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DE-PASS Best Evidence Statement (BEST) – Modifiable determinants of physical activity and sedentary behaviour in children and adolescents aged 5-19 years: A systematic review protocol

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TITLE

DE-PASS Best Evidence Statement (BEST) – Modifiable determinants of physical activity and sedentary behaviour in children and adolescents aged 5-19 years: A systematic review protocol

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3 147 **ABSTRACT**

4 148 **Introduction:** Physical activity among children and adolescents remains insufficient, despite the
5
6 149 substantial efforts made by researchers and policymakers. Identifying and furthering our
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8 150 understanding of potential modifiable determinants of physical activity behaviour (PAB) and sedentary
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10 151 behaviour (SB) is crucial for the development of interventions that promote a shift from SB to PAB. The
11
12 152 current protocol details the process through which a series of systematic literature reviews (SLRs) and
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14 153 meta-analyses (MAs) will be conducted to produce a best-evidence statement (BEST) and inform policy
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16 154 makers. The overall aim is to identify modifiable determinants that are associated with changes in PAB
17
18 155 and SB in children and adolescents (aged 5-19 years) and to quantify their effect on, or association
19
20 156 with, PAB/SB.

21 157 **Methods and analysis:** A search will be performed in MEDLINE, SportDiscus, Web of Science,
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23 158 PsychINFO and Cochrane Central Register of Controlled Trials. Randomized controlled trials (RCT)s and
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25 159 controlled trials (CT)s that investigate the effect of interventions on PAB/SB and longitudinal studies
26
27 160 that investigate the associations between modifiable determinants and PAB/SB at multiple time points
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29 161 will be sought. Risk of bias assessments will be performed using adapted versions of Cochrane's RoB
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31 162 2.0 and ROBINS-I tools for RCTs and CTs, respectively, and an adapted version of the National Institute
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33 163 of Health's tool for longitudinal studies. Data will be synthesised narratively and, where possible, MAs
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35 164 will be performed using Bayesian statistics. Modifiable determinants will be discussed considering the
36
37 165 settings in which they were investigated and the PAB/SB measurement methods used.

38 166 **Ethics and dissemination:** No ethical approval is needed as no primary data will be collected. The
39
40 167 findings will be disseminated in peer-reviewed publications and academic conferences where possible.
41
42 168 The BEST will also be shared with policy makers within the DE-PASS consortium in the first instance.

43 169 **Systematic review registration:** CRD42021282874

44 170 **Keywords:**

45 171 Physical activity, sedentary behaviour, children, adolescents, determinants, systematic review
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3 173 **Strengths and limitations of this study**

- 4 174 • Our goal is to identify modifiable and measurable determinants of physical activity and
5 175 sedentary behaviour and mitigate sedentary behaviour to inform future interventions.
6 176 • Modifiable determinants will be summarized and described within the settings in which they
7 177 were investigated to contextualize how they interact with other determinants and
8 178 subsequently affect physical activity and sedentary behaviour.
9 179 • The body of evidence from high quality research will be summarised, accounting for
10 180 differences in study designs, methodological quality and measurement methods of physical
11 181 activity and sedentary behaviour.
12 182 • The summarized body of work will be used to produce a best-evidence statement that can best
13 183 inform future interventions and policy development.
14 184 • Modifiable determinants reported in study designs which are not included in the current works
15 185 may be overlooked and should be investigated in future reviews as they may provide insights
16 186 into potentially effective interventions.
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189 INTRODUCTION

190 Physical inactivity among children and adolescents is a global public health issue. Four in five (81%)
191 adolescents across the world do not meet the World Health Organisation's (WHO) physical activity (PA)
192 guidelines.[1,2] Physical inactivity is a contributing factor to the high prevalence of cardiovascular,
193 metabolic and bone-health related conditions.[3] It is therefore important to promote physical activity
194 behaviour (PAB) and minimize sedentary behaviour (SB) as part of a healthy lifestyle in children and
195 adolescents to mitigate the negative effects of physical inactivity.[4] PA protects against the health
196 conditions resulting from early physical inactivity and has a positive impact on the development of
197 physical and mental health as children and adolescents transition into adulthood.[5] Despite
198 substantial research efforts, relatively little robust and lasting changes in PAB and SB have been
199 observed in this population.[6] The fact that PA guidelines are not met in a large proportion of young
200 people points towards a lack of understanding and insufficient translation of the evidence behind what
201 makes children and adolescents physically active into policy and public interventions.[7,8] Therefore,
202 a better understanding of the determinants of PAB/SB is a crucial first step in developing interventions
203 that lead to a sustained increase in PAB and reduced SB.[6,9] In the current protocol, we refer to
204 'determinants' of PAB or SB as mechanisms that drive and explain behaviour adaptation in specific
205 contexts.[9,10] We focus on modifiable determinants, signifying those which are malleable and can be
206 altered through interventions, and present opportunities to intervene from public health and policy
207 perspectives.[9,11] Using a rigorous methodology, our goal is to synthesise high-quality evidence on
208 the effectiveness and association of key modifiable determinants on PAB/SB and produce a Best
209 Evidence Statement (BEST) which can inform future interventions. We also aim to identify the settings
210 for interventions that are most readily translatable to policy.

211 The current evidence of the effectiveness of modifiable determinants on PAB/SB is fragmented due to
212 considerable variations in the methodologies used and the methodological quality across the available
213 studies, which has contributed to largely inconclusive findings in systematic literature reviews (SLR)s
214 and meta-analyses (MA)s.[6–8,11–16] To limit the variations across studies and extract trustworthy
215 evidence, it is important to identify high-quality studies. Factors that contribute to methodological
216 quality include research design and PAB/SB measurement methods. A range of research designs have
217 been applied in existing PA research (e.g., cross-sectional, longitudinal, randomised controlled trials
218 (RCT) and controlled trials (CT)). Potential causality between modifiable determinants and the
219 outcome measures can be indicated by RCTs and CTs, and a well-designed RCT can minimise bias
220 through randomisation and intention-to-treat analyses.[6,17,18] However, challenges in
221 randomisation of PAB/SB interventions have been recognised,[19] therefore, CTs might be the next
222 most credible alternative. Whilst RCTs are regarded as the 'gold standard', high-quality longitudinal

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3 223 studies can provide indications of a causal relationship between modifiable determinants and the
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5 224 outcome measures by virtue of the repeated measurements over time.[7] Furthermore, RCTs and CTs
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7 225 can be short-lasting and may not capture the prolonged exposures that can be explored in longitudinal
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9 226 follow-ups.[6] Therefore, we consider RCTs, CTs and longitudinal studies to be amongst the highest
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11 227 quality of evidence appropriate to develop the BESt.

