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Life after major trauma

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Cumulative research on health-related quality of life and return to work after major trauma

Dissertation

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Zusammenfassung

Umgangssprachlich ist ein Polytrauma durch eine Kombination aus mehreren schweren Verletzungen in mehreren Körperregionen gekennzeichnet. In den letzten Jahren haben die Fortschritte der prähospitalen und klinischen Behandlung von Schwer- und Schwerstverletzten die Sterblichkeitsrate deutlich gesenkt. Schwer- und Schwerstverletzte leiden häufig unter einer Vielzahl von Problemen wie chronischen Schmerzen, psychosomatischen Erkrankungen, Arbeitslosigkeit und posttraumatischer Morbidität, die mit einer verminderten gesundheitsbezogenen Lebensqualität (hrQoL) und einer verzögerten oder fehlenden Arbeitsfähigkeit einhergehen. Das übergeordnete Ziel dieser Forschungsarbeit war es, den Genesungsprozess von Schwer- und Schwerstverletzten bis zur Arbeitsfähigkeit zu erforschen anhand von a) Faktoren, die die Arbeitsfähigkeit beeinflussen könnten (via Systematic Review), und b) Erfahrungen von Schwerverletzten, einschließlich Arbeitsfähigkeit und hrQoL (mittels Patient:inneninterviews). Die Studien konnten die Erfahrungen von Schwer- und Schwerstverletzten im deutschen Gesundheitssystem von der Verletzung bis zur Genesung sowie die aktuelle Evidenz zu Faktoren, die die Arbeitsfähigkeit nach Polytrauma beeinflussen, aufzeigen. Die Untersuchung mit zwei verschiedenen Forschungsmethoden ermöglichte ein erweitertes und tiefgehendes Verständnis der Genesung von Überlebenden nach Polytrauma. Der Systematic Review ergab mehrere Faktoren, z. B. die Schwere der Verletzung und das Alter der Patient:innen, die den Genesungsprozess beeinflussen könnten, sowie die Wechselbeziehung zwischen den identifizierten Faktoren. Die Patient:innenbefragungen hingegen gaben Aufschluss über Aspekte wie Kommunikation und psychische Gesundheit sowie den Einfluss von Familie, Freund:innen und Arbeitgeber:innen auf den Genesungsprozess. Beide Studien bieten die Möglichkeit zu verstehen, wie unterschiedliche Studiendesigns die Chance bieten können, verschiedene Perspektiven auf dasselbe Thema zu ermöglichen. Die meisten, der in dem Systematic Review ermittelten Faktoren sind nicht durch Maßnahmen des Gesundheitswesens veränderbar. Die Erfahrungen der Patient:innen jedoch zeigen eine Vielzahl von Faktoren und Themen, die durch Interventionen verbessert werden könnten, wie z. B. Kommunikationsprobleme zwischen dem medizinischen Personal und den Patient:innen. Auch wenn jedes Studiendesign durch verschiedene Faktoren und Verzerrungen begrenzt ist, bieten die Synergieeffekte der Kombination von Studiendesigns die Möglichkeit, dass die Ergebnisse von Studien besser verstanden werden können, einfacher auf die Praxis übertragbar sind und auch auf andere Umstände übertragen werden können, was die Forschungsergebnisse generalisierbarer und damit nachhaltiger machen.

Summary

A major trauma (also known as polytrauma, severe trauma, severely injured) is characterized by a combination of multiple serious injuries to several regions of the body. In recent years, advances in prehospital and clinical treatment of major trauma patients have significantly reduced mortality. Major trauma survivors often suffer from a variety of issues ranging from chronic pain, psychosomatic illnesses, unemployment and post-traumatic morbidity which goes along with reduced hrQoL and delayed or no return to work (RTW). The overall aim of this research was to explore the recovery process of major trauma survivors until RTW with a) factors that might influence RTW via systematic review and b) lived experiences of major trauma survivors including RTW and hrQoL via patient interviews. The aim was to demonstrates the experiences of major trauma survivors in the German health care system from injury to recovery as well as the current evidence surrounding factors that influence RTW after major trauma. The exploration via two different research methods enabled a broadened and deepen the understanding of the recovery of major trauma survivors. The systematic review resulted in several factors e.g. injury severity and age of patients that might influence the recovery process as well as it explores the interrelation between the identified factors. The patient interviews, on the other hand, gave insight in aspects such as communication, mental health and the impact of family, friends and employers on the recovery process. Both studies give an opportunity to understand how different study designs can offer the chance to consider different perspectives of the same issue. The systematic review provides insight in the data collected by register and cohort studies. Most of the factors identified via systematic reviews are not modifiable via healthcare service interventions. However, the experiences of patients within the German healthcare system show that there are a variety of factors and topics that have the potential to be improved via healthcare service intervention such as communication issues between the medical personnel and patients but also interdisciplinary communication issues. Even though, each study design is limited by several factors and biases, but the synergetic effects of combining study designs offers that results of studies are understood in more depth, are better translatable to practice and may also be transferred to other circumstances, which makes the research more generalizable and therefore, more sustainable.

Abbreviations

AIS	Abbreviated Injury Scale
AMA	American Medical Association
AUC	Akademie der Unfallchirurgie
DGU	Deutsche Gesellschaft für Unfallchirurgie
EQ-5D	European Quality of Life 5 Dimensions
ER	Emergency room
FIM	Functional independency measurement
FU	Follow up
GP	General Practitioner
ICF	International Classification of Function, disability and Health
ICU	Intensive care unit
ISS	Injury Severity Score
hrQoL	health-related Quality of Life
LOS	Length of stay
LOS hospital	Length of stay hospital
M/F	Male/Female
NISS	New Injury Severity score
P.A.R.T.Y.	Prävention. Alkohol. Risiko. Trauma. Youth
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PTSD	Posttraumatic Stress Disorder
QUIPS	Quality in prognostic studies tool
RTW	Return to work
RoB	Risk of Bias
SIP	Sickness Impact Profile

Table of content

1. Introduction

1.1. Introduction of the research topic

Major trauma (also known as polytrauma, severe trauma, severe injury) is characterized by a combination of multiple serious injuries to several regions of the body. These serious injuries are associated with an inflammatory reaction and abnormal physical functions and can lead to failure of uninjured organs. These physical reactions increase the overall risk of complications and death after major trauma. Hence, a major trauma is not merely an injury due to an accident and not just a single injury itself, but rather a multitude of injuries, their interactions, and synergetic effects on health and recovery (1,2). The TraumaRegister of the German Trauma Society recorded 31,217 people with a major trauma in 2023. Of these 32.0% had life-threatening injuries (3).

In recent years, advances in the prehospital and clinical treatment of patients with major trauma have significantly reduced mortality (4). Major trauma survivors often suffer from a variety of issues, including chronic pain, psychosomatic illnesses, unemployment and post-traumatic morbidity, which are accompanied by reduced hrQoL. All these issues can lead to slowed ability or inability to RTW (5–7). Further, not always considered in literature on major trauma survivors, the consequences of a major trauma not only lead to reduced productivity in paid work but also reduce abilities in unpaid work, such as care work (8–10). Reduced hrQoL seems to be related to mental health issues such as post-traumatic stress disorder (PTSD) and anxiety, as Lotfalla et al. (2023) found in their systematic review, which, in turn, influences RTW. These interrelations and their interplay with the personal and societal environments have only recently been the focus of this research field (10,11). A systematic review by David et al. (2022) found that approximately one-third of patients after a major trauma do not RTW one year after being discharged from the hospital (9). Hence, major trauma is related to high direct and indirect costs due to in-hospital, post-hospital (e.g., rehabilitation, vocational training) and productivity loss (12–14).

1.2. Aim of the research

The overall aim of this dissertation was to explore the recovery process of major trauma survivors until RTW with a) factors that might influence RTW via systematic review and b) lived experiences of working-age major trauma survivors, including RTW and hrQoL, through patient interviews.

Both studies were integrated into the projects LeAf Trauma (principal investigator: PD Dr. Dan Bieler), and the systematic review on RTW after major trauma was further integrated into the project TraumaEvidence (project leaders: Univ.-Prof. Dr. Joachim Windolf and Anne Neubert). LeAf Trauma focusses on the exploration of hrQoL and RTW of major trauma survivors in Germany. It consists of stakeholder interviews, retrospective analysis of electronic health data, and a prospective cohort study conducted in over 40 hospitals in Germany (15). TraumaEvidence is a project founded by the German Trauma Society and the University Hospital Düsseldorf. The aim of this project is to foster evidence-based medicine in traumatology.

a) The aim of the systematic review was to systematically explore the evidence regarding factors that influence RTW after major trauma. Many studies in the field of major trauma research have investigated RTW, and some have explored factors that might influence RTW, including personal and system-related factors. These factors may delay or hinder RTW. The present systematic review was the first to summarize such factors for in a clearly defined population of major trauma survivors with an injury severity score (ISS) of 16 or more. This offered a comprehensive understanding of factors and their interdependencies, which could help in the design of health care service interventions for major trauma survivors. It was designed to understand the factors that might influence the recovery process. The integration within TraumaEvidence offered the opportunity to have an evidence-based approach and to understand especially methodological issues that might hinder or at least influence knowledge generation within this research field. The integration of the systematic review in the LeAf Trauma project offered a profound understanding of possible factors that shape the recovery process of major trauma survivors beyond

the included literature due to the extensive clinical expert network in which the LeAf trauma is embedded. On the other hand, the results of the systematic review supported the analysis of other study arm within LeAf trauma such as the retrospective analysis of electronic health data (15,16).

b) The aim of the patient interviews was to explore the lived experiences of major working-age trauma survivors regarding their recovery process in the German healthcare system using semi-structured exploratory interviews. Several studies have explored major trauma from various angles, such as evaluation of long-term health- and work-related outcomes over 6 to 12 months, utilizing validated outcome assessment instruments, such as the European Quality of Life 5 Dimensions (EQ-5D) or investigating predictors of RTW and hrQoL. However, despite the growing literature on major trauma survivors, there is a gap in investigating the subjective experiences of these patients, as the main research body focuses on study designs that utilize standardized patient-reported outcome measures, as well as functional or clinical/radiological outcomes. Moreover, a qualitative analysis also offers an exploration of systemic challenges and opportunities within the framework of the German healthcare system with its processes and structures (17). As the patient interviews are part of the project LeAf trauma, they served several purposes: (1) they helped the project to understand the healthcare system processes from injury to recovery from the subjective viewpoint of patients, and (2) the results aided the design of the questionnaires used in the prospective cohort study to explore patient recovery. An ethical vote was retrieved from the ethical commission of the Heinrich-Heine-University (study nr. 2022-1970) (15,17).

2. Return to work after major trauma: a systematic review.
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REVIEW

Open Access

Return to work after major trauma: a systematic review

Anne Neubert[1,2*], Sebastian Hempe[3], Dan Bieler[3], Denise Schulz[1,2], Carina Jaekel[1,2], Michael Bernhard[4] and Joachim Windolf[1,2]

Abstract

Introduction Individuals suffering from major trauma and survive, often face diverse physical, psychological, and cognitive restrictions which can influence the (health-related) quality of life and the ability to work. Even though, return to work is not necessarily related to the health status of the individual, but it is viewed as a sign of successful reintegration and is a vital parameter of recovery.

Objective The aim was to systematically review factors influencing return to work (RTW) after suffering from major trauma.

Material and methods A search on seven databases was performed. The identified publications were selected according to the inclusion criteria: adults (≥ 16 years) who suffered a major trauma (Injury Severity Score ≥ 16) in studies that explored factors associated with RTW. Risk of bias was assessed with the 'Quality in Prognostic studies' tool. Due to reporting quality of the included studies no meta-analysis was performed. Data were clustered, qualitatively analyzed and factors are assessed based on the strength of evidence. (PROSPERO registration: CRD42022357649).

Results 12 studies with 6907 participants (mean age 45 years, 75% males, mean ISS 28) were included. The included studies had low to moderate risk of bias for most domains, the domain 'study confounding' had most often a high risk of bias. Many factors were identified including physical (e.g., injury locations), personal (e.g., age) but also environmental factors (e.g., preinjury income). Only four factors (age, educational level, intensive care unit (ICU) stay and Length of stay (LOS) hospital) are based on moderate or strong evidence. The identified factors reflect the complex interactions within the process of regaining the ability to work after major trauma.

Discussion This systematic review was able to map the evidence surrounding factors affecting RTW after major trauma. Most of the identified factors are currently only based on limited evidence. According to these factors, younger patients with a higher educational level who have a shorter LOS in hospital and a shorter ICU stay might have better chances of RTW.

Keywords Major trauma, Polytrauma, Return to work, Ability to work, Prediction, Systematic review

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Introduction

Injuries are one of the leading causes of death and disability worldwide, especially in those individuals severely injured due to a high energy trauma [1, 2]. Individuals suffering from a major trauma and survive often face diverse physical, psychological and cognitive restrictions which can influence the (health-related) quality of life and the ability to work [3]. The inability to work is a major personal, public health and financial burden. Those individuals who do not return to work (RTW) due to illness or injury experience more physical and psychological suffering. Further, individuals face reduced finances and career opportunities. This can lead to decreased self-reported health and quality of life [4, 5]. Additionally, there are high societal costs involved e.g., due to loss of productivity [6–10]. RTW is for many individuals who survived a major trauma an important goal. Even though, RTW is not necessarily related to the health status of the individual, but it is viewed as a sign of successful reintegration and is, hence, a vital parameter of recovery [8–12].

Several publications are concerned with RTW after major trauma, some of them attempt to delineate factors that might influence RTW including e.g., personal and system-related factors [13]. To date, no systematic review has been conducted that summarizes such factors in individuals after major trauma (Injury Severity Score of ≥ 16). There is a need to systematically review the existing literature regarding factors that are associated with the RTW after a major trauma. This will offer a comprehensive understanding of factors which could support the design of interventions to support individuals after major trauma. Possibly many factors are complex and have possible interdependencies beyond the trauma. The aim of this study is to systematically review the evidence regarding factors that influence RTW after a major trauma.

Methods

This study is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [14]. The underlying methods are based on the guides to systematic reviews and meta-analysis of prognostic studies [15, 16]. The protocol was registered on PROSPERO (CRD42022357649).

Eligibility criteria

The eligibility criteria are shown in Table 1. After discussion in the research team, the patient age was adjusted to 16 years (18 years and older stated in protocol) as there are many adults in this age group who are already working. A major trauma is defined in this systematic review as an individual with an Injury Severity Score (ISS) of ≥ 16 or an Abbreviated Injury Scale (AIS) ≥ 3 and at least one other injury [17, 18]. In contrast to the registered protocol, studies with mixed population regarding ISS and more than 5% of patients with ISS < 16 were excluded. A higher percentage would capture a different population of those less severely injured (ISS 9-15). In addition to the protocol, studies that merely investigate the proportion of majorly injured, who returned to work

Table 1 Eligibility criteria

	Inclusion criteria	Exclusion criteria
Population	• Age ≥ 16 years (working age) Major trauma defined as: • Injury Severity Score (ISS) of ≥ 16 • Abbreviated Injury Scale (AIS) ≥ 3 and at least one other injury	• Children (age < 16 years) • Studies that include more than 5% of patients with ISS < 16 • Other injuries: frailty fracture, mono injuries such as isolated facial fractures, isolated closed fractures or spinal injuries, malignant disease, amputations for other reasons than due to the major trauma (e.g., diabetes mellitus), war related injuries, burns as well as psychological trauma (if not related to the major physical trauma) • Use of other score to determine major trauma which could not be translated into ISS (e.g., Hannover Score for Polytrauma Outcome, New Injury Severity Score)
Intervention	• Any intervention is eligible including but not limited to any clinical, behavioral, and multidisciplinary interventions	
Comparison	• Any comparison is eligible including	
Predictive factors	• Any factors that affect the ability to RTW	• Factors affecting other related outcomes such as disability
Outcome	• RTW or related concepts such as ability to work, time of sick leave or others	• Studies that merely investigate the proportion of those returning to work without investigation of the influencing factors
Study designs	• Any interventional and observational study with a comparison	• Editorial notes, comments, case reports/series, abstracts, books, grey literature, systematic reviews

AIS, abbreviated injury scale; ISS, injury severity score; RTW, return to work

without further investigation of influencing factors, were excluded.

Search strategy

The search was performed on 09. November 2022 on several databases (MEDLINE via PubMed, CENTRAL, PEDro, TRIP, PsychINFO, Web of Science and bibnet). Additionally, the clinical trial registers, WHO ICTRP and clinicaltrials.gov, were searched. A search strategy was developed which contains the keywords polytrauma and RTW with related synonyms. The search strategy was modified to fit the syntax of each database and trial register. There were no limitations on the timeframe. A peer review of the search strategy was performed by DS. The search strategies for each database can be found in Additional file 1—Search strategy. Additionally, the bibliographies of included studies and relevant systematic reviews related to the topic were searched for potentially eligible studies. Only publications in English and German were eligible.

Selection

Two authors (AN & SH) screened title/abstract and full text of the identified publications, independently. The selection of studies is based on the defined inclusion and exclusion criteria (Table 1). The authors used the Covidence software to screen the publications [19]. Disputes were solved in discussion.

Data extraction

Two authors (AN & SH) extracted the data in Excel, independently. An adapted version of the data extraction sheet by the Cochrane Methods Prognosis Group was used guided by the data extractions items described in Moons (2014) [16, 20]. The data extraction sheet was tested on two studies and adjusted accordingly. Disputes between the two authors were solved in discussion. Data on study characteristics (e.g., study design, setting), patient-related data (e.g., demographic data, comorbidities), trauma-related data (e.g., ISS, mechanism of injury, organ involvement, brain/head injuries), work related data (e.g., duration of sick leave), as well as factors affecting RTW (including statistical methods used) investigated by the included studies were extracted.

