MONASH University

Faculty of Medicine, Nursing and Health Sciences

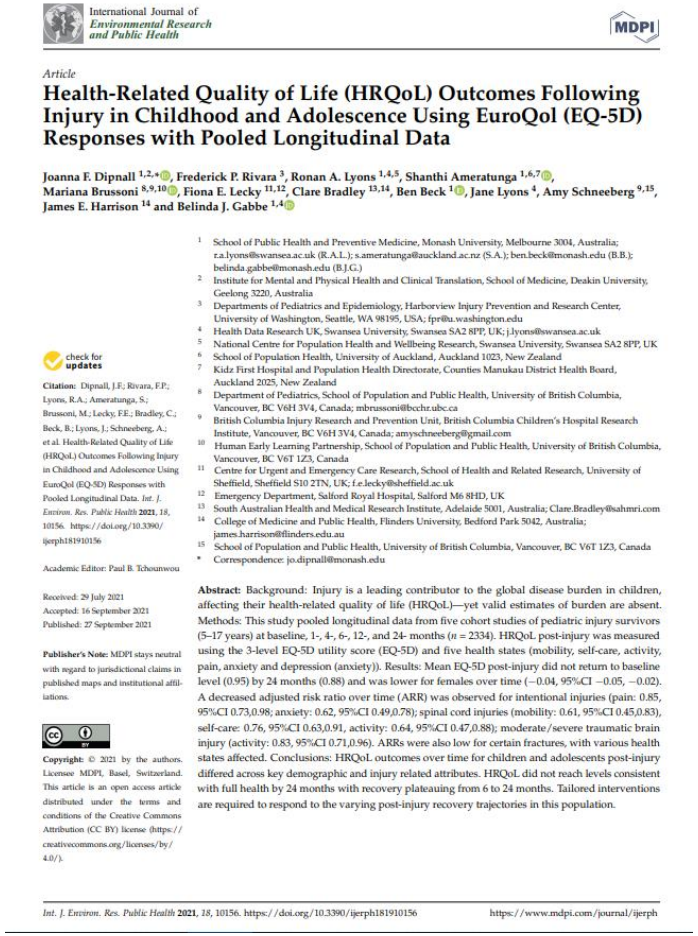
Managing complex pooled international cohort data in Stata:

Health-related quality of life (HRQoL) outcomes following injury in childhood and adolescence using EuroQol (EQ-5D) responses with pooled longitudinal data

Dr Joanna Dipnall, Monash University

Co-authors:

Frederick P. Rivara, Ronan A. Lyons, Shanthi Ameratunga, Mariana Brussoni, Fiona E. Lecky, Clare Bradley, Ben Beck, Jane Lyons, Amy Schneeberg, James E. Harrison, Belinda J. Gabbe.



International Journal of Environmental Research and Public Health

MDPI

Article

Health-Related Quality of Life (HRQoL) Outcomes Following Injury in Childhood and Adolescence Using EuroQol (EQ-5D) Responses with Pooled Longitudinal Data

Joanna F. Dipnall [1,2,*], Frederick P. Rivara [3], Ronan A. Lyons [1,4,5], Shanthi Ameratunga [1,6,7], Mariana Brussoni [8,9,10], Fiona E. Lecky [11,12], Clare Bradley [13,14], Ben Beck [1], Jane Lyons [4], Amy Schneeberg [9,15], James E. Harrison [14] and Belinda J. Gabbe [1,4]

1 School of Public Health and Preventive Medicine, Monash University, Melbourne 3004, Australia; r.a.lyons@swansea.ac.uk (R.A.L.); s.ameratunga@auckland.ac.nz (S.A.); ben.beck@monash.edu (B.B.); belinda.gabbe@monash.edu (B.J.G.)
2 Institute for Mental and Physical Health and Clinical Translation, School of Medicine, Deakin University, Geelong 3220, Australia
3 Departments of Pediatrics and Epidemiology, Harborview Injury Prevention and Research Center, University of Washington, Seattle, WA 98195, USA; fpr@u.washington.edu
4 Health Data Research UK, Swansea University, Swansea SA2 8PP, UK; j.lyons@swansea.ac.uk
5 National Centre for Population Health and Wellbeing Research, Swansea University, Swansea SA2 8PP, UK
6 School of Population Health, University of Auckland, Auckland 1023, New Zealand
7 Kidz First Hospital and Population Health Directorate, Counties Manukau District Health Board, Auckland 2025, New Zealand
8 Department of Pediatrics, School of Population and Public Health, University of British Columbia, Vancouver, BC V6H 3V4, Canada; mbrussoni@bcchr.ubc.ca
9 British Columbia Injury Research and Prevention Unit, British Columbia Children's Hospital Research Institute, Vancouver, BC V6H 3V4, Canada; amyschneeberg@gmail.com
10 Human Early Learning Partnership, School of Population and Public Health, University of British Columbia, Vancouver, BC V6T 1Z3, Canada
11 Centre for Urgent and Emergency Care Research, School of Health and Related Research, University of Sheffield, Sheffield S10 2TN, UK; f.e.lecky@sheffield.ac.uk
12 Emergency Department, Salford Royal Hospital, Salford M6 8HD, UK
13 South Australian Health and Medical Research Institute, Adelaide 5001, Australia; Clare.Bradley@sahmri.com
14 College of Medicine and Public Health, Flinders University, Bedford Park 5042, Australia; james.harrison@flinders.edu.au
15 School of Population and Public Health, University of British Columbia, Vancouver, BC V6T 1Z3, Canada
* Correspondence: jo.dipnall@monash.edu

check for updates

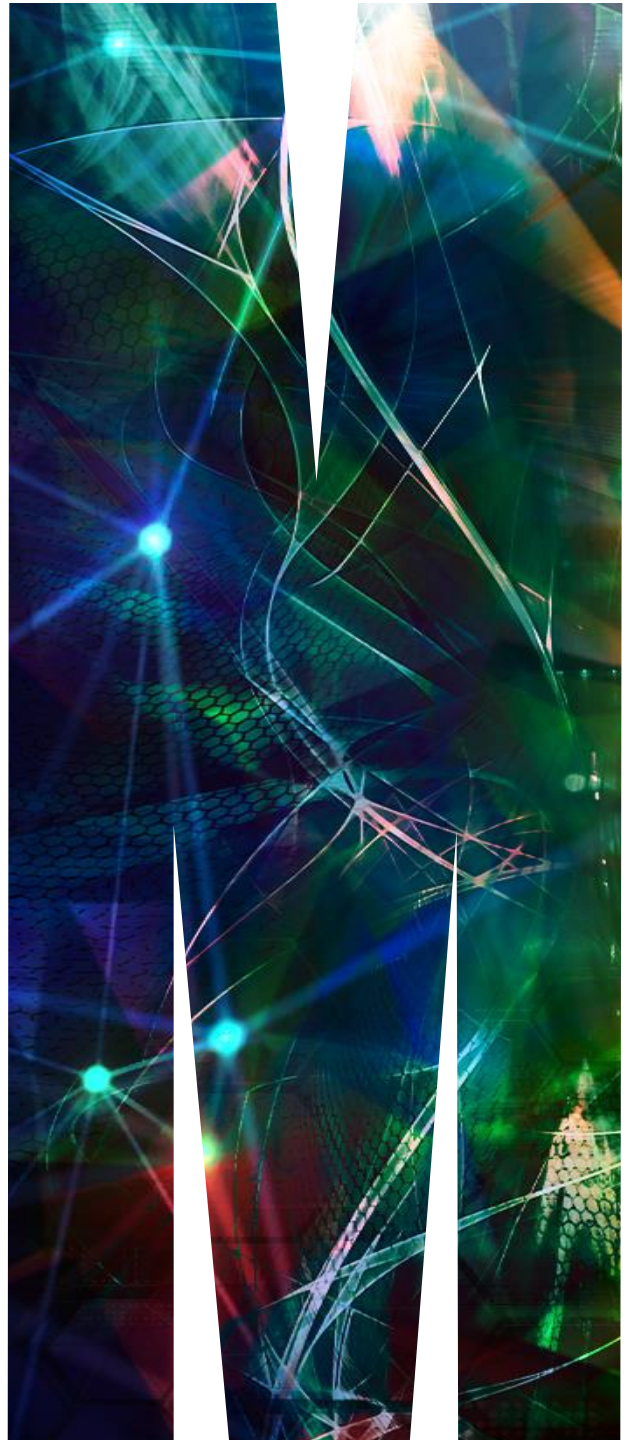
Citation: Dipnall, J.F.; Rivara, F.P.; Lyons, R.A.; Ameratunga, S.; Brussoni, M.; Lecky, F.E.; Bradley, C.; Beck, B.; Lyons, J.; Schneeberg, A.; et al. Health-Related Quality of Life (HRQoL) Outcomes Following Injury in Childhood and Adolescence Using EuroQol (EQ-5D) Responses with Pooled Longitudinal Data. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10156. https://doi.org/10.3390/ijerph181910156

Academic Editor: Paul B. Tchounwou

Received: 29 July 2021
Accepted: 16 September 2021
Published: 27 September 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

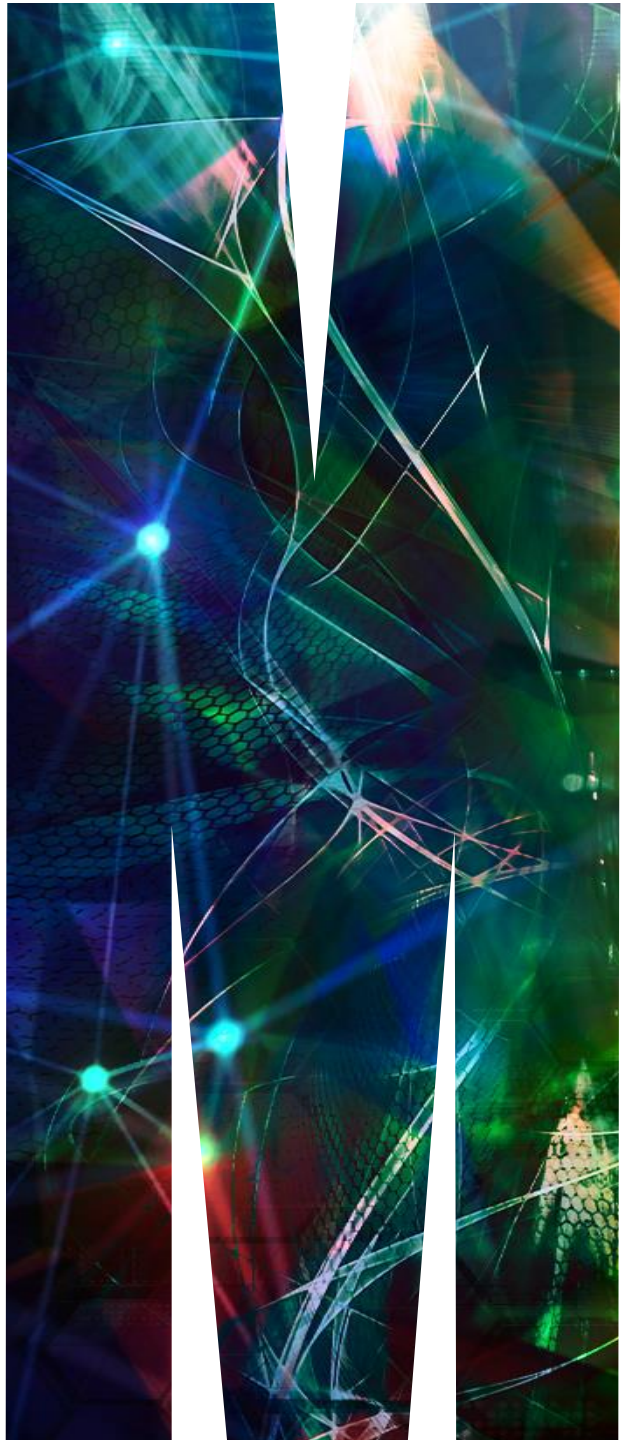
Abstract: Background: Injury is a leading contributor to the global disease burden in children, affecting their health-related quality of life (HRQoL)—yet valid estimates of burden are absent. Methods: This study pooled longitudinal data from five cohort studies of pediatric injury survivors (5–17 years) at baseline, 1-, 4-, 6-, 12-, and 24- months (n = 2334). HRQoL post-injury was measured using the 3-level EQ-5D utility score (EQ-5D) and five health states (mobility, self-care, activity, pain, anxiety and depression (anxiety)). Results: Mean EQ-5D post-injury did not return to baseline level (0.95) by 24 months (0.88) and was lower for females over time (−0.04, 95%CI −0.05, −0.02). A decreased adjusted risk ratio over time (ARR) was observed for intentional injuries (pain: 0.85, 95%CI 0.73,0.98; anxiety: 0.62, 95%CI 0.49,0.78); spinal cord injuries (mobility: 0.61, 95%CI 0.45,0.83), self-care: 0.76, 95%CI 0.63,0.91, activity: 0.64, 95%CI 0.47,0.88); moderate/severe traumatic brain injury (activity: 0.83, 95%CI 0.71,0.96). ARRs were also low for certain fractures, with various health states affected. Conclusions: HRQoL outcomes over time for children and adolescents post-injury differed across key demographic and injury related attributes. HRQoL did not reach levels consistent with full health by 24 months with recovery plateauing from 6 to 24 months. Tailored interventions are required to respond to the varying post-injury recovery trajectories in this population.



