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Psychological distress and physical disability in patients sustaining severe injuries in road traffic crashes: Results from a one-year cohort study from three European countries

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ABSTRACT

The current study aimed to follow-up a group of road crash survivors for one year and assesses the impact of injury on their psychological and physical condition. All crash survivors that were admitted to the intensive or sub-intensive care units of selected hospitals in Greece, Germany and Italy over one year period (2013–2014), were invited to participate in the study and were interviewed at three different time-points as follows: (a) at one month (baseline data), (b) at six months, and (c) at twelve months. The study used widely recommended classifications for injury severity (AIS, MAIS) and standardized health outcome measures such as the Disability Assessment Schedule II (WHODAS 2.0) to measure disability, "Impact of Event Scale" (IES-R) to measure Post-Traumatic Stress Disorder (PTSD), Center for Epidemiological Studies Depression Scale (CES-D Scale) to measure depression. A total of 120 patients were enrolled in the study in all the partner countries and 93 completed all follow up questionnaires. The risk of physical disability was 4.57 times higher [CI 1.98–2.27] at the first follow up and 3.43 times higher [CI 1.43–9.42] at the second follow up as compared with the time before the injury. There was a 79% and an 88% lower risk of depression at the first and the second follow up respectively, as compared with the baseline time. There was also a 72% lower risk of Post-Traumatic Stress at the second follow up as compared with the baseline time. A number of factors relevant to the individuals, the road crash and the injury, were shown to distinguish those at higher risk of long-lasting disability and psychological distress including age, marital status, type of road user, severity and type of the injury, past emotional reaction to distress. The study highlights the importance of a comprehensive and holistic understanding of the impact of injury on an individual and further underlines the importance of screening and treating psychological comorbidities in injury in a timely manner.

Introduction

A large number of road users involved in road traffic crashes recover from their injuries, but some of them never fully recover [1]. Literature shows many of them to experience some kind of permanent disability and deficits in self-reported health [1–7] as well as psychological problems including depression and Post-traumatic Stress Disorder (PTSD) [8–10]. Road traffic injuries have also been shown to place a heavy burden on households [11]. Particularly in low- and middle income countries, many families

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are driven deeper into poverty by the loss of a breadwinner, or by the expenses of prolonged medical care, or the added burden of caring for a family member who is disabled from a road traffic injury [12,13]. The economic costs also strike hard at a national level, imposing a significant burden on health, insurance and legal systems, which exceeds 5% of the GDP in low- and middle-income countries and has been estimated at approximately 2% of the GDP in EU countries [14].

Although the European Commission and the UN General Assembly have adopted Resolutions (64/255) [15] and taken action towards improving elements of post-impact care with the aim to address this growing epidemic, the attention paid by health policymakers, by the medical community and by the road safety field to trauma-related care and research has been disproportionately small so far [16–18].

In light of the aforementioned circumstances, the attention has been refocused on the plight of victims of road crashes while action has been urged in conducting more national studies on road crashes as well as in addressing the problems of under-reporting and misclassification of injuries through improvements in injury recording at hospitals and other medical institutions [19].

The current study is part of a collaborative project, which was funded by the European Commission DG Mobility and Transport (MOVE/C4/SUB/2011-294/SI2.628846/REHABIL-AID) and sought to explore the physical, psychosocial, emotional and financial sequel of the injuries sustained in road traffic crashes, one year after the crash. The REHABIL-AID project was expected to guide European policy on the complex needs of injured patients and develop an integrated and holistic response to patients' needs. Most importantly, the project was expected to produce uniform European protocols for data collection in European countries as well as increase the chances of building European estimates on the effectiveness of safety functions.

Among the objectives of the current study were to follow-up a group of road crash survivors for one year and assess the impact of injury on their psychological and physical condition, using widely recommended classifications and standardized health outcome measures. The study comes to fill a big gap in the literature, as there are very few studies examining the specific outcomes of road injury in Europe from the victims' perspective, especially for this hard-to-reach multi-trauma patient population. Although the majority of severely injured survivors recover, investigation of their profile and identification of variables that contribute to the development of post-trauma psychopathology and disability is important from a treatment perspective to reduce the burden on individual and community resources. Such empirical information is highly warranted from Europe as current evidence seems to have derived from studies with serious methodological limitations [20]. Most importantly, as the majority of empirical studies from Europe investigate the consequences of road traffic crashes immediately after the crash, this study comes to shed light to the long-term needs of the survivors during a neglected post-injury period. It further comes to produce up-to-date evidence in an area with scarce research data from the European region [4], despite the wealth of research from other geographical regions [21–23].

The current empirical work involves a carefully selected mixture of countries in southern and Western Europe, where the prevalence of injuries is above the EU average and the costs for national health budgets are very high such as in Italy and Germany [18].

Methods

Research strategy

A total of seven public hospitals were conveniently selected and involved in all the study sites; five in Greece (Region of Crete), one in Italy (Pavia) and one in Germany (Hannover). Both the intensive and the sub-intensive care units were involved in the study. Sub-intensive care refers to the second-level care, which represents the site of the most complete response to in-hospital emergency/urgency in a given territory. Second-level care includes a trauma centre, a functional aggregation of various operative units that, on the basis of established protocols, is able to deliver the quickest and most suitable treatment to patients with major injuries.

