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## SYSTEMATIC REVIEW OF RISK FACTORS ASSOCIATED WITH QUAD BIKE CRASHES: PROTOCOL FOR SYSTEMATIC REVIEW OF OBSERVATIONAL STUDIES

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# SYSTEMATIC REVIEW OF RISK FACTORS ASSOCIATED WITH QUAD BIKE CRASHES: PROTOCOL FOR SYSTEMATIC REVIEW OF OBSERVATIONAL STUDIES.

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## ABSTRACT

### Introduction

Quad bikes are four-wheeled vehicles, driven off-road on uneven terrains by farmers for work or young adults for leisure. Quad bike accidental injuries mostly result due to the unique ecosystem of uneven terrain, where these unstable vehicles are driven, and distinctive demographic characteristics of drivers.

The conventional risk factors associated with motor vehicle injuries cannot be extrapolated to quad bike injuries. In the absence of any literature on quad bike injuries in the UAE, this study aims to review available observational studies from all geographical regions and all demographic groups to identify the common risk factors relating to quad bike injuries. This will provide the basis for additional analysis of the problem in the UAE to provide holistic intervention program to control quad bike injuries in the country.

### Methods and Analysis

A comprehensive search for literature on quad bike injuries will be conducted in five electronic databases: PubMed, Embase, Scopus, Web of Science and PsycInfo. Selected sources for grey literature will be included. Five researchers will be involved in the screening, reviewing full text articles, using the inclusion and exclusion criteria. Covidence software (Veritas Health Innovation, 2020) will be used to assist in blinded screening, article selection and data extraction. Three researchers will help resolving conflicts during screening and will help to verify the extracted data. Information on crashes leading to injury, target population characteristics and risk factors will be collated in addition to assessing the quality of the researched articles.

### Ethics and dissemination

Since it is a systematic review of published literature, ethical approval is not needed. Results of the review will be disseminated through peer-reviewed publications, conference presentations and risk reports to the concerned authorities.

**Prospero registration number: CRD42020170245**

## ARTICLE SUMMARY - STRENGTH AND LIMITATIONS OF THIS STUDY

- This study will follow the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines.
- It will attempt to employ a transparent and rigorous screening and review methodology involving multiple independent researchers, using the Covidence software (Veritas Health Innovation, 2020).
- The study will help to fill up the evidence gap, using the public health approach to identify the risk factors for quad bike injuries, namely the Haddon Matrix and Ecological Model.
- Limitations may include failure to retrieve the available data for the study or the low level of evidence generated from the observational studies.

## BACKGROUND

Quad bikes are four-wheeled, off- road vehicles, characterized by low air pressure tyres, saddle seat and handlebars. They are distinct in their narrow wheel base and have been widely used for farm work and recreation [1]. In the United Arab Emirates (UAE), quad bikes have become popular recreational sport in the cooler winter months among children and adults. Regular quad bike use is associated with increased aerobic fitness, improved blood lipid profile and lower risk of metabolic syndrome [2]. In terms of health benefits, quad bikes can be compared with other outdoor sports like bicycling. However, in terms of risk and severity of injuries associated with quad bikes, it is said to be comparable to motor vehicle injuries [3].

Quad bike injuries constitute a growing public health problem at an individual and societal levels, including disability, injury and death, in addition to the direct and indirect costs related to medical treatment and work absenteeism. As such, the prevention of quad bike injuries is essential to maintain the health and wellbeing of the society in the UAE and to reduce the unnecessary costs of these injuries.

Quad bikes have an inherent instability in their design. When used in desert and rugged terrain, they are characterized by high uncertainty in the driving surface. The unpaved terrain, narrow wheel base, high center of gravity and large engine size makes them prone to rollover and collision, even at low speed [3, 4]. The nature of risk while riding a quad bike is enhanced in the context of outdoor sport and the demographic group involved [5]. Young adults, adolescents and children are known to carry an additional psychological impulse for risk taking, high speed and aggressive driving [4]. Thus, the risk factors associated with quad bikes are unique in terms of the environmental influence, the vehicle, and the driver

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3 characteristics. Consequently, the conventional risk factors associated with motor vehicle injuries cannot  
4 be blindly extrapolated to quad bike injuries.  
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7 This review will use the Haddon Matrix framework to classify risk factors related to quadbike injuries.  
8 Developed by William Haddon [6, 7], the matrix looks at risk factors related to the personal attributes,  
9 vector attributes and environmental attributes, in relation to the time of the incident occurrence; before,  
10 during and after the incident (whether an injury or death). As such the framework identifies the risk factors  
11 that can be controlled before, during and after the event, through education, engineering and  
12 environment [8].  
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14  
15 Any safety intervention begins with a robust risk assessment study, which requires an understanding of  
16 all risk factors associated with the activity [9]. A systematic and an objective review of existing scientific  
17 literature can highlight the possible risk factors associated with quad bikes. Unlike road traffic injuries and  
18 occupational injuries, there has been limited research on the risk assessments of quad bike injuries. A  
19 comprehensive search for systematic reviews on quad bike injuries, by the authors, resulted in only one  
20 review, which have been carried out in 2018 [10]. However, the review focused only on helmet use among  
21 quad bike users and didn't provide an exhaustive list of other risk factors.  
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24  
25 In the absence of a standardized methodology for systematic review of risk factors and etiologic studies,  
26 it was a challenge to develop a protocol to meet the objectives of the study and maintaining the quality  
27 of review [11]. This study will attempt to develop a more rigorous method of reviewing studies on quad  
28 bike injury prevention, using the predominant observational studies.  
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31 The study aims to identify and classify the risk factors responsible for quad bike crashes related to use on  
32 uneven terrain. The results from this review will help to understand the risk factors responsible for quad  
33 bike injuries in the UAE, especially, the factors that can be reduced, controlled or eliminated altogether,  
34 using interventional programs. Subsequently, the study will help to acquaint policy makers about the  
35 potential strategies to control quad bike injuries in the UAE and elsewhere in the world.  
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## 38 39 40 41 42 43 44 45 46 47 48 **Research Question** 49

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51 This study will attempt to identify and classify the primary risk factors for crashes due to quad bike use  
52 through systematic review of the published and the grey literature. The target population include people  
53 of any region, age, gender or occupation, who use quad bikes. The exposure under focus involves driving  
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3 a quadbike or similar four-wheeled saddle-seated, off road motor vehicle on an uneven terrain. The health  
4 outcome of interest is any injuries, disability or death due to the quad bike crash.  
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9 **PECO research question:** What are the risk factors for crashes leading to injury, disability and death,  
10 among quad bike drivers, associated with quad bike use on uneven terrain?  
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## 14 15 16 OBJECTIVES

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19 1. To identify risk factors and protective factors for crashes leading to injury associated with quad  
20 bike use on uneven terrain.  
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22 2. To classify the determinants of these risk factors including, the personal, engineering and  
23 environmental risk factors.  
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25 3. To analyze these risk factors using the Haddon Matrix and the ecological model to determine the  
26 primary, secondary and tertiary interventional measures needed to control the problem.  
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## 31 32 METHODS

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36 This study will follow the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols  
37 (PRISMA-P) guidelines [12].  
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### 40 41 Inclusion Criteria

#### 42 43 *Study design:*

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45 The study will comprise all observational studies, intervention studies and case series studies on quad bike  
46 injuries. Qualitative studies like observational studies, focus groups and survey will be included. In addition  
47 to published journal articles, this review will include review articles, reports, white papers, thesis, policy  
48 briefs, to identify risk factors that might have been missed in observational studies. Though primary  
49 studies are preferred in identifying risk factors, systematic reviews will be included to identify other  
50 primary studies that were missed in our search. Policy documents, especially those describing legal-  
51 regulatory environment of the region will be included to identify social and policy environmental risk  
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3 factors. Risk factors and protective factors will be included in the review with no preference given to either  
4 of the two categories. All effect measures quantifying and identifying risk factors such as relative risk, odds  
5 ratio, risk difference towards the main outcome will be included in the review. Qualitative studies and  
6 studies that report the risk without objective risk measures will be included in the review.  
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#### 10 *Study population:*

