = 383 (12.8%)	n = 900 (13.3%)	n = 502 (27%)	n = 181 (43%)
45–64	n = 1011 (33.8%)	n = 1359 (20%)	n = 465 (25%)	n = 82 (19%)
65–74	n = 659 (22.1%)	n = 867 (12.8%)	n = 457 (25%)	n = 30 (7.1%)
75–84	n = 548 (18.3%)	n = 1584 (23.3%)	n = 160 (9%)	n = 21 (5%)
85+	n = 253 (8.5%)	n = 1593 (23.5%)	n = 28 (1.5%)	n = 4 (1%)
Educational level[$]				
Low educational level	n = 1389 (47%)	n.a.*	n = 494 (27%)	n = 92 (22%)
Middle educational level	n = 870 (29%)	n.a.*	n = 677 (37%)	n = 168 (40%)
High educational level	n = 642 (22%)	n.a.*	n = 623 (34%)	n = 153 (36%)
Other	n = 0 (0%)	n.a.*	n = 45 (2%)	n = 10 (2.4%)
Missing	n = 86 (3.0%)	n.a.*	n = 0 (0.0%)	n = 0 (0%)
Cause of injury				
At home	n = 1609 (53.9%)	n = 3808 (56.1%)	n.a.	n.a.
Traffic accident	n = 866 (29.0%)	n = 1267 (18.7%)	n.a.	n.a.
Work-related	n = 147 (4.9%)	n = 190 (2.8%)	n.a.	n.a.
Sport	n = 238 (8.0%)	n = 230 (3.4%)	n.a.	n.a.
Violence	n = 39 (1.3%)	n = 166 (2.4%)	n.a.	n.a.
Self-inflicted	n = 9 (0.3%)	n = 30 (0.4%)	n.a.	n.a.
Other	n = 31 (0.9%)	n = 51 (0.8%)	n.a.	n.a.
Missing	n = 48 (1.6%)	n = 1045 (15.4%)	n.a.	n.a.
Mean ISS				
1–3	n = 751 (25.1%)	n = 1754 (25.8%)	n.a.	n.a.
4–8	n = 1072 (35.9%)	n = 1845 (27.2%)	n.a.	n.a.
9–15	n = 995 (33.3%)	n = 2489 (36.7%)	n.a.	n.a.
≥16	n = 147 (4.9%)	n = 286 (4.2%)	n.a.	n.a.
Missing	n = 22 (0.7%)	n = 413 (6.1%)	n.a.	n.a.
Mean days admitted to hospital				
≤2	n = 910 (30.5%)	n = 1943 (28.6%)	n.a.	n.a.
3–7	n = 1243 (41.6%)	n = 2343 (34.5%)	n.a.	n.a.
8–14	n = 473 (15.8%)	n = 1375 (20.3%)	n.a.	n.a.
≥15	n = 152 (5.1%)	n = 615 (9.1%)	n.a.	n.a.
Missing	n = 209 (7.0%)	n = 511 (7.5%)	n.a.	n.a.
ICU-admission				
Yes	n = 216 (7.2%)	n = 434 (6.4%)	n.a.	n.a.
No	n = 2771 (92.8%)	n = 6353 (93.6%)	n.a.	n.a.
Missing	n = 0 (0%)	n = 0 (0%)	n.a.	n.a.

Abbreviations: ICU = Intensive Care Unit, ISS = Injury Severity Score, ISS = Injury Severity Score, SD = standard deviation, yrs = years.
* Educational level was not collected in the group of non-responders of the injury cohort.
$ Educational level is based on highest degree of education an individual has completed.

compared to participants of the reference cohort. The responders of the reference cohort showed almost similar distributions of educational level compared to the inhabitants of the Noord-Brabant region [26] and compared to the Dutch population [27] (low education: reference cohort = 27%, Noord-Brabant region = 35%, Dutch population = 31%; middle education reference cohort = 37%, Noord-Brabant region = 41%, Dutch population = 39%; high educational level: reference cohort = 34%, Noord-Brabant region = 24%, Dutch population = 28%). Furthermore, in the injury cohort, almost half of the patients (47%) had low educational level while in the reference cohort, only 27% had low educational level (see Table 1).

Comparisons between (pre-injury) HS of the injury and reference cohort

In both cohorts, males reported better HS compared to females. In general, people with low educational level revealed the lowest HS while people with high educational level revealed the highest HS.

In both the injury and reference cohort, the EQ-5D-3L summary score and EQ-VAS decreased when age increased. However, this trend was less apparent for the EQ-VAS of the reference cohort, especially in male participants. In almost all strata, injured patients reported better recalled pre-injury HS compared to the HS of the reference cohort (see Table 2 and Fig. 2). Female patients with low educational level aged 75 or older compromise a large proportion (12%) of the injury cohort. These patients showed lower pre-injury HS as compared with the HS of the reference cohort.

In the univariate analyses, all independent variables of interest were significantly associated with both the EQ-5D-3L summary score (p-value age <0.001, p-value gender <0.001, p-value educational level<0.001 (for middle educational level) and <0.001 (for high educational level)) and the EQ-VAS ((p-value age <0.001, p-value gender <0.001, p-value educational level <0.001 (for middle educational level) and <0.001 (for high educational level)). Therefore, all variables were entered into the multiple regression model.

Because gender might influence the association between educational level and HS [28], interaction terms between gender and educational level were included in the model to test for effect modification. For this, dummy variables were created for educational level (low educational level as reference group). Interaction terms between gender and educational level were statistically significant for both the EQ-5D-3L summary score (p-value = 0.010 (for middle educational level) and p-value = 0.028 (for high educational level)) and the EQ-VAS (p-value = 0.008 (for middle educational level) and p-value = 0.004 (for high educational level)). Therefore, results of the regression analyses were reported separately for males and females.

Multiple regression models were conducted with adjustment for age and educational level. The EQ-5D-3L summary score of the

Table 2
Descriptive statistics of the (pre-injury) EQ-5D-3L utility score as completed by the injury cohort and as completed by the reference cohort. Results were stratified by gender, age and educational level.

		Males				Females			
		Injury cohort		Reference cohort		Injury cohort		Reference cohort	
Age groups (yrs.)	Educational level	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
18–34	Low	44 (1%)	0.99 (0.05)	32 (2%)	0.93 (0.16)	24 (1%)	0.86 (0.22)	33 (2%)	0.85 (0.22)
	Middle	99 (3%)	0.96 (0.10)	91 (5%)	0.92 (0.15)	46 (1%)	0.94 (0.15)	139 (8%)	0.88 (0.17)
	High	44 (1%)	0.96 (0.12)	63 (3%)	0.97 (0.08)	35 (1%)	0.94 (0.13)	113 (6%)	0.89 (0.17)
35–44	Low	37 (1%)	0.98 (0.07)	15 (1%)	0.92 (0.11)	9 (0%)	0.94 (0.11)	18 (1%)	0.74 (0.37)
	Middle	63 (2%)	0.96 (0.08)	48 (3%)	0.93 (0.11)	33 (1%)	0.94 (0.12)	62 (3%)	0.88 (0.24)
	High	27 (1%)	0.99 (0.05)	50 (3%)	0.95 (0.12)	40 (1%)	0.95 (0.08)	60 (3%)	0.90 (0.20)
45–54	Low	88 (3%)	0.90 (0.20)	24 (1%)	0.90 (0.12)	67 (2%)	0.84 (0.27)	34 (2%)	0.74 (0.35)
	Middle	91 (3%)	0.96 (0.13)	42 (2%)	0.93 (0.11)	63 (2%)	0.89 (0.19)	54 (3%)	0.91 (0.14)
	High	75 (2%)	0.98 (0.06)	29 (2%)	0.95 (0.09)	44 (1%)	0.97 (0.07)	28 (2%)	0.91 (0.11)
55–64	Low	140 (5%)	0.88 (0.20)	31 (2%)	0.81 (0.25)	85 (3%)	0.89 (0.14)	42 (2%)	0.83 (0.22)
	Middle	119 (4%)	0.93 (0.13)	46 (3%)	0.89 (0.19)	62 (2%)	0.93 (0.10)	39 (2%)	0.89 (0.12)
	High	92 (3%)	0.94 (0.13)	40 (2%)	0.94 (0.16)	49 (2%)	0.97 (0.07)	47 (3%)	0.88 (0.17)
65–74	Low	145 (5%)	0.91 (0.15)	77 (4%)	0.90 (0.15)	190 (6%)	0.86 (0.20)	114 (6%)	0.85 (0.19)
	Middle	94 (3%)	0.92 (0.14)	60 (3%)	0.89 (0.18)	50 (2%)	0.83 (0.23)	42 (2%)	0.89 (0.14)
	High	93 (3%)	0.92 (0.14)	92 (5%)	0.93 (0.11)	46 (2%)	0.91 (0.14)	54 (3%)	0.88 (0.14)
≥75	Low	141 (5%)	0.81 (0.26)	28 (2%)	0.87 (0.13)	364 (12%)	0.74 (0.26)	46 (3%)	0.80 (0.21)
	Middle	62 (2%)	0.86 (0.15)	30 (2%)	0.84 (0.21)	64 (2%)	0.81 (0.21)	24 (1%)	0.81 (0.19)
	High	62 (2%)	0.94 (0.08)	38 (2%)	0.89 (0.15)	24 (1%)	0.89 (0.10)	9 (0%)	0.78 (0.22)

Abbreviations: SD = standard deviation, yrs = years.