12 228 Methods for measurement of PAB/SB contribute to the disparities in the methodologies used between
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14 229 studies. Data obtained from self-report methods are generally considered to be less sensitive to
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16 230 change than data obtained via device-based methods due to recall errors, under-/overestimation or
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18 231 interpretation discrepancies.[12,13,20,21] On the one hand, device-based measurements are deemed
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20 232 to be more sensitive to behaviour change and can detect cognitively salient behaviours, such as time
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22 233 spent in SB.[21] On the other hand, many studies rely on self-report measurements as they are less
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24 234 costly, logistically easier to implement and are more applicable in some domains of behaviour (e.g.,
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26 235 strength training) than device-based measurements.[21] Given that both device-based and self-report
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28 236 methods present strengths and weaknesses, we consider it methodologically appropriate to include
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30 237 both in BESt, provided that validity and reliability of the instruments are assessed and reported
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32 238 thoroughly in the included studies. However, as previous research has shown low levels of agreement
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34 239 between the two measurement methods, we will conduct separate analyses per method within SLRs
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36 240 and MAs.[22]

37 241 Over the years, PAB/SB measurements have been used to assess different forms of PA, such as
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39 242 structured PA (e.g., physical education), leisure-time PA and active transport PA, and different domains
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41 243 where sedentary time is spent, such as screen-based activities (e.g., doing homework on computers),
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43 244 leisure-based activities (e.g., sitting and reading), and transport-related (e.g., sitting in a bus).[13]
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45 245 Recently, there has been an increased emphasis on identifying the settings (or contexts) in which
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47 246 PAB/SB take place and the determinants at work within the settings, so that the settings of the most
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49 247 impactful, modifiable determinants can be targeted when translating research into policy.[7,23]
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51 248 Answering the questions about what works for whom (children and/or adolescents), why
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53 249 (determinants and their interactions) and when/where (settings) is critical to advance our
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55 250 understanding of the implementation and possible effectiveness of interventions.[24] Therefore, to
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57 251 produce the BESt, we aim to investigate the modifiable determinants in their respective settings in
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59 252 SLRs and MAs so that our results can inform future interventions within settings that speak to policy
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253 makers.

254 The current protocol will be used to produce a series of SLRs and MAs aiming to investigate the
255 effectiveness of modifiable determinants on PAB/SB in children and adolescents using high-quality

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3 256 evidence available. Investigating the modifiable determinants of PAB/SB in their respective settings
4
5 257 will help contextualize their modifiability and effect. Therefore, to produce the BEST, it is important to
6
7 258 ascertain methodological rigour which is set apart from previous efforts in understanding PAB/SB
8
9 259 determinants in children and adolescents. By considering the settings of the modifiable determinants,
10
11 260 our results can readily inform policy makers and future PA interventions.

12 261 **Objectives**

13 262 The overarching aim of the proposed SLRs and MAs is to identify modifiable determinants that are
14
15 263 associated with changes in PAB and SB in children and adolescents (aged 5-19). Specific aims are:

- 16
17 264 • To investigate which modifiable determinants of PAB and SB have been targeted in
18
19 265 interventions designed to promote PA in children and adolescents in RCTs and CTs.
- 20
21 266 • To investigate which modifiable determinants are associated with PAB and SB in children and
22
23 267 adolescents in longitudinal studies.
- 24
25 268 • To investigate what is the strength of the association between such modifiable determinants
26
27 269 and PAB/SB in children and adolescents.

28 29 270 **METHODS AND ANALYSIS**

30 271 The current protocol was registered in the International prospective register of systematic reviews
31
32 272 (PROSPERO) on 12/10/2021 with the registration number: CRD42021282874. The reporting in the
33
34 273 current protocol manuscript was guided by the Preferred Reporting Items for Systematic Review and
35
36 274 Meta-Analysis Protocols (PRISMA-P).[25]

37 275 The modifiable determinants that have been targeted in all included studies will be listed and analysed
38
39 276 narratively in SLRs. Meta-analytic methods will be applied to the data from intervention and
40
41 277 longitudinal studies. Analyses will be performed for different categories of studies based on (i)
42
43 278 methods for measurement of PAB/SB (e.g., self-report, device-based) and (ii) age (e.g., children aged
44
45 279 5-12 years, adolescents aged 12-19 years) in a series of SLRs and MAs with varying focus. Study settings
46
47 280 (e.g., school, home-based, leisure-time) will also be identified.

48 281 **Population**

49 282 Studies targeting children and adolescents with and without disabilities aged 5-19 years will be
50
51 283 included. Studies that report data for ages exceeding the specified age range will be excluded, unless
52
53 284 data for a sub-group within the included mean age can be extracted. Studies that include children
54
55 285 and/or adolescents with any reported diagnosed medical conditions known to affect PA participation
56
57 286 will be excluded (e.g., studies including cancer patients or individuals with anterior cruciate ligament
58
59 287 injury).

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2
3 288 **Patient and Public Involvement**

4 289 No patient involved

6 290 **Types of studies**

7 291 We will include studies examining modifiable PAB/SB determinants in RCTs, CTs and longitudinal
8
9 292 studies. RCTs and CTs that investigate the effectiveness of interventions aiming to promote PA or
10
11 293 reduce SB in children and adolescents, should include control groups or other intervention groups, that
12
13 294 are matched to the experimental groups, and report pre- and post-intervention measurements of both
14
15 295 outcome measures and modifiable determinants. Longitudinal studies should investigate the
16
17 296 association between modifiable determinants of PA and PAB/SB in children and adolescents and report
18
19 297 measurements of both the modifiable determinants and PAB/SB at least at two time-points. No control
20
21 298 groups or comparisons will be required for the longitudinal studies. Length of follow-up or length of
22
23 299 intervention in any of the study designs will not be restricted, data will be extracted if reported for
24
25 300 participants within the specified age range (5-19 years).

25 301 **Outcomes**

26 302 The main outcome measures targeted in the current protocol are PAB and SB. Physical activity is
27
28 303 defined as any bodily movement produced by skeletal muscles that requires energy expenditure, thus
29
30 304 including any modality of movement at any intensity.[2] As such, PAB encompasses behaviours of
31
32 305 sedentary, light, moderate and vigorous intensity PA and SB includes any waking behaviour
33
34 306 characterised by an energy expenditure of 1.5 METs or lower while sitting, reclining or lying.[2,26]
35
36 307 Therefore, we will categorise PAB into light, moderate and vigorous intensity and SB-based types of
37
38 308 activities reported in the included studies. Any of the two types of measurement methods for PAB/SB,
39
40 309 including self-report methods (e.g., questionnaires, diaries, recall), and device-based methods (e.g.,
41
42 310 accelerometers, pedometers) will be included.[21] Moreover, we target studies which have reported
43
44 311 modifiable determinants as secondary measures. Where possible, we will explore the mediating effect
45
46 312 of the modifiable determinants in the changes in PAB/SB by analysing the structural relationship
47
48 313 between the modifiable determinants and PAB/SB.

47 314 **Comparators**

48 315 The main comparator will include PAB/SB measurement methods. The included studies will comprise
49
50 316 those adopting self-report or device-based measures of PAB/SB or both as outcome measures. Self-
51
52 317 report and device-based measures will be analysed separately. In studies where both device-based
53
54 318 and self-report measures are reported, the data for both measurement methods will be extracted and
55
56 319 analysed separately. In addition, to strengthen the BEST, results from the respective measurement
57
58 320 methods will be compared to provide further indication of the strength of the evidence yielded from
59
60 321 studies, depending on their measurement methods for PAB/SB. Classification of the settings in which
322 the modifiable determinants were targeted will be identified once data have been extracted.

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2
3 **323 Search strategy**

4 324 A search will be performed in MEDLINE (Ovid), PsycINFO (EBSCO), Web of Science, Sport Discus, and
5
6 325 Cochrane Central Register of Controlled Trials (CENTRAL). The piloted search strategy is presented in
7
8 326 Table 1. The search strategy is built using the main outcome measures of (1) PAB and (2) SB, and
9
10 327 synonyms of PAB/SB that are commonly used in PA research; (3) the targeted study designs (i.e., RCT,
11
12 328 CT and longitudinal studies) and related terms; (4) determinant and synonyms that are commonly used
13
14 329 in PA research; (5) the targeted population, to identify children and adolescents and synonyms that
15
16 330 are commonly used in PAB/SB research; and (6) measurement methods for PAB/SB such as
17
18 331 accelerometer or pedometer for device-based methods and diary and activity recall for self-report
19
20 332 methods.

