Study protocol

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# Combinations of physical activity, sedentary behavior, and sleep and health outcomes in older adults: a systematic review protocol

## Combinações de atividade física, comportamento sedentário e sono e desfechos de saúde em idosos: protocolo de revisão sistemática

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ABSTRACT

Recent systematic reviews highlighted important relationships between combinations of movement behaviors (ie. sleep, sedentary behaviour, and physical activity) and health outcomes among children and adolescents. However, it is unclear whether similar relationships occur in older adults. Therefore, the purpose of this protocol was to describe the aims and methods for a systematic review to summarize the studies examining the relationships between movement behaviors and health outcomes in older adults. A systematic review will be developed based on searches of articles in seven electronic databases and references of retrieved articles, contact with authors, and study repositories. Eligibility criteria: observational or experimental studies examining the association of at least two movement behaviours (sleep, sedentary behaviour, and physical activity) with health outcomes in older adults (≥ 60 years old). Selection of the studies and extraction of the data will be carried out by two reviewers independently. Characteristics of the study, participants, methods of combinations, and main results will be extracted and described. Risk of bias and level of evidence in the studies will be assessed according to the study quality tool of the US National Heart, Lung, and Blood Institute and the GRADE guidelines. The data will be synthesized using random effects meta-analysis for results that are sufficiently homogeneous in terms of statistical, clinical, and methodological characteristics. If not, then a narrative synthesis will be conducted. The results of this review may provide insights to improve current guidelines on 24-hour cycle in older adults, as well as guide future studies in this research field.

**Keywords**: Physical activity; Sedentary behaviour; Sleep; Movement behaviours; Older adults.

RESUMO

*Recentes revisões sistemáticas têm demonstrado haver uma relação entre combinações de sono, comportamento sedentário e atividade física e desfechos de saúde em crianças e adolescentes. Entretanto, ainda permanece incerto se essas relações ocorrem de forma similar em idosos. Portanto, este protocolo objetivou descrever os objetivos e métodos de uma revisão sistemática que sumarizará os estudos que examinaram a relação entre combinações de sono, comportamento sedentário e atividade física e desfechos de saúde em idosos. Uma revisão sistemática será desenvolvida com base nas buscas de artigos em sete bases de dados, nas referências dos artigos incluídos, em contato com os autores e em repositório de estudos. Como critérios de inclusão, estudos observacionais ou experimentais analisando a associação entre a combinação de pelo menos dois dos três comportamentos (sono, comportamento sedentário e atividade física) com desfechos de saúde em idosos (≥ 60 anos). O processo de seleção e extração dos dados será realizado por dois revisores de forma independente. As características dos estudos, participantes, métodos de combinação dos comportamentos e principais resultados serão extraídos e descritos. O risco de viés e o nível de evidência serão analisados, respectivamente, pela ferramenta de avaliação de qualidade do US National Heart, Lung, and Blood Institute e pelo guideline GRADE. Os dados serão sintetizados usando metanálise com efeitos randômicos quando os resultados apresentaram suficiente homogeneidade estatística, clínica e metodológica. Do contrário, os resultados serão apresentados por meio de síntese narrativa. Os resultados desta revisão podem fornecer informações para aprimorar as diretrizes do ciclo das 24 horas, bem como podem fornecer informações para futuros estudos nesse campo de pesquisa.*

**Palavras-chave**: *Atividade física; Comportamento sedentário; Sono; Idosos.*

## Introduction

The aging population is growing rapidly worldwide. It is estimated that the number of individuals aged 60 years or older will rise from 900 million to 2.1 billion between 2015 and 2050, moving from 12% to 22% of the total global population[1]. This scenario brings economic and health-related challenges and, therefore, optimizing health and wellbeing in older adults has

become increasingly important.

Individuals' health is strongly associated with lifestyle, particularly on how people structure their time each day. During the day, individuals distribute their time in a sequence of behaviors [ie. sleep, sedentary behaviour (SB), light intensity physical activity (LIPA), and moderate to vigorous physical activity (MVPA)], which are part of the daily routine[2]. The health effects of MVPA and proper sleep are well documented[3]; thereby, public health guidelines for these specific lifestyle components have been published[4,5]. In fact, insufficient amount of MVPA is the fourth leading risk factor for global mortality[6], thus, individuals aged >18 years old are recommended to spend between 150-300 minutes of MVPA per week[7]. Likewise, it has been found that both short (≤6 hrs) or long (≥10hrs) sleep durations are associated with worse health parameters, such as physical frailty[8], poorer cognitive function[9], and multimorbidity in older adults[10]. Therefore, older adults are generally advised to sleep 7-8 hours/day in order to maintain or improve health[11].

In past decades, emerging evidence has suggested that SB is unfavorably related with increased risk for chronic diseases and premature mortality in general population[12], which justifies more recent recommendations such as "sitting less and moving more" to improve health. In older adults, a systematic review of studies from 10 countries found that they spend an average of 9.4 hours/day in SB[13], which is alarming since excessive time spent in SB is detrimentally associated with an increased risk of metabolic syndrome, overweight and abdominal obesity, as well as all-cause mortality in older adults[14]. Likewise, despite the well-known health benefits of MVPA, it represents only a small fraction (3-5%) of the awake time of older adults, mostly being LIPA[13]. Interestingly, there is a growing body of evidence demonstrating that LIPA may also be associated with improved health outcomes, especially in older adults[15]. Together these data support the importance of reducing SB and increasing LIPA for promoting health in older adults.

It should be mentioned that despite the isolated effect of each behaviour, certain combinations of time among them could influence health in a different manner. For example, Ekelund at al.[16] conducted a harmonized meta-analysis including more than one million men and women and found that the risk of mortality associated to sitting time was eliminated in those individuals in the highest quartile of moderate physical activity (ie. 60-75 minutes per day), indicating an interaction between these two behaviors.

Accordingly, there has been a tendency towards a more complex and integrated view of the movement behaviors along the whole day with several countries such as Canadian[17,18], Australia[19], New Zealand[20], South Africa[21], as well as the World Health Organization[22] releasing their recommendations considering the 24-hour cycle. Previous systematic reviews have addressed the impact of combinations of these movement behaviors in the health of preschool[23] and school-aged children and adolescents[17]. Despite that, the evidence on the combinations of these behaviors in older adults has yet to be systematically reviewed or synthesized to provide evidence-based information on what is known and future directions in this research field.

Thus, the purpose of this protocol was to describe the aims and methods for a systematic review to summarize the studies examining the relationships between movement behaviors and health outcomes in older adults.

## Methods

The protocol has been registered with the International Prospective Register of Systematic Reviews (PROSPERO) under registration number 42018086713 (http://www.crd.york.ac.uk/PROSPERO). The Preferred Reporting Items of Systematics Reviews and Meta-Analyses (PRISMA)[24] will guide the report of this systematic review and this protocol was prepared and written according to PRISMA-Protocol[25] as presented in Supplementary file 1.

The systematic review will include studies that meet the following eligibility criteria based on the Population, Intervention, Control, Outcome and Study design framework (PICOS framework)[26].

Studies will be accepted when the sample is composed by individuals aged 60 years or older (or the mean age within this range). In cases of studies including a mixture of young, middle age, and older individuals (ie. 40-80 years), they will only be eligible if they provide separated analysis for those individuals aged 60 years or older. Finally, studies conducted exclusively with individuals with a clinical diagnosis (i.e., hypertension, diabetes, dementia), bedridden, or living in nursing homes will not be included.

For experimental studies, interventions will have to target at least two of three movement behaviours (ie. both physical activity and sedentary behaviour). For observational studies, the exposure will be any com-

bination of two or three movement behaviours (ie. sleep, SB, and physical activity). Briefly, relevant interventions/exposures for each individual movement behaviour will be operationalized as the durations (sleep, SB, and physical activity), patterns and types (SB and physical activity), and intensities (physical activity) of behaviours. The rationale for these decisions was based on previous systematic reviews on the relationship between movement behaviors and health outcomes in children and adolescents[17,23]. No limits concerning the measurement method (i.e., self-reported, accelerometer based) for any of the behaviors will be imposed.

The comparator will be various durations and combinations of movement behaviors. However, a comparator group or control group will not be required for inclusion.

Critical health indicators will be adiposity (ie. body mass index [BMI], skinfold thickness, body fat, waist circumference), psycho-social health/emotional regulation (e.g., self-efficacy, self-esteem, prosocial behaviour, aggression, social functioning, depressive symptoms, anxiety symptoms, quality of life, stress, mood, hyperactivity/impulsivity), cognitive function (e.g., attention, executive functioning), fitness (e.g., cardiovascular fitness, musculoskeletal fitness), bone and skeletal health (e.g., bone mineral content, bone mineral density), cardiometabolic health (e.g., blood pressure, glucose, insulin resistance, blood lipids), risk of fall, and frailty[14,17]. To be included, studies should report the measure of effect and/or association for the relationship between any combination of movement behavior among older adults (>60) and at least one of these health outcomes, which can be linear (i.e., regression coefficients, mean differences, effect sizes) or categorical (i.e., odds ratio, hazard ratio) statistical parameters.

It will be included all observational studies examining the association of combinations of movement behaviors with at least one of the health outcomes as well as experimental studies that employ interventions focusing on the combination at least in two behaviors (ie. SB, sleep, and physical activity).

An electronic search of the literature will be carried out in six databases and two repositories of studies:

1) Medline (PubMed)
2) Scopus
3) Web of Science
4) PsyINFO
5) LILACS
6) Cochrane clinical trials

Keywords will be selected by assessment of the Medical Subject Headings (MeSH) in the National Library of Medicine and relevant text to the area. The organization of search terms will be carried out according to the PICOS framework. The search strategy for each of the following databases is presented in Supplementary file 2.

We will use additional search strategy to further explore the grey literature, as following:

*1) Consultation of the reference lists of all original articles included:* we will review references of each included study and review studies in the field to identify potential studies not found in the initial search:

*2) Contact with the authors:* (i) if complete articles are not available; and (ii) if certain data are not available in the original article, such as data presented only in graphs.

*3) Searches in repositories of clinical trials*: The ClinicalTrials.gov (http://clinicaltrials.gov/) and the Brazilian Clinical Trial Registry (http://www.ensaiosclinicos.gov.br) will be also consulted and eligibility criteria will be applied to the original studies and those in the repositories for inclusion in this review. If we find eligible studies that are unpublished, we will contact the authors to obtain the results.

A software (EndNote X7) will be used for management of references and duplicates removal. Subsequently, the data will be imported to the Rayyan software[27], so the screening process can be performed. The review process is presented below in a step-by-step fashion.

Following the search in databases, all references will be transferred to a single EndNote X7 library for subsequent duplicate removal, using the "find duplicates" tool. A manual check of all references will be performed to ensure that all duplicates have been removed. Subsequently, all references will be transferred to the Rayyan QCRI software[27] with the intention to enable independent selection by two experienