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DOUTORAMENTO EM CIÊNCIAS FORENSES – RAMO MEDICINA LEGAL

Personal Injury Assessment in the Setting of Road Traffic Accidents.

Contribution to Older Adults and Children's Medico-Legal Evaluation.

Flávia da Cunha Diniz

D
2023

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D. FMUP 2023

DISSERTAÇÃO DE CANDIDATURA AO GRAU DE DOUTOR EM CIÊNCIAS FORENSES – RAMO MEDICINA LEGAL APRESENTADA À FACULDADE DE MEDICINA DA UNIVERSIDADE DO PORTO

FLÁVIA DA CUNHA DINIZ

PERSONAL INJURY ASSESSMENT IN THE SETTING OF ROAD TRAFFIC ACCIDENTS.

CONTRIBUTION TO OLDER ADULTS AND CHILDREN'S MEDICO-LEGAL EVALUATION.

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COORIENTADOR – Professor Doutor Tiago Salgado Magalhães Taveira Gomes (Professor Auxiliar Convidado da Faculdade de Medicina da Universidade do Porto)

Porto, 2023

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assunto

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"***We should be taught not to wait for inspiration to start a thing. Action always generates inspiration. Inspiration seldom generates action.***"

Frank Tibolt

Aos meus pais.

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Este caminho não é apenas meu, é sobretudo Teu, meu Deus, pois eu sei que este jamais seria possível sem a Tua ajuda e vontade.

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ORIGINAL PUBLICATIONS

This Thesis includes original papers published or submitted for publication in peer-reviewed journals. The complete list of publications is presented below. The articles under evaluation are marked with (*).

Paper 1

Flávia Cunha-Diniz, Tiago Taveira-Gomes, José Manuel Teixeira & Teresa Magalhães (2022) Trauma outcomes in non-fatal road traffic accidents: a Portuguese medico-legal approach. Forensic Sciences Research, 2022. 7:3, 528-539, DOI: 10.1080/20961790.2022.2031548 [1]. (Impact score 2022: 3.79, Q1 – Pathology and Forensic Medicine)

Paper 2

Flávia Cunha-Diniz, Tiago Taveira-Gomes, Agostinho Santos, José Manuel Teixeira & Teresa Magalhães (2023). Are There Any Differences in Road Traffic Injury Outcomes between Older and Younger Adults? Setting the Grounds for Posttraumatic Senior Personal Injury Assessment Guidelines. Journal of Clinical Medicine, 2023. 12(6): p. 2353, DOI: 10.3390/jcm12062353 [2]. (Impact score 2022: 4.81, Q1 – Medicine Miscellaneous)

Paper 3

Flávia Cunha-Diniz, Tiago Taveira-Gomes, José Manuel Teixeira & Teresa Magalhães. Children outcomes in road traffic accidents: Challenges for personal injury assessment. (Submitted to Forensic Sciences Research on 22/12/2022; Accepted on 03/08/2023. Impact score 2022: 3.79, Q1 – Pathology and Forensic Medicine)

Art.º 48º, parágrafo 3º - "A Faculdade não responde pelas doutrinas expendidas na dissertação." (Regulamento da Faculdade de Medicina da Universidade do Porto – Decreto-Lei n.º 19337 de 29 de janeiro de 1931).

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LIST OF ABBREVIATIONS

$\overline{X}$	Average / Mean
3D	Three-Dimensional
CDDS	California Department of Developmental Services
CEREDOC	*Confédération Européenne d'Experts en Évaluation et Réparation du Dommage Corporel*
CI	Confidence Interval
DPVAT	*Danos Pessoais causados por Veículos Automotores de via Terrestre*
EU	Europe Union
FD	Future Damage
G1	Analysed age group sample
G2	Control age group sample
GNP	Gross National Product
ICD-10	International Classification of Diseases – 10th revision
IHA	Inventory for Handicap Assessment
INMLCF	National Institute of Legal Medicine and Forensic Sciences
ISS	Injury Severity Score
Max	Maximum
Min	Minimum
OR	Odds Ratio
p	p-value
PAD	Permanent Aesthetic Damage
PFD	Permanent Functional Deficit
PIA	Personal Injury Assessment
PPR	Permanent Professional Repercussions
PRSA	Permanent Repercussion on Sexual Activity
PRSLA	Permanent Repercussion on Sporting and Leisure Activities
QD	*Quantum Doloris*
RTA	Road Traffic Accident
TBI	Traumatic Brain Injuries
TBIMS	Traumatic Brain Injury Model Systems
US$	American dollar
WHO	World Health Organization

RESUMO

Introdução geral: Os acidentes de viação representam um grave problema com alto impacto na saúde e a nível social, legal e económico para as vítimas e seus familiares, bem como para toda a sociedade. São causa de milhões de mortes por ano em todo o mundo e as vítimas de lesões não fatais revelam consequências significativas a curto e longo prazo, com afetação da sua funcionalidade e qualidade de vida. A avaliação médico-legal do dano na pessoa pós-traumático constitui um momento relevante da intervenção nestes casos. Para além de contribuir para a justa e útil reparação dos danos (numa perspetiva legal), contribui, também, para a promoção da saúde. Neste último caso, a saúde é promovida através da perceção da vítima e de seus familiares, de que foi feita a justiça, bem como através do contributo da perícia médico-legal para assegurar o objetivo de reabilitação e reintegração familiar, social e profissional ou de formação (conforme o caso) da vítima. No entanto, existem diversas situações em que esta avaliação do dano é particularmente complexa, não estando disponíveis orientações/guidelines para a sua realização. Um exemplo destes casos é a avaliação no extremo das idades: nos adultos mais velhos e nas crianças.

Objetivos: Este estudo tem como objetivo geral produzir evidência sobre as diferenças e especificidades das consequências pós-traumáticas dos acidentes de viação não-fatais no caso de adultos mais velhos e crianças. Pretende-se, com isto, contribuir para melhor orientar a avaliação do dano na pessoa nestes casos, abrindo caminho à elaboração de futuras orientações/guidelines. Os objetivos específicos são: (a) Analisar as consequências temporárias e permanentes, considerando a faixa etária e o sexo das vítimas, utilizando as normas médico-legais portuguesas para a avaliação do dano na pessoa; (b) Analisar as diferenças entre uma população de adultos mais velhos e outra de adultos jovens e de meia-idade; (c) Analisar as diferenças entre uma população de crianças e outra de adultos jovens e de meia-idade.

Material e métodos: Realizaram-se três estudos retrospetivos, partindo de amostras de conveniência, com base em relatórios médico-legais de avaliação do dano na pessoa em direito civil, relativos a vítimas de acidentes de viação, elaborados numa empresa de seguros portuguesa. A base de dados relativa a cada um dos estudos, foi elaborada pela médica que orientou esta investigação e que realizou a maior parte das perícias. Para os estudos, consideraram-se três faixas etárias: (a) crianças (<18 anos); (b) adultos jovens e de meia-idade (18-64 anos); e (c) adultos mais velhos (>64 anos). No primeiro estudo usou-se uma população total de 667 indivíduos. Nos segundo e terceiro estudos, as

amostras de adultos jovens e de meia-idade foram pareados com as amostras de adultos mais velhos (n=239) e de crianças (n=114), respetivamente, considerando a pontuação de gravidade das lesões (*Injury Severity Score* – ISS). De uma forma genérica, os critérios de inclusão foram os seguintes: (a) relatório médico-legal final sobre vítimas de acidentes de viação, com nexo de causalidade entre o trauma e o dano estabelecido; (b) realizada numa unidade de saúde de uma companhia de seguros portuguesa; (c) ocorrido entre 2018 e 2020; e (d) realizada por três médicos selecionados, com especialização em medicina legal e alta experiência em avaliação do dano na pessoa, para garantir a confiabilidade dos dados. Para a descrição das consequências permanentes utilizou-se a metodologia de *avaliação tridimensional* do dano na pessoa. Para a quantificação da gravidade destas sequelas, usou-se o *Inventário para Avaliação do Dano Corporal*. Para a quantificação dos parâmetros de danos temporários e permanentes, seguiram-se as normas do Instituto Nacional de Medicina Legal e Ciências Forenses de Portugal. Para análise estatística utilizou-se, no primeiro estudo: (a) estatística descritiva, caracterizando-se a população, total e estratificada por idade e sexo; (b) teste qui-quadrado, para avaliar a dependência entre as variáveis de frequência; (c) teste-t de Student, para verificar diferenças entre as variáveis. Nos segundo e terceiro estudos utilizou-se: (a) estatística descritiva, para caracterizar a população, total e estratificada por idade; (b) teste qui-quadrado, para avaliar a dependência entre as variáveis de frequência; (c) regressão logística, para estimar o odds ratio (OR), considerando o intervalo de confiança de 95% (IC 95%) para todas as medidas de efeito analisadas. Em todas as análises, o nível de significância estatística foi considerado $p<0.05$.

Resultados: No primeiro estudo, não foram encontradas diferenças entre os sexos para os danos temporários e permanentes. Foram, no entanto, encontradas diferenças entre as idades, relativamente ao grupo dos adultos mais velhos e das crianças, quando comparados com os adultos jovens e de meia-idade, respetivamente. No segundo estudo, os adultos mais velhos revelaram uma evolução significativamente mais grave das consequências permanentes, em relação aos adultos jovens e de meia-idade; estas consequências verificaram-se a nível *corporal*, *funcional* e *situacional*, bem como do *coeficiente de dano*; no entanto, não se encontraram diferenças significativas em relação aos parâmetros de dano, designadamente para o *Déficit Funcional Permanente*. No terceiro estudo, as crianças revelaram uma evolução significativamente mais favorável das consequências permanentes, em relação aos adultos jovens e de meia-idade, quer no que se refere à *avaliação tridimensional do dano*, quer relativamente ao *Déficit*

Funcional Permanente; verificou-se, contudo, que os resultados podem variar de acordo com o tipo de lesão, e o consequente tempo necessário para a sua consolidação médico-legal e a última avaliação pericial.

Discussão e Conclusão: Com base nos resultados destes estudos, foram encontradas especificidades nas extremidades dos grupos etários, na sequência do que, e de uma forma genérica, se identificaram como os principais desafios, os aspetos relacionados com: (a) a ausência frequente do estado fisiológico e de saúde anterior; (b) a determinação do link causal médico; (c) a determinação da data de consolidação; (d) a decisão sobre a data final da PIA; (e) o uso exclusivo frequente de tabelas de incapacidade permanente para avaliar o déficit funcional permanente; (f) a ausência de uma avaliação multidimensional e transdisciplinar nos casos mais complexos, a saber, identificar as necessidades permanentes; e (g) a ausência de estudos portugueses para determinar a sobrevivência a longo prazo após lesões traumáticas graves. Estas especificidades, que simultaneamente constituem dificuldades para os peritos médicos que realizam a avaliação do dano pós-traumático na pessoa, carecem de mais investimento a nível da investigação científica, tendo em vista a criação de orientações/guidelines sólidas para este tipo de perícias.

ABSTRACT

General introduction: Road traffic accidents (RTA) represent a severe problem with a high health, social, legal, and economic impact on victims, their families, and society as a whole. RTA produce millions of deaths worldwide annually, and the RTA's non-fatal injuries victims have significant short- and long-term consequences, affecting their functionality and quality of life. The posttraumatic personal injury assessment (PIA) is a relevant moment of intervention in these cases. In addition to contributing to the fair and proper repair of damages (from a legal perspective), it also contributes to health promotion. Health promotion occurs through the perception, by the victims and their family members, that justice has been done, as well as through the medico-legal expertise contribution ensuring the victim's rehabilitation and family, social and professional, or training reintegration (according to the case). However, there are several situations where PIA is particularly complex, and guidelines are unavailable. An example of these cases is the assessment at the extreme of age: in older adults and children.

Objectives: This study has the general objective of producing evidence on the differences and specificities of posttraumatic outcomes in non-fatal RTA cases of older adults and children, aiming to better guide personal injury assessment (PIA) in these cases and to contribute to the elaboration of future guidelines in each age group. The specific objectives are, for victims of non-fatal RTA: (a) to analyse the temporary and permanent outcomes, considering the victim's age group and sex, using Portuguese medico-legal rules for PIA; (b) to analyse the differences between older adults and young- and middle-aged adults populations; (c) to analyse the differences between children and young- and middle-aged adult populations.

Material and methods: Three retrospective studies were conducted using convenience samples based on medico-legal reports of PIA cases in civil law related to RTA victims performed in a Portuguese insurance company. The database for each of the studies was prepared by the physician who supervised this investigation and who performed most of the expertise. For the studies, three age groups were considered: (a) children (<18 years old); (b) young- and middle-aged adults (18-64 years); and (c) older adults (>64 years). In the first study, a total population of 667 individuals was used. For the second and third studies, samples from young- and middle-aged adults were matched with samples from older adults (n=239) and children (n=114), respectively, considering the *Injury*

Severity Score (ISS). Generally, the inclusion criteria were the following: (a) final medical-legal report about RTA victims, with the causal link between the trauma and the damage established; (b) executed at a healthcare unit of a Portuguese insurance company; (c) occurred between 2018 and 2020; and (d) performed by three selected physicians, with specialisation in forensic medicine and a high experience in PIA, to assure data reliability. The *three-dimensional methodology* was used to describe the permanent consequences and to quantify the severity of sequelae in the *Inventory for Handicap Assessment*. The rules of the National Institute of Legal Medicine and Forensic Sciences of Portugal were followed to quantify the damage's temporary and permanent parameters. For statistical analysis, the first study used: (a) descriptive statistics, characterizing the population, total and stratified by age and sex; (b) chi-square test, to assess the dependence between the frequency variables; (c) Student's t-test, for differences between variables. In the second and third studies, was used: (a) descriptive statistics, characterizing the population, total and stratified by age; (b) chi-square test, to assess the dependence between the frequency variables; (c) logistic regression, to estimate the odds ratio (OR), considering the 95% confidence interval (95% CI) for all measures of effect analysed. In all analyses, the level of statistical significance was set at a p-value of <0.05.

Results: The first study found no differences between the sexes in temporary and permanent damage. However, differences were found for age, concerning older adults and children when compared with young- and middle-aged adults. In the second study, older adults showed a significantly more severe evolution of permanent damage than young- and middle-aged adults; these outcomes were verified at *body*, *functional* and *situational* levels, as well as the *damage coefficient*. However, no significant differences were found concerning the damage parameters, namely for the *Permanent Functional Deficit*. In the third study, children showed a significantly more favourable evolution of permanent outcomes compared to young- and middle-aged adults, regarding the *three-dimensional methodology* and the *Permanent Functional Deficit*; it was found, however, that the results may vary according to the type of injury and the time required for medical-legal consolidation and the last PIA.

Discussion and Conclusion: Based on the results of these studies, specificities were found in the extremes of the age groups, following what, and in a generic way, is identified as the main challenges, the aspects related to: (a) the frequent absence of the

previous physiological and health status; (b) the determination of the medical causal link; (c) the determination of the consolidation date; (d) the decision about the final PIA date; (e) the frequent exclusive use of permanent disability tables to assess the *Permanent Functional Deficit*; (f) the absence of a multidimensional and transdisciplinary assessment in the more complex cases, namely to identify the permanent needs; and (g) the absence of Portuguese studies to determine the person long-term survival after severe traumatic injuries. These specificities, which simultaneously constitute difficulties for the medical experts that evaluate posttraumatic damage in the person, lack more investment in the level of scientific research in view of the creation of solid guidelines/guidelines for this type of expertise.

I. GENERAL INTRODUCTION

1. Road traffic accidents, injuries, and outcomes

Road traffic accidents (RTA) are a significant problem with a high health, social, legal, and economic impact on the victims and their families, as well as on all of society [3-8].

Legal medicine, namely in personal injury assessment (PIA), should play an essential role in the intervention on these cases: (a) in prevention (of RTA and significant injuries); (b) in victims' rehabilitation and familial, social, and professional/training reintegration; and (c) in victims' compensation.

1.1. Statistics

According to the World Health Organization (WHO), RTA cause 1.35 million deaths annually worldwide. It is the eighth cause of death for people of all ages and the first cause of death for children and young adults between 5 and 29 years old (it is the leading cause of death among 15 to 19 years old and the second among 10 to 14 years old) [3-6, 9-16]. WHO estimates that, although the number of non-fatal injuries is decreasing, it was at a much lower rate over the years than fatal injuries [7, 8, 17, 18] and will become, by 2030, the third leading cause of disability [3-8, 19], with substantial economic and human costs to society [8, 20]. It is essential to realise that there are several thousand injury survivors for each death [11-14, 21-24]. More than 5 million victims remain lifelong disabled due to RTA injury [5, 9], with a significant negative impact on families and community networks [8, 14, 21-23].

Road traffic fatalities declined in the European Union (EU), over the past ten years, from nearly 33 000 in 2009 to less than 23 000 in 2019 [25, 26]. Comparing the accident rate in 2000 with that recorded in 2018, the EU reduced the number of fatalities by around 61%. However, in the same period, the decreasing curve of non-fatal injuries was lower, with the serious ones reduced by 42% and the minors by 31% [27]. Altogether, the number of road traffic non-fatal injuries has declined in the pasts 10-year period, from 1.5 million to 1.2 million per year [25, 26].

In Portugal, remarkable progress has been made in RTA in the last 20 years. In 1999 more than 2 000 people died. In 2019, there were 35 704 accidents with victims,

resulting in 626 fatalities, 2 168 severe injuries and 43 183 minor injuries (Figure 1) [17, 27]. However, compared with the population of each Member State of the EU, Portugal is in the sixth worst position according to RTA numbers, with a rate of 67 road traffic fatal victims per million inhabitants, with the EU average being 51 in 2019 [25, 26].

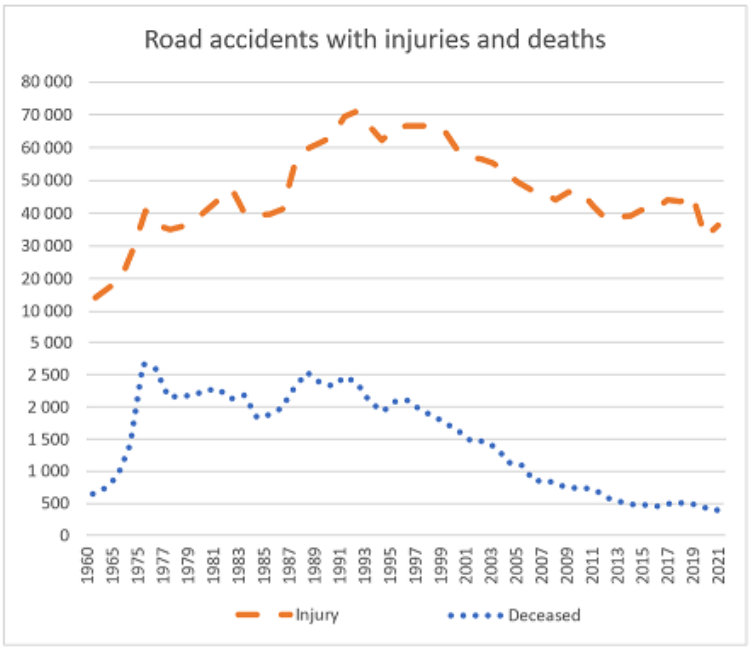

Figure 1 – Road accidents with injuries and deaths in Portugal

The economic cost of RTA and injuries is estimated to be 1% of the gross national product (GNP) in low-income countries, 1.5% in middle-income countries, and 2% in high-income countries, with the global cost estimated at US$ 518 billion per year [28]. In Portugal, the economic and social cost of RTA with victims in 2019 was approximately 3 714 million euros (around 1.6% of the GNP) [27, 29].

1.2. Accident mechanism

An RTA is an unexpected incident caused by a motor vehicle, generating damage to people, property, or both. This fact may arise from vehicle collision, vehicle-individual or animal (being run over) or even between them and a movable or immovable object [30].

RTA occur as a result of a complex combination of risk factors, such as behavioural and personal characteristics of drivers, time of day, road characteristics, vehicle and traffic conditions, and environmental and weather circumstances. The personal and behavioural risks include, for example, lack of driving experience, violation of traffic rules, carelessness, fatigue, drowsiness, psychological stress, driving under the influence of alcohol and drugs, and the use of mobile phones during driving, which increases the risk and extent of injuries in accidents [4, 28, 31, 32].

The RTA severity risk can be explained by kinetic energy, human body tolerance, and post-accident care [28]. There are four elements in the RTA risk [28, 31, 32]: (a) exposure, which includes the time and frequency of the road utilisation and the number of users/population density at a particular moment; (b) probability of the accident, given the exposure, which depends on human, vehicle and road factors, among others; (c) probability of injury, considering the accident characteristics; and (d) outcome of injury, depending of some victim's factors (mainly their previous health and age), as well as of the environmental factors (mainly the precocity and quality of medical assistance in last).

RTA is mainly preventable and predictable and can be subject to rational analysis and corrective actions [28, 31]. Several measures have been proposed and implemented to mitigate RTA, such as improvements in road infrastructure, environmental engineering, advances in vehicle safety features, enforcement of traffic rules and regulations, public education and awareness campaigns, and improvement in medical care. With all these measures, there was a significant decrease in fatal injuries after RTA. However, this progress needs to be improved [7, 8, 17, 18].

In Portugal, the most frequent type of RTA in 2019 was side collision with another vehicle (18%), followed by sideslips (17%) and pedestrians run-over (13%) – Figures 2 and 3. Regarding the vehicle category involved in accidents, cars remain the first ones (75%), followed by motorcycles (12%) [27].

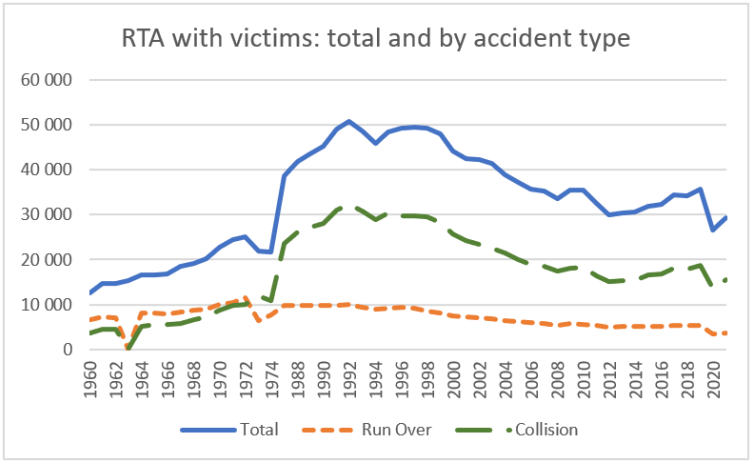

Figure 2 – RTA with victims in Portugal: total and according to the accident type [33]

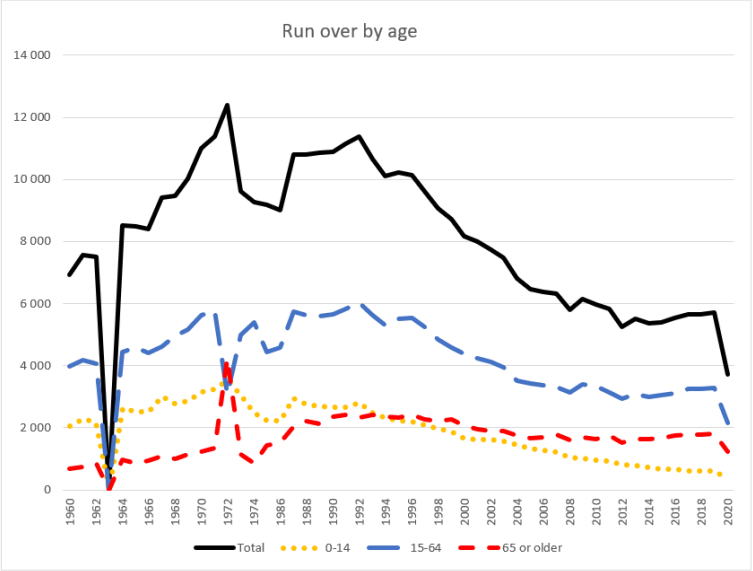

Figure 3 – Run over in Portugal: total and by age [34]

Considering RTA by type of victim, pedestrians, cyclists, and motorcyclists are the more vulnerable. They represent more than half of global RTA deaths, mainly because they do not have the protection structure assured by a car or other similar vehicles. In non-fatal cases, the impact on the victim's health is even more significant [6-8].

Run-over is a leading cause of death and disability in children in multiple countries [34-36]. Its mortality increases with age, being people aged 50 and over, particularly women, primarily affected [34, 35]. Adults over 70 are the most impacted by RTA, in terms of fatalities and serious injuries [27, 34, 35, 37]. (Figure 3)

This subject imposes many study variables, so this aspect was not considered in the present research.

1.3. Injuries

In a medico-legal context, a physical injury is considered an acute damage to any part of the body due to the application of mechanical or other traumatic agents [38].

Injuries resulting from RTA depend on several factors, including the victim's characteristics (e.g., sex, age, physical characteristics, the previous state of health) and the accident mechanism (e.g., the type of accident, the impact energy, and the existence of protection measures) [5, 7, 39].

The most frequent injuries are orthopaedic and in the limbs. However, despite the high rates of orthopaedic injuries in severe cases, the neurological ones are the more significant in terms of outcomes severity [20, 40-43].

The severity of acute injuries can be measured using several methodologies, such as *Injury Severity Score* (ISS), which is used to quantify, rank and compare injuries by severity. Injuries suffered by each body system (head and neck, face, chest, abdomen, extremities – including pelvis, and external lesions) are classified according to their severity degree, from 1 (minor injury) to 6 (maximal damage - unsurvivable). Then the ISS is calculated using the three worse body systems, with a good correlation between ISS severity, victim mortality, and future outcomes [20, 44, 45]. In the case of head trauma, the Glasgow Coma Scale is used to assess the level of consciousness of a patient. It evaluates three factors: eye-opening, verbal and motor response [46].

In addition to acute injuries, it is essential to consider those that may result from secondary clinical complications and even iatrogenic injuries. If they are associated with the injuries resulting from the accident, they should also be considered in PIA.

1.4. Temporary and permanent outcomes

RTA injuries can lead to both temporary and permanent damage.

In the temporary outcomes, variables such as age, injury severity, occupation, work absence period, and financial compensation system have been reportedly related to

long-term temporary outcomes, and the extent of the temporary period is an essential predictor of permanent outcomes [47].

Permanent outcomes include the physical and functional consequences (sequelae), their consequent repercussion for activities in the different contexts of the person's life, and the consequences for his/her quality of life [48].

Loss of quality of life and health status are some of the main consequences of the RTA burden [5, 7]. Two years after the accident, many victims reported unrecovered health status, impacting occupation or formation, economic status, family, friends, affective life, and leisure or sport activities difficulties [7, 19, 49, 50]. A negative impact on the general health status and a deterioration in the quality of life among individuals involved in RTA result in disability [51-54].

According to WHO, quality of life is a multidimensional concept, related with the individual's perception of his/her life status, which integrates physical and psychological health, in balance with social, cultural, environmental, and socioeconomic interactions, together with his/her own goals, expectations, standards and interests [5-7, 28].

A substantial number of RTA victims suffer from long-term impairments, disabilities, and handicaps, with at least half having one or more residual problems and their functional outcomes being unsatisfactory [49, 55-57].

One of the major intervention goals in trauma victims, namely victims of RTA, should focus on their rehabilitation and reintegration in all different life contexts, to reduce permanent outcomes as much as possible. This involves not only the rehabilitation therapies, but also the use of the available technology (e.g., technical aids, prostheses and orthoses, or environmental adaptations) to promote people's autonomy even if they depend on these kinds of aids [58].

2. Personal injury assessment in Portuguese civil law

2.1. Legal aspects

The Portuguese Civil Code (Decree-Law 8/2022, 10th January) establishes, in articles 503 to 508, the strict liability regime for land motor vehicles-related damage. It determines that the driver or vehicle owner/responsible is liable for damages caused by

vehicles, both to third parties and transported persons. There is also mandatory civil liability insurance covering damages arising from the circulation of motor vehicles (Decree-Law 291/2007, 21st August) [59].

One of the fundamental rights of each individual is his/her psycho-physical integrity so that when any harm occurs, the right to have the corresponding compensation for the damage suffered occurs. The obligation to repair the damage, to restore the victim to his/her previous state, arises (Art 562, Decree-Law 8/2022, 10th January). The law defines the requirements of the obligation to compensate, but the existence of damage is a necessary condition for civil liability [48, 60-62].

For compensation purposes, two types of damage are considered: patrimonial and extra-patrimonial. Patrimonial (economic) damage corresponds to the consequences of actual damage to the victim's and third party's property, including the so-called emerging damages and loss of profits. It refers to damages subject to financial assessment and compensation, comprising the expenses and losses of gain, both temporary and permanent, in a direct and specific relationship with the event. It covers damages that, subject to financial assessment, can be repaired, if not directly (through natural restoration or specific reconstitution of the situation before the injury), at least indirectly (through equivalent or monetary indemnity). Extra-patrimonial damage (non-economic) is a subjective damage. It refers to issues related to personal interests, physical integrity, or personality. It encompasses, therefore, the consequences of a physical, moral, psychological, and aesthetic nature, analysed in a generic sense. All these damages are described in the medico-legal report (damage parameters) and, depending on their severity, may give rise to a specific reparation [29, 48, 61, 63, 64].

Most medico-legal assessments related to civil law are extrajudicial and carried out by medical experts of insurance companies, along with frequent examinations carried out by private medical experts at the victims' request. Only if parties do not reach an agreement, which currently happens residually, will a lawsuit be filed. In the latter case, the court requires medico-legal expertise to be performed at the National Institute of Legal Medicine and Forensic Sciences (INMLCF) – Law 45/2004, 19th August, actualised by the Decree-Law 53/2021, 16th July.

2.2. Object and objectives

PIA is a part of clinical forensic medicine, and in Portugal, it constitutes a Competency recognised by the National Medical Association, with its own scientific and doctrinal body. It has gained relevance in medical practice and should always be tied to medical evidence, social realities, and legal dispositions [48, 61, 62, 65-68].

The PIA's object is the person. That is, in the assessment of the damage, not only bodily harm is evaluated, but all the personal damage, in a multidimensional concept of the victim's health [48, 57]: bio-psychological and social aspects (Figure 4). Also, the ecological perspective of the injured person should be considered in his/her different contexts of life (e.g., family, workplace, school, neighbourhood, near the community, and society) – Figure 5 [48, 57].

The objective of PIA is to describe, from a clinical perspective, the temporary and permanent outcomes, and quantify the different damage parameters. Such an objective, must consider the injury's impact on the person's daily quality of life and ensure personal rehabilitation and reintegration (including the satisfaction of all needs), as well as fair compensation of the damage suffered [48, 61, 62, 65-67].

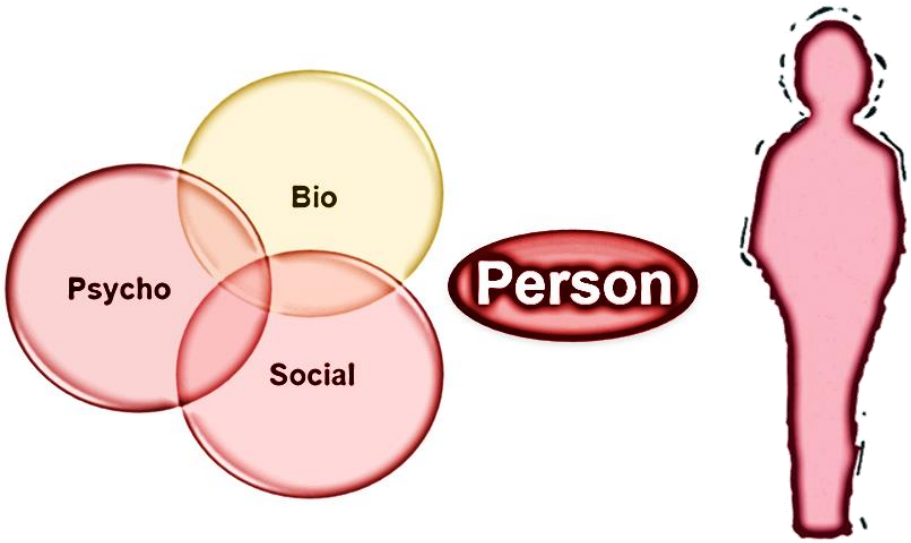

Figure 4 – Multidimensional concept of a person's health (adapted and authorized by Teresa Magalhães, https://uporto.cloud.panopto.eu/Panopto/Pages/Viewer.aspx?id=0122fe04-2f39-4bc9-975d-ab7c009b158d)

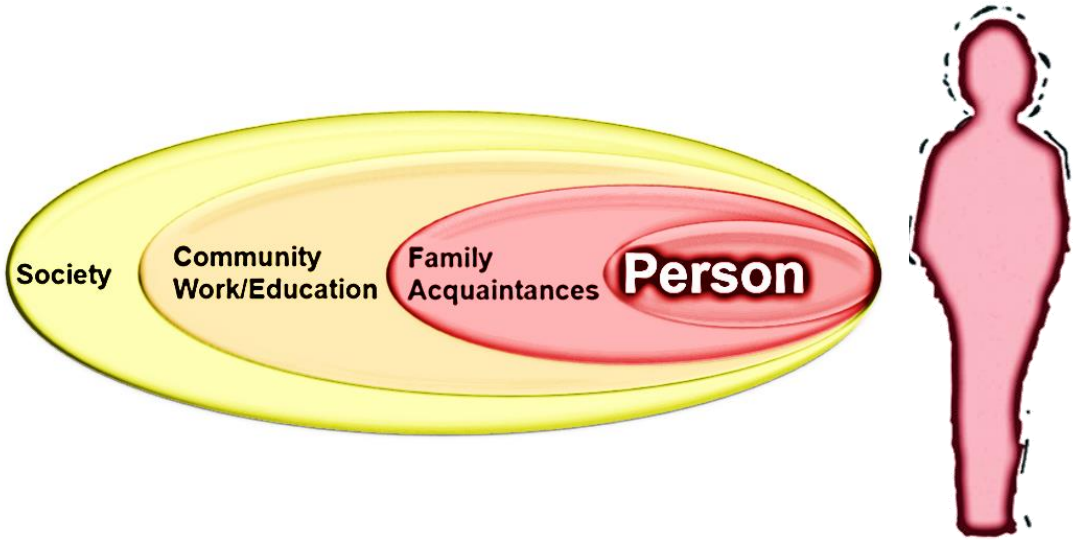

Figure 5 – Ecological perspective of the injured person (adapted and authorized by Teresa Magalhães, https://uporto.cloud.panopto.eu/Panopto/Pages/Viewer.aspx?id=0122fe04-2f39-4bc9-975d-ab7c009b158d)

The main objective of the compensation, especially for the victims with a severe affectation of their functionality, must focus on providing the services, resources and support necessary to allow these victims a dignified life, improve their quality of life and obtain, if possible, a better degree of autonomy. This must be done holistically, concerning the anatomic and functional sequelae, and the multiple consequences in daily, affective, family and professional or educational life. Also, the victim and his/her family's particularities should be considered [48, 61].

2.3. Medico-legal assessment methodology

In Portugal, the PIA's rules are dictated by the INMLCF [64, 69]. Its methodology varies according to the aetiology of the damage and the area of law-related requests (criminal, civil or labour) [61, 62].

As referred to in the Portuguese PIA rules, the medico-legal expert's role is to perform a detailed physical examination, analyse the affected functions and situations due to the

traumatic event, and describe all the findings in detail. They have to know how to respond to the objective of the expertise, impartially and objectively, and to translate its complexity into simple words from a technical point of view so that all the professionals involved can appreciate it on concrete bases to allow a reasoning decision on the case [48, 61].

PIA is concluded through a medico-legal written report. It should contain the detailed description of the traumatic event, the resulting injuries and their evolution, treatments and ancillary exams conducted, the victim's previous history, the victim's current complaints and examination, defining the sequelae and establishing the causal link between trauma mechanism/injuries/sequelae, the date of cure or consolidation, and the different parameters of temporary and permanent damages (depending on the legal framework of the expertise, but always including the victim's needs) [48, 61, 63, 64, 69].

It may be necessary to request transdisciplinary expertise in more complex cases, such as in persons with a severe affectation of their functionality. This will make it possible to define, in a concrete manner, the victim's needs and promote his/her autonomy with the resource to technical solutions, such as technical aids, orthoses and prostheses, adaptations of the different environments and transports, professional reintegration or reconversion, and special education needs, among others [58, 63]. In these cases, the following notions are essential, as stated by Magalhães [48]: (a) the most important thing is not what is lost but what remains; (b) the real-life consequences (*situational* level) are relative, depending not only on personal but also on environmental factors, which means that it may be possible to reduce them by altering the environment; and (c) quality of life depends on taking advantage of the remaining capacities.

2.3.1. Three-dimensional assessment

The *three-dimensional methodology* is used to describe the permanent damage outcomes. This approach considers *body*, *functional*, and *situational* damage levels, providing a comprehensive description of the permanent outcomes [48].

This methodology includes three levels of personal damage and the association of these levels [48, 57]:

a) *Body level*: assess all biological outcomes, including morphological, anatomical, physiological, and even genetic particularities;
b) *Functional level or capacities*: are the mental and physical functions or aptitudes (actual or potential) specific to the person's age and sex, irrespective of the live setting. Their limitations may arise after an alteration of some body function or psychological modification caused by its anatomical or functional alteration, being responsible for its functional incapacity;
c) *Life situations or participation and activities*: assesses the confrontation (actual or potential) between the person and the reality of their physical, social, cultural, educational and professional environment. Its outcome may arise due to injury or sequelae of the body and its function, with an alteration in the activities that the victim performed in his/her daily life and generating specific or situational incapacities, such as alteration in the daily life, autonomous or independence of the person, family or social life, leisure, education, professional life, or others, within a framework of social participation.

It also considers personal and environmental factors which may influence human functioning. These relations between the person and external factors allow for a concrete and helpful intervention, whether on a personal level, in adapting to the environment or concerning social participation [57].

This methodology also allows quantification of each severity level and a global appraisal of the damage severity, by using the *Inventory for Handicap Assessment* (IHA) [57]. This global damage is the *Damage Coefficient*, which corresponds to the average of the final scores resulting from each level severity of the *body, functions* and *situations* [48, 57].

2.3.2. Medical causal link

Faced with a change in the victim's psycho-physical integrity, it is up to the medical expert to state whether or not the observed outcomes are a consequence of the trauma mechanism in question and whether the victim's sequelae are linked to such injuries. The causal link corresponds to the relation of imputability between trauma and an injury. That is, the causal link is established by verifying the linked nature in question,

relating the sequelae to the injuries and the trauma mechanism, demonstrating that the trauma caused the injuries and these were the cause of the sequelae [48, 62, 64]. This is one of the most critical assessments in the expertise.

Classically, in the causal link evaluation, the expert must analyse the following criteria and whether there is consistency between [48, 62]:

a) The type of injury or sequelae and the concrete trauma mechanism;
b) The type of the event aetiology and the injury or sequelae incurred;
c) The site of the trauma and the site of the injury or sequelae;
d) The clinical physiopathology consistency between the trauma, injuries, and sequelae;
e) Temporal consistency between the event, injury, and sequelae;
f) Exclusion of the possibility that the injury or sequelae may have pre-existed;
g) Exclusion of the possibility that the injury or sequelae may have been caused by a mechanism other than the event.

The evaluation of the previous state is fundamental in the PIA to correctly establish the injuries caused by a traumatic event. However, physiological characteristics/changes and other vulnerabilities should not be considered initial conditions. It is necessary to analyse the medical history and the victim's previous state, as well as the probable evolution of the previous state without the accident, of the trauma without the previous state, and the consequences between the association of the previous state and the trauma [70]. This is particularly difficult to assess in children and older adults [71].

Once the causal link between the traumatic event in question and the outcomes presented by the victim is ensured, the experts' next mission consists of setting the cure or consolidation date [62].

2.3.3. Medico-legal cure or consolidation date

The victim's injuries will progress to the cure or consolidation, depending on multiple factors such as the nature and severity of the injury, the victim's age and previous condition, and the occurrence of complications, among others [62].

From a medico-legal point of view, the cure is the complete resolution/healing of any physical or psychological effects of the traumatic event. That is when the victim returns to the same state before the event, fully recovering his/her health from an anatomical, functional, and psycho-sensorial point of view. Consolidation is the process of stabilising the injuries' effects, which ensues when the injuries no longer exhibit appreciable clinical evolution or alteration over time, evolving with some permanent outcomes in the psycho-physical integrity and the life conditions/style [48, 62].

Establishing the cure or consolidation date is fundamental in the expert report. These dates correspond to the moment when temporary damages disappear or are considered permanent, respectively. Also, these aspects may be particularly difficult when considering children and older adults [71].

2.3.4. Medico-legal damage parameters

The damage parameters may vary according to the legal framework of the expertise [48]. The following temporary and permanent damage parameters will be described within the scope of the Portuguese Civil Law. This damage quantification will support victim compensation regardless of the case being judicial or extrajudicial.

2.3.4.1. Temporary

Temporary damages occur between the RTA date and the injuries' cure or consolidation. In temporary damage, the expert will attribute [48, 57, 61, 62]:

a) *Total Temporary Functional Deficit*: corresponds mainly to the hospitalisation period (in days), in which the victim is prevented from autonomously performing acts of daily, family, and social life;
b) *Partial Temporary Functional Deficit*: period (in days) during which the victim may resume daily, family, and social life activities with some degree of autonomy, although with limitations;
c) *Temporary Professional Repercussion*: period (in days) during which the victim is unable to perform his/her usual professional activity;
d) *Quantum Doloris* (QD) – represents the physical and psychic suffering experienced by the victim during temporary damage.

2.3.4.2. Permanent

From the moment when the consolidation date is considered, the permanent period starts. The permanent damage elements, both patrimonial and non-patrimonial, are [48, 57, 61, 62, 72]:

a) *Permanent Functional Deficit* (PFD): corresponds to the sequelae at physical/psychological levels and its repercussion at functional and situational levels; it is determined with the support of the National Permanent Disability Table (Annex 2 of the Decree-Law no. 352/2007, 23rd October);

b) *Future Damage* (FD)*:* corresponds to a specific future aggravation of some sequelae in the future, being this certain*;*

c) *Permanent Professional Repercussion* (PPR): is the assessment of the victim's possibility of returning to his/her usual work activity;

d) *Permanent Aesthetic Damage* (PAD): it is the repercussion of the sequelae on the victim's image, both his/her own and others;

e) *Permanent Repercussion on Sexual Activity* (PRSA): evaluated when the victim's physical and/or psychological sequelae cause total or partial limitation of the level of sexual performance/gratification;

f) *Permanent Repercussion on Sporting and Leisure Activities* (PRSLA): assessed when the victim's physical and/or psychological sequelae restrict totally or partially the performance of leisure physical or social activities that he/she performed regularly and represented a clear source of personal fulfilment and gratification;

g) *Permanent Dependences and Needs*: correspond to the needs arising from the victim's injuries and sequelae to improve his/her rehabilitation and reintegration, which may impact the person's independence and autonomy, and, when possible, stimulate a faster return to active life.

Thus, it is essential in PIA to refer to the victim's environment and life context, including family and social support system, occupational activities and the working environment, the living conditions, among others. All these elements can influence the individual's recovery after a traumatic event. The expert should suggest the necessary interventions considering the person (e.g., treatment and rehabilitation) and the individual's environment (e.g., loved ones, housing, place of study, work or recreation, transport, or access to specially adapted services) supported by a transdisciplinary approach.

II. GENERAL OBJECTIVES

Regarding literature and previous experience with PIA, it is here considered that the cases of RTA related to victims at the age extremes (children and older adults) present a significant and constant challenge to medico-legal experts concerning PIA. These challenges are due to the particularities of the physiopathology and longevity of these individuals, among others.

However, there is a lack of guidelines to orientate experts in the correct performance of these exams. As far as we know, there are no published guidelines on this issue, and, in Portugal, the INMLCF did not yet presented rules on this complex subject.

Therefore, scientific evidence is needed to create future guidelines on this topic because these cases must be correctly assessed and compensated.

The general objective of this research is to provide evidence on the differences and specificities of non-fatal RTA outcomes in the case of children and older adults, to contribute to the elaboration of future PIA guidelines considering these age groups.

The specific objectives are:

a) To compare the posttraumatic outcomes, considering the victims' age group and sex, using the Portuguese medico-legal rules for PIA;
b) To analyse the differences between posttraumatic outcomes in older adults and young- and middle-aged adult populations;
c) To analyse the differences between posttraumatic outcomes in children and young- and middle-aged adult populations.

III. GENERAL MATERIAL AND METHODS

1. Data collection

Retrospective studies were conducted using convenience samples based on medico-legal reports of PIA cases. The general inclusion criteria were as follows: (a) final medico-legal report about victims of RTA (the accident type and the type of insurance responsibility were not considered – regardless of fault), showing the establishment of the trauma-damage causal link; (b) performed at a healthcare unit of a Portuguese insurance company since this includes most of these reports; (c) occurred between 2018 and 2020; and (d) performed/signed by three selected physicians, with specialisation in forensic medicine and a high experience in PIA, to assure data reliability (all aligned with the official Portuguese rules on this subject, and the use of the *three-dimensional methodology* for describing permanent outcomes and the different levels and types of damage, for quantifying outcomes [48, 64, 69]).

Three tasks were accomplished. In the first, the total population (n=667) was used, and three age groups were considered: (a) children (n=56; 8%); (b) young- and middle-aged adults (n=431; 65%); and (c) older adults (n=180; 27%). For the second and third tasks, the number of children (n=114) and older adult (n=239) cases was increased (considering the first study) as much as possible, to ensure a suitable number of victims for the analysis of the outcomes; the two samples were matched with the young- and middle-aged adults' sample control for ISS.

A database was created for each study. They were filled by the responsible physician who performed the majority of the medico-legal assessment, considering the following variables: (a) sex; (b) age at the time of the accidents; (c) occupational activity; (d) type of accident; (e) resulting injuries type and their severity (ISS); (f) *three-dimensional methodology* outcomes; (g) temporary damage parameters; (h) permanent damage parameters; and (i) permanent needs. No information was included that could allow those involved to be identified by the others research.

In this study, accidents involving bicycles were classified as pedestrian accidents because they are non-motorised vehicles.

The Ethics Committee of the Faculty of Medicine of the University of Porto / Centro Hospitalar de São João approved this research project, which was also authorized by Fidelidade – Companhia de Seguros S.A. to be performed.

2. Assessment methodologies

The medico-legal diagnosis relied on clinical criteria, functional status, and ancillary exam criteria, complying with the expert assessment to the standards defined in this matter by the INMLCF [64, 69].

The clinical records were used to retrospectively estimate injury severity (ISS) in the acute phase [20, 44, 45]. The ISS variables were categorised in classes as 0 (non-existent), 1–8 (minor or moderate), 9–15 (serious), 16–24 (severe), and 25–75 (critical).

For the *three-dimensional methodology*, the IHA was used to quantify the severity degree of the *body*, *functional* and *situational* levels, and the *damage coefficient* at the date of the PIA [48, 57].

PFD was categorised considering the severity degree/personal impact that may be labelled by these groups: 0 – non-existent; 1 to 9 – minor; 10 to 19 – moderate; 20 to 39 – serious; and 40 to 100 – severe to critical.

3. Data analysis

All analyses were performed using SPSS for Windows Version 25.0 or 27.0 (IBM Corp., Armonk, NY, USA).

In the first task, data analysis was used to: (a) the descriptive statistics of the studied population, in total and stratified by age and sex; (b) a chi-square test to assess the dependence between the frequency variables; (c) Student's t-test for differences between variables. Continuous variables were assumed to be normal. In all analyses, the level of statistical significance was set at a P-value of <0.05.

In the second and third tasks, data analysis was used to: (a) the descriptive statistics of the studied population in total and stratified by age; (b) chi-square test to assess the dependence between the frequency variables; (c) logistic regression, to estimate the odds ratio (OR), considering a 95% confidence interval (95% CI) for all measures of

effect analysed. In all analyses, the level of statistical significance was set at a p-value of <0.05. The OR was statistically significant if the confidence interval did not cross the value 1.

IV. RESULTS

This section presents the papers corresponding to each of the three specific objectives. The papers were re-formatted according to this document's style, and each paper's references were re-indexed and presented in the **General References,** chapter VII.

1. Trauma outcomes in non-fatal road traffic accidents: a Portuguese medico-legal approach[1]

Flávia Cunha-Diniz [a,e*], Tiago Taveira-Gomes [a-c,f], José Manuel Teixeira [d], Teresa Magalhães [a,b,d,g]

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ABSTRACT

The objective of this study was to compare the outcomes of nonfatal road traffic accidents by the victims' age group and sex. We used the Portuguese medico-legal rules for personal injury assessment, in the scope of the Civil Law in that country, which includes a *three-dimensional methodology*. This was a retrospective study including 667 victims of road traffic accidents aged 3–94 years old. Their final medico-legal reports all used the Portuguese methodology for personal injury assessment. Outcomes were analysed by the victims' age group (children, working-age adults, and older people) and sex. Road traffic accidents were generally serious (ISS mean 9.5), with higher severity in children and older people. The most frequent *body* sequelae were musculoskeletal (64.8%), which were associated with *functional* and *situational* outcomes. Temporary damage resulted in an average length of impairment of daily life of 199.6 days, 171.7 days to return to work, and an average degree of *quantum doloris* (noneconomic damage related to physical and psychological harm) of 3.7/7. The average permanent damage was 7.3/100 points for *Permanent Functional Deficit*, 0.43/3 for *Permanent Professional Repercussion*, 2/7 for *Permanent Aesthetic Damage*, 3.9/7 for *Permanent Repercussion on Sexual Activity* and 3.2/7 for *Permanent Repercussion on Sport and Leisure Activities*. Overall, 19% of people became permanently dependent (10.6% needed third-party assistance). The medico-legal methodology used, considering victims' real-life situation, allows a comprehensive assessment. There were several significant differences

[1] Flávia Cunha-Diniz, Tiago Taveira-Gomes, José Manuel Teixeira & Teresa Magalhães (2022) Trauma outcomes in non-fatal road traffic accidents: a Portuguese medico-legal approach. Forensic Sciences Research, 2022. 7:3, 528-539, DOI: 10.1080/20961790.2022.2031548.

among the three age groups but none between sexes. These differences and the impact of the more severe cases justify further detailed medico-legal studies in these specific situations on children, older people, and severely injured victims.

Key points:

• This was a retrospective study of accident mechanisms and injury outcomes in Portugal, and considered the outcomes in the victims' real-life situation.

• Lesions from road traffic accidents were generally serious, with higher severity among children and older people.

• The most frequent sequelae were musculoskeletal, and associated with *functional* and *situational* outcomes.

• Both temporary and permanent outcomes had repercussions for the victims.

• There were significant differences between children, working-age adults and older people, but none between sexes.

Introduction

Road traffic accidents (RTA) are a global health, social and economic problem that cause up to 50 million injuries each year [6]. In Portugal, in 2019, there were 35 704 accidents involving victims, and 474 fatal and 45 503 nonfatal injuries [17]. The non-fatal injuries affected 442.4 victims/100 000 inhabitants. In 2020, these accidents decreased significantly because of the pandemic.

RTA survivors experience short- and long-term health consequences, sometimes leading to impairment and disability, with considerable economic costs that may have a major impact on their quality of life and their families [8]. Personal outcomes depend on the characteristics of the accident (e.g. pedestrians, cyclists and motorcyclists are more likely to be severely injured [7, 8]), the characteristics of the victim (e.g. age, sex and previous health condition), and the type and severity of lesions, which seem to be the primary predictive factor for the outcome of the trauma [7]. However, only a few medico-legal studies examine RTA outcomes analysed from a comprehensive and personalised perspective, and consider temporary, permanent, economic and noneconomic outcomes.

Personal injury assessment (PIA) in legal medicine may offer a detailed and personalised description and quantification of trauma outcomes. However, medico-legal methodologies, including the damage parameters that are assessed, differ with national

legislative systems [73]. In many countries, no official guidelines are available for this assessment. In Portugal, there are rules for PIA dictated by the National Institute of Legal Medicine and Forensic Sciences. These rules are set out in Civil Law and followed by both public and private services. They include the following [64, 69].

1. A *three-dimensional* (3D) *methodology* for a comprehensive description of any permanent damage [48, 57]. This method offers a systematic and validated solution to describe and analyse, in an eco-systemic way, the consequences of a specific trauma on physical and psychological integrity and health. It considers three personal levels: (a) the body level assesses biological outcomes that may include morphological, anatomical, histological, physiological and even genetic particularities; (b) capacities (or functions) assess physical and mental capacities (current or potential), taking into account the age and sex, irrespective of the live setting; (c) life situations (or participation and activities) assess the confrontation (concrete or potential) between those affected and the reality of their physical, familial, social, cultural, educational and professional environment.
2. The damage parameters (Table 1), which consider temporary and permanent outcomes, including economic and noneconomic aspects, are assessed using the Portuguese rules [48, 64, 69].

The objective of this study was therefore to compare the outcomes of nonfatal RTA, considering the victims' age group and sex, using the Portuguese medico-legal rules for PIA.

Table 1 – Portuguese medico-legal damage parameters

Damage parameters	Meaning and evaluation criteria
Temporary Professional Repercussion	Economic temporary damage: period (days) in which the victim is unable to perform his/her usual professional activity.
Total Temporary Functional Deficit	Noneconomic temporary damage: period (days) in which the victim is prevented from autonomously performing acts of daily, family, and social life (without any reference to professional activity). Mostly corresponds with hospitalisation time.
Partial Temporary Functional Deficit	Noneconomic temporary damage: period (days) in which the victim may resume activities of daily, family, and social life with some degree of autonomy, although still with limitations.
Quantum Doloris	Noneconomic temporary damage: physical and psychic suffering experienced by the victim during the period of temporary damage on a 7-points scale of increasing severity.

Permanent Professional Repercussion	Economic permanent damage: victim's ability to perform professional activity. Levels: 0 – Without work affected; 1 – Additional effort for usual work or need for workplace adaptation or use of technical aids; 2 – Total incapacity for work in the scope of his/her technical-professional qualifications, with need of professional reconversion; 3 – Total incapacity for any kind of work.
Permanent Functional Deficit	Noneconomic permanent damage: definitive effects on the victim's physical and/or psychic integrity, with repercussion on daily life activities, including family and social life, leisure, and sporting activity, although it is independent of professional activities. Assessed by the *National Permanent Disability Table* (Annex 2 of the Decree-Law no. 352/2007, 23rd October); 100-points scale of increasing severity.
Future Damage	Damage that is not yet observable in the PIA, but whose development is sure, corresponding to an aggravation of the sequelae, in the future, and consequent aggravation of certain damage parameters, namely, *Permanent Functional Deficit*.
Permanent Aesthetic Damage	Noneconomic permanent damage: repercussion of the sequelae upon the victim's self-image and image from others on a 7-points scale of increasing severity.
Permanent Repercussion on Sexual Activity	Noneconomic permanent damage: total or partial limitation on the level of sexual performance/gratification arising from the physical and/or psychic sequelae on a 7-points scale of increasing severity.
Permanent Repercussion on Sporting and Leisure Activities	Noneconomic permanent damage: impossibility of the victim engaging in certain leisure, physical or social activities which he/she did regularly, and which represented a clear source of personal fulfilment and gratification on a 7-points scale of increasing severity.
Permanent Dependences	Economic permanent damage: it corresponds to the victim's needs, with repercussion on his/her independence and autonomy; it should be assessed considering the victim's best chances of rehabilitation and reintegration.

Materials and Methods

This was a retrospective study using a convenience sample based on medico-legal reports of PIA cases. The reports' inclusion criteria were as follows: (a) final medico-legal report about victims of RTA (we did not consider the victim's age and sex, the accident type, severity of injuries, or type of insurance responsibility—with or without fault—at this stage), showing that the causality nexus between the trauma and damage was established; (b) performed at a healthcare unit of a Portuguese insurance company because this includes the majority of these reports; (c) occurring between 2018 and 2019; and (d) performed by the same physician, to assure data reliability and considerable experience of the Portuguese official rules, and the use of the 3D methodology for describing permanent outcomes [48, 64, 69] and the different levels and types of damage, for quantifying outcomes (Table 1) [64, 69]. This gave a total of 667 cases, and three age groups were considered: (a) children (<18 years) (n=56; 8%);

(b) working-age adults (18–64 years) (n=431; 65%); and (c) older people (>64 years) (n=180; 27%).

The *Injury Severity Score* (ISS) was used for retrospective estimation of injury severity [44, 45] in the acute phase, using the clinical files. The ISS variables were categorised in classes as 0 (non-existent), 1–8 (minor or moderate), 9–15 (serious), 16–24 (severe), and 25–75 (critical). The *Inventory for Handicap Assessment* (IHA) was used to quantify the severity of damage at the *body*, *functional* and *situational* levels, and the *damage coefficient* [57], at the date of the PIA. This coefficient corresponds to the average of the final scores that results from each scale of the *body*, *functional* and *situational* levels and considers five severity groups (Table 2). *Permanent Functional Deficit* (PFD) was categorised as 0, 1–9, 10–19, 20–39 and 40–100, drawing on the case distribution and the severity groups.

A database was created for the study and completed by the physician who performed the medico-legal assessment of the cases. No information was included that could allow those involved to be identified. All analyses used SPSS for Windows Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to describe the study population, in total and stratified by age and sex. The chi-square test was used to assess the dependence between the frequency variables. Continuous variables were assumed to be normal, and tests for differences between variables were performed using Student's t-test. In all analyses, the level of statistical significance was set at a P-value of <0.05.

Table 2 – Meaning of the severity degree of *body*, *functional* and *situational* levels, and *damage coefficient*, considering the *three-dimensional methodology*

Degree	***Body* sequelae**	***Functional* and *Situational* permanent outcomes**	***Damage Coefficient***
0	Non-existent	Without difficulties	Independence
1	Minimal	Minimum difficulties	Independence but slowness or discomfort
2	Mild	Medium difficulties	Dependence of either medicines or technical aid
3	Important	Important difficulties	Dependence of partial third-party assistance
4	Severe	Impossible	Dependence of total third-party assistance

Results

The average timespan between RTA and the final PIA was 337.4±421.9 days (Min=32; Max=4 476).

Victim demographics

Overall, there were similar numbers of female victims (n=334; 50.1%) and male victims (n=333; 49.9%), but there were more women (103/180; 57.2%) among the older people (P=0.05). The mean age at the date of RTA was 48.7±21.5 years (Min=3; Max=94), with working-age adults being the main population (65%). Male victims were younger than female ones (P=0.01), with mean ages of 46.6 ± 20.9 vs. 50.8 ± 22.0. Most people were professionally active at the date of the accident (n=342; 51.3%), with the remainder being students (n=63; 9.4%), stay-at-home spouses (n=16; 2.4%), retired (n=194; 29.1%), unemployed (n=47; 7.0%), and preschool children (n=5; 0.8%). The majority presented a pathological (n=431; 64.6%) and/or traumatic history (n=213; 31.9%), with significant differences between older people and adult victims for pathological cases (P=0.05): 19.4% (35/180) vs. 10.0% (43/431).

Accident characterisation

The majority of RTA consisted of a motor vehicle impact (423/667; 63.4%), with the next-largest groups being pedestrians who were run over (n=214), and bicyclists hit (n=30) by a motor vehicle (244/667; 36.6%). In motor vehicle impact cases, cars were the most common vehicle (277/423; 65.5%), followed by motorcycle (109/423; 25.8%), then truck, tractor, or bus (37/423; 8.7%). Most of the motor vehicle impacts were crashes between vehicles (337/423; 79.7%), with the remaining being sideslips (52/423; 12.3%), victims falling inside a bus (22/423; 5.2%), and victims falling from the vehicle (4/423; 0.9%), with eight (1.9%) classified as “others”. The victim was the driver in 63.1% (267/423) of cases. Most victims wore protective devices at the time of the accident (363/415; 87.5%), including seat belts (254/306; 83.0%) or helmets (109/109; 100%). In cars with airbags (198/305; 64.9%), 49.0% (97/198) deployed.

Both children and older people were more likely to be run over than working-age adults (P=0.03 and P<0.001). However, working-age adults experienced more collisions in motor vehicles than children or older people (P=0.01 and P<0.001).

Injury characterisation

Limbs were the most commonly injured body region (53.5% lower and 49.5% upper limbs) (Table 3). Only two victims experienced no physical injuries but complained of psychiatric distress due to the severity of the injuries suffered by other victims involved in the RTA, including one death. There were differences between the age groups in injury distribution.

Table 3 – Injury location and severity

		Total (*n*=667) *n* (%)	**Children** (*n*=56) *n* (%)	**Adults** (*n*=431) *n* (%)	**Older people** (*n*=180) *n* (%)	**Adults *vs* Children** (*P*)	**Adults *vs* Older people** (*P*)
Injury location[a]	Lower limbs	357 (53.5)	30 (53.6)	232 (53.8)	95 (52.8)	0.97	0.81
	Upper limbs	330 (49.5)	21 (37.5)	219 (50.8)	90 (50)	0.006*	0.86
	Head and neck	258 (38.7)	20 (35.7)	155 (36)	83 (46.1)	0.97	0.02*
	Chest and abdomen	172 (25.8)	9 (16.1)	102 (23.7)	61 (33.9)	0.16	0.01*
	Spine/spinal cord	162 (24.3)	3 (5.4)	108 (25.1)	51 (28.3)	<0.001*	0.4
	Face	118 (17.7)	14 (25)	71 (16.5)	33 (18.3)	0.16	0.58
	Non-existent	2 (0.3)	1 (1.8)	1 (0.2)	0 (0)	-	-
ISS	1-8 (minor/moderate)	362 (54.3)	26 (46.4)	267 (61.9)	69 (38.3)	0.03*	<0.001*
	9-15 (serious)	161 (24.1)	18 (32.1)	88 (20.4)	55 (30.6)	0.08	0.01*
	16-24 (severe)	72 (10.8)	6 (10.7)	38 (8.8)	28 (15.6)	0.64	0.03*
	≥25 (critical)	70 (10.5)	5 (8.9)	37 (8.6)	28 (15.6)	0.93	0.02*
	Non-existent	2 (0.3)	1 (1.8)	1 (0.2)	0 (0)	-	-

[a] Injury location categories are not mutually exclusive.

The mean ISS was 9.5±9.8 (Min=0; Max=50), with 21.3% being severe or critical (≥16). The ISS was 12.0±10.3 in older people, 9.6±5.0 in children, and 8.5±9.2 in working-age adults, with a significant difference between older people and working-age adults (P=0.004). The ISS was significantly different between those who were run over and in collisions (11.8±10.5 vs. 8.2±9.3, P<0.001). No differences were found by sex.

Temporary outcomes

The medico-legal evaluation of temporary damage parameters is described in Table 4, with differences between age groups but not between sexes. *Quantum doloris* (QD) was attributed in all cases, and its degree of distribution was: (a) 1 (n=1; 0.1%); (b) 2 (n=36;

5.4%); (c) 3 (n=244; 36.6%); (d) 4 (n=278; 41.7%); (e) 5 (n=86; 12.9%); (f) 6 (n=21; 3.1%); and (g) 7 (n=1; 0.1%). Differences were found between all temporary damage and ISS severity and between the type of accident and QD (Table 5).

Table 4 – Parameters of damage among the three age groups (n=667)

	Total		**Children**	**Adults**	**Older people**	**Adults *vs* Children**	**Adults *vs* Older people**
	($\bar{X}$)	Min-Max	($\bar{X}$)	($\bar{X}$)	($\bar{X}$)	(*P*)	(*P*)
Total Temporary Functional Deficit (days)	23.8±81.7	0-1095	33.3±148.7	18.1±69.2	34.4±79.5	0.03*	0.001*
Partial Temporary Functional Deficit (days)	179±212.2	0-2101	215.4±397.1	181.5±196.3	161.7±160.2	0.004*	0.005*
Temporary Professional Repercussion (days)	171.7±208.9	0-1252	-	-	-	-	-
Quantum Doloris (1-7)	3.7±0.9	1-7	4±1	3.6±0.0	4±0.8	0.003*	<0.001*
Permanent Functional Deficit (0-100)	7.3±12.3	0-100	4.9±15.9	6.2±11.0	10.9±13.2	0.44	<0.001*
Permanent Professional Repercussion (0-3)	0.43±0.7	0-3	-	0.4±0.7	0.8±1	-	0.08
Permanent Aesthetic Damage (1-7)	2.0±1.0	1-6	2.3±1.5	2±1.0	1.8±0.8	0.04*	0.73
Permanent Repercussion on Sexual Activity (1-7)	3.9±1.7	1-7	-	3.6±1.5	4.5±1.6	-	0.05*
Permanent Rep. Sport./ Leisure Activities (1-7)	3.2±1.8	1-7	4±1.8	2.9±1.7	3.6±1.9	0.97	0.29
Damage Coefficient (0-4)	2±0.9	0-4	1.4±0.7	1.8±0.7	2.5±1.1	<0.001*	<0.001*

Table 5 – Correlations between ISS severity and RTA type (n=667) for different parameters of damage

	ISS		***P***	**Type of accident**		***P***
	<16	**≥16**		**Collisions**	**Run overs**	
Total Temporary Functional Deficit	7.4±33.0	84.5±150.9	<0.001*	20.3±87.9	31.2±74.8	0.12
Partial Temporary Functional Deficit	149.7±174.9	287.1±289.6	<0.001*	175.2±208.9	203.3±238.2	0.13
Temporary Professional Repercussion	139.5±185.8	352.3±239.2	<0.001*	169.9±210.5	195.9±228.2	0.35
Quantum Doloris	3.5±0.8	4.6±0.8	<0.001*	3.6±0.9	3.9±0.8	<0.001*
Permanent Functional Deficit	3.8±5	20.3±20.1	<0.001*	6.7±12.5	9±12.6	0.03*
Permanent Professional Repercussion	1.1±0.4	2±1.2	<0.001*	1.4±0.9	1.5±1	0.6
Permanent Aesthetic Damage	1.7±0.9	2.4±1.2	<0.001*	2±1	2±1.1	0.5
Permanent Repercussion Sexual Activity	2±1.7	4.2±1.5	0.03*	4.2±1.4	3.6±1.6	0.3
Permanent Rep. Sport./Leisure Activities	2.4±1.7	3.6±1.7	0.007*	2.9±1.7	3.5±1.8	0.2
Damage Coefficient	1.74±0.7	2.7±1.1	<0.001*	1.8±0.8	2.1±1	<0.001*

Permanent outcomes

The 3D evaluation of permanent damage is described in Table 6. The most frequent *body* sequelae were musculoskeletal (64.8%). They were associated with *functional* outcomes, primarily for carriage/ displacement/transfers (52.0%), and with *situational* outcomes, particularly related to acts of daily life (51.7%). The majority of injuries had a 3D severity degree of 0–1 (non-existent or minimal) for (a) *body* sequelae (65.9%);

(b) *functional* outcomes (88.0%); (c) *situational* outcomes (87.8%); and (d) *damage coefficient* (85.3%) (Table 7). Differences were observed between children and working-age adults (P=0.001; P=0.4; P<0.001; and P<0.001 for each degree) and between older people and working-age adults (all P<0.001) but not between sexes. Differences were also observed between ISS and all types of severity degrees (all P<0.001).

Table 6 – Permanent outcome description from the *three-dimensional* evaluation (*n*=667)

		***n* (%)**
***Body* sequelae[b]**	Orthopaedic	432 (64.8)
	Aesthetic	67 (10.0)
	Neurologic	55 (8.3)
	Psychiatric	33 (5.0)
	Dermatologic	22 (3.3)
	Otorhinolaryngologic	15 (2.3)
	Angio-cardiologic	9 (1.4)
	Stomatologic	9 (1.4)
	Ophthalmologic	7 (1.1)
	Gastroenterologic	6 (0.9)
	Urologic	5 (0.8)
	Others	3 (0.5)
	Non-existent	169 (25.3)
***Functional* permanent outcomes[b]**	Carriage, displacement, and transfers	347 (52.0)
	Manipulation and grip	197 (29.5)
	Cognition and affectivity	126 (18.9)
	Sphincter's control	25 (3.8)
	Communication	20 (3.0)
	Sexuality	20 (3.0)
	Senses	17 (2.6)
	Others	71 (10.7)
	Non-existent	183 (27.4)
***Situational* permanent outcomes[b]**	Acts of daily living	345 (51.7)
	Affective and social life, sporting and leisure activities	270 (40.5)
	Professional life or academic training	243 (36.4)
	Non-existent	187 (28.0)

[b] Three-dimensional outcomes are not mutually exclusive.

Table 7 – Severity degree of permanent outcomes (*three-dimensional methodology*) [*n*=667, see Table 2] – n (%)

	0	**1**	**2**	**3**	**4**
Body	169 (25.3)	271 (40.6)	163 (24.4)	49 (7.4)	15 (2.3)
Functions	458 (68.7)	129 (19.3)	72 (10.8)	6 (0.9)	2 (0.3)
Situations	441 (66.1)	145 (21.7)	57 (8.6)	16 (2.4)	8 (1.2)
Damage Coefficient	206 (30.9)	363 (54.4)	27 (4.1)	64 (9.6)	7 (1.0)

The evaluation of medico-legal permanent damage parameters is described in Tables 4 and 8. PFD (Table 8) was considered in 72.9% of cases (486/667), ranging from 1 to 19 points in 64.0% of cases (427/667), with differences between older people and working-age adults (P<0.001) but not between sexes (Table 4). Correlations were also found between PFD and all types of severity degrees (all P<0.001) and ISS (P<0.001). It was considered that in cases with prior pathological history (n=431), the previous state of the victim had influenced the accident outcomes, increasing the PFD value from an average of 5.8 ± 12.7 points to 8.2 ± 12 points (P=0.02).

Table 8 – Other permanent outcomes (*n*=667)

		n (%)
***Permanent Functional Deficit* (0-100 points)**	0	181 (27.1)
	1 – 9	335 (50.2)
	10 – 19	92 (13.8)
	20 – 39	38 (5.7)
	40 – 100	21 (3.2)
Permanent Professional Repercussion	0	242 (36.3)
	1	103 (15.4)
	2	15 (2.3)
	3	9 (1.3)
	Non-applicable	298 (44.7)
***Permanent Needs*[c]**	Third-party assistance (partial or total)	71 (10.6)
	Regular medical treatments	47 (7.1)
	Regular medical appointment	42 (6.3)
	Technical aids	38 (5.7)
	Drugs	29 (4.4)
	Orthoses	16 (2.4)
	Consumables	12 (1.8)
	Prothesis	11 (1.7)
	Others	26 (4.0)
	Non-existent	540 (81.0)

[c] *Permanent Needs* are not mutually exclusive.

In 19 cases, *Future Damage* (FD) was attributed to the increased damage that was expected to occur because of intraarticular fractures (wrist [n=2], hip [n=7], knee [n=8] and ankle [n=3]) and joint instability (shoulder [n=3] and ankle [n=1]). In these cases, it was considered that posttraumatic arthrosis was very likely to develop, and the placement of a total prosthesis would be necessary in the future. In some of these cases, victims had more than one type of FD. In these situations, the PFD was higher (P=0.03) because FD points were added to the PFD. Among those eligible (n=369), 6.5% (n=24)

of victims were considered unable to perform either their usual work (grade 2) or any kind of work (grade 3) (Tables 5 and 8) (*Permanent Professional Repercussions*, PPR). Overall, 19 became unemployed and four retired because of a disability resulting from the RTA. This means that 6.2% (23/369) of individuals became professionally inactive as a result of the RTA. Correlations were found between PPR and all types of severity degrees (all P<0.001), ISS (P<0.001), PFD (P<0.001), and FD (P=0.009). No correlation was observed between PPR and pathological history (P=0.12) or sex (P=0.22).

Table 4 shows the results for *Permanent Aesthetic Damage* (PAD), *Permanent Repercussion on Sexual Activity* (PRSA) and *Permanent Repercussion on Sporting and Leisure Activities* (PRSLA). The distribution of levels of PAD (n=299; 44.8%) was: (a) 1 (n=118; 39.5%), (b) 2 (=109; 36.5%), (c) 3 (n=39; 13.0%), (d) 4 (n=27; 9.0%), (e) 5 (n=5; 1.7%), and (f) 6 (n=1; 0.3%). For PRSA levels (n=24; 3.6%), the distribution was: (a) 1 (n=2; 8.3%), (b) 2 (n=3; 12.5%), (c) 3 (n=4; 16.7%), (d) 4 (n=7; 29.2%), (e) 5 (n=4; 16.7%), (f) 6 (n=2; 8.3%), and (g) 7 (n=2; 8.3%). For PRSLA (n=66; 9.9%), the distribution was: (a) 1 (n=14; 21.2%), (b) 2 (n=17; 25.8%), (c) 3 (n=10; 15.2%), (d) 4 (n=5; 7.6%), (e) 5 (n=11; 16.7%), (f) 6 (n=8; 12.1%), and (g) 7 (n=1; 1.5%). No significant differences were found between these damage parameters and sex.

Overall, 19% (127/667) of victims were estimated to have permanent needs resulting from the accident (Table 8), and 10.6% (71/667) became dependent on third-party assistance, including 64 (9.6%) being partially dependent and seven (1%) wholly dependent. Most of the victims being dependent on third-party assistance were older people (48/71, 67.6%), and only one (1.4%) was a child, who had a PFD of 100 points because of very severe brain injuries. There was a difference between older people and working-age adults (P<0.001) but no significant difference by sex.

Discussion and Conclusions

Victims

No differences were found in the sex distribution, which is consistent with some studies [74, 75]. However, others found some differences, albeit some finding male predominance in RTA [7, 8, 20, 41, 42, 57, 76-81] and other female predominance [39, 43]. The group most commonly affected was working-age adults (65%), followed by

older people (27%) [20, 75], which may be related to the different risk exposures of each group. Men were more likely to be younger than women (P=0.01), with more women in the older people group (P=0.05). This is consistent with other work [20, 82], and is probably the result of longer female active life and longevity.

Accidents

Most RTA were associated with a vehicle impact (63.4%), most often cars (65.5%), followed by motorcycles (25.8%). Overall, 63.1% of victims were drivers. However, previous studies have found the type of vehicle varies by country and primary mode of transport [7, 8]. Many studies have reported more cars involved in RTA [7, 41, 78, 81-83], but in the Netherlands, for example, accidents are more likely to involve bicycles [8, 20], an aspect that can contribute to different RTA outcomes.

The group most involved in collisions was working-age adults, and most of the victims wore protective devices at the time of the accident (87.5%), usually seatbelts (83%) or helmets (100%), as in other studies [84]. For car drivers, there was some variation (82.3%–93%), depending on the existence of a reminder within the vehicle [85].

Accidents involving someone being run over were more frequent in both children and older people than working-age adults (P=0.03 and P<0.001). Age (under 15 and over 75) and physical condition are the primary risk factors for pedestrians [36]. Pedestrians hospitalised after RTA are often older than both the average road user and motor vehicle occupants who are also hospitalised [37].

Injuries

Most injuries occurred in the limbs, either lower (53.5%) or upper (49.5%), followed by the head and neck (38.7%), with significant differences among the three age groups, as reported in other studies [20, 41-43, 57, 79]. This seems to be primarily related to the physical characteristics of the victims, such as size [76], previous health state, and type of accident (collisions or being run over) [7, 39].

Around one-fifth of injuries (21.3%) were severe or critical (ISS≥16), and older people had a significantly higher ISS (P=0.004), consistent with previous studies [20, 76, 82]. This may be because of the poorer physical condition of this age group, making these

individuals more vulnerable in trauma cases [86] and to the greater number of accidents involving being run over in this age group. We did not observe any difference between sexes, but some authors have found that women, especially older women, tend to have more serious injuries than men [43, 76]. However, others have found that men have more severe lesions [42]. Studies have also shown that men and women experience accidents differently. Women have a higher risk of permanent disability due to injuries from whiplash (recovering more poorly than men), and body size (which means that the effectiveness of vehicle safety equipment is lower in women, who tend to sit with the seat further forward, making them more susceptible to trauma in the chest and lower limbs). By contrast, men tend to experience more serious injuries, with higher ISS, probably because they suffer more violent/high energy accidents, and are more likely not to wear seat belts [43, 76].

Temporary outcomes

Temporary outcomes are defined as those that are identified from the moment of the accident until the date when either the injury is deemed to have healed without having resulted in any sequelae or of injury "consolidation" (the date after which no further significant clinical development is expected in terms of sequelae, corresponding to the end of the period of temporary damage) [48]. This period includes any resulting injuries, complications, treatments, hospital stays and sick leave (considering the day-to-day activities and work or training activities), and the physical and psychological suffering inherent in the experience of the trauma and the subsequent process [48].

We found that the average *Temporary Functional Deficit* (length of time during which daily life was impaired) was 199.6 days among working-age adults. This can be considered a relevant period of inactivity or reduced activity. Among older people, this period was longer for *Total Temporary Functional Deficit* (hospitalisation) because of the greater ISS, but lower for *Partial Temporary Functional Deficit*. This is probably because in the recovery period rehabilitation is not as rapid as in working-age adults, because of older people's lower capacity and need for future physical activities. This means that more older people became dependent on a third-party (26.7%, 48/180), compared with 5.1% (22/431) of working-age adults. Children showed a longer period of *Partial Temporary Functional Deficit*, which may be because in many injuries, especially traumatic brain injuries and lower limb fractures, the medico-legal evaluation

is only completed after the end of the pubertal period, which greatly increases the number of days assigned to this damage parameter. This issue needs further study because it reflects an important personal, familial, and economic impact, and it may constitute a specific aspect of medico-legal PIA. Almost no previous studies have examined this issue.

The average length of *Temporary Professional Repercussion* was 171.7 days, which is lower than the results of Murgatroyd (231 days) [81] but still represents an important number of days before a return to work. ISS was significantly linked to the period of recovery time (Table 5) [79, 83]. There were no differences by type of accident and recovery time, despite accidents involving people being run over being more severe (Table 5).

Most victims were assigned QD grades 3 and 4 (78.3%), and only 3.2% had grades 6–7. The only victim with QD 7 was a child with severe neurological, orthopaedic, and gastroenterological sequelae, with higher *body*, *functional* and *situational* outcomes, and a PFD of 100 points, who was totally dependent on third-party assistance. There were 21 victims with QD 6, mostly related to severe accidents, injuries, and sequelae, and just one who had witnessed the death of a family member during the RTA. Differences were found by QD, ISS, and type of accident, which is a particularly important aspect. This allows us to suggest that, in this study, QD considered aspects related to both accident experience and injury severity, which is consistent with the original concept (Table 1) [48].

Permanent outcomes

To assure a comprehensive evaluation of permanent outcomes, the 3D methodology for PIA is used in Portugal. In our sample, this evaluation showed the existence of permanent *body*, *functional* and *situational* consequences in 74.7%, 72.6% and 72.0% of cases (Table 6). This showed a good correlation between these outcome levels and both DFP ($P<0.001$, $P<0.001$, $P<0.001$) and PPR ($P<0.001$, $P<0.001$, $P<0.001$). This is fundamental, and allows us to suggest that the damage parameters attributed concretely assess the outcomes reported by the victims, considering their health condition and their daily life and situation.

The most frequent *body* sequelae were musculoskeletal (64.8%, Table 5) and particularly affected the limbs [40]. This was expected because 73% of accident-related disabilities are attributed to orthopaedic impairment [19]. The *functional* outcomes (Table 5) were mostly related to posture, dislocations, and transfers (52.0%), which is in line with the most frequent type of *body* sequelae. It is also consistent with a previous study that found 49% of RTA victims experienced functional activity limitations [19].

Situational outcomes are the consequences for the victims' daily life. Findings included the following.

1. Acts of everyday life (Table 6): 51.7% of the victims reported that their daily life was affected, but the rate and severity of the effect may depend on the ISS and the age group. This issue deserves separate and more detailed analysis. One previous study [42] found that 55% of RTA victims with serious injuries reported an impact on their everyday life, but only 22% of victims with mild-to-moderate injury reported the same impact. These acts of everyday life are one of the aspects considered in PFD evaluation. However, in this study, PFD was attributed to more victims (72.9%), perhaps because its evaluation also considers aspects related to affective and social life and sporting and leisure activities. PFD was correlated with ISS ($P<0.001$), as expected [42, 79]. Older people had higher PFD values than adults ($P<0.001$), which is in line with both the ISS, their previous state (pathological and physiological) and the literature [7, 19, 50].
2. Affective and social life and sporting and leisure activities (Table 6): 40.5% of victims reported some damage to these aspects of life. Another study [7] indicated that 25.2% of victims reported an impact on affective or family life and 46.9% on leisure or sports activities. These aspects are considered in the PFD evaluation, and may also be included in PAD, PRSA and PRSLA, which were considered present in 44.8%, 3.6%, and 9.9% of the cases in this study. The first two damage parameters showed differences between the age groups (Table 4), as expected, considering the personal lower valorisation of aesthetic and sexual aspects by older persons. The low rate of PRSA (3.6%) is common in the PIA context, primarily because many victims do not disclose this damage, often because they are ashamed to do so [87].

3. Professional life (Table 6): 36.4% of victims reported some difficulties, similar to a previous study [7]. The damage parameter that corresponds to this aspect is PPR, which, in this study, was considered present in 34.4% (127/369) of the applicable cases (Table 8). The minimal difference found between these two kinds of evaluations of professional life activities (2%) may be because some victims described complaints that did not have a medical explanation. Overall, 6.5% of victims were considered unable to perform their usual work because of RTA sequelae, compared with a rate of 5%–16% in the literature, varying by the severity of the accident [7, 78, 83]. The literature also shows that success in returning to work after an RTA depends on (a) injury type and severity [7, 77, 78, 81, 83]; (b) occupational skill levels, where low levels are considered a significant risk of a longer time before return to work [78, 81, 83]; and (c) age and sex because older and female victims are more likely to need more time off work following an RTA, with a significant number of older people failing to return to work [83, 88]. Correlations were found between PPR and ISS ($P<0.001$), PFD ($P<0.001$), and FD ($P=0.009$) but not between PPR and pathological and traumatological history ($P=0.2$ and $P=0.4$).

Damage coefficient, calculated through the 3D methodology, showed that victims (a) recovered fully or with minimal difficulties, but with autonomy and without dependency in 85.3% of cases; (b) were dependent on medication and/or technical aids in 4.0% of cases; (c) were partially dependent on third-party assistance in 9.6% of cases; and (d) totally dependent on a third-party in 1.0% of cases. These results are similar to another study [41], which found that 79.2% of victims experienced full recovery, with 13.2% showing mild disability, 2.9% moderate disability, and 1.1% severe disability. One study stated that 90% of the burden of serious road injuries is due to lifelong consequences that are encountered in 20% of victims [40].

Children exhibited a lower damage coefficient than adults, and older people a higher coefficient ($P<0.001$; $P<0.001$). This is consistent with the literature, which suggests that children progress with less disability than adults, but older people experience a greater impact on their health than younger people [7, 43, 80, 89]. Another study [75] reported that very young and old individuals tend to have the highest risk for low quality of life compared to victims between those ages. However, several authors have

found that women experience more sequelae than men in all age [7, 43, 74, 75, 80], and one study stated that the risk of disability related to traffic injury was higher in women [89].

Medico-legal personal injury assessment methodology

The Portuguese medico-legal methodology for PIA used in this study considers victims in their real-life situation, which allows a comprehensive assessment, supporting effective and useful damage repair. This is because it uses a 3D description of the permanent outcomes and links that to quantification of temporary and permanent damages, considering several parameters of damage [48, 57, 64, 69]. However, despite the relevance of the outcomes that we have described, and the importance of medico-legal assessment and compensation for these damages, there is very little medico-legal literature on this issue. The literature also shows differences in medico-legal PIA methodologies by country [73, 90, 91], which hampers the comparison of results from different studies.

This is true even within Europe, especially between northern and southern countries, because of differences in civil law. However, it is not solely a function of civil law because there are differences even between countries with similar legislation. In Spain, for example, there is a specific law for RTA, with a medical scale (Act 35/2015, 22 September). This sets out the norms for PIA, including temporary and permanent incapacities, aesthetic damage, dependencies, and technical aids. It respects the basic principles of injury compensation, but there are no official assessment guidelines [92-94]. In France, there are several medical scales for permanent incapacity evaluation in civil law [95, 96]. The "*Barème du Concours Médical*" (*Décret* 2003-314, 4th April) [45] is mandatory for PIA ordered by insurance companies. The *Société de Médecine Légale et de Criminologie de France*, in association with the *Association des Médecins Experts en Dommage Corporel*, has also published the "*Barème d'évaluation médico-légale*" , which is more comprehensive and includes scales for assessment of suffering, as well as for aesthetic and sexual damages [97]. However, there are no official assessment guidelines. In Portugal, there are strict and thorough standards, including scales and official tables, for a personal and comprehensive medico-legal evaluation of victims of RTA, considering both temporary and permanent damage, and both economic and noneconomic aspects [64, 69].

In the USA, the gold standard methodology used for personal damage assessment is the *American Medical Association's Guides to the Evaluation of Permanent Impairment* [98]. Its aim is to calculate and estimate the percentage of injury suffered by a person caused by trauma or illness that manifests itself as a structural or functional loss in some organic system [99]. In Brazil, the law that established mandatory insurance for RTA (*Danos Pessoais causados por Veículos Automotores de Via Terrestre*, DPVAT) published a table to assess permanent incapacity (Law No. 6194/1974). However, there is no official and systematic protocol for PIA in civil law [67, 100].

These are just some examples demonstrating that each country has its own methodology and tools to assess PIA. Considering these differences and the absence of global criteria for medico-legal PIA, the harmonisation of this practice seems to be an important goal. It would be particularly useful for examiners and would make it possible to perform comparative studies between different populations and samples. This is currently a difficult, if not impossible, task.

These harmonisation attempts have been performed by the *Confédération Européenne d'Experts en Évaluation et Réparation du Dommage Corporel* (CEREDOC) since 1998. Standards and a medical table for the assessment of noneconomic damage were introduced in 2003 and have been updated several times [101]. However, these standards are largely consensual in most countries of Europe and South America [91], and differences persist (e.g. in the terminology used to refer to various parameters of damage, the criteria for assessment and the tables for disability and other damage assessment).

Results Summary

This study revealed that RTA severity was generally serious (ISS mean 9.5), and higher in children and older people. The most frequent *body* sequelae were musculoskeletal (64.8%), which were associated with *functional* and *situational* outcomes (51.7% for acts of everyday life, 40.5% for affective and social life, and sporting and leisure activities, and 36.4% for professional life). Temporary damage resulted in an average length of impairment of daily life of 199.6 days, and required 171.7 days before return to work. The average degree of QD was 3.7/7. Permanent parameters of damage were, on average, 7.3/100 points for PFD, 0.43/3 for PPR, 2/7 for PAD, 3.9/7 for PRSA, and

3.2/7 for PRSLA. Overall, 19% of victims had *permanent needs* (10.6% needed third-party assistance). These outcomes have significant repercussions for the victim's life. The Portuguese medico-legal methodology, by considering victims in the context of their everyday life and situation, allows for a comprehensive assessment and supports effective and useful damage repair. The differences among the three age groups and the impact of the more severe cases justify further detailed medico-legal studies in these specific situations on children, older people, and severely injured victims.

Limitations of this study and further studies

The greatest limitation of this study is that there are no studies with similar methodologies for results comparison. The number of cases among children and older individuals was also significantly lower than among working-age adults, and the sample of severely injured people was also small, which prevented further analysis.

Considering the significant differences found between the three age groups, showing that children and older people have important specificities, we consider that these age groups deserve additional studies. They may even merit the creation of medico-legal guidelines that, to our knowledge, do not currently exist. This may also be true of more severe cases, which deserve deeper and more detailed medico-legal studies.

2. Are there any differences in road traffic injury outcomes between older and younger adults? Setting the grounds for posttraumatic senior personal injury assessment guidelines[2].

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ABSTRACT

Injury outcomes seem to be more severe in older than younger persons. This may make personal injury assessment (PIA) particularly difficult, mainly because of seniors' previous health frailties. To set the grounds for seniors' PIA guidelines, we compared an older with a younger adult population of trauma victims and, secondarily, identified differences between the groups regarding *three-dimensional* and medico-legal damage parameters assessment. Using a retrospective study of victims of road traffic accidents, we compared the groups (n=239 each), assuring similar acute injury severity (ISS *standardised difference*=0.01): G1 (older adults); G2 (younger adults). Logistic regression was used to estimate the odds ratio. G1 revealed higher negative consequences when considering the *three-dimensional* damage assessment, with more frequent and severe outcomes, being a cause of further difficulties in daily living activities, with a loss of independence and autonomy. Nevertheless, regarding the medico-legal damage parameters, *permanent functional disability* did not show significant differences. This study generates evidence that reveals the need to rethink the traditional methodology of PIA in older persons, giving more relevance to the real-life contexts of each person. It is essential to: obtain complete information about previous physiologic and health states, begin the medico-legal assessment as early as possible, make regular follow-ups, and perform a multidisciplinary evaluation.

[2] Flávia Cunha-Diniz, Tiago Taveira-Gomes, Agostinho Santos, José Manuel Teixeira & Teresa Magalhães (2023). Are There Any Differences in Road Traffic Injury Outcomes between Older and Younger Adults? Setting the Grounds for Posttraumatic Senior Personal Injury Assessment Guidelines. Journal of Clinical Medicine, 2023. 12(6): p. 2353, DOI: 10.3390/jcm12062353.

Keywords: Road traffic accident; Medico-legal evaluation; Injury assessment; Damage assessment; Older adult; Elderly

1. Introduction

Ageing can be defined as the standard, predictable, and irreversible changes of various body systems over time. These physiological changes generally result in the loss of functional reserve in most body systems [102, 103]. Healthy ageing is the process of increasing and preserving physical and mental capacities and the functional ability that enables well-being in older age [56, 104]. Not all elderly individuals are frail, and to better assess the ability to recover from trauma and injuries, an assessment of the frailty of the older victim should be carried out [50, 105]. The frailty syndrome is defined to evaluate the health status of older people in whom there is a progressive age-related decrease in functional physiological reserve and a decline in various body systems, presenting a low resistance to stressors and causing vulnerability and a worse response to adverse events, which is also associated with several critical chronic diseases, such as cardiovascular and pulmonary diseases and diabetes. Among the frailty markers are decreased muscle mass, strength, endurance, balance, and walking performance, as well as low activity [104, 106]. The frailty syndrome is catalogued in the International Classification of Diseases—10th revision (ICD-10) under the code R54—Senility, which includes senescence, senile asthenia and debility, excluding age-related cognitive decline (R41.81), senile psychosis (F03), and sarcopenia (M63.84) [107].

Population ageing is about to become one of the most significant social world transformations, with cross-cutting implications for all sectors of life. Worldwide, the population aged 65 and over is growing faster than all younger age groups [56, 108-110]. This older age group currently constitutes 21% of the inhabitants of the European Union and represents 23.4% of the Portuguese population (while in 1970, it was only 9.7%) [111, 112] (Figure 6).

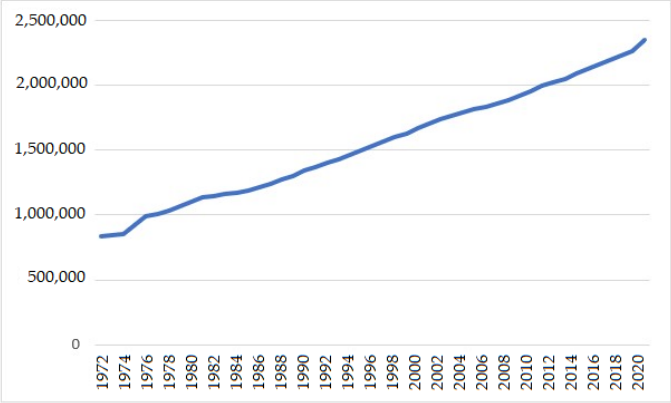

Figure 6 – Evolution of the population aged 65 and over in Portugal [112]

In fact, scientific and medical advances, as well as improvements in living conditions, contribute to the increase in life expectancy and allow older adults to be progressively more active and autonomous [113]. They now have more mobility, walking and travelling more frequently and for longer distances when compared to previous cohorts [82, 114-116]. Therefore, they are more often victims of road traffic accidents (RTAs) [114, 115, 117].

The main reasons for increased trauma rates, namely, related to RTAs in elderly individuals, are the decline in physical capacities, with decreased sensory, psychomotor, and cognitive skills, associated with decreased reaction speed, slowed pace, poor vision and audition, reduced reflexes, and vehicle speed calculation error [49, 71, 102, 115, 118, 119].

RTAs in senior victims differ in their characteristics and outcomes from RTAs in young- and middle-aged adult victims [24]. The energy needed to cause injuries decreases as the person's age increases, having more severe consequences than in younger people; road accidents occur because some particularities of this age group are related to more frequent health fragilities [120]. Older adults generally suffer less serious trauma mechanisms, although the risk of severe and critical injuries is more considerable, causing significant morbidity and mortality, which increases with age [20, 76, 82, 86, 116, 120-122]. Furthermore, the elderly population usually presents health problems before RTAs due to the anatomical deterioration of structures, physiological frailties (with decreased physiological reserve, reduced immunity, and decreased bone and neuromuscular strength, in addition to decreased effectiveness in metabolic and endocrine responses), specific comorbidities, and even previous traumas. All this is a cause of reduced efficacy of compensatory mechanisms after an RTA trauma, impairing healing [102, 113, 117, 123,

124]. In seniors, even low-severity injuries can destabilise the previous physical and psychological states, causing important outcomes [49, 50, 53, 71, 113, 114, 124, 125].

Owing to these aspects, trauma in senior persons is generally associated with: (a) a more extended period of hospitalisation, particularly in intensive care units [49, 56, 57]; (b) a more significant posthospitalisation decline in functional status, with a reduction in their quality of life, often with loss of their independence and autonomy [49, 56, 57]; and (c) an acceleration on senile evolution, with significant deterioration and increased functional disability after trauma, leading to a state of dependence that did not previously exist [53, 56].

All these facts create great complexity and challenges in older persons' health care and personal injury assessment (PIA), but the scientific evidence in this field is very scarce. This is stated in a critical article that resulted from the first multidisciplinary *Consensus Conference on Medico-Legal Assessment of Personal Damage in Older People*, held in 2019 [126]. This article considers the need for the development of formal guidelines on this subject and identifies four thematic areas that need further research: (a) differences in injury outcomes in older people compared to younger people and their relevance in PIA; (b) preexisting status reconstruction and evaluation; (c) medico-legal examination procedures; and (d) multidimensional assessment and scales.

Therefore, the general objective of our study is to set the grounds for senior people's PIA guidelines, comparing an old adult with a young- and middle-aged adult population of RTA victims. The secondary objectives are to identify differences between both populations regarding: (a) *body*, *functional*, and *situational* outcomes (*three-dimensional* damage assessment); and (b) Portuguese medico-legal damage parameters assigned to the cases.

2. Materials and Methods

2.1. Data collection methodology

This is a retrospective study using a convenience sample based on medico-legal reports of PIA cases. The report inclusion criteria were as follows: (a) final medico-legal report about adult victims of RTA (≥18 years old), showing that the link between trauma and injuries was established; (b) performed at a health care unit of a Portuguese insurance company; (c) between 2018 and 2020; (d) by three selected physicians, with a specialisation in forensic medicine and great experience in PIA, to assure data reliability (they are all aligned with the

official Portuguese rules on this subject). We did not consider the victim's sex, the accident type, or the type of insurance responsibility—with or without fault—at this stage.

A database was created for the study and was completed by one of the physicians who performed the medico-legal assessment of the cases. No information was included that could allow those involved to be identified.

Two age groups were considered: (a) G1 (case sample)—senior adults (≥65 years old, because according to the United Nations, in developed countries, people are classified as elderly when they are 65 years of age or more [109]) (n=239; 50%); this sample size corresponds to all available data of older adults, considering the defined inclusion criteria, namely, the time span of the study and the final PIA reports performed by the three selected physicians during the studied period; (b) G2 (control sample)—young- and middle-aged adults (18–64 years old); initial cases were sorted out from all available data of this age group, considering the same inclusion criteria of G1 (n=431); using *Propensity Score Matching* from SPSS, we found the final control sample (n=239; 50%).

The *injury severity score* (ISS) [44, 45] was used as a predictor to ensure that G1 and G2 presented a similar initial picture after the RTA. ISS was retrospectively estimated in the acute phase of the cases, considering the clinical records. The ISS variables were categorised into four classes, as shown in Table 9. To verify if the matched sample was comparable, we used the *standardised difference*, which is considered balanced when it is ≤0.1 [127]. Thus, as shown in Table 9 and Figure 7, our samples are balanced, considering the clinical severity of the cases (ISS).

Table 9 – Matched sample characterisation regarding ISS

	ISS	**Total (n=478)**	**G1 (n=239)**	**G2 (n=239)**	**Standardised difference**
$\bar{X}$		11.6±10.1	11.71±10.4	11.51±10	0.01
n (%)	1-8 (mild/moderate)	195 (40.8)	96 (40.2)	99 (41.4)	0.01
	9-15 (serious)	139 (29.1)	71 (29.7)	68 (28.5)	-0.01
	16-24 (severe)	77 (16.1)	39 (16.3)	38 (15.9)	-0.01
	≥25 (critical)	67 (14)	33 (13.8)	34 (14.2)	0.01

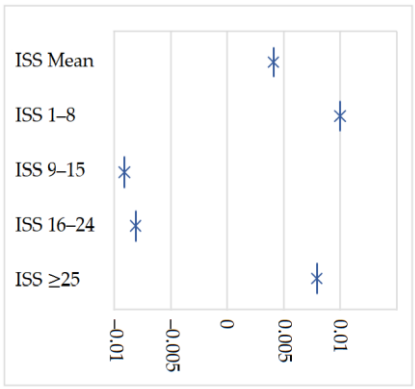

Figure 7 – Matched predictors' *standardised difference* (propensity score matching)

2.2. Assessment methodology

A *three-dimensional methodology* (*body*, *functional* and *situational* levels) was used to describe permanent outcomes according to the official Portuguese rules [48, 64, 69].

To quantify permanent outcomes severity, we used the *Inventory for Handicap Assessment* [57], a validated instrument for Portuguese victims of RTAs, but only up to 65 years of age. However, we chose it because it is a medico-legal instrument intended for PIA purposes and because no other instrument has been validated for the older population until now. It allows us to quantify the severity degree of the *body*, *functional* and *situational* levels, and the *damage coefficient*. This coefficient corresponds to the average of the final scores resulting from each scale of three referred levels and considers five severity groups of increasing severity. The meaning of each level is [1, 48, 57]:

1. *Body* level: assesses biological outcomes, which may include morphological, anatomical, histological, physiological, and even genetic particularities;
2. *Capacities*/*functions* level: assesses physical and mental capacities (current or potential), taking into account age and sex, irrespective of the live setting;
3. *Life situations*/*participation*/*activities level*: assesses the confrontation (concrete or potential) between those affected and the reality of their physical, familial, social, cultural, educational, and professional environment.

To quantify the different parameters of damage in civil law, we used some of the Portuguese medico-legal permanent damage parameters [64, 69]:

(a) *Total Temporary Functional Deficit*: period (days) in which the victim is prevented from autonomously performing acts of daily, family, and social life (without any reference to professional activity). Mostly corresponds with hospitalisation time;

(b) *Partial Temporary Functional Deficit*: period (days) in which the victim may resume activities of daily, family, and social life with some degree of autonomy, although still with limitations;

(c) *Quantum Doloris*: physical and psychic suffering experienced by the victim during the period of temporary damage on a 7-point scale of increasing severity;

(d) *Permanent Functional Deficit* (PFD): definitive effects on the victim's physical and/or psychic integrity, with repercussions on functions and situations (daily life activities, including family and social life, leisure, and sporting activity, although it is independent of professional activities). The evaluation utilises a table of permanent disability (Decree-Law 352/2007, 23rd October, annexe 2), which uses a 100-point scale of increasing severity. PFD was categorised as 0, 1–9, 10–19, 20–39, and 40–100, drawing on the case distribution and the severity groups;

(e) *Future Damage*: damage that is not yet observable in the PIA moment but whose development is sure, corresponding to an aggravation of the sequelae in the future and consequent aggravation of specific damage parameters, namely, PFD;

(f) *Permanent Aesthetic Damage*: repercussion of the sequelae on the victim's self-image and image in terms of others; evaluated on a 7-point scale of increasing severity;

(g) *Permanent Repercussion on Sporting and Leisure Activities*: impossibility or difficulty of the victim engaging in certain leisure, physical, or social activities that he or she regularly did and which represented a clear source of personal fulfilment and gratification; evaluated on a 7-point scale of increasing severity;

(h) *Permanent Needs*: these correspond to the victim's needs, with repercussions on his or her independence and autonomy; they should be assessed considering the victim's best chances of rehabilitation and reintegration.

Regarding *Temporary Professional Repercussion* and *Permanent Professional Repercussion*, we did not analyse them because, in G1, only 16 persons were professionally

active before the RTA. We also did not analyse *Permanent Repercussion on Sexual Activity* because 87% (n=208) of G1 victims did not refer to this type of damage (OR=2.7, 95% CI 1.7–4.3).

2.3. Data analysis

All analyses were performed using SPSS for Windows Version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to describe the study population in total and stratified by age. The chi-square test was used to assess the dependence between the frequency variables. Logistic regression was used to estimate the odds ratio (OR), considering the 95% confidence interval (95% CI) for all measures of effect analysed. The OR was statistically significant if the confidence interval did not cross the value 1. In all analyses, the level of statistical significance was set at a p-value of <0.05.

3. Results

The timespan between RTA and the final PIA was, on average, 307.1±236.2 days (Min=15; Max=1888; OR=0.998).

Most of the victims presented a pathologic history prior to the RTA (n=352; 73.6%), with 91.6% in G1 and 55.6% in G2, with a significant difference (OR=8.7, 95% CI=5.2–14.7). Considering trauma history, only 35.8% (n=171) of the victims presented it, with 36.8% in G1 and 34.7% in G2, without differences (OR=1.1, 95% CI=0.8–1.6).

3.1. Temporary outcomes

The temporary outcomes are described in Table 10.

The mean *Quantum Doloris* degree was similar in the two groups, with most victims assigned to grade 3 or 4. However, in G1, the higher grades were more frequently assigned.

3.2. Permanent outcomes

Using *the three-dimensional* evaluation, the description of the permanent outcome is presented in Table 11.

Table 10 – Temporary outcomes (medico-legal damage parameters)

			G1 (n=239)	G2 (n=239)	OR	95% CI (Min-Max)
Temporary Functional Deficit ($\bar{X}$ days)	*Total*		31.3 ± 77	29 ± 87.2	1	0.99-1.03
	Partial		165.3 ± 148.8	222.6 ± 215.2	0.99	0.97-0.99*
Quantum Doloris (Grade 1-7)	$\bar{X}$		3.9 ± 1	3.9 ± 0.9	1.04	0.85-1.3
	n (%)	1-3	72 (30.1)	86 (36)	0.8	0.5-1.1
		4-7	167 (69.9)	153 (64)	1.3	0.9-1.9

* Significant differences

Table 11 – Permanent outcomes (*three-dimensional methodology*)

Permanent Outcomes		G1 n (%) (n=239)	G2 n (%) (n=239)	OR	95% CI (Min-Max)
Body	Orthopaedic	191 (79.9)	167 (69.9)	1.7	1.1-2.6*
	Neuro-psychiatric	40 (16.7)	38 (15.9)	1.1	0.7-1.7
	Others	48 (20.1)	64 (26.8)	0.7	0.4-1.1
	Nonexistent	29 (12.1)	49 (20.5)	0.5	0.3-0.9*
Functions	Carriage, displacement, and transfers	167 (69.9)	140 (58.6)	1.6	1.1-2.4*
	Manipulation and grip	95 (39.7)	62 (25.9)	1.9	1.3-2.8*
	Cognition, affectivity, and communication	61 (25.5)	52 (21.8)	1.2	0.8-1.8
	Chronic pain	42 (17.6)	29 (12.1)	1.5	0.9-2.6
	Sphincter control	18 (7.5)	5 (2.1)	3.8	1.4-10.4*
	Senses	11 (4.6)	9 (3.8)	1.2	0.5-3
	Nonexistent	27 (11.3)	55 (23)	0.4	0.3-0.7*
Situations	Acts of daily life	188 (78.7)	133 (55.6)	2.9	2-4.4*
	Affective, social life, and leisure activities	124 (48.1)	114 (47.7)	1.2	0.8-1.7
	Nonexistent	40 (16.7)	51 (21.3)	0.7	0.5-1.2
Permanent needs	Third-party assistance (partial or total)	55 (23)	19 (7.9)	3.5	2-6*
	Regular medical treatments	30 (12.6)	22 (9.2)	1.4	0.8-2.5
	Regular medical appointment	18 (7.5)	21 (8.8)	0.8	0.4-1.6
	Medication	25 (10.5)	13 (5.4)	2	1.01-4.1*
	Orthoses	20 (8.4)	11 (4.6)	1.9	0.9-4
	Technical aids	18 (7.5)	8 (3.3)	2.4	1.01-5.5*
	Prothesis	4 (1.7)	9 (3.8)	0.4	0.1-1.4
	Consumables	7 (2.9)	4 (1.7)	1.8	0.5-6.1
	Ancillary exams	4 (1.7)	2 (0.8)	2	0.4-11.1
	Nonexistent	153 (64)	193 (80.8)	0.4	0.3-0.6*

* Significant differences. Note: *Body*, *functional*, *situational* outcomes, and *permanent needs* categories are not mutually exclusive.

Concerning the *three-dimensional methodology*, permanent severe damage quantification is referred to in Table 12. All three levels assessed (*body*, *functions*, and *situations*) were much more severe in G1: 1.3, 1.7, and 1.3 more times, respectively. Dividing G1 into two groups (<75 and ≥75 years), the older group presented more *body* sequelae (OR=1.3, 95% CI=1.008–1.7), more *functional* outcomes (OR=1.4, 95% CI=1.05–1.9), and more *situational* outcomes (OR=1.7, 95% CI=1.3–2.2). The *damage coefficient* also showed an increase of 60% in G1, and the older group (≥75 years) also presented a higher coefficient (OR=1.6, 95% CI=1.2–2.1).

Table 12 – Severity of permanent outcomes (*three-dimensional methodology*)

Severity (0-4)	G1 $\bar{X}$	G2 $\bar{X}$	Standardised difference	OR	95% CI (Min-Max)
Body sequelae	1.6 ± 1.0	1.3 ± 1.0	0.27	1.3	1.1-1.6*
Functional outcomes	0.9 ± 0.9	0.5 ± 0.8	0.43	1.7	1.3-2.1*
Situational outcomes	0.9 ± 1.1	0.6 ± 0.9	0.28	1.3	1.1-1.6*
Damage Coefficient	1.5 ± 1.0	1.1 ± 0.8	0.44	1.6	1.3-2.0*

* Significant differences

There was a correlation between pathologic history and *damage coefficient* (P=0.008), using the groups as a control variable.

The evaluation of medico-legal permanent damage parameters considered for this study is described in Table 13.

Table 13 – Permanent medico-legal damage parameters assessed

			G1 (n=239)	G2 (n=239)	OR	95% CI (Min-Max)
Permanent Functional Deficit	$\bar{X}$	(0-100 points)	10.4±13.6	8.8±13.4	1.009	0.995-1.023
	n (%)	0	31 (13)	51 (21.3)	0.5	0.3-0.9*
		1-9	117 (49)	124 (51.9)	0.9	0.6-1.3
		10-19	60 (25.1)	37 (15.5)	1.8	1.2-2.9*
		20-39	21 (8.8)	16 (6.7)	1.3	0.7-2.6
		≥ 40	10 (4.1)	11 (4.6)	0.9	0.4-2.2
Permanent Aesthetic Damage	$\bar{X}$	(Degree 1-7)	1.9±1	2.1±1	0.9	0.7-0.99*
	n (%)	1	43 (18)	44 (18.4)	0.97	0.6-1.5
		2	44 (18.4)	45 (18.8)	0.97	0.6-1.5
		3	21 (8.8)	19 (8)	1.1	0.6-2.1
		4-7	5 (2.1)	20 (8.4)	0.2	0.09-0.6*
		Nonexistent	126 (52.7)	111 (46.4)	1.3	0.9-1.8
Permanent Rep. Sport. & Leisure Activities	$\bar{X}$	(Degree 1-7)	3.06±1.7	3.13±1.7	0.9	0.8-1.1
	n (%)	1	5 (2.1)	7 (2.9)	0.7	0.2-2.3
		2	17 (7.1)	7 (2.9)	2.5	1.03-6.2*
		3	8 (3.3)	5 (2.1)	1.6	0.5-5
		4-7	13 (5.5)	13 (5.5)	1	0.5-2.2
		Nonexistent	196 (82)	207 (86.6)	0.7	0.4-1.2

* Significant differences

Regarding the totality of cases, PFD was assigned in 82.8%,with a mean of 9.6±13.5 points (Min=0; Max=83). No correlation was found between pathologic history and PFD (P=0.06), using the groups as control variables. Additionally, taking G1+G2, *Future Damage* was assigned in 20 cases, 5% (n=12) in G1 and 3.3% (n=8) in G2; these cases were related to intra-articular fractures or joint instability of the wrist (n=2), hip (n=6), knee (n=12), and ankle (n=1); in one case, the victim presented two different anatomical regions affected.

4. Discussion

The number of senior adults becoming road users and victims of RTAs is progressively increasing. This is due to an ageing population associated with seniors currently being healthier, more active, and more autonomous. However, a significant number of elderly persons present prior health conditions (physiological and/or pathological) that impair posttrauma recovery, making outcomes more severe. This circumstance constitutes a public health, as well as a medico-legal, concern [114, 115, 126], deserving further research.

Considering the proposals of the first multidisciplinary *Consensus Conference on Medico-Legal Assessment of Personal Damage in Older People* [126], we analysed the differences in injury outcomes between older and younger people and their relevance to PIA in the context of an insurance company. To perform this discussion, we will try to answer some questions posed in the paper resulting from the referred *Conference* [126].

This is a preliminary study of the subject.

4.1. Evidence That Posttraumatic Injury Outcomes Differ Between Older and Younger Victims

According to Ingravallo et al., there is some evidence of the more unfavourable outcomes of traumatic injury being usually associated with ageing; this evidence considers the published systematic reviews on the subject (two of average quality, one of low quality, and two of very low quality), two non-systematic reviews (of very low quality), and experts' opinions [126]. With the present study, we have generated evidence about posttraumatic outcomes in senior people through a comparison between two medico-legal samples. Next, we discuss this aspect in more depth, considering temporary and permanent outcomes.

4.1.1. Evidence Regarding Temporary Outcomes

As expected, no relevant differences were found between G1 and G2 in terms of temporary damages, given that this study used propensity–ISS score-matched samples to ensure a similar degree of acute injury severity (Table 9 and Figure 7). That is, the cases started from the same degree of injury severity to assess whether they evolved differently according to age.

However, despite an absence of a significant OR, we noticed a tendency towards more days of *Total Temporary Functional Deficit* in the older population, in agreement with other authors [116, 122] and as we found in our previous study without matching ISS samples (P=0.001) [1]. Nevertheless, we should note that seniors are more vulnerable to bed rest and reduced food intake, which should be avoided due to the effects of immobilisation (loss of strength and muscle mass, decrease in aerobic capacity, and functional decline); such effects already appear with just ten days of bed rest [12, 128, 129].

A significant difference was found for *Partial Temporary Functional Deficit*, with a higher OR in G2. This result was also found in a previous study (P=0.005) [1] and may be related to the more demanding physical rehabilitation period in younger people, given the greater need for their activity (Table 10).

Although the literature reports that the elderly have greater resilience to pain than adults [50, 115], in our first study [1], a higher *Quantum Doloris* average was found in the elder group (P<0.001), but in the current study, no significant differences were observed (Table 10). This last result was expected, considering that the concept of *Quantum Doloris* includes the severity of acute injuries, which was forcibly similar in both groups [48].

4.1.2. Evidence Regarding Permanent Outcomes

Despite the similar injuries severity in the acute phase (Table 9 and Figure 7), the results showed a more significant negative evolution of the permanent outcomes in older adults (Table 11). This fact is widely reported in the literature but with very little evidence [12, 71, 102, 113, 117, 123, 124]. Our analysis derives from the results of the application of a tool used in Portugal, the *Inventory for Handicap Assessment* [57] (*three-dimensional methodology* of PIA), as well as of the Portuguese permanent damage parameters used in civil law.

Regarding the *three-dimensional* damage assessment, our results showed the following:

(a) *Body* sequelae: they were more frequent and more severe in G1 (Tables 11 and 12), increasing with age, especially from the age of 74. The most frequent sequels were orthopaedic, as occurs in the general cases of RTAs [1], but in G1, they were 1.7 times more frequent than in G2 (Table 11). Regarding neurological and psychiatric sequelae, the results did not show significant differences between groups, which may be associated with the small number of these cases in each group.

(b) *Functional* outcomes: G1 presented significantly more deficits in some of the analysed functions than G2 (Table 11) and greater severity outcomes (Table 12). *Functional* outcome severity was even higher than the respective *body* sequelae severity: 1.7 and 1.3 times more, respectively (Table 12). This leads us to consider that in this age group, any physical sequel, even a minor one, can have a high functional impact. Regarding chronic pain, we did not find differences between groups, perhaps because the number of cases was small (Table 11).

(c) *Situational* outcomes: G1 showed significantly more difficulties in the acts of daily life than G2 (Table 11). The severity of the outcomes was 1.3 times higher in G1 (Table 12). Following these real-life situations, G1 also presented a high OR for *permanent needs*, especially for third-party dependence (loss of autonomy);

(d) *Damage Coefficient*: it represents the average of *body, functional* and *situational* outcomes, shown to be 1.6 times more likely to evolve negatively in G1 than in G2, particularly for victims older than 74 years.

These results are well explained from a physiopathological point of view in the scientific literature. Physical health decline observed in older adults increases the probability of poor outcomes among these persons when they are victims of trauma. Even minor trauma can present more severe implications for a senior person when compared with a younger person who suffers the same injury [49, 50, 53, 71, 113, 114, 124-126].

Considering orthopaedic trauma, more frequent in RTAs [1], the bones of older people are less resistant, which is associated with a decrease in muscle mass (linked with age evolution), causing less resilience to traumatic mechanical forces. These effects act synergistically with some pathologies, such as osteopenia, osteoporosis, and sarcopenia, with the incidence of fractures even higher in persons with these health conditions. These comorbidities also make the recovery and return to the previous state more difficult as they reduce the physiological functional reserve [12, 71, 102, 113, 117, 123, 124].

Neurocerebral and psychiatric posttraumatic consequences are complex subjects, particularly in older persons. Associated with ageing, there is a gradual loss of cognitive abilities, explained by several factors, including changes in brain plasticity [103]. Traumatic events, even mild ones, can trigger or accelerate senile evolution due to the decrease in neurocognitive capacity; thus, cognitive changes can appear, such as distorted

consciousness, confusion, altered attention, thought, perception, and memory [3, 71, 124, 130-132]. A return to the previous mental state often occurs within a few days of the causal event. Nevertheless, it can also initiate neuropsychological dysfunction, which can progress to pseudodementia or dementia and can unmask previously unknown mental health conditions, leading to a significant reduction in health and functional status, with loss of autonomy and independence, and, consequently, a decrease in quality of life after trauma [3, 71, 133]. Studies have also shown a relationship between physical impairment and adverse psychiatric outcomes in people with a prior history of mental illness [133], with an increased disability expected in these cases [124, 130-132]. In addition, the loss of skills and functionality, affecting daily activities, can complicate and exacerbate the already existing mental issues [3], working like a snowball mechanism.

The literature suggests that older adults react better to chronic pain than younger adults, with middle-aged adults showing higher rates of catastrophic chronic pain [115] and a higher rate of depression associated with chronic pain than older adults [121]. These findings indicate that elderly individuals tend to be more tolerant of pain than younger individuals. Another study states that older adults react to actual pain intensity, while younger adults associate pain with emotional response [50]. However, persistent pain after trauma is frequent in older adults and is associated with functional decline and activity limitations, including in daily life tasks [53].

Functional capacity is an essential indicator of geriatric health because this deficit results in the loss of independence/autonomy and is a predictor of mortality [134]. As said before, even minor or mild injuries in the elderly can lead to loss of skills and activities/ participation regarding daily living tasks in previously independent and autonomous older adults [54]. Two years after the RTA, injuries continue to negatively impact the daily life of seniors, being associated with tiredness and increased physical limitations, decreased skills to perform activities of daily living, and consequences on social life [7, 19, 49, 50]. However, there are some positive predictors for returning to independent living after trauma, such as improvement in cognitive function, mobility, and nutritional status [134]. However, some reasons may justify why seniors limit their activities after trauma, such as: (a) the assumption that the loss of autonomy after trauma, in this age group, is a natural outcome; and (b) the fear of reinjury, mainly by the risk of falling, sometimes increased after trauma. This is a cause of reduced independence and autonomy in the activities of daily living [135], with higher rates of third-party dependence.

4.2. The Medico-Legal Relevance of More Severe Posttraumatic Outcomes in Older Adults than in Other Persons

The results of the present study led us to believe that the PIA methodology traditionally used may not be adapted to the correct evaluation of these cases in older people.

Medico-legal PIA rules vary between countries, according to each legislation and forensic organisation. Some do not have concrete rules for PIA, but others do, as happens in Portugal [48, 64, 69]. Nevertheless, most countries consider temporary and permanent damages with the respective damage parameters [73, 90-92, 101]. In general, the most valued parameters are those related to PFD and *Permanent Professional Repercussion*.

In the current study, PFD did not show significant differences between G1 and G2, despite increasing with age. This result was not expected, taking into account everything that has been said previously about the physiopathological aspects of trauma in the ageing process. This was also not expected, considering the results obtained with the *three-dimensional methodology*. It can, therefore, be considered that there is no total correlation between the evaluation obtained through the *three-dimensional methodology* and the use of the Portuguese table of permanent disabilities (Decree-Law 352/2007, 23rd October, annexe 2) to assess the PFD (compare the results of Tables 12 and 13).

We consider that one reason for these results may rely on the use of a table of permanent disabilities, which tends to value the *body* sequelae more than the *functional* and *situational* outcomes. A table of disabilities is a standardised tool that does not allow for personalised and comprehensive evaluations. On the contrary, functions and, particularly, situation descriptions can translate the reality of the aftermath of trauma regarding a person's reality in his or her different contexts of life and participation. Therefore, the PFD also needs to reflect these aspects, and experts should be attentive to correctly quantify this damage parameter, as well as others, particularly in seniors, avoiding limiting the PIA to the use of a table of permanent disabilities [126].

Another reason we consider is the previous health state of the victim; the group of older people necessarily presents more physical and mental weaknesses related to the physiological process of ageing. Simultaneously, this group presented high rates of pathologic and trauma history (92% and 37%, respectively, in our study). Thus, it is possible to admit that it is sometimes difficult to distinguish, in the analysis of the previous state, which aspects are due to ageing, a prior disease, or trauma (e.g., joint arthrosis). This fact

can lead the experts, when using a table of disabilities, to determine the PFD with a greater focus on *body* sequelae based on what was expected, given the injury that gave rise to it. On the other hand, if the expert considers that the previous state has worsened or was aggravated by the sequelae of the trauma, the PFD will be less valued than if everything resulted from it. These aspects may explain why the PFD has not increased proportionally to the different levels of the *three-dimensional methodology* and the *damage coefficient*. This is a key point on this subject, which will deserve a discussion later in this paper.

Consequently, we think that a global and personalised PIA is compulsory, especially in senior cases, to correctly contextualise all aspects related to changes due to age.

Permanent Aesthetic Damage was the only parameter of damage assessed that was significantly different between groups, being less valued in G1 than in G2 (Table 13). This is understandable because older people do not have the same exigences as young people in this matter, but we must be careful with this aspect, respecting the perception of each person, independent of his or her age.

Considering *Permanent Repercussions of Sporting and Leisure Activities*, we have found no differences, although G1 was higher, which may be due to the contrariety/frustration related to the loss of independence and autonomy (Table 13).

Other damage parameters were not analysed for the reasons described in the Materials and Methods chapter, but increasingly, issues such as sexuality and work activity are also relevant for older people. Ignoring these aspects just because of age can be considered ageism, and experts should take this into consideration.

4.3. Time of the First Medico-Legal Examination in Older Adults

According to a study performed by the *Associação Portuguesa de Seguradores* [136], the minimum time interval before the injured person undergoes medico-legal evaluation may depend on the severity of each case and the scope of the expertise. The date of the first assessment of damage by the insurer's medical expert should occur within 30 days after the accident, whenever possible. This first evaluation aims to: (a) assess the quality/suitability of the provided treatments (including rehabilitation measures); (b) forecast future damages, which allows the insurer to make a provision; (c) signal possible needs (e.g., support products, home adaptation, third-party assistance); and (d) contribute to the preparation of clinical discharge (return to home). Follow-up evaluations will follow, which must be

conducted by the same expert who carried out the first evaluation, with the appropriate frequency for each case, and maintain the same objectives mentioned above. During this entire period, if necessary, rehabilitation and reintegration teams are mobilised to evaluate and prepare an intervention plan, chosen, as far as possible, by agreement between the insurer and the victim or his or her legal representative. When the clinical stabilisation of the injuries is reached and the rehabilitation process related to the acute phase is concluded, the medical-legal expert will carry out the final PIA, which aims to describe and quantify the temporary and permanent damages (including economic and noneconomic damages) as well as identifying permanent needs (e.g., support products; home, workplace, and/or vehicle adaptations; third-party support). According to our study, the final PIA requires an average of 300 days to take place (Min=15; Max=1888).

If there is no agreement between the parties, there will be a legal process, and in this case, expertise at the National Institute of Legal Medicine and Forensic Sciences (INMLCF) will be mandatory, which, in principle, should only take place after the medico-legal consolidation. According to our study, the consolidation time (*Total Temporary Functional Deficit* plus *Partial Temporary Functional Deficit*) is, on average, 200 days (Table 10).

4.4. Number of Medico-Legal Examinations in Older Adults

The number of examinations vary according to their context.

At Portuguese insurance companies, after the first evaluation, the necessary follow-up consultations should be conducted with the appropriate frequency for each case [136]. When the medico-legal consolidation of the injuries is reached, the expert may perform the final PIA [136].

At the INMLCF, there may be several evaluations, even if the medico-legal case is consolidated. This is because the expert responsible may request ancillary exams or specialised medical advice, or, in some rare cases, the injuries may not have consolidated yet [48, 64, 69].

4.5. Duration of the Medico-Legal Examination in Older Adults

This aspect varies, obviously, according to the demand and necessity of the victim. The more complex the case, the longer it may be. It also varies with the type of examination

(preliminary, follow-up, or final). According to our experience, the average time is 1.5 h if we consider that there will be more than one examination during the recovery time. In severe cases, 2 h may not be enough; however, the patient may not be able to handle more than that, so a new appointment may have to be made to complete the evaluation.

4.6. Logistical Conditions of the Medico-Legal Examination in Older Adults

Regarding the logistical issues of the visit, in Portugal, this can occur in an inpatient setting, in the patient's home or institution, via video call, or in the expert's office. We believe that video call consultations can be useful to maintain a regular follow-up of these persons, avoiding the inconvenience related to their displacement, especially when large distances and mobility problems are involved; however, they can only take place in some moments of the follow-up, and in most cases, elderly victims need the support of someone to use the informatic tools. In the case of the expert's office, it will be important to ensure a comfortable space with adequate dimensions to admit a patient on a litter or in a wheelchair as well as an observation table that allows height adjustment. A special mention must, however, be made concerning evaluating people in their real living spaces. The victim's inhabiting environment is one of the most significant determinants of his or her situation and participation [58]. It can offer both barriers and resources that can alter the individual's autonomy and involvement in activities that interest him or her. The association between the individual's intrinsic capabilities and the characteristics of their life-space and their interaction are fundamental in determining his or her functional abilities and the degree of independence and autonomy. Thus, in the more complex and severe cases, these evaluations should be conducted at the victim's home or nursing home as part of a multidimensional assessment program for older adults [104, 126].

4.7. Accompanying Person of the Older Adult Examination

In Portugal, the family member or caregiver can attend the medico-legal visit whenever the victim wants them to or whenever the victim is unable, by his or her means, to participate in the clinical interview. In principle, they will only be able to assist and provide the necessary support to the victim, not being authorised to intervene. However, especially in the case of older people, whether due to cognitive, hearing, or other problems, we consider that the

intervention of the family member or caregiver can be beneficial for the expert to provide the necessary information or complement/validate the information given by the victim.

We also consider that to perform the physical examination, the expert must ask the victim again whether he or she still wants the presence of the accompanying person. If this person remains present during the physical examination, his or her assistance in, for example, walking or undressing/dressing clothes, should only be consented to after the expert has observed the victim trying to do so by his or her own means.

According to our opinion, this presence should be registered in the medico-legal report.

4.8. Access to Clinical Information about the Case

The information required from the victim and/or his or her accompanying person will be related to the circumstances of the accident, his or her personal trauma experience, the resulting injuries, the subsequent treatments and eventual hospitalisations, medical consultations, ancillary exams, and rehabilitation therapies, in addition to the information about his or her pathologic/traumatic history (previous status) [48, 64, 69]. The clinical records will later confirm and complement all this information [48, 71]. For this last purpose, in the case of private medical practice, in Portugal, the victim or his or her legal representative can provide the clinical records to the expert, authorising them to consult and transcribe what they deem appropriate. If they do not have these clinical elements, a written authorisation can be given to the insurance company or the physician to request these documents directly from the respective institutions. In this study, the experts had access to the needed information.

According to the law (Law 45/2004, 19th August, actualised by the Decree-Law 53/2021, 16th July), in the INMLCF case, an expert may directly access these documents within the public services or request them from other institutions without the need for consent by the victim or his or her legal representative.

The victim must also respond to his or her complaints in functional and situational terms through questions that should be as open as possible and not suggestive. To describe the complaints, in Portugal, medical experts follow the *three-dimensional* PIA model [57]. In the case of the first exam and follow-up exams, the medical expert must, at the end of the visit, inform the victim about his or her clinical evolution and the therapeutic and support procedures that will follow, verifying if there is motivation and agreement from the victim.

In the case of the last visit, the expert must explain which route will be given in the medico-legal report at the end.

4.9. Access to Information about the Previous State

As said before, the previous health state is a crucial point in PIAs, mainly what older adults are concerned about. Therefore, the medico-legal expert must always collect the preinjury status.

This may be possible through information directly provided by the victim or whoever represents him or her [71]. However, the victim often does not understand the objectives of the medical-legal evaluation and may act with reserve or suspicion and might, consciously or not, act with simulation, dissimulation, or exaggeration of his or her complaints. Thus, the victim can conceal his or her previous status, not collaborate with the physical exam, or report overstated complaints and disabilities, with a discrepancy between these and the physical exam as well as the ancillary exams performed.

Therefore, the experts must have access to clinical medical records and other documents that could inform them about the previous situation of the victim. Nevertheless, in Portugal, if acting in public service (INMLCF), the experts have the legal right to access clinical documentation (Law 45/2004, 19th August, actualised by the Decree-Law 53/2021, 16th July); the same is not valid for private services (including insurance companies) due to the right of privacy and to the Personal Data Protection Law (Decree-Law 58/2019, 8th August). Thus, this aspect can be a complex problem, given that most PIAs related to RTAs take place using insurance companies' medical services. In this way, to achieve a reliable reconstitution of the previous health state, the medical experts of the insurance companies must explain to the victims and/or to their representatives the importance of providing all the documents needed (including reports from the general practitioner physician), authorising their consultation and description in the medico-legal report. This may promote the extrajudicial resolution of the case instead of a court resolution, which further increases the costs of the process and delays the conclusion of the case. In the present study, much of the information considering the previous state was obtained through the hospital clinical reports related to the accident, where the pathologic history is usually described. Additionally, several times, the physical examination and ancillary exams allowed us to obtain important information about prior conditions.

The information needed should include, among others, the following [48, 71, 126]: (a) preexisting pathologies, malformations, and previous trauma history; (b) pharmacological, psychological, or rehabilitation therapies; (c) history of regular consultations, and previous ancillary exams; (d) ageing process and related frailties; (e) former functional status, including cognitive performance (memory impairments, education status, mental disabilities, or other problems); (f) independence level and personal autonomy degree (ability to perform autonomously personal care, autonomy in activities of daily living, domestic tasks); (g) consumption habits (alcohol, tobacco, and other drugs); (h) nutritional conditions (type of alimentation, including weight); (i) lifestyle (physical activities, hobbies, sports, recreational tasks, among others); (j) family context and affective state; (k) social relations, interactions, and leisure activities; and (l) professional activities among others with economic relevance.

Nevertheless, according to our experience, all this information may not be obtainable just through medical documents, and therefore, a multidisciplinary assessment, including the participation of social workers and psychologists, in certain cases at the victim's place, can be extremely helpful in informing the expert [136].

4.10. Aspects to Be Considered in Damage Assessment in Older Adults

The expert should perform a personalised and comprehensive evaluation, including *functional* and *situational* complaints and the results of the body examination [48]. The confrontation of the findings between them and with the mechanism of the trauma, injuries, treatments and clinical complications may orientate the expert to determine the date of consolidation and the causality link [70]. However, we consider that the expert should always have in mind that in older person cases, this should not be enough, and deep information about the previous state should be sought, as well as a multidimensional/multidisciplinary examination *in-loco* performed, particularly in more severe or complex cases.

4.11. Ancillary Exams in Older Adults

These exams can be very useful not only for the current medico-legal diagnosis of lesions but also for detecting previous pathologies or sequelae that should be considered. In the cases where the medico-legal expert requests an exam, the patient or his or her legal representative needs to give the necessary informed consent.

4.12. Causal Link in Posttraumatic Cases of Older Adults

Our practice shows that one of the great difficulties that can be felt by medico-legal experts in the PIA of senior persons may be related to the link between trauma/injuries and the effective permanent outcomes, especially *functional* and *situational* outcomes, which often seem to be disproportional to *body* sequelae. This creates problems in the discussion and admissibility of the nexus link and the assignment of the medico-legal damage parameters, including the real permanent needs of the older person. However, it is overly noted in the literature and this study that older adults can lose their autonomy and become third-party-dependent when suffering even minor injuries [12, 54, 120]. Thus, when evaluating elderly persons, medico-legal experts should perform a comprehensive and personalised assessment to try to understand the whole picture, considering the real context of the person's life and avoiding limiting the PIA to the injury or *body* sequelae evaluation [48, 69, 71], always keeping in mind the evidence regarding the physiopathology of trauma in elderly persons.

The expert must analyse the various assumptions involved in its evaluation [48]: (a) consistency between the type of injury or sequelae and the concrete trauma dynamics; (b) consistency between the type of trauma and type of injury or sequelae incurred; (c) consistency between the site of the trauma and the site of the injury or sequelae; (d) anatomical–clinical consistency between the trauma and injury or sequelae; (e) temporal consistency between the event, injury, and sequelae; (f) exclusion of the possibility that the injury or sequelae may have pre-existed; and (g) exclusion of the possibility that the injury or sequelae may have been caused by a mechanism other than the event.

In the case of older people, each of these assumptions is a challenge in our daily clinical practice, but the most difficult will often be relative to the previous state. Fundamentally, the discussion of the anatomical–clinical consistency between the trauma and sequelae/outcomes will mean that the expert will be able to explain why he or she accepts the nexus with some outcomes and not with others [70]. For this, we advise the experts to always consider the victim in his or her real and specific life context, as well as to be aware of the current knowledge regarding the effect of trauma on the ageing process, which can lead to unexpected and serious developments.

Thus, it is essential to consider not only the specific previous diseases and comorbidities, along with the current sequelae, but also how they interact and impact each other and with the victim's functionality and integration into his or her environment, which is also a much better predictors of survival and other outcomes [56, 126].

In a simplistic way, we could say that the expert should compare the victim's previous state (considering all the above information) with the posttrauma status. The difference between the previous and the current status should be considered to correspond to the damage resulting from the accident. As mentioned before, even minor or mild injuries and sequelae in older people can evolve from a state of total autonomy to a status of dependence with a loss of autonomy [12, 54, 120]. Furthermore, one must always keep in mind that age is not a co-cause [71], although this consideration deserves a special discussion due to the fact that old age is currently included in the ICD-10 [107]. In any case, as demonstrated in this study, trauma does contribute to worse outcomes in older people, and the medical expert must know the physiopathological consequences of trauma in the ageing process and accept them in the causal nexus, totally or partially, since this evolution is clinically reasonable and explainable.

4.13. Consolidation Date in Older Adults

In general, consolidation in older persons should be considered when no further evolution of the injuries is expected, as it happens in other cases [64, 69]. However, in more complex or severe clinical situations, physical and functional consolidation may not be enough. In these cases, the medico-legal expert should wait for the reorganisation of their livelihood to be carried out, as well as the reintegration process [48].

According to our study, the consolidation time (*Total Temporary Functional Deficit* plus *Partial Temporary Functional Deficit*) is, on average, 200 days after the RTA for G1, while it is higher for G2. Our practice shows that this date sometimes may be assigned earlier than for younger people, as the demands in terms of the outcome of rehabilitation may not be very high for the type of daily activity they will have. On the other hand, many of these people will maintain rehabilitation treatments regularly for the rest of their lives, which does not mean that the consolidation date is extended indefinitely. Furthermore, it is often important for the victim to complete the insurance process, which is regularly associated with the consolidation date. Another relevant decision, in some cases, is about a new living place for that person. In any case, we consider that consolidation should not be assigned before all these logistical aspects are well defined and implemented, an aspect that may substantially extend the consolidation date in the more severe cases.

4.14. Assessment Tools in Older Adults

In Portugal, we use the *three-dimensional methodology* to describe the sequelae [48, 57, 64, 69]. However, more important than a tool is that the medico-legal expert rigorously and systematically describes all of the complaints in functional terms and in the patient's real-life situation, which must be compared with the results of the physical examination and other eventual ancillary exams, to assess the feasibility of these complaints.

To quantify the damage, we use a scale of 1–7 degrees of increased severity for noneconomic damages and a table of permanent disabilities in civil law to determine PFD (Decree-Law 352/2007, 23rd October, annexe 2).

The results of the use of these instruments may not always be well aligned, especially in the case of older people, as verified in this study. Therefore, we think that the medico-legal expert must use them in a complementary way, with his or her clinical and medico-legal judgement always prevailing, taking into account the concrete reality of the case and the result of other forms of evaluation that he or she may resort to.

4.15. Multidisciplinary and Multidimensional Assessment in Older Adults

A multidimensional assessment of older persons should be undertaken, especially in severe cases and where accessibility and mobility are concerned [58]. However, we believe that other aspects must also be considered, such as social isolation, poverty, and difficulties in familial dynamics. In this sense, the multidimensional assessment requires a multidisciplinary approach, that is, not only by the medico-legal expert but also with the contribution of other professionals, whose expertise may vary according to the specific case (e.g., social worker, psychologist, rehabilitation nurse, ergo-therapist, engineer, architect). This *in-loco* evaluation may allow, in addition to the physical and functional assessment, the real analysis of the situational state, such as in activities of daily living, evaluating the ability to perform basic activities (e.g., eating, mobility, use of the toilet, dressing, and bathing), instrumental activities (e.g., using the telephone, shopping, preparing food, taking care of the house, washing clothes, using transportation, taking responsibility for his or her medication, and taking care of his or her economic affairs), and advanced activities (e.g., cultural, recreational, and professional activities) [48, 57, 71, 126].

Our experience shows that these collaborations may also allow a more comprehensive evaluation and help the expert to prepare a medico-legal report that, in addition to the

assessment of the various damage parameters, also considers the real temporary and permanent needs of the victim in his or her concrete life contexts. Moreover, the identification *in-loco* of the various difficulties and limitations resulting from the RTA for the victim will better allow the expert to substantiate the causal link between the trauma suffered and the resulting outcomes. This reasoning, when decontextualised from the reality of each individual, may not be sufficiently enlightening and may lead to the underestimation of the true damage suffered by seniors.

In more complex cases, the evaluation of mental status must be performed by a psychiatrist and/or a psychologist. We consider that this, perhaps, the most difficult part of the older person assessment and of causal link discussion because even without brain injuries, intellectual functions (such as attention, memory, spatial perception, orientation, judgement capacity, ability to expose and solve problems, language and psycho-affective framework, maintenance of interests, sleep quality, mood, and sense of well-being) may decline or be aggravated by injuries, trauma experience, hospitalisation, removal from home and family, and the interruption of life routines, among others. This functional mental damage will affect daily life, social and leisure, and relational activities [3, 48, 71, 130, 131].

Many of the aspects covered in our study are already based on information resulting from hospital, home, and video consultations prior to the last consultation, which, the vast majority of the time, is at the doctor's office.

5. Limitations of this study and further studies

The limitations of this study were: (a) the use of a convenience sample with a relatively small size, which was not possible to avoid in the current study, considering the available data; (b) the fact that the analyses of the temporary outcomes and the higher vulnerability of the older adults to the initial trauma impact were impaired by the study's design (match of the ISS); (c) the delimitation of the study to RTAs and to the Portuguese context in civil law; (d) the absence of the analysis concerning the number of medico-legal examinations that the victims underwent and the respective duration, as well as the concrete difficulties in access information about the previous state of the victim; and (e) the absence of a validated tool to assess older adults in the *three-dimensional* perspective, although we used a validated inventory for RTA outcomes assessment in a medico-legal context [57].

Further research should consider: (a) a real-world, retrospective, observational, and cross-sectional study on this subject using a federated data analysis methodology, which may constitute an essential contribution to a better understanding of these complex cases; (b) a study including and comparing other countries to understand if there are differences when considering other realities; (c) a study focusing on a multidimensional and multidisciplinary approach in these cases; (d) a study considering another kind of trauma (e.g., occupational accidents); and (e) the validation of the *Inventory for Handicap Assessment* for individuals over 64 years old.

6. Conclusions

The present study used a sample of RTA victims aged 65 years or more (G1), which was compared with another sample of younger victims (G2), assuring a similar degree of acute injury severity in both (using propensity–ISS score-matched samples). We verified the following:

(a) In G1, 92% had a pathological history (8.7 times more than G2) and 37% had a trauma history;

(b) No relevant differences were found between G1 and G2 in terms of temporary damages, as expected, given that both age groups had a similar degree of acute injury severity; an exception was found for G2, which had a higher *Partial Temporary Functional Deficit* than G1 (OR=0.99);

(c) Regarding the *three-dimensional methodology* evaluation of permanent outcomes, G1 presented more sequelae than G2: (a) *body* sequelae—orthopaedic (OR=1.7); (b) *functional* outcomes—carriage, displacement, and transfers (OR=1.6), manipulation and grip (OR=1.8), and sphincter control (OR=3.8); and (c) *situational* outcomes—acts of daily life (OR=2.9); G2 had more nonexistent *body* sequelae (OR=0.5) and *functional* outcomes (OR=0.4);

(d) All three levels of damage severity (*body*, *functions*, and *situations*) and the *damage coefficient* were much more severe in G1 (1.3, 1.7, 1.3, and 1.6 more times, respectively);

(e) G1 presented more *Permanent Needs* than G2 regarding third-party assistance (OR = 3.5), medication (OR=2), and technical aids (OR=2.4); G2 evolved more without any *Permanent Needs* (OR=0.4);

(f) There was no difference in the *Permanent Functional Deficit* between the two age groups, although G2 was assigned more grade 0s (OR=0.5) and G1 more grade 2s (OR=1.8);

(g) G2 was assigned more *Permanent Aesthetic Damage* than G1 (OR=0.9).

This study offers evidence that the consequences for older victims of RTAs are more severe than for younger counterparts. Based on these results and the literature, we offer some contributions to set the grounds for posttraumatic senior PIA guidelines.

3. Children outcomes in road traffic accidents: Challenges for personal injury assessment[3].

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ABSTRACT

(1) Introduction: Children represent a specific group of victims of road traffic accidents (RTAs). Performing a children's personal injury assessment (PIA) represents a significant challenge, especially the assessment of permanent disabilities and needs. However, medico-legal recommendations for PIA in these cases are lacking. (2) Objectives: The main objective of this study is to analyse the differences between children and a young- and middle-aged adult population of victims of RTA, aiming to contribute to future guidelines on the subject. The secondary objectives are to identify and characterise specificities of children's posttraumatic damages regarding: (a) temporary and permanent outcomes; and (b) medico-legal damage parameters in the Portuguese context. (3) Methods: A retrospective study of victims of RTA was performed comparing two groups (n=114 each) matched for acute injury severity (ISS *standardised difference*=0.01): G1 (children); G2 (young- and middle-aged adults). Logistic regression was used to estimate the odds ratio. (4) Results: G1 presented a greater chance of evolving without or with a less severe *body*, *functional*, and *situational* outcomes (*three-dimensional* assessment methodology) and with lower *Permanent Functional Disability* values than G2. (5) Discussion and Conclusions: Our findings suggest that childhood trauma generally has a better prognosis than that in young and middle-aged adults. This study generated evidence on the subject, highlighting the most significant difficulties encountered by medico-legal experts in children's PIA.

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Keywords: Road traffic accident; Medico-legal evaluation; Injury assessment; Damage assessment; Outcomes; Children

Key points:

• This was a retrospective study of personal injury assessment in children victims of road traffic accidents in Portugal and considered the outcomes in the victims' real-life situations.

• Several significant differences between children and young- and middle-aged adults were observed.

• Children's cases presented better results for the severity of *body*, *functional* and *situational* outcomes, and permanent damage parameters.

• The average time between RTA and final PIA date and the consolidation time was longer in children due to the need to wait for the child's next phase of growth or their final pubertal period in some cases, which increases the time for PIA conclusion.

• Several difficulties occur in the medical-legal evaluation of children's cases, being a complex process due to trauma affecting a person in the growth phase.

1. Introduction

Accidental injury is one of the leading causes of death and acquired disability in children [10-16]. In the United States, the overall paediatric trauma survival rate ranges from 80 to 95% [11-14, 24]; in the Netherlands, for every child killed in road traffic accidents (RTA), another 42 are seriously injured [137]. In Portugal, in 2019, among 5700 children's RTA victims, 0.6% died, 3.5% were seriously injured, and 95.9% suffered minor injuries [27].

These nonfatal injuries, even those that are mainly minor, can have significant short- and long-term corporal and psychological outcomes associated with significant losses in all life contexts, including quality of life. These injuries represent one of the leading causes of temporary and permanent disability with a significant negative impact on families and community networks [11-14, 16, 21-24].

Children are an especially vulnerable group in traffic. In particular, younger children have an increased risk of being run over by a vehicle because, despite already having the necessary motor skills to walk on the streets, they lack cognitive, sensory and behavioural perception skills to perceive traffic and its risks as well as to understand the meaning of road signs [138, 139]. Being run over by a vehicle is the leading cause of death and disability in children in multiple countries [34, 35], and the respective injuries tend to be worse than those suffered when inside motor vehicles [140]. Furthermore, children suffer different injuries than adults because: (a) their mass is less than that of

adults, and their kinetic force is also reduced, causing a lower-intensity accident; and (b) children sit in the vehicle's rear seats, where they are more protected. Thus, injury patterns also differ between children and adults. Children tend to have fewer thoracic, intraabdominal, pelvic and long bone injuries and evolve with a lower *Injury Severity Score* (ISS) despite a higher Glasgow Coma Scale [139, 141]. Additionally, the evolution and severity of injuries and their outcomes tend to have a better prognosis in children than in adults [1, 71].

These results may be due to a better adaptive process and more remarkable physiological plasticity with a better response to trauma, which allows children to evolve further without permanent sequelae [71]. However, when cases evolve with sequelae, it is a great challenge to perform children's personal injury assessment (PIA), namely, in what concerns permanent disabilities and needs, which are very difficult to predict for their future life. Nevertheless, to the best of our knowledge, there are no published medico-legal recommendations for PIA in children's cases. Therefore, it is urgent to develop medico-legal research on these cases to support medical experts with scientific evidence.

The main objective of this study is to analyse the differences between children and a young- and middle-aged adult population of victims of RTAs, aiming to contribute to future guidelines on the subject. The secondary objectives are to identify and characterise specificities of children's posttraumatic damages regarding: (a) temporary and permanent outcomes; and (b) medico-legal damage parameters in the Portuguese context.

2. Materials and Methods

2.1. Data Collection Methodology

This is a retrospective study using a convenience sample based on medico-legal reports of PIA cases. The reports' inclusion criteria were as follows: (a) final medico-legal report about victims of RTA, showing that the causality link between the trauma and injuries was established; (b) victims under 65 years of age; (c) performed at a health care unit of a Portuguese insurance company; (d) between 2018 and 2020; and (e) assessed by three selected physicians with specialisation in forensic medicine and a high experience in PIA to assure data reliability (all of physicians are aligned with the official Portuguese rules, including the *three-dimensional methodology*, for describing

permanent outcomes [48, 64, 69] and the different parameters of damage in Civil Law, for outcome quantification [64, 69]). We did not consider the victim's sex, the accident type, or the type of insurance responsibility – with or without fault – at this stage.

One of the children's cases was excluded because it deviated too much from the median. It was a case in which the outcome was a persistent vegetative coma, which exaggeratedly increased the results of the mean values of the children. However, this case is presented and discussed later.

A database was created for the study and completed by one of the physicians who performed the medico-legal assessment of the cases. No information was included that could allow those involved to be identified.

Two age groups were considered: (a) G1 – children (<18 years old – the World Health Organization defines a child as someone under 18 years of age unless a national law defines otherwise [142]) [*n*=114; 50%]; and (b) G2 – young- and middle-aged adults (18-64 years old) [*n*=114; 50%]. G2 were identified from an original sample of 431 persons using *propensity score matching* with SPSS software. G1 corresponded to the analysed sample, and G2 corresponded to the control sample. G1 included 65 (57%) males, and the age average was 11.4±4.8 years (<1 year old: 1.8%; 1-4 years: 7.8%; 5-10: 30.8%; and ≥11: 59.6%).

ISS [44, 45] was used as a predictor to ensure that G1 and G2 presented a similar initial picture after the RTA. ISS was retrospectively estimated in the acute phase of the cases, considering the clinical records. The ISS variables were categorised into four classes, as shown in Table 14. To determine whether the matched samples were comparable, we used the *standardised difference*, which is considered balanced when it is ≤0.1 [127]. Thus, as shown in Table 14 and Figure 8, our samples are balanced across all the selected predictors.

Table 14 – Matched sample characterisation regarding ISS

	ISS	**Total** (n=228)	**G1** (n=114)	**G2** (n=114)	***Standardised difference***
$\overline{X}$		9.3 ± 9.5	9.3 ± 9.4	9.3 ± 9.7	-0.001
n (%)	0 (no acute lesion)	3 (1.3)	2 (1.8)	1 (0.9)	-0.006
	1-8 (mild/moderate)	106 (46.5)	52 (45.6)	54 (47.4)	0.02
	9-15 (serious)	77 (33.8)	39 (34.2)	38 (33.3)	-0.008
	16-24 (severe)	22 (9.6)	11 (9.6)	11 (9.6)	0
	≥25 (critical)	20 (8.8)	10 (8.8)	10 (8.8)	0

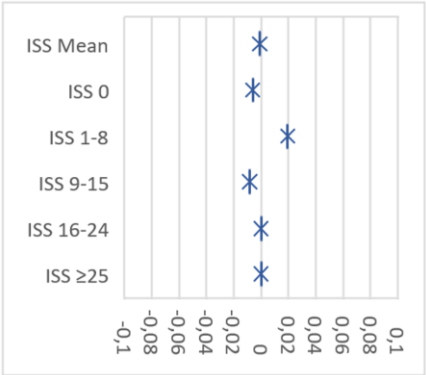

Figure 8 – Matched predictors' *standardised difference* (*Propensity Score Matching*)

2.2. Assessment methodology

The clinical records were analysed to retrospectively estimate injury severity in the acute phase (ISS) [44, 45]. The ISS variables were categorised into classes as 0 (nonexistent), 1-8 (minor or moderate), 9-15 (serious), 16-24 (severe), and 25-75 (critical).

The *three-dimensional methodology* (*body*, *functional* and *situational* levels) was used to describe permanent outcomes according to the official Portuguese rules [48, 64, 69]. This methodology includes the *Inventory for Handicap Assessment* [57], which was used to quantify permanent outcome severity. It is a tool validated for Portuguese victims of RTA between 16 and 65 years of age. However, we chose it because it is a medico-legal inventory intended for PIA purposes and because no other instrument has been validated for the child population to date to our knowledge. This tool allows us to quantify the severity degree of the *body*, *functional* and *situational* levels and the *damage coefficient* [1, 48, 57]. This *coefficient* corresponds to the average of the final scores resulting from each scale of three referred levels and considers five severity groups of increasing severity. The meaning of each level is provided [1, 48, 57]: (a) *body* level, which assesses biological outcomes that may include morphological, anatomical, histological, physiological, and even genetic particularities; (b) *capacities/functions* level, which assesses physical and mental capacities (current or potential), taking into account age and sex, irrespective of the live setting; and (c) *life situations*/*participation*/*activities* level, which assesses the confrontation (concrete or potential) between those affected and the reality of their physical, familial, social, cultural, educational and professional environment.

To quantify the different parameters of damage in Civil Law, we used some of the Portuguese medico-legal damage parameters [64, 69]:

a) *Total Temporary Functional Deficit*: period (days) in which the victim is prevented from autonomously performing acts of daily, family, and social life (without any reference to professional activity). This parameter mostly corresponds with hospitalisation time;
b) *Partial Temporary Functional Deficit*: period (days) in which the victim may resume activities of daily, family, and social life with some degree of autonomy, although still with limitations;
c) *Quantum Doloris*: physical and psychic suffering experienced by the victim during the period of temporary damage based on a 7-point scale of increasing severity;
d) *Permanent Functional Deficit* (PFD): definitive effects on the victim's physical and/or psychic integrity with repercussions on daily life activities, including family and social life, leisure, and sporting activity, although it is independent of professional activities. This parameter is assessed on a 100-point scale of increasing severity and was categorised as 0, 1-9, 10-19, 20-39 and 40-100 based on the case distribution and the severity groups;
e) *Future Damage*: damage that is not yet observable in the PIA but is certain to develop, corresponding to an aggravation of the sequelae in the future and consequent aggravation of specific damage parameters, namely, PFD;
f) *Permanent Aesthetic Damage*: repercussion of the sequelae upon the victim's self-image and image from others. This parameter is rated on a 7-point scale of increasing severity;
g) *Permanent Repercussion on Sporting and Leisure Activities*: the impossibility of the victim engaging in certain leisure, physical or social activities that he or she regularly participated in and that represented a clear source of personal fulfilment and gratification. This parameter is rated on a 7-point scale of increasing severity;
h) *Permanent Needs*: the victim's needs, with repercussions on his or her independence and autonomy. This parameter should be assessed considering the victim's best chances of rehabilitation and reintegration.

We did not analyse *Permanent Repercussion on Sexual Activity* despite it being a critical function to assess. Additionally, we did not analyse *Temporary Professional Repercussion* and *Permanent Professional Repercussion* because children can only start working from 16 years of age (Decree-Law 7/2009, 12th February) in Portugal. Children in Portugal generally do not work before 18 years of age (*n*=4 in our sample).

2.3. Data analysis

All analyses were performed using SPSS for Windows Version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to describe the study population in total and stratified by age. The chi-square test was used to assess the dependence between the frequency variables. Continuous variables were assumed to be normal. Logistic regression was used to estimate the odds ratio (OR), considering the 95% confidence interval (95% CI) for all measures of effect analysed. The OR was statistically significant if the confidence interval did not cross the value 1. In all analyses, the level of statistical significance was set at a p value of <0.05.

3. Results

The average timespan between the RTA date and the final PIA date was 510.1±764 days (Min=28; Max=4476), and the average consolidation time was 321.8±572 days (Min=6; Max=4311). Both results demonstrated statistical significance for global samples (Table 15).

However, due to the stage of children's development when they suffered the RTA, in 17 cases, the experts had to delay the last PIA until the next developmental phase (*n*=10) or growth stabilisation (*n*=7), which corresponds to the end of the pubertal period. In these cases, the timespan between the RTA date and the final PIA date as well as the medico-legal consolidation date are described in Table 15, and significant differences are noted. The injuries in these cases included: (a) upper and lower limb fractures (*n*=13); (b) traumatic brain injuries (*n*=9); (c) facial bone fractures (*n*=4); (d) severe vertebral fracture/spinal cord injury (*n*=4); (e) thoracic/abdominal trauma (*n*=4); (f) severe tooth lesion (n=1); and (g) ear trauma with tympanic membrane perforation (*n*=1). In several of these cases, the victims had more than one type of injury.

Evaluating the global sample after removing the 17 referred cases (*n*=211), the average timespan between the RTA date and the final PIA date was 321.8±256.9 days (Min=28;

Max=1495), and the medico-legal consolidation date was 219.7±220.6 days (Min=6; Max=1248) (Table 15).

Table 15 – Average timespan between the RTA date and the final PIA date and medico-legal consolidation date

	Average time (days)	G1	G2 (*n*=114)	OR	95% CI Min-Max
RTA/PIA date	Global sample (n=114)	676.2±1021.8		1.01	1-1.01*
	Considering 17 cases in G1	2848.5±1066.4	344.1±269.7	1.08	1.01-1.02*
	Global sample without the 17 cases (n=97)	295.5±239.6		0.99	0.98-1.00
Medico-legal consolidation	Global sample (n=114)	400.6±766.5		1.01	1-1.01*
	Considering 17 cases in G1	1588.8±1469.6	243.1±239	1.03	1.01-1.04*
	Global sample without the 17 cases (n=97)	192.3±194.4		0.99	0.98-1.00

Regarding the previous state of the victims before RTA, we observed the following significant differences: (a) 39.5% (*n*=90) presented a pathologic history, including 22.8% in G1 and 56.1% in G2 (OR=0.2, 95% CI=0.1-0.4); (b) 20.6% (*n*=47) presented traumatic history, including 6.1% in G1 and 35.1% in G2 (OR=0.1, 95% CI=0.1-0.3).

3.1. Temporary outcomes

The temporary outcomes are described in Table 16.

Analysing the *Total Temporary Functional Deficit* and the *Partial Temporary Functional Deficit* without the 17 cases described above, the average time in G1 was smaller in both damage parameters. Regarding the *Total Temporary Functional Deficit*, the average was 6±12.4 days (OR=0.96, 95% CI=0.97-0.99), and a significant difference was noted between the groups. Regarding the *Partial Temporary Functional Deficit*, the average was 187.9±196.7 days (OR=0.94, 95% CI=0.99-1.001), and no significant difference was observed.

The *Quantum Doloris* results were similar in G1 and G2, with most victims assigned with grade 3 or 4 in both groups.

Table 16 – Temporary outcomes (medico-legal damage parameters)

			G1 (n=114)	G2 (n=114)	OR	95% CI (Min-Max)
Temporary Functional Deficit ($\bar{X}$ days)	*Total*		14.8±33.6	36.1±112	0.996	0.99-1.01
	Partial		328.7±609.9	190±193.1	1.001	1-1.002*
Quantum Doloris (Grade 1-7)	$\bar{X}$		3.7±1	3.8±1	0.95	0.7-1.2
	n (%)	1-2	12 (10.5)	11 (9.7)	1.1	0.5-2.6
		3-4	81 (71.1)	82 (71.9)	0.96	0.5-1.7
		5-7	21 (18.4)	21 (18.4)	1	0.5-2

* Significant differences

3.2. Permanent outcomes

Using the *three-dimensional methodology*, the description of the permanent outcomes is presented in Table 17, and the severity degree is presented in Table 18.

G1 presented a greater chance to evolve without any of the three sequelae levels assessed (*body*, *functions*, and *situations*): OR = 2.8, 3.4, and 3.6, respectively. G1 also presented 50%, 80%, 70% and 50% increased chances to evolve with a minor severity of *body*, *functional*, and *situational* outcomes as well as *damage coefficient*, respectively.

Few *permanent needs* related to the RTA were noted overall with most G1 and G2 evolving without them.

Table 17 – Permanent outcomes (*three-dimensional methodology*)

		G1 (n=114)	G2 (n=114)	OR	95% CI Min-Max
Body	Orthopaedical	36 (31.6)	75 (65.8)	0.2	0.1-0.4*
	Neurological	10 (8.8)	8 (7)	1.3	0.5-3.4
	Psychiatric	8 (7)	8 (7)	1	0.4-2.8
	Others	21 (18.4)	26 (22.8)	0.8	0.4-1.5
	Nonexistent	56 (49.1)	29 (25.4)	2.8	1.6-4.9*
Functional	Carriage, displacement, and transfers	18 (15.8)	54 (47.4)	0.2	0.1-0.4*
	Cognition and affectivity, and communication	25 (21.9)	25 (21.9)	1	0.5-2
	Manipulation and grip	9 (7.9)	31 (27.2)	0.2	0.1-0.5*
	Ingestion	4 (3.5)	3 (2.6)	1.3	0.3-6.2
	Sense	2 (1.8)	3 (2.6)	0.7	0.1-4
	Sphincter's control	4 (3.5)	1 (0.9)	5.1	0.5-37.3
	Chronic pain	9 (7.9)	12 (10.5)	0.5	0.3-1.8
	Nonexistent	66 (57.9)	33 (28.9)	3.4	1.9-5.8*
Situational	Acts of daily living	16 (14)	52 (45.6)	0.2	0.1-0.4*
	Affective, social life, and leisure activities	28 (24.6)	44 (38.6)	0.5	0.3-0.9*
	Nonexistent	69 (60.5)	34 (29.8)	3.6	2.1-6.3*

Permanent needs	Third-party assistance (partial or total)	1 (0.9)	8 (7)	0.1	0.01-0.95*
	Regular medical treatments	5 (4.4)	7 (6.1)	0.7	0.2-2.3
	Regular medical appointment	12 (10.5)	10 (8.8)	1.2	0.5-3
	Medication	3 (2.6)	5 (4.4)	0.6	0.1-2.5
	Orthoses	2 (1.8)	4 (3.5)	0.5	0.1-2.7
	Technical aids	4 (3.5)	5 (4.4)	0.8	0.2-3
	Prothesis	2 (1.8)	5 (4.4)	0.4	0.1-2
	Consumables	3 (2.6)	1 (0.9)	3.1	0.3-29.8
	Ancillary exams	2 (1.8)	2 (1.8)	1	0.1-7.2
	Nonexistent	100 (87.7)	93 (81.6)	1.6	0.8-3.4

* Significant differences

Note: The categories of *body*, *functional* and *situational* outcomes and *permanent need*s are not mutually exclusive.

Table 18 – Severity of permanent outcomes (*three-dimensional methodology*)

Severity (0-4)	**G1** $\bar{X}$	**G2** $\bar{X}$	**OR**	**95% CI Min-Max**	**Standardised difference**
Body sequelae	0.7±0.9	1.3±1.1	0.5	0.4-0.7*	-0.60
Functional outcomes	0.1±0.4	0.5±0.8	0.2	0.1-0.5*	-0.63
Situational outcomes	0.1±0.4	0.5±0.9	0.3	0.1-0.5*	-0.57
Damage coefficient	0.7±0.7	1±0.9	0.5	0.4-0.8*	-0.37

* Significant differences

The medico-legal permanent damage parameters considered for this study are described in Table 19.

Considering the totality of cases, PFD was assigned in 60.5% with a mean of 6±12.1 points (Min=0; Max=80). G1 evolved more without PFD (OR=2.9), and its average was less than that noted for G2 (OR=0.96). No correlation was found between pathologic and traumatic history and PFD (P=0.6 and P=0.4, respectively) using the age groups as control variables. Additionally, *Future Damage* was assigned in 6 cases: G1 (*n*=3; 2.6%) and G2 (*n*=3; 2.6%). These cases were related to intra-articular fractures or joint instability of the hip (*n*=2), knee (*n*=3), and ankle (*n*=1).

Table 19 – Permanent medico-legal damage parameters

			G1	**G2**	**OR**	**95% CI Min-Max**
Permanent Functional Deficit	$\bar{X}$	(0-100 points)	3.9±10.1	8±13.5	0.96	0.93-0.99*
	n (%)	0	59 (51.8)	31 (27.2)	2.9	1.7-5*
		1 – 9	43 (37.7)	56 (49.1)	0.6	0.4-1.06
		10 – 19	7 (6.1)	17 (14.9)	0.4	0.1-0.9*
		20 – 39	3 (2.6)	5 (4.4)	0.6	0.1-2.5
		≥ 40	2 (1.8)	5 (4.4)	0.4	0.1-2

Permanent Aesthetic Damage	$\bar{X}$	(Degree 1-7)	1.1±1.3	1.2±1.4	1.1	0.9-1.3
	n (%)	1	23 (20.2)	25 (21.9)	0.9	0.5-1.7
		2	19 (16.7)	23 (20.2)	0.8	0.4-1.6
		3	8 (7)	7 (6.2)	1.2	0.4-3.3
		4	7 (6.1)	8 (7)	0.9	0.3-2.5
		5	2 (1.8)	3 (2.6)	0.7	0.1-4
		Nonexistent	55 (48.2)	48 (42.1)	1.3	0.8-2.2
Permanent Rep. Sport. & Leisure Activities	$\bar{X}$	(Degree 1-7)	0.4±1	0.4±1.3	1.02	0.8-1.3
	n (%)	1	1 (0.9)	4 (3.5)	0.2	0.03-2.2
		2	7 (6.1)	2 (1.8)	3.7	0.7-18
		3	6 (5.2)	2 (1.8)	3.1	0.6-15.8
		4	2 (1.8)	1 (0.9)	2	0.2-22.6
		5	1 (0.9)	5 (4.3)	0.2	0.02-1.7
		6	0 (0)	1 (0.9)	-	-
		Nonexistent	97 (85.1)	99 (86.8)	0.9	0.4-1.8

4. Discussion

Several significant differences between children and young- and middle-aged adults were observed. Better results in children's cases were found for the severity of *body*, *functional* and *situational* levels, as well as for permanent damage parameters. These findings will be discussed below.

4.1. Evidence about posttraumatic injury outcomes in children

Ample evidence on this topic is presented in the scientific literature on paediatric traumatology [11, 143-149]. However, to the best of our knowledge, nothing has been published regarding the medico-legal context.

Considering the temporary damage parameters, from a global perspective, we did not find differences between G1 and G2. This was expected, given that we started from a sample matched by ISS. Even so, G1 showed a tendency for shorter recovery times, which is consistent with that reported in the literature [12, 116, 122, 147]. This finding can be considered contradictory to a previous study performed by our team [1], which found that children (n=56) presented a longer *Total Temporary Functional Deficit* (days of hospitalisation) than adults (n=431), and the difference was significant (P=0.03). However, this last result may be explained by including a severe case related to a child in a vegetative coma in the study. This case deviated from the mean values of the temporary outcomes.

Although we know that these temporary damages are more frequently lower in children, this aspect is linked to one of the most significant difficulties of PIA in this age group,

that is, determining the date of the final PIA as well as the date of the medico-legal consolidation (which may correspond or not). Given its relevance and particularities, this topic will be discussed later.

Concerning *Quantum Doloris*, no difference was found between G1 and G2. Remarkably similar results were noted in both groups, which may be attributed to the use of the ISS-matched sample.

Regarding permanent outcomes, although the groups presented similar injury severity in the acute phase (Table 14 and Figure 8), globally, G1 evolved better than G2 (Tables 17 to 19), as noted in the literature [1, 71].

The *three-dimensional* damage assessment revealed the following results: (a) *Body* sequelae were less frequent and with minor severity in G1. These events were nonexistent in 49.1% of the cases. Most body damage cases were orthopaedic, similar to that noted in general RTA cases [1]; however, these events were 80% less common in G1. (b) *Functional* outcomes were not present in 59.1% of G1. In the other cases, outcomes related to motor function were less common and less severe than that noted in G2, and most of the other capacities included very few cases. (c) *Situational* outcomes were absent in 60.5% of G1. When present, these outcomes were also less common and less severe than that noted in G2. (d) The *damage coefficient* showed that G1 had a 50% greater chance to evolve better than G2. The *standardised difference* in Table 18 revealed that the groups were no longer balanced for severity in the permanent damage period.

Considering the permanent medico-legal damage parameters, we found that G1 had a 190% greater probability of evolving without PFD or with a minor PFD average than G2, which is consistent with the described above, reinforcing this evidence.

4.2. Basis for understanding children's trauma outcomes

In mild or moderate ISS injuries, children evolve with less disability than adults and seniors [11, 13, 16, 143]. Furthermore, younger children recover better than older children after injury [16, 138, 143]. However, acquired disability during childhood is always critical given the potential losses (which depend on the developmental phase when trauma occurs) and the longer implications due to the remaining period of life [11, 12].

Traumatic factors can modify a child's harmonious development and require prolonged vigilance. Trauma can trigger a regression to a previous stage of development with loss

of capabilities already acquired, worsening or delaying the growth stage. Moreover, trauma can prevent the acquisition of other expected capabilities. For example, in adolescence, the most frequent group in this study (59.6%), trauma can cause feelings of inferiority and inappropriate social behaviour. Additionally, trauma can have wide-ranging impacts on various aspects of life, including school, social activities, and parents' personal and professional lives. These consequences include absenteeism, changes in educational settings, limited participation in extracurricular activities, and disruptions to parents' schedules and careers [150-154].

It is also important to note some aspects concerning the type of injuries and respective sequelae in children:

a) Long bone fractures: Fractures constitute 10 to 25% of all paediatric traumatic injuries, primarily affecting the upper limbs [155, 156]. Children's fractures differ from adults' fractures due to skeletal immaturity and bone physiology [12, 71]. Fortunately, children have advantages such as remodelling capacity and avoiding long-term deformities [156]. Nevertheless, some prognostic factors may be considered [71, 143, 156-158]: (i) children's age (the younger the child, the eventually more significant the deformity and dysmetria); (ii) energy of trauma; (iii) type and severity of fractures (especially if it affects the growth plate, which may disturb the individual's future growth and development); (iv) skin integrity/degree of bone exposure; (v) presence of vascular or nerve branch lesions; (vi) quality of fracture reduction (when appropriate); and (vii) type of treatment (conservative or surgical). Growth disorders are the most common sequelae resulting from premature growth plate closure or rapid partial growth, leading to shortening or deformity of the affected bone segment.
b) Spine fractures and spinal cord injury: Children experience more severe spine fractures than adults, as the trauma mechanism required to produce these injuries in children is more forceful [71, 156, 159]. These fractures often affect cartilage growth in the vertebral bodies, leading to scoliosis or kyphosis [71]. Additionally, children under 8 years old are at a higher risk of spinal cord injury without radiological abnormalities [71, 159]. Furthermore, due to the children's anatomic features, including a proportionally larger and heavier head, 75% of cervical spine injuries occur in the upper region [14, 156].
c) Traumatic brain injuries (TBI): Due to brain plasticity, children exhibit a better response and adaptation after TBI [160, 161]. Children are prone to TBI due to

their thin skulls and increased vulnerability in RTA when not seated properly in vehicles [15]. Although most TBIs in children are minor, those with persistent disabilities can experience significant cognitive and neuropsychological impairments [11, 143, 162]. Psychological or behavioural disorders, as well as cognitive impairments like executive function disability or memory disorder, are common [16, 163, 164]. However, recovery patterns after early TBI in children are unpredictable, making it challenging to identify high-risk cases requiring intensive follow-up and intervention [163, 164].

d) Orofacial trauma: Dental injuries in children require special consideration due to tooth germs and bone characteristics during childhood. In those aged 1-3 years old, trauma to the temporal incisors and, in particular, deciduous tooth loss (which does not cause any sequel), dislocations, subluxations, or intrusions are highly prevalent. However, damage to permanent teeth in older children can have critical effects. Dislocations may require reimplantation, which is complicated by root resorption and potential tooth loss [71, 151, 165]. Regarding fractures affecting the maxillary bones, the possible detection of mandibular bone growth should be highlighted. If the fracture occurs before age 12, it is necessary to consider the possibility of affecting the adjacent tooth germs with the consequent loss of said tooth pieces. In subluxations, changes in dental germs should be monitored through radiological studies [71, 151, 165].

4.3. Medico-legal difficulties in the children's cases and proposals

Given the complex process whereby trauma affects a person in his or her growth phase, several difficulties occur in the medico-legal assessment of children's cases. Some of these difficulties are described below:

a) ***The short previous state due to age - Limited comparison elements***: The evaluation of the current state is always performed by comparing it with the previous state. However, evaluating a child's current state is challenging due to the lack of previous baseline information, especially in infancy and early childhood. Therefore, experts do not have a starting point for assessing some specific skills. To overcome this, we consider that it is necessary to: (i) describe the child's current capacities by comparing them with other children of the same age group without sequelae; (ii) seek information to assess development status from parents, family members, and also from teachers (kindergarten or school,

depending on the child's development status); and (iii) explain in the medico-legal report how sequelae may impact future capacities and general competencies in adulthood, considering the current scientific evidence in this subject.

b) ***Establishing the medical causal link:*** At least three particular aspects must be considered in the discussion of a medical causal link in children: (i) children usually presents a better evolution of injuries compared to adults, and the anatomical-clinical consistency between the trauma and sequelae (which is fundamental to determining the causal link) may justify particular reasoning in the medico-legal reports [48]; (ii) outcomes should be understood and justified considering the children's growth phase; thus, medico-legal experts must be aware of the effect of trauma on the growth process and the physiopathology of trauma in children, which can lead to unexpected developments; (iii) medico-legal experts must always keep in mind that some sequelae may not be present at the moment of the expertise but may arise later; in these cases, the final PIA must be postponed to the end of pubertal development (with a regular follow-up until that moment); (iv) determining the timing for establishing a causation link can be challenging. Thus, experts can initially discuss a preliminary link based on the observed sequelae at a specific moment while emphasizing the need for further evaluations and a reassessment of the causality link at the final PIA.

c) ***The determination of the consolidation date and the moment of the final PIA***: Consolidation is considered when no further evolution of the injuries is expected [48] and frequently corresponds to the last PIA date or is retrospectively calculated in that final assessment. However, in children, this procedure can be different [71], as previously noted in our study (Table 15): (i) in most cases (85.1%; ranging from 7 to 1134 days – 192.3±194.4), the consolidation date aligns with the expected healing time for a specific injury; (ii) in some particular cases (14.9%; ranging from 47 to 4311 days – 1588.8±1469.6), where determining the final sequelae is challenging, the last PIA is postponed to the subsequent developmental phase or final pubertal period. This delay can significantly extend the average closing time of these cases by 827%. Some clinical examples of these cases include: (1) fractures affecting the growth plate, requiring assessment until the final puberty period [71, 166]; (2) spinal cord injuries and spinal cord injury, which require time for motor function recovery

until adolescence [14, 167]; (3) certain TBI, because the neurocognitive recovery can continue even after 10 years [168]; (4) and dental-stomatology injuries that require evaluation of the final dentition growth for prosthesis placement at 16 or 18 years of age [71, 151, 165].

d) ***The assessment of permanent damages, including loss of prospective potential and future needs***: In Portugal, under civil law, compensation processes are typically closed quickly, even in severe cases involving children, because many of their legal representatives prefer capital compensation and closing the process as soon as possible. However, the option for compensation in rent is legally foreseen and can facilitate clinical follow-up and evaluation of these cases. Furthermore, paediatric patients' disabilities can be challenging to quantify and have more significant temporal implications because of their longer lifespan [12, 71]. Evaluating the long-term impact of trauma on children's physical, mental, and social development is, if not impossible, at least very challenging, as many parameters may not be fully evident at the time of assessment. This responsibility to determine permanent outcomes and needs for a lifetime at a very early stage of the person's life is, if not impossible, at least very challenging to assume. Additionally, predicting and prospective potential can be complex, considering that children possess untapped potential and that many damage parameters to be assessed may not yet be present at the final PIA (e.g., related to sexual and professional aspects). The same occurs with the prediction of *permanent needs*; in our sample, 12.3% of children had *permanent needs*, but this topic is particularly important in severe cases, which will be discussed later. Finally, to address these challenges, we believe that the most reasonable solution involves: (i) delaying the final assessment as much as possible and maintaining long-term surveillance until the individual reaches the end of their growth development period; (ii) anticipating the potential need to reopen the process in the future, as outlined in the official Portuguese rules on Future Damage, and addressing it in the medico-legal report [64, 166].

e) ***The long-term survival after severe traumatic injuries***: Estimating the long-term survival of victims with severe sequelae is one of the aspects systematically asked to the medico-legal expert. The risk of death in these victims is highest within the first two years after the injury and is directly related to the level of disability [169-173]. Factors impacting long-term survival include immobility,

severe cognitive, intellectual and communication impairment, compromised self-feeding ability, the need for ventilatory support, and uncontrolled epilepsy. Nevertheless, modern rehabilitation and quality of care can enhance function, survival and reduce mortality [169-173]. However, a limited number of life/mortality tables are available for use by the medico-legal expert, and these tables are not validated for the Portuguese population. Our proposal on this topic is to: (1) estimate survival time by using the existing tables (e.g., Traumatic Brain Injury Model Systems (TBIMS) funded by the National Institute on Disability and Rehabilitation Research and California Department of Developmental Services (CDDS) [173]) or the existing evidence on the matter; (2) promote long-term studies in the Portuguese population, mainly of victims of severe TBI and spinal cord injury; and (3) validate scales that assess the survival time of victims of severe sequelae in the Portuguese population.

f) ***Medico-legal communication with the child***: Marked differences are noted between how children and adults interpret and report on their health. One critical point to consider is how to address children and adolescents, which can be challenging. Due to age-related differences in cognitive abilities, some children can interpret and express their health status more than others [12, 149, 156, 174]. Children aged 5 and older can reliably report pain, complaints, and symptoms, although they may have difficulties quantifying and describing symptom duration [174]. A family member or caregiver should accompany children and younger adolescents during medico-legal visits, especially when the child is unable to fully participate. While parents often provide valuable insights into the impact of the child's condition on the family, their reports may introduce biased measurements of their children's health based on how they have been affected, namely because they may occasionally search for increased gains [141, 154, 161]. Similarly, parents can influence children to describe their difficulties exaggeratedly. Thus, we consider that it is essential to: (i) listen to problems/complaints reported by family members and children separately whenever possible; (ii) rigorously and systematically describe the complaints in functional terms and the patient's real-life situations along with the thorough physical exam, confronting the reported complaints with the results of the physical examination and other eventual ancillary exams to assess the feasibility

of these complaints; and (iii) use an age-appropriate language during assessments for different children's growth stages.

4.4. High severity cases

As referred to in the Materials and Methods chapter, one case from our sample was excluded from this study because it deviated too much from the median.

This case refers to a 3-year-old child at the time of the RTA who suffered a very severe TBI with hypoxic-ischaemic encephalopathy and upper limb fracture (ISS=34). The case evolved to a minimally conscious state. After 4 years of regular medico-legal follow-up examinations, a final PIA was needed. The maximum damage parameters were assigned, and *permanent needs* were considered for regular medical consultations and treatments, medication, consumables, orthoses, technical aids, adaptation of home and transportation, and permanent third-party assistance (24/24 hours).

We found 2 severe cases (1.75%) in our children's sample (PFD≥40 points; Table 19). In these cases, a multidimensional and transdisciplinary assessment of the child and his or her family should be promoted. The association between the individual's intrinsic capabilities and the characteristics of his or her life-space and personal interactions are fundamental in determining the remaining functional abilities and the degree of independence and autonomy [58]. Social workers and psychologists are fundamental in considering the reformulation of familial dynamics and the need for earlier psychosocial, educational, and professional support. Living space and transport adaptation experts must also participate in adapting the home, vehicle, and other spaces to promote accessibility and mobility when needed. Rehabilitation professionals are also fundamental to define the different rehabilitation needs, and technical aids are needed to assist the victim's physical comfort and to orientate the family. All these evaluations must be made in the real living spaces of the child and will allow the medico-legal expert to perform an objective and valuable assessment report.

5. Limitations of this study and further studies

Some limitations of this study are as follows:

a) The use of a convenience sample with a relatively small size;
b) The fact that the analyses of the temporary outcomes were impaired by the study's design (ISS matching);

c) The delimitation of the study to RTAs and to the Portuguese context in civil law;
d) The absence of analysis regarding the number of medico-legal examinations to which the victims were submitted and their duration as well as the concrete difficulties in accessing the information on the victim's previous status;
e) The absence of a medico-legal validated tool to assess children of each age group. The existing scales have not been validated specifically for paediatric posttraumatic cases.

To better understand these complex cases, further studies are needed as noted below:

a) A real-world, retrospective, observational, cross-sectional and multicentric study on this subject using a federated data analysis methodology;
b) A focused study on a multidimensional and transdisciplinary approach of these cases;
c) Studies considering other types of trauma (e.g., sports accidents);
d) A validation study of the *Inventory for Handicap Assessment* for children;
e) A validation study of a long-term survival scale for the Portuguese children population;
f) The thinking about guidelines for children's PIA as described for older adults through the *Consensus Conference on Medico-Legal Assessment of Personal Damage in Older People* [126].

6. Conclusions

The present study allows us to conclude that significant differences exist between children and young- and middle-aged adults:

a) Regarding the severity of *body*, *functional* and *situational* levels, children presented better results, respectively: (i) no *body*, *functional* and *situational* sequelae were shown in 49.1%, 59.1%, and 60.5% of cases, respectively; and (ii) more chances of minor *body*, *functional* and *situational* sequelae were observed in 50%, 80%, and 70% of cases, respectively;
b) For the *damage coefficient*, children were revealed to have 50% greater chance to evolve with a minor *damage coefficient*;
c) For PFD, children presented a 190% greater chance to evolve without PFD and had a minor PFD mean (3.9±10.1);

d) The average time between RTA and final PIA date in children was higher than that in adults (676.2±1021.8 days);
e) The average time of consolidation in children was higher than that in adults (400.6±766.5 days);
f) The two previous results were due to the need to wait for the next growth children phase or to his or her final pubertal period (n=17), which increases the time for medico-legal PIA conclusion;
g) The average time between RTA and final PIA date and the average time to the consolidation date without the 17 referred cases was lower than in adults but the difference was not significant (295.5±239.6 and 192.3±194.4 days, respectively).

This study underscores the need for more research on this subject to propose guidelines for children's PIA based on scientific evidence.

V. GENERAL DISCUSSION

The three preceding studies revealed particularities/differences related to the RTA outcomes of older adults and children compared to young- and middle-aged adults.

These particularities create some medico-legal PIA challenges, related not only with the special characteristics of the age groups in cause, but also with the information available and the PIA methodology in use (namely the available tools). Regarding these challenges, we can highlight, among others: (a) the frequent absence of the previous physiological and health status; (b) the determination of the medical causal link; (c) the determination of the consolidation date; (d) the decision about the final PIA date; (e) the frequent exclusive use of permanent disability tables to assess the *Permanent Functional Deficit*; (f) the absence of a multidimensional and transdisciplinary assessment in the more complex cases, namely to identify the permanent needs; and (g) the absence of Portuguese studies to determine the person long-term survival after severe traumatic injuries.

1. Personal injury assessment in civil law

Personal injury is a set of damages suffered by a person, which can have psychological, physical, functional, interpersonal/relational, social, professional, and/or economic consequences, among others. These consequences must be indemnified, not only pecuniarily (both for economic and noneconomic damage), but also considering all the necessary support (technological, architectural, and personal) on posttraumatic rehabilitation and familial, social and professional/educational reintegration [48, 57].

1.1. Are we speaking about justice or health?

In Portugal, when considering PIA, one usually thinks about legal medicine. And when speaking about legal medicine, one thinks of Justice. Hence, the former Legal Medicine Institutes and the current INMLCF always functioned under the scope of the Ministry of Justice.

Without necessarily criticising the forensic organisation in Portugal, it seems, however, important to emphasize the relevance of Health concerning medico-legal issues.

In fact, current scientific evidence about the consequences of violence (intentional or accidental) has revealed that these are manifested, above all, in terms of the health of victims and their relatives.

Examples of what has just been stated are the resulting health outcomes associated with:

a) The injuries and the respective treatments: these aspects are the most frequently considered and assessed; and this is the reason why, in this research, we mostly analysed the outcomes related with suffered injuries; even so, we found particularities of the damage in the extreme of the age groups;
b) The adverse violent experience: this is particularly important, mainly in severe cases. The experiences of RTA may generate a situation of chronic stress for the victim. This is due to the permanent awareness of the temporary or permanent limitations, the treatment repetition throughout life, and, sometimes, the clinical complications that may arise, in addition to the often extended legal quarrel [175]. Chronic stress can increase the likelihood of risky health behaviours and specific physical and mental health conditions, with reduced longevity [176, 177]. However, regarding this last aspect, the causal link will always be, if not impossible, at least very difficult to prove. Therefore, it is essential for health and medical experts to be aware of these risks and ponder a possible prevention;
c) The decrease or loss of daily life and professional/educational activities: activity, including professional, is essential, providing physical and intellectual performance, interpersonal and social interaction, self-confidence and quality of life, preventing psychosocial isolation, and promoting emotional stability. On the other hand, inactivity is associated with poor outcomes, increasing morbidity related to previous and current health conditions (mainly psychological morbidity, such as depression and anxiety). Furthermore, inactivity contributes to increasing social isolation, with a reduction in functional independence, as well as in life settings and experiences [12, 47, 54, 128, 129, 134].
d) Some professional procedures in the victims' approach: some practices/behaviours in the field of health, legal medicine, police, law, and insurance companies, among others, may contribute to the secondary victimization of people who suffered an RTA [175, 178, 179]. Examples are,

among many others, the repeated questioning about the case and the complaints, or the multiple physical examinations undergone in the context of the expertise. However, the more or less empathetic way that victims are approached by the different professionals and the time given to speak freely and spontaneously, are also very relevant in this matter. This subject can be significant in the case of more fragile people (older adults, children and people with severe impairment of functionality). However, it was not the subject of our study, but the reflection we have made on the issue leads us to consider that this needs further research, thinking about the health of people who were a victim of RTA;

e) The victim's perception that the case could have had a better outcome and that justice has not been done: this may happen regarding treatments, as well as indemnity, and may contribute to harming people's health. In fact, it is known that negative perceptions cause negative emotions, which can be prolonged, increasing the risk of mental and somatic health problems, and difficulties in the victim's family and social participation. Studies have shown a direct relationship between the perception of justice accomplishment and the fair compensation process, with better posttraumatic health recovery [178-180]. However, one will always have to distinguish between people's dissatisfaction because their case effectively could have been better handled, or because they expected an increased gain from the RTA. This subject has not yet been studied in the medico-legal field nor our research, but it deserves to be seriously considered for further investigation.

That said, we increasingly believe that Justice and Health are genuinely connected in legal medicine and the different medical specialities dealing with violence victims. Thus, are we speaking about justice or health when we speak about PIA? Our answer is both, which implies that professionals working with victims of violence, such as RTA, need to develop knowledge, attitudes, and competencies that allow them to work on this 'sensitive bridge' that connects medicine (e.g., clinical, surgical, occupational, medico-legal) and law.

1.2. Methodology harmonisation and guidelines. Are they needed?

Harmonising the norms for carrying out the PIA is essential within each country, and it would be ideal, at least, between countries with unique connections, such as, for example, European countries or Portuguese-speaking countries. This would allow similar cases to have similar legal treatment [48, 61]. Furthermore, harmonisation helps everyone involved in the process to communicate better and stay aligned. This may help protect victims' rights and ensure transparency throughout all clinical and legal processes. It may also promote the victim's trust in a fair compensation achievement, reducing unnecessary litigation and promoting extrajudicial case resolution [181].

To ensure this type of harmonisation, guidelines creation is necessary to clarify terminology and concepts, and offer recommendations regarding practices and personal injury parameters assessment.

Unfortunately, in the 21st century, it is still a fact that between the countries of the EU and the Portuguese-speaking countries, there is no PIA harmonisation, namely in civil law. Much effort has been made to achieve this harmonisation [38, 73, 91, 101, 181]. However, it is understandable that each country's specific civil law issues make this objective challenging and lengthy.

In Portugal, we have general guidelines, namely in civil law, proposed by the INMLCF [48, 62, 64]. Nevertheless, in some other countries, these are absent. This lack of general guidelines in the PIA can lead to medico-legal experts' poor performance by presenting unrigorous and unsubstantiated reports, which jeopardizes the entire value of the expertise [64, 73, 90, 91]. This circumstance can lead law or insurance administrators, and experts, to differ in their medico-legal report's conclusions. The result is that the victim will be subject to conflicting decisions that may not be the most correct and may prolong the process. Furthermore, if there is no methodological compliance in the medico-legal expert PIA, similar assessments may receive discrepant indemnity [181]. Finally, different methodologies do not allow us to perform accurate scientific studies comparations.

Nevertheless, we believe that general guidelines, while fundamental, are not enough. There are specific cases that also deserve specific guidelines. As it is observable throughout this research, there are no guidelines or standardization of the PIA methodology for RTA in children and older adults. Despite the topic's relevance, this

gap may be due to the specificities in these age groups and the scarcity of scientific evidence.

Finally, it must be pointed out that in more specific cases, despite guidelines or rules, common clinical sense must always prevail. This is because the assessment must increasingly be personalized and adapted to the victim's particularities and real needs, considering the multiple consequences on his/her life situations [58].

1.3. What are the more significant challenges on PIA?

In the practice of medico-legal PIA, some situations of considerable complexity are more challenging for the expert. For example, the assessment:

a) At the extremes of age (children and older adults), which we have analysed in detail in the present research, offering some evidence, considerations and proposals;
b) Of the victims with severe injuries and outcomes, such as persistent vegetative states, severe cognitive-affective disorders, plegies, extensive amputations, severe burns, polytrauma, or amaurosis. In these cases, a great disturbance in the personal capacities, life situations, and the subjectivity may exist, impeding them from carrying out their daily living and professional/educational activities with autonomy [58, 62]. Thus, the expertise must be multidimensional and transdisciplinary to ensure all the victim's real needs, particularly their rights to dignity, social integration and quality of life [58, 182]. Although these cases deserve specific research, we did not study them regarding the extremes of ages, due to the difficulty in obtaining a robust sample of these situations;
c) Of victims suffering overlapping accidents (immediately followed or very close in time). It is challenging to establish the medical causal link and to separate the damage and sequelae caused by each accident. These situations of true concausality represent a significant challenge in the medico-legal practice, mainly due to the great variability of situations arising in this context [183]. We did not study these cases in the extremes of ages because they deserve a specific approach due to their legal complexity and because we did not have a large enough sample available.

2. Personal injury assessment in the two extreme age groups

The present research contributed to a better understanding of the differences in the RTA outcomes in the extreme age groups.

2.1. Personal injury assessment of older adults

Our research findings and reflections about older adult victims of RTA are summarised below (Tables 20 and 21).

Table 20 – Difficulties and challenges in PIA of older adults

Difficulties	Comment's summary
Access to information about the RTA and the previous state	1. It is fundamental for the medico-legal expert to access medical reports about the case (including trauma experience and mechanism, resulting injuries, treatments, hospitalizations, medical appointments, and other therapies), which is frequently a challenging task in insurance and private medicine [48, 71]; 2. It is also fundamental to access medical reports about previous health conditions. Older adults have an extensive previous state, with high rates of pathologic and trauma history (91.6% and 36.8%, respectively), which seems to influence the outcomes very much [48, 71, 126]. However, this task is even more challenging for insurance and private experts.
Medical causality link	1. It could be challenging to distinguish between health problems related to ageing, prior disease or trauma, and those related to the RTA [71]; 2. The *functional* and *situational* outcomes may not always be proportional to the *body*'s sequelae. For balanced ISS injuries in the older adults, the *functional* and *situational* severity was more significant than in younger adults (170% and 130% higher severity – Table 12); 3. This prior result may be related to decreased physical and mental "plasticity" and reduced physiological functional reserve, which may accelerate ageing, including the more rapid development of senile dementia, among others [12, 71, 102, 113, 117, 123, 124].
PIA methodologies	1. There is no medico-legal PIA methodology for older adult victims of RTA; 2. The traditional PIA methodology, mainly using disability tables, may not be adapted to the more complete and rigorous evaluation of older people [48, 69, 71]; 3. We found a lack of correlation between the PFD and the *three-dimensional methodology* (compare the results of Tables 12 and 13); 4. This may be due to the fact that those tables evaluate mainly the organic aspect, little of the *functional*, and nothing about the *situational* [126].
Permanent needs assessment	1. It could be challenging to distinguish between the older adult's previous and current needs (due to the RTA) [12, 54, 120]; 2. However, we found that these persons present more *Permanent Needs* than the younger ones regarding third-party assistance (OR=3.5), medication (OR=2), and technical aids (OR=2.4).

Table 21 – Proposals for PIA of older adults

Difficulties	Proposals' summary
Access to information about the RTA and the previous state	1. In insurance and private medicine, victims of RTA should have an obligation to present the clinical documents demonstrably necessary (either relating to the accident in question or the previous state of health) [48, 64, 69, 71, 126]; 2. This would be similar to what happens in Portugal regarding public services (INMLCF); in this case, experts even can access medical information directly (Law 45/2004, 19th August, actualised by the Decree-Law 53/2021, 16th July); 3. As many people resist giving information to medical experts, a closer intervention with the victim and his/her family, especially in the field of psychology and social work, could help increase the victims' confidence and encourage them to deliver this clinical information.
Medical causality link	1. The expert must explain, through the report's discussion, the causal link between the trauma and the resulting injuries/sequelae and eventual complications [48]; 2. The expert also must explain the interaction and impact of the previous state with the post-trauma status, which can lead to unexpected and severe developments; 3. Considering the previous points, the expert must define and substantiate, according to scientific evidence, the outcomes that he/she considers that, in a clinically reasonable and explainable way, can be accepted as having a causality link with the RTA [70]; 4. It is necessary to be aware of the current knowledge regarding the effect of trauma on the ageing process, which can lead to unexpected and severe developments [12, 54, 120].
PIA methodologies	1. The medico-legal expert should perform a personalised and comprehensive evaluation, including *functional* and *situational* complaints and the *body* examination, avoiding limiting PIA to the injury or *body* sequelae evaluation through the only utilisation of disabilities tables [48, 69, 71]; 2. A multidimensional and transdisciplinary assessment of older persons should be taken, especially in severe cases, with the contribution of other professionals, whose expertise may vary according to the specific case [48, 57, 58, 71, 126]; 3. The *in-loco* evaluation will allow, in addition to the physical and functional assessment, an actual analysis of the situational state, such as in activities of daily living, evaluating the ability to perform basic, instrumental, and advanced activities [3, 48, 71, 130, 131].
Permanent needs assessment	1. The RTA outcomes can originate profound changes in life, family, leisure and professional situations for these victims [48], with great disturbance of autonomy. In these cases, the expert needs to be able to assess if all the necessary responses to the victim's needs have been accomplished [58]; 2. However, older adults could have an impairment in their independence and autonomy before the accident; 3. In the previous case, it may be difficult to distinguish the needs that were already present from those raised by the event (as mentioned concerning the causal link); 4. Therefore, assessing clinical information about the prior state, as well as the multidimensional and transdisciplinary assessment above referred could be an essential tool to support this kind of assessment.

2.2. Personal injury assessment of children

Our research findings and reflections on children's victims of RTA are summarised below (Tables 22 and 23).

Table 22 – Difficulties and challenges in PIA of children

Difficulties	Comment's summary
Access to information about the RTA and the previous state	1. Victims, especially in infancy and early childhood, present a short previous state due to their age. Therefore, the comparison elements are very scarce or null in these cases; 2. We found that only 22.8% of the children group presented a pathologic history and 6.1% a traumatic history; 3. However, in these cases, the previous health history may not be the most important aspect. To predict the future outcomes of a child's life, the more concretely possible, it will be necessary for the expert to know aspects related to the victim's potential abilities and talents, which is not possible, especially in younger children. This limits, in some instances, the expert's ability in PIA.
Medical causality link	1. The trauma's effect on the growth process and its physiopathology in children can lead to unexpected developments [48]; 2. Children usually evolve with fewer outcomes than foreseen, even with a high ISS, which may generate in the child's family, a high expectation about damage indemnity; 3. We found that for balanced ISS injuries in children, the *body*, *functional* and *situational* severity was better than in adults (50%, 80%, and 70% minor severity – Table 18); 4. This prior result may be related to their increased healing capacity, associated with higher physiological plasticity and, consequently, a better recovery [16, 138, 143]; 5. These aspects represent a challenge for causality link determination, mainly before the end of the growth process.
Consolidation and last PIA date	1. In children, in several injuries, such as long bone fractures, spine fractures, spinal cord injury, traumatic brain injuries, and orofacial trauma [11, 14, 71, 143, 151, 156-162, 165-168], the consolidation will only happen in the next growth phase or at the end of the pubertal period, requiring further attention; 2. We found that in 17 children (14.9%), the expert needed to wait for the next growth phase or to their final pubertal period; 3. This fact, in our study, made the average time between RTA and final PIA date in children higher than that in adults (676.2±1021.8 days), and the consolidation time longer (400.6±766.5 days) (Table 15); 4. Considering the children group without the 17 referred cases, the average time between RTA and final PIA date and the consolidation time was lower in children than in adults, but without significant differences (295.5±239.6 and 192.3±194.4 days, respectively).
Permanent damage assessment	1. Some damage parameters outcomes in children can only be evaluated later in life [71, 143, 151, 156-161, 165]; 2. It could be a challenge to determine the children's future perspectives of damages and losses at the time of the expertise [12, 71]; 3. In the more severe cases, predicting permanent needs for a lifetime in a yearly period of the person's life is really not possible; 4. In our study, 12.3% of the children victims presented a permanent need.

Long-time survival assessment	1. In children with very severe RTA outcomes, the expert is asked to determine the victim's life expectancy; 2. Their life expectancy is directly related to their disability degree; 3. The functional changes with the most significant impact on long-term survival are immobility, severe cognitive, intellectual, and communication impairment, compromised self-feeding ability, need for ventilatory support, and epilepsy sequels uncontrolled or poorly controlled [169-173]; 4. The life/mortality tables are few [173], and none is validated for the Portuguese population. Thus, this kind of assessment by the expert has low support in scientific evidence, especially in the medico-legal field.

Table 23 – Proposals for PIA of children

Difficulties	Proposals' summary
Access to information about the RTA and the previous state	1. In insurance and private medicine, victims of RTA should have an obligation to present the clinical documents demonstrably necessary (either relating to the accident in question or the previous state of health); 2. This would be similar to what happens in Portugal, regarding public services (INMLCF); in this case, experts even can access medical information directly (Law 45/2004, 19th August, actualised by the Decree-Law 53/2021, 16th July); 3. Furthermore, the medical expert should seek information about the victim, not only from parents and family members but also from eventual kindergarten professionals or school teachers (in cases of a more advanced development status) and even from videos of the children to assess the skills already acquired.
Medical causality link	1. The trauma's effect should be acknowledged by the expert considering the child's growth phase; 2. The expert also should know that trauma can lead to unexpected developments in children [12, 71]; 3. Thus, in these PIA report cases, the expert must compulsorily make particular reasoning about the concrete RTA outcomes, explaining the respective case's pathophysiology based on existing scientific evidence; 4. The expert also must be aware of some sequels that may arise in a later period.
Consolidation and last PIA date	1. In certain injuries, the expert must wait for the next growth phase or until the end of the pubertal period, to carry out the final PIA; 2. This does not prevent the expert from discussing a preliminary link considering the sequelae already present and determining a consolidation date. However, the expert must signal to need for further evaluations and a new discussion of the causality link at the final PIA.

Permanent damage assessment	1. It is essential to be aware that it is very difficult or even impossible to predict the child's abilities and skills in the future at a personal, social, and professional level; 2. However, the medical expert should describe the current capacities of the child, comparing it with the previous status, if possible, and with children of the same age group without sequelae; 3. Then the expert should explain how the sequelae may affect future abilities and general competencies in adulthood; 4. In the most severe cases, the expert also should try to estimate the loss of prospective potential and predict future needs. To support this task, a multidimensional and transdisciplinary assessment should be promoted, with the participation of other specialists, such as social workers and psychologists, experts in adaptions of living spaces and transport, and rehabilitation professionals [71]; 5. Instead of predicting permanent needs for a lifetime in a yearly stage of the person's life, a better solution would be to reopen the process later [64, 166]; 6. The ideal solution should be to choose a regular income payment (*renda*) that would allow the regular follow-up of the victim's difficulties and needs throughout his/her life, which is considered in civil law.
Long-time survival assessment	1. To estimate the long-time survival, the expert should know that, in severe cases, the risk of death is much higher in the first two years after the injury [169-173]. Therefore, he/she should not close the case at least before that date; 2. This estimation should be based on the existing life/mortality tables [173] and scientific evidence; 3. As these tables are not validated for Portugal, there is a need to promote long-term studies in the Portuguese population, mainly of victims of severe traumatic brain injury and spinal cord injury, to support these tables' validation.

3. Limitations and further studies

There are some limitations of this research:

a) The use of convenience samples with relatively small sizes;
b) The fact that in older adults and children, the analyses of the temporary outcomes were impaired by the study's design (ISS match);
c) The delimitation of the research to RTA and the Portuguese context in civil law;
d) The absence of an analysis that considers the number and duration of the medico-legal examinations that the victims underwent, as well as the concrete difficulties in accessing information about the previous state of the older adults and children's victims;
e) The absence of a validated tool to assess PIA in older adults and children, although a validated inventory was used for RTA outcomes assessment in a medico-legal context [57].
f) The existence of few studies about posttraumatic outcomes in older adults and the inexistence in children to compare the present results.

Further studies should consider the following:

a) Real-world, retrospective, observational, cross-sectional, and multicentric studies on these subjects using a federated data analysis methodology, which may constitute an essential contribution to a better understanding of these complex cases;
b) Focused studies on multidimensional and transdisciplinary approaches in these cases;
c) Studies considering other types of traumas (e.g., occupational and sports accidents);
d) A validation study of the *Inventory for Handicap Assessment* for children under 16 years old and older adults over 64 years old;
e) Validation studies of long-term survival scales for the Portuguese population;
f) The development of guidelines for the PIA of older persons and children;
g) In the case of PIA of children, organizing a conference similar to the *Consensus Conference* on medico-legal PIA in older people [126].

VI. GENERAL CONCLUSIONS

The present research contributed to a better understanding of the differences in the RTA outcomes in the extreme age groups. It offered some contributions to support future guidelines in these cases.

In the three tasks of this research, we concluded, respectively:

1. (a) RTA severity was generally severe (ISS mean 9.5) and higher in children and older people; (b) The most frequent *body* sequelae were musculoskeletal (64.8%), which were associated with *functional* and *situational* outcomes (51.7% for acts of everyday life, 40.5% for affective and social life, and sporting and leisure activities, and 36.4% for professional life); (c) Temporary damage resulted in an average length of impairment of daily life of 199.6 days and required 171.7 days before return to work; (d) The average degree of QD was 3.7/7; (e) Permanent parameters of damage were, on average, 7.3/100 points for PFD; (f) 19% of victims had permanent needs (10.6% needed third-party assistance), with significant repercussions for the victim's life. By considering victims in the context of their everyday life and situation, the Portuguese medico-legal methodology allows for a comprehensive assessment and supports effective and useful damage repair. The differences among the three age groups and the impact of the more severe cases justify further detailed medico-legal studies in these specific situations on children, older people, and severely injured victims.
2. (a) In older adults (G1), 92% had a pathological history (8.7 times more than in young- and middle-aged adults – G2), and 37% had trauma history; (b) No relevant differences were found between G1 and G2 in terms of temporary damages, as expected, given that both age groups had a similar degree of acute injury severity; an exception was found for G2, which had a higher *Partial Temporary Functional Deficit* than G1 (OR=0.99); (c) Regarding the *three-dimensional methodology* evaluation of permanent outcomes, G1 presented more sequelae than G2: *body* sequelae – orthopaedic (OR=1.7), *functional* outcomes – carriage, displacement, and transfers (OR=1.6), manipulation and grip (OR=1.8), and sphincter control (OR=3.8), *situational* outcomes – acts of

daily life (OR=2.9). G2 had more non-existent *body* sequelae (OR=0.5) and *functional* outcomes (OR=0.4); (d) All three levels of damage severity (*body*, *functions*, and *situations*) and the *damage coefficient* were much more severe in G1 (1.3, 1.7, 1.3, and 1.6 more times, respectively); (e) G1 presented more *Permanent Needs* than G2 regarding third-party assistance (OR=3.5), medication (OR=2), and technical aids (OR=2.4); G2 evolved more without any *Permanent Needs* (OR=0.4); (f) There was no difference in the *Permanent Functional Deficit* between the two age groups, although G2 was assigned more grade 0 (OR=0.5) and G1 more grade 2 (OR=1.8); (vii) G2 was assigned more *Permanent Aesthetic Damage* than G1 (OR=0.9). Based on these results and the literature, we could offer some contributions to set the grounds for posttraumatic senior PIA guidelines.

3. (a) Regarding the severity of *body*, *functional* and *situational* levels, children (G1) presented better results than young- and middle-aged adults (G2), respectively: (1) No *body*, *functional* and *situational* sequelae were found in 49.1%, 59.1%, and 60.5% of cases, respectively; and (2) More chances of minor *body*, *functional* and *situational* sequelae were observed in 50%, 80%, and 70% of cases, respectively. (b) For the *damage coefficient*, G1 was revealed to have a 50% greater chance to evolve with a minor *damage coefficient*; (c) For PFD, G1 presented a 190% greater chance to evolve without PFD and had a minor PFD mean (3.9±10.1); (d) The average time between RTA and final PIA date in G1 was higher than that in G2 (676.2±1021.8 days); (e) The average time of consolidation in G1 was higher than that in G2 (400.6±766.5 days); (f) The two previous results were due to the need to wait for the next growth children phase or to his or her final pubertal period (n=17), which increases the time for medico-legal PIA conclusion; (g) The average time between RTA and final PIA date and the average time to the consolidation date without the 17 referred cases was lower in G1 than in G2, but the difference was not significant (295.5±239.6 and 192.3±194.4 days, respectively). This study underscores the need for more research to propose guidelines for children's PIA based on scientific evidence.

As a final and general conclusion of this research, it is important to point out that there are many differences between the two extreme age groups, which create difficulties and challenges for medico-legal experts, and that there is scarce literature on the subject for older adults and none for children. Therefore, more investment is needed in medico-legal scientific research in these fields. Until then, experts should orient their PIA in older persons and children based on the general guidelines on PIA and on the clinical evidence, mainly in traumatology. We hope this research may support the creation of specific guidelines for older adults and children in a near future.

VII. GENERAL REFERENCES

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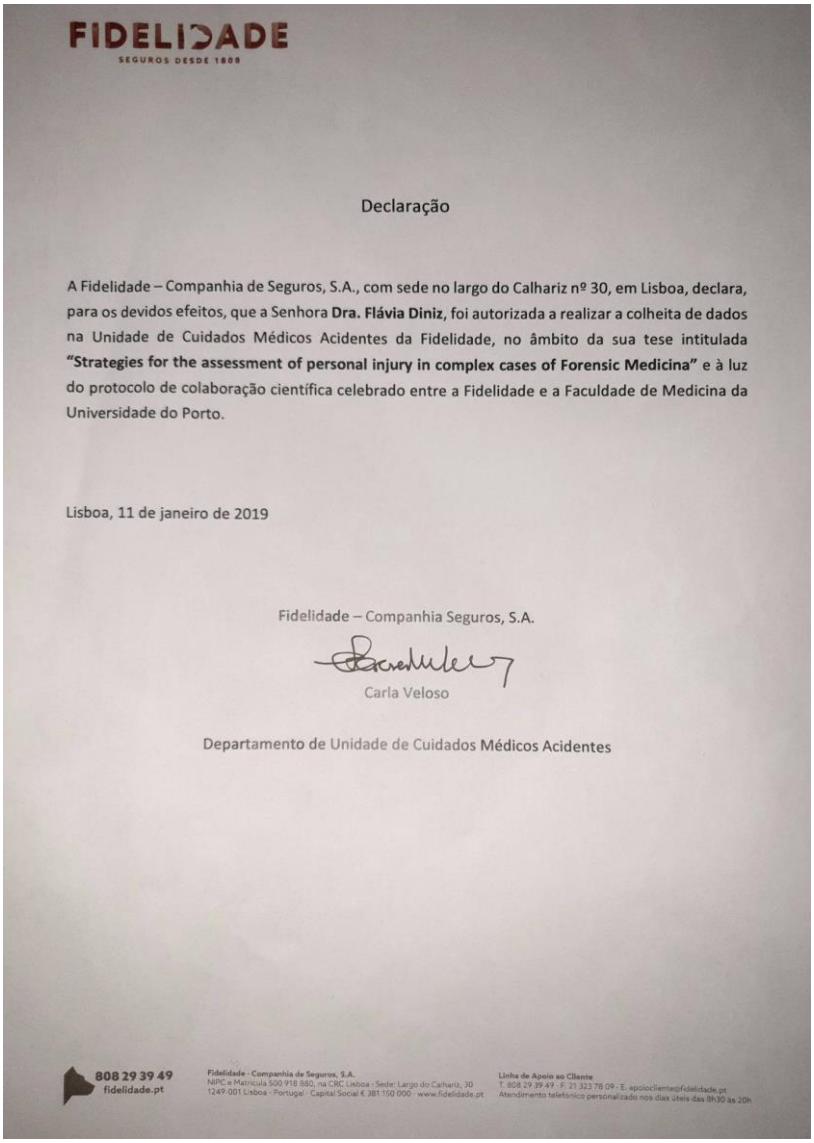
APPENDIX

1. Approval from the Insurance Company where the study was conducted



FIDELIDADE
SEGUROS DESDE 1808

Declaração

A Fidelidade – Companhia de Seguros, S.A., com sede no largo do Calhariz nº 30, em Lisboa, declara, para os devidos efeitos, que a Senhora **Dra. Flávia Diniz**, foi autorizada a realizar a colheita de dados na Unidade de Cuidados Médicos Acidentes da Fidelidade, no âmbito da sua tese intitulada **"Strategies for the assessment of personal injury in complex cases of Forensic Medicina"** e à luz do protocolo de colaboração científica celebrado entre a Fidelidade e a Faculdade de Medicina da Universidade do Porto.

Lisboa, 11 de janeiro de 2019

Fidelidade – Companhia Seguros, S.A.

Carla Veloso

Departamento de Unidade de Cuidados Médicos Acidentes

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Fidelidade - Companhia de Seguros, S.A.
NIPC e Matrícula 500 918 882, na CRC Lisboa - Sede: Largo do Calhariz, 30
1249-001 Lisboa - Portugal - Capital Social € 381 150 000 - www.fidelidade.pt

Linha de Apoio ao Cliente
T. 808 29 39 49 - F. 21 323 78 09 - E. apoiocliente@fidelidade.pt
Atendimento telefónico personalizado nos dias úteis das 8h30 às 20h

2. Ethical Committee Approval

Comissão de Ética Centro Hospitalar São João / Faculdade de Medicina da Universidade do Porto n.º 302 / 18

SÃO JOÃO

U.PORTO FMUP FACULDADE DE MEDICINA UNIVERSIDADE DO PORTO

Questionário para submissão de Investigação

Exmo. Sr. Presidente da Comissão de Ética do Centro Hospitalar de São João/ Faculdade de Medicina da Universidade do Porto,

Pretendendo realizar a investigação infracitada, solicito a V. Exa., na qualidade de Investigador, a sua apreciação e a elaboração do respetivo parecer. Para o efeito, anexo toda a documentação requerida.

IDENTIFICAÇÃO DO ESTUDO

Título da investigação: STRATEGIES FOR THE ASSESSMENT OF PERSONAL INJURY IN COMPEX CASES OF FORENSIC MEDICINE

Nome do investigador: Flávia da Cunha Diniz

Endereço eletrónico: flaviacdiniz@gmail.com **Contacto telefónico:** 915008370

Caracterização da investigação:

☐ Estudo retrospetivo ☐ Estudo observacional ☒ Estudo prospetivo

☐ Inquérito ☐ Outro. Qual? _____

Tipo de investigação:

☐ Com intervenção ☒ Sem intervenção

Formação do investigador em boas práticas clínicas *(GCP)*: ☐ Sim ☒ Não

Promotor *(se aplicável)*: _____

Nome do orientador de dissertação/tese *(se aplicável)*: Teresa Magalhães

Endereço eletrónico: imlfmup@gmail.com

Local/locais onde se realiza a investigação: Fidelidade Companhia de Seguros S.A. - Unidade Clínica Médica Acidentes

Data prevista para início: 01 / 09 / 2018 Data prevista para o término: 30 / 06 / 2021

PROTOCOLO DO ESTUDO

Síntese dos objetivos:

O objetivo geral deste estudo é identificar as dificuldades específicas na avaliação do dano pessoal em casos identificados como mais complexos e desenvolver diretrizes para apoiar esta avaliação.
Os objetivos específicos são:
a) caracterizar estes casos (crianças, idosos, situações de handicap grave e situações com acidentes sucessivos);
b) identificar as principais dificuldades em sua avaliação médico-legal;
c) propor diretrizes para cada tipo de caso.

Fundamentação ética (ganhos em conhecimento/inovação; ponderação benefícios/riscos):

Entre as diversas situações de valoração do dano pessoal, existem algumas especialmente complexas, mais desafiadoras para o médico perito, como:
a) casos relativos a pessoas nas faixas etárias mais extremas (crianças e seniores), havendo questões relativas ao estado anterior (ligado, designadamente, às particularidades da fisiologia nestas idades), que têm de ser equacionadas;
b) casos com afetação grave da funcionalidade, cujas questões de reabilitação e reintegração (associada a diversos tipos de necessidades/dependências) constituem um grande desafio para o perito;
c) casos em que em causa estão acidentes sucessivos e próximos no tempo, podendo tornar-se difícil, ou até impossível, estabelecer uma imputabilidade médica direta para cada lesão e respetivo acidente.
As normas e diretrizes para a avaliação nesses casos de alta complexidade são escassos ou inexistentes, sendo primordial definir critérios de harmonização destes casos.

1/3

QES-M0007-0

CONFIDENCIALIDADE

De que forma é garantida a anonimização dos dados recolhidos de toda a informação?

Não há identificação dos nomes dos pacientes analisados, apenas dos números dos processos internos da Fidelidade.

O investigador necessita ter acesso a dados do processo clínico? ☒ Sim ☐ Não

Está previsto o registo de imagem ou som dos participantes? ☐ Sim ☒ Não

Se sim, está prevista a destruição deste registo após o sua utilização? ☐ Sim ☐ Não

CONSENTI MENTO

O estudo implica recrutamento de:

Doentes: ☐ Sim ☒ Não Voluntários saudáveis: ☐ Sim ☒ Não

Menores de 18 anos: ☐ Sim ☒ Não

Outras pessoas sem capacidade do exercício de autonomia: ☐ Sim ☒ Não

A investigação prevê a obtenção de Consentimento Informado: ☐ Sim ☒ Não

Se não, referir qual o fundamento para a isenção:

Serão avaliados os relatórios médicos finais das avaliações de danos já realizadas na unidade de clínica médica da Seguradora Fidelidade.

Existe informação escrita aos participantes: ☐ Sim ☒ Não

PROPRIEDADE DOS DADOS

A investigação e os seus resultados são propriedade intelectual de:

☐ Investigador ☐ Promotor ☒ Ambos ☐ Serviço onde é realizado

☐ Não aplicável Outro: _____

BENEFÍCIOS, RISCOS E CONTRAPARTIDAS PARA OS PARTICIPANTES

Benefícios previsíveis:

Identificar as diversas complexidades para a avaliação do dano pessoal destes casos complexos, e elaborar orientações que apoiem os especialistas nestas avaliações complexas.

Riscos/incómodos previsíveis:

Os participantes serão submetidos apenas as avaliações de dano que já teriam que ser submetidos caso não houvesse o estudo.

São dadas contrapartidas aos participantes:

- ***pela participação*** ☐ Sim ☒ Não ☐ Não aplicável
- ***pelas deslocações*** ☐ Sim ☒ Não ☐ Não aplicável
- ***pelas faltas ao emprego*** ☐ Sim ☒ Não ☐ Não aplicável
- ***por outras perdas e danos*** ☐ Sim ☒ Não ☐ Não aplicável

CUSTOS / PLANO FINANCEIRO

Os custos da investigação são suportados por:

☐ Investigador ☐ Promotor ☐ Serviço onde é realizado

☒ Não aplicável Outro: _____

Existe protocolo financeiro? ☐ Sim ☒ Não

LISTA DE DOCUMENTOS ANEXOS

- ☐ Pedido de autorização ao Presidente do Conselho de Administração do Centro Hospitalar de São João *(se aplicável)*
- ☐ Pedido de autorização à Diretora da Faculdade de Medicina da Universidade do Porto *(se aplicável)*
- ☒ Protocolo do estudo
- ☐ Declaração do Diretor de Serviço onde decorre o estudo
  (sendo um estudo na área de enfermagem deve anexar também a concordância da chefia de enfermagem)
- ☐ Profissional de ligação
- ☒ Informação dos orientadores
- ☐ Informação ao participante
- ☐ Modelo de consentimento
- ☒ Instrumentos a utilizar *(inquéritos, questionários, escalas, p.ex.)*: Ficha de colheita de dados
- ☒ Curriculum Vitae abreviado *(máx. 3 páginas)*
- ☐ Protocolo financeiro
- ☐ Outros:

COMPROMISSO DE HONRA E DECLARAÇÃO DE INTERESSES

Declaro por minha honra que as informações prestadas neste questionário são verdadeiras. Mais declaro que, durante o estudo, serão respeitadas as recomendações constantes da Declaração de Helsínquia (1960 e respetivas emendas), e da Organização Mundial da Saúde, Convenção de Oviedo e das "Boas Práticas Clínicas" (GCP/ICH) no que se refere à experimentação que envolve seres humanos. Aceito, também, a recomendação da CES de que o recrutamento para este estudo se fará junto de doentes que não tenham participado em outro estudo, nos últimos três meses. Comprometo-me a entregar à CES o relatório final da investigação, assim que concluído.

Porto, 16 *de* julho *de* 2018

Nome legível: Flávia da Cunha Diniz

Flávia da Cunha Diniz
assinatura

Parecer da Comissão de Ética do Centro Hospitalar de São João/ FMUP Emitido na reunião plenária da CE de 19/10/18

Aguarda esclarecimentos.

Prof. Doutor Filipe Almeida
Presidente da Comissão de Ética

Centro Hospitalar **São João**.

CONSIDERADOS QUE FORAM COMO SATISFATÓRIOS OS ESCLARECIMENTOS PRESTADOS PELO(A) INVESTIGADOR(A), A CES APROVA POR UNANIMIDADE O PARECER DO RELATOR, PELO QUE NADA TEM A OPOR À REALIZAÇÃO DESTE PROJETO DE INVESTIGAÇÃO.

14/11/19

Prof. Doutor Filipe Almeida
Presidente da Comissão de Ética

Comissão de Ética para a Saúde do HSJ
Parecer

Projeto de investigação: "Strategies for the assessment of personal injury in complex cases of forensic medicine".

Promotor:

- Não aplicável.

Concepção e pertinência do estudo

- Trata-se de um estudo prospectivo e sem intervenção, a realizar no âmbito de um Programa Doutoral em Ciências Forenses da FMUP pela Dra. Flávia da Cunha Diniz, sob orientação da Prof.ª Doutora Teresa Magalhães da FMUP, que tem como objectivos: identificar as dificuldades específicas na avaliação do dano pessoal em casos identificados como mais complexos e desenvolver directrizes para apoiar esta avaliação.

- Tem ainda como objectivos específicos: caracterizar estes casos (crianças, idosos, situações de handicap grave e situações com acidentes sucessivos); identificar as principais dificuldades em sua avaliação médico-legal; propor directrizes para cada tipo de caso.

- Serão realizados 4 subestudos a partir dos casos de acidentes de viação, um envolvendo danos pessoais em crianças e outro em seniores, outro com vítimas com acidentes simultâneos, ou seja, com dois ou mais acidentes sofridos, e o último envolvendo vítimas que sofreram dano corporal grave.

- Todos os dados pertinentes e adequados aos objectivos do estudo, serão obtidos, de forma anonimizada, a partir da plataforma informática dos serviços médicos da Unidade de Acidentes Médicos – Fidelidade, no Porto.

- O estudo não terá encargos financeiros para o Centro Hospitalar de S. João, nem para a FMUP.
- O estudo é importante, pertinente e está muito bem fundamentado. As normas e directrizes para a avaliação nos casos de alta complexidade (crianças, idosos, situações de handicap grave e situações com acidentes sucessivos) são escassos ou inexistentes, sendo primordial definir critérios de harmonização destes casos.

- A Investigadora Principal, a Dra. Flávia da Cunha Diniz, especialista de Medicina do Trabalho, dispõe das competências técnicas e científicas para a realização do estudo.

- O estudo será realizado na Fidelidade Companhia de Seguros S.A. – Unidade Clínica Médica Acidentes, que dispõe das condições necessárias para a realização do estudo, *mas não está presente no dossier entregue à CES a autorização do responsável por esta entidade seguradora.*

– Beneficio/Risco

- Dada a natureza não intervencional do estudo, não haverá benefícios, riscos ou incómodos para os participantes.

– Respeito pela liberdade e autonomia do sujeito do ensaio

- *A tratar-se de um estudo prospectivo, no protocolo submetido à CES, devia constar uma folha de informação ao participante e aos representantes legais do menor, e uma formulário de consentimento informado apropriado para os participantes e/ou seus representantes legais.*

– Confidencialidade dos dados

A confidencialidade dos dados está garantida.

– Indemnização por danos

Não aplicável.

– Continuação do tratamento

Não aplicável.

- Propriedade dos dados

- Não aplicável.

Conclusão

Em face da análise do protocolo do estudo "Strategies for the assessment of personal injury in complex cases of forensic medicine", proponho a sua aprovação pela CES do HSJ/FMUP, depois de obter as respostas às questões formuladas em itálico e em sublinhado.

Porto, 19 de outubro de 2018

O Relator
Prof. Manuel Vaz Silva

RESPOSTA ADEQUADA
À QUESTÃO FORMULADA.
M. Vaz 04/11/2019

3. Data collection form

1. **ID nº:**
2. **Perito (1 a 5):**
3. **Nº Processo (PROC):**
4. **Data da perícia (DATA P):**
5. **Sexo (S)**
    1. Masculino
    2. Feminino
6. **Idade data do acidente (IA):**
7. **Idade data perícia (IP):**
8. **Atividade antes do acidente (ATI A)**
    1. A trabalhar
    2. Estudante
    3. Doméstica
    4. Desempregado
    5. Reformado
    6. De baixa por doença
    7. Sem atividade
9. **Atividade depois do acidente, à data da consolidação (ATI D)**
    1. A trabalhar
    2. Estudante
    3. Doméstica
    4. Desempregado
    5. Reformado
    6. De baixa por doença
    7. Sem atividade
10. **Profissão à data do acidente (PROF A)**
    1. Quadros Superiores
    2. Especialistas das Profissões Intelectuais e Científicas
    3. Técnicos e Profissionais de Nível Intermédio
    4. Pessoal Administrativo e Similares
    5. Pessoal dos Serviços e Vendedores
    6. Agricultura e Pescas

7. Operários, Artífices e Trabalhadores Similares

8. Operadores de Instalações e Máquinas e Trabalhadores da Montagem

9. Trabalhadores não Qualificados

10. Forças armadas

11. Outra

99. NA

11. Setor profissional à data do acidente (SET A)

1. Primário

2. Secundário

3. Terciário

99. NA

12. Profissão depois do acidente, à data da consolidação (PROF D)

1. Quadros Superiores

2. Especialistas das Profissões Intelectuais e Científicas

3. Técnicos e Profissionais de Nível Intermédio

4. Pessoal Administrativo e Similares

5. Pessoal dos Serviços e Vendedores

6. Agricultura e Pescas

7. Operários, Artífices e Trabalhadores Similares

8. Operadores de Instalações e Máquinas e Trabalhadores da Montagem

9. Trabalhadores não Qualificados

10. Forças armadas

11. Outra

99. NA

13. Setor profissional depois do acidente, à data da consolidação (SET D)

1. Primário

2. Secundário

3. Terciário

99. NA

14. Data do acidente (DATA A):

15. Tipo de acidente (AV)

1. Atropelamento
2. Colisão em viatura, com outra viatura
3. Despiste
4. Queda de veículo
5. Outro

16. Vítima em viatura (VEIC)

1. Automóvel /CARRINHA
2. Mota / Motorizada
3. Bicicleta
4. Camioneta / autocarro
5. Outra

99. NA

17. Lugar na viatura (LUG)

1. Condutor
2. Ao lado do condutor
3. Atrás

99. NA

18. Proteção em viatura (PRO)

1. Cinto de segurança
2. Capacete
3. Nenhuma

99. NA

19. Airbags (automóvel) (AIR)

1. Abriu
2. Não abriu
3. Não tinha

99. NA

20. Antecedentes patológicos

1. Sem influência sobre as sequelas
2. Com influência nas sequelas
3. Inexistentes

21. Antecedentes traumáticos

1. Sem influência sobre as sequelas
2. Com influência nas sequelas
3. Inexistentes

22. Localização das lesões (LL) (escolha múltipla)

1. Crânio/pescoço
2. Face
3. Ráquis/medula
4. Tórax/abdómen
5. Membros superiores
6. Membros inferiores
7. Inexistentes

23. Tipo das lesões (TL) (escolha múltipla)

1. Traumatismos do crânio e/ou pescoço
2. Traumatismo raquimedular isolado ou associado a outras lesões
3. Traumatismo dos membros isolados ou associados a outros traumatismos, exceto crânio e raquimedulares
4. Traumatismos do tórax e abdómen e traumatismos da face isolados
5. Inexistentes

24. ECG:

25. ISS:

26. Sequelas por especialidade TNI (SEQ) (escolha múltipla)

1. Ortopédicas
2. Dismorfias
3. Neurológicas
4. Otorrinolaringologia
5. Oftalmológicas
6. Angiocardiológicas
7. Pneumológicas
8. Nefrológicas/Urológicas
9. Gastrenterológicas
10. Psiquiátricas

11. Dermatológicas
12. Reprodução
13. Hematológicas
14. Endocrinológicas
15. Estomatológicas
16. Oncológicas
17. Inexistentes

27. Gravidade sequelas corporais (GSC) (1 a 5)

28. Sequelas Funcionais (SF) (escolha múltipla)

1. Postura, deslocamentos e transferências
2. Manipulação e preensão
3. Comunicação
4. Sentidos
5. Cognição e afetividade
6. Controlo de esfíncteres
7. Ingestão
8. Sexualidade e procriação
9. Outras
10. Inexistentes

29. Gravidade sequelas funcionais (GSF) (1 a 5):

30. Sequelas Situacionais (SS) (escolha múltipla)

1. Atos da vida corrente
2. Vida afetiva, social, desportiva e de lazer
3. Vida profissional ou de formação
4. Inexistentes

31. Gravidade sequelas situacionais (GSS) (1 a 5):

32. Data da consolidação:

33. Défice Funcional Temporário Total (DFTT):

34. Défice Funcional Temporário Parcial (DFTP):

35. Repercussão Temporária Absoluta nas Atividades Profissionais (RTAAP): ……. 99. NA

36. Quantum Doloris (QD) (1 a 8):

37. Défice Funcional Permanente (DFP):

38. Dano Futuro (DF):

1. Sim
2. Não

39. Repercussão Permanente na Capacidade de Trabalho (RPCT) (1 a 5): ..... 99. NA

40. Dano Estético Permanente (DEP) (1 a 8):

41. Repercussão na Atividade Sexual (RAS) (1 a 8):

42. Repercussão Permanente nas Atividades Desportivas e de Lazer (RPADL) (1 a 8):

43. Necessidades Permanentes (NP) (escolha múltipla)

1. Consultas
2. Exames complementares de diagnóstico
3. Tratamentos médicos regulares
4. Ajudas medicamentosas
5. Consumíveis
6. Produtos de apoio
7. Próteses
8. Ortóteses
9. Adaptação do domicílio
10. Adaptação do veículo
11. Desporto adaptado
12. Transporte especial
13. Ajuda de terceira pessoa
14. Inexistentes

44. Ajuda de terceira pessoa

1. De substituição (total)
2. De complemento ou assistência (parcial)
3. De incitação ou estimulação (parcial)
4. De vigilância (passiva)
5. Inexistente

45. Residência

1. Domicílio
2. Instituição

46. Coeficiente de dano (0 a 4):

4. Inventory for Handicap Assessment (IHA)

ESCALAS DE GRAVIDADE DO INVENTÁRIO PARA AVALIAÇÃO DO DANO CORPORAL

Corpo	Capacidades	Situações
0. Sem sequelas	0. Sem dificuldades	0. Sem dificuldades
1. Sequelas mínimas	1. Dificuldades mínimas (lentidão, desconforto)	1. Dificuldades mínimas (lentidão, desconforto)
2. Sequelas de importância média	2. Dificuldades médias (ajuda técnica ou medicamentosa)	2. Dificuldades médias (ajuda técnica ou medicamentosa ou adaptação do meio)
3. Sequelas importantes	3. Dificuldades importantes (ajuda humana)	3. Dificuldades importantes (ajuda humana ou reconversão profissional)
4. Sequelas muito importantes	4. Impossibilidade ou ajuda humana total (de substituição)	4. Impossibilidade ou ajuda humana total (de substituição)

SCORE FINAL

Corpo: valor do item maior

	Capacidades	Situações	
		Com vida profissional ou de formação	Sem vida profissional ou de formação
0	0-5	0-5	0-12
1	6-13	6-16	13-25
2	14-35	17-43	26-38
3	36-64	44-75	39-51
4	65-92	76-108	52-64

ESCALA DE GRAVIDADE DO COEFICIENTE DE DANO

0 - Sem sequelas ou sequelas sem relevância médico-legal;
1 - Dano corporal ligeiro, sem necessidade de recurso a ajudas técnicas ou humanas (sem dependência); pode haver dificuldades ou desconforto;
2 - Dano corporal de gravidade média, havendo necessidade de recurso a ajudas técnicas ou medicamentosas, mas não a ajuda humana;
3 - Dano corporal importante, havendo necessidade de recurso a ajudas humanas;
4 - Dano corporal muito importante, com dependência total de terceira pessoa (sem autonomia nem independência).

INVENTÁRIO DE AVALIAÇÃO DO DANO CORPORAL

			ANTES DO ACIDENTE						DEPOIS DO ACIDENTE					
1-*CORPO*			0	1	2	3	4		0	1	2	3	4	
Crânio e pescoço		1						2						
Face		3						4						
Coluna e medula		5						6						
Tórax e abdómen (conteúdo pélvico e períneo incluídos)		7						8						
Membros (pelve óssea incluída)		9						10						
2-*CAPACIDADES*			(Score1 =)						(Score2 =)					
POSTURA DESLOCAMENTOS TRANSFERÊNCIAS	Permanecer na posição de pé	11						12						
	Permanecer na posição sentada	13						14						
	Virar-se em posição deitada	15						16						
	Passar da posição deitada à posição sentada	17						18						
	Passar da posição sentada à posição de pé	19						20						
	Andar ou deslocar-se em plano horizontal	21						22						
	Correr	23						24						
	Levantar-se do chão	25						26						
MANIPULAÇÃO PREENSÃO	Preensão com a mão direita	27						28						
	Preensão com a mão esquerda	29						30						
	Posicionar a mão direita no espaço	31						32						
	Posicionar a mão esquerda no espaço	33						34						
COMUNICAÇÃO	Oral	35						36						
	Escrita	37						38						
	Gestual	39						40						
COGNIÇÃO AFECTIVIDADE	Memória	41						42						
	Aprendizagem	43						44						
	Orientação	45						46						
	Afectividade	47						48						
CONTROLO DE ESFÍNCTERES	Controlar a emissão de urina	49						50						
	Controlar a emissão de fezes	51						52						
SEXUALIDADE PROCRIAÇÃO	Ter relações sexuais completas	53						54						
	Procriar	55						56						
3-*SITUAÇÕES*			(Score3 =)						(Score4 =)					
ACTOS DA VIDA CORRENTE	Comer e beber	57						58						
	Ir à casa de banho	59						60						
	Fazer a sua higiene pessoal	61						62						
	Vestir-se e despir-se	63						64						
	Deitar-se e levantar-se da cama	65						66						
	Deslocar-se dentro de sua casa	67						68						
	Fazer as actividades caseiras	69						70						
	Apanhar um objecto do chão	71						72						
	Escrever	73						74						
	Telefonar	75						76						
	Gerir os seus bens	77						78						
	Tomar a sua medicação	79						80						
	Sair e entrar em casa	81						82						
	Subir ou descer uma escada ou uma rampa	83						84						
	Fazer compras e as actividades exteriores habituais	85						86						
	Utilizar um meio de transporte comum	87						88						
	Utilizar um meio de transporte pessoal	89						90						
VIDA AFECTIVA E SOCIAL	Relações afectivas com a família	91						92						
	Relações afectivas com os amigos e vizinhos	93						94						
	Praticar actividades de lazer passivas	95						96						
	Praticar actividades de lazer activas	97						98						
VIDA PROFISSIONAL OU DE FORMAÇÃO	Exercer uma actividade profissional ou de formação	99						100						
	Deslocar-se para o trabalho ou para a escola	101						102						
	Deslocar-se no local de trabalho ou na escola	103						104						
	Ir à casa de banho no local de trabalho ou na escola	105						106						
	Alimentar-se no local de trabalho ou na escola	107						108						
	Estabelecer boas relações no trabalho ou na escola	109						110						
			(Score5 =)						(Score6 =)					

Score final (Coeficiente de Dano) = $\frac{S2 + S4 + S6}{3}$ = ...