21 333 For languages other than English, studies will be included if an English version is available, or if a
22
23 334 translation can be obtained through members of the review team. We will include studies published
24
25 335 from 2010 - which was the year when the first global PA guidelines were published by WHO[27] and
26
27 336 around the time previous SLRs with similar aims were published.[28,29] Only peer-reviewed studies
28
29 337 will be included and grey literature such as research reports, working papers, conference proceedings
30
31 338 and theses will be excluded during the search and at the initial screening of the studies.

32 339 Table 1. The search terms, Boolean commands and field indicators, presented for each domain.

Domain	Search terms
Outcome: Physical activity behaviour ¹	("Physical activ*") OR (exercise) OR (sport*) OR (play) OR (exertion) OR (recreation) OR (training) OR ("motor activit*") OR ("physical performance") OR ("physical movement") OR ("physical effort") OR (exergaming)
OR	
Outcome: Sedentary behaviour ¹	(sedentar*) OR ("screen time") OR (gaming) OR ("computer use") OR (sitting) OR (inactiv*) OR ("seated posture") OR ((watch* or view*) N/2 (TV or television))
AND	
Target population ¹	(child*) OR (youth) OR (adolescen*) OR ("young people") OR ("school age*") OR (p?ediatric) OR (juvenile) OR (teen*)
AND	
Study design ²	(RCT) OR ("control* trial*") OR (quasi) OR (longitudinal) OR (intervention*) OR (prospective) OR ("follow up")
OR	
Determinants ²	(determinant*) OR (antecedent*) OR (predictor*) OR (mediator*) OR (moderator*) OR (exposure*)
AND	
Measurement methods ²	(acceleromet*) OR ("activity profile") OR (recall) OR (diary) OR ("activity monitor*") OR ("heart rate monitor*") OR ("direct observation") OR (actigraph*) OR ("activity track*") OR ("self report*") OR (survey) OR (pedomet*) OR (wearable*)

¹Restricted search to title, abstract and keywords

²Search in entire study

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3 341 **Study records**

4 342 The initial screening will be performed by one member of the review team to exclude records of grey
5 343 literature and duplicates from the different databases. This will be performed in EndNote x9[30] – a
6 344 reference management software. The same member of the review team will upload the resulting list
7 345 to Covidence[31] – an online tool for SLRs in which screening, study selection, data extraction and risk
8 346 of bias assessment will be completed. Covidence allows the distribution of studies among several
9 347 reviewers in a process based on the PRISMA flow diagram for SLRs.[32]

10
11 348 Several workshops will be held before the commencement of the respective stages (i.e. study
12 349 screening, risk of bias assessments and data extraction) to ensure that all reviewers will be proficient
13 350 in the procedures and to ensure agreement among them. As the review team consists of 31 members,
14 351 an online communication tool – Slack[33] – will be used to maintain communication among the
15 352 members of the review team throughout the review process to respond to queries and provide
16 353 updates on the process. A core group of the review team will guide and support the review team
17 354 members throughout the review process.

18
19
20 355 **Screening process**

21 356 At each stage of the screening process, each study will be screened by two blinded independent
22 357 reviewers of the review team. Any conflicts between the independent reviewers will be resolved by a
23 358 third reviewer, who is a member of the core group. An equal number of studies will be distributed
24 359 among reviewers and random studies are selected by Covidence to be distributed to each reviewer. At
25 360 the first stage, titles and abstracts will be assessed for eligibility using a pre-piloted decision tree based
26 361 on the inclusion/exclusion criteria expected to be found in either the title or abstract. The full-text
27 362 version of the studies that remain after title and abstract screening will then be uploaded to Covidence.
28 363 At the second stage, full texts will be assessed for eligibility using the full inclusion/exclusion criteria.
29 364 Reasons for exclusion of studies at the full-text stage will be recorded. Following the full-text screening,
30 365 the included studies will be checked by one reviewer to exclude any duplicate reporting, that is,
31 366 reporting of the results from the same sample in multiple studies or studies that have been published
32 367 more than once. For this purpose, study information will be compared between studies, such as
33 368 authors, study locations and settings, intervention content and design, sample size, demographic
34 369 information and ethical committee approval number.[34] If duplicate reporting is detected among
35 370 included studies, the reviewers will attempt to identify the main study which was duplicated. If the
36 371 main study cannot be identified, the study with the longest follow-up or highest number of
37 372 measurement time points will be selected for inclusion.[35,36]

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373 **Data extraction**

374 A data extraction form will be created in Covidence and piloted ahead of the data extraction stage. The
375 data extraction from each study will be completed by two independent reviewers. If any information
376 or data are missing, or if clarifications are needed, the corresponding author of the respective studies
377 will be contacted. If a response is not provided before data extraction completes, or if the reporting
378 remains incomplete, the study will be excluded. Following the independent data extraction, the two
379 reviewers will perform a consensus procedure to resolve any conflicts and ascertain the correctness of
380 the extracted data.

381 The data extracted will include the following items:

- 382 • Study/intervention description: Study design, brief study intervention description, description
383 of intervention design and content, description of control group activity, study setting.
- 384 • Sample information: Sample size, sample age (including age by sex), sex (including grouping
385 based on sex; % Male, % Female), population type (disability/non-disability).
- 386 • Outcome measures and modifiable determinants: PAB/SB outcome measurement method
387 type (e.g., self-report, device-based) and instrument (e.g., ActiGraph, Youth activity Profile, 7-
388 day recall), length of device-based PAB/SB measurement (days), days of the week for device-
389 based PAB/SB measurement (weekdays/weekend day), wear-time requirement for device-
390 based PAB/SB measurement, unit of measure for PAB/SB, reported validity and reliability of
391 PAB/SB measurements, modifiable determinant measurement instruments and their reported
392 validity and reliability.
- 393 • Time frames: Intervention length (weeks), intervention location (country), number of
394 measurement time points, length of follow-up (weeks).
- 395 • Results data: PAB/SB outcome data (mean, measures of variance), modifiable determinant
396 data (mean, measures of variance).

397 **Risk of bias**

398 Different scales will be used for the assessment of risk of bias depending on the study design of each
399 included study. For RCTs, a modified version of the Cochrane risk of bias tool for randomized trials (RoB
400 2.0) will be used.[37] For CTs without randomization, a modified version of Cochrane's Risk of Bias in
401 Non-randomized Studies - of Interventions (ROBINS-I) will be used.[38] The Cochrane tools, RoB 2.0
402 and ROBINS-I, are modified to include an additional domain concerning the bias in measurement of
403 the determinant(s). For longitudinal studies, an adapted version of the National Institutes of Health
404 (NIH) quality assessment tool will be used.[39] The adaptation of the latter tool involves the
405 exclusion/addition of items relevant to longitudinal studies, based on the tool used by Kontostoli et
406 al.[40]

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3 407 The two independent reviewers who extract the data from the respective studies will perform the risk
4
5 408 of bias assessment to ensure familiarity with the studies. The risk of bias assessment will be completed
6
7 409 in forms created in Covidence with the respective risk of bias tools as templates. Following the
8
9 410 independent data extraction, the two reviewers will perform a consensus procedure to resolve any
10
11 411 conflicts and ascertain the correctness of the assessment.