MONASH University

ACKNOWLEDGEMENT OF COUNTRY

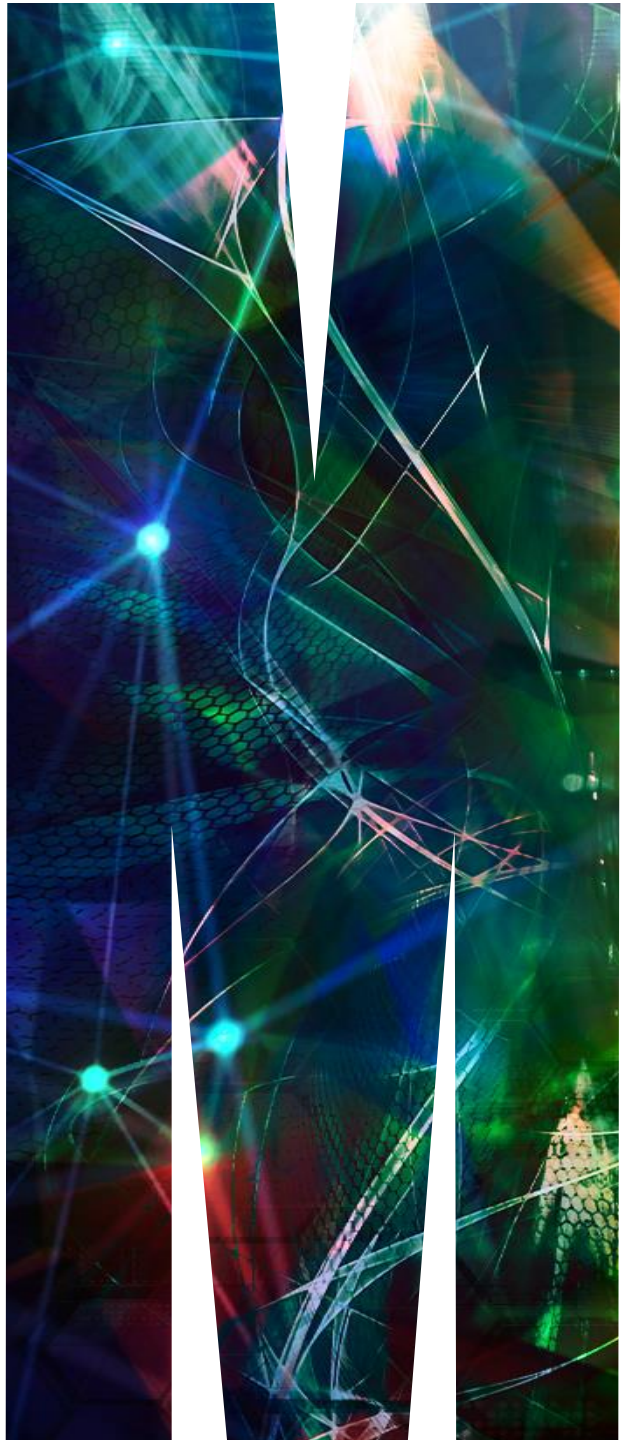
We acknowledge the Traditional Owners of the land we are on today and pay respect to elders past, present and emerging and acknowledge any Aboriginal and Torres Strait Islander People with us today.



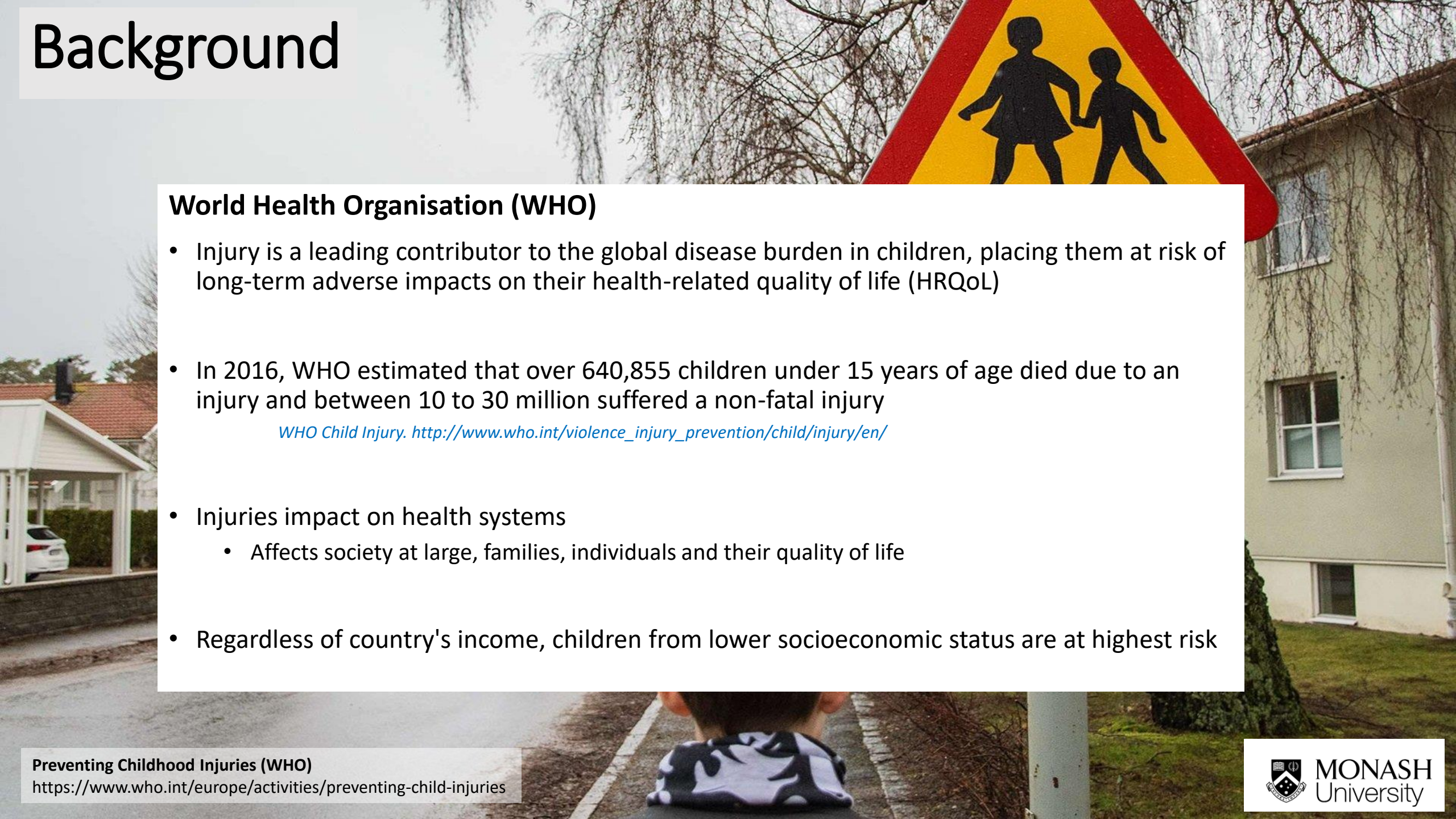
MONASH University

FORMAT OF PRESENTATION

1. Background to this research
2. Complexities
    1. Data sets & challenges
    2. Measures & challenges
3. Models
4. Management
5. Results
6. Conclusion



Background



World Health Organisation (WHO)

- Injury is a leading contributor to the global disease burden in children, placing them at risk of long-term adverse impacts on their health-related quality of life (HRQoL)

- In 2016, WHO estimated that over 640,855 children under 15 years of age died due to an injury and between 10 to 30 million suffered a non-fatal injury

  WHO Child Injury. http://www.who.int/violence_injury_prevention/child/injury/en/

- Injuries impact on health systems
  - Affects society at large, families, individuals and their quality of life

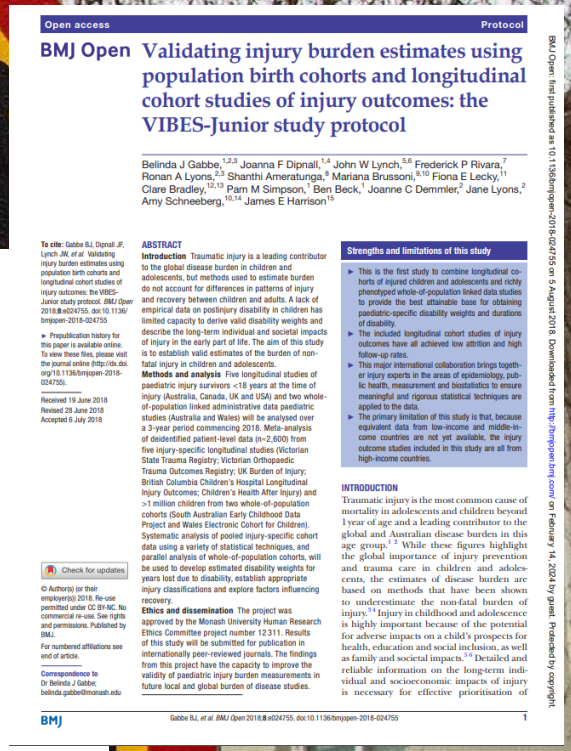
- Regardless of country's income, children from lower socioeconomic status are at highest risk

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Background

- Patterns of injuries (and recovery) in children differ to adults:
  - Mechanism of injury
  - Pattern of injury
  - Childhood history
  - Examination and management of the injury
- Methods used to estimate burden **do not account for differences in patterns of injury and recovery between children and adults**
- **Need more empirical data** on postinjury disability in children to derive valid disability weights and describe the long-term individual and societal impacts of injury in the early part of life



Open access Protocol

BMJ Open

Validating injury burden estimates using population birth cohorts and longitudinal cohort studies of injury outcomes: the VIBES-Junior study protocol

Belinda J Gabbe,[1,2,3] Joanna F Dipnall,[1,4] John W Lynch,[5,6] Frederick P Rivara,[7] Ronan A Lyons,[2,3] Shanthi Ameratunga,[8] Mariana Brussoni,[9,10] Fiona E Lecky,[11] Clare Bradley,[12,13] Pam M Simpson,[1] Ben Beck,[1] Joanne C Demmler,[2] Jane Lyons,[2] Amy Schneeberg,[10,14] James E Harrison[15]

To cite: Gabbe BJ, Dipnall JF, Lynch JW, *et al*. Validating injury burden estimates using population birth cohorts and longitudinal cohort studies of injury outcomes: the VIBES-Junior study protocol. *BMJ Open* 2018;**8**:e024755. doi:10.1136/bmjopen-2018-024755

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2018-024755).