11 All quad bike riders are subject for the study. Studies and reports targeting quad bike drivers of all regions,  
12 age groups, occupational groups and gender will be included in this review. The vehicle under review is  
13 an open, saddle seated four wheeled off-terrain vehicle. All vehicle terminology associated with this kind  
14 of vehicle like quad bike, off-road vehicle, four-wheel bike, all-terrain vehicle etc will be included.  
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#### 19 *Study outcome:*

20 All studies and reports related to quad bike crashes with health outcomes ranging from injuries to  
21 disability or death will be included in this review.  
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#### 25 *Filter for selection:*

26 We will not apply exclusion criteria based on the date of publication, place of publication or language of  
27 publication. Articles in all languages will be included and translated into English during review to identify  
28 risk factors. Since nuanced translation is not needed, Google Translate will be used for this purpose.  
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### 36 **Exclusion criteria**

#### 37 *Source:*

38 Blog posts, editorials, opinion articles without specifying health effect, social media accounts,  
39 advertisement brochure and news articles will be excluded from this review.  
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#### 45 *Outcome:*

46 Articles related to the mechanics of the vehicle not related to crash risk factors, and those related to  
47 armed combat, without reference to crash or stability, will be excluded from this review. Studies focusing  
48 on long term exposure and chronic health outcomes as well as those on positive health outcomes will be  
49 excluded from this study.  
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### *Risk environment:*

To increase the specificity of the review, articles related to quad-bike injury on paved roads and quad bike related traffic injuries will be excluded. Articles related to other off-road vehicles like dirt bikes and snowmobiles will be excluded as they present heterogeneous vehicular and terrain-related risk factors.

## **Search Strategy**

### *Developing research question and search query domains*

The research question for the review was developed using the population-exposure-outcome parameters sought to be appropriate for the etiologic review methodology. The research question was divided into functional areas of population involved and exposure factors.

The focus will be on increasing the sensitivity of the search for identifying studies on quad-bike users of any region, demographic group, occupation group and gender. Thus, the search query did not use any specific population related terms associated with region, gender, occupation group and age groups, as it includes the risk of excluding the other population groups. This was tested with pre-searches that showed no improvement in the sensitivity of the search when including population related keywords.

Risk was defined at any personal, vehicle engineering or environmental factors that could directly or indirectly influence quadbike crash, resulting from driving on uneven terrain. The search terms identifying injury related causality or risk inclusive of all risk classes. It will also include protective factors that have been reported by the studies to reduce the risk of crash. The health effects of crashes were not specified as they ranged from injury, disability to death within 48 hours of the event. The focus of the review was on risk factors associated with quadbike crash, and not any one specific health effect.

Thus, the search terms were focused on the nomenclature related to quad bikes to specify target population and broad risk related terms. This combination of target population and risk exposure keywords yielded maximum number of articles on pre-search trials.

Pre-searches in PubMed to identify search terms and develop the search string was performed in May-June 2020 and the full search will be completed in September/October 2020. All selected search terms will be searched in a combination of the fields: title, abstract and MeSH/Thesaurus (when available) for the best possible information retrieval. No filters or limitations will be used for the search. A search log

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3 with detailed search strategies, results and notes for each database included will be appended to the  
4 review.  
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## 10 **Data extraction and management**

### 11 *Screening and study selection:*

12 The published and grey literature will be the primary sources of our research through a systematic search  
13 in PubMed, Scopus, Embase, PsycInfo and Web of Science and in selected sources for grey literature. Hand  
14 screening of the reference list of included studies will be conducted.  
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19 All studies identified in the databases search will be exported to the systematic review software Covidence  
20 (Veritas Health Innovation, 2020) for automatic de-duplication and blinded screening. The complete  
21 search strategy and results from the pre-search in PubMed is available in appendix/supplementary  
22 materials.  
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26 PM and MK will screen the titles and abstracts using systematic review software Covidence (Veritas Health  
27 Innovation, 2020). They will apply the inclusion and exclusion criteria and screen blindly. Any conflict  
28 between them will be resolved by MS and MD. Titles without abstracts will be traced using sites like  
29 Research Gate. Authors will be contacted directly to access articles with missing abstract or unavailable  
30 full text. Full text PDF files of the selected articles will be uploaded to Covidence by the National Medical  
31 Library staff at the UAE University.  
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36 Similarly, full text review and study selection will be conducted by two independent reviewers with an  
37 external reviewer for conflict resolution. The list of studies selected and rejected for review will be  
38 provided with the reason for rejection.  
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### 43 *Data extraction:*

44 The summary of variables in which data will be extracted are: study setting, author details, study design,  
45 geographical location, target population or demographic group, vehicle specification, health outcome, risk  
46 factors, risk factor characteristics, strength of association, and safety intervention methods. Data  
47 extraction will be carried out by PM and MD using data extraction form developed in Covidence. Pilot data  
48 extraction for the 25 most cited articles will be followed by evaluation of the data extraction tool and  
49 correction by the team. While PM and MD will assess quality of study, MK, MS, MG and LO will check for  
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transcription errors, incomplete data and classification errors. Every article will be reviewed to minimize errors and identify bias.

### *Risk of bias in primary study:*

Appropriate population acknowledged biases and addressed biases would be the basic criteria to assess validity of the study results. Precision of measurement instrument, statistical analysis and sound sampling method would be an added bonus, but not necessarily a pre-requisite for these studies [13].

This review is expected to identify a wide variety of study designs like qualitative studies, pre-post interventions, non-randomized interventions, quantitative descriptive studies, and cross-sectional observational studies. One validated tool to assess all these study methodologies is the Mixed Method Appraisal Tool [14]. PM, MD and MK will assess the quality of the data employing validated Mixed Method Appraisal Tool and check their eligibility for data extraction.

### *Data Synthesis:*

All selected studies will be included in the synthesis. Data extracted from translated articles will be validated by language experts. Analysis will follow the qualitative meta-summary approach and data synthesis will involve compiling and classifying risk factors according to Haddon Matrix and ecological model. Data compilation will be based on the person, vehicle engineering and environment risk factors and health outcomes that emerge from the review data. Studies will be classified according to the quality of data and could influence data synthesis. The results will be presented in a non-quantitative narrative overview.

## **OUTPUT**

The study will present the PRISMA (Preferred Reporting Items for systematic Reviews and Meta-analysis) flow diagram, summarizing the study selection process. A comprehensive table of study characteristics will be given along with study quality rating. It will summarize the risk factors identified in each study. All this information will be synthesized to classify risk factors and present them according to the Haddon Matrix and ecological model [6, 7, 15, 16]. Here the hazards and risk factors are classified into groups based on their influence before, during and after the crash incident. They will also be grouped according to their level of influence, which could be at a personal level or at community level or national level. This

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3 design of data presentation would contribute to more effective intervention plans relevant to policy  
4 makers.  
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## 9 10 **BIAS MINIMISATION**

11 Multiple databases will be searched to get published literature as well as grey literature. Publication bias  
12 is minimized by a broad inclusion criteria of study design, type of publication and adverse health  
13 outcomes. Publication bias is further reduced in the absence of treatment effect or meta-analysis, where  
14 results of all sources and design are given equal weightage. Selection bias will be assessed by quality  
15 checks on a sample of included articles and excluded articles assessing uniform adoption of inclusion and  
16 exclusion criteria. Data extraction process will be audited by three reviewers MS, MK, MG and LO to  
17 ensure adherence to inclusion and exclusion criteria, minimize transcription errors and bias. All  
18 information on study details and extraction process will be shared in the public domain during publication.  
19 Information bias on the validity of study results will be assessed by extracting information on the objective  
20 measurement tool and statistical analysis accounting for confounders. In addition to the source, the  
21 screening process by multiple reviewers will be blinded using Covidence software.  
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## 34 **DISCUSSION AND POSSIBLE CHALLENGE**