12 412 **Data synthesis**

13 413 Data extraction will yield a data file containing data for the included RCTs, CTs and longitudinal studies,
14
15 414 and include populations with and without disabilities. A summary table will be created describing the
16
17 415 overall characteristics of the included studies with information on the methods (i.e., intervention
18
19 416 description for intervention studies/exposure for longitudinal studies), settings, modifiable
20
21 417 determinant(s), sample characteristics (i.e., sample size, age), and outcomes (i.e., outcome measures,
22
23 418 measure type, number of measures, measurement time points). Results of the risk of bias assessment
24
25 419 will be reported in a separate table.[41]

26 420 Findings will be synthesised narratively to identify and list the modifiable determinants and the settings
27
28 421 they were investigated in. Studies for disability and non-disability populations, and studies reporting
29
30 422 PAB/SB measured using self-report and device-based methods will be discussed separately. The
31
32 423 findings will be discussed considering the different settings and the quality of evidence included in the
33
34 424 review.

35 425 Most data extracted from the included studies are expected to be continuous. Where possible, meta-
36
37 426 analytic methods will be applied. MAs will be performed using both frequentist and Bayesian
38
39 427 approaches to statistical inference in JASP statistics software.[42] MAs will be performed for
40
41 428 intervention studies (RCTs and CTs) to investigate the effect of the interventions on PAB/SB and for
42
43 429 longitudinal studies to investigate the strength of the association between identified modifiable
44
45 430 determinants and PAB/SB. For studies including more than one experimental group or modifiable
46
47 431 determinant, each will be included in the MAs.

47 432 Direct effect will be investigated in frequentist pairwise comparisons, for which the standardized mean
48
49 433 difference (SMD) and the 95% confidence intervals (CI) will be calculated. We expect the presence of
50
51 434 heterogeneity among included studies in each MA due to the nature, settings or types of interventions.
52
53 435 Therefore, the MAs will be conducted using random effects models. For intervention studies, the post-
54
55 436 intervention data will be used to calculate the between-group difference while controlling for baseline
56
57 437 differences. For longitudinal studies, the within-group difference will be calculated as control groups
58
59 438 are not expected to be included in longitudinal studies. For data interpretation, effect size values of
60
439 SMD < 0.50 indicate small, of $0.50 \leq \text{SMD} < 0.80$ indicate medium, and of $\text{SMD} \geq 0.80$ indicate large

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3 440 effects.[43] Heterogeneity will be identified using Cochran's Q, which is based on a Chi-square test
4
5 441 using the confidence interval size in relation to the degrees of freedom. Heterogeneity will also be
6
7 442 quantified by using I^2 , which represents the degree (in %) of methodological consistency across studies
8
9 443 using the Chi-square statistic Q in relation to the degrees of freedom. For interpretation of
10
11 444 heterogeneity, $I^2 < 25\%$ indicates low heterogeneity, $25\% < I^2 < 50\%$ indicates moderate heterogeneity,
12
13 445 and $I^2 > 75\%$ indicates high heterogeneity.[44] Benchmarks will be used to give an approximation for
14
15 446 the level of heterogeneity: 0% to 40%: might not be important; 30% to 60%: may represent moderate
16
17 447 heterogeneity; 50% to 90%: may represent substantial heterogeneity; 75% to 100%: considerable
18
19 448 heterogeneity.[45] The level for statistical significance will be set to $\alpha < 0.05$.

20
21 449 The Bayesian approach to statistical inference will be applied for the MAs using random effects models.
22
23 450 For this, Gibbs sampling of the Markov Chain Monte Carlo (MCMC) algorithm will be used in JASP.[42]
24
25 451 The probability for publication bias will also be calculated using the JASP extension Robust Bayesian
26
27 452 Meta-analysis (RoBMA). We will apply RoBMA to conduct state of the art publication bias-adjusted
28
29 453 MA.[46,47] The Bayesian framework will allow for Bayesian model averaging,[48] taking several
30
31 454 plausible models into account and alleviating concerns about selecting the right model from the variety
32
33 455 of adjustment methods available.[49] In addition, RoBMA has several other benefits – it allows
34
35 456 researchers to (1) quantify evidence on a continuous scale, including for the null, (2) avoid
36
37 457 accumulation bias, and (3) ease estimation problems by using prior distributions. We will use the prior
38
39 458 specifications[46] and models with the modification of removing the fixed-effects models.

40
41 459 Additionally, the mediation effects of determinants on PAB/SB will be investigated using frequentist
42
43 460 meta-analytical structural equation modelling (meta-SEM).[50] To conduct meta-SEM, the covariance
44
45 461 structure of the mediation is required. If this information is not presented in a primary study, the
46
47 462 authors will be contacted. We will conduct meta-SEM only when we can extract the required data.

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463 **ETHICS AND DISSEMINATION**

464 The current protocol describes the process through which a series of SLRs and MAs will be performed,
465 with the aim to identify modifiable determinants that are (in)effective in influencing PAB and SB in
466 children and adolescents. The findings of the resultant studies will be disseminated in peer-reviewed
467 publications and academic conferences where possible. Modifiable determinants from studies with
468 different study designs and measured using self-report or device-based methods will be reported
469 separately in different publications. The BEST will also be shared with policy makers within the DE-PASS
470 consortium in the first instance. As no primary data will be collected, no ethical approval is required.

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3 471 **Author contributions**

4
5 472 Conceptualization: C.M., F.C.M.L., M.K., A.M., G.D.T., K.N.

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7 473 Methodology: C.M., F.C.M.L., M.K., A.M., G.D.T., K.N., F.B., R.P., M.M.

8
9 474 Writing—original draft preparation: M.K., A.M., G.D.T., F.C.M.L.

10
11 475 Writing—review and editing: M.K., A.M., G.D.T., K.N., F.B., R.P., M.M., F.B., S.B., M.B., G.C., A.C., C.C.,

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15 477 G.H., S.H., P.I., H.J., J.J., P.J., A.K., A.K., E.K., F.M., B.M., T.M., P.J.M., M.M., K.O., A.O.T., F.P., S.P.,

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17 478 O.P., Z.P., J.R., P.L.S.R., P.S., M.S., M.S., I.S., H.P.V.D.P., A.V.H., S.V., C.W., K.W., L.C., C.M., F.C.M.L.

18
19 479 Supervision: F.C.M.L., G.D.T.

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21 480 Project administration: F.C.M.L., A.M., K.N., G.D.T., M.K.

22
23 481 All authors have read and agreed to the submitted version of the manuscript.

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33 489 to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

34 490 www.cost.eu

35
36 491 **Competing interests**

37 492 The authors declare no competing interests.

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For peer review only

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item
ADMINISTRATIVE INFORMATION		
Title:		
Identification	1a	Identify the report as a protocol of a systematic review
Update	1b	If the protocol is for an update of a previous systematic review, identify as such
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number
Authors:		
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review
Amendments	4	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
Support:		
Sources	5a	Indicate sources of financial or other support for the review
Sponsor	5b	Provide name for the review funder and/or sponsor
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol
INTRODUCTION		
Rationale	6	Describe the rationale for the review in the context of what is already known
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)
METHODS		
Eligibility criteria	8	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
Information sources	9	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
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated
Study records:		
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review

Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2 , Kendall's τ)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

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DE-PASS Best Evidence Statement (BEST) – Modifiable determinants of physical activity and sedentary behaviour in children and adolescents aged 5-19 years: A protocol for systematic review and meta-analysis

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TITLE

DE-PASS Best Evidence Statement (BEST) – Modifiable determinants of physical activity and sedentary behaviour in children and adolescents aged 5-19 years: A protocol for systematic review and meta-analysis

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57 146 **Keywords:**
58 147 Physical activity, sedentary behaviour, children, adolescents, determinants
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3 148 **ABSTRACT**

4 149 **Introduction:** Physical activity among children and adolescents remains insufficient, despite the
5
6 150 substantial efforts made by researchers and policymakers. Identifying and furthering our
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8 151 understanding of potential modifiable determinants of physical activity behaviour (PAB) and sedentary
9
10 152 behaviour (SB) is crucial for the development of interventions that promote a shift from SB to PAB. The
11
12 153 current protocol details the process through which a series of systematic literature reviews (SLRs) and
13
14 154 meta-analyses (MAs) will be conducted to produce a best-evidence statement (BEST) and inform policy
15
16 155 makers. The overall aim is to identify modifiable determinants that are associated with changes in PAB
17
18 156 and SB in children and adolescents (aged 5-19 years) and to quantify their effect on, or association
19
20 157 with, PAB/SB.