Received 19 June 2018
Revised 28 June 2018
Accepted 6 July 2018

For numbered affiliations see end of article.

Correspondence to
Dr Belinda J Gabbe;
belinda.gabbe@monash.edu

ABSTRACT

Introduction Traumatic injury is a leading contributor to the global disease burden in children and adolescents, but methods used to estimate burden do not account for differences in patterns of injury and recovery between children and adults. A lack of empirical data on postinjury disability in children has limited capacity to derive valid disability weights and describe the long-term individual and societal impacts of injury in the early part of life. The aim of this study is to establish valid estimates of the burden of non-fatal injury in children and adolescents.

Methods and analysis Five longitudinal studies of paediatric injury survivors <18 years at the time of injury (Australia, Canada, UK and USA) and two whole-of-population linked administrative data paediatric studies (Australia and Wales) will be analysed over a 3-year period commencing 2018. Meta-analysis of deidentified patient-level data (n=2,600) from five injury-specific longitudinal studies (Victorian State Trauma Registry; Victorian Orthopaedic Trauma Outcomes Registry; UK Burden of Injury; British Columbia Children's Hospital Longitudinal Injury Outcomes; Children's Health After Injury) and >1 million children from two whole-of-population cohorts (South Australian Early Childhood Data Project and Wales Electronic Cohort for Children). Systematic analysis of pooled injury-specific cohort data using a variety of statistical techniques, and parallel analysis of whole-of-population cohorts, will be used to develop estimated disability weights for years lost due to disability, establish appropriate injury classifications and explore factors influencing recovery.

Ethics and dissemination The project was approved by the Monash University Human Research Ethics Committee project number 12 311. Results of this study will be submitted for publication in internationally peer-reviewed journals. The findings from this project have the capacity to improve the validity of paediatric injury burden measurements in future local and global burden of disease studies.

Strengths and limitations of this study

- This is the first study to combine longitudinal cohorts of injured children and adolescents and richly phenotyped whole-of-population linked data studies to provide the best attainable base for obtaining paediatric-specific disability weights and durations of disability.
- The included longitudinal cohort studies of injury outcomes have all achieved low attrition and high follow-up rates.
- This major international collaboration brings together injury experts in the areas of epidemiology, public health, measurement and biostatistics to ensure meaningful and rigorous statistical techniques are applied to the data.
- The primary limitation of this study is that, because equivalent data from low-income and middle-income countries are not yet available, the injury outcome studies included in this study are all from high-income countries.

INTRODUCTION

Traumatic injury is the most common cause of mortality in adolescents and children beyond 1 year of age and a leading contributor to the global and Australian disease burden in this age group.[1 2] While these figures highlight the global importance of injury prevention and trauma care in children and adolescents, the estimates of disease burden are based on methods that have been shown to underestimate the non-fatal burden of injury.[3 4] Injury in childhood and adolescence is highly important because of the potential for adverse impacts on a child's prospects for health, education and social inclusion, as well as family and societal impacts.[5 6] Detailed and reliable information on the long-term individual and socioeconomic impacts of injury is necessary for effective prioritisation of

The VIBES-Junior Study

- The aim of the VIBES-Junior study is to **establish valid estimates of the burden of non-fatal injury in children and adolescents**

Ethics : Project approved by the Monash University Human Research Ethics Committee (project number 12311) and was conducted in compliance with the NHMRC National Statement on Ethical Conduct in Human Research (2007)—Updated 2018 and the ICH Guideline for Good Clinical Practice E6(R2).

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Data

Data: 5 International cohorts in pooled analysis

- **Australia:**
  - The Victorian State Trauma Registry (**VSTR**)
    - Population-based trauma registry that captures data about all major trauma patients in the state of Victoria in Australia
  - The Victorian Orthopedic Trauma Outcomes Registry (**VOTOR**)
    - Clinical registry of orthopedic injuries, treatment, complications and outcomes based on admissions to four Australian centres
- **United States of America**:
  - The US Children's Health After Injury (**CHAI**) study
    - Children with mild, moderate and severe traumatic brain injury (TBI) or with upper extremity injuries who presented to a set of US hospitals
- **United Kingdom:**
  - The United Kingdom Burden of Injury (**UKBOI**)
    - Injured individuals with children recruited from emergency department (ED) presentations and hospital admissions in four UK centers
- **Canada:**
  - The British Columbia Children's Hospital Longitudinal Injury Outcomes (**BCCH-LIO**) study
    - Children who attended the British Columbia Children's Hospital in Canada for an injury
- **Data integration procedures were documented using DIPIT Protocol (i.e. Table of 10 steps)**

Methods 69 (2014) 237–246

Contents lists available at ScienceDirect

Methods

journal homepage: www.elsevier.com/locate/ymeth

Data Integration Protocol In Ten-steps (DIPIT): A new standard for medical researchers

Joanna F. Dipnall [a,b], Michael Berk [a,c,d,e], Felice N. Jacka [a,c], Lana J. Williams [a,c], Seetal Dodd [a,c,e], Julie A. Pasco [a,f]

[a] IMPACT Strategic Research Centre, School of Medicine, Deakin University, Geelong, Victoria, Australia
[b] Department of Statistics, Data Science and Epidemiology, Swinburne University of Technology, Hawthorn, Victoria, Australia
[c] Department of Psychiatry, The University of Melbourne, Parkville, Victoria, Australia
[d] Florey Institute of Neuroscience and Mental Health, Parkville, Victoria, Australia
[e] Orygen Youth Health Research Centre, Parkville, Victoria, Australia
[f] NorthWest Academic Centre, Department of Medicine, The University of Melbourne, St Albans, Victoria, Australia

ARTICLE INFO

Article history:
Received 10 February 2014
Revised 2 June 2014
Accepted 5 July 2014
Available online 12 July 2014

Keywords:
Data integration
Data linkage
Merging
Data aggregation
Data mining
Standard

ABSTRACT

Introduction: The exponential increase in data, computing power and the availability of readily accessible analytical software has allowed organisations around the world to leverage the benefits of integrating multiple heterogeneous data files for enterprise-level planning and decision making. Benefits from effective data integration to the health and medical research community include more trustworthy research, higher service quality, improved personnel efficiency, reduction of redundant tasks, facilitation of auditing and more timely, relevant and specific information. The costs of poor quality processes elevate the risk of erroneous outcomes, an erosion of confidence in the data and the organisations using these data. To date there are no documented set of standards for best practice integration of heterogeneous data files for research purposes. Therefore, the aim of this paper is to describe a set of clear protocol for data file integration (Data Integration Protocol In Ten-steps; DIPIT) translational to any field of research.

Methods and results: The DIPIT approach consists of a set of 10 systematic methodological steps to ensure the final data are appropriate for the analysis to meet the research objectives, legal and ethical requirements are met, and that data definitions are clear, concise, and comprehensive. This protocol is neither file specific nor software dependent, but aims to be transportable to any data-merging situation to minimise redundancy and error and translational to any field of research. DIPIT aims to generate a master data file that is of the optimal integrity to serve as the basis for research analysis.

Conclusion: With linking of heterogeneous data files becoming increasingly common across all fields of medicine, DIPIT provides a systematic approach to a potentially complex task of integrating a large number of files and variables. The DIPIT protocol will ensure the final integrated data is consistent and of high integrity for the research requirements, useful for practical application across all fields of medical research.

1. Introduction

EQ5D – Mixed Methods Data Integration

DIPIT STEP	Action	Strategy	Standard
1	Define the data requirement:	• Define research hypothesis • Establish files to integrate • Assess data quality	VEES-Junior Aim 1: Characterize and measure deficits in physical and psychosocial functioning following injury in childhood and adolescence.
2	Establish ethical, legal and privacy issues:	Establish ethical, legal and privacy issues for each data file to integrate	The project was approved by the Monash University Human Research Ethics Committee-project number 12311, and will be conducted in compliance the NHMRC National Statement on ethical Conduct in Human Research (2007) and the Note for Guidance on Good Clinical Practice (CPMP/ICH-135/95).
3	Order the files to integrate	Set up a flowchart for all files to be integrated, incorporating all file names	Performed in a Master Stata .do file MASTER_Combined_Setup.do under the Stata Project file Combined.stpr
4	Establish the file formats:	Amend the flowchart in step 3 to document the file format for each file integrated and the final master file.	NA
5	Define the variables of interest	Create a table containing the variable of interest for research containing as a minimum: • Final variable name • Original variable name • Source file of variable • Preliminary Rule(s) for variable • Description of variable	Tables created as part of Investigator Meeting analysis – November 2018.
6	Set up link(s) for integration	Create a table containing the variable(s) link- and linkage method(s) used containing as a minimum: • Link variable(s) • Method of linkage • Automation used (if applicable)	Files appended using Data V16. Refer Combined_Setup_POOLED.do file.
7	Document the integration path	Document the structure of the path take for integration to include as a minimum: • The integration of the primary files • The merge of the Master file format in a standard file naming structure • The variables of interest to be retained • The variables standard naming format • The merging of all files into the *Master* file • A log of statistics of the key variables, and missing data analysis	Refer Stata file referred to in Step 3. Files integrated after only key variables taken from source files: BCCH-LIO_Combined.dta CHAI_Combined.dta UKBOI_Combined.dta VSTORM_Combined.dta All Stata files create text log files (refer individual Stata .do files)
8	Flowchart the type of integration	Document on flowchart type of integration: • one-to-one • many-to-one • one-to-many • many-to-many	Integration used was appending as linking not required across study cohorts
9	Document the integration outcome	Define linkage quality measure. Table of mismatches of records by variable to contain as a minimum: • Variable name • Source of mismatch • Reason for mismatch	NA
10	Check variables and missing data	Initial data inspection to include as a minimum: • Analysis of key variable(s) • Missing data analysis	Tables of key variables initially reviewed by International Investigators in November 2018. Final Table 1 reviewed by investigators as part of manuscript. Included missing data proportions.

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Data

Table 1. Specific details of VIBES-Junior cohorts.