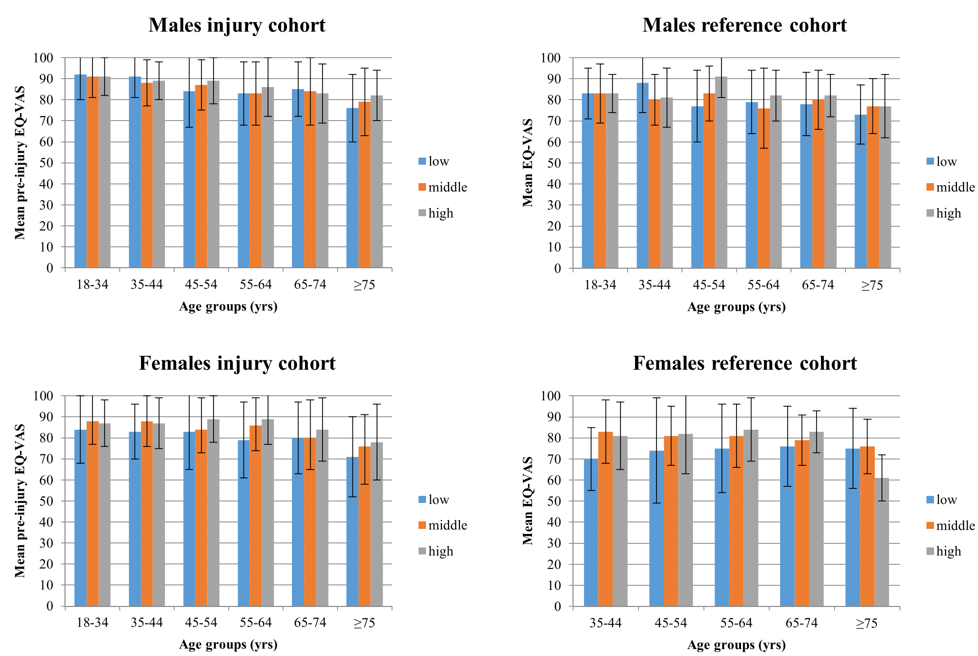

Fig. 2. Mean (SD) (pre-injury) EQ-VAS of the injury and reference cohort classified by age, gender and educational level.
Low educational level; reference cohort n = 494, injury cohort n = 1389. Middle educational level; reference cohort n = 677, injury cohort n = 870. High educational level; reference cohort n = 623, injury cohort n = 642.
Abbreviations: EQ-VAS = EuroQol Visual Analogue Scale, yrs.=years.

injury cohort was significantly higher compared to the summary score of the reference cohort (β = 0.020 [95% CI: 0.007, 0.033] for males and β = 0.025 [95% CI: 0.007, 0.043] for females) (Table 3). The beta in block 3 increased ≥10% compared to the beta in block 2. The EQ-VAS was significantly higher in the injury cohort compared to the reference cohort (Table 3). When also adjusted for educational level, the beta increases <10% in males (from β = 4.778 [95% CI: 3.617, 5.940] in block 2 to β = 5.051 [95% CI: 3.881, 6.221] in block 3). However in females, the beta increases ≥10% (from β = 3.635 [95% CI: 2.147, 5.123] in block 2 to β = 4.189 [95% CI: 2.705, 5.672] in block 3). The ≥10% increment after the addition of educational level in the multiple regression analysis suggests that educational level is a confounder for HS, next to age and after stratification on gender.

For the logistic regression, significant differences in ORs were found for the 'self-care', 'pain/discomfort' and 'anxiety/depression'

Table 3
Multiple linear regression analysis of the (pre-injury) EQ-5D-3L and EQ-VAS.