21 158 **Methods and analysis:** A search will be performed in MEDLINE, SportDiscus, Web of Science,
22
23 159 PsychINFO and Cochrane Central Register of Controlled Trials. Randomized controlled trials (RCTs) and
24
25 160 controlled trials (CTs) that investigate the effect of interventions on PAB/SB and longitudinal studies
26
27 161 that investigate the associations between modifiable determinants and PAB/SB at multiple time points
28
29 162 will be sought. Risk of bias assessments will be performed using adapted versions of Cochrane's RoB
30
31 163 2.0 and ROBINS-I tools for RCTs and CTs, respectively, and an adapted version of the National Institute
32
33 164 of Health's tool for longitudinal studies. Data will be synthesised narratively and, where possible, MAs
34
35 165 will be performed using frequentist and Bayesian statistics. Modifiable determinants will be discussed
36
37 166 considering the settings in which they were investigated and the PAB/SB measurement methods used.

38 167 **Ethics and dissemination:** No ethical approval is needed as no primary data will be collected. The
39
40 168 findings will be disseminated in peer-reviewed publications and academic conferences where possible.
41
42 169 The BEST will also be shared with policy makers within the DE-PASS consortium in the first instance.

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44 170 **Systematic review registration:** CRD42021282874
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3 172 **Strengths and limitations of this study**

- 4 173 • Modifiable determinants will be summarized and described within the settings in which they
5
6 174 were investigated to contextualize how they interact with other determinants and
7
8 175 subsequently affect physical activity and sedentary behaviour in children and adolescents.
- 9 176 • The body of evidence from high quality research will be summarised, accounting for
10
11 177 differences in study designs, methodological quality and measurement methods of physical
12
13 178 activity and sedentary behaviour of children and adolescents.
- 14 179 • Bayesian meta-analysis will be used in addition to frequentist meta-analysis to allow for
15
16 180 assessment of the plausibility of the results and provide more nuanced conclusions regarding
17
18 181 the effectiveness of physical activity and sedentary behaviour interventions in children and
19
20 182 adolescents.
- 21 183 • Modifiable determinants reported in study designs which are not included in the current works
22
23 184 may be overlooked and should be investigated in future reviews as they may provide insights
24
25 185 into potentially effective interventions.
- 26 186 • While our aim is to quantify the effect of modifiable determinants on physical activity and
27
28 187 sedentary behaviour of children and adolescents, the analyses of most included studies might
29
30 188 not permit the quantification, thus a narrative approach will be adopted.

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191 INTRODUCTION

192 Physical inactivity among children and adolescents is a global public health issue. Four in five (81%)
193 adolescents across the world do not meet the World Health Organisation's (WHO) physical activity (PA)
194 guidelines.[1,2] Physical inactivity is a contributing factor to the high prevalence of cardiovascular,
195 metabolic and bone-health related conditions.[3] Reducing levels of physical inactivity from a young
196 age has a positive impact on physical and mental health as children and adolescents transition into
197 adulthood.[4] It is therefore important to promote physical activity behaviour (PAB) and minimize
198 sedentary behaviour (SB) as part of a healthy lifestyle in children and adolescents to mitigate the
199 negative effects of physical inactivity.[5] In the global action plan on PA 2018–2030, the WHO adopted
200 a target to reduce physical inactivity worldwide by 15% by 2030.[6] To achieve this target, evidence-
201 based policies need to be created and adopted worldwide.[7] Furthermore, the fact that PA guidelines
202 are currently not met in a large proportion of young people points towards a lack of understanding
203 and insufficient translation of the evidence behind what makes children and adolescents physically
204 active into policy and public interventions.[9,10] Therefore, a better understanding of the
205 determinants of PAB/SB is a crucial first step in developing interventions that lead to a sustained
206 increase in PAB and reduced SB and a foundation for PA policy development.[8,11] In the current
207 protocol, we refer to 'determinants' of PAB or SB as mechanisms that drive and explain behaviour
208 adaptation in specific contexts.[11,12] We focus on modifiable determinants, signifying those which
209 are malleable and can be altered through interventions, and present opportunities to intervene from
210 public health and policy perspectives.[11,13] Using a rigorous methodology, our goal is to synthesise
211 high-quality evidence on the effectiveness and association of key modifiable determinants on PAB/SB
212 and produce a Best Evidence Statement (BEST) which can inform future interventions. We also aim to
213 identify the settings for interventions that are most readily translatable to policy.

214 The current evidence of the effectiveness of modifiable determinants on PAB/SB is fragmented due to
215 considerable variations in the methodologies used and the methodological quality across the available
216 studies, which has contributed to largely inconclusive findings in systematic literature reviews (SLRs)
217 and meta-analyses (MAs).[8–10,13–18] To limit the variations across studies and extract trustworthy
218 evidence, it is important to identify high-quality studies. Factors that contribute to methodological
219 quality include research design and PAB/SB measurement methods. A range of research designs have
220 been applied in existing PA research (e.g., cross-sectional, longitudinal, randomised controlled trials
221 (RCTs) and controlled trials (CTs). Potential causality between modifiable determinants and the
222 outcome measures can be indicated by RCTs and CTs, and well-designed RCTs can minimise bias
223 through randomisation and intention-to-treat analyses.[8,19,20] However, challenges in
224 randomisation of PAB/SB interventions have been recognised,[21] therefore, CTs might be the next

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3 225 most credible alternative. Whilst RCTs are regarded as the 'gold standard', high-quality longitudinal
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5 226 studies can provide indications of a causal relationship between modifiable determinants and the
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7 227 outcome measures by virtue of the repeated measurements over time.[9] Furthermore, RCTs and CTs
8
9 228 can be short-lasting and may not capture the prolonged exposures that can be explored in longitudinal
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11 229 follow-ups.[8] Therefore, we consider RCTs, CTs and longitudinal studies to be amongst the highest
12
13 230 quality of evidence appropriate to develop the BESt.