Study & Setting	Month/Year & Participants	Inclusion Criteria & Injury Diagnosis Coding	Post-Injury Follow-Up Time Point EQ-5D Measures & Mode of Interview
VSTR Australia	03/2009 to 03/2017 *n* = 824, 5–16 years	In hospital death, ISS > 12, ICU admission or urgent surgery, met burns criteria 20–29% full/partial thickness. ICD-10-AM	EQ-5D total score and items at 6, 12 and 24 months. Telephone
VOTOR Australia	03/2009 to 03/2017 *n* = 502, 16–17 years	16+ years of age, orthopedic injury admission >24 h or death ICD-10-AM	EQ-5D total score and items at 6, 12 and 24 months. Telephone
CHAI United States of America	03/2007 to 09/2008 *n* = 635, 5–17 years	Presentation to ED or hospital admission for either a TBI or an upper extremity injury ICD-9 mapped to ICD-10	PedsQL scores mapped to EQ-5D total score at 3, 12, and 24 months. Online, telephone and postal
UKBOI United Kingdom	09/2005 to 04/2007 *n* = 174, 5–17 years	Presentation to ED or hospital admission. ICD-10	EQ-5D total score and items at 1, 6 and 12 months. Postal
BCCH-LIO Canada	02/2011 to 12/2013 *n* = 199, 5–16 years	Presentation to ED or hospital admission. ICD-10	EQ-5D total score and items at 1, 4, and 12 months. Postal and online

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Measures

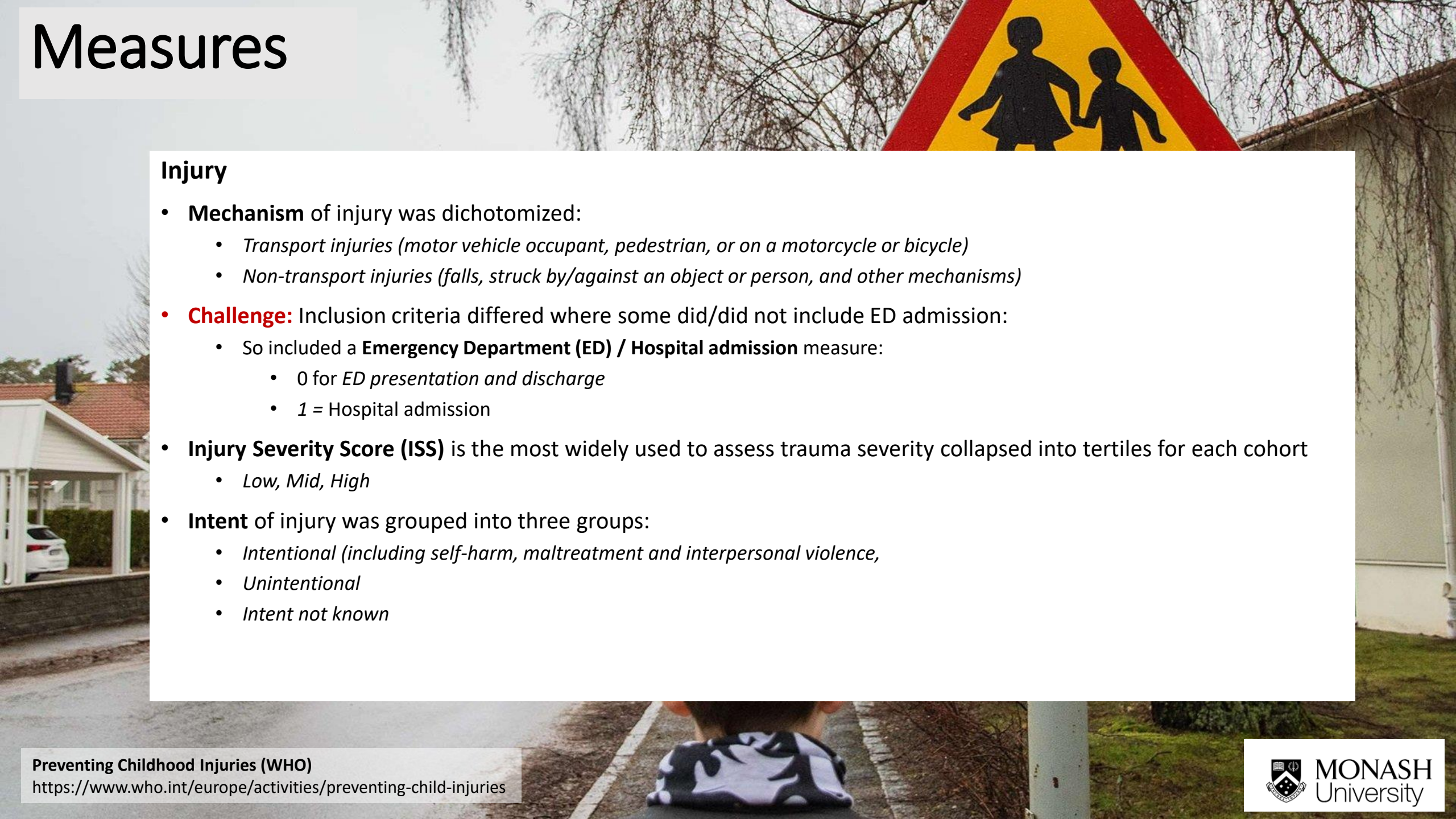
Demographics

- Baseline measures:
  - Sex
    - *Male, female*
  - Three age groups to align with the World Health Organization (WHO) classification within the age band of our pooled cohort
    - *5–9 years, 10–14 years, 15–17 years*
  - Measure of socio-economic status (SES) collapsed from quintiles into tertiles (*low, moderate, high*)
    - **Challenge**: SES differed
    - **Australia:** Quintiles of the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) area-based measure released by the Australian Bureau of Statistics;
    - **USA:** Quintiles created from principal components analysis using income and education variables
    - **UK:** Quintiles from Townsend Deprivation Score reversed so that higher quintiles reflect higher SES;
    - **Canada:** Initially contained quintiles Quintile of Annual Income Per Person Equivalent (QAIPPE) area-based measure released by Statistics Canada.

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Measures



Injury

- **Mechanism** of injury was dichotomized:
  - *Transport injuries (motor vehicle occupant, pedestrian, or on a motorcycle or bicycle)*
  - *Non-transport injuries (falls, struck by/against an object or person, and other mechanisms)*
- **Challenge:** Inclusion criteria differed where some did/did not include ED admission:
  - So included a **Emergency Department (ED) / Hospital admission** measure:
    - 0 for *ED presentation and discharge*
    - *1* = Hospital admission
- **Injury Severity Score (ISS)** is the most widely used to assess trauma severity collapsed into tertiles for each cohort
  - *Low, Mid, High*
- **Intent** of injury was grouped into three groups:
  - *Intentional (including self-harm, maltreatment and interpersonal violence,*
  - *Unintentional*
  - *Intent not known*

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Measures

Comorbidities

- Comorbidities present at the time of injury was based on the 27 health conditions described by Mitchell et al. and were collapse into two groups
  - No comorbidities
  - ≥1 comorbidities

Mitchell, R.J.; Curtis, K.; Braithwaite, J. Health outcomes and costs for injured young people hospitalised with and without chronic health conditions. Injury 2017, 48, 1776–1783.

Diagnoses

- **Challenge:** Diagnoses and external cause codes were classified using different International Classification of Disease (ICD) so used ICD-10:
  - **Australia, UK & Canada:** ICD 10th Revision (ICD-10)
  - **USA:** ICD 9th Revision (ICD-9) mapped to the ICD-10
- All diagnosis codes were then mapped to the 2013 Global Burden of Disease (GBD) study injury health states

Original article

OPEN ACCESS

The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013

Juanita A Haagsma,[1,60] Nicholas Graetz,[1] Ian Bolliger,[1] Mohsen Naghavi,[1] Hideki Higashi,[1] Erin C Mullany,[1] Semaw Ferede Abera,[2,3] Jerry Puthenpurakal Abraham,[4,5] Koranteng Adofo,[6] Ubai Alsharif,[7] Emmanuel A Ameh,[8] Walid Ammar,[9] Carl Abelardo T Antonio,[10] Lope H Barrero,[11] Tolesa Bekele,[12] Dipan Bose,[13] Alexandra Brazinova,[14] Ferrán Catalá-López,[15] Lalit Dandona,[1,16] Rakhi Dandona,[16] Paul I Dargan,[17] Diego De Leo,[18] Louisa Degenhardt,[19] Sarah Derrett,[20,21] Samath D Dharmaratne,[22] Tim R Driscoll,[23] Leilei Duan,[24] Sergey Petrovich Ermakov,[25,26] Farshad Farzadfar,[27] Valery L Feigin,[28] Richard C Franklin,[29] Belinda Gabbe,[30] Richard A Gosselin,[31] Nima Hafezi-Nejad,[32] Randah Ribhi Hamadeh,[33] Martha Hijar,[34] Guoqing Hu,[35] Sudha P Jayaraman,[36] Guohong Jiang,[37] Yousef Saleh Khader,[38] Ejaz Ahmad Khan,[39,40] Sanjay Krishnaswami,[41] Chanda Kulkarni,[42] Fiona E Lecky,[43] Ricky Leung,[44] Raimundas Lunevicius,[45,46] Ronan Anthony Lyons,[47] Marek Majdan,[48] Amanda J Mason-Jones,[49] Richard Matzopoulos,[50,51] Peter A Meaney,[52,53] Wubegzier Mekonnen,[54] Ted R Miller,[55,56] Charles N Mock,[57] Rosana E Norman,[58] Ricardo Orozco,[59] Suzanne Polinder,[60] Farshad Pourmalek,[61] Vafa Rahimi-Movaghar,[62] Amany Refaat,[63] David Rojas-Rueda,[64] Nobhojit Roy,[65,66] David C Schwebel,[67] Amira Shaheen,[68] Saeid Shahraz,[69] Vegard Skirbekk,[70] Kjetil Søreide,[71] Sergey Soshnikov,[72] Dan J Stein,[73,74] Bryan L Sykes,[75] Karen M Tabb,[76] Awoke Misganaw Temesgen,[77] Eric Yeboah Tenkorang,[78] Alice M Theadom,[79] Bach Xuan Tran,[80,81] Tommi J Vasankari,[82] Monica S Vavilala,[57] Vasiliy Victorovich Vlassov,[83] Solomon Meseret Woldeyohannes,[84] Paul Yip,[85] Naohiro Yonemoto,[86] Mustafa Z Younis,[87] Chuanhua Yu,[88,89] Christopher J L Murray,[1] Theo Vos,[1] Shivanthi Balalla,[28] Michael R Phillips[90]

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/injuryprev-2015-041616).

For numbered affiliations see end of article.

Correspondence to
Dr Juanita A Haagsma, Institute for Health Metrics and Evaluation, University of Washington, Seattle, WA, USA; jhaagsma@uw.edu

Received 22 March 2015
Revised 13 July 2015
Accepted 30 July 2015
Published Online First 3 December 2015

Linked

► http://dx.doi.org/10.1136/injuryprev-2015-041920

To cite: Haagsma JA, Graetz N, Bolliger I, *et al. Inj Prev* 2016;**22**:3–18.

ABSTRACT

Background The Global Burden of Diseases (GBD), Injuries, and Risk Factors study used the disability-adjusted life year (DALY) to quantify the burden of diseases, injuries, and risk factors. This paper provides an overview of injury estimates from the 2013 update of GBD, with detailed information on incidence, mortality, DALYs and rates of change from 1990 to 2013 for 26 causes of injury, globally, by region and by country.

Methods Injury mortality was estimated using the extensive GBD mortality database, corrections for ill-defined cause of death and the cause of death ensemble modelling tool. Morbidity estimation was based on inpatient and outpatient data sets, 26 cause-of-injury and 47 nature-of-injury categories, and seven follow-up studies with patient-reported long-term outcome measures.

Results In 2013, 973 million (uncertainty interval (UI) 942 to 993) people sustained injuries that warranted some type of healthcare and 4.8 million (UI 4.5 to 5.1) people died from injuries. Between 1990 and 2013 the global age-standardised injury DALY rate decreased by 31% (UI 26% to 35%). The rate of decline in DALY rates was significant for 22 cause-of-injury categories, including all the major injuries.

Conclusions Injuries continue to be an important cause of morbidity and mortality in the developed and developing world. The decline in rates for almost all injuries is so prominent that it warrants a general statement that the world is becoming a safer place to live in. However, the patterns vary widely by cause, age, sex, region and time and there are still large improvements that need to be made.