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37 We expect that the studies which will be reviewed would be predominantly descriptive etiologic studies,  
38 describing a well-defined population, with well-defined exposure and a defined crash outcome. The  
39 population will be all drivers of four-wheeled, all-terrain bikes. The outcome would include crashes leading  
40 to accidental injuries, disability or death, while driving the quad bike on uneven terrain. All modifiable risk  
41 factors that increase the risk of these health effects will be recorded and synthesized in this review. This  
42 systematic review does not meet a PICO equivalent research question and would need a different  
43 approach, appropriate for etiologic studies. The protocol was designed according to ROBIS and Amstar  
44 assessment tools that is in addition to the reporting guidelines of PRISMA [12, 13, 17].  
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51 In the absence of a standardized protocol for systematic review of observational studies and any  
52 competent scale for the assessment of qualitative studies, we will develop an appropriate method for our  
53 research objective. We expect the specific population involved in quad bike entertainment and the  
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3 resulting health effects, the search for risk factors could be very extensive. However, the information  
4 extracted from these articles, using objective measures, could help to understand the risk factors of quad  
5 bike injuries and the mitigation strategies needed to reduce their adverse health effects. Despite the  
6 methodological weakness of using observational data to synthesize evidence, a rigorous systematic  
7 review could help to provide new opportunities for quad bike injury prevention research. Additionally,  
8 the research may also provide research evidence to policy makers for interventional strategies.  
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37  
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### 43 44 45 *Author Contribution*

46  
47 PM, MS, MK, MG, MD and LO were involved in conceptualization and protocol development. PM, LO and  
48 MS were involved in developing search strategy and grey literature search.  
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## Appendix-1: Preliminary Search Strategy

**Database:** PubMed

**Search date:** 2020-06-10

**Search specifications:** no filters or limitations applied

**Result:** 755 references

Search string
("Off-Road Motor Vehicles"[Mesh] OR "off-road bike"[Title/Abstract] OR "off road bike"[Title/Abstract] OR "off-road bikes"[Title/Abstract] OR "off road bikes"[Title/Abstract] OR "off-road motor vehicle"[Title/Abstract] OR "off road motor vehicle"[Title/Abstract] OR "off-road motor vehicles"[Title/Abstract] OR "off road motor vehicles"[Title/Abstract] OR "all-terrain vehicle"[Title/Abstract] OR "all-terrain vehicles"[Title/Abstract] OR "all terrain vehicle"[Title/Abstract] OR "all terrain vehicles"[Title/Abstract] OR "all terrain motor vehicle"[Title/Abstract] OR "all-terrain motor vehicle"[Title/Abstract] OR "all terrain motor vehicles"[Title/Abstract] OR "all-terrain motor vehicles"[Title/Abstract] OR "quad bike"[Title/Abstract] OR "quad bikes"[Title/Abstract] OR "quad-bike"[Title/Abstract] OR "quad-Bikes"[Title/Abstract] OR "urban off road vehicle"[Title/Abstract] OR "urban off-road vehicle"[Title/Abstract] OR "urban off road vehicles"[Title/Abstract] OR "urban off-road vehicles"[Title/Abstract] OR "4-wheel ATV"[Title/Abstract] OR "four-wheel ATV"[Title/Abstract] OR "4 wheel ATV"[Title/Abstract] OR "four wheel ATV"[Title/Abstract] OR "4-wheel ATVs"[Title/Abstract] OR "four-wheel ATVs"[Title/Abstract] OR "4 wheel ATVs"[Title/Abstract] OR "four wheel ATVs"[Title/Abstract] OR "off-road recreational vehicle"[Title/Abstract] OR "off-road recreational vehicles"[Title/Abstract] OR "off road recreational vehicle"[Title/Abstract] OR "off road recreational vehicles"[Title/Abstract] OR "recreational off-highway vehicle"[Title/Abstract] OR "recreational off-highway vehicles"[Title/Abstract] OR "recreational off highway vehicle"[Title/Abstract] OR "recreational off highway vehicles"[Title/Abstract]) AND (Risk[Mesh] OR Risk Reduction Behavior[Mesh] OR Causality[Mesh] OR Accident[Mesh] OR Risk Management[MeSH Terms] OR Protective Devices[MeSH Terms] OR caus*[Title/Abstract] OR risk*[Title/Abstract] OR "precipitating factor"[Title/Abstract] OR "precipitating factors"[Title/Abstract] OR predispos*[Title/Abstract] OR hazard*[Title/Abstract] OR safe*[Title/Abstract] OR unsafe[Title/Abstract] OR harm*[Title/Abstract] OR danger*[Title/Abstract] OR proneness[Title/Abstract] OR protect*[Title/Abstract] OR prevent*[Title/Abstract] OR threat*[Title/Abstract] OR accident*[Title/Abstract] OR helmet*[Title/Abstract] OR seatbelt*[Title/Abstract])

## Appendix-2: Data Extraction-Data Items

### 1. Journal Article /Report Source Details

#### 1.1. Type of publication

#### 1.2. Journal/website of report

- 1
- 2
- 3 1.3. Link
- 4
- 5 1.4. Date of publication
- 6
- 7 1.5. Date of access
- 8
- 9 1.6. Citation
- 10
- 11 1.7. Author name
- 12
- 13 1.8. Author details
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- 15 1.9. Author email/contact
- 16
- 17 1.10. Link to other study/paper by the same team
- 18
- 19 2. Study /Report Detail
- 20
- 21 2.1. Summary
- 22
- 23 2.2. Aim/Objective
- 24
- 25 2.3. Study population
- 26
- 27 2.4. Location-geographic
- 28
- 29 2.5. Demographic involved
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- 31 2.6. Study Design
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- 33 2.7. Qualitative/quantitative
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- 35 2.8. Primary/secondary data
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- 37 2.9. Data source
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- 39 2.10. Data management
- 40
- 41 2.11. Statistical analysis
- 42
- 43 2.12. Sample size
- 44
- 45 2.13. Limitation
- 46
- 47 2.14. Model-dependant variable
- 48
- 49 2.15. Model- independent variable
- 50
- 51 2.16. Model- identified confounders
- 52
- 53 2.17. Sensitivity analysis, or any other treatment
- 54
- 55 2.18. Outcome-primary
- 56
- 57 2.19. Outcome-secondary
- 58
- 59 2.20. Outcome-others
- 60
- 61 2.21. Vehicle specification
- 62
- 63 3. Data Quality Assessment Score
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- 65 4. Data for Review
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- 3 4.1. Risk/Protective factor-personal-name
- 4 4.2. Risk/Protective factor-personal-association/attributable factor
- 5 4.3. Risk/Protective -vehicular-name
- 6 4.4. Risk/Protective -vehicular-association/attributable factor
- 7 4.5. Risk/Protective -environmental-name
- 8 4.6. Risk/Protective -environmental-association/attributable factor
- 9 4.7. Risk/Protective -socio-cultural-name
- 10 4.8. Risk/Protective - socio-cultural -association/attributable factor
- 11 4.9. Risk/Protective -others-name
- 12 4.10. Risk/Protective -others-association/attributable factor
- 13 4.11. Statistically significant relationship
- 14 5. Data outside of review [Miscellaneous]
- 15 5.1. Burden-prevalence/incidence
- 16 5.2. Economic burden
- 17 5.3. Intervention
- 18 5.4. Intervention effect
- 19 5.5. If intervention, summary of outcome
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### Appendix 3: Screening checklist

- 35 1. Does the study involve adverse health effect or injuries? Select if Yes
- 36 2. Are the health effect adverse and acute in nature? Select if Yes
- 37 3. Does the study focus primarily on quad bikes or similar all terrain vehicle? Select if Yes
- 38 4. Are the injuries occurring on paved road or as a road traffic accident? Select if No
- 39 5. Is it an opinion, editorial or commentary? Select if No.
- 40 6. Are the risk factors or protective factors to quad bike injury mentioned? Select if Yes.
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### Appendix 4: Mixed Method Assessment Tool Screening Questions

For all types

- 50 S1. Are there clear research questions?
- 51 S2. Do the collected data allow to address the research questions?
- 52
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Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.

#### 1. Qualitative

- 1.1. Is the qualitative approach appropriate to answer the research question?
- 1.2. Are the qualitative data collection methods adequate to address the research question?
- 1.3. Are the findings adequately derived from the data?
- 1.4. Is the interpretation of results sufficiently substantiated by data?
- 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?