14 231 Methods for measurement of PAB/SB contribute to the disparities in the methodologies used between
15
16 232 studies. Data obtained from self-report methods are generally considered to be less sensitive to
17
18 233 change than data obtained via device-based methods due to recall errors, under-/overestimation or
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20 234 interpretation discrepancies.[14,15,22,23] On the one hand, device-based measurements are deemed
21
22 235 to be more sensitive to behaviour change and can detect cognitively salient behaviours, such as time
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24 236 spent in SB.[23] On the other hand, many studies rely on self-report measurements as they are less
25
26 237 costly, logistically easier to implement and are more applicable in some domains of behaviour (e.g.,
27
28 238 strength training) than device-based measurements.[23] Given that both device-based and self-report
29
30 239 methods present strengths and weaknesses, we consider it methodologically appropriate to include
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32 240 both in BESt, provided that validity and reliability of the instruments are assessed and reported
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34 241 thoroughly in the included studies. However, as previous research has shown low levels of agreement
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36 242 between the two measurement methods, we will conduct separate analyses per method within SLRs
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38 243 and MAs.[24]

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40 244 Over the years, PAB/SB measurements have been used to assess different forms of PA, such as
41
42 245 structured PA (e.g., physical education), leisure-time PA and active transport PA, and different domains
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44 246 where sedentary time is spent, such as screen-based activities (e.g., doing homework on computers),
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46 247 leisure-based activities (e.g., sitting and reading), and transport-related activities (e.g., sitting in a
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48 248 bus).[15] Recently, there has been an increased emphasis on identifying the settings (or contexts) in
49
50 249 which PAB/SB take place and the determinants at work within the settings, so that the settings of the
51
52 250 most impactful, modifiable determinants can be targeted when translating research into policy.[9,25]
53
54 251 Answering the questions about what works for whom (children and/or adolescents), why
55
56 252 (determinants and their interactions) and when/where (settings) is critical to advance our
57
58 253 understanding of the implementation and possible effectiveness of interventions.[26] Therefore, to
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60 254 produce the BESt, we aim to investigate the modifiable determinants in their respective settings in
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256 SLRs and MAs so that our results can inform future interventions within settings that speak to policy
makers.

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3 257 The current protocol will be used to produce a series of SLRs and MAs aiming to investigate the
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5 258 effectiveness of modifiable determinants on PAB/SB in children and adolescents using high-quality
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7 259 evidence available. Investigating the modifiable determinants of PAB/SB in their respective settings
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9 260 will help contextualize their modifiability and effect. Therefore, to produce the BEST, it is important to
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11 261 ascertain methodological rigour which is set apart from previous efforts in understanding PAB/SB
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13 262 determinants in children and adolescents. By considering the settings of the modifiable determinants,
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15 263 our results can readily inform policy makers and future PA interventions.

264 **Objectives**

265 The overarching aim of the proposed SLRs and MAs is to identify modifiable determinants that are
266 associated with changes in PAB and SB in children and adolescents (aged 5-19). Specific aims are:

- 267 • To investigate which modifiable determinants of PAB and SB have been targeted in
268 interventions designed to promote PA in children and adolescents in RCTs and CTs.
- 269 • To investigate which modifiable determinants are associated with PAB and SB in children and
270 adolescents in longitudinal studies.
- 271 • To investigate the strength of the association between such modifiable determinants and
272 PAB/SB in children and adolescents.

273 **METHODS AND ANALYSIS**

274 The current protocol was registered in the International prospective register of systematic reviews
275 (PROSPERO) on 12/10/2021 with the registration number: CRD42021282874. The reporting in the
276 current protocol manuscript was guided by the Preferred Reporting Items for Systematic Review and
277 Meta-Analysis Protocols (PRISMA-P).[27]

278 The modifiable determinants that have been targeted in all included studies will be listed and analysed
279 narratively in SLRs. Meta-analytic methods will be applied to the data from intervention and
280 longitudinal studies. Analyses will be performed for different categories of studies based on (i)
281 methods for measurement of PAB/SB (e.g., self-report, device-based) and (ii) age (e.g., children aged
282 5-12 years, adolescents aged 12-19 years) in a series of SLRs and MAs with varying focus. Study settings
283 (e.g., school, home, community) will also be identified.

284 **Population**

285 Studies targeting children and adolescents with and without disabilities aged 5-19 years will be
286 included. According to the International Classification of Functioning, Disability and Health (ICF)[28],
287 disability is an umbrella term for impairments, activity limitations and participation restrictions,
288 denoting the negative aspects of the interaction between an individual and that individual's contextual
289 factors. Studies that include children and/or adolescents with any reported ongoing diagnosed medical

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3 290 conditions known to affect PA participation and includes patients under treatment on all levels of care
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5 291 will be excluded (e.g., studies including cancer patients or individuals with anterior cruciate ligament
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7 292 injury, or studies where the intervention takes place in a clinical setting). Studies that report data for
8
9 293 ages exceeding the specified age range will be excluded, unless data for a sub-group within the eligible
10
11 294 mean age can be extracted.

12 295 **Types of studies**

13 296 We will include studies examining modifiable PAB/SB determinants in RCTs, CTs and longitudinal
14
15 297 studies. RCTs and CTs that investigate the effectiveness of interventions aiming to promote PA or
16
17 298 reduce SB in children and adolescents, should include control groups or other intervention groups, that
18
19 299 are matched to the experimental groups, and report pre- and post-intervention measurements of both
20
21 300 outcome measures and modifiable determinants. Longitudinal studies should investigate the
22
23 301 association between modifiable determinants of PA and PAB/SB in children and adolescents and report
24
25 302 measurements of both the modifiable determinants and PAB/SB at least at two time-points. No control
26
27 303 groups or comparisons will be required for the longitudinal studies. Length of follow-up or length of
28
29 304 intervention in any of the study designs will not be restricted, data will be extracted if reported for
30
31 305 participants within the specified age range (5-19 years).

32 306 **Outcomes**

33 307 The main outcome measures targeted in the current protocol are PAB and SB. Physical activity is
34
35 308 defined as any bodily movement produced by skeletal muscles that requires energy expenditure, thus
36
37 309 including any modality of movement at any intensity.[2] As such, PAB encompasses behaviours of
38
39 310 sedentary, light, moderate and vigorous intensity PA and SB includes any waking behaviour
40
41 311 characterised by an energy expenditure of 1.5 METs or lower while sitting, reclining or lying.[2,29]
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43 312 Therefore, we will categorise PAB into light, moderate and vigorous intensity and SB-based types of
44
45 313 activities reported in the included studies. Any of the two types of measurement methods for PAB/SB,
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47 314 including self-report methods (e.g., questionnaires, diaries, recall), and device-based methods (e.g.,
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49 315 accelerometers, pedometers) will be included.[23] Moreover, we target studies which have reported
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51 316 modifiable determinants as secondary measures. Modifiable determinants will be identified based on
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53 317 the context of each study, where manipulation of the determinant is hypothesized to have an effect
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55 318 on PAB/SB. Where possible, we will explore the mediating effect of the modifiable determinants in the
56
57 319 changes in PAB/SB by analysing the structural relationship between the modifiable determinants and
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59 320 PAB/SB.

56 321 **Comparators**

57 322 The main comparator will include PAB/SB measurement methods. The included studies will comprise
58
59 323 those adopting self-report or device-based measures of PAB/SB or both as outcome measures. Self-

324 report and device-based measures will be analysed separately. In studies where both device-based
 325 and self-report measures are reported, the data for both measurement methods will be extracted and
 326 analysed separately. In addition, to strengthen the BESt, results from the respective measurement
 327 methods will be compared to provide further indication of the strength of the evidence yielded from
 328 studies, depending on their measurement methods for PAB/SB. Classification of the settings in which
 329 the modifiable determinants were targeted will be identified once data have been extracted.

330 **Search strategy**

331 A search will be performed in MEDLINE (Ovid), PsycINFO (EBSCO), Web of Science, Sport Discus, and
 332 Cochrane Central Register of Controlled Trials (CENTRAL). The piloted search strategy is presented in
 333 Table 1. The search strategy is built using the main outcome measures of (1) PAB and (2) SB, and
 334 synonyms of PAB/SB that are commonly used in PA research; (3) the targeted study designs (i.e., RCTs,
 335 CTs and longitudinal studies) and related terms; (4) determinant and synonyms that are commonly
 336 used in PA research; (5) the targeted population, to identify children and adolescents and synonyms
 337 that are commonly used in PAB/SB research; and (6) measurement methods for PAB/SB such as
 338 accelerometer or pedometer for device-based methods and diary and activity recall for self-report
 339 methods.