INTRODUCTION

Since the late 1940s the use of epidemiological analyses to assess the gains of prevention of injury has been advocated, reflecting the changing view of injuries as preventable events.[1] These epidemiological analyses entail the use of data to quantify the injury problem and assess causative factors to guide the development of preventive measures and to enable periodic evaluation of the effectiveness of instituted prevention programmes.[1] For many decades, injury epidemiologists have largely relied on mortality data.[2] However, since the launch of

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

GBD 2013 Study

- Contained tables related to injury health state classifications to enable cross-walking from the ICD-10 codes to the GBD injury groups
- GBD 2013 Injury groups were in order of severity and collapsed into 17 binary variables indicating the presence or absence of that injury

GBD 2013 Injury Groups	
1. Spinal cord lesion	10. Burns (including lower airways)
2. Fracture of femur	11. Fracture of vertebral column
3. Fracture of patella, tibia, fibula, or ankle	12. Asphyxiation, non-fatal submersion
4. Moderate to severe TBI	13. Contusion, open wound
5. Crush injury, fracture foot/hand bones	14. Other injuries of muscle & tendon and other dislocations
6. Internal hemorrhage in abdomen or pelvis	15. Fracture of clavicle, scapula, or humerus
7. Minor TBI	16. Fracture of radius or ulna
8. Fracture of pelvis	17. Other. (I.e. included injuries such as amputation of one limb/toe, poisoning, injured nerves, environmental factors, injured nerves, dislocation of shoulder/hip/knee, fracture of ribs/sternum/skull/face bone, foreign body in ear/gastrointestinal or urogenital system, superficial injury, and injury to eyes)
9. Severe chest injury	

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Outcomes

Outcome Measure

- Generic and easily administered multi-attribute utility instruments such as the EUROQOL 5 Dimension (EQ-5D) have been used for both recovery and health economic analyses

Overall EQ-5D utility score

- Score derived according to a set of weights (country specific) that reflect, on average, people's preferences about how good or bad the health state is
- Values are anchored at 1 (full health) and 0 (a state as bad as being dead) as required by their use in economic evaluation
- Negative values represent health states regarded as "worse than a state that is as bad as being dead"
- **Challenge: Australia, UK & Canada:** Collected the EQ-5D outcomes at multiple time points after injury but **USA:** Collected the Pediatric Quality of Life Inventory (PedsQL)
  - Responses to these questions were mapped to the EQ-5D using the algorithm developed by Khan et al.

    Khan, K.A.; Petrou, S.; Rivero-Arias, O.; Walters, S.J.; Boyle, S.E. Mapping EQ-5D utility scores from the PedsQL™ generic core scales. Pharmacoeconomics 2014, 32, 693–706.
- **Challenge:** Country-specific weights - needed to develop own Stata program (i.e. ado) for to provide the, then, recent Australian weights

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Outcomes

Three-level EQ-5D scale (EQ-5D-3L)

- Three level measure: *No problems, Some problems, Extreme problems*
- **Five health states** measured:
  1. Mobility
  2. Self-care
  3. Activity
  4. Pain
  5. Anxiety & Depression
- **Challenge:** Due to low frequency across the three categories a binary measure was created:
  - 1 = No problems
  - 0 = Problems (some/extreme)
- **Challenge:**
  - As there was no map available of the individual EQ-5D-3L health state questions from the PedsQL, the US cohort was excluded from this analysis

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Models

- Missing data on the covariates included in the models was quantified and found to be acceptable at <5%

  Tabachnick, B.G.; Fidell, L.S. Using Multivariate Statistics, 6th ed.; Pearson: Boston, MA, USA, 2013.Newman, D.A. Missing data: Five practical guidelines. Organ. Res. Methods 2014, 17, 372–411

- Mixed Effects (ME) linear regression modelled EQ-5D utility
  - Estimated average EQ-5D and 95% CI
- ME modified Poisson modelled the five binary EQ-5D health state items
  - Estimated relative risks (RR) and 95%CI for each binary outcome

    Zou, G. A modified poisson regression approach to prospective studies with binary data. Am. J. Epidemiol. 2004, 159, 702–706
  - Predicted margins across time estimated and graphed
- ME regression models uses as has been shown to be flexible in handling missing data compared to using multiple imputation which has been found to potentially produce unstable results

  Twisk, J.; de Boer, M.; de Vente, W.; Heymans, M. Multiple imputation of missing values was not necessary before performing a longitudinal mixed-model analysis. J. Clin. Epidemiol. 2013, 66, 1022–1028
- Time was treated as a discrete categorical variable in the models, requiring no assumptions to be made about its mathematical function

ME linear example:

$$y = X\beta + Zu + \epsilon$$

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Management

Storage:

- All data was stored in the Monash Safe eResearch Platform (SeRP)
  - Restricted access based on ethics approval
  - Secure separate study drive to store study data
    - Analysis performed in user drive so that study data kept separate

Stata Projects & Do Files:

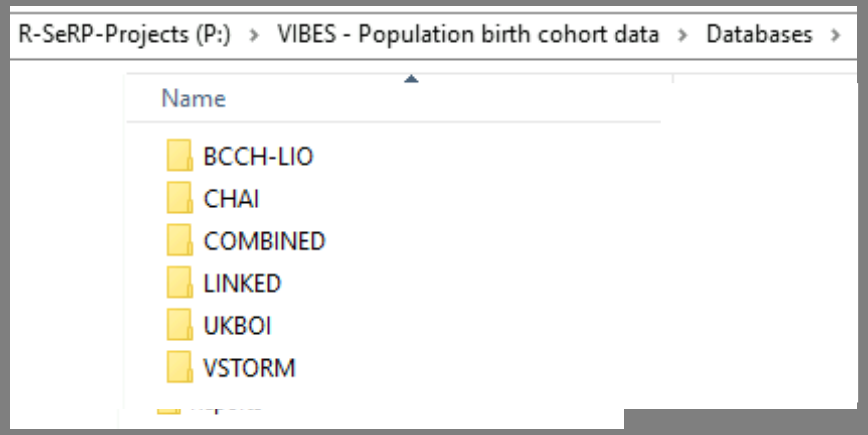
- Stata V16 was used to manage the data and run the analysis and ensure reproducibility
  - A VIBES-Junior Stata Project file was set up for the data management
    - folders were set up to indicate:
      - Stages of each cohort preparation
      - Pooling of cohort data
      - Stages of analysis
    - Do files were grouped and numbered accordingly

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

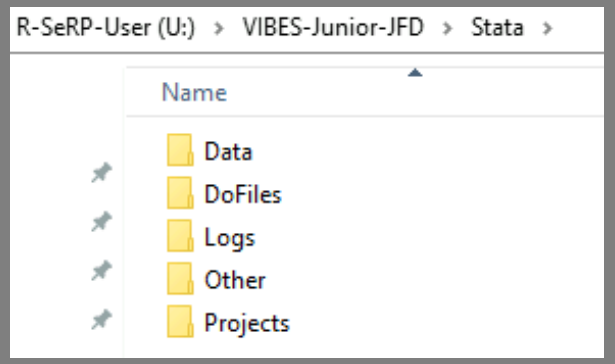
MONASH University

Storage

Project Drive P:
- **Restricted (read)**
- **Secure**



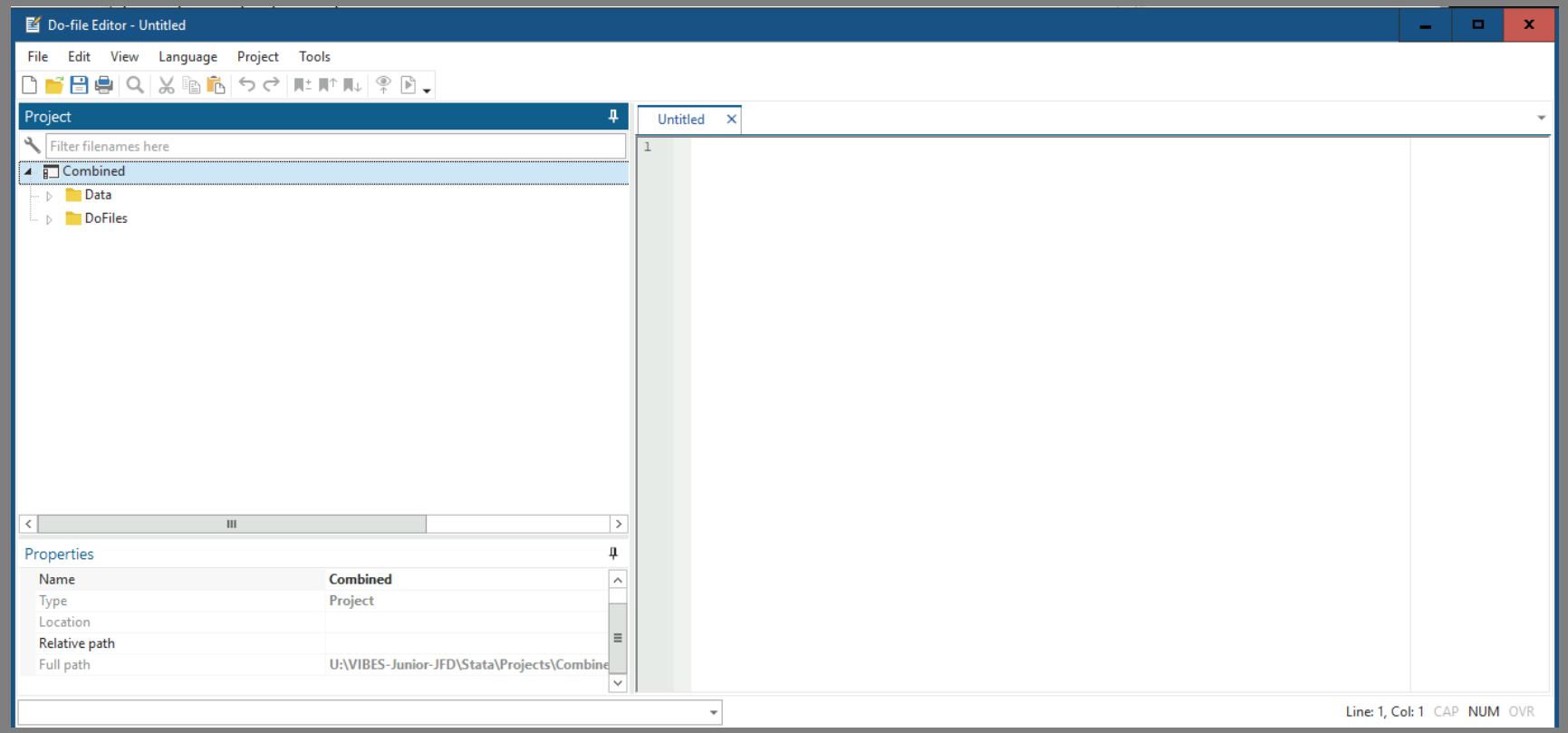
User Drive U:
- **Read/write**
- **Personal**