		EQ-5D-3L summary score	EQ-VAS
Block 1 Unadjusted	Males	β: 0.006 95% CI: −0.007, 0.019	β: 3.932 95% CI: 2.749, 5.115
	Females	β: −0.018 95% CI: −0.035, −0.001	β: 0.744 95% CI: −0.559, 2.248
Block 2 Adjusted for age	Males	β: 0.014 95% CI: 0.001, 0.027	β: 4.778 95% CI: 3.617, 5.940
	Females	β: 0.018 95% CI: −0.001, 0.036	β: 3.635 95% CI: 2.147, 5.123
Block 3 Adjusted for age and educational level	Males	β: 0.020 95% CI: 0.007, 0.033	β: 5.051 95% CI: 3.881, 6.221
	Females	β: 0.025 95% CI: 0.007, 0.043	β: 4.189 95% CI: 2.705, 5.672

Reference cohort = reference group.
Abbreviations: EQ-5D-3L = EuroQol-5D-3L, EQ-VAS = EuroQol Visual Analogue Scale, β=unstandardized beta, 95% CI = 95% Confidence interval.

dimensions between the injury cohort and reference cohort (OR = 1.655 [95% CI: 1.233, 2.221] for 'self-care', OR = 0.564 [95% CI: 0.491, 0.647] for 'pain/discomfort' and OR = 0.805 [95% CI: 0.671, 0.965] for 'anxiety/depression') after adjustment for age and gender (Table 4). The ORs of the 'mobility' and the 'daily activities' dimensions did not differ between both cohorts after adjustment for age and gender. When also adjusted for educational level, the injury cohort reported significantly more problems on the 'self-care' dimension (OR = 1.497 [95% CI: 1.112, 2.016]) compared to the reference cohort. Furthermore, the injury cohort reported significantly less problems on the dimensions 'pain/discomfort' and 'anxiety/depression' (OR = 0.522 [95% CI: 0.454, 0.602] for 'pain/discomfort' and OR = 0.745 [95% CI: 0.619, 0.897] for 'anxiety/depression'). Compared to the beta in block 2 (adjustments for age and gender), the beta in block 3 (adjustment for age, gender and educational level) decreased in all dimensions. In line with the findings in Table 3, the beta in block 3 changed ≥10% compared to the beta in block 2 for all individual items of the EQ-5D-3L. This indicates that educational level is a confounder in addition to age and gender for all dimensions of the EQ-5D-3L.

Discussion

This study reveals that retrospectively assessed pre-injury HS of the injury cohort is higher compared to the HS of the reference cohort. After adjustment for age, gender and educational level, there is still a bias in the measured pre-injury HS.

Our findings are in line with the results of previous studies in which a better HS was found in trauma patients as compared to a normative sample [15] or as compared to the general population norm [16,17,29,30]. We expect that the difference in HS between the reference cohort and the injury cohort could partly be explained by differences in educational level of the two cohorts. However, after adjustment for educational level (Table 3) and consequently by making the groups more comparable, the difference in reported HS between the injury and reference cohort further increased. The contribution of differences in educational level might partially cancels out the (positive) effect of other unmeasured confounders. Also as in our study, previous findings revealed better pre-injury outcomes predominantly in younger patients [29]. A higher activity level increases the risk of an injury [31]. Additionally, a higher activity level may also contribute to a better HS, leading to a healthy worker effect in the injury cohort. Subsequently, HS of the general population might underestimate the pre-injury HS because of a higher level of activity on the part of the trauma population. Besides, as stated in the introduction, retrospectively collected data can be distorted due to recall bias [7]. Due to the large impact an injury might have, patients generally overestimate their HS prior to their trauma [6]. Previous research also found that demographic characteristics such as age or educational level influence recall accuracy [32].

There is a lack of a clear definition of SES and there are large differences in methodology to determine SES. Today, educational level is used most frequently to indicate SES [33].

The trauma population is an ageing population. In this study, 12% of the responders of the injury cohort included elderly females with low educational level. Subsequently, the HS as reported by this group of patients might have influence the study findings.

In contrast to previous studies amongst representative German and English study samples [34,35], the reference cohort in our study showed no clear trend on the EQ-VAS when participants were categorized by low, middle or high educational level.In contast to the five dimensions of the EQ-5D-3L which ask about very specific functional states or activities, the VAS is a very subjective assessment of HS.

The impact of a trauma can largely influence patients' internal standards [36]. Compared to the reference cohort, the injury cohort

Table 4
Logistic regression analysis of the individual dimensions of the (pre-injury) EQ-5D-3L.