Risk of bias

For the assessment of risk of bias and the sufficiency of reporting, the Quality in Prognosis Studies (QUIPS) Tool was used as recommended by Cochrane . The QUIPS tool relies on six domains, 1) study participation, 2) attrition, 3) prognostic factor measurement, 4) outcome measurement, 5) study confounding and 6) statistical analysis and reporting [21, 22]. The tool rates the RoB as well as the quality of reporting within the studies. The overall RoB was determined as shown in Table 2 [22, 23]. The sufficiency of reporting was rated as sufficient , partial , and insufficient reporting. The QUIPS assessment was carried out by two authors (AN & SH), independently. Disputes were settled by discussion.

Synthesis

The meta-analysis was planned in the protocol to synthesize the effects of the identified factors. However, many issues appeared in the included studies that prevented a meta-analysis. Among others, the studies had missing data (e.g., statistical information about the performed analysis) and factors had different effect measurements (e.g., risk ratio, odds ratio) not comparable with each other. The studies used different measurement time points and used varying definitions for RTW and the prognostic factors. Many of these issues result in increased heterogeneity. The included studies were judged to be too heterogenous to perform a meta-analysis. Hence, a narrative analysis of the results was performed. No sensitivity analysis, subgroup analysis and analysis of publication bias were performed.

As several studies only reported factors that were found to be significant in multivariate analysis, only those factors were included in the synthesis. Factors from univariate analysis or non-regression analysis (e.g., group comparisons like the Chi-Quadrat test) were not used in the synthesis but reported in Additional file 4. If only median and interquartile range were provided by the included studies, means were calculated using the Quantile Estimation method proposed by McGrath (2020) [24].

The factors were clustered according to the International Classification of Functioning, Disability and Health (ICF) framework model. In the framework model functioning and disability are outcomes that are conditioned on the interplay between health conditions, personal,

Table 2 Determination of overall risk of bias

Overall rating of risk of bias	Number of domains of a total of 6 in each category		
	Low	Moderate	High
Low risk of bias	6	0	0
	4–5	1–2	0
Moderate risk of bias	3	3	0
	Any	1	1
High risk of bias	Any	≥ 2	1
	Any	Any	≥ 2
	Any	≥ 4	Any

contextual, and environmental factors. Here the modified framework by McDougall (2010) is used that included also quality of life and human development across time as visualized in Fig. 1 [25]. The ICF offers a deepened understanding of the interplay between the identified factors [26].

After clustering, the strength of evidence method was used as described in several orthopedic systematic reviews on prognostic factors to synthesis the identified evidence [27–29]. The applied method of categorization of the strength of evidence is shown in Table 3. The quality of the included studies is rated based on the combined results of the RoB and sample size. Factors, that were described as having positive association with RTW in one study and as having negative association with RTW in another, are judged as inconsistent. Factors without mentioning of the direction of association are shown but not considered to contribute to the strength of evidence. To be considered as consistent evidence the effect measures and p-values should result in the same conclusion (e.g., factor X has a positive, no, or a negative association on RTW). If a factor is only reported in one study, the strength of evidence is considered limited. [27–29].

Results

The search revealed 2,126 hits with 103 duplicates. Therefore, 2,023 titles and abstracts were screened which led to 132 full texts. Additionally due to the hand search, 60

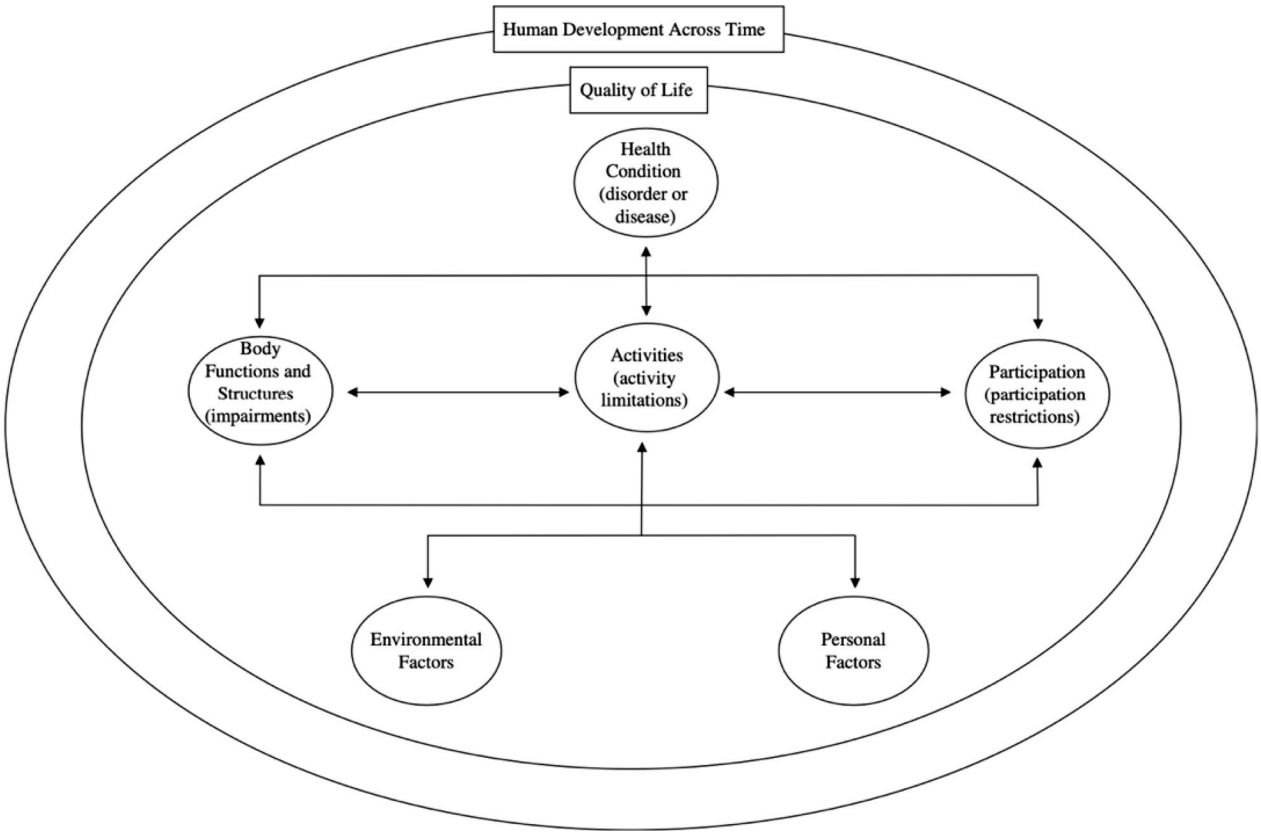

Fig. 1 modified International Classification of Functioning, Disability and Health (ICF) framework model [25, 26]

Table 3 Rating of strength of evidence

Strong evidence: Consistent findings in at least 2 high-quality cohort study
Moderate evidence: One high-quality cohort study and consistent findings in one or more low-quality cohort study
Limited evidence: Findings of one cohort study or consistent findings in more than one low-quality cohort study
Inconsistent evidence: Inconsistent findings irrespective of study quality

Based on the approach described in Ariëns (2000) [29]

title/abstract were screened which led to 11 full texts for the screening. The screening of full texts revealed a total of 14 publications of 12 studies that were included in this systematic review. The most common reason for exclusion of full texts was "*wrong population*" (n = 81) predominantly due to populations with an ISS mostly below 16. The selection process is illustrated in the PRISMA flowchart (Fig. 2) and an overview of the excluded studies with reasons can be found in Additional file 2.

Population characteristics

The twelve studies included nine prospective, two retrospective and one registry-based studies. No ongoing study was identified. The included studies are from various countries like the Netherlands (n = 4) and Germany (n = 2). They were published between 1990 and 2023 as shown in Table 4. In total the systematic review includes 6,907 patients with a mean age of 45 years (mean range 31–49 years) and a mean ISS of 27.9 (mean range 21–38.9). 74.7% of the population are men. Nine studies (1,207 patients) reported the main injury mechanisms as traffic accidents (60.7%). The LOS hospital was measured in eight studies with a mean of 16.8 days in hospital (mean range 13.5–79.9 days). Five studies also measured the LOS ICU with a mean of 22 days (mean range 15–30 days). Of the included patients 90.3% (n = 6236) were working prior to injury. Eight studies performed regression analysis for the RTW outcome [13, 30–36]. These studies developed a prediction model without external validation. Three studies only determined whether there were group differences for the outcome RTW in relation to certain characteristics. For others, it was uncertain which statistical methods were used [36–39].

Return to work

All studies included determined the concept of RTW as an outcome. Additional file 3 provides an overview of definitions, measurement time points and proportions of those individuals that RTW. While in some studies patients were simply asked for their RTW status (yes / no RTW), other studies asked more detailed (full-time / part-time / change in occupation / re-training / change of working hours / retirement / unemployment / sick leave). It is unknown whether studies that measured RTW dichotomously, also included patients that RTW part-time or those that are part of a reintegration program in which they RTW on an hourly basis while still on sick leave. Additionally, some studies rated RTW only

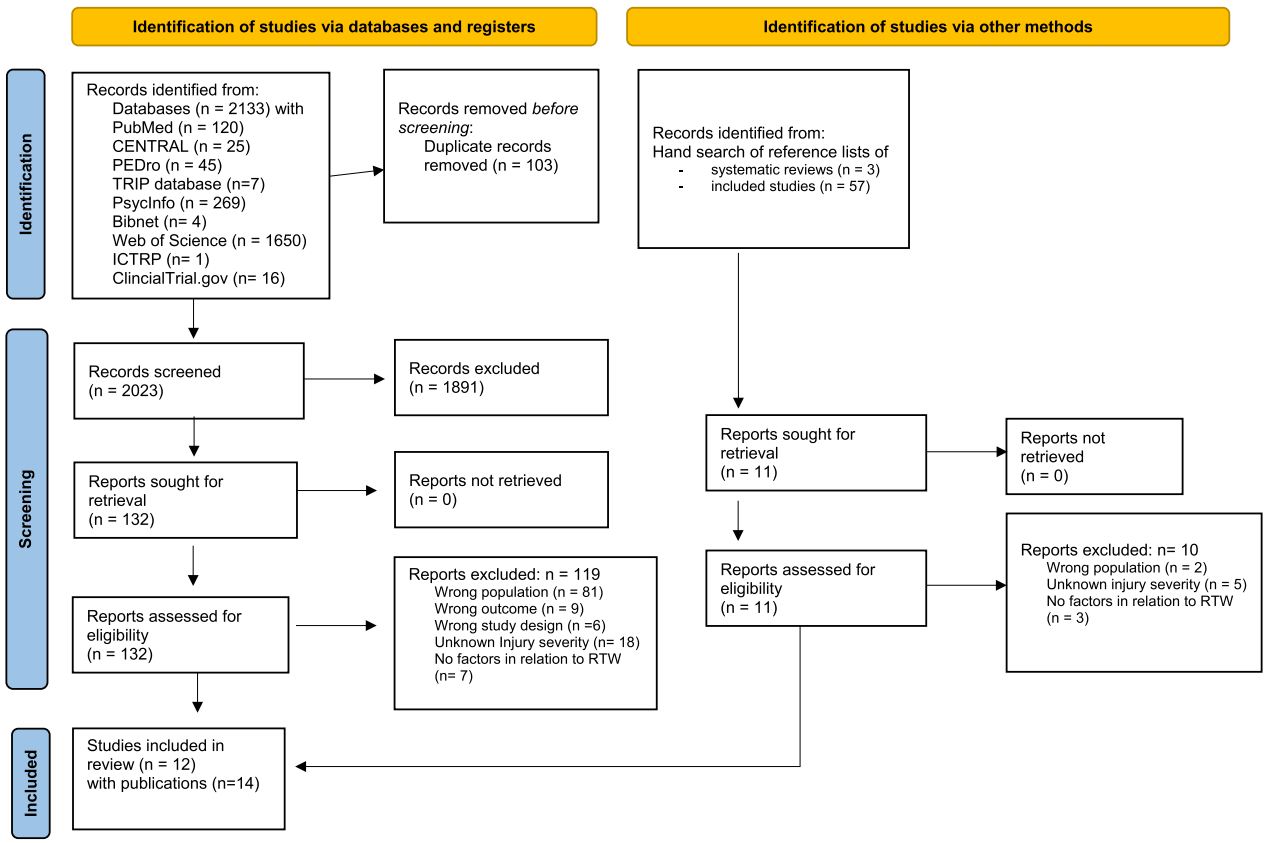

Fig. 2 PRISMA flow chart as recommended by Page (2021) [14]

Table 4 Characteristics of included studies

Study ID	Country of origin	Study design	Sample size	Age (Mean ± SD in years)	Sex (M/F)	ISS (Mean ± SD)
Gabbe [35]	Australia	Prospective cohort	243	35.3	199/44	30
Gross [32]	Switzerland	Prospective cohort	237	39.5 ± 20.6	180/57	27.5 ± 8.2
Grotz [39] Grotz [40]*	Germany	Retrospective cohort	50	33.6 ± 2.1	35/13	36.8 ± 1.6
Haas [35]	Canada	Retrospective cohort	5,341	47.3 ± 8.8	3974/1367	ø
Holtslag [13] Van Erp [41]*	Netherlands	Prospective cohort	214	34.8 ± 11.6	184/30	25.0 ± 11.1
Kivioja [36]	Finland	Prospective cohort	92	31	65/27	38.9 ± 1.2
Livingston [37]	USA	Existing registry	100	42	81/19	28
Post [42]	Netherlands	Prospective cohort	53	37.3 ± 13.2	43/10	23.5 ± 8.2
Simmel [31]	Germany	Prospective cohort	127	37.3 ± 11.5	66/61	35.6 ± 7.9
Soberg [30]	Norway	Prospective cohort	102	34.5 ± 13.5	84/18	28.1 ± 11.3
Van Ditshuizen [38]	Netherlands	Prospective cohort	182	49.3	116/66	21.3
Vles [34]	Netherlands	Prospective cohort	166	35	134/32	23

ISS, injury severity score; M/F, male/female; SD, standard deviation; ø, not reported

*Both publications investigate the same study population, only the results of the top publications on are used for analysis

if the participants returned to a paid occupation [35, 38, 42] thereby excluding participants that are e.g. volunteers or doing care work from the analysis. Whereas, Soberg (2007) also included participants who returned to education [30, 37] and Vles (2005) considered the inability to work [35].

The median time for the outcome measurement was 3.8 years (range 6 months to 20 years). The RTW rate also varied considerably. Among the studies that only measured RTW (yes/no) it ranged from 56.5 to 79.3%. Gabbe (2008) who measured RTW six months post-injury showed a RTW rate of 58.6% [33] whereas Grotz (1997) reported it to be 64% in their cohort after a mean of 4.9 years [39]. In studies that measured the RTW more differentiated, a range of full-time RTW of 37% to 58.4% was shown. They reported a partial RTW rate between 21.5% and 65%. Further, several studies reported on unemployment/ workless rates of 7% to 20.1% and a retirement rate of 1.9% to 13% which is also reflecting the lengths of follow-up in the single studies. Similarly, the rate of change of occupation ranged from 7.6% to 29%. The difference in retirement and change of occupation rate could be a reflection of differences in health systems as well as it could be influenced by the lengths of follow up between 1 and 5.6 years, respectively. As a results of this heterogeneity, also the proportion of those RTW varied considerably between the studies.

Reporting and risk of bias

Reporting

Overall, the studies have a rather moderate quality of reporting, much information is missing in the publications especially in relation to prognostic factor measurement, outcome measurement, study confounding and the performed statistical analyses. Only one study, Haas (2021) reported probable confounding factors and how confounding was investigated. [35]. All other studies lack the necessary information on confounding. However, all studies showed a sufficient reporting of the study participants with adequate reporting on place of recruitment, inclusion criteria and baseline characteristics. Also, regarding study attrition most studies showed moderate or sufficient quality of reporting.

Risk of bias assessment

The overall RoB was assessed to be moderate to high for most studies as shown in Table 5. Several studies potentially have a bias in relation to study confounding, prognostic factor measurement, study attrition, and/or statistical analysis. Confounding was mostly not addressed at all. Further, the domain statistical analysis was rated in most studies with a moderate risk of bias. Most studies had a small sample size [30, 31, 34, 36–38, 40, 42]. Hence, probably several studies have an issue with overfitting as the sample sizes are probably too small to detect a certain effect. Kivioja (1990) and Grotz (1997) show a high risk of bias [36, 39]. Both studies did not describe any approach for prognostic factor measurement. Moreover, Kivioja (1990) have a moderate risk of bias in the areas of study participation,—attrition and statistical analysis [36].

Factors affecting return to work

The included studies found 32 unique factors that may influence RTW. 22 factors were only associated in single studies. All factors were clustered according to the

Table 5 Risk of bias

Study ID	Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Study confounding	Statistical analysis and reporting	Overall RoB
Gabbe [33]	Low	Low	Low	Low	High	Moderate	Moderate
Gross [32]	Low	Moderate	Low	Low	Moderate	Moderate	Moderate
Grotz [39]	Low	Moderate	High	Low	High	Low	High
Haas [35]	Low	Low	Low	Low	Low	Low	Low
Holtslag [13]	Low	Low	Low	Moderate	High	Moderate	High
Kivioja [36]	Moderate	Moderate	High	Low	High	Moderate	High
Livingston [37]	Low	Low	Moderate	Low	High	Low	Moderate
Post [30]	Low	Low	Low	Moderate	High	Low	Moderate
Simmel [31]	Low	Moderate	Low	Low	High	Moderate	High
Soberg [30]	Low	Low	Low	Low	Moderate	Low	Low
Van Ditshuizen [38]	Low	Moderate	Low	Low	High	Moderate	High
Vles [34]	Low	Low	Low	Moderate	High	Low	Moderate

Source: QUIPS Assessment [20]

modified ICF Framework in Table 6. It illustrates the complex interplay of personal (e.g., age), body function/structure (e.g., extremity injuries), participations and activity (e.g., physical fitness) and environmental factors (e.g., low preinjury income) combined with five factors not groupable according to ICF (e.g., ICU stay). It demonstrates, furthermore, that several factors probably have overlapping concepts e.g., educational level and low preinjury income. Additionally, it also shows that several aspects are not investigated at all or only seldom such as psychosocial, occupational or health system aspects.