#### 2. Quantitative randomized controlled trials

- 2.1. Is randomization appropriately performed?
- 2.2. Are the groups comparable at baseline?
- 2.3. Are there complete outcome data?
- 2.4. Are outcome assessors blinded to the intervention provided?
- 2.5. Did the participants adhere to the assigned intervention?

#### 3. Quantitative nonrandomized

- 3.1. Are the participants representative of the target population?
- 3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?
- 3.3. Are there complete outcome data?
- 3.4. Are the confounders accounted for in the design and analysis?
- 3.5. During the study period, is the intervention administered (or exposure occurred) as intended?

#### 4. Quantitative descriptive

- 4.1. Is the sampling strategy relevant to address the research question?
- 4.2. Is the sample representative of the target population?
- 4.3. Are the measurements appropriate?
- 4.4. Is the risk of nonresponse bias low?
- 4.5. Is the statistical analysis appropriate to answer the research question?

#### 5. Mixed methods

- 5.1. Is there an adequate rationale for using a mixed methods design to address the research question?
- 5.2. Are the different components of the study effectively integrated to answer the research question?
- 5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?
- 5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?
- 5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?

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For peer review only

# Reporting checklist for protocol of a systematic review.

Based on the PRISMA-P guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the PRISMA-Reporting guidelines, and cite them as:

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1.

			Page Number
<b>Title</b>			
Identification	<a href="#">#1a</a>	Identify the report as a protocol of a systematic review	1
Update	<a href="#">#1b</a>	If the protocol is for an update of a previous systematic review, identify as such	

1	<b>Registration</b>		
2			
3			
4		<a href="#">#2</a>	2
5		If registered, provide the name of the registry (such as	
6		PROSPERO) and registration number	
7			
8			
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10	<b>Authors</b>		
11			
12			
13	Contact	<a href="#">#3a</a>	1
14		Provide name, institutional affiliation, e-mail address of all	
15		protocol authors; provide physical mailing address of	
16		corresponding author	
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19			
20	Contribution	<a href="#">#3b</a>	11
21		Describe contributions of protocol authors and identify the	
22		guarantor of the review	
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25			
26	<b>Amendments</b>		
27			
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29		<a href="#">#4</a>	
30		If the protocol represents an amendment of a previously	
31		completed or published protocol, identify as such and list	
32		changes; otherwise, state plan for documenting important	
33		protocol amendments	
34			
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39	<b>Support</b>		
40			
41			
42	Sources	<a href="#">#5a</a>	11
43		Indicate sources of financial or other support for the review	
44			
45	Sponsor	<a href="#">#5b</a>	11
46		Provide name for the review funder and / or sponsor	
47			
48	Role of sponsor or	<a href="#">#5c</a>	
49	funder	Describe roles of funder(s), sponsor(s), and / or	
50		institution(s), if any, in developing the protocol	
51			
52			
53	<b>Introduction</b>		
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1	Rationale	<a href="#">#6</a>	Describe the rationale for the review in the context of what is	3
2			already known	
3				
4				
5				
6	Objectives	<a href="#">#7</a>	Provide an explicit statement of the question(s) the review	4,5
7			will address with reference to participants, interventions,	
8			comparators, and outcomes (PICO)	
9				
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13				
14	<b>Methods</b>			
15				
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17	Eligibility criteria	<a href="#">#8</a>	Specify the study characteristics (such as PICO, study	5,6
18			design, setting, time frame) and report characteristics (such	
19			as years considered, language, publication status) to be	
20			used as criteria for eligibility for the review	
21				
22				
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27	Information	<a href="#">#9</a>	Describe all intended information sources (such as	8
28			electronic databases, contact with study authors, trial	
29	sources		registers or other grey literature sources) with planned dates	
30			of coverage	
31				
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36				
37	Search strategy	<a href="#">#10</a>	Present draft of search strategy to be used for at least one	7,8
38			electronic database, including planned limits, such that it	
39			could be repeated	
40				
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45	Study records -	<a href="#">#11a</a>	Describe the mechanism(s) that will be used to manage	8
46			records and data throughout the review	
47	data management			
48				
49				
50	Study records -	<a href="#">#11b</a>	State the process that will be used for selecting studies	8
51			(such as two independent reviewers) through each phase of	
52	selection process		the review (that is, screening, eligibility and inclusion in	
53			meta-analysis)	
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1	Study records -	<a href="#">#11c</a>	Describe planned method of extracting data from reports	8,9
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3	data collection		(such as piloting forms, done independently, in duplicate),	
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5	process		any processes for obtaining and confirming data from	
6				
7			investigators	
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11	Data items	<a href="#">#12</a>	List and define all variables for which data will be sought	8,12
12				
13			(such as PICO items, funding sources), any pre-planned	
14				
15			data assumptions and simplifications	
16				
17				
18	Outcomes and	<a href="#">#13</a>	List and define all outcomes for which data will be sought,	8,12
19				
20	prioritization		including prioritization of main and additional outcomes, with	
21				
22			rationale	
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26	Risk of bias in	<a href="#">#14</a>	Describe anticipated methods for assessing risk of bias of	10
27				
28	individual studies		individual studies, including whether this will be done at the	
29				
30			outcome or study level, or both; state how this information	
31				
32			will be used in data synthesis	
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35				
36	Data synthesis	<a href="#">#15a</a>	Describe criteria under which study data will be	
37				
38			quantitatively synthesised	
39				
40				
41				
42	Data synthesis	<a href="#">#15b</a>	If data are appropriate for quantitative synthesis, describe	9
43				
44			planned summary measures, methods of handling data and	
45				
46			methods of combining data from studies, including any	
47				
48			planned exploration of consistency (such as I <sup>2</sup> , Kendall's $\tau$ )	
49				
50				
51	Data synthesis	<a href="#">#15c</a>	Describe any proposed additional analyses (such as	
52				
53			sensitivity or subgroup analyses, meta-regression)	
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1 Data synthesis [#15d](#) If quantitative synthesis is not appropriate, describe the type 9  
2  
3 of summary planned  
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6 Meta-bias(es) [#16](#) Specify any planned assessment of meta-bias(es) (such as  
7  
8 publication bias across studies, selective reporting within  
9  
10 studies)  
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13  
14 Confidence in [#17](#) Describe how the strength of the body of evidence will be 9  
15  
16 cumulative assessed (such as GRADE)  
17  
18 evidence  
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21  
22 None The PRISMA-P checklist is distributed under the terms of the Creative Commons Attribution  
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25  
26 made by the [EQUATOR Network](#) in collaboration with [Penelope.ai](#)  
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# BMJ Open

## SYSTEMATIC REVIEW OF RISK FACTORS ASSOCIATED WITH QUAD BIKE CRASHES: A PROTOCOL FOR SYSTEMATIC REVIEW OF OBSERVATIONAL STUDIES.

Journal:	<i>BMJ Open</i>
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Secondary Subject Heading:	Epidemiology, Occupational and environmental medicine, Public health, Sports and exercise medicine
Keywords:	Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, OCCUPATIONAL & INDUSTRIAL MEDICINE, PUBLIC HEALTH, SPORTS MEDICINE, EPIDEMIOLOGY

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# SYSTEMATIC REVIEW OF RISK FACTORS ASSOCIATED WITH QUAD BIKE CRASHES: A PROTOCOL FOR SYSTEMATIC REVIEW OF OBSERVATIONAL STUDIES.

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Word Count: 3283

Key Words: Quad Bike, Off-road Motor Vehicle, Injury, Risk Factor, Systematic Review

## ABSTRACT

### Introduction

Quad bikes are four-wheeled vehicles, driven off-road on uneven terrains by farmers for work or young adults for leisure. Quad bike accidental crashes result mostly due to the unique ecosystem of uneven terrain, where these unstable vehicles are commonly driven, in addition to numerous distinctive socio-demographic characteristics related to drivers. This is a protocol for a systematic review of observational studies from all geographical regions and demographic groups to summarize the common risk factors relating to quad bike crashes.