	Dimension 'Mobility' No problems (= 0) vs moderate/severe problems (= 1)	Dimension 'Self-care' No problems (= 0) vs moderate/severe problems (= 1)	Dimension 'Daily activities' No problems (= 0) vs moderate/severe problems (= 1)	Dimension 'Pain/ discomfort' No problems (= 0) vs moderate/severe problems (= 1)	Dimension 'Anxiety/ depression' No problems (= 0) vs moderate/severe problems (= 1)
Block 1 Unadjusted	β: 0.527 OR: 1.694 95% CI: 1.460, 1.966	β: 1.043 OR: 2.837 95% CI: 2.146, 3.749	β: 0.275 OR: 1.317 95% CI: 1.124, 1.543	β: -0.313 OR: 0.731 95% CI: 0.644, 0.830	β: -0.263 OR: 0.769 95% CI: 0.647, 0.914
Block 2 Adjusted for age and gender	β: 0.019 OR: 1.019 95% CI: 0.863, 1.203	β: 0.504 OR: 1.655 95% CI: 1.233, 2.221	β: -0.047 OR: 0.954 95% CI: 0.805, 1.132	β: -0.573 OR: 0.564 95% CI: 0.491, 0.647	β: -0.217 OR: 0.805 95% CI: 0.671, 0.965
Block 3 Adjusted for age, gender and educational level	β: -0.073 OR: 0.929 95% CI: 0.785, 1.101	β: 0.403 OR: 1.497 95% CI: 1.112, 2.016	β: -0.133 OR: 0.875 95% CI: 0.736, 1.041	β: -0.649 OR: 0.522 95% CI: 0.454, 0.602	β: -0.294 OR: 0.745 95% CI: 0.619, 0.897

Reference cohort = reference group.
Male = reference group.
Low educational level = reference group.
Age = continue variable.
Abbreviations: β=beta, OR = Odds Ratio, 95% CI = 95% Confidence interval.

reported significantly less problems on the ‘pain/discomfort’ and ‘anxiety/depression’ dimensions, but reported significantly more problems on the ‘self-care’ dimension. The health states of the EQ-5D-3L are converted into a summary score by applying a formula that adds values (i.e. weights) to each of the levels in each of the five dimensions [24]. Therefore, the EQ-5D-3L does not reflect all dimensions of HS equally and subsequently, it is important to examine the multiple components of HS.

Limitations

For the Netherlands, general EQ-5D population norm scores by age and gender category are available [37]. Comparison of the HS of the reference cohort and the Dutch general population norms showed that the general norm scores deviated from the HS of the reference cohort (data not shown). In the majority of the strata, better HS was found in the reference cohort. This raises the question regarding the representativeness of the reference cohort in our study. However, since we used strata for the comparisons and since we corrected for age, gender and educational level in the regression analysis, we argue that this does not have a large influence on the study results. Secondly, the response rate of the injury cohort was low (31% of the total eligible injured population). Patients with a very minor injury (ISS 1–3), patients with a mild injury (ISS 9–15) and those who were admitted ≥8 days were less likely to participate into our study. The responders and non-responders of the injury cohort differed largely according to age and gender. Thirdly, we had no information of the non-responders of the injury cohort regarding educational level which apparently can lead to selection bias. Consequently, the respondents’ pre-injury HS is most probably not representative of the pre-injury HS of the population we intended to analyse. Fourth, due to the different timing assessments of HS prior to the trauma, results might be biased [12]. Fifth, we cannot exclude change findings due to multiple testing. Change findings might particular have occured for the results of the individual domain scores of the EQ-5D-3L.

Recommendations for future research

This study leads to new research questions. More research is needed to examine whether a more earlier assessment might minimize the high pre-injury HS. Researchers should also find explanations for the increased differences between pre-injury HS and HS of the reference cohort after adjustment for educational level. Apart from age, gender and educational level, factors such as occupational status [38], living alone or not [38], activity level [31] or the presence of comorbidities [39–41] can influence HS as well. In all probability, these known (and other still unknown) characteristics differ amongst the injury and reference cohort. More research is necessary to examine which differences in characteristics exist between injury and reference cohorts and future research is vital to examine the influence of these characteristics on HS.

Conclusions

Without adjustments as well after adjustment for both age, gender and educational level, injured patients report better recalled pre-injury HS compared to the HS of a reference cohort. After adjustment for educational level, the difference in HS between the injured population and the reference cohort increases. This underlines that other confounders might also influence HS.

Compliance with ethical standards

The BIOS was approved by the Medical Ethics Committee Brabant, the Netherlands (project number NL50258.028.14). This study was conducted according to the 1964 Declaration of Helsinki and its later amendements.

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Ethical approval

Informed consent was obtained from all individual participants included in the study.

Conflict of interest

The authors declare that there is no financial or personal conflict of interest.

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