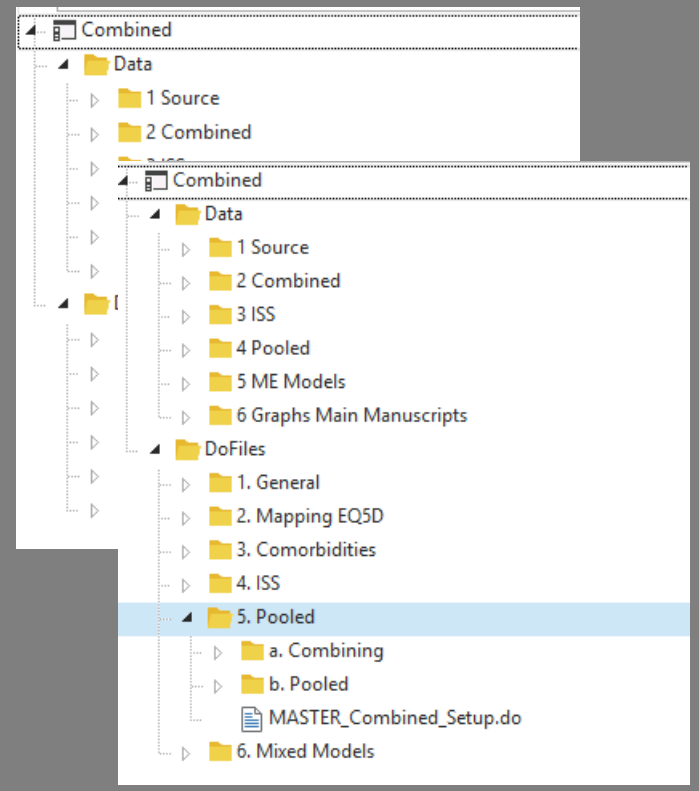


Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Projects & Do Files

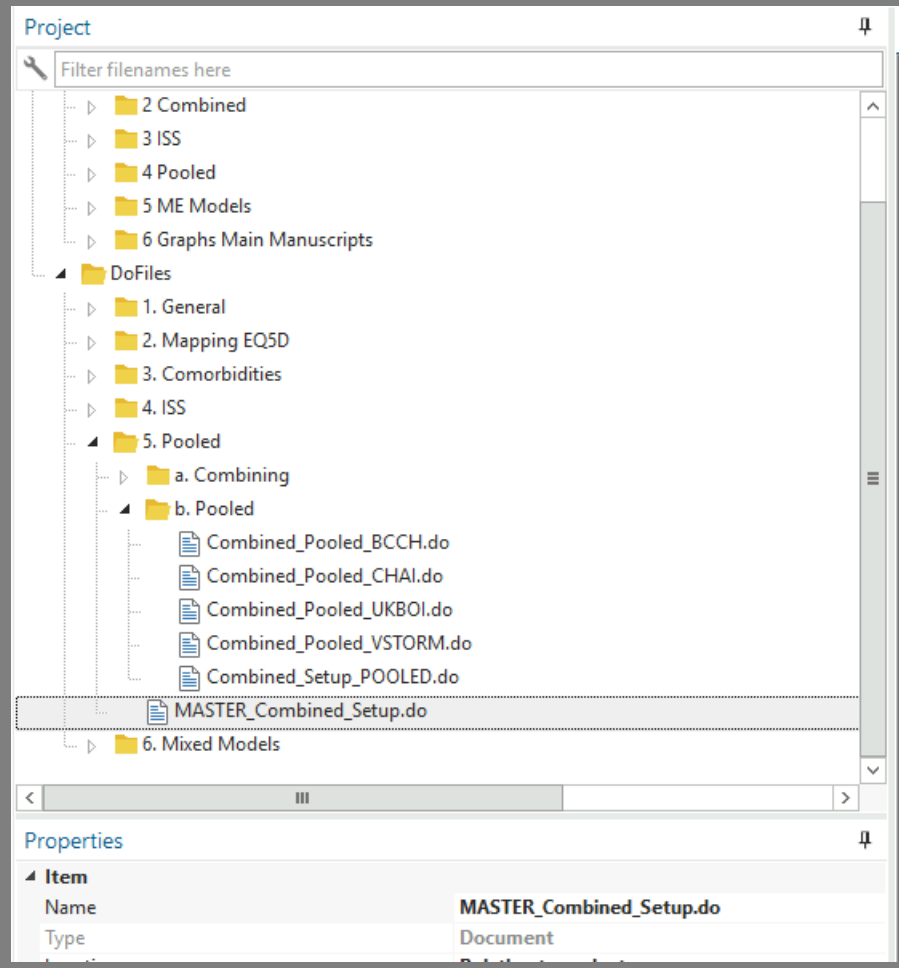


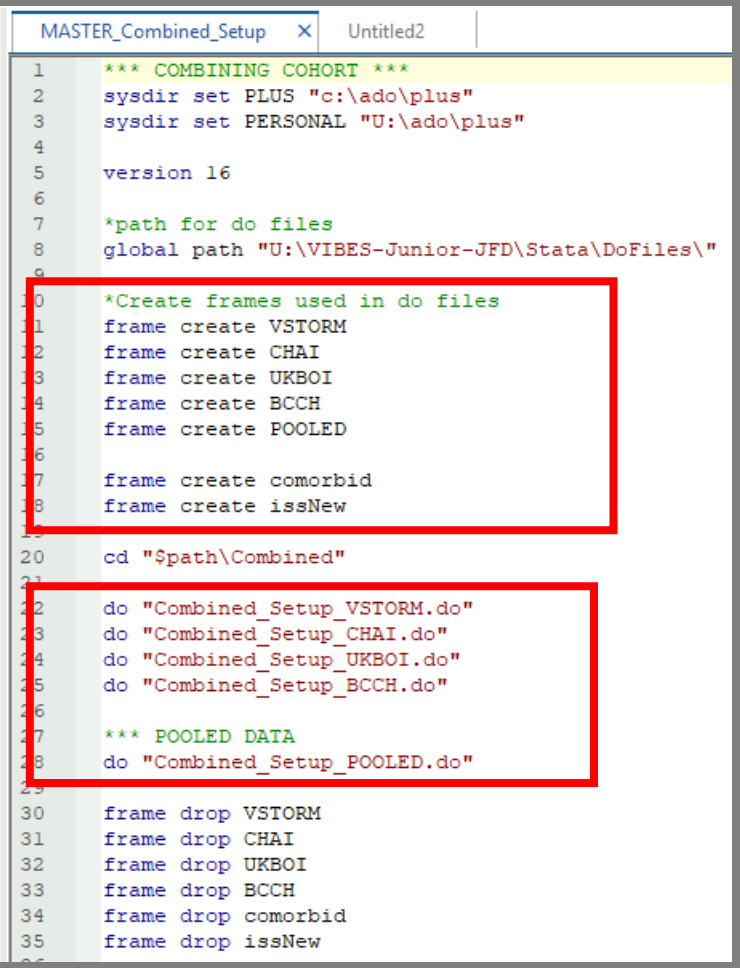


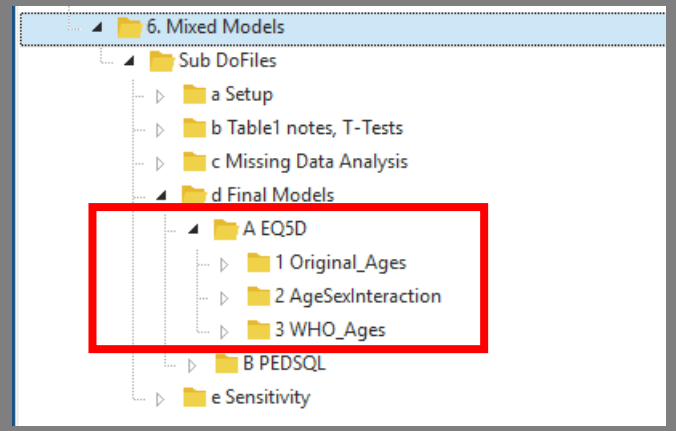
Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Projects & Do Files







Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

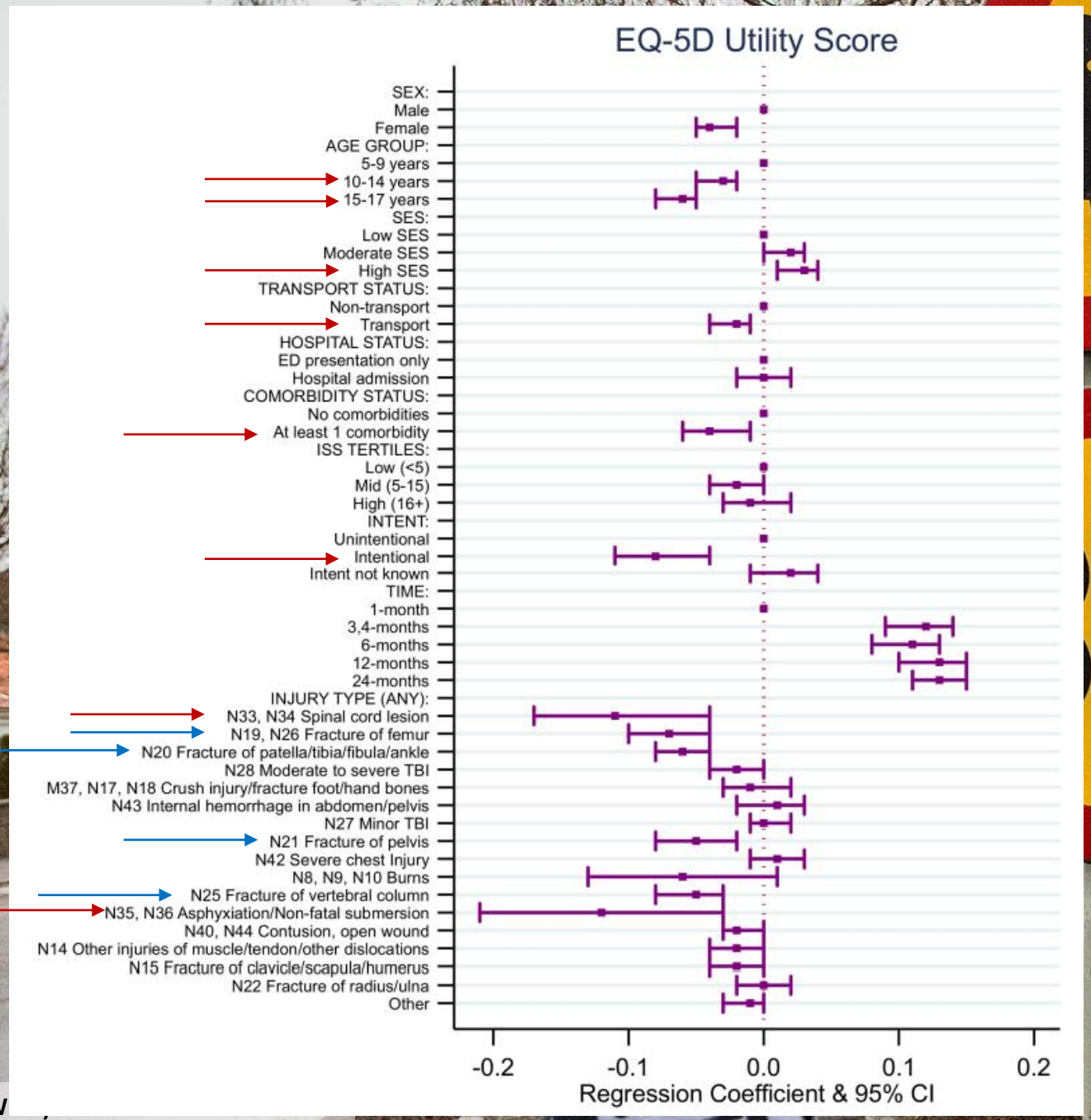
MONASH University

Results

- 2,334 children and adolescents were included in the pooled analysis
  - Majority male (73%)
  - Mean age of 13.6 years (SD = 3.5)
  - 62% from moderate to high SES
  - 63% had a non-transport related injury
  - 73% had a hospital admission
  - 92% had no comorbidities recorded at the time of their injury