### Methods and Analysis

A comprehensive search for the literature on quad bike crashes and related injuries will be conducted in five electronic databases: PubMed, Embase, Scopus, Web of Science, IEEE and PsycInfo. Proquest

29 Dissertation and Thesis, OpenGrey, and BASE will be searched for grey literature. Five researchers will be  
30 involved in the screening, and the review of full text articles, using the inclusion and exclusion criteria.  
31 Disagreements between reviewers will be resolved by discourse. Three researchers will help resolving  
32 conflicts that may arise during the screening process and will resolve eventual conflicts identified in the  
33 screening process and verify the extracted data with the help of the software. Information on crashes  
34 leading to injuries and death, target population characteristics and risk factors involved will be extracted  
35 from eligible articles in addition to the assessment of the quality of the researched articles.

## 36 Ethics and dissemination

37 Since this is a systematic review of published literature, a formal ethical approval is not needed. Results  
38 of the review will be disseminated through peer-reviewed publications, conference presentations and  
39 reports to the concerned authorities.

40 Prospero registration number: CRD42020170245 Prospero registration number:  
41 CRD42020170245

## 43 ARTICLE SUMMARY - STRENGTH AND LIMITATIONS OF THIS STUDY

- 45 • The study will follow the Preferred Reporting Items for Systematic Review and Meta-Analysis  
46 Protocols (PRISMA-P) guidelines.
- 47 • The study will present a transparent and rigorous screening and review methodology involving  
48 multiple independent researchers, using the Covidence software (Veritas Health Innovation,  
49 2020).
- 50 • The study will help to fill up the evidence gap, using the public health approaches to identify the  
51 risk factors for quad bike crashes and injuries, namely the Haddon Matrix and the Ecological  
52 Model.
- 53 • Limitations may include the low level of evidence generated from the observational studies.

## 55 BACKGROUND

56 Quad bikes are four-wheeled, off- road vehicles, characterized by low air pressure tyres, saddle seat and  
57 handlebars. They are distinct in their narrow wheel base and have been widely used for farm work and  
58 more recently, for recreational purposes (1). Regular quad bike use is associated with increased aerobic  
59 fitness, improved blood lipid profile and lower risk of metabolic syndrome (2). In terms of health benefits,  
60 quad bikes can be compared with other outdoor sports like bicycling. However, in terms of crash risk and  
61 severity of the resulting injuries associated with quad bikes, it is said to be comparable to motor vehicle  
62 injuries (3).

63 Quad bike crashes constitute a growing public health problem at the individual and societal levels, due to  
64 their adverse debilitating health consequences, including disability, injury and death, in addition to the  
65 direct and indirect costs related to medical treatment and work related losses from to disability and  
66 absenteeism (4, 3). As such, the prevention of quad bike injuries important in order to preserve and  
67 maintain the health and wellbeing of the society in the UAE and to reduce the unnecessary costs of these  
68 needless injuries.

69 Quad bikes have an inherent instability in their design. When used in desert and rugged terrain, they are  
70 characterized by high uncertainty in the driving surface. The unpaved terrain, narrow wheel base, high  
71 center of gravity and large engine size makes them prone to rollover and collision, even at low speed (3,  
72 5). The nature of risk while riding a quad bike is enhanced in the context of outdoor sport and the  
73 demographic group involved (6). Young adults, adolescents and children are known to carry an additional  
74 psychological impulse for risk taking, high speed and aggressive driving (5, 7). Thus, the risk factors  
75 associated with quad bikes are more related to the environment where they are driven, the unique  
76 vehicular engineering, and the driver characteristics. Consequently, the conventional risk factors  
77 associated with motor vehicle injuries cannot be blindly extrapolated to quad bike injuries.

78 Any safety intervention to control unintentional injuries begins with a robust risk assessment study, which  
79 requires an understanding of the primary risk factors associated and involved with the activity, leading to  
80 injuries (8). Therefore, a systematic and an objective review of the existing scientific literature is  
81 imperative to highlight and identify the possible risk factors associated with quad bike crashes and  
82 injuries. Unlike road traffic injuries and occupational injuries however, there has been limited research on  
83 the risk factors of quad bike injuries. A comprehensive search for systematic reviews on quad bike injuries,  
84 by the authors, resulted in only one review, which have been carried out in 2018 (9). However, the review

85 focused only on helmet use among quad bike users and did not provide an exhaustive list of other risk  
86 factors.

87 In the absence of a standardized methodology for systematic review of the risk factors of quad bikes  
88 crashes and injuries, it was a challenge to develop a protocol to meet the objectives of the study and  
89 maintaining the quality of the review (10). This study will attempt to develop a more rigorous method to  
90 review studies on quad bike crashes and injuries, using the predominant observational studies.

91 The results from this review will help to understand the risk factors responsible for quad bike crashes and  
92 injuries, especially, the factors that can be reduced, controlled or eliminated altogether, using  
93 interventional programs.

94

## 95 **Research Question**

96 As the review aims to identify and classify the risk factors for crashes due to quad bike use , the research  
97 question follows the Population-Exposure-Control-Outcome format [PECO] (11). The target population  
98 include people of any region, age, gender or occupation, who use quad bikes on paved roads and uneven  
99 terrain. The exposure under focus involves driving a quadbike or similar four-wheeled saddle-seated, on  
100 paved roads or uneven terrain. The control would be those who are not driving quad bikes or those who  
101 have not crashed. The health outcome of interest would be any quad bike crashes that could lead to  
102 injuries, disability or death. Thus the research question that drives this review would be: What are the risk  
103 factors for crashes, associated with, quad bike use on paved roads and uneven terrain, leading to injury,  
104 disability and death among quad bike drivers?

105

## 106 **OBJECTIVES**

- 107 1. To identify the risk factors and protective factors of crashes related to quad bike use on paved  
108 roads and uneven terrain.
- 109 2. To classify the risk factors into personal, engineering and environmental risk factors.
- 110 3. To analyze these risk factors using the Haddon Matrix and the ecological model to determine the  
111 primary, secondary and tertiary interventional measures needed to control the problem.

112

## 113 METHODS

114  
115 This study will follow the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols  
116 (PRISMA-P) 2009 guidelines (12).

### 117 Inclusion Criteria

#### 118 *Study design:*

119 The review will comprise of all observational studies, including cross-sectional analytical studies, case-  
120 control studies, prevalence studies, surveys, mixed methods and qualitative studies. Policy documents,  
121 especially those describing legal-regulatory environment of the region will be included to identify risk  
122 factors related to social and policy environment.

123 Risk factors refer to factors that either predispose or protect the quad bike driver from crash. Both  
124 predisposing and protective factors will be included in the review with no preference given to either of  
125 the two categories. All effect measures quantifying and identifying risk factors such as relative risk, odds  
126 ratio, risk difference towards the main outcome will be included in the review.

#### 127 *Study population:*

128 All quad bike riders who experienced crashes are subjects for the review. Therefore, studies and reports  
129 targeting quad bike drivers of all regions, age groups, occupational groups and gender will be included in  
130 the review. The vehicle under review is an open, saddle seated four wheeled off-terrain vehicles. It may  
131 or may not have rollover protection structures like roll cage, quad bar or lifeguard. The comparison group  
132 would be those who do not drive quad bikes or who have not experienced crash from quad bike use.

#### 133 *Study outcome:*

134 The health effects of crashes will not be specified as they range from injury, disability to death within 48  
135 hours of the event. The focus of the review will be on the risk factors associated with quadbike crashes,  
136 and not any specific health effect or outcome. All studies and reports related to quad bike crashes  
137 resulting in outcomes ranging from no injuries to disability or death will be included in the review.