Several of the factors are based on heterogenous definitions (ICU stay, ventilator days, spinal injury, head injury). While one study defined ICU stay as the admission to ICU [35], another defined it as an ICU stay of more than 21 days [13] and a third as the length of stay in the ICU [31]. Similarly, also the factor mechanical ventilation was defined by one study as patients that had to be mechanically ventilated [35] and by others as the length of mechanical ventilation [37, 39]. Head injury was also defined diversely (severe head injury [35], presence of any head injury [34] or head AIS [37]. Also spinal injury was defined as spinal cord injury [13] or as injury to spine and pelvis [34]. Some studies used instruments to measure the influence of certain concepts on RTW, such as using the Groningen Activity Restriction Scale to measure the concept of disability [13].

Furthermore, Additional file 4 shows all factors investigated by the included studies (including ratios and confidence intervals) including those investigated in univariate analyses but not included in multivariate analyses or assessed with other statistical analysis (e.g., Chi Square tests). These factors involve personal (e.g., profession or marital status), injury related factors (e.g., type of injury) and factors related to the post-injury functioning (e.g., functional independency measurement (FIM) score).

Strength of evidence

Nine factors were investigated in more than one study with the use of multivariate regression models. Table 7 shows that one factor (LOS hospital) has strong evidence whereas the factors age, educational level and ICU stay are of moderate strength of evidence. Further, sex, injury severity, head injury, extremity injury and spinal (cord) injury are of limited evidence. Sex is rated with limited evidence as the study with the largest sample size showed no association between sex and RTW . The two studies investigating spinal injuries are very heterogenous. Hence, the consistency of the evidence is questionable. Head injury is based on one high quality study, but the accompanied studies show inconsistent findings probably due to varying underlying definitions (e.g., severe head injury versus head injury). The results of injury severity as a factor are based on studies with moderate to high RoB with less than 250 participants each, but the limited evidence suggests that a lower ISS is increasing the chance of RTW. Extremity injury is based on one study with a moderate and one with a high RoB. The former

Table 6 Grouping of factors according to ICF

Domain	Factors	Study ID
Personal factors	Age	Gabbe [33]; Haas [35]; Holtslag [13]; Kivioja [36]; Simmel [31]; Soberg [30]; Vles [34];
	Sex	Haas [35]; Soberg [30];
Body function & structure	ISS	Gross [32]; Holtslag [13]; Kivioja [36]; Soberg [30]; Vles [34];
	NISS	Soberg [30]
	Extremity injury	Soberg [30]; Vles [34]
	Head injury	Haas [34]; Holtslag [13]; Kivioja [36]; Soberg [30]; Vles [34]
	Abdominal injury	Vles [34]
	Thorax injury	Vles [34]
	Spinal injury	Holtslag [13]; Soberg [30]; Vles [34]
	Number of body areas with injury	Vles [34]
	General health status	Simmel [31]
	FIM motor score	Gabbe [43]
	Head injury Symptom Checklist without anxiety	Holtslag [13]
	Co-morbidity	Holtslag [13]
Participation & activity	Physical fitness	Kivioja [36]
	Physical functioning	Soberg [30]
	Groningen Activity Restriction Scale	Holtslag [13]
	Nottingham Health Profile	Gross [32]
	Percentage of permanent impairment (AMA)	Holtslag [13]
	Educational level	Gross [32]; Soberg [30];
	Social function	Soberg [30]
	Powerful other locus of health control	Soberg[30]
Environmental factors	Low preinjury income	Haas [35]
	Time in ER	Gross [32]
	Mean nurse per day and per patient ratio	Gross [32]
	Compensable status	Gabbe [43]
	Profession	Soberg [30]
Not identifiable via ICF	ICU stay / Length of stay ICU	Haas [35]; Holtslag [13]; Simmel [31]
	LOS hospital	Haas [35]; Holtslag [13]
	Mechanical ventilation	Haas [35];
	Discharge destination	Gabbe [43]; Holtslag [13]
	Time between hospital discharge and FU	Simmel [31]

AMA, American medical association; ER, emergency room; FIM, functional independency measurement; FU, follow up; ICF, International classification of functioning, disability and health; ICU, intensive care unit; LOS, length of stay

states that an injury to one or more extremities is protective in relation to RTW whereas the later does not indicate the direction of association [36].

Final model of potentially influential factors

The model is based on the result of the strength of evidence rating and additional, three factors shown by one of two studies with a low RoB and sample sizes of more than 100 participants: mechanical ventilation, low preinjury income, and social functioning (Additional file 4) [30, 35]. Moreover, five factors of studies with a moderate RoB and sample sizes of more than 100 participants were shown to have a significant association with RTW: locomotion item, FIM motor score, time in emergency room (ER), mean nurse labor per day per patient and the Nottingham health profile [32, 33]. These factors have a limited strength of evidence and are integrated in the final ICF framework model of factors with a potential to influence RTW after major trauma (Fig. 3). The colors indicate the strength of evidence: the more intense the color the stronger the evidence. Several factors related to body function and structure, participation, and personal factors but also some environmental factors as well as some not integrable within the ICF model were included. The multitude of other factors shown in section "factors affecting RTW" are currently

Table 7 Strength of evidence rating

Study ID	Age (Increasing age)	Sex (male)	Educational Level (higher level)	Injury severity (higher ISS)	Head injury	Extremity injuries	Spinal (cord) injury	ICU stay	Length of hospital stay
Gabbe 2008 (41)	* ▲								
Gross 2010 (30)			* ▼	* ▲					
Haas 2021 (33)[a]	*	▶			* ▲			* ▲	* ▲
Holtslag 2007 (11)	* ▲			▲			* ▲		
Kivioja 1990 (34)	*			*		*			
Simmel 2019 (29)	* ▲							* ▲	
Soberg 2007 (28)	▲	▲	* ▼						* ▲
Vles 2005 (32)	▲	* ▲		* ▲	▲	* ▼	▲		
Strength of evidence	Moderate evidence	Limited evidence	Moderate evidence	Limited evidence	Limited evidence	Limited evidence	Limited evidence	Moderate evidence	Strong evidence

*Legend: *significant association <0.05*

Color: low RoB; moderate RoB; high RoB

Direction of arrow: ▲ *factor has a negative influence on RTW;* ▼ *factors have a positive influence on RTW;* ▶ *no influence on RTW;* ***no arrow:*** *direction of association not reported.*

Size of arrow: ▲ *>100 patients;* ▲ *>250 patients*

* significant association < 0.05

lacking the evidence base to be integrated in the final model.

Discussion

For many severe injured patients RTW is a goal and it is certainly a determinant of functional and mental recovery after a major trauma. This systematic review was able to map the evidence surrounding factors affecting RTW after major trauma. Most of the identified factors are currently only based on limited evidence. Only four identified factors (age, educational level, ICU stay and LOS hospital) are based on moderate or strong evidence. The use of the ICF model enabled a deeper insight into the complex interactions of bodily, personal, participatory, and environmental factors in the process of regaining the capacity to RTW after major trauma. Also other studies with similar cohorts have pointed out the complex relations and that not only injury related factors but also personal, social and environmental factors account for difficulties in RTW or non-RTW [8–10, 44–49].

Factors such as ICU stay, LOS hospital or LOS rehabilitation are possibly surrogate measures for the severity of

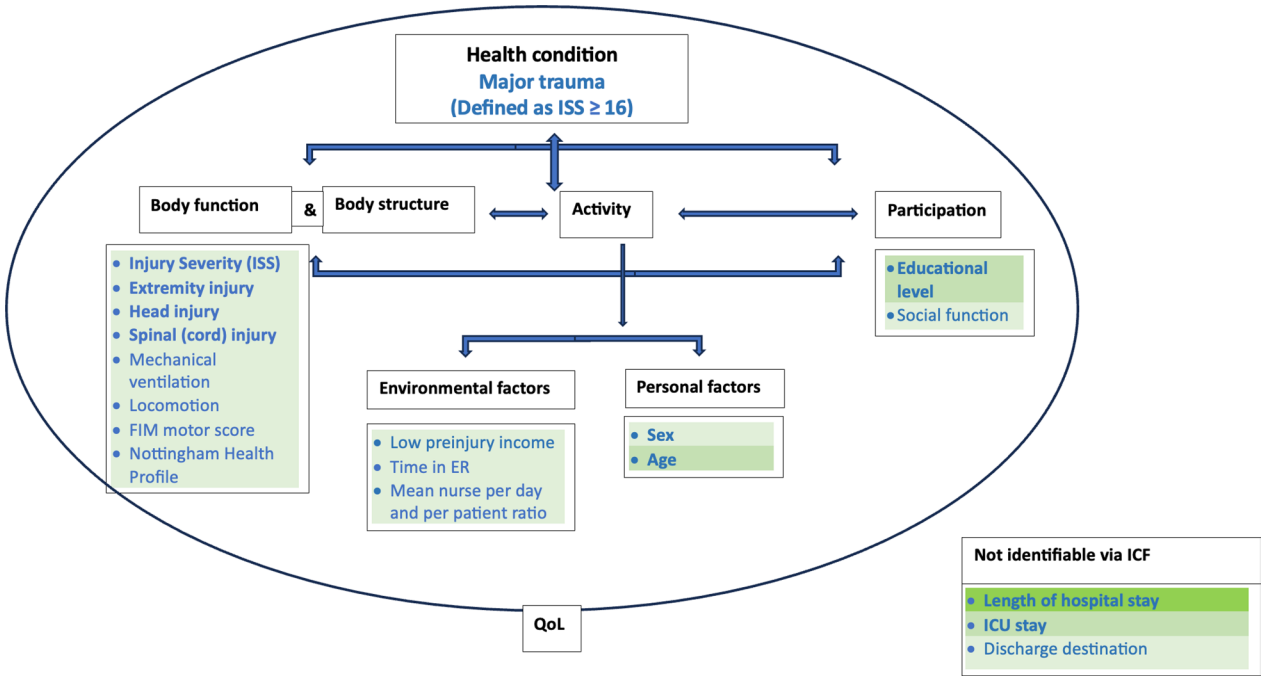

Fig. 3 ICF for predictors of RTW after major trauma. Bold factors = factors investigated in more than 1 study

a patients' sickness. They may reflect on the combination of the severity of injury, the general health status, and co-morbidities of the injured patient. In case of ICU stay, it could merely reflect the special need of some patients for monitoring based on their pre-existing co-morbidities. Additionally, LOS in hospital and rehabilitation is highly influenced by differences in healthcare systems as also pointed out by others [50, 51]. Even though co-morbidities were not found to be a significant factor by the included studies, others have shown its importance in regard to RTW (e.g., for psychological co-morbidity or multi-morbidity) [52, 53]. Nonetheless, these factors may just be a reflection of the short follow up period in several included studies. According to Hepp and colleagues (2011) non-RTW within the first year post-injury is mainly due to medical and rehabilitation therapy [8–10]. Gabbe und colleagues (2017) showed that 3 years post-injury still 37% had problems with mobility, 50% pain and 21% problems with self-care [54]. Hence, more sophisticated analyses of pre-injury healthy individuals compared with individuals with pre-injury co-morbidities could offer an understanding of these possible surrogate factors, a more detailed understanding of the influence of pre-injury health status on RTW.

Age as a determinant of RTW was suggest by several studies, however most of these studies also point out that this factor probably measures patients ability to recover slower also under the background of possible co-morbidities in older patients, to secure or find a job with increasing age or an incentive for early retirement [47, 48, 55]. Also, educational level was found to be associated with RTW. Herrera-Escobar and colleagues (2019) found in their cohort (average ISS 14.2) that lower educational levels have the strongest association with long-term outcomes. They also pointed out the difficulties due to the interconnectedness of concepts (educational level, income level & socio-economic status), but they showed that educational level has the strongest association of these three related concepts [56].

The influence of head or spinal injuries is likely underestimated in the present study as many studies that investigate patients with severe head injuries or spinal injuries often have a strong focus on these injured body parts and do not evaluate other body parts as influential for RTW. Further, these studies often lacked the sufficient information in relation to injury severity to be included in this systematic review [57–59].

Strengths & limitations

The strength of this study is the systematic exploration of evidence surrounding factors that affect RTW after major trauma. This study was conducted by a multidisciplinary team on several hierarchical level which enabled a better understanding of the identified factors and their interdependencies. A broad search was performed on a range of databases which reduced a possible publication bias.

Moreover, this study adhered to strict inclusion criteria which enabled the illumination of the target populations of patients with major trauma defined as an ISS ≥ 16.

However, the present analysis was restricted by several limitations. During the screening process the issue of terminology in the field of major trauma hindered the selection. The inclusion criteria had to be slightly adapted to include publications that were in line with the target population of severely injured patients with an ISS ≥ 16. Several countries define major trauma in various ways which is influenced by e.g., differences of inclusion criteria by trauma registers globally. Within the ISS group of moderate to severe injury (ISS 9–16) there are several studies that also investigate factors affecting RTW [44, 53, 55, 60–63]. However, these studies reflect on a different cohort of less severe injured and hence, had to be excluded. Nevertheless, this adaptation of inclusion criteria to have a clearly defined population may have hindered the identification of all suitable studies and may have increased the risk of evidence selection bias. When comparing our results with studies that investigate patients with an ISS ≥ 9, but mostly below ISS 16, some factors appear to be in line with our results: age, educational level, ICU admission, LOS hospital, discharge destination, ISS, extent of extremity injury [50, 55]. However, the studies also showed a wide range of other indicators e.g. sick leave prior to injury, psychiatric comorbidity [50] or alcoholism, physically demanding job, social support (esp. practical assistance), receipt of compensation (esp. workers compensation) [55]. Additionally, when the present results are compared with results from a systematic review by Clay and colleagues on RTW after acute musculoskeletal injuries several factors are in line with our findings: education (strong evidence), gender (moderate evidence), age (inconsistent evidence), injury severity (moderate evidence) [28].

Several studies used different approaches to investigate RTW. Often authors only investigate the pure fact of RTW without any differentiation (change in occupation, reduction of working hours, etc.). Many only recognize RTW if patients return to paid work which ignores those in unpaid work [32, 42, 64, 65]. Thus, it does not shade any light on those unemployed and those who lost their employment due to the injury [64, 65]. Furthermore, the included studies investigated RTW at varying measurement time points (6 months to 20 years) which is influencing the comparability of RTW rates as well as it influences the RTW rate itself. Individuals that were followed-up for 20 years could have obtained more care and could have possibly retrained in this timeframe more probable than individuals that were only follow-up for six months. Moreover, RTW rates are highly influenced by rules and regulations of social security schemes, insurances, and self-employment within countries. Countries that are in this regard more generous may have at certain measurement time points lower rates of RTW than other countries with more restrictive systems as also pointed out by Holtslag and colleagues [13]. Additionally, RTW rates are influenced by work capacity which is a somewhat different concept as the capacity reflects on the relation between occupation and the specific injury much more than the static concept of RTW. Our results show that several of the influential factors on RTW are in the domain of body function and structure and may, hence, influence also the capacity to work. A construction worker may have a longer road to achieve the work capacity needed to RTW as someone who works in a bureau. An internationally recognized definition of major trauma and RTW would help to explore determinants in more depth as heterogeneity would be reduced, leading to more valid and reliable results which improves research through better comparability and would make research projects more useful for clinical practice internationally. To develop such a definition was beyond the scope of this systematic review and would need to derive from an in-depth exploration of RTW as an outcome in major trauma research.

In relation to limitations of the included studies, all developed a prediction model for RTW after major trauma, none of the included studies validated an existing model [13, 30–39, 42]. Hence, these studies are exploratory in nature and most likely not explanatory. Most studies had a small sample size [30, 31, 34, 36–38, 40, 42] which are often more prone to high RoB– often more explorative in nature and are usually based on a convenient sample. Several studies explored many different factors for RTW which often led to spurious or even biased results. Whereas larger studies such as Haas and colleagues are more confirmatory in nature and often show better reporting and are more often protocol-driven which makes them less likely to find spurious effect estimates [15, 35]. Furthermore, in several studies the inclusion of factors in the multivariate regressions models was based on an association between each of the factors with RTW in univariate regression analyses (univariate significance testing) [7, 30–33].This approach increases the risk of predictor selection bias, especially in small samples [16]. Among others, due to the small sample sizes and probable predictor selection bias in several included studies, it is likely that the estimates of the predictive performance of the models are judged exceedingly optimistic (so-called overfitting). Consequently, the actual predictive power of the models is only poor and may be unreliable.

Only, one study addressed confounding factors. Based on the literature surrounding major trauma and the

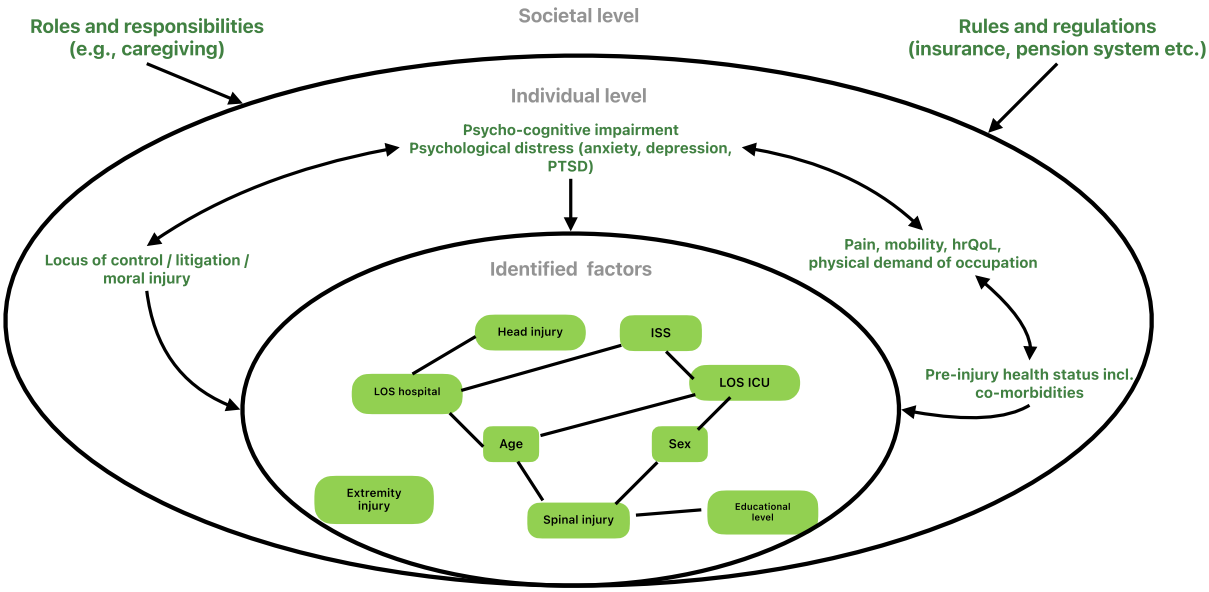

Fig. 4 Confounder model

discussion on the definition of RTW and the identified factors above, a confounder model (Fig. 4) was designed to illustrate the interdependencies of the identified factors (inner circle) and other factors on individual level e.g. psychological distress [49], litigation [66, 67], and mobility (second circle) [47, 48, 66, 68], and societal level such as roles and responsibilities (surrounding layer) [69, 70]. The inner circle shows how the different factors influence each other and the outcome, for example, age is related to length of ICU and hospital stay, and the latter is concurrently linked to head injuries [71, 72]. Hence, several of the identified factors may be confounders such as age which is related to RTW but also to length of stay. Further, also the surrounding layer may serve as predictor, covariate or confounder in the interplay of RTW. Due to physical weakening and a reduced adaptability, older patients may not return to physically demanding job. The latter is again also related to education as often those with lower educational levels have physically more demanding jobs [66]. The influence of age on RTW can further be fostered by rules and regulations e.g. by incentives for early retirement in older adults [47, 48].