340 For languages other than English, studies will be included if an English version is available, or if a
 341 translation can be obtained through members of the review team. We will include studies published
 342 from 2010 - which was the year when the first global PA guidelines were published by WHO[30] and
 343 around the time previous SLRs with similar aims were published.[31,32] Only peer-reviewed studies
 344 will be included and grey literature such as research reports, working papers, conference proceedings
 345 and theses will be excluded during the search and at the initial screening of the studies.

346 Table 1. The search terms, Boolean commands and field indicators, presented for each domain.

Domain	Search terms
Outcome: Physical activity behaviour ¹	("Physical activ*") OR (exercise) OR (sport*) OR (play) OR (exertion) OR (recreation) OR (training) OR ("motor activit*") OR ("physical performance") OR ("physical movement") OR ("physical effort") OR (exergaming)
OR	
Outcome: Sedentary behaviour ¹	(sedentar*) OR ("screen time") OR (gaming) OR ("computer use") OR (sitting) OR (inactiv*) OR ("seated posture") OR ((watch* or view*) N/2 (TV or television))
AND	
Target population ¹	(child*) OR (youth) OR (adolescen*) OR ("young people") OR ("school age*") OR (p?ediatric) OR (juvenile) OR (teen*)
AND	
Study design ²	(RCT) OR ("control* trial*") OR (quasi) OR (longitudinal) OR (intervention*) OR (prospective) OR ("follow up")
OR	

Determinants ²	(determinant*) OR (antecedent*) OR (predictor*) OR (mediator*) OR (moderator*) OR (exposure*)
AND	
Measurement methods ²	(acceleromet*) OR ("activity profile") OR (recall) OR (diary) OR ("activity monitor*") OR ("heart rate monitor*") OR ("direct observation") OR (actigraph*) OR ("activity track*") OR ("self report*") OR (survey) OR (pedomet*) OR (wearable*)

¹Restricted search to title, abstract and keywords

²Search in entire study

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348 **Study records**

349 At the initial screening, records of grey literature and duplicates from the different databases will be
 350 excluded. The initial screening will be performed before the start of the blinded review process by one
 351 member of the review team. For this, EndNote x9[33] – a reference management software will be
 352 used. The same member of the review team will upload the resulting list to Covidence[34] – an online
 353 tool for SLRs in which the blinded review process, including title and abstract screening, full-text
 354 screening, study selection, data extraction and risk of bias assessment, will be completed. Covidence
 355 allows the distribution of studies among several reviewers in a process based on the PRISMA flow
 356 diagram for SLRs.[35]

357 Several workshops will be held before the commencement of the respective stages (i.e. study
 358 screening, risk of bias assessments and data extraction) to ensure that all reviewers will be proficient
 359 in the procedures and to ensure agreement among them. As the review team consists of 31 members,
 360 an online communication tool – Slack[36] – will be used to maintain communication among the
 361 members of the review team throughout the review process to respond to queries and provide
 362 updates on the process. A core group of the review team will guide and support the review team
 363 members throughout the review process.

364 **Screening process**

365 At title and abstract screening and full-text screening, each study will be screened by two blinded
 366 independent reviewers of the review team. Any conflicts between the independent reviewers will be
 367 resolved by a third reviewer, who is a member of the core group. An equal number of studies will be
 368 distributed among reviewers and random studies are selected by Covidence to be distributed to each
 369 reviewer. At the first stage, titles and abstracts will be assessed for eligibility using a pre-piloted
 370 decision tree based on the inclusion/exclusion criteria expected to be found in either the title or
 371 abstract. The full-text version of the studies that remain after title and abstract screening will then be
 372 uploaded to Covidence. At the second stage, full texts will be assessed for eligibility using the full
 373 inclusion/exclusion criteria. Reasons for exclusion of studies at the full-text stage will be recorded.
 374 Following the full-text screening, the included studies will be checked by one reviewer to exclude any

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3 375 duplicate reporting, that is, reporting of the results from the same sample in multiple studies or studies
4 376 that have been published more than once. For this purpose, study information will be compared
5 377 between studies, such as authors, study locations and settings, intervention content and design,
6 378 sample size, demographic information and ethical committee approval number.[37] If duplicate
7 379 reporting is detected among included studies, the reviewers will attempt to identify the main study
8 380 which was duplicated. If the main study cannot be identified, the study with the longest follow-up or
9 381 highest number of measurement time points will be selected for inclusion.[38,39]

382 **Data extraction**

383 A data extraction form will be created in Covidence and piloted ahead of the data extraction stage. The
384 data extraction from each study will be completed by two independent reviewers. If any information
385 or data are missing, or if clarifications are needed, the corresponding author of the respective studies
386 will be contacted. If a response is not provided before data extraction completes, or if the reporting
387 remains incomplete, the study will be excluded. Following the independent data extraction, the two
388 reviewers will perform a consensus procedure to resolve any conflicts and ascertain the correctness of
389 the extracted data.

390 The data extracted will include the following items:

- 391 • Study/intervention description: Study design, brief study intervention description, description
392 of intervention design and content, description of control group activity, study setting.
- 393 • Sample information: Sample size, sample age (including age by sex), sex (including grouping
394 based on sex; % Male, % Female), population type (disability/non-disability).
- 395 • Outcome measures and modifiable determinants: PAB/SB outcome measurement method
396 type (e.g., self-report, device-based) and instrument (e.g., ActiGraph, Youth Activity Profile, 7-
397 day recall), length of device-based PAB/SB measurement (days), days of the week for device-
398 based PAB/SB measurement (weekdays/weekend day), wear-time requirement for device-
399 based PAB/SB measurement, unit of measure for PAB/SB, reported validity and reliability of
400 PAB/SB measurements, modifiable determinant measurement instruments and their reported
401 validity and reliability.
- 402 • Time frames: Intervention length (weeks), intervention location (country), number of
403 measurement time points, length of follow-up (weeks).
- 404 • Results data: PAB/SB outcome data (mean, measures of variance), modifiable determinant
405 data (mean, measures of variance).

Risk of bias

Different scales will be used for the assessment of risk of bias depending on the study design of each included study. For RCTs, a modified version of the Cochrane risk of bias tool for randomized trials (RoB 2.0) will be used.[40] For CTs without randomization, a modified version of Cochrane's Risk of Bias in Non-randomized Studies - of Interventions (ROBINS-I) will be used.[41] The Cochrane tools, RoB 2.0 and ROBINS-I, are modified to include an additional domain concerning the bias in measurement of the determinants. For longitudinal studies, an adapted version of the National Institutes of Health (NIH) quality assessment tool will be used.[42] The adaptation of the latter tool involves the exclusion/addition of items relevant to longitudinal studies, based on the tool used by Kontostoli et al.[43]

The two independent reviewers who extract the data from the respective studies will perform the risk of bias assessment to ensure familiarity with the studies. The risk of bias assessment will be completed in forms created in Covidence with the respective risk of bias tools as templates. Following the independent data extraction, the two reviewers will perform a consensus procedure to resolve any conflicts and ascertain the correctness of the assessment.

Data synthesis

Data extraction will yield a data file containing data for the included RCTs, CTs and longitudinal studies, and include populations with and without disabilities. A summary table will be created describing the overall characteristics of the included studies with information on the methods (i.e., intervention description for intervention studies/exposure for longitudinal studies), settings, modifiable determinants, sample characteristics (i.e., sample size, age), and outcomes (i.e., outcome measures, measure type, number of measures, measurement time points). Results of the risk of bias assessment will be reported in a separate table.[44]

Findings will be synthesised narratively to identify and list the modifiable determinants and the settings they were investigated in. Studies for disability and non-disability populations, and studies reporting PAB/SB measured using self-report and device-based methods will be discussed separately. The findings will be discussed considering the different settings and the quality of evidence included in the review.

Most data extracted from the included studies are expected to be continuous. Where possible, meta-analytic methods will be applied. MAs will be performed using both frequentist and Bayesian approaches to statistical inference in JASP statistics software.[45] MAs will be performed for intervention studies (RCTs and CTs) to investigate the effect of the interventions on PAB/SB and determinants and for longitudinal studies to investigate the strength of the association between

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3 439 identified modifiable determinants and PAB/SB. For studies including more than one experimental
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5 440 group or modifiable determinant, each will be included in the MAs.

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7 441 Direct effect will be investigated in frequentist pairwise comparisons, for which the standardized mean
8
9 442 difference (SMD) and the 95% confidence intervals (CI) will be calculated. We expect the presence of
10
11 443 heterogeneity among included studies in each MA due to the nature, settings or types of interventions.
12
13 444 Therefore, the MAs will be conducted using random effects models. For intervention studies, the post-
14
15 445 intervention data will be used to calculate the between-group difference while controlling for baseline
16
17 446 differences. For longitudinal studies, the within-group difference will be calculated as control groups
18
19 447 are not expected to be included in longitudinal studies. For data interpretation, effect size values of
20
21 448 SMD < 0.50 indicate small, of $0.50 \leq \text{SMD} < 0.80$ indicate medium, and of $\text{SMD} \geq 0.80$ indicate large
22
23 449 effects.[46] Heterogeneity will be identified using Cochrane's Q, which is based on a Chi-square test
24
25 450 using the confidence interval size in relation to the degrees of freedom. Heterogeneity will also be
26
27 451 quantified by using I^2 , which represents the degree (in %) of methodological consistency across studies
28
29 452 using the Chi-square statistic Q in relation to the degrees of freedom. For interpretation of
30
31 453 heterogeneity, $I^2 < 25\%$ indicates low heterogeneity, $25\% < I^2 < 50\%$ indicates moderate heterogeneity,
32
33 454 and $I^2 > 75\%$ indicates high heterogeneity.[47] Benchmarks will be used to give an approximation for
34
35 455 the level of heterogeneity: 0% to 40%: might not be important; 30% to 60%: may represent moderate
36
37 456 heterogeneity; 50% to 90%: may represent substantial heterogeneity; 75% to 100%: considerable
38
39 457 heterogeneity.[48] The level for statistical significance will be set to $\alpha < 0.05$.

40
41 458 The Bayesian approach to statistical inference will be applied for the MAs using random effects models.
42
43 459 The primary benefits of using Bayesian meta-analysis in addition to frequentist meta-analysis include
44
45 460 (a) the ability to include prior knowledge of the effect into a model, updating the existing knowledge
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47 461 as evidence accumulates (b) the ability to make more nuanced conclusions that expand on a simple
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49 462 presence or absence of support for the hypotheses based on a p-value, and (c) the ability to assess the
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51 463 plausibility of the results and to make conclusions based on the probability that the results are within
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53 464 a given range.[49,50] For the Bayesian meta-analysis, Gibbs sampling of the Markov Chain Monte Carlo
54
55 465 (MCMC) algorithm will be used in JASP.[45] The probability for publication bias will also be calculated
56
57 466 using the JASP extension Robust Bayesian Meta-analysis (RoBMA). We will apply RoBMA to conduct
58
59 467 state of the art publication bias-adjusted MA.[51,52] The Bayesian framework will allow for Bayesian
60
468 model averaging,[49] taking several plausible models into account and alleviating concerns about
469 selecting the right model from the variety of adjustment methods available.[53] In addition, RoBMA
470 has several other benefits – it allows researchers to (1) quantify evidence on a continuous scale,
471 including for the null, (2) avoid accumulation bias, and (3) ease estimation problems by using prior

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3 472 distributions. We will use the prior specifications[51] and models with the modification of removing
4
5 473 the fixed-effects models.

6
7 474 Additionally, the mediation effects of determinants on PAB/SB will be investigated using frequentist
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9 475 meta-analytical structural equation modelling (meta-SEM).[54] To conduct meta-SEM, the covariance
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11 476 structure of the mediation is required. If this information is not presented in a primary study, the
12
13 477 authors will be contacted. We will conduct meta-SEM only when we can extract the required data.

14 15 478 **ETHICS AND DISSEMINATION**

16 479 The current protocol describes the process through which a series of SLRs and MAs will be performed,
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18 480 with the aim to identify modifiable determinants that are (in)effective in influencing PAB and SB in
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20 481 children and adolescents. The findings of the resultant studies will be disseminated in peer-reviewed
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22 482 publications and academic conferences where possible. Modifiable determinants from studies with
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24 483 different study designs and measured using self-report or device-based methods will be reported
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26 484 separately in different publications. The BESt will also be shared with policy makers within the DE-PASS
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28 485 consortium in the first instance. As no primary data will be collected, no ethical approval is required.
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3 486 **Author contributions**

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5 487 The current systematic review protocol was produced by members of the COST Action CA19101
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7 488 Determinants of Physical Activities in Settings (DE-PASS). The protocol was conceived and designed
8
9 489 by C.M., F.C.M.L., M.K., A.M., G.D.T. and K.N. The methodology was planned and outlined by C.M.,
10
11 490 F.C.M.L., M.K., A.M., G.D.T., K.N., F.B., R.P. and M.M. The protocol was initially drafted by M.K., A.M.,
12
13 491 G.D.T. and F.C.M.L. Subsequent drafts were reviewed by the included members of DE-PASS: F.B.,
14
15 492 R.P., M.M., F.B., S.B., M.B., G.C., A.C., C.C., H.C., A.C., S.C., J.C.S., V.Č., C.C., C.C., E.D., A.D.B., A.D.C.,
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17 493 P.D., R.M.D.T., F.G., E.G.S., M.G., B.G., M.G., G.H., S.H., P.I., H.J., J.J., P.J., A.K., A.K., E.K., F.M., B.M.,
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19 494 T.M., P.J.M., M.M., K.O., A.O.T., F.P., S.P., O.P., Z.P., J.R., P.L.S.R., P.S., M.S., M.S., I.S., H.P.V.D.P.,
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21 495 A.V.H., S.V., C.W., K.W., L.C. and C.M. Revisions were made by M.K., A.M., G.D.T., K.N. and F.C.M.L.
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23 496 All authors have read and agreed to the submitted version of the manuscript.

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505 www.cost.eu

506 **Competing interests**

507 The authors declare no competing interests.

508 **Key dates**

509 The project commenced in June 2021. At the time of submission, the search was complete and data
510 extraction underway. The expected completion date is October 2022.

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PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item
ADMINISTRATIVE INFORMATION		
Title:		
Identification	1a	Identify the report as a protocol of a systematic review
Update	1b	If the protocol is for an update of a previous systematic review, identify as such
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number
Authors:		
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review
Amendments	4	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
Support:		
Sources	5a	Indicate sources of financial or other support for the review
Sponsor	5b	Provide name for the review funder and/or sponsor
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol
INTRODUCTION		
Rationale	6	Describe the rationale for the review in the context of what is already known
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)
METHODS		
Eligibility criteria	8	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
Information sources	9	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
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated
Study records:		
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review

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Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2 , Kendall's τ)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

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