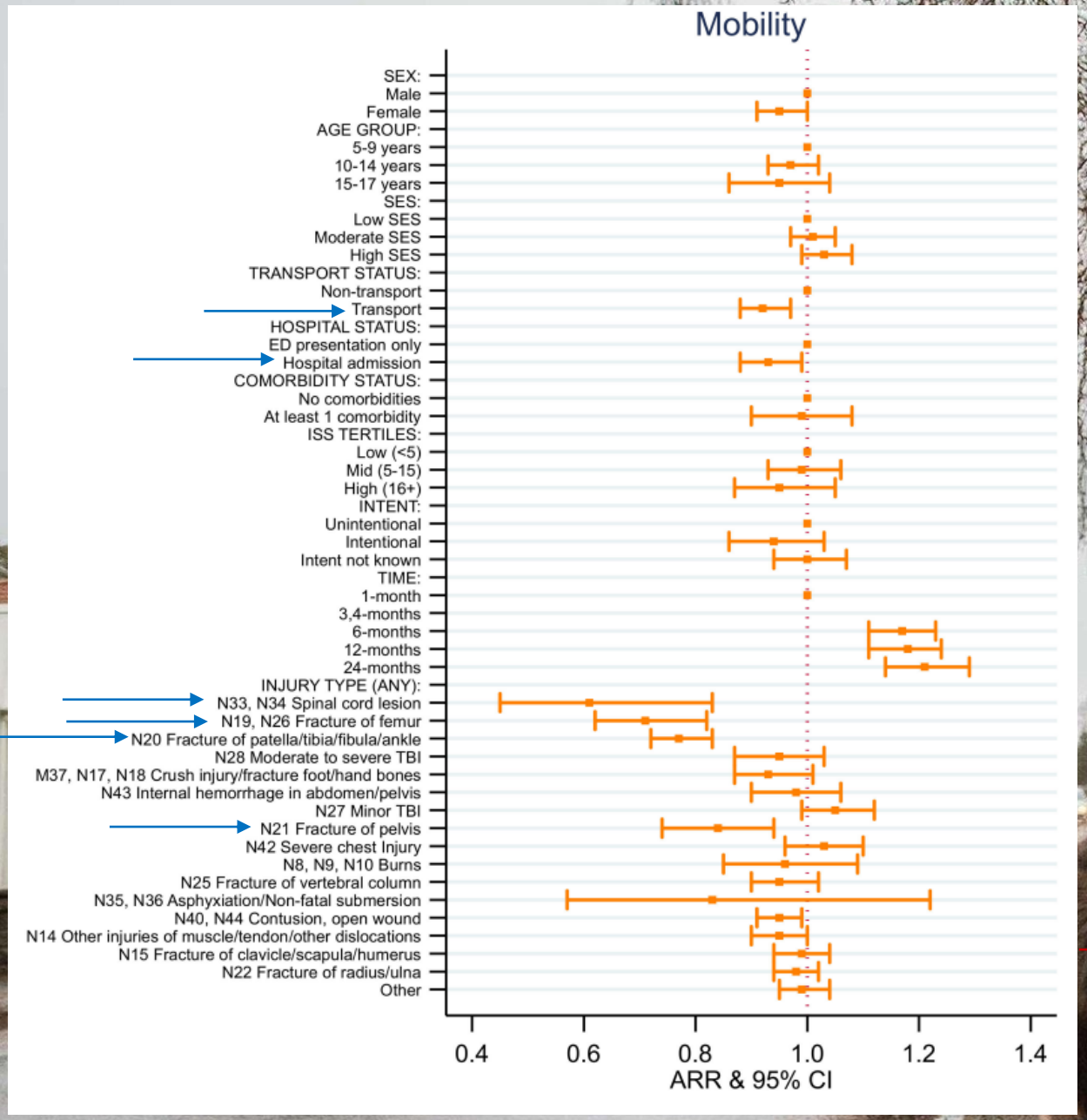
Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

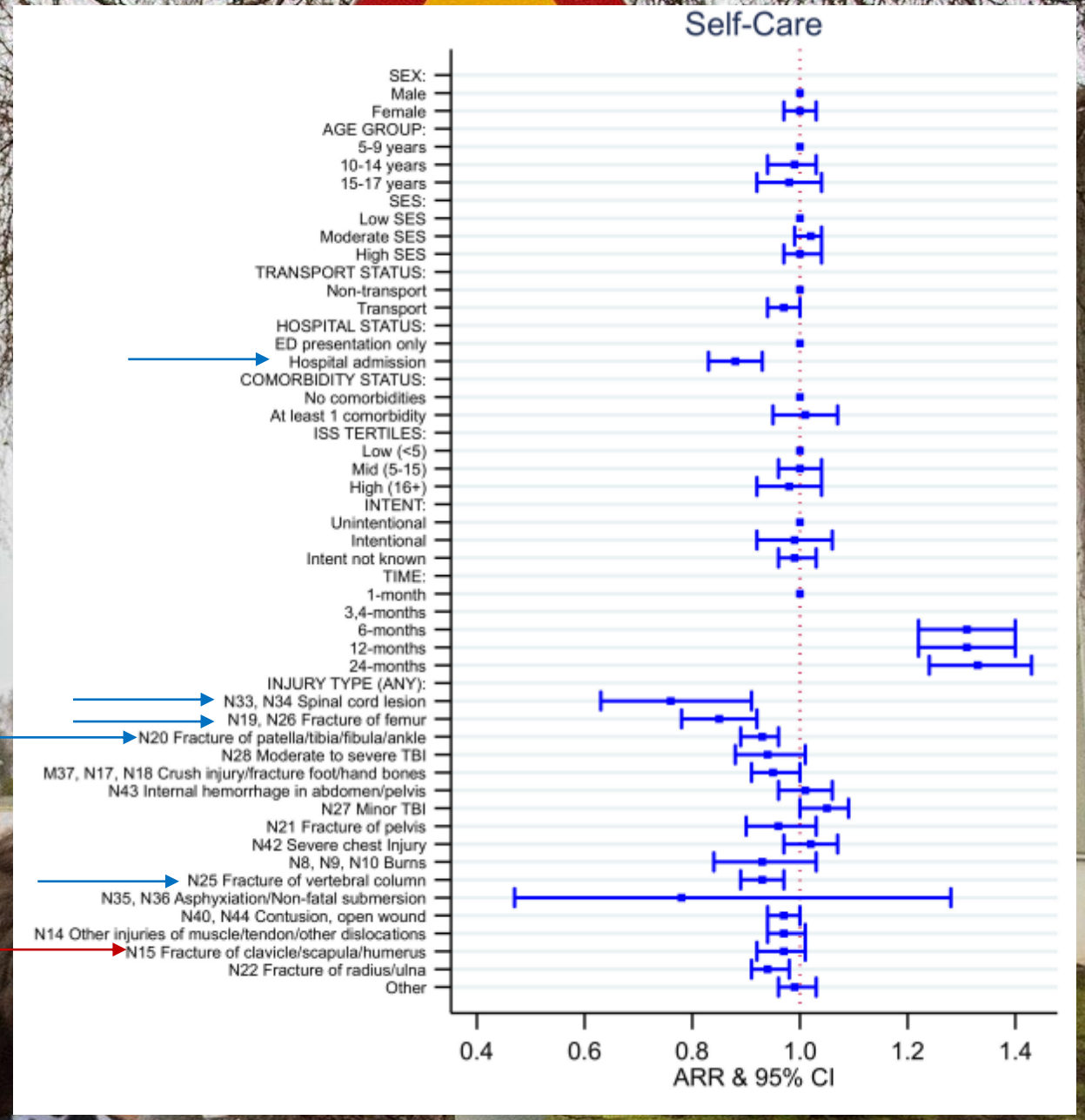
MONASH University



Preventing Childhood Injuries (W
https://www.who.int/europe/activities/preventing-child-injuries

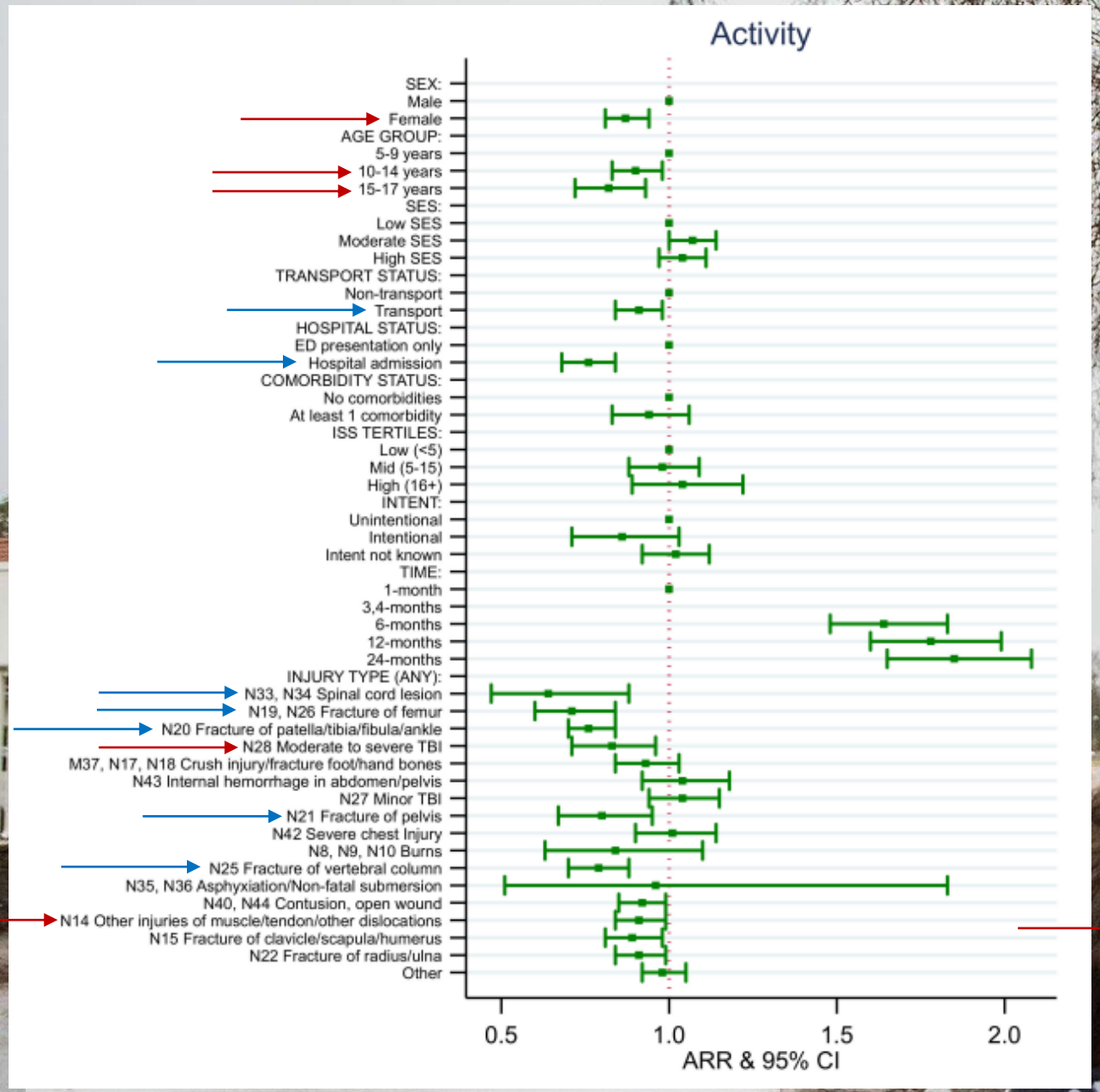
MONASH University

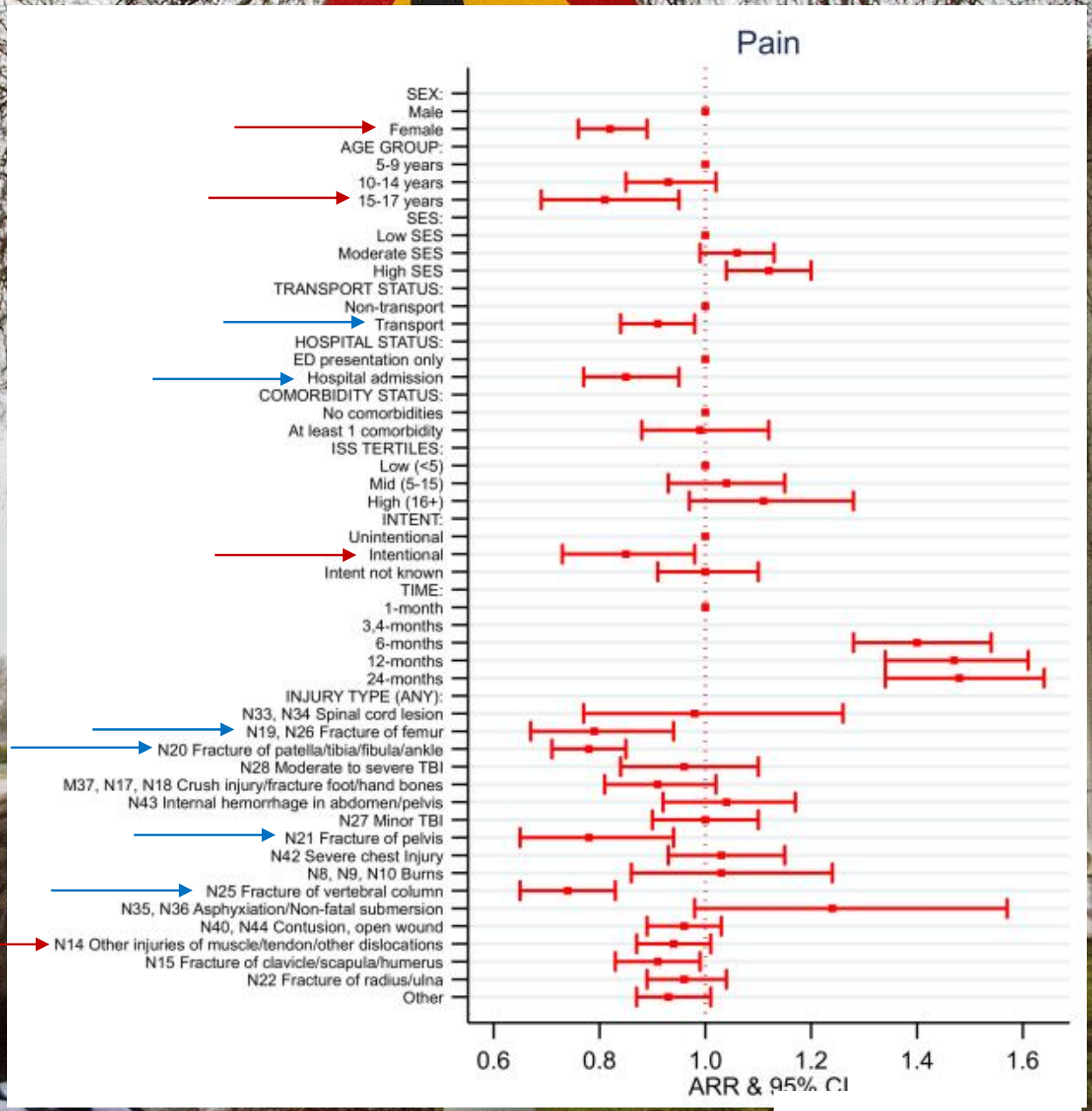




Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

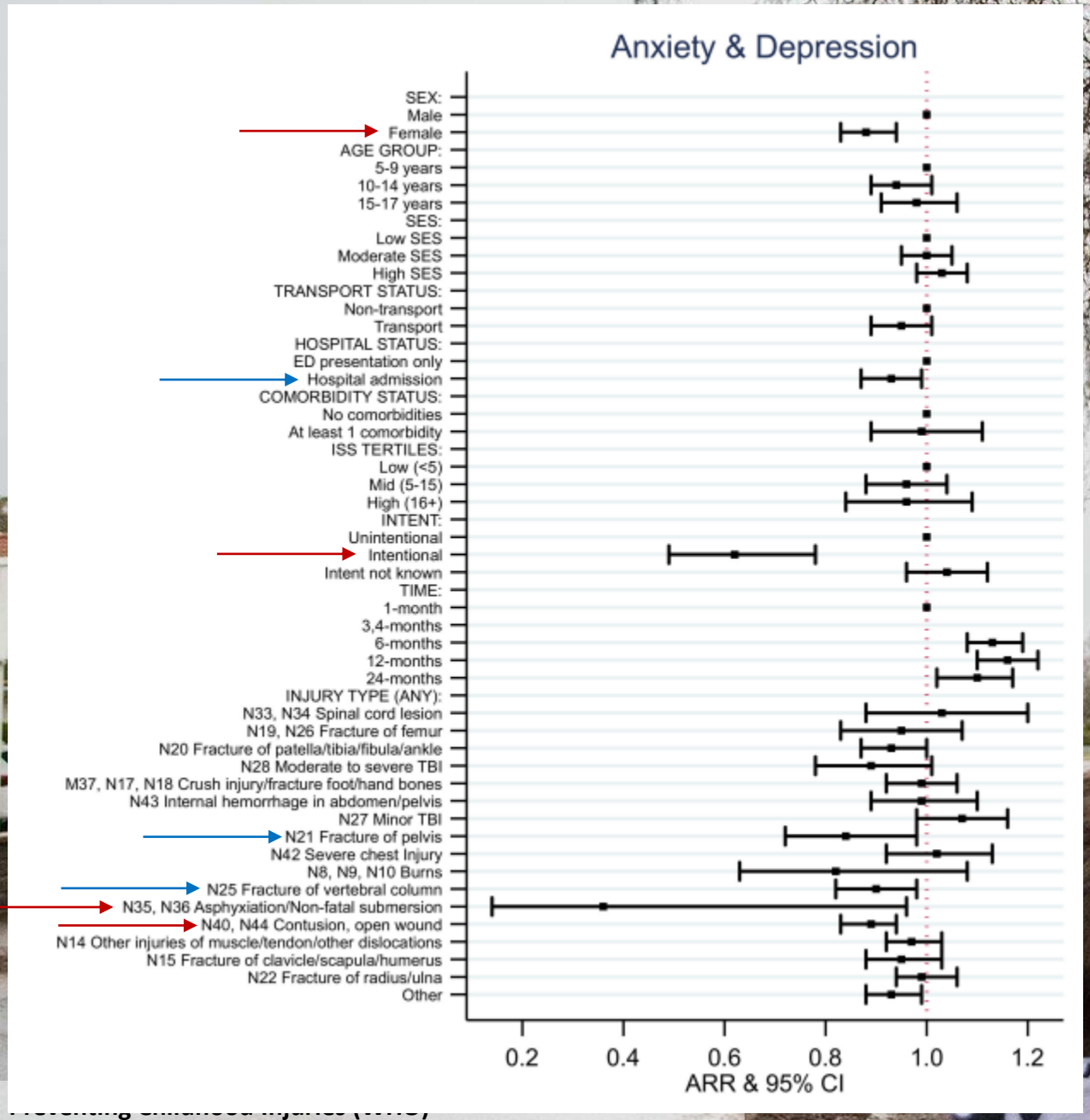
MONASH University

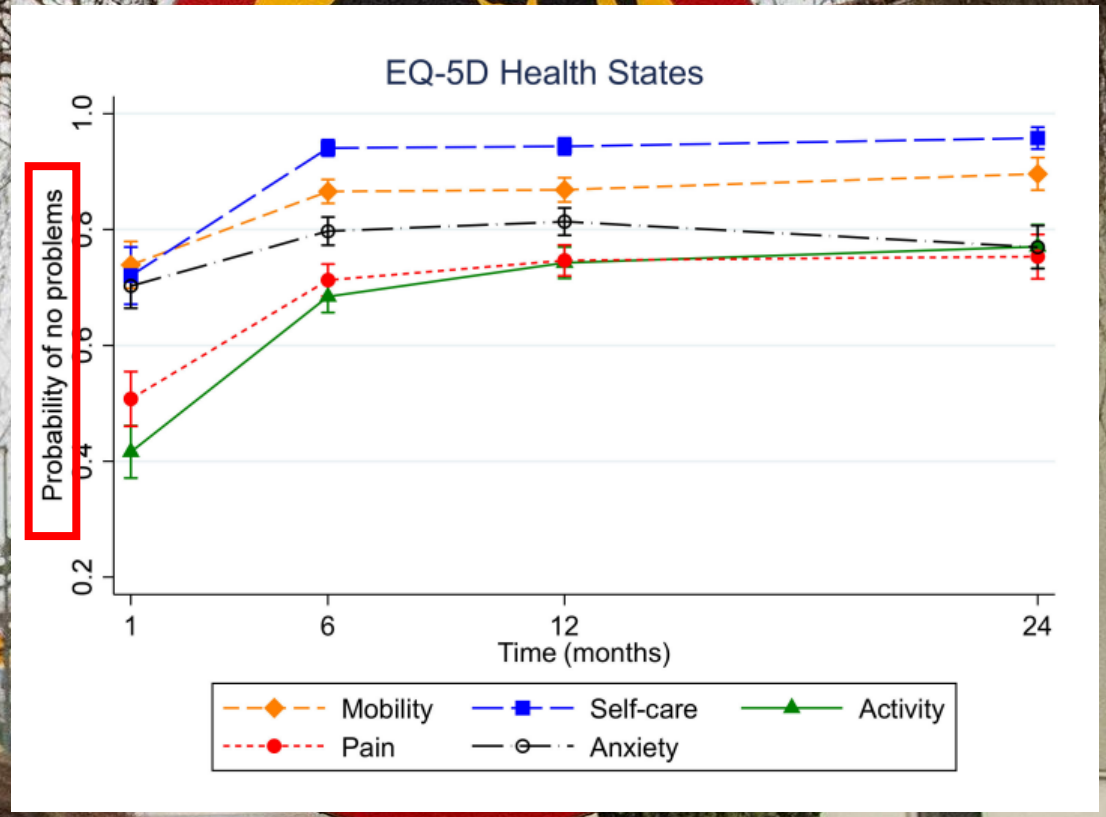




Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University





https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

Conclusion

- HRQoL outcomes over time for children and adolescents post-injury differed across key demographic and injury related attributes
- HRQoL did not reach levels consistent with full health by 24 months with recovery plateauing from 6 to 24 months
- Tailored interventions are required to respond to the varying post-injury recovery trajectories in this population

- Systematic management procedures and use of Stata projects, structured do files make it easy to
  - Manage the complexities of pooling different cohort data
  - Replicate the results of this complex study

- Refer to article for extended Discussion including strengths and limitations

Preventing Childhood Injuries (WHO)
https://www.who.int/europe/activities/preventing-child-injuries

MONASH University

MONASH University

ACKNOWLEDGMENTS

The authors would like to extend their gratitude and acknowledgements to all study participants and study team members for the time and energy they spent on this project

StataCorp for allowing me to share this important work with you

Funding associated with this research:

VIBES-Junior project: National Health and Medical Research Council of Australia (NHMRCAPP1142325);

UKBOI: Policy Research Programme, Department of Health (#0010009);

VSTR: Department of Health (Victoria), Transport Accident Commission (TAC); CHAI: US Centers for Disease Control and Prevention (CDC) grant R49 CE 001021;

BCCH-LIO: Canadian Institutes of Health Research (#TIR-104028), Michael Smith Foundation for Health Research.

MB: BCCH Research Institute and Michael Smith Foundation for Health Research Scholar Award.

BG: Australian Research Council Future Fellowship (FT170100048).

J.L. and R.A.L.: Health Data Research UK (HDR-9006) and Health and Care Research Wales-National Centre for Population Health and Wellbeing