1  
2  
3 138 *Study environment*

4  
5 139 The results of this review will be systematically evaluated, thematically synthesized and analyzed using  
6  
7 140 the Haddon Matrix which helps to identify the risk factors related to personal attributes, vector or agent  
8  
9 141 attributes and environmental attributes; before, during and after injury or death (13)). We define uneven  
10  
11 142 terrain as those surfaces that lack smooth surface or have surface irregularities (14). These include slopes,  
12  
13 143 sand dunes, dirt track, unpaved surfaces, gravel, grass or agricultural workplace environment. The vehicle  
14  
15 144 / vector related risk factors of a quad bike on paved roads are clearly different from those on unpaved  
16  
17 145 roads (15, 16). The vehicle related protective features for on-road safety, like seatbelts, sometimes  
18  
19 146 contradicts basic quad bike protective features on uneven terrain like active dismount (17). This is because  
20  
21 147 the injury mechanism on roads, due to head on collision crashes, are different from that of off-road  
22  
23 148 injuries [rollover, ejection] (18, 19). Therefore, to increase the specificity of the review, articles describing  
24  
25 149 quadbikes crashes on paved roads and uneven terrain will be included but synthesized separately.

26  
27 150

28  
29 151

30  
31 152 **Exclusion criteria**

32 153 *Source:*

33 154 Blog posts, opinion articles, editorials, advertisement brochure and news articles that do not cite primary  
34  
35 155 source or research findings will be excluded from data extraction as they may compromise the data  
36  
37 156 quality. However, they will be included to the screening list as hand searched references.

38  
39 157

40  
41 158 *Outcome:*

42  
43 159 Articles related to the mechanics of the vehicle but not related to crash risk factors, and those related to  
44  
45 160 armed combat, without reference to crash or stability, will be excluded from this review. Studies focusing  
46  
47 161 on long term exposure and chronic health outcomes as well as those on positive health outcomes will be  
48  
49 162 excluded from this study.

50  
51 163 *Risk environment:*

52  
53 164 Articles related to other off-road vehicles like dirt bikes and snowmobiles will be excluded as they present  
54  
55 165 heterogenous vehicular and terrain-related risk factors.

166

## 167 **Search Strategy**

### 168 *Developing research question and search query domains*

169 The research question for the review was developed using the population-exposure-outcome parameters  
170 sought to be appropriate for the etiologic review methodology. The research question was divided into  
171 functional areas of population involved and exposure factors.

172 Our focus will be on increasing the sensitivity of the search by identifying studies on quad-bike users of  
173 any region, demographic group, occupation group and gender. Thus, the search query will not include any  
174 specific population related terms associated with region, gender, occupation group or age groups. This  
175 was tested with pre-searches that showed no improvement in the sensitivity of the search when including  
176 population related keywords.

177 Crash risk was defined as any personal, vehicle engineering or environmental factors that could directly  
178 or indirectly influence the occurrence of quadbike crashes, resulting from driving quadbikes on paved  
179 roads or uneven terrain. Search-terms used will include injury related causality or risk inclusive of all risk  
180 levels. It will also include terms for protective risk factors that have been reported in the published  
181 research to reduce the crash risk.

182 Thus, our search terms will focus on the nomenclature related to quad bikes to specify the target  
183 population and broad risk related terms. Our search strings will include vehicle related terms such as  
184 “Quad bikes”, “All terrain Vehicle”, “Four wheel ATV” etc., and risk related terms such as “Safety”, “Risk”  
185 or “Cause”. Detailed search string is available in the supplementary file. This combination of target  
186 population and risk exposure keywords yielded maximum number of articles on pre-search trials.

187 Pre-searches in PubMed to identify search terms and develop the search string was performed in May-  
188 June 2020 and the full search will be completed in March 2021. A search update of all information sources  
189 will be performed and appended to the final manuscript. All selected search terms will be searched in a  
190 combination of fields: title, abstract and MeSH/Thesaurus (when available) for the best possible  
191 information retrieval. No filters or limitations will be used for the search. Hand screening of the reference  
192 list of studies that have been included will also be conducted. A search log with detailed search strategies,  
193 results and notes for each database included will be appended to the review.

1  
2  
3 194 The published literature will be the primary sources of our research through a systematic search in  
4  
5 195 PubMed, Scopus, Embase, PsycInfo, and Web of Science. The grey literature will be sourced from Proquest  
6  
7 196 Thesis and Dissertations, OpenGrey and BASE. A copy of the pre-searches in PubMed is available in  
8  
9 197 supplementary materials.

10  
11 198 We will not apply exclusion criteria based on the date of publication, place of publication or language of  
12  
13 199 publication. Articles in all languages will be included and translated into the English language during the  
14  
15 200 review to identify risk factors. Since nuanced translation is not needed, Google Translate will be used for  
16  
17 201 this purpose.

18 202

19 203

20 204

## 25 205 **Data extraction and management**

### 27 206 *Screening and study selection:*

28 207 All studies identified in the databases search will be exported to the systematic review software Covidence  
29  
30 208 (Veritas Health Innovation, 2020) for automatic de-duplication and blinded screening.

31  
32  
33 209 Two reviewers will screen the titles and abstracts against the inclusion and exclusion criteria with the help  
34  
35 210 of blind screening functions in Covidence (Veritas Health Innovation, 2020). Any conflict identified by the  
36  
37 211 software will be resolved by a third reviewer. Full text PDF files of the papers selected for further full-text  
38  
39 212 screening will be uploaded to Covidence by the National Medical Library staff at the UAE University.

40  
41 213 Similarly, full text review and study selection will be conducted by two independent reviewers with a third  
42  
43 214 external reviewer for conflict resolution. Studies included in the full text screening will be documented  
44  
45 215 with the reason for exclusion in a PRISMA flow-diagram.

46 216 This review will screen reports, white papers, thesis, editorials and policy briefs, to identify primary  
47  
48 217 research publications that might have been missed from the databases.

### 50 218 *Data extraction:*

51  
52 219 The summary of variables in which data will be extracted are: author, journal, year of publication, study  
53  
54 220 setting, study design, geographical location, studied population or demographic group, vehicle  
55  
56 221 specification, health outcome, risk factors, risk factor characteristics, strength of association, and safety

222 intervention methods. Data extraction will be carried out by two reviewers using data extraction form  
223 developed in Covidence. Pilot data extraction for the 25 most cited articles will be followed by evaluation  
224 of the data extraction tool and correction by the team. Five reviewers will assess quality of study, and will  
225 check for transcription errors, incomplete data and classification errors. Every article will be reviewed to  
226 minimize errors and identify bias.

### 227 *Risk of bias in primary study:*

228 Appropriate population acknowledged biases and addressed biases would be the basic criteria to assess  
229 validity of the study results. Precision of measurement instrument, statistical analysis and sound sampling  
230 method would be an added bonus, but not necessarily a pre-requisite for these studies (20).

231 This review is expected to identify a wide variety of study designs like qualitative studies, pre-post  
232 interventions, non-randomized interventions, and cross-sectional analytical studies. One validated tool to  
233 assess all these study methodologies is the Mixed Method Appraisal Tool (21) . Five reviewers will assess  
234 the quality of the data employing validated Mixed Method Appraisal Tool and check their eligibility for  
235 data extraction.

### 236 *Data Synthesis:*

237 All selected studies will be included in the synthesis. Data extracted from translated articles will be  
238 validated by language experts. Analysis will follow the narrative meta-summary approach and data  
239 synthesis will involve compiling and classifying risk factors according to the Haddon Matrix and ecological  
240 model. This review will use the Haddon Matrix framework to classify the risk factors related to quadbike  
241 crashes and injuries. Developed by William Haddon (22, 23), the matrix looks at risk factors related to the  
242 personal attributes, vector attributes and environmental attributes, in relation to the time of the incident  
243 occurrence; before, during and after the incident (whether an injury or death). The combination between  
244 the epidemiological triad and levels of prevention, gives the analyst a way to look at planning for injury  
245 prevention and intervention strategies by phases in time of the event. As such the framework identifies  
246 the risk factors that can be controlled before, during and after the event, through education, engineering  
247 and environment interventional measures (24).

248 Data compilation will be based on the person, vehicle engineering and environment risk factors and health  
249 outcomes that emerge from the review data. Studies will be classified according to the quality of data and  
250 could influence data synthesis. The results will be presented in a non-quantitative narrative overview.

## 251 *Patient and Public Involvement*

252

253 No patients or individuals from the public will be involved in this review. Patient consent is not required  
254 for this review.