This model is not mutually exhaustive, possible other factors may interplay too, but it illustrates the interdependencies of factors and levels in determining the outcome RTW. This model shall serve as a basis for the exploration of interdependencies of predictors, covariates and confounders in determining RTW in major trauma survivors. It shows that there is a high need for investigation of confounders in prognostic studies in major trauma research. Hence, also the usefulness of the identified factors for research and clinical practice should be validated [73]. This study provides a comprehensive, international overview, based on which more specific research questions (e.g. definitions of RTW, confounder) could be carried out.

Conclusion

The analysis of evidence on factors that affect RTW after major trauma showed that there are several factors that might influence RTW. Through the ICF model, it was possible to show that younger patients who have a shorter LOS in hospital might have a better chance of RTW. Similarly, those with a higher educational level and a shorter or no ICU stay might have a better chance of RTW. However, several of the identified factors, also including those with limited evidence, probably rather reflect the severity of overall sickness of the patient and therefore, it is questionable how important the single factors are in determining RTW in comparison to injury severity, co-morbidities, and general health status. Further, issues with terminology, definitions, insufficient reporting, and overfitting hampered the analysis. There is a need for more sophisticated studies of larger populations to validate these indicators and the impact for practical use such as tailored interventions for specific groups of patients after major trauma.

Abbreviations

AIS	Abbreviated injury scale
AMA	American medical association
ER	Emergency room
ICF	International classification of function, disability and health
ICU	Intensive care unit
ISS	Injury severity score
FIM	Functional independency measurement
FU	Follow up
LOS	Length of stay
LOS hospital	Length of stay hospital

M/F	Male/female
NISS	New injury severity score
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
QUIPS	Quality in prognostic studies tool
RTW	Return to work
RoB	Risk of bias

Supplementary Information

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Additional file 1.

Additional file 2.

Additional file 3.

Additional file 4.

Author contributions

AN–conceptualization, study design & methods, 1. Reviewer, (screening title/abstract & full texts, data extraction & risk of bias assessment), analysis, writing and revision manuscript. SH—2. Reviewer (screening title/abstract & full texts, data extraction & risk of bias assessment), revision of manuscript. DB—3. Reviewer, clinical expertise, revision of manuscript. CJ—clinical expertise, revision of manuscript. DS—methodological support, revision of manuscript. MB—supervision, clinical expertise, revision of manuscript. JW—supervision, clinical expertise, revision of manuscript.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article and its supplemental information files.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Lived experiences of working-age polytrauma patients in Germany - A qualitative Analysis

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ABSTRACT

Background: Survivors of a major trauma experience a range of difficulties in relation to the reduction in physical, psychosocial, and cognitive functions, which can result in a reduced health-related quality of life. This study aims to explore lived experiences of major trauma survivors in the German healthcare system.
Methods: Semi-structured exploratory interviews were performed with nine major trauma survivors (18–55 years; Injury Severity Score ≥16). For exploratory analyses, an artificial intelligence-based coding software was used. Further, results were clustered by using the International Classification of Functioning, Disability and Health framework (ICF).
Results: Communication was one of the major topics concerning amongst others diverting opinions between different healthcare disciplines and a general lack of information. The participants showed a high demand for a contact person. Furthermore, social support was essential during recovery for those interviewed. Social network was not only important as emotional and physical support but also for overcoming of gaps in the healthcare system. The support by employers and colleagues seemed to be beneficial for our participants in relation to returning to work. Further, psychological consequences of trauma, and that mobility is a key factor for quality of life, self-efficacy and return to work were discussed.
Discussion: The qualitative analyses highlight several topics such as communication, burden of sickness, support systems that the participants mentioned as important along their journey through the German healthcare system during recovery. Through the ICF model the interplay of certain components that influenced the outcome of the major trauma survivors was visualized.
Implications: These results might offer a deepened understanding of modifiable components of a patient pathway in recovery process such as improvements of patient communication, provision of a contact person and others.

Introduction

A major trauma is characterized by the presence of multiple injuries, with at least one severe and life-threatening injury, in different body regions, such as the chest, the abdomen, the pelvis and the extremities. Often severe traumatic brain injury, hemorrhage or the combination of different severe injuries are fatal [1,2]. In 2022, the TraumaRegister® by the German Society of Traumatology (DGU) showed in their annual report, the mortality rate among severe trauma patients is only 12 %. Epidemiologically survivors of major trauma are primarily male and

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averaging 54 years [3].

Survivors experience a range of difficulties in relation to the reduction in physical, psychosocial, and cognitive functions, which can result in a reduced health-related quality of life (hrQoL) [4,5]. Being in the center of their working age, major trauma survivors additionally face challenges of workforce reintegration [6]. Additionally, the confrontation with the complexities of the healthcare system, in Germany this includes for example the influence of health insurance status (social, private or employer's liability insurance) on treatment and administrative modalities. Understanding the aspects of health (functionally and qualitatively) and return to work of these patients becomes increasingly important, especially considering the broader impact in relation to the socioeconomic consequences [7].

Recent research on major trauma survivors focuses on the evaluation of long-term health- and work-related outcomes over 6 to 12 months, utilizing validated outcome assessment instruments, such as the EQ-5D [8], the Glasgow Outcome Scale Extended [4], the Short Form-36 Health Survey [7,9,10] or the Sickness Impact Profile (SIP) [11,12]. Additionally, research tries to identify factors associated with return to work and hrQoL [13,14]. Predictors of diminished hrQoL include for example female gender, older age, higher Injury Severity Score (ISS). Moreover, psychosocial factors, pre-traumatic comorbidities, and sociodemographic aspects such as living alone or being unable to return to work might influence hrQoL after a major trauma [4]. Furthermore, satisfaction with healthcare services seems to be dependent on the quality of psychosocial care provided by medical professionals and the active patient involvement in medical decisions [6].

Despite the numerous studies on hrQoL and return to work, there is a remaining gap about understanding the subjective experiences of survivors after a major trauma, as the usual measures mainly focus on standardized patient-reported outcome measures as well as functional or clinical and radiological outcomes. Moreover, the systemic challenges within the framework of the German healthcare system and suggestions on optimization of healthcare processes and structures are rarely addressed [6].

Therefore, this study aims to explore lived experiences of working-age major trauma survivors in the German healthcare system using semi-structured exploratory interviews.

Methods

Study design

Semistructured in-depth interviews were used to explore the lived experiences of working-age major trauma survivors within the German healthcare system and investigate their path from injury to return to preinjury activity and/or work. Focusing on the identification of problematic interfaces in the cross-sectoral care of major trauma survivors as well as the exploration of patient perspectives on the return to work after major trauma, the identification of factors influencing the ability to return to work and quality of life.

A positive vote from the ethic committee of the Heinrich-Heine-University Duesseldorf was obtained (study ID: 2022-1970). Semi-structured interviews were used to enable a discourse between the participants and the interviewer. Using a flexible interview protocol with open questions that were supplemented by follow-up questions and comments enabling participants to speak more freely about their experiences, thoughts and feelings, and foster a delve into more sensitive topic areas [15].

Participants and recruitment

Convenience sampling was used to recruit patients from the accident prevention program P.A.R.T.Y. of the DGU or patients of the polytrauma outpatient department at the Department of trauma surgery, orthopedics, and plastic surgery (University medical center Goettingen).

The P.A.R.T.Y. accidental prevention program is a prevention program for school classes and young people aged 15–18 years in collaboration with leading accident clinics. The aim of the program is to raise awareness for injuries ("trauma") caused by alcohol and risky behavior in young people [16]. Information and invitation for potential participants were forwarded from the Academy for Trauma Surgery (AUC) to the participating P.A.R.T.Y. clinics. These clinics then forwarded the information and invitations to those willing to participate in the study. Potential participants then registered directly with the research staff at the University hospital Duesseldorf to take part in an interview.

The polytrauma outpatient department is an aftercare service at the Department of trauma surgery, orthopedics, and plastic surgery (University medical center Goettingen) where the polytrauma patients are usually seen 2, 6 and 8 weeks and at 3, 6 and 12 months after discharge from the hospital. However, most patients come back to the outpatient department longer due to planning of further surgical procedures such as metal removal, revisions or cosmetic procedures. The Information and invitation for potential participants to the interviews were forwarded through the responsible physician of the outpatient department. The potential participants then registered directly with the research staff at the University hospital Duesseldorf to take part in an interview.

We included participants aged 18–55 years who survived a major trauma defined by an ISS $\geq$16. Patients still in acute hospital care for their physical or psychological trauma were deliberately excluded from the study as well as those patients at risk for psychological trauma reactivation [17]. The risk of reactivation of the trauma was considered low in participants of the P.A.R.T.Y. program as they are used to talk about their trauma in front of strangers. Patients from the polytrauma outpatient department were selected by an experienced trauma surgeon who oversees the entire patients' pathway of these individuals. Additionally, the research staff paid attention to sensitive communication during recruitment and subsequent interviews with the participants.

Twenty patient interviews were planned. However, due to the COVID pandemic prior to the study the recruitment was more difficult than anticipated as there were not many persons still actively participating the P.A.R.T.Y. program. Due to these difficulties in the accessibility of the study populations convenience sampling was chosen. Due to the inclusion criteria and the risk of psychological trauma reactivation the pool of possible participants is limited. Convenience sampling helped us to achieve saturation without introducing a regional bias by selecting predominantly participants from a certain region in Germany. In order to reduce regional bias, we limited the number of participants from the polytrauma outpatient department as they are all from one specific region in Germany, whereas participants from the P.A.R.T.Y. program are from several clinics in different regions of Germany. The focus was on reaching saturation points for the main topics. Hence, participants were recruited consecutively from both the P.A.R.T.Y. program and polytrauma outpatient department Goettingen until saturation points were reached [18].

Description planning and conduct of interviews

The interviews were conducted either individually or in pairs. We offered the participants that the interview could be conducted in person at the University hospital Duesseldorf or online. The rationale for offering paired or individual interviews was to generate a pleasant atmosphere in which the participants felt that they can share their experiences freely and in most depth. The participants had the choice between individual and pair interviews as well as between online and in-person interviews. This also aimed at supporting the psychological safety as participants were only interviewed in pairs if they wanted to. The matching of pairs was done randomly. The participants were free to discontinue the interview at any point. Informed consent was obtained prior to the interviews. The participants information and consent form can be found in supporting file 2. Two researchers (a full-time researcher and a senior attending orthopedic surgeon) with several years of

experience in trauma research conducted the interviews. In case of participation in person, traveling costs were reimbursed. All participants received an allowance of expenses for their time invested in the interview. Both types of interview conduct were planned for 2–3 h. The interviews content was structured in three blocks: (1) experiences from trauma to current daily life, (2) ideas for optimization of healthcare processes and structures, and (3) work ability & quality of life. The interview guide with questions and prompts has been added as Supporting File 1.

Analysis

A verbatim transcript of all interviews was prepared in a Word document. In this process, all person-identifying features were anonymized to protect the privacy of participants. As a first step, we performed an exploratory analysis. For this purpose an artificial intelligence-based coding (AI coding) software ATLAS.ti 2 was used [19]. This step was mainly used to generate a general overview of topics discussed by the participants. A researcher went through all codes and verified whether the coded topics are what participants really discussed. Further the whole transcripts were scanned for subtle themes which the AI software could have missed. Lastly, we used the International Classification of Functioning, Disability and Health framework (ICF) as an analytical framework. All codes were assigned to one component of the four domains within the ICF as displayed in Fig. 1– model and Table 1 – overview of domains.

The ICF was used to investigate the reciprocities of health conditions, personal, contextual, and environmental factors with the lived experiences of the major trauma patients interviewed. It offers a deepened understanding of how the outcomes are results of these reciprocities [20]. The results were reviewed and discussed within the interdisciplinary research team of trauma surgeons and researchers.

Results

We interviewed nine participants (7 male / 2 female) of working age in two single and four paired interviews. Six of the participants were part of the P.A.R.T.Y. program and three were patients in the polytrauma outpatient department of the University medical center Goettingen. The injury mechanisms were car, bike, or motorcycle and agricultural accidents. All participants completed rehabilitation programs several months or even some years prior to the interviews. At the time of the interview, none were in acute care or rehabilitation care for their major trauma. However, several participants still receive physio-, occupational, psychological or other forms of care for complications or trauma residuals due to their major trauma.

General topics

The general topics discussed by all the interviewed participants were concerning the healthcare system, challenges in relation to health, health impairments, communication, work, and daily life. In the following, a detailed overview of these topics is given.

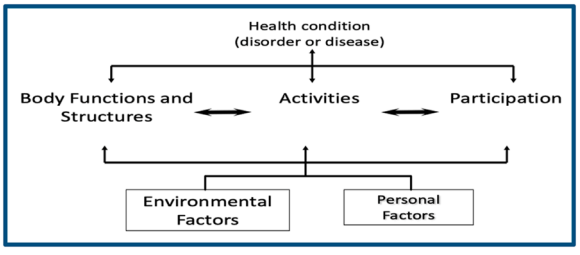

Fig. 1. International Classification of Functioning, Disability and Health (ICF) framework model (19).

Table 1
Overview of ICF domains and components.

Body Function:	Activities and Participation:
Mental functions	Learning and applying knowledge
Sensory functions and pain	General tasks and demands
Voice and speech functions	Communication
Functions of the cardiovascular, hematological, immunological, and respiratory systems	Mobility
Functions of the digestive, metabolic, endocrine systems	Self-care
Genitourinary and reproductive functions	Domestic life
Neuromusculoskeletal and movement-related functions	Interpersonal interactions and relationships
Functions of the skin and related structures	Major life areas
	Community, social and civic life
Body Structure:	**Environmental Factors:**
Structure of the nervous system	Products and technology
The eye, ear, and related structures	Natural environment and human-made changes to environment
Structures involved in voice and speech	Support and relationships
Structure of the cardiovascular, immunological, and respiratory Systems	Attitudes
Structures related to the digestive, metabolic, and endocrine systems	Services, systems, and policies
Structure related to genitourinary and reproductive systems	
Structures related to movement	
Skin and related structures	

Based on the International Classification of Functioning, Disability and Health framework (19).

Healthcare system

Participants often expressed their dissatisfaction with the German healthcare system. They described uncertainties and insecurities, dissatisfaction, confusion, and deficiencies within the system as well as lack of support, disappointment, and doubts. Participants understood that some of the deficiencies in the system are a consequence of skilled labor shortage. One participant stated:

> "I also had the feeling that some of the medical personnel was overworked. I had lots of different ones [medical personnel], some of them didn't really know what, […] what was going on with me, without the pad [notes], where it was all written down, they would have been lost and that, the nursing staff definitely just have too many patients and can't take care of everything."

Further, they discussed the general healthcare provision and specific service provisions with their experiences in the hospital and rehab, as well as the received treatments as in- and outpatients. Often, they named various professional disciplines they encountered e.g., nurses, physiotherapists, psychosocial care, physicians (in- and outpatient). These experiences were frequently related to communication with these disciplines. One participant reported situations of diverting opinions between doctors and how this contributed to feelings of uncertainty and doubt.

> "Sometimes the opinions of some doctors differ and then you often realize that some doctors have perhaps imposed their opinion, their personal opinion, […] but then you also realize later that after a period where I was in treatment, that it was not always completely ideal. And then someone else said to me, so let's try something else. Because it hadn't gotten any better while the doctor wanted it to. Exactly, (pause) it's sometimes difficult as a patient to believe what's better now. Yes, because the opinions of the doctors went in different directions […]."

Several participants talked about the role of the general practitioners (GPs) and expressed that they only visit their GP when they need a

prescription, but that they use specialized healthcare services (e.g., outpatient practice for orthopedics) if they have any issues related to their major trauma or related health and psychological impairments.

Challenges in relation to health

The patients reported several challenges including physical and psychological challenges. The main areas of discussion were rehabilitation and (current) health status, treatments, but also topics like hope, help and friends were amongst them. They described the multitude of health impairments due to their major trauma. Pain, health impairments, movement restrictions and (severe) disabilities were amongst the most mentioned topics. Participants discussed the general importance of movement as a key for a feeling of being in control and to regain hope and self-efficacy. One participant put it like this:

> "Um, yes, so of course I had certain expectations, without being able to clearly define what was actually coming, […] when I first used the forearm crutches, the physiotherapist arrived and said "Mr. […] today we're going to put you on your feet for the first time" I cried when I stood there, finally standing on my feet again, although still supported and then it went like this, I'll say one step at a time. A forearm walker, then a wheelchair, then a rollator, then at some point there were crutches and then every day […] you were challenged […]."

Additionally, bureaucracy combined with general administrative challenges were emphasized by most participants. One participant stated in relation to bureaucracy:

> "[…] this process is very, very lengthy, so if I have to deal with something bureaucratically, first of all the reading, but then the writing involves quite a bit of effort, […] Yes, and it's extremely time-consuming and labor-intensive, and I'm a bit arrogant, I used to press the keyboard quickly and now I have to do it and sit at it for half a day or whatever […] And then these are things that create a certain restlessness in me, right […]."

Psychological challenges were another area of discussion. Participants reported personal psychological challenges while others preferred to talk about experiences with others regarding psychological challenges. The main challenges reported involved those of the psychological trauma itself, the participants frustration with several aspects of their recovery but also with the healthcare system. Their fears and uncertainties concerning the future at certain points of the recovery process. They shared their experiences with pain, disappointments, and their emotional burden. Also, the emotional strain on their social network was addressed. One participant said:

> "Yes, but, as I said, it took me a long time before I understood what that meant for me, what it meant for the rest of my life, and as I've already said, the person speaking to those present here didn't want any more. So when I knew that I was paralyzed […] I had a living will and I told my parents beforehand that it could happen at any time, that if I ride a motorcycle I could have a bad accident at any time and I don't want to grow old as a nursing case […] So I don't want to be on my loved ones' backs and just mess up their lives, then I'd rather not, no […]"

Health and support

Support was of tremendous importance for all participants. All shared their experiences with social support by family and friends and how this helped to overcome gaps within the healthcare system. One participant was friends with a physiotherapist and therapy was carried out more often than prescribed. This enabled the patient to train more frequently and intensively then the health insurance company would have paid for, additionally covering the rehabilitation gap between acute inpatient hospital and rehabilitation center. In addition, participants described how their own role within the family changed as a result of the intensive support they needed and the impact this change in family role had on all family members, but in particular on their spouses. One participant put it like this:

> "You're not the same anymore, you can't do as much, my wife and my daughter had to step in more […]. You have to grow back into your old role, where you actually want to be, because it's taken a lot of strength from my family, I'll say, my wife had to do everything on her own from one day to the next, we have a big house, we have a big garden […] she had to, I'll put it this way now, because she had to mow the lawn […] you have to take a step back a bit, logically, you realize that not so much is working yet."

One the other hand, children of participants were often a source of hope and helped them to carry one. One participant stated:

> "I'm currently at home, I'll definitely be at home until my daughter is three. And psychologically, she was my luck, I have to say, I think it was the only thing that really brought me back to life."

Several participants reported about the psychosocial support system. Often, they concluded it to be insufficient but most of them have had contact with psychosocial services either in form of a psychologist/psychotherapist - most often in the rehabilitation center - or in form of a pastoral worker – most often in hospital.

Burden

On the other side, participants also reported about the burden. The burden of psychological and emotional load, loneliness, dependency, and the necessity to change due to their injury and the consequences this burden had on their private life and reintegration. One of the participants said in relation to the experienced psychological distress:

> "For the feeling yes, for the feeling of having a right to it and for the feeling of being heard, because the doctors don't really listen, at least not to what's going on with my psyche at the moment and the pain is one thing, but what's going on in your head is a completely different matter. "

Communication

Communication was one of the central topics with impact on many other discussed topics. Often communication viewed broadly as a problem but also specifically defined e.g., as communication problems, lack of information, diverting opinions. Participants gave many examples of communication issues they experienced in relation to doctor-patient-communication but also in communication with other specialties e.g., nurses, physiotherapists – in inpatient and outpatient settings. Several participants stated that they felt that there was general lack of information they received during inpatient and outpatient care in relation to treatment, prognosis, and support systems. Moreover, they experienced not only problems within the communication with patients but also issues in interdisciplinary communication between the disciplines vertical and horizontally as well as communication with family members. One participant stated in relation to interdisciplinary communication:

> "[…] so, I practically had to tell him [the doctor] everything again. I didn't have the feeling [that the doctor was well informed], and I remember that very well, because the doctor had so many question marks over his head when I started to tell him [about my patient journey]. So, I practically had to tell him everything. No, he definitely didn't really know much about it."

Many participants missed a contact person in the inpatient and outpatient setting who could help to guide them through their injury and recovery pathway as well as all discrepancies in e.g., treatment plan between disciplines or through the general lack of communication and information exchange as one participant put it:

"As I said, I would like someone to accompany you right from the start and be at your side. Someone who can sort a lot of things out and help you. And I would like to have a doctor or a small group of doctors to act as a contact person, as was the case for me in the third clinic, who would then, let's say, treat you and who would also be available for you in the consultation hours, let's say. Because only this doctor knows what you have, how you're feeling and what happens next. He practically has the plan. And all the others, I say, if you have any other doctors in between, they just start again somewhere. But that's just my opinion. So, I had the feeling in the third clinic that I was in good hands here. "

Work and daily life

Further, as we asked the participants about their return to daily life, they reported many aspects regarding return to work, quality of life and their daily life structure.

Work life

Many aspects in relation to work were reported, the most striking was the support many participants received from their employers and colleagues and how this support helped them to return to work. The support was mostly in-kind, meaning that their colleagues and employers just called or visited the participants and gave them a sense of belonging to the company. One participant framed the support of colleagues and employer like this:

"I was incredibly supported by my colleagues from work and also by friends. Actually, at the time when visitors were still possible [due to COVID restrictions], there wasn't a single day when I didn't have visitors. They had made a plan. There was at least one or two every day. Even when the therapy sessions were finished during rehab, there was always someone sitting in the room or at the bedside. So, you realized that people were thinking about you, supporting you and so on. I have to say that helped me a lot. Psychologically, it built me up tremendously, which is still the case."

However, also structural workplace changes were mentioned as support mechanisms. The participants, further, talked about their journey back to work in general, work conditions and bureaucratic procedures. How some of them had to professionally reorientate themselves and others had to retire and how all of them had to adapt to the new circumstances and challenges due to physical or psychological limitations as a result of the injury.

Quality of life

The participants described their new daily life as characterized by recovery, adaptions to limitations or the overcoming of limitations, changes in family roles or new living arrangements like a new apartment or retirement, and the general importance of mobility in daily life. Most participants had great positivity in relation to their sickness and recovery which is interlinked with gratitude felt by most of them. For most participants the positive experience of this pathway outweighs the negative ones due to their ability to return to daily life, the challenges, and limitations they have to overcome due to the support received (medical, family, psychological and others) but also due to their own resilience and realization of capabilities. They reported that at the point where they could self-determine their path again quality of life increased and how self-efficacy is a major driver of quality of life. Others reported how family and friends contributed along the way to quality of life and in building up self-efficacy and self-determination again. Mobility was described as a key to quality of life. Many gave examples of the first time they stood up again or went to toilet alone. One participant described the interplay of mobility and self-efficacy in this way:

[…] And the physiotherapy here at home, yes, that helped me a lot at the beginning. So, I think it was important that we did that. Also, simply for me to have a feeling that I can do something. So that you get a bit of a feeling of self-efficacy again. That you don't feel so helplessly at the mercy of others. That was good for me, but at some point, later I realized that the physiotherapist no longer had to come to my home, I was mobile enough that I could go to the practice. And then at some point I realized that I didn't need it anymore, I don't want to say that I'm still dependent on doing my exercises, strengthening my back muscles, that will never stop, so it will always be important for me. But at some point, I had the impression that I didn't want to do it anymore and that I wanted to do it with, with, yes, with company. In other words, that I no longer have to go to the physiotherapist's twice a week […] I had the impression that I could do it myself now. Well, but in the beginning, it was good to have someone, that's for sure."

ICF applied to the experiences of major trauma survivors

The most frequently discussed topics were clustered according to the components and domains in the ICF model (Fig. 2). It enables a better understanding of the interplay of the topics, their origin, and their potential for modification. It shows that several of the discussed topics are in the area of body function and structure, hence, related to the injury the participants experienced. These are often modifiable during inpatient and outpatient pathway but not always as it highly depends on the injury itself. The model also highlights that activity and participation are areas that play a significant role in major trauma survivors. Central components are communication, relationship (family, friends) but also interactions (family, friends, medical and other personnel in and around the healthcare system) that shaped the patients` journey. Mobility seems to be central for quality of life and a prospect on healing and recovery. Environmental factors include components that form the outside influences of patients all topics that influence the healthcare system with its positive and negative factors as well as administrative institutions and their influence on well-being after a major trauma. This component of the model also highlights again the importance of support and relationships that help to overcome gaps within the healthcare system.

Discussion

Our analysis enabled an in-depth exploration of lived experiences of major trauma survivors in Germany. It offers a profound insight into the journeys of these patients in the German healthcare system from injury to return to work. Several topics emerged as predominant, these are related to physical and psychological challenges and impairments, communication, support systems, as well as topics regarding the healthcare system and its personnel. The ICF model enabled the view on the interplay of these topics.

Communication, mobility & locus of control

Communication was one of the major topics discussed by the participants. The results show intra- and interdisciplinary issues in the communication the participants experienced. Important topics were amongst others diverting opinions between different healthcare disciplines and a general lack of information. The participants showed a high demand for a contact person in the in- and outpatient setting. Patients felt more in control of their situation if they were involved in their treatment and received enough coherent information about it or knew whom to ask in order to increase their information level. Visser and colleagues (2021) reported similar findings in their qualitative analysis of multiple injured patients, and described that this lack of information or the delivery of incorrect information in relation to expectations and consequences of the patients' injury lead to a lack of clarity regarding treatments and prognosis of patients [21]. Also, other studies point out the issues of miscommunication or lack of information delivered to

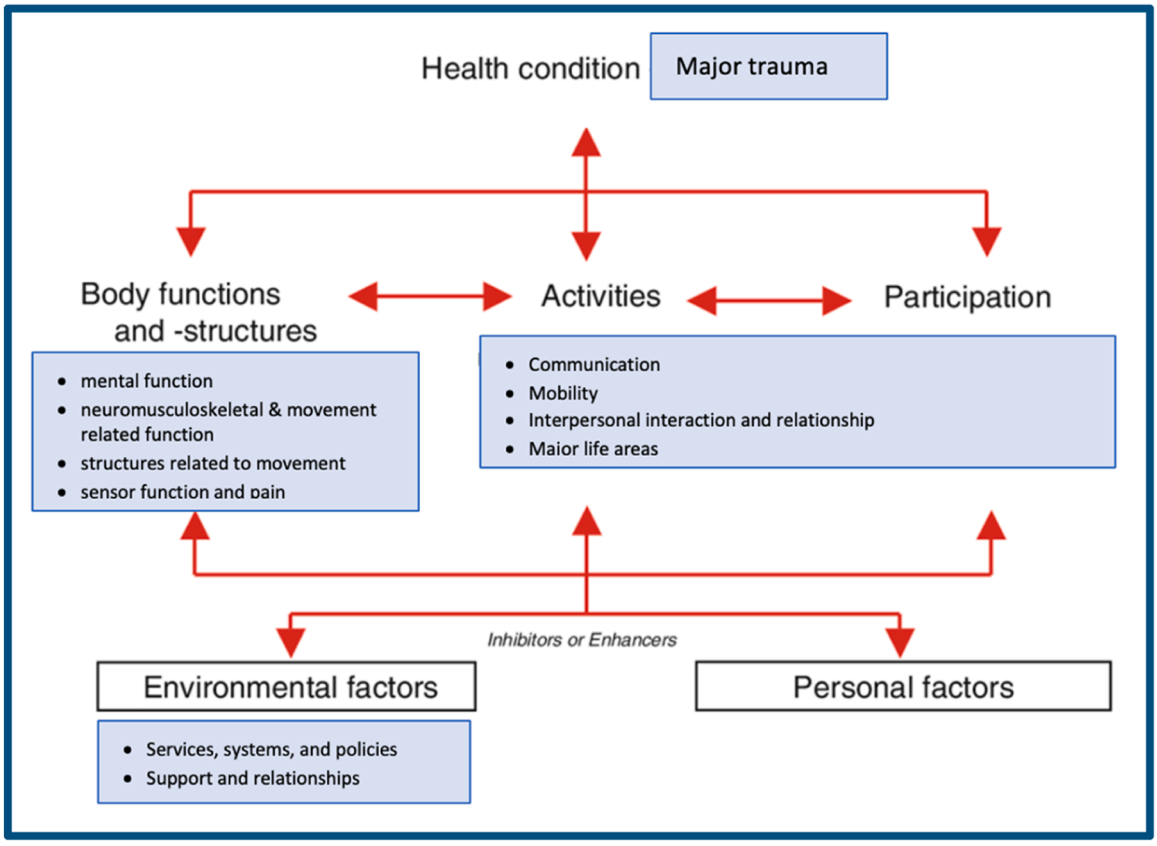

Fig. 2. ICF Model of major trauma survivors.

patients [22–25].

Kellezi and colleagues (2015) show that the need for information and the range of information major trauma survivors need during their journey changes over time [23]. They propose a list of information that is adapted to the information needs of patients at different time points during inpatient stay. If this list is used it could help to improve the communication (medical personnel – patient) in combination with a general understanding of reasons for miscommunication (e.g., time constraints, diverting opinions among healthcare personnel, patients being in shock, poor or lack of communication between in- and outpatient services) [23]. Whereas Sandström and colleagues (2019) describe that a shared understanding between patients and healthcare professionals about the patient's injury and status quo could help to ensure that the patient's needs and problems are addressed, so that not only healthcare professionals have more information, but also patients have the opportunity to exercise control over their recovery process [24].

The importance of the feeling of being in control was shown in our analysis when the participants talked about the communication problems they experienced and how this also led to a feeling of being overwhelmed and helpless but also when the participants described mobility as a key factor for hope and self-efficacy. Being at the mercy of healthcare personnel and without control over the situation not only due to physical dependency but also with regards to having no or conflicting information about the injury, treatment options and prognosis. Furthermore, the factors of locus of control and helplessness can play an important role in the development of affective disorders such as major depression and anxiety disorders [26,27]. The development of such disorders can also influence the social support patients receive and consequently their return to work [28].

Soberg and colleagues (2007) showed in their analysis an association between external locus of control and non-return to work after two years which seems to have a relation to physical functioning [29]. Also, our participants described mobility as a key factor in feeling in control and regain self-efficacy (e.g., "the first time, when I stood up again"). Hence, improvements in communication and investing in early and continuous mobilization could help patients to feel more in control of their recovery which could be preventative regarding posttraumatic stress disorders and could promote the process of returning to work in contrast to lack of control or a perceived external locus of control [29,30]. This is also in line with the finding of Visser and their proposed shared understanding to improve outcomes for major trauma survivors which could be established improving the documentation of the patient pathway by including the patients' perspective of understanding their injury, treatment and prognosis [21]. Hence, there might be a need for early psychological support in the inpatient setting as well as a need for psychotherapy during the post-stationary recovery process [31].

Support

Family and friends

Furthermore, the results show that social support seems to be essential during recovery. The participants reported that the social network is not only important as emotional and physical support (e.g., organizing a new apartment, driving participant to doctors' appointments) but more over in relation to overcoming gaps in the healthcare system (e.g., having a friend who is physiotherapist to increase access to physiotherapy). Also, other studies found that family and friends are important to support the recovery process in e.g., coordinating care [24,25,32]. Others like Mitchell and colleagues (2019) point out that the integration of family and friends in the care for example by providing guidance and establishing a partnership is also benefiting the recovery of the patient [33,34]. This could already start in the early phase of recovery at the intensive care unit as some researcher showed for critically ill patients. They found that the integration of friends and family

could not only benefit the patient, but also nurses and doctors e.g., through a better understanding of the patients' personality [7,34]. In relation to the former section, family and friends could even be a facilitator for improving the communication between patients and healthcare personnel especially in times when patients are still overwhelmed or cognitively unable to process the given information [25,32]. Hence, as Sandström and colleagues pointed out, maybe family and friends are momentarily still underused by the healthcare personnel and should be increasingly integrated to improve care and outcomes of major trauma survivors [24].

Employer

Moreover, the support by employers and colleagues seemed to be beneficial for our participants in relation to returning to work. They described how positive and open support by employers and colleagues helped them to re-integrate in their working environment. Visser and colleagues showed in their qualitative cohort that the need for positive support by the employer is high [21]. This is in line with the proposed common principles for a successful return to work by Cancelliere and colleagues (2016) in which they recommend among others that employers speak with the injured worker early and thoughtful in the recovery process and that employers offer modifications to the work place which could facilitate early and safe return to a suitable, in relation to patients' health impairments adapted, work environment [35].

Limitations

Our study has some limitations due to the flexibility we offered the participants to choose between a single or paired interview, and whether they wanted to attend online or in person. Due to this flexibility a bias could have been introduced. When participants are interviewed in pairs it could lead to socially desirable answers. However, the effect is probably low due to the sensitive nature of topics which were discussed. Further, we think that giving participants the choice also enabled them to choose the interview circumstances in which they felt most comfortable to talk about their experiences. Maybe a paired interview even offered a deepened insight, as the participant shared the experiences, and this could have led to a more open interview environment. Nevertheless, the limitations also due to pair composition and the sensitivity of the investigated topics might have influenced the interviews as also discussed by others [36,37]. Similarly, a bias could have been introduced due to the choice of online or in person interviews. Maybe interviews in person were more personal in nature and offered the participants a more open environment to talk about experiences. However, as several of our participants still suffer from physical and psychological impairments, we wanted to offer them the choice as traveling could be troublesome depending on their impairments. Moreover, it also offered us to include patients that might have not been able to attend an interview if it would have only been carried out in person. Further, it can be argued that patients might have felt most safe and open during online interviews while sitting at home. Further, a selection bias is possible as all participants needed to be able to give informed consent and to answer the questions in German. Hence, also a certain degree of language skills was needed to participate in the study. On the other hand, the included participants provided a broad range of perspectives in a horizontal and vertical way which broadened our understanding of major trauma care in Germany, but nonetheless, the condition "major trauma" is wide ranging and could have certainly more topics and phenomena not covered by this qualitative analysis.

Further, the use of AI software in qualitative research is still in its infancy and can lead to several limitations such as biased coding, inability to recognize subtle themes and others) as discussed recently by others [38–40]. We used a double coding process und a systematic framework to decrease the impact of this limitations. We used AI coding to generate a general overview of themes discussed by participants but even though the AI software was able to identify subtle themes/concepts such as self-efficacy, it can only be used a starting point for an in-depth analysis. Hence, the AI Software was used an assistant to grasp ideas and themes within the interviews (exploration). However, it needs the researcher who 1) needs to know the data very well, 2) needs to engage with the data to identify themes and ideas especially subtle once which the software could not recognize and 3) to give meaning to the ideas and connect them with each other and to a systematic framework as also discussed by Morgan (2023) [38].

Implication for practice

From the findings, it is apparent that there is a need for a fixed and continuous contact person to which patients and relatives can turn regarding information on injury, treatment, and prognosis. In best case this contact person should facilitate the whole recovery process as this would enable the contact person a comprehensive insight into the patients' journey and the injury with its residual impairments as also proposed by others. Some studies discussed the GP as a contact person for major trauma patients [25,41], but our participants signaled that the GP is not the person they would turn to in regard to their major trauma due to its complexity and the wide range of residual impairments they are experiencing. The concept of a polytrauma outpatient service within the hospital in which the patients were treated initially could possibly serve as such a contact point if there is one physician responsible for the care of these major trauma survivors.

Further, there is a clear need for psychosocial support by psychologists and social workers. We are aware that this often cannot be implemented due to structural problems within the healthcare system. Nevertheless, our participants reported a clear need for more support in this regard. Maybe with a fixed and continuous contact person, patients in need for psychosocial support can be identified earlier in the recovery process and could, hence, be supported in finding help in this regard even with constraint structural resources.

As pointed out earlier there is a need for improved communication with patients and their relatives but also inter- and intradisciplinary communication must be strengthened to improve recovery process of major trauma survivors. Kellezi and colleagues (2015) described several feasible approaches to improve communication between healthcare personnel and patients as described above [23]. However, it should not be disregarded that staff shortages, time pressure and high workload are factors that strongly influence good communication in the healthcare setting [21].

Implications for research

By now, social, and psychological factors in major trauma research did not receive much attention in the long-term follow-up. However, they are of particular importance in the reality of major trauma survivors [42]. The findings of qualitative studies such as ours can be used in the design of questionnaires as measures of patient-reported outcomes and experiences in larger samples. This could enhance our understanding of barriers and facilitators of health-related quality of life and return to work after major trauma as well as it would help to adapt healthcare services to the needs of major trauma survivors. We used the findings of this qualitative analysis to guide the design of the questionnaire used in our large German cohort study with a long-term follow-up of 18 months (LeAf Trauma Study; https://www.leaf-trauma.de/leaf-trauma). We hope that it will enable a more broadened understanding (horizontally and vertically) of health-related quality of life and ability to work of major trauma survivors.

Conclusion

The qualitative analysis of working-age major trauma survivors in Germany highlights several topics such as communication, burden of sickness, support systems that the participants mentioned as important

along their journey through the healthcare system from injury to recovery. The participants reported feelings of helplessness, insecurity, being overwhelmed, but also gratefulness. A central issue was communication problems with medical staff (doctors, nursing staff, physiotherapists, psychosocial care) in form of e.g., lack of information or differences in opinion which are interlinked with a strong desire for a contact person within the healthcare system and/or hospital. However, participants were aware of the deficits of the healthcare system such as staff shortages. Mobility is a key factor for quality of life, self-efficacy and return to work. Through the whole injury and recovery process family and friends are important anchor points who help to avoid or overcome gaps within the healthcare system. The analysis highlights that the support by colleagues and/or the employer is central for returning to work. However, the participants also highlighted the importance of psychological consequences of a major trauma. Through the usage of the ICF model it is possible to visualize the interplay of certain components that influenced the outcome of major trauma survivors we interviewed. This might offer a more in depth understanding of modifiable components within a patient pathway from injury to recovery.

Clinical trial registry number

The study LeAf Trauma is registered under the DRKS-ID: DRKS00028841.

Ethics

Ethical approval was obtained from the Heinrich-Heine-University Duesseldorf (study ID:2022-1970).

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CRediT authorship contribution statement

Anne Neubert: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sebastian Hempe:** Writing – review & editing, Data curation. **Carina Jaekel:** Writing – review & editing, Investigation, Data curation. **Catharina Gaeth:** Writing – review & editing, Writing – original draft, Validation, Data curation. **Christopher Spering:** Writing – review & editing, Data curation. **Katharina Fetz:** Writing – original draft, Writing – review & editing, Supervision. **Joachim Windolf:** Writing – review & editing, Supervision, Resources. **Erwin Kollig:** Writing – review & editing, Supervision. **Dan Bieler:** Writing – review & editing, Supervision, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2024.111938.

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4. Discussion

The recovery of major trauma survivors is influenced by several factors; both studies were able to explore these factors using evidence from existing studies and by exploring the experiences of major trauma survivors. The International Classification of Functioning, Disability, and Health (ICF) model used in the systematic review showed that younger patients who have a shorter length of hospital stay might have a better chance of RTW. Similarly, those with a higher educational level and shorter or no intensive care unit stay might have a better chance of RTW. However, several of the identified factors probably reflect the severity of the overall sickness of the patient. The importance of individual factors in determining RTW in comparison to injury severity, comorbidities, and general health status is questionable (16).

The patient interviews highlighted several topics such as communication, burden of sickness, and support systems that the participants mentioned as important during their journey from injury to recovery. A central issue was communication problems with medical staff (physicians, nursing staff, physiotherapists, psychosocial care) and the importance of the psychological consequences of major trauma. Mobility was identified as a key factor for quality of life, self-efficacy, and RTW. Friends and family are important to recovery in the form of overcoming healthcare system gaps, but they also highlight the support of colleagues and/or the employer for recovery. Using the ICF model, it is possible to visualize the dependencies of certain components (17).

Both studies are complementary in nature because the quantitative analysis of factors for RTW via systematic review emphasizes factors other than the most important topics derived from patient interviews, as visualized in both ICF models within the publications (16,17). Hence, exploration via the two different research methods enabled a vertically and horizontally deepened understanding of the recovery of major trauma survivors. Factors explored in primary studies within the systematic review focused on rather “hard” facts and factors derived from hospital chart reviews or standardized instruments such as the EQ-5D for hrQoL or functional outcomes retrieved via several routes, such as radiological measures or functional tests. Lotfalla et al. (2024) investigated factors that influence hrQoL after major trauma. Many of the factors they identified were the same

as those in the present systematic review, such as age, gender, injured body region, and severity of injury (18). In contrast, Silverstein et al. (2021) found that besides the variables also identified in the present systematic review (age, gender, educational status, injury severity, and others), mental health, positive coping, self-efficacy, and perception of physical state were the most predictive of hrQoL after major trauma (19). Hence, despite the differential outcomes in these two systematic reviews by Lotfalla (2024) and Silverstein (2021), the same as well as additional factors were identified. This is also underpinning the reliability of the current results (18,19). Furthermore, it substantiates the interrelation between RTW and hrQoL, as also pointed out by van Ditzhuisen et al (2022) (20).

All identified factors provided essential insight into modifiable and unmodifiable factors but could not offer a profound understanding of the social, emotional, structural, or institutional processes of recovery. This is a starting point to patient-centered approaches, as also demanded by others (18). To some extent this was realized though the patient interviews.

Qualitative analysis via patient interviews offered a more subjective personal insight into the recovery process and the major trauma care provided in the German healthcare system. It offers perspectives on the emotional, social, and institutional constructs and connections that shape care and recovery. These aspects are frequently underrepresented in quantitative research on major trauma survivors. However, the patients showed the importance of these topics in their personal recovery, and future research should focus on these aspects, as their focused exploration could improve the understanding of individual recovery processes. This is especially important because of the heterogeneity of patients who experience a major trauma.

Other studies have also shown that qualitative studies on major trauma survivors can enhance the understanding of their recovery, Visser et al. (2021) emphasize the influence of physical, psychological, and social well-being after a major trauma. Whereas Maher et al. (2015 & 2019) qualitatively explored the recovery of mothers after injury qualitatively and showed how care responsibilities might influence the recovery process (21–23). The latter highlights that the exploration of such issues via quantitative data

will not generate adequate information to develop among others workplace interventions to support mothers in RTW (21).

Both studies have overarching limitations, as well as limitations that affect only one of each. Overarching limitations concerning terminological issues in the field of major trauma and RTW research. It was important for both studies to investigate major trauma survivors (patients with an ISS ≥ 16 at the time of their injury). However, the definition of major trauma differs across countries because of differences in e.g., inclusion criteria of trauma register globally. Further, there are several ways to name major trauma, such as polytrauma, severe injury, multiple injury and others. This also influences the investigation, as no clear frame is set for this condition in terms of naming and definition (16).

In relation to the limitations of the systematic review alone, the operationalization of RTW in the included studies was problematic, as it significantly influenced the rate of RTW. Operationalization is influenced by several factors such as terminology, timeframe, and measurement methods and their definitions. Additionally, RTW is very influenced by the social system in which an individual suffers major trauma e.g. rules and regulations, insurance schemes, and others.

Confounding is an under-investigated issue in the field of major trauma research. However, how confounding influences the results of the systematic review remains uncertain. Based on knowledge from both studies, a confounder model was derived and integrated into the systematic review. It should illustrate the interconnectedness of the societal system with the individual level and with the identified factors from the systematic review to offer an understanding of the complex dependencies that shape major trauma recovery. It also confirms the roles of family, friends, and employers.

Future research needs to enhance the understanding of how emotional and social support influences major trauma survivors, and how individuals in close proximity to the patient might help to overcome gaps within the healthcare system in order to improve recovery processes, as pinpointed by participants of the patient interviews (17). Other studies have found that social support fosters recovery (24,25). Coronas et al. (2008) showed that social support can reduce pain intensity and increase functional outcome

and hence can also support RTW after injury. Furthermore, lack of social support can on increase the risk of posttraumatic stress disorders (26). The confounder model also emphasizes the influence of mental health and moral constructs on RTW (16).

In relation to the patient interviews, the results may be limited by the fact that major trauma survivors are a heterogenous group of patients, and even though a saturation point for several of the investigated topics was reached, there are possibly more topics and phenomena not examined during the patient interviews. Moreover, the use of artificial intelligence software is still in its infancy and can lead to several limitations, such as biased coding. Even though a double coding process and a systematic framework were used to decrease the impact of these limitations, it needs a researcher who has to know the data very well and who needs to engage with the data to identify subtle themes and to give meaning to certain ideas or interrelations between aspects (17). Therefore, even if each study design is limited by several factors and biases, the combination of both fosters an understanding of the recovery process and enables synergetic effects by combining study designs that offer a more profound understanding of the derived results.

5. Conclusion

Major trauma survivors are influenced by a variety of factors (e.g. age, injury severity, length of stay in the hospital). Most of the identified factors are not modifiable via health service interventions. However, the experiences of patients within the German healthcare system showed that there are a variety of aspects that have the potential to improve the outcome if modified by e.g. health services interventions such as interdisciplinary communication issues.

However, the studies also highlighted the issues within major trauma research e.g. terminological issues but also showed that the integration of patients' experiences could identified aspects of recovery processes which were not identified via systematic review. The knowledge gained from both studies has the potential to improve the understanding of recovery, hrQoL and RTW after major trauma. It could help to developed interventions that are targeted towards the needs of major trauma survivors. Even though, each study design is limited by several factors and biases, the synergetic effects of combining study designs offers that results are understood in more depth, are better translatable to

practice and other circumstances, which makes the research more generalizable and therefore, more sustainable.

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Appendix 1

Additional file of the publication: Return to work after major trauma: a systematic review

Additional file 1.1 - Search strategy

MEDLine via PubMed

1. (("Multiple Trauma"[MeSH Terms] OR "Multiple Trauma"[Title/Abstract] OR "polytrauma"[Title/Abstract] OR "major trauma"[Title/Abstract]) OR ("severe trauma"[Title/Abstract]))
2. "Return to Work"[MeSH Terms] OR "Return to Work"[Title/Abstract] OR "Returned to Work"[Title/Abstract] OR "Returning to Work"[Title/Abstract] OR "back to work"[Title/Abstract] OR "back at work"[Title/Abstract] OR "ability to work"[Title/Abstract]
3. #1 AND #2

CENTRAL

#1	MeSH descriptor: [Multiple Trauma] explode all trees
#2	"Multiple Trauma"
#3	polytrauma
#4	"major trauma"
#5	"severe trauma"
#6	#1 OR #2 OR #3 OR #4 OR #5
#7	MeSH descriptor: [Return to Work] explode all trees
#8	"Return to Work"
#9	"back to work"
#10	#7 OR #8 OR #9
#11	#6 AND #10

PEDro

1. Search: Major trauma
2. Search: Return to work AND trauma

TRIP database

Population: polytrauma

Outcome: return to work

APA PsycInfo via OVID

1	"multiple trauma".mh. or "major trauma".af. or "multiple trauma".af. or polytrauma.af. or "severe trauma".af.
2	"return* to work".mh. or "return to work".af. or "ability to work".af. or "back to work".af.
3	1 and 2

Bibnet via LIVIVO
("multiple trauma" OR polytrauma OR "major trauma" OR "severe trauma") AND ("return to work")

Web of science
(AB= (polytrauma OR major trauma OR multiple trauma OR severe trauma OR severe injury OR multiple injury)) AND AB=(return* to work OR ability to work OR back to work)

ICTRP
polytrauma OR major trauma OR multiple trauma OR severe trauma
AND
return to work OR back to work OR ability to work

Clinicaltrial.gov
Polytrauma OR major trauma OR multiple trauma OR severe trauma
Outcome measure: return to work

Additional File 1.2 - Excluded Studies

Study ID	Reason for exclusion	Reasons extended
Abedzadeh-Kalahroudi 2015 (1)	Wrong patient population	Mean ISS =10
Abedzadeh-Kalahroudi 2017 (2)	Wrong patient population	Most patients with ISS 9-15
Ahmed 2017 (3)	Wrong patient population	Inclusion of patients with ISS >9, no separate data for patients ISS ≥ 16
Airey 2001 (4)	No factors related to RTW	No factors related to RTW
Anders 2013 (5)	Wrong patient population	Mixed patient population with ISS ><16
Anke 1997 (6)	Wrong patient population	Includes children (age >12)
Athanasou 2015 (7)	Wrong patient population	ISS unclear
Bai 2018 (8)	Injury Severity unknown /unclear	ISS unclear
Ballabeni 2011 (9)	Injury Severity unknown /unclear	No ISS reported
Baldry Currens 2000 (10)	Wrong patient population	Includes children and ISS range 1-75
Beck 2016 (11)	Wrong population	Mean ISS 9 (range 5-14)
Beck 2017 (12)	Wrong patient population	Mean ISS = 9 (range 5-14)
Berger-Estilita 2019 (13)	Wrong outcome	No relation to RTW
Brenneman 1997 (14)	Wrong patient population	Employed patients had a mean ISS=23 ± 11.3 &
Brenner 2011 (15)	No factors related to RTW	No factors analyzed
Castillo-Angeles 2021 (16)	Wrong patient population	Median ISS = 13, (IQR: 9; 21)
Chaboyer 2010 (17)	Wrong patient population	ISS Range 9-14
Collie 2019 (18)	Wrong patient population	IQR of ISS: 14;22
Cunha-Diniz 2022 (19)	Wrong patient population	Most patients with ISS <16
Czaja 2009 (20)	Wrong patient population	Mixed population regarding ISS, no separate data for RTW for patients with ISS >16
Daly 2022 (21)	Wrong patient population	ISS >16
De Munter 2020 (22)	Wrong patient population	Mean ISS 5 (Range 4-9)
Denu 2022 (23)	Wrong patient population	ISS not reported, definition of population unclear
Dinh 2016 (24)	Wrong patient population	Median ISS= 9, IQR: 4;17
Doan 2020 (25)	Wrong patient population	Median ISS = 9; IQR 4-9
Duckworth 2018 (26)	Wrong study design	Literature review
Faux 2015 (27)	Wrong patient population	Most patients with an ISS <9; mean ISS 5.27
Fleischhacker 2020 (28)	Wrong study design	Literature review
Folkard 2016 (29)	Wrong patient population	Mean ISS = 12
Fox 2013 (30)	Wrong patient population	Mean ISS 17 ± 8
Gabbe 2006 (31)	Wrong patient population	ISS Range 1-66
Gabbe 2007 (32)	Wrong patient population	Group 1: Median ISS = 9 (Range 1-38) Group 2: Median 13 (Range 1-57)
Gabbe 2013 (33)	Wrong patient population	More than 5% of patients with ISS <16
Gabbe 2015 (a) (34)	Wrong patient population	ISS ><16
Gabbe 2015 (b) (35)	Injury Severity unknown /unclear	ISS in this paper was dichotomized with a cutoff at ISS 12, distribution of ISS unclear
Gabbe 2016 (36)	Wrong patient population	Inclusion of patients ISS >12, median ISS = 17; IQR: 14;25
Gabbe 2021 (37)	no factors related to RTW	Only proportion of those returning to work reported
Gabbe 2022 (38)	no factors related to RTW	no factors related to RTW
Giummarra 2020a (39)	Wrong patient population	More than 30% of patients with ISS<15
Giummarra 2020b (40)	Wrong patient population	Includes 70% of patients with an ISS <16
Giummarra 2021 (41)	Wrong patient population	Includes 70% of patients with an ISS <16
Glancy 1992 (42)	Wrong patient population	Mean ISS 8.92
Graham 2016 (43)	Wrong study design	Abstract only
Gray 2018 (44)	Wrong patient population	Mostly non-severely/no major trauma injured patients
Gray 2019 (45)	Injury Severity unknown /unclear	ISS unclear
Gross 2012 (46)	no factors related to RTW	no factors related to RTW
Gross 2019 (47)	Wrong patient population	Mean ISS = 13.5 ± 7.2
Haagsma 2012 (48)	Wrong outcomes	No RTW as outcome
Haider 2020 (49)	Wrong patient population	Median ISS = 10
Hebert 2000 (50)	Wrong patient population	Mean ISS 17.27 ± 10.61; Range 4-75
Hepp 2011 (51)	Wrong patient population	ISS Range = 10-51
Herrera-Escobar 2018 (52)	Wrong patient population	Mean ISS =14
Herrera-Escobar 2019a (53)	Wrong patient population	70% of patients with ISS 9-15
Herrera-Escobar 2019b (54)	Wrong patient population	Mean ISS 14.3±7.3
Hodgson 2018 (55)	Wrong patient population	No traumatological study population
Holmes 2007 (56)	Wrong outcomes	No desirable outcome related to RTW investigated
Horn 2021 (57)	Wrong patient population	Mean ISS = 5
Hours 2010 (58)	Wrong patient population	Mixed study population of minorly, moderately, and severely injured