The study participants were enrolled during a 12-month period starting from April 2013. Eligibility for participation in the study was based on the following list of inclusion criteria: (a) injury of different levels of severity (based on MAIS score) and different location (based on the body region e.g. head, thorax, lower extremities) sustained at road traffic crashes (RTC) independently of the type of vehicle, (b) hospitalization $\geq$1 day in the intensive or sub-intensive care unit of the selected hospitals, (c) age $\geq$18 years, and (d) sufficient ability to communicate and understand the research questionnaires. Patients aged $<$18 years and those in coma status or death during the enrollment period were excluded from the study. Patients who accepted the invitation to participate in the study were monitored for one year after the date of admission to the intensive or sub-intensive care unit and were interviewed at three different time-points as follows: (a) at one month (baseline data), (b) at six months (1st follow up), and (c) at twelve months (2nd follow up). In addition to the self-reported information, all the eligible participants provided information drawn from their medical records.

Procedures

One or two interviewers were recruited in each study site with the task of collecting the baseline and follow up data from all the new patients. Selected health care professionals (medical doctors and nurses) were appointed in each collaborating hospital upon the consent of the hospital administration to assist the principal investigators in conducting the study. More particularly, the nurses were assigned with the task of regularly controlling for new patient admissions that fulfilled the inclusion criteria of the study and notifying the principal researchers as well as the appointed interviewers in each study site. They were also in charge of establishing the first contact with the patients and their carers and introducing the interviewer to them upon their approval. The medical doctors were assigned with the task of assisting the interviewers with recording injury-related and other medical information from patients' records. The interviewers recruited in the three study sites (Greece, Italy, Germany) received training at two different time points; the first training session had a total duration of 6 h and was delivered by the principal investigators at the beginning of the baseline data collection. The second training session had a total duration of 5 h and was delivered at the beginning of the first follow up. A manual was also developed for the training of the interviewers aiming to guide them during the data collection phase. The manual contained brief explanations of each item as well as instructions on the interview procedures and the questionnaire administration.

Data collection

All patients that were admitted in the intensive or sub-intensive care units of the selected hospitals within the 12-month enrollment period (2013–2014) and met the inclusion criteria were invited to participate in the study. Written consent was requested by all the eligible patients prior to participation in the study upon receiving information about the study objectives and procedures. All patients were informed that the completion of the questionnaire was optional, all information provided would be

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handled with confidentiality, and that the questionnaires would become available to the principal investigators only and would be strictly used for research purposes. The interviewers were notified by the appointed nurses in each hospital about new admissions and arranged a meeting at a convenient time for the patients and their carers, so that the interviewers could come and collect the baseline data. The baseline data collection was carried out either at a hospital unit (usually orthopedics or neurological clinic), where the patient was transferred after discharge from the intensive or sub-intensive care unit or at their house if no further hospitalization was needed. The first and second follow up were carried out at the patients' house upon telephone arrangement. The mean duration of the data collection was 1 h and 15′ for the baseline data and 1 h and 30′ for the follow up.

Research instruments

A self-reported questionnaire was developed to serve the purpose of the study. The questionnaire was administered by an interviewer at three different times (Months 1, 6, 12) after the injury and included the following measures:

(a) *Socio-demographic information* (e.g. gender, age, education, occupation, marital status).
(b) *Road incident characteristics* (e.g. type of road user, crash location).
(c) *Disability* was examined using the interviewer-administered 12-item version of WHODAS 2.0 'Disability Assessment Schedule II' developed by the World Health Organization (WHO) [24] to better understand the difficulties people may have due to their health conditions. This instrument measured general health and disability levels, including mental and neurological disorders, based on the International Classification of Functioning, Disability and Health (ICF). Respondents were asked to report the level of difficulty they experience while engaging in certain activities as compared with how they usually experienced these activities before their injury (e.g. in the last 30 days, how much difficulty did you have in: (a) standing for long periods such as 30 min; (b) concentrating on doing something for ten minutes; (c) getting dressed, etc.). In each item, individuals had to estimate the magnitude of the disability during the previous 30 days using a five-point scale (none = 1, mild = 2, moderate = 3, severe = 4, extreme/cannot do = 5), higher scores reflecting greater disability. Based on the WHODAS 2.0, a score ≥25 indicated the presence of disability [24].
(d) *Post-traumatic Stress Disorder* (PTSD) was assessed using the "Impact of Event Scale" (IES-R) [25], which involved two subscales; the "Intrusion Scale" (7 items) and the "Avoidance Scale" (8 items). Each question was responded using a Likert scale as follows: "0" for "not at all", 1 for "rarely", 3 for "sometimes" and 5 for "often". The "intrusion total" came from adding the scores for the 7 items (e.g. *I thought about it when I didn't mean to; I had trouble falling asleep or staying asleep, because pictures or thoughts about it came into my mind; I had dreams about it), while the "avoidance total" came from adding the scores for the 8 items (e.g. I tried to remove it from memory; I stayed away from reminders of it; I felt as if it hadn't happened or it wasn't real; I tried not to talk about it).* The intrusion and avoidance totals were added for the full total. High scores indicating more stress. A score ≥26 indicated a stressful condition [25].
(e) *Depression* was measured using the "Center for Epidemiological Studies Depression Scale (CES-D Scale), a 20-item self-report measure designed to assess depressive symptoms over the previous week, including depressed affect, lack of hope, feelings of guilt and shame, and somatic symptoms (e.g., disrupted sleep or appetite) [26]. Respondents were asked to report the frequency of experiencing certain feelings and behaviours during the past week using a frequency scale anchoring from 0 to 3 (0 = Rarely or none of the time, 1 = Some or a little of the time, 2 = Occasionally or moderate amount of time, 3 = Most or all of the time). Four items were worded positively and reverse coded. High scores indicating greater depressive symptoms. A score ≥16 indicated the presence of depression [26].
(f) *Information on the injury* was retrieved upon patients' consent, from medical records using a data extraction form. The form replicated the structure and content of the national accident and injury database in Germany (German In-Depth Accident Study, GIDAS) [27] and extracted information on the body area of the injury (head, face, neck, thorax, abdomen, spine, upper extremities, lower extremities, and external), the type and the extent of the injury as well as information on the physical condition of the patient. The Abbreviated Injury Scale (AIS) was then calculated for each participant based on AIS- 2005 (Update 2008) [28]. Each injury was assigned an AIS score on an ordinal scale ranging from 1 (minor injury) to 6 (maximum injury, possibly lethal). The abbreviated injury scale (AIS) was selected in the current study as the most widely reported severity scale. The Maximum Abbreviated Injury Scale (MAIS) was calculated for multiple injured participants. MAIS3+ was accepted as the common definition of very seriously injured at the Road Safety High Level Group organized by the European Commission, DG Mobility and Transport at Copenhagen, 27 June 2012.

Statistical analysis

The data were analyzed using STATA ® v. 12. Descriptive statistics for each scale (WHODAS 2.0, IES-R, CES-D) were performed by time, separately for each country, and for the whole sample. The Kruskal-Wallis rank sum test was used for each score of the scales to evaluate if there is a difference by country and by time of the study (baseline, 1 st follow-up, and 2nd follow-up). If Kruskal-Wallis rank sum test was statistically significant, the appropriate sign test was performed for each couple of countries, reducing the level of significance (p-value) from 0.05 to 0.017, because of the Bonferroni's correction for multiple post-hoc comparison. The sign test was carried out for each scale in order to evaluate if there is a difference by time of the study in each country, and for the whole sample. Finally, using the Friedman's test, it has been possible to underline differences for the three times together. If this test was significant, the appropriate post-hoc sign test was carried out to investigate which couple of time was different, for each country and for the whole sample, always adjusting the p-value with Bonferroni's correction (p-value ≤0.017). Logistic regression analysis was performed to identify risk factors associated with functional status after the injury. The score of each scale was split into two categories, using a cut-off that was identified as critical value, as follows: (a) Depression: based on CES-D scale, a score ≥ 16 indicated the presence of depression; (b) Disability: based on WHODAS 2.0 scale, a score ≥25 indicated the presence of disability; (c) Post-traumatic stress: based on the Impact of the event scale (IES-R), a score ≥ 26 indicated a stressful condition. The McNemar's test for paired proportion was used, to evaluate if there is a change between two time points for each outcome (baseline vs 6 months, baseline vs 12 months, 6 vs 12 months), in order to quantify the amount of the change, an odds ratio with relative confidence interval at 95% was reported. For each score at 6 months, the subjects with outcome were described

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through some medical and crash and injury-related information and the best models were performed to underline which characteristics are relevant to the rehabilitation process. Logistic regression analyses to identify risk factors associated with functional status after the crash were carried out. Odds-ratios and their 95% confidence interval, were derived from the logistic regression analysis. Due to the sample size reduction in each time of the study we could include in the model only few independent variables, in order to get a valid model. In each model the explicative variables change according to their statistical significant to obtain the best fit.

Results

Participants' profile and flow in the study

A total of 239 persons (52 Crete, Greece; 131 Hannover, Germany; 56 Pavia, Italy) were admitted in the ICU of the three study sites due to injuries caused in a road traffic accident during a 12-month period within 2013–2014. Out of the persons recorded during that one-year period, a total of 120 persons were enrolled in the study (Greece = 41, Germany = 39, Italy = 40) (due to refusals, deaths and low communication level). Out of the 120 persons that enrolled in the study, a total of 93 persons provided full self-reported data through completing all the three follow up questionnaires. Detailed information on the flow of the participants in the study is shown in Fig. 1. As regards to the personal and injury-related characteristics of the participants enrolled in the study, a total of 93 participants (77.5%) were men with a mean age of 41.8 years (SD 16.7). Fifty nine participants (49.2%) obtained high education and similar proportion was married or cohabitated with someone (n = 65, 54.2%). A total of 40 participants (33.3%) sustained the injury as motorcyclists and equal proportion of participants was injured as drivers of motorized four-wheel vehicles (n = 40, 33.3%). Forty eight participants (40.0%) sustained the injury in city roads and a similar proportion of participants were injured in rural roads (n = 41, 34.2%). A great amount of road crashes occurred at a straight road. Half of the injuries were classified as 'MAIS-3' (n = 60, 50.0%), most of them involved multiple fractures and the most severe injuries in multi-trauma patients were located at the lower extremities. Details on the socio-demographic, road-incident and injury-related information are presented in Table 1.

Physical disability and psychological distress by country over time

Physical disability

A less favourable performance was evident among the Greek participants in item DA13 (level of difficulties' interference with life) and DA15 (number of days totally unable to carry out usual activities or work due to health condition) at the second follow up as compared with the first follow up, and this difference was statistically significant. No other statistically significant differences were evident in the performance of the Greek participants over time. The German and the Italian participants performed worse in most of the "Physical disability" scales in both the first and the second follow up as compared with the baseline, with the only exemption of DA16 for Germany (number of days the person cut back or reduce usual activities or work due to health condition) and DA15 for Italy (number of days totally unable to carry out usual activities or work due to health condition), which did not change significantly over time. The German participants were the only ones who showed evidence of improved performance in the second follow up as compared with the first follow up and only in

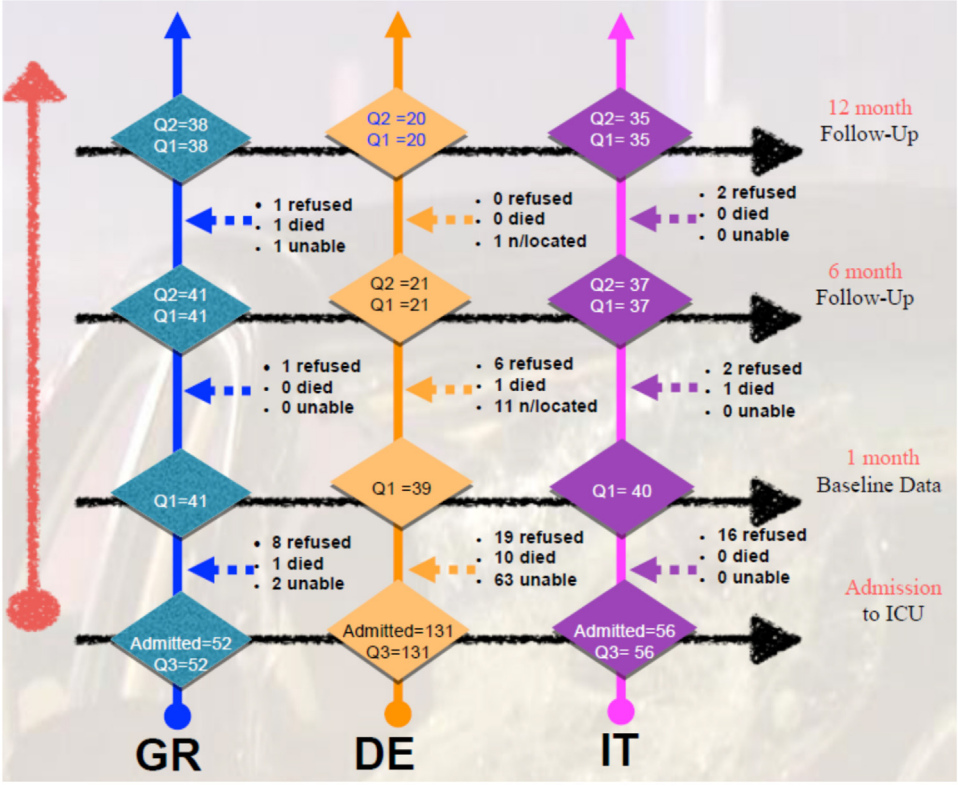

Fig. 1. Participants' flow in the study based on the assessment of costs.

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Table 1
Participants' socio-demographic and injury profile.

	Greece		Germany		Italy		Total	
	n	%	N	%	n	%	n	%
Socio-demographic information								
Gender								
Men	36	87.8	27	69.2	30	75.0	93	77.5
Women	5	12.2	12	30.8	10	25.0	27	22.5
Age (in years)[a]	35.9 (SD15.9)		42.7 (SD16.4)		47.0 (SD16.4)		41.8 (SD16.7)	
Marital status								
Single	21	51.2	9	23.1	11	27.5	41	34.2
Married/cohabitating	15	36.6	27	69.2	23	57.5	65	54.2
Divorced	4	9.8	1	2.6	4	10.0	9	7.5
Widow	1	2.4	2	5.1	2	5.0	5	4.1
Education								
Low (primary education)	33	80.5	2	5.1	12	30.0	47	39.2
High (secondary education)	8	19.5	30	76.9	21	52.5	59	49.2
Higher education	0	0.0	7	18.0	7	17.5	14	11.6
Road incident information								
Type of road user								
Pedestrian	2	4.9	5	12.8	7	17.5	14	11.7
Cyclist	1	2.4	3	7.7	10	25.0	14	11.7
Motorcyclist	20	48.8	12	30.8	8	20.0	40	33.3
Driver 4-wheel	14	34.1	16	41.0	10	25.0	40	33.3
Passenger 4-wheel	4	9.8	3	7.7	5	12.5	12	10.0
Type of road								
City road (in urban areas)	21	51.2	11	28.2	16	40.0	48	40.0
Rural road (in rural areas)	1	2.4	20	51.3	20	50.0	41	34.2
Highway	14	34.1	7	17.9	1	2.5	22	18.3
Other	5	12.2	1	2.6	3	7.5	9	7.5
Crash location								
Intersection	3	7.3	5	12.8	6	15.0	14	11.7
Straight road	24	58.5	28	71.8	24	60.0	76	63.3
On bends	13	31.7	0	0.0	8	20.0	21	17.5
Parking	0	0.0	4	10.3	2	5.0	6	5.0
Other	1	2.4	2	5.1	0	0.0	3	2.5
Injury-related information								
Max. AIS score[b]								
MAIS-1	2	4.9	0	0.0	0	0.0	2	1.7
MAIS-2	11	26.8	6	15.4	17	42.5	34	28.3
MAIS-3	25	61.0	22	56.4	13	32.5	60	50.0
MAIS ≥ 4	2	4.8	11	28.2	10	25.0	23	19.1
Fractures								
Single	5	12.5	2	5.1	4	10.0	11	9.2
Multiple	35	87.5	37	94.9	36	90.0	108	90.8
MAIS score & body region[c]								
Head	25	61.0	7	18.0	9	22.5	41	34.2
Face	1	2.4	3	7.7	2	5.0	6	5.0
Thorax	7	17.1	23	59.0	5	12.5	35	29.2
Abdomen	6	14.6	4	10.3	1	2.5	11	9.2
Spine	2	4.9	3	7.7	7	17.5	12	10.0
Lower extremities	10	24.4	15	38.5	19	47.5	44	36.7
Upper extremities	3	7.3	1	2.6	4	10.0	8	6.7

[a] Mean, Standard Deviation.
[b] AIS code was not possible for one subject.
[c] Based on total of subject for each country and for entire sample.

the case of the DA score (DA1-DA12). Details on the participants' performance in the "Physical disability" scales over time are presented in Table 2.

Post-traumatic stress

No statistically significant differences were found in the performance of the German participants in any of the two "IES-R" subsets over time. On the contrary, a more favourable performance was evident in the Greek participants in the "intrusion" subset both at the first and the second follow up. In the case of the Greek and the Italian participants, performance in the "intrusion" subset was significantly improved at the second follow up as compared with the baseline. Details on the participants' performance in the "IES-R" scales over time are presented in Table 2.

Depression

The Greek and the Italian participants performed more favourably in the "CES-D" scale in both the first and the second follow up as compared with the baseline. The Greek participants were the only ones who showed evidence of improved performance in the second follow up as compared with the first follow up, while no significant changes were evident in the performance of the German participants over time. Details on the participants' performance in the "CES-D" scales over time are presented in Table 2.

Risk of physical disability and psychological distress over time

The percentage of participants with physical disability (WHO-DAS score $\geq$25) increased at the first follow up and decreased at the

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Table 2
Changes in the overall scores of "Physical disability", "IES-R" and "CES-D" by time and country.

Differences by time	Baseline	1st FUP	2nd FUP	Friedman		Baseline–1st FUP	Baseline–2nd FUP	1st FUP–2nd FUP
	n	n	n	test	p-value	p-value	p-value	p-value
Greece								
DA1-DA12	35	36	37	1.1	0.565	n.s.	n.s.	n.s.
DA13	35	36	37	1.3	0.519			
DA14	35	35	36	0.6	0.742			
DA15	35	35	36	1.6	0.457			
DA16	35	35	36	0.7	0.707			
IES-R Avoidance subset	32	33	35	5.4	0.067	n.s.	n.s.	n.s.
IES-R Intrusion subset	32	33	35	29.0	<0.001	0.006	<0.001	<0.001
Total IES-R score	32	33	35	24.7	<0.001	0.004	<0.001	<0.001
CES-D score	33	33	35	28.1	<0.001	<0.001	<0.001	0.009
Germany								
DA1-DA12	38	21	20	19.7	<0.001	<0.001	0.001	0.004
DA13	39	21	19	13.4	0.001	0.001	0.004	n.s.
DA14	39	21	20	14.4	<0.001	<0.001	0.004	
DA15	39	21	20	10.0	0.007	0.002	0.003	
DA16	39	21	20	5.4	0.066	n.s.	n.s.	
IES-R Avoidance subset	36	21	20	4.5	0.104	n.s.	n.s.	n.s.
IES-R Intrusion subset	36	21	20	5.4	0.066			
Total IES-R score	36	21	20	4.8	0.092			
CES-D score	33	21	20	6.4	0.040	n.s.	n.s.	n.s.
Italy								
DA1-DA12	40	37	35	37.5	<0.001	<0.001	<0.001	n.s.
DA13	40	37	35	24.7	<0.001	<0.001	<0.001	
DA14	40	37	35	25.8	<0.001	<0.001	<0.001	
DA15	40	37	35	1.6	0.453	n.s.	n.s.	
DA16	40	37	35	20.8	<0.001	<0.001	<0.001	
IES-R Avoidance subset	40	37	35	2.10	0.350	n.s.	n.s.	n.s.
IES-R Intrusion subset	40	37	35	9.8	0.007	n.s.	0.017	
Total IES-R score	40	37	35	6.7	0.035*	n.s.	n.s.	
CES-D score	39	37	35	16.2	<0.001	<0.001	0.006	n.s.

n.s.= not significant; Friedman test.

second follow up. The risk of physical disability was 4.57 times higher at the first follow up and 3.43 times higher at the second follow up as compared with the baseline time (before the injury). The risk of physical disability was lower by 75% at the second follow up as compared with the first follow up.

On the other hand, the percentage of people with depression (CES-D $\geq$16) and PTSD (IES-R $\geq$ 26) was lower at the first and the second follow up as compared with the baseline time (immediately after the injury) ($p < 0.001$). There was a 79% and an 88% lower risk of depression at the first and the second follow up respectively, as compared with the baseline time. Furthermore, the results showed an 80% lower risk of depression at the second follow up as compared with the first follow up.

Overall, the impact of the injury at the second follow up was lower by 72% than the baseline time and by 94% as compared with the first follow up. Details on the prevalence and risk of physical disability and psychological distress over time are presented in Table 3.

Factors that increase the likelihood of physical disability and psychological distress over time

Six months after the injury (1st follow up)

The results of the logistic regression showed that the risk of presenting physical disability 6 months after the injury was 5.27 times higher for participants assigned a MAIS score equal or higher than 4 points ($p = 0.018$) and 3.09 times higher for participants sustaining injuries with the MAIS score in the low extremities as compared with those sustaining injuries with MAIS score in another body regions ($p = 0.019$). Likewise, the risk of being affected by post-traumatic stress 6 months after the injury was found to be 2.84 times higher for participants who sustained injuries with the MAIS score in the low extremities ($p = 0.033$) and 3.23 times higher for the participants who were affected by post-traumatic stress at baseline ($p = 0.015$). Finally, the risk of presenting depression 6 months after the injury was 4.77 times higher for the participants who were affected by depression at

Table 3
Prevalence and risk of physical disability and psychological distress over time.

	Participants with symptoms at different time points				Participants with symptoms–differences over time				
	Baseline n (%)	1st FUP n (%)	2nd FUP n (%)	Baseline–1st FUP McNemar *p*-value	OR [CI 95%]	Baseline–2nd FUP McNemar *p*-value	OR [CI 95%]	1st FUP–2nd FUP McNemar *p*-value	OR [CI 95%]
Physical Disability	9 (8.0)	38 (40.4)	28 (30.4)	<**0.001**	4.57 [1.98–12.27]	**0.003**	3.43 [1.43–9. 42]	**0.035**	0.25 [0.05–0.93]
Post traumatic stress	47 (43.5)	36 (39.6)	19 (21.1)	**0.078**	n.s.	<**0.001**	0.28 [0.12–0.60]	<**0.001**	0.06 [0.01–0.40]
Depression	57 (54.3)	30 (33.0)	21 (23.3)	<**0.001**	0.21 [0.07–0.51]	<**0.001**	0.12 [0.03–0.34]	**0.039**	0.20 [0.02–0.94]

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Table 4
Factors that had an influence on physical disability and psychological distress six months after the injury.

1st FUP	Physical disability n = 89	Post-traumatic stress n = 86	Depression n = 84
	OR [CI 95%] *p*-value		
Marital Status			
In couple vs single			1.24 [0.36–4.21] 0.733
Divorced/widow vs single	n.s.	n.s.	7.49 [1.44–38.99] 0.017
Education			
High vs low education			0.34 [0.11–1.08] 0.067
Higher vs low education	n.s.	n.s.	3.44 [0.56–21.2] 0.183
Symptom present at baseline	0.5 [0.08–2.94] 0.420	3.23 [1.25–8.33] 0.015	4.77 [1.39–16.4] 0.013
Max AIS Score			
MAIS-3 Vs MAIS-1or MAIS-2	2.06 [0.70–6.17] 0.194	n.s.	n.s.
MAIS ≥ 4 Vs MAIS-1or MAIS-2	5.27 [1.33–20.77] 0.018		
Max AIS score in low extremities region	3.09 [1.21–7.91] 0.019	2.84 [1.09–7.41] 0.033	n.s.

baseline (p = 0.013) and 7.49 times higher for the participants who were divorced or widow (p = 0.017). Details on the factors affecting disability and distress at the first follow up are shown in Table 4.

Twelve months after the injury (2nd follow up)

The second model of logistic regression analysis indicated that the risk of developing a physical disability 12 months after the injury was 4.40 times higher for people that reported injuries with the MAIS score who in the low extremities (p = 0.007), and 13.48 times higher for divorced or widowed people with the respect to single people (p = 0.003). Similarly, the risk of being affected by post-traumatic stress due to the crash 12 months after is 4.31 times higher for participants who sustained injuries with the MAIS score in the low extremities compared to other people(p = 0.011). Finally, the risk of being affected by depression 12 months from crash was 3.70 times higher if subject were depressed at baseline (p = 0.061); moreover, there is a significant decreased risk of developing depression, 87% for people in a 4 wheel motorized vehicle with respect to pedestrians or cyclists (p = 0.008). Furthermore, the risk of having depression at 12 months increased by 5% when the age increased by one year (p = 0.036). Details on the factors affecting disability and distress at the second follow up are shown in Table 5.

Discussion

This study is one of the few existing studies in Europe exploring the long term burden of patients admitted to intensive care units of public hospitals due to severe injuries sustained in road traffic

Table 5
Factors that had an influence on physical disability and psychological distress twelve months after the injury.

2nd FUP	Physical disability n = 82	Post-traumatic stress n = 77	Depression n = 81
	OR [CI 95%] p-value		
Age	n.s.	n.s.	1.05 [1.00–1.10] 0.036
Marital Status			
In couple vs single	1.56 [0.46–5.32] 0.480		
Divorced/widow vs single	13.48 [2.43–74.81] 0.003	n.s.	n.s.
Symptom present at baseline	0.73 [0.12–4.42] 0.731	0.95 [0.31–2.90] 0.931	3.70 [0.94–14.58] 0.061
Max AIS Score			
MAIS-3 Vs MAIS-1or MAIS-2	n.s.	n.s.	0.28 [0.07–1.20] 0.087
MAIS ≥ 4 Vs MAIS-1or MAIS-2			2.11 [0.40–11.17] 0.379
Max AIS score in low extremities region	4.40 [1.49–12.96] 0.007	4.31 [1.40–13.3] 0.011	n.s.
Type of road users in the crash			
Two-wheels motorized vs Pedestrian and Cyclists	n.s.	n.s.	1.20 [0.25–5.76] 0.822
Four-wheels motorized vs Pedestrian and Cyclists			0.13 [0.03–0.59] 0.008

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crashes. Despite the small number of patients enrolled in the three partner countries, the study has managed to replicate existing evidence from other countries, primarily from Australia and US, on the huge burden that follows an injury and the factors that influence the recovery process. Attempting an interpretation of these findings in terms of their clinical importance, would probably be not meaningful enough given the small number of recruited participants. The study however has managed to generate evidence on the profile of patients highly affected, which is very important for policy makers to effectively meet their needs. This policy perspective is highly emphasized throughout the discussion.

Prevalence of physical disability and psychological distress one year after the injury

What stands out of the results of this study is the fact that people sustaining severe injuries in road traffic crashes were shown to shoulder a psychological burden, as one in every two patients developed symptoms of serious psychological distress directly after the injury. Other studies of patients sustaining injuries in road traffic crashes have shown the rates of PTSD to anchor between 6 and 45% [29], the incidence of depressive symptoms to be 10% [30], anxiety symptoms 36% [31], and travel phobia 20% [31]. This finding is potentially explained by the increased fragility linked with hospitalization in the intensive care unit (ICU). In particular, it has been noted that there are several factors in ICU that make individuals more psychologically fragile, such as a real or potential risk of death, the aggressiveness of many life-saving therapies (intubation, ventilation), the iatrogenic effects of some medications (such as high doses of benzodiazepines or opiates), the severity of disease, or the extreme conditions associated with the hospitalization (eg, lack of communication due to orotracheal intubation, separation from loved ones, noisy equipment, permanent harsh lighting, patients who are tied down) [32].

What is most striking is the fact that the current study acknowledged a great proportion of patients maintaining high levels of psychological distress and physical disability one year after the injury. Although someone would expect that "time heals all wounds", 20–25% of patients in the current study reported high levels of psychological distress one year after the traumatic event and more than 30% reported physical disability at the same time. Although it sounds surprising, there is some research in accordance with our finding [17,33–35]. For example, an 18-month follow-up study of young victims of road traffic crashes revealed that although the levels of post-traumatic stress decreased from 2 to 16 days to 12–15 weeks, no change in the levels of stress was detected from the second assessment to 18 months, when one-third of the victims still displayed moderate or severe PTSD symptoms [36]. In an attempt to explain this long lasting burden, it has been suggested that there are certain conditions delaying the process of psychological recovery in patients hospitalized in ICU such as the slow physical recovery but also the lack of certain defense mechanisms used by the patient, such as active coping, positive reframing, humor, acceptance, optimism, engagement in leisure activities, and familial support [31]. In this study a high proportion of patients maintained physical disability 6 and 12 months after the injury and this could imply a slow recovery process and potentially justify high associated distress. This finding further underscores the need of follow-up consultation after discharge from the ICU, which could serve as an early stage intervention capable of preventing long lasting distress. It should be however noted that one-session based psychological debriefing was not shown in previous research to be sufficient for the victims of road traffic crashes [37]. A more systematic and comprehensive approach seems to be necessary for the psychological support of the victims in the post-traumatic period [38].

Factors related to long-lasting disability and psychological distress

Interestingly, a number of factors relevant to the individuals, the road incident and the injury, were shown to distinguish those at higher risk of long-lasting disability and psychological distress. The severity and the type of injury were shown to have such an effect, with patients sustaining injuries of higher severity scores and those with lower limb involvement running an increased risk of physical disability and distress 6 and 12 months after the injury. Previous research has produced similar outcomes with victims suffering lower limb involvement to face long-lasting restrictions in daily life [39] and those suffering injuries of high severity at the time of the crash, reporting more frequently poor physical outcomes at one year [40,41] and deteriorated physical health at 6 months [42] as well as disabling illness and psychological distress [43]. It has been noted that the effect of injury severity particularly on emotional distress is complex because they have direct effects on fear of dying, and fear of dying has direct effects on feeling anxious/fearful and depressed/sad but also has a direct effect on peritraumatic dissociation [44].

Another important finding of this study was related to the initial psychological response to the injury, which appeared to be a vulnerability factor for maintaining psychological distress 6 and 12 months after the injury. It has been shown in previous research that emotional problems even before experiencing the road traffic crash is a factor that could affect the development of emotional problems after the injury [45]. This study did not collect information about past emotional problems as there was a potential for this information to be confounded by the current psychological distress due to the critical condition of the patients. However, the study identified the vulnerability of those affected by psychological distress immediately after the injury and this could be important information to guide initial treatment and early stage intervention.

In agreement with previous research [40,42,43,46,47], our study demonstrated that older subjects were most at risk of long-lasting distress. Likewise, cyclists and pedestrians were shown in the current study to be types of road users most at risk of poor outcome 12 months after the injury. This factor has been shown in the literature as a predictive factor for consequences, with the types most at risk of poor outcome being 2-wheel drivers [47] and pedestrians [40]. Experience of high severity injuries in these types of road users may well explain the long-lasting distress. In general, individual characteristics such as the age and the type of road user could serve as identifiers of patients susceptible to long-lasting outcomes and serve as a screening tool capable to direct certain groups of victims to more personalized treatment options. Early and targeted treatment of susceptible individuals could reduce the enormous costs of long-lasting outcomes to victims and the health care systems.

Policy implications

The aforementioned findings are quite alarming and bring into our attention several policy gaps relevant to the organization of the trauma care in Europe, the levels of investment in the trauma care infrastructure, the level of maturation of trauma systems and the level of enhancement of care protocols. Where does Europe stand? Have we invested sufficiently on post-trauma care? Have we evaluated the effectiveness of trauma care systems in terms of sufficiently addressing patients' needs? There is still evidence showing that the composition of the health care providers treating trauma patients differs from country to country and that the level of

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training and the degree of professionalism involved shows wide variation [48,49]. There is also evidence indicating that urban settings are more prepared to treat trauma patients that rural settings and this is very critical for patient safety and outcomes [50].

Despite these regional variations in the treatment of trauma, it has been noted that post-impact care is often neglected in national road safety plans and programmes in European countries because it is outside the direct responsibility of the lead agency for road safety, which is generally the Ministry of Transport [16]. It has also been argued that the financial crisis in many European countries could entail the risk that road safety measures are abandoned due to lack of resources [50]. Is that argument enough to explain the shortcomings in post-traumatic care in Europe? Could it be also a matter of political priorities with some countries assigning less importance to road safety and post-traumatic care of the victims? Greece for example, in contrast with Germany and Italy, lacks an organized trauma system at the present moment and this is a serious shortcoming preventing optimized care and outcomes for trauma patients [49,50]. Is it the crisis that still prevents Greece from seeking a more organized response to prevention and post-traumatic care given the fact that for many years or decades Greece is one of the leading countries in Europe in road fatalities? We think that European policy needs to put a priority to effective prevention and treatment of road injury as it will soon be the leading cause of death [47]. We further underline the need for Europe to seek for a higher level of uniformity regarding trauma monitoring and treatment and we see plenty of opportunities for such an effort in using many of the good practices that have been reported and could be replicated to countries with less organized systems of care.

Study limitations

A number of limitations to the study were apparent. The results are subject to response bias and recall bias, particularly in the reporting of pre-crash health. That pre-crash health was examined prior to discharge and were the first questions of the interview, while not ideal, is arguably the best available option, particularly as the WHODAS 2.0 score has excellent reliability and validity for the past four weeks. Nevertheless, psychological condition was not assessed at pre-injury level to avoid patients' subjective assessment without psychiatric assessment. Given the limited number of hospitals involved in the study, it is unlikely that the sample is representative of the state-wide population involved in traffic crashes. However, this was not designed as an epidemiological study but as a multi-country study that sought to describe the long term burden of people sustaining severe injuries in road traffic crashes. Furthermore, fatality crashes were deliberately excluded from the study due to their unique outcomes and requirements. If victims of fatal crashes were included in the sample, a different victim profile and overall burden might have been revealed. Lastly, we can't overlook the high drop-out rate at the German site, due to some patients' refusal to continue and the strict confidentiality regulations activated upon their transfer of other patients to their home cities/countries, which resulted in the researchers' inability to trace them. A lower drop-out rate could have resulted in different victims' profile in Germany. However, this was highly expected as according to the hospital protocol, seriously injured trauma patients are stabilized at the hospital and then transported to a certified trauma unit. Besides that, the specific Germany hospital serves many international patients who are then transferred to their home cities/countries.

Conclusion

This study has managed to uncover the huge and long-lasting disability and psychological burden shouldered by patients sustaining severe injuries in road traffic crashes. It was evident from the results that a significant percentage of patients not only do not recover one year after the injury but suffer great disability and psychopathology, which potentially prevent them from returning to normality. This comes to highlight the importance of a comprehensive and holistic understanding of the impact of injury on an individual. It further underlines the importance of screening and treating psychological comorbidities in injury in a timely manner to avoid long lasting disability and prevent the potential impact on recovery. The factors that were identified as individual risk factors related to people's tendency to maintain distress and disability over time, could be assessed in the early stages of recovery to direct these individuals to specialized treatment options and care. These individual difference factors should be taken into account in the rehabilitation programme. Future research could employ larger samples of patients to increase our understanding on the role of these factors on the recovery process. Last but not least, it is important to mention that many countries, particularly in the Southern European region, have neither a full national programme to promote road safety and rehabilitation of injured people nor a multidisciplinary national body under mandate to monitor road injuries and to develop and coordinate the implementation of preventive or intervention programmes. Thus, the need for developing measures and specific methodologies to reduce the incidence of road injuries, and help in maintaining good health of the individual and society, is demonstrated in the current study.

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Competing interest

None.

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