255

## 256 **Ethics and Dissemination**

257 Since this research is confined only to the published literature and does not involve any direct contact  
258 with human subjects, it will not need an ethics clearance by the university human research ethics  
259 committee. Yet, the research will follow the ethics guidelines for systematic review described by Wagner  
260 et al.(25). The review will include studies of all regions, socio-demographic groups and occupations. It will  
261 not exclude studies based on their results or due to conflict with other study results. In the absence of  
262 meta-analysis, only significant results will be extracted and presented. However, if any conflicting results  
263 from multiple studies were cited, they will be presented without further filtering.

264 The study will use the software Covidence (Veritas Health Innovation, 2020) for the screening and  
265 extraction of data to ensure the blinding and full transparency of the screening and selection process. The  
266 review will identify redundant publications with the same results. The scientific status of the final selected  
267 articles published in Open Access journals will be analyzed with the help of Predatory reports from Cabells  
268 Scholarly Analytics (26).

269 Since the review aims to inform policy makers in designing interventions, the extracted data will need to  
270 be synthesized and presented, using the conceptual framework of the Haddon Matrix to identify the risk  
271 factors related to personal attributes, vector or agent and environmental attributes; before, during and  
272 after injury or death. The results of the study will be published in peer-reviewed journals. The results from  
273 the review will also be presented in workshops and meetings with relevant stakeholders and policy  
274 makers. Information will be presented in simple tables and infographics.

275

## 276 **OUTPUT**

277 The study will present the PRISMA (Preferred Reporting Items for systematic Reviews and Meta-analysis)  
278 flow diagram, summarizing the search and study selection process. A comprehensive table of study  
279 characteristics will be given along with study quality rating. It will summarize the risk factors identified in

1  
2  
3 280 each study. All information will be synthesized to classify and evaluate the relative importance of the  
4  
5 281 different risk factors , using the Haddon Matrix and the Haddon's strategies for prevention (27, 28, 23,  
6  
7 282 22).

8  
9 283

## 10 11 284 **BIAS MINIMISATION**

12  
13  
14 285 Multiple databases will be searched to get published literature as well as grey literature. Publication bias  
15  
16 286 is minimized by a broad inclusion criteria of study design, type of publication and adverse health  
17  
18 287 outcomes. Publication bias is further reduced in the absence of treatment effect or meta-analysis, where  
19  
20 288 results of all sources and design are given equal weightage. Selection bias will be assessed by quality  
21  
22 289 checks on a sample of included articles and excluded articles assessing uniform adoption of inclusion and  
23  
24 290 exclusion criteria. Data extraction process will be audited by five reviewers MS, MK, MG, RHA and LÖ to  
25  
26 291 ensure adherence to inclusion and exclusion criteria, minimize transcription errors and bias. All  
27  
28 292 information on study details and extraction process will be shared in the public domain during publication.  
29  
30 293 Information bias on the validity of study results will be assessed by extracting information on the objective  
31  
32 294 measurement tool and statistical analysis accounting for confounders. In addition to the source, the  
33  
34 295 screening process by multiple reviewers will be blinded using the systematic review software Covidence.  
35

36 296

## 37 297 **DISCUSSION AND POSSIBLE CHALLENGE**

38 298

39 299 It is expected that most of the studies which will be reviewed would be predominantly descriptive studies,  
40  
41 300 describing a well-defined population, with well-defined exposure and a well- defined crash outcome. The  
42  
43 301 population will comprise all drivers of four-wheeled, all-terrain quad bikes. The outcomes would include  
44  
45 302 crashes leading to accidental injuries, disability or death, while driving the quad bike on paved roads or  
46  
47 303 uneven terrain. Though the wide range of outcomes identify a common set of injury risk factors, they  
48  
49 304 might not allow meta-analysis for risk association. All modifiable risk factors that increase the risk of these  
50  
51 305 health effects will be recorded and synthesized in this review. This systematic review does not meet a  
52  
53 306 PICO equivalent research question and would need a different approach, appropriate for etiologic studies.  
54  
55 307 The protocol was designed according to PRISMA-P guidelines with influence of ROBIS and Amstar  
56  
57 308 assessment tools (20, 29, 12).In the absence of a standardized Risk of Bias tool for systematic review of

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2  
3 309 observational studies and any competent scale for the assessment of qualitative studies, we will develop  
4  
5 310 an appropriate method for our research objective. Notwithstanding, the specific population involved in  
6  
7 311 quad bike entertainment and the resulting health effects, the search for risk factors could be very  
8  
9 312 extensive. However, the information extracted from these articles, using objective measures, could help  
10  
11 313 to elucidate the risk factors of quad bike crashes and the mitigation strategies necessary to reduce their  
12  
13 314 adverse health effects. Despite the methodological weakness of using observational data to synthesize  
14  
15 315 evidence, a rigorous systematic review could help to provide new opportunities for quad bike injury  
16  
17 316 prevention research. Additionally, the research may also provide new research evidence to policy makers  
18  
19 317 for interventional safety strategies.

318

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328

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### 331 *Author Contribution*

332 PM, MS, MK, RHA, MG, and LÖ were involved in conceptualization and protocol development. PM, LÖ and  
333 MS were involved in developing search strategy and grey literature search. Literature search will be  
334 conducted by PM and LO. PM, MK, MD will be involved in screening. MK, MD, RHA, MG and MS will resolve  
335 conflicts. PM and MD will extract data, which will be validated by MS, MK, MG, RHA and LÖ.

### 336 *Competing Interests*

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3 337 None declared.  
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For peer review only

## Appendix-1: Preliminary Search Strategy

**Database:** PubMed

**Search date:** 2020-06-15

**Search specifications:** no filters or limitations applied

**Result:** 778 references

Search string
"Off-Road Motor Vehicles"[Mesh] OR "off-road bike"[Title/Abstract] OR "off road bike"[Title/Abstract] OR "off-road motor vehicle"[Title/Abstract] OR "off road motor vehicle"[Title/Abstract] OR "all-terrain vehicle"[Title/Abstract] OR "all terrain vehicle"[Title/Abstract] OR "all terrain motor vehicle"[Title/Abstract] OR "all-terrain motor vehicle"[Title/Abstract] OR "quad Bike"[Title/Abstract] OR "quad-bike"[Title/Abstract] OR "urban off road vehicle"[Title/Abstract] OR "urban off-road vehicle"[Title/Abstract] OR "4-wheel ATV"[Title/Abstract] OR "four-wheel ATV"[Title/Abstract] OR "4 wheel ATV"[Title/Abstract] OR "four wheel ATV"[Title/Abstract] OR "off-road recreational vehicle"[Title/Abstract] OR "off road recreational vehicle"[Title/Abstract] OR "recreational off-highway vehicle"[Title/Abstract] OR "recreational off highway vehicle"[Title/Abstract]
AND
Risk[MeSH Terms] OR Risk Reduction Behavior[MeSH Terms] OR causality[MeSH Terms] OR accident[MeSH Terms] OR risk management[MeSH Terms] OR protective devices[MeSH Terms] OR caus*[Title/Abstract] OR risk*[Title/Abstract] OR "precipitating factor"[Title/Abstract] OR predispos*[Title/Abstract] OR hazard*[Title/Abstract] OR safe*[Title/Abstract] OR unsafe[Title/Abstract] OR harm*[Title/Abstract] OR danger*[Title/Abstract] OR proneness[Title/Abstract] OR protect*[Title/Abstract] OR prevent*[Title/Abstract] OR threat*[Title/Abstract] OR accident*[Title/Abstract] OR helmet*[Title/Abstract] OR seatbelt*[Title/Abstract]

## Appendix-2: Data Extraction-Data Items

### 1. Journal Article /Report Source Details

- 1.1. Type of publication
- 1.2. Journal/website of report
- 1.3. Link
- 1.4. Date of publication
- 1.5. Date of access
- 1.6. Citation
- 1.7. Author name
- 1.8. Author details
- 1.9. Author email/contact