Hours 2013 (59)	Wrong patient population	Mixed study population of minorly, moderately, and severely injured
Hung 2022 (60)	Wrong patient population	Median ISS =10
Iakova 2012 (61)	Wrong patient population	No polytrauma population
Ioannou 2018 (62)	Injury Severity unknown /unclear	ISS unclear
Kabak 2003 (63)	Wrong patient population	ISS Range 12-66
Kellezi 2017 (64)	Wrong patient population	Only a few patients with serious injuries included
Kendrick 2012 (65)	Injury Severity unknown /unclear	Severity of included injuries unclear
Kendrick 2017 (66)	Wrong patient population	Only 18% of patients with serious injuries
Kendrick 2018 (67)	Wrong patient population	Only about 20% of patients with serious injuries
Kendrick 2021 (68)	Wrong patient population	Inclusion criteria: ISS >8
Kissinger 2008 (69)	Wrong study design	Literature review
Kruithof 2020 (70)	Wrong patient population	Median ISS = 5
Kulmala 2019 (71)	Injury Severity unknown /unclear	severe injury was defined as an occupational injury that caused 30 or more days of consecutive sick-leave.
Lange 2007 (72)	Wrong patient population	Mean ISS = 12.6
Larsen 2016 (73)	Wrong patient population	Mean ISS 14.6 ± 11.4
Lau 2020 (74)	Wrong patient population	55.4% of the study population with an ISS <16
Lehmann 1997 (75)	Injury Severity unknown /unclear	Study used the Hannover Polytrauma Schlüssel to determine the severity of injuries
Lehmann 1999 (76)	no factors related to RTW	no factors related to RTW
Lilley 2012 (77)	Injury Severity unknown /unclear	ISS unclear
Lippert-Gruner 2007 (78)	no factors related to RTW	No factors analyzed
MacKenzie 1987 (79)	Injury Severity unknown /unclear	No ISS reported
MacKenzie 1988 (80)	Injury Severity unknown /unclear	No ISS reported
MacKenzie 1998 (81)	Wrong patient population	Only 24% of patients with ISS >16
MacKenzie 2006 (82)	Injury Severity unknown /unclear	ISS unclear
Madhu 2007 (83)	Wrong patient population	ISS range 9-27
Maher 2015 (84)	Injury Severity unknown /unclear	ISS unclear
Marasco 2015 (85)	Wrong patient population	ISS ><16
Meerding 2004 (86)	Injury Severity unknown /unclear	Severity of injury was defined as number of injuries and motor vehicle involvement
Michaels 1998 (87)	Wrong patient population	Mean ISS = 14 ± 10
Morris 1991 (88)	Injury Severity unknown /unclear	No ISS reported
Murgatroyd 2016 (89)	Wrong patient population	Most patients with ISS<16
National Taiwan University Hospital 2015 (90) → ongoing study	no factors related to RTW	no RTW as an outcome
Nehra 2019 (91)	Wrong patient population	Mean ISS =15
Nguyen 2017 (92)	Wrong patient population	Nearly 50% of patients with ISS <16
Nhac-Vu 2014 (93)	Injury Severity unknown /unclear	>50% with mild and moderate injuries; range of NISS 0-8
Nyberg 2003 (94)	Injury Severity unknown /unclear	ISS unclear
O'Donnell 2010 (95)	Wrong patient population	Group 1 mean ISS 12.46 Group 2 mean ISS 11.54
O'Toole 2008 (96)	Wrong patient population	Only 84 patients of the study population with an ISS >17
Ott 1996 (97)	Injury Severity unknown /unclear	Study used the Hannover Polytrauma Schlüssel to determine the severity of injuries
Padovani 2016 (98)	no factors related to RTW	No factors related to RTW explored
Palmer 2020 (99)	Wrong patient population	57% der population with ISS <16
Parks 2007 (100)	Injury Severity unknown /unclear	Injury Severity unknown /unclear
Pelissier 2017 (101)	Wrong patient population	Patient population: Patients with one severe injury defined as an injury M-AIS3+
Pelissier 2020 (102)	Wrong patient population	Mixed population of mild, moderate, and severe injuries
Prang 2015 (103)	Wrong patient population	Study population are no polytrauma patients
Pransky 2005 (104)	Injury Severity unknown /unclear	Severity of injury unclear
Rainer 2018 (105)	Wrong patient population	ISS >< 16
Redmill 2006 (106)	Wrong patient population	Includes children 2-18 years
Richmond 2003 (107)	Wrong patient population	Mean ISS 13.46 ± 8.42
Ringgren 2020 (108)	Injury Severity unknown /unclear	includes patients who had an ambulance dispatched following a traffic accident – severity of injuries unknown
Rissanen 2019 (109)	Wrong patient population	Only 27% with MAIS 3
Savitsky 2020 (110)	Wrong patient population	90% of study population with an ISS <16
Schnyder 2003 (111)	Wrong patient population	Mean ISS 22±10
Seekamp 1994 (112)	Injury Severity unknown /unclear	Study used the Hannover Polytrauma Schlüssel to determine the severity of injuries
Seekamp 1996 (113)	no factors related to RTW	Describes no factors related to RTW
Simmel 2018 (114)	Wrong study design	Literature review
Simmel 2021 (115)	Wrong study design	Literature review

Soberg 2008 (116)	Injury Severity unknown /unclear	Study used the NISS to determine the severity of injuries
Soberg 2011 (117)	Wrong patient population	NISS & ISS/ for RTW group mean ISS 25.8 ±10.8
Spreadborough 2018 (118)	Wrong patient population	45% of the study population with an ISS >16
Tate 1992 (119)	Wrong patient population	Reports only on patients with isolated fractures
Toien 2012 (120)	Wrong patient population	Mean ISS = 13.7 ± 12.97
Uleberg 2019 (121) → **study protocol: Norwegian University of Science 2015 (122)**	Wrong patient population	Only 16% of patient population with an ISS >16
Urquhart 2006 (123)	Wrong patient population	30% of the study population with isolated orthopedic injuries
Van Delft-Schreurs 2014 (124)	Wrong outcomes	Investigates health related quality of life
Van der Sluis 1998 (125)	Na factors related to RTW	no factors related to RTW
Van der Vlegel 2021 (126)	no factors related to RTW	no factors related to RTW
Visser 2021 (127)	Wrong patient population	>50% of the patient population with an ISS <16
Wudel 1991 (128)	Wrong patient population	Mean ISS between 10 and 35.7 (depending on the group)
Zeckey 2011 (129)	no factors related to RTW	no factors related to RTW

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Additional file 1.3 - Overview RTW including definitions, measurement timepoints and RTW rates

Study ID	Outcome name	Definition	Sample size	Measurement timepoint											
				6 months			1 year			2 years			<3 years		
				RTW	Partial	Full	RTW	Partial	Full	RTW	Partial	Full	RTW	Partial	Full
Gabbe 2008 (45)	Return to work	Return to work/study (Yes/No) of those previously working	103	58.6%											
Gross 2010 (31)	Capacity to work	"2 years post-injury reduced capacity to work versus non-reduced capacity to work." – compared to capacity prior to injury – verification via insurance and medical data the authors rated it reduced, when less than 100% or less than prior to injury	115							47%	53%				
Grotz 1997 (32)	Return to work	"Patients were asked about their job situation before and after the accident and their pension status was documented."	42										64%		
Haas 2021 (34)	Working	"Working in the third calendar year after injury, as indicated by nonzero Y+3 earnings and (2) the change in total annual earnings attributable to the traumatic injury from Y-1 to Y+3"	5,167										79.3%		
Holtslag 2007 (12)	Return to work	"Complete RTW or nearly complete RTW (>80% part-time work) to former employment"	214				79,9%*	21.5%	58.4%						
Kivioja 1990 (36)	Working ability	Working ability before and after the trauma	92										56.5%		
Livingston 2009 (37)	Return to work / school	No definition provided	76										49%		
Post 2006 (38)	Return to work	"Return to work of those in paid labour before injury"	40				87%	14%	71%						
Simmel 2019 (39)	Return to work	"RTW is defined as the general return to gainful employment. Persons who were able to work at the time of the survey were included in the analyses as patients with	84										58%		

		RTW and persons who were not able to work at the time of the follow-up survey or who were retired due to an accident were included as patients without RTW. No differentiation was made as to the extent to which earning capacity was present or which occupational rehabilitation measures were required in the field."													
Soberg 2007 (40)	Return to work /education	Return to work/education (RTW) was dichotomized into two categories based on patient information: complete RTW, and not complete return to work/education (NRTW). RTW time was also based on patient information. In the NRTW group, sick leave, active sick leave, medical or vocational rehabilitation, or disability pension were assessed. (…)"	1 year n=100 2 years N=97				61%	33%**	28%	80%	37%**	43%			
Van Ditshuizen 2022 (41)	Return to work	- working age 18-65 years "How many days and how many hours per week, they had paid work before and 1 year after trauma."	100				68%	31%	37%						
Vles 2005 (42)	Ability to return to work	- Measuring unable to work and change of work/ daily activity	127				74%								

Legend:

**The remaining 20.1% were unemployed 12 months post-injury.*

*** defined as "active or part- time sick-leave/rehabilitation compensation."*

Additional file 1.4 - Factors affecting RTW

Study ID	Number of participants in multivariate analysis	% loss to follow up / missing data	Analysis	Multivariate analysis: significant results	Multivariate analysis: Non-significant results	Univariate analysis: significant results	Factors from other analysis (no regression analysis)
Gabbe 2008 (34)	103	3.4%	logistic regression analyses	• Higher discharge **FIM motor scores**: (AOR 1.03, 95% CI: 1.01–1.04) • **Age** 35 to 44 years: (AOR 0.31, 95% CI: 0.13–0.76) • **accident compensation schemes** for work and transported-related injury: (AOR 0.28; 95% CI: 0.11–0.72)		• compensable status • age • Presence of extremity injury • ISS • Discharge from hospital destination • modified FIM locomotion item • FIM motor score • total FIM score • modified FIM total	
Gross 2010 (33)	115	36.1%%	Logistic regression analysis	• **Educational level** (OR: 0.249; 95%CI 0.068-0.916, p=0.036) Nagelkerke R^2 0.74 • **ISS** (OR:1.115; 95%CI 1.020 – 1.220) • **Time in ER** (OR: 0.917, 95%CI 0.862-0.974 p=0.005)		• Pain • EQ-5D • SF-36 • FIM • MFA • Time to CT • Time to emergency OR	

				• **LEP** (OR: 1.002, 95%CI 1.000 1.004, p= 0.033) • **NHP** (OR: 1.103, 95%CI: (1.058 1.150), p=0.001)		• GCS • ISS • AIS head • RTS • $SapO_2$ 1 day • TRISS • SAPS II mort • Smoking pre-trauma	
Grotz 1997 (39)	42	27.5%	Chi-Quadrat Test and Mann-Whitney U-Test				**Significant:** • Traumatic brain injury (grade) • LOS Rehab • Limited movement Tegner Activity Score **Non-significant:** • Age • Sex • Polytrauma Schlüssel • GCS • GOS • ICU stay • Mechanical ventilation • Limited movement (hands, elbow, shoulder, knee, ankle)

Haas 2021 (41)	5,167	Retrospective analysis	Weighted multivariable probit regression	• **ICU admission** mean difference-in-difference change in per- centage employed: with intensive or special care unit, −22.1% [95% CI, −24.4% to −19.8%] • **Severe head injury** presence of a severe head injury (mean difference-in-difference change in percentage employed: yes, −17.9% [95% CI, −19.9% to −15.8%] • Longer index **LOS hospital** (mean difference-in-difference change in percentage employed: low tercile, −5.6% [95% CI, −7.3% to −3.8%] • **Mechanical ventilation** (mean difference- in-difference change in percentage employed: yes, −26.8% [95% CI, −30.1% to −23.5%] • Low preinjury **income** (mean difference in difference −18.5% [95% CI, −20.8% to −16.2%] • Age	• Sex • Marital status • Self-employment		
Holtslag 2007 (12)	214	7%	logistic regression analysis	**At discharge:** Nagelkerke R^2= 0.23 • **Age** (OR 1.89; CI 95% 1.03-3.46) • **Spinal cord injury** (OR 4.3; CI 95% 1.07 – 17.2) • **Hospital LOS** <21 (OR 2.65; CI 95% 1.35 – 5.18) • **Discharge home** (OR 0.41; Ci 95% 0.20 – 0.84) **At 12-18 months post-injury** • **GARS-ADL** (OR 3.69; CI 95% 1.71 – 7.95) • **HISCwA** (OR 2.63; CI 95% 1.24 – 5.58) • **AMA** (OR 7.51, CI 95% 3.29 – 17.1) Nagelkerke R^2= 0.507	**At discharge:** • ISS • Comorbidity • ICU stay • Injury location – brain **At 12-18 months post-injury** • ISS • Comorbidities • Injury location – brain • ICU stay	• Age • Co-morbidity • Injury location – brain • Injury location – spinal cord • ISS • ICU stay • Discharge home • Discharge to rehab center • AMA • GARS-ADL • HISCwA	

Kivioja 1990 (36)	71	15.6%	Logistic regression	• **ISS** • **Age** • **Physical fitness** • **Complaints from lower extremity injury**			
Livingston 2009 (37)	76	28.6%	Kruskal-Wallis and ^{2} tests /Student's *t* and Mann-Whitney *U* tests	/			Non-sign. • Presence of any TBI • Head AIS • Extremity AIS • Presence of any extremity fracture • ISS • Age • Ventilator days
Post 2006 (43)	40	24.3%	chi-square tests / Student's t-tests	/			**Significant** • Age **Non-significant** • Head injury • Extremity injury • ISS • Blue collar and white collar
Simmel 2019 (32)	84	40%	Logistic regression	• **Age** (OR 1.088; p<0.05) • **General health status** (OR 0.934; p<0.01) • **LOS ICU** (OR 1.072; p<0.01) Nagelkerkes R^2 = 0,526	• Time between follow-up and accident	• LOS hospital • Cost bearer for treatment • Head injury • Abdomen injury • More support during hospitalization expected	

Soberg 2007 (31)	97	34.2%	Cox regression model	• **Social functioning** (RR 2.72; CI95% 1.04–7.13) • **LOS hospital** (RR 5.06; CI95% 1.28–20.01) • **Education** (RR 4.14; CI95% 1.99–8.61)	• profession • NISS • powerful other locus of health control • physical functioning • sex • age		
Van Ditshuizen 2022 (38)	100	50%	Chi-square test or Fisher's exact test was used as applicable	/			**Sign.** • Better score in all health domains of EQ-5D • Injury Severity **Non-sign.** • Gender • Type of injury • Age • Level of education • No of comorbidities • Severity of specific organ injuries 1-year post-injury
Vles 2005 (35)	127	15%	Logistic regression and linear regression	• **ISS** ($p < 0.001$) • **Gender** ($p < 0.05$) • **Injury of one or more extremities** (protective effect – $p< 0.05$)	• Age • Nr. Of body areas with injury • Head injury		

					• Abdominal injury • Thorax injury • Injury remaining body • Isolated head injury • Injury spine / pelvis		

Legend: AIS = Abbreviated Injury Scale; AMA = percentage of permanent impairment according to the fourth American Medical Association guide; CT= computer tomography; EQ-5D = European Quality of Life 5 Dimensions 3 Level Version; ER = emergency room; FIM = functional independency measurement; GARS-ADL = Groningen Activity Restriction Scale-Activities of Daily Living; GCS = Glasgow Coma Scale; GOS = Glasgow Outcome Scale; HISCwA = Head Injury Symptom Checklist, without anxiety; ICU = intensive care unit, ISS= Injury Severity Score; LEP = Mean nurse per day and per patient ratio; LOS = length of stay, MFA = Musculoskeletal functional Assessment NHP = Nottingham Health Profile, NISS = New injury Severity Score; RTS = Revised Trauma Score; $SapO_2$ = arterial hemoglobin saturation by pulse oximetry; SAPS II mort = expected Simplified Acute Physiology Score II mortality; SF-36 = Short Form 36; TRISS = Trauma and Injury Severity Score

Appendix 2

Additional files of the publication: Lived experiences of working-age polytrauma patients in Germany - A qualitative Analysis

Additional file 2.1 - Guidelines: interviews with patients

Leitfaden: Gruppeninterviews/Einzelinterviews Patienten

Vorab: Einholen der Einwilligungserklärung

Das Interview:

Einführungsphase		**5 Minuten**
Projekt und Interviewziel kurz erklären	• Kurz und knapp Projekt und Ziele erklären • Interview warum/ für was	
Rahmenbedingungen und Grundregeln	• Datenschutz insbesondere in Bezug auf Videoaufnahme • Aufnahme • Auf Stille Beobachter aufmerksam machen • Anonymisierung der Daten während der Transkription → Patienten darauf hinweisen möglichst auf personenbezogene Angaben zu verzichten • Respekt und Wertschätzung aller Meinung	
Warm-Up Phase		**10-15 Minuten**
Vorstellungsrunde	• Name • Ein paar persönliche Details ○ Sind Sie wieder berufstätig	
Aufwärmfrage	• Was war für Sie die Schlüsselmomente in der gesamten Zeit von Trauma bis zur Rückkehr in den Alltag?	**Video starten**
Hauptteil		**60 Minuten**
Themenblock 1 Patientenpfade		
<u>Hauptfrage:</u> • **Wie würden Sie rückblickend Ihren Weg vom Trauma bis zurück in Ihren Alltag beschreiben? (in die Berufstätigkeit, in die Umschulung, ...)**	Vertiefende Fragen: ○ Wenn Sie sich zurückerinnern: Wie verlief ihre Behandlung? ▪ Welche Dinge liefen besonders gut? (→ in der Akutklinik, in der Reha, in der Zeit danach) ▪ Welche Dinge liefen besonders schlecht? (→ in der Akutklinik, in der Reha, in der Zeit danach)	

Versuchen Sie in Abschnitten zu denken Akutklinik Rehaklinik Zeit danach **(siehe Handout)**	▪ Welche Berufsgruppen waren an Ihrer Behandlung beteiligt? ○ Wie haben Sie die Kommunikation der Behandler mit Ihnen erlebt? ▪ Wie wurden Sie im Behandlungsverlauf über die jeweils nächsten Schritte informiert → wie beispielsweise Ihren Verlauf und Ihr Verletzungsbild? • Wie würden Sie die Qualität dieser Kommunikation mit Ihnen werten? ▪ Wie haben Sie die Kommunikation zwischen den Behandlern untereinander erlebt? (siehe Handout) ○ Wie wurden Sie in die Entscheidung über die Behandlung mit einbezogen worden? ▪ In welchen Situation wurden Sie mit einbezogen? ▪ Wenn nicht mit einbezogen: Wie hätten Sie sich eine Einbeziehung in die Behandlung gewünscht? ○ Wie beurteilen Sie Ihre Nachbehandlung insgesamt? (ab Reha-Aufenthalt) Gibt es noch etwas, das Sie in Bezug auf die von Ihnen erlebte Versorgung hinzufügen wollen?
Themenblock 2: **Optimierung des Prozesses**	
<u>Hauptfrage</u> **Wenn Sie sich die optimale Behandlung vorstellen könnten: Wie sähe diese aus?**	Vertiefende Fragen: ○ Welche Merkmale hätte diese? ○ Hatten Sie einen Rehabegleiter? • Wenn Ja: Wie wichtig war Ihnen diese Unterstützung? • Wenn nein: Hätten Sie sich eine Bezugsperson im Rehaprozess gewünscht? ○ Haben Sie psychosoziale Unterstützung erhalten) • In Welcher Form? → Psychologen, Psychotherapeuten oder Sozialarbeiter, Seelsorger .... ▪ Hatten Sie jemals Kontakt zu einem Psychiater oder Psychologen, um über das

Trauma und dessen Folgen zu sprechen.
- Wenn Ja: Wie wichtig schätzen Sie diesen Kontakt ein?
- Wenn nein: Hätten Sie sich diesbezüglich Unterstützung gewünscht?

- Sollte aus Ihrer Sicht eine psychosoziale Unterstützung zur Bewältigung des Unfalls angeboten werden?

Gibt es noch etwas, das Sie gern in Bezug auf die aus Ihrer Sicht optimale Versorgung hinzufügen wollen?

Themenblock 3: Arbeitsfähigkeit und Lebensqualität

Hauptfrage:	Vertiefende Fragen:
○ **Wie leben Sie heute nach Ihrem Trauma?**	○ Wie empfinden Sie Ihr Leben momentan im Vergleich zu vor dem Unfall? • Ist Ihr Leben aktuell besser / gleich / schlechter als vor dem Unfall? • Woran machen Sie das fest? ○ Wenn Sie an die Zeit von Unfall bis Arbeitsfähigkeit (/Berentung / Umschulung /bei AU) bis jetzt denken, welches ist das vorherrschende Gefühl? • positiv oder negativ? • Warum? Berufstätig? **Wenn ja** ▪ Wenn ja, welches waren die Hauptgründe, dass Sie wieder ins Arbeitsleben zurückkehren konnten? ▪ Wenn ja, wie funktionierte Ihr Wiedereintritt ins Arbeitsleben? ▪ Wurden Sie im Prozess des Wiedereintritts ins Arbeitsleben von Ihrem Arbeitgeber unterstützt? ▪ Was hat Sie in Bezug auf den Wiedereintritt ins Arbeitsleben beeinflusst? • Wenn nicht deutlich gesagt, dann: ○ Was hat Sie positiv beeinflusst? ○ Was hat Sie negativ beeinflusst? ▪ Kam es während Ihrer gesundheitlichen Versorgung zu bürokratischen Problemen mit der Rückkehr zur Arbeit? ▪ Wie wurden diese gelöst? **Wenn nein, dann** ▪ Wenn nein, welches waren die Hauptgründe, dass Sie nicht wieder ins Arbeitsleben zurückkehren konnten? ▪ Kam es während Ihrer gesundheitlichen Versorgung zu bürokratischen Problemen? ▪ Welche Rolle hatte ihr Arbeitgeber in dem Prozess?

Wie wichtig waren in der Zeit des Traumas bis zur Arbeitsfähigkeit /bis jetzt/ bis zur Berentung die Unterstützung durch Familie und Freunde?

- Hätten Sie sich mehr Kommunikation der Behandler mit Ihrem sozialen Umfeld gewünscht?

Gibt es noch etwas, das Sie gern in Bezug auf Arbeitsfähigkeit und Lebensqualität hinzufügen wollen?

Abschluss	**10 Minuten**

Kurze Zusammenfassung der wichtigsten Gesichtspunkte

Bedeutung für mögliche zukünftige Entwicklungen (für die weiteren Interviews, für die Studie insgesamt)

Additional file 2.2 - Patient information and informed consent form

Informationen für Teilnehmende an den Gruppeninterviews für das Projekt „LeAf Trauma“ – Lebensqualität und Arbeitsfähigkeit nach schwerem Trauma

Sehr geehrte Patientin, sehr geehrter Patient!

Sie wurden in der Vergangenheit wegen schweren Verletzungen ärztlich behandelt. Wir möchten Sie aus diesem Grund um die Teilnahme an der Studie „LeAf Trauma“ bitten. Im Rahmen dieser Studie soll untersucht werden, welche Einflüsse im Behandlungsverlauf eines schwerst- und schwerverletzten Patientinnen und Patienten Auswirkungen auf die Genesung und das Wiedererlangen der Arbeitsfähigkeit haben können.

Um eingrenzen zu können, welche Aspekte im Behandlungspfad einer/s Patientinnen und Patienten von wesentlicher Bedeutung sind, würden wir gerne Ihre Erfahrung aus Ihrer Behandlung nutzen.

Bevor Sie teilnehmen können, benötigen wir von Ihnen eine schriftliche Einwilligungserklärung. Dazu möchten wir Sie bitten, sich kurz Zeit zu nehmen, um die nachfolgenden Informationen zur Studie durchzulesen.

Ihre Einwilligung ist freiwillig. Wenn Sie sich nicht an der „LeAf Trauma“-Studie beteiligen möchten oder Ihre Einwilligung später widerrufen möchten, entstehen Ihnen daraus keine Nachteile.

Welche Ziele verfolgt die Studie?

In Akutkliniken besteht eine erhebliche Wissenslücke zum weiteren Genesungsverlauf von Schwerst- und Schwerverletzten, da nach der initialen Behandlung häufig kein Kontakt mehr zu diesen Patientinnen und Patienten besteht. Dadurch endet die Qualitätssicherung in

Krankenhäusern mit Entlassung und die Möglichkeiten zur Verbesserung der Versorgung beschränkt sich auf Bewertungen des Zustandes in diesem Moment.

Ob und wie sich Einflüsse im gesamten Behandlungsverlauf auf die Genesung auswirken, ist kaum erforscht. In der vom Innovationsfond geförderten Studie „LeAf Trauma“ sollen Einflussfaktoren auf die Lebensqualität und Wiedererlangung der Arbeitsfähigkeit von Patientinnen und Patienten nach schwerem Trauma identifiziert und quantifiziert werden. Damit soll unter anderem das Verständnis für die sektorenübergreifenden Patientenpfade verbessert werden.

Langfristig sollen aus den gewonnenen Erkenntnissen praxistaugliche Handlungsempfehlungen abgeleitet werden und damit die Versorgung insgesamt verbessert werden.

Wer ist an der Studie beteiligt?

Die Studie wird von den folgenden Einrichtungen verantwortet:

- AUC – Akademie der Unfallchirurgie GmbH (Gesamtleitung)
- Institut für Forschung in der operativen Medizin an der Universität Witten/Herdecke Köln
- Klinik für Orthopädie und Unfallchirurgie, Universitätsklinikum Düsseldorf
- Universitätsklinik für Unfallchirurgie, Otto-von-Guericke-Universität Magdeburg
- Klinik für Unfall-, Hand-und Wiederherstellungschirurgie, Universitätsklinikum Essen
- Wissenschaftliches Institut der AOK, Forschungsbereich Qualitäts- und Versorgungsforschung (WIdO)

Die Studie kooperiert mit mehr als 40 Krankenhäusern in Deutschland.

Ablauf der Studie

Mit Hilfe eines halbstrukturierten Leitfadens werden Sie über Ihre Erfahrungen zu den Themen Versorgung von Schwerst- und Schwerverletzten im gesamten Versorgungspfad und deren Akteure und über Wiedereintritt in die Arbeitswelt befragt. Das Gespräch findet in Kleingruppen von ca. 2 Personen statt und dauert etwa 1,5 Stunden. Das Gespräch wird mit einem Diktafon aufgezeichnet.

Wie verwenden wir die Daten?

In der Verarbeitung Ihrer personenbezogenen Daten befolgen wir die nationalen Datenschutzbestimmungen und die EU-Datenschutz-Grundverordnung (DSGVO). Die Audioaufnahmen aus den Gesprächen dienen ausschließlich der projektbezogenen wissenschaftlichen Auswertung. Sie werden sobald wie möglich nach den Gesprächen transkribiert, d.h. verschriftlicht und die Audioaufnahmen anschließend gelöscht.

Bereits während der Transkription der Audioaufnahmen werden personen- und ortsbezogene Angaben gelöscht oder wenn es für die Verständlichkeit des Transkripts notwendig ist, durch Merkmale gleicher Bedeutung (Beispiel: Kiefernklinik wird durch Klinik ersetzt) ersetzt. Die

Daten sind nach der Transkription anonymisiert und können nicht mehr auf Ihre Person zurückbezogen werden. Die Audioaufnahme wird nach der Transkription gelöscht.

Die Ergebnisse des Interviews werden anonymisiert ausgewertet. An Konsortialpartnern des Projekts, die direkt an der Auswertung und Lagerung der Daten beteiligt sind (das Institut für Forschung in der Operativen Medizin (IFOM), Universität Witten/Herdecke, Köln; die Universitätsklinik für Unfallchirurgie, Otto-von-Guericke-Universität Magdeburg; die Akademie der Unfallchirurgie) werden die Daten ausschließlich anonymisiert weitergegeben. An andere Wissenschaftler oder an die Öffentlichkeit werden die Ergebnisse der Studie nur in anonymisierter Form kommuniziert.

Falls Sie Fragen zum Umgang mit Ihren Daten in dieser Studie haben, wenden Sie sich bitte zunächst an die Konsortialsführung des Projekts, die Akademie der Unfallchirurgie. Diese kann Ihr Anliegen wird entsprechend an Personen, die für den Datenschutz verantwortlich sind, weiterleiten.

AUC – Akademie der Unfallchirurgie GmbH
Emil-Riedel-Str. 5, 80538 München
E-Mail: leaf-trauma@auc-online.de
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Wer hat Zugang zu den Daten und wie werden diese geschützt?

Ausschließlich die Mitarbeiter der Klinik für Orthopädie und Unfallchirurgie der Universitätsklinik Düsseldorf werden ihre personenbezogenen Daten erfahren. Mitarbeiter des Instituts für Forschung in der operativen Medizin an der Universität Witten/Herdecke Köln und der Universitätsklinik für Unfallchirurgie, Otto-von-Guericke-Universität Magdeburg werden die Ergebnisse der Gruppeninterviews auswerten. Diese Mitarbeiter erhalten die ausschließlich die anonymisierte Daten. Die anonymisierten Daten werden bei der Akademie der Unfallchirurgie gespeichert.

Das Forscherteam wird alle angemessenen Schritte unternehmen, um den Schutz Ihrer Daten gemäß den Datenschutzstandards der Europäischen Union zu gewährleisten. Die Daten sind gegen unbefugten Zugriff gesichert. Bereits bei der Transkription der Gesprächsaufzeichnung werden personen- und ortsbezogene Angaben anonymisiert. Somit können diese Daten nicht mehr einer spezifischen Person oder Ort zugeordnet werden. Diese Informationen werden gesondert aufbewahrt und unterliegen technischen Maßnahmen, die gewährleisten, dass die personen- oder ortsbezogenen Daten nicht einer identifizierten oder identifizierbaren natürlichen Person oder Ort zugewiesen werden. Eine Entschlüsselung ist nicht möglich.

Wie lange bewahren wir Ihre Daten auf?

Transkripte werden 10 Jahre und alle weiteren schriftlichen Materialien werden bis zum Abschluss der Studie aufbewahrt und anschließend vernichtet.

Welcher Nutzen und welche Risiken sind mit Ihrer Einwilligung verbunden?

Bei Teilnahme wird sich in der Regel kein direkter Nutzen für Sie ergeben. Sie leisten aber einen wichtigen Beitrag zur Verbesserung der Versorgungsqualität sowie von bestehenden Behandlungsmethoden und ermöglichen die Untersuchung neuer Ansätze bei der Versorgung nach schweren Unfällen.

Im Rahmen der Befragungen werden ausschließlich Informationen dokumentiert, es finden keine medizinischen Eingriffe statt. Es besteht für Sie also kein gesundheitliches Risiko.

Bei jeder Übermittlung und Speicherung von Gesundheitsdaten besteht aber immer das Restrisiko einer Rückverfolgbarkeit zu Ihrer Person, etwa durch das Hinzuziehen weiterer Informationen aus dem Internet, sozialen Netzwerken oder Pressemeldungen.

Freiwilligkeit Ihrer Einwilligung und Ihr Widerrufsrecht

Ihre Einwilligung ist freiwillig. Wenn Sie keine Erlaubnis zur Nutzung Ihrer Daten erteilen möchten, entsteht Ihnen dadurch kein Nachteil.

Sie können Ihre Einwilligung jederzeit schriftlich oder mündlich ohne Angabe von Gründen widerrufen, ohne dass Ihnen dadurch Nachteile entstehen**.** Ihr Widerruf wirkt sich immer nur auf die künftige Verwendung Ihrer Daten aus, bereits durchgeführte Vorhaben können also nicht mehr rückgängig gemacht werden. Durch die Anonymisierung Ihrer Daten während der Transkription der Audioaufnahme können diese nicht mehr Ihrer Person zugeordnet werden. Daten können demzufolge nachträglich nicht entfernt oder vernichtet werden, sofern diese bereits anonymisiert wurden.

Für einen Widerruf Ihrer Einwilligung wenden Sie sich bitte an:

Klinik für Orthopädie und Unfallchirurgie
Universitätsklinikum Düsseldorf
E-Mail: leaf trauma@hhu.de

Zwecke und Rechtsgrundlage der Verarbeitung

Wir verarbeiten Ihre Daten ausschließlich für wissenschaftliche Zwecke. Unser Bestreben ist, dass hier gestellte Forschungsprojekt zu einer Verbesserung der Versorgungsstrukturen von Schwerst- und Schwerverletzten führt.

Rechtsgrundlage für die Verarbeitung Ihrer Daten ist Ihre Einwilligung nach Art. 9 Absatz 2 Buchstabe a) und Art. 6 Absatz 1 Unterabsatz 1 Buchstabe a) DSGVO.

Vielen Dank für Ihre Teilnahme!

Einwilligungserklärung:
Interview und Datennutzung für die Studie „Lebensqualität und Arbeitsfähigkeit nach schwerem Trauma“

Ich habe die Informationsschrift gelesen und fühle mich über das Ziel und den Ablauf der Studie verständlich aufgeklärt. Alle meine Fragen wurden zu meiner Zufriedenheit beantwortet. Ich stimme der Teilnahme an der Studie freiwillig zu. Ein Exemplar der Informationsschrift und der Einwilligungserklärung habe ich erhalten.

Mit meiner Unterschrift willige ich ein, dass personenbezogene Daten, insbesondere Informationen zu meiner **Gesundheit**, meiner **Lebensqualität** und meiner **Arbeitsfähigkeit** erhoben und wie in der Information für Teilnehmende beschrieben digital gespeichert, verwendet und weitergegeben werden.

Datenschutz: Ich wurde darüber aufgeklärt und stimme freiwillig zu, dass meine in der Studie erhobenen Daten zu den in der Informationsschrift beschriebenen Zwecken in anonymisiert ausgewertet werden. Bei der Veröffentlichung von Ergebnissen der Studie wird mein Name ebenfalls nicht genannt. Die Daten werden nach Studienabschluss weitere zehn Jahre aufbewahrt. Die Daten sind gegen unbefugten Zugriff gesichert. Ich kann meine Einwilligung jederzeit schriftlich oder mündlich ohne Angabe von Gründen widerrufen, ohne dass mir dadurch Nachteile entstehen. Die Rechtmäßigkeit der bis zum Widerruf erfolgten Datenverarbeitung wird davon nicht berührt. Ich wurde darüber aufgeklärt, das meine Daten nach der Anonymisierung nicht mehr entfernen oder vernichten werden können.

Ort, Datum _____

Name Patient/in oder Vertreter/in _____

Unterschrift Patient/in oder Vertreter/in _____

Ich habe das Aufklärungsgespräch geführt:

Name Mitarbeiter/in _____

Danksagung

Der größte Dank gebührt meinen Eltern, die durch ihr unglaubliches Vertrauen in mich die Möglichkeit geschaffen haben, dass dies hier entstehen konnte. Ihr habt diese lange Reise ermöglicht, durch euch habe ich die Kraft und den Mut dafür aufgebracht. DANKE euch!

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