- 1
- 2
- 3 1.10. Link to other study/paper by the same team
- 4
- 5 2. Study /Report Detail
- 6 2.1. Summary
- 7
- 8 2.2. Aim/Objective
- 9
- 10 2.3. Study population
- 11
- 12 2.4. Location-geographic
- 13
- 14 2.5. Demographic involved
- 15
- 16 2.6. Study Design
- 17
- 18 2.7. Qualitative/quantitative
- 19
- 20 2.8. Primary/secondary data
- 21
- 22 2.9. Data source
- 23 2.10. Data management
- 24 2.11. Statistical analysis
- 25 2.12. Sample size
- 26
- 27 2.13. Limitation
- 28 2.14. Sensitivity analysis, or any other treatment
- 29
- 30 2.15. Outcome-primary
- 31 2.16. Outcome-secondary
- 32 2.17. Outcome-others
- 33
- 34 2.18. Vehicle specification
- 35
- 36
- 37 3. Data Quality Assessment Score
- 38
- 39 4. Data for Review
- 40 4.1. Risk/Protective factor-personal-name
- 41 4.2. Risk/Protective factor-personal-association/attributable factor
- 42 4.3. Risk/Protective -vehicular-name
- 43 4.4. Risk/Protective -vehicular-association/attributable factor
- 44 4.5. Risk/Protective -environmental-name
- 45 4.6. Risk/Protective -environmental-association/attributable factor
- 46 4.7. Risk/Protective -socio-cultural-name
- 47 4.8. Risk/Protective - socio-cultural -association/attributable factor
- 48 4.9. Risk/Protective -others-name
- 49 4.10. Risk/Protective -others-association/attributable factor
- 50
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4.11. Statistically significant relationship

Appendix 3: Screening checklist

1. Does the study involve adverse health effect or injuries? Select if Yes
2. Are the health effect adverse and acute in nature? Select if Yes
3. Does the study focus primarily on quad bikes or similar all terrain vehicle? Select if Yes
4. Is it an opinion, editorial or commentary? Select if No.
5. Are the risk factors or protective factors to quad bike injury mentioned? Select if Yes.

Appendix 4: Mixed Method Assessment Tool Screening Questions

For all types

S1. Are there clear research questions?

S2. Do the collected data allow to address the research questions?

*Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.*

1. Qualitative

- 1.1. Is the qualitative approach appropriate to answer the research question?
- 1.2. Are the qualitative data collection methods adequate to address the research question?
- 1.3. Are the findings adequately derived from the data?
- 1.4. Is the interpretation of results sufficiently substantiated by data?
- 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?

2. Quantitative randomized controlled trials

- 2.1. Is randomization appropriately performed?
- 2.2. Are the groups comparable at baseline?
- 2.3. Are there complete outcome data?
- 2.4. Are outcome assessors blinded to the intervention provided?
- 2.5. Did the participants adhere to the assigned intervention?

3. Quantitative nonrandomized

- 3.1. Are the participants representative of the target population?
- 3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?
- 3.3. Are there complete outcome data?
- 3.4. Are the confounders accounted for in the design and analysis?
- 3.5. During the study period, is the intervention administered (or exposure occurred) as intended?

4. Quantitative descriptive

- 4.1. Is the sampling strategy relevant to address the research question?
- 4.2. Is the sample representative of the target population?

1  
2  
3 4.3. Are the measurements appropriate?

4 4.4. Is the risk of nonresponse bias low?

5 4.5. Is the statistical analysis appropriate to answer the research question?  
6  
7

8 5. Mixed methods

9 5.1. Is there an adequate rationale for using a mixed-methods design to address the research question?

10 5.2. Are the different components of the study effectively integrated to answer the research question?

11 5.3. Are the outputs of the integration of qualitative and quantitative components adequately  
12 interpreted?

13 5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately  
14 addressed?

15 5.5. Do the different components of the study adhere to the quality criteria of each tradition of the  
16 methods involved?  
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# Reporting checklist for protocol of a systematic review.

Based on the PRISMA-P guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the PRISMA-Preorting guidelines, and cite them as:

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015;4(1):1.

		Reporting Item	Page Number
<b>Title</b>			
Identification	<a href="#">#1a</a>	Identify the report as a protocol of a systematic review	1
Update	<a href="#">#1b</a>	If the protocol is for an update of a previous systematic review, identify as such	
<b>Registration</b>			
	<a href="#">#2</a>	If registered, provide the name of the registry (such as PROSPERO) and registration number	2
<b>Authors</b>			
Contact	<a href="#">#3a</a>	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1

1	Contribution	<a href="#">#3b</a>	Describe contributions of protocol authors and identify the guarantor of the review	12
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4	<b>Amendments</b>			
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7		<a href="#">#4</a>	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	
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14	<b>Support</b>			
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16	Sources	<a href="#">#5a</a>	Indicate sources of financial or other support for the review	11
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20	Sponsor	<a href="#">#5b</a>	Provide name for the review funder and / or sponsor	11
21				
22	Role of sponsor or funder	<a href="#">#5c</a>	Describe roles of funder(s), sponsor(s), and / or institution(s), if any, in developing the protocol	
23				
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26	<b>Introduction</b>			
27				
28	Rationale	<a href="#">#6</a>	Describe the rationale for the review in the context of what is already known	2,3
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32	Objectives	<a href="#">#7</a>	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	4
33				
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38	<b>Methods</b>			
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40	Eligibility criteria	<a href="#">#8</a>	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	4,5,6
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48	Information sources	<a href="#">#9</a>	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	7
49				
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55	Search strategy	<a href="#">#10</a>	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	7,Supplementary
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1	Study records -	<a href="#">#11a</a>	Describe the mechanism(s) that will be used to	7,8
2	data management		manage records and data throughout the review	
3				
4	Study records -	<a href="#">#11b</a>	State the process that will be used for selecting	7,8
5	selection process		studies (such as two independent reviewers)	
6			through each phase of the review (that is, screening,	
7			eligibility and inclusion in meta-analysis)	
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11	Study records -	<a href="#">#11c</a>	Describe planned method of extracting data from	7,8,9
12	data collection		reports (such as piloting forms, done independently,	
13	process		in duplicate), any processes for obtaining and	
14			confirming data from investigators	
15				
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18	Data items	<a href="#">#12</a>	List and define all variables for which data will be	5,7,8
19			sought (such as PICO items, funding sources), any	
20			pre-planned data assumptions and simplifications	
21				
22				
23	Outcomes and	<a href="#">#13</a>	List and define all outcomes for which data will be	5
24	prioritization		sought, including prioritization of main and additional	
25			outcomes, with rationale	
26				
27				
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29	Risk of bias in	<a href="#">#14</a>	Describe anticipated methods for assessing risk of	8,10
30	individual studies		bias of individual studies, including whether this will	
31			be done at the outcome or study level, or both; state	
32			how this information will be used in data synthesis	
33				
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36	Data synthesis	<a href="#">#15a</a>	Describe criteria under which study data will be	NA
37			quantitatively synthesised	
38				
39				
40	Data synthesis	<a href="#">#15b</a>	If data are appropriate for quantitative synthesis,	NA
41			describe planned summary measures, methods of	
42			handling data and methods of combining data from	
43			studies, including any planned exploration of	
44			consistency (such as I <sup>2</sup> , Kendall's $\tau$ )	
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48	Data synthesis	<a href="#">#15c</a>	Describe any proposed additional analyses (such as	NA
49			sensitivity or subgroup analyses, meta-regression)	
50				
51				
52	Data synthesis	<a href="#">#15d</a>	If quantitative synthesis is not appropriate, describe	8,9,10
53			the type of summary planned	
54				
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56	Meta-bias(es)	<a href="#">#16</a>	Specify any planned assessment of meta-bias(es)	NA
57			(such as publication bias across studies, selective	
58			reporting within studies)	
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1 Confidence in [#17](#) Describe how the strength of the body of evidence 8  
2 cumulative  
3 will be assessed (such as GRADE)  
4 evidence  
5

6 None The PRISMA-P checklist is distributed under the terms of the Creative Commons Attribution  
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8 made by the [EQUATOR Network](#) in collaboration with [Penelope.ai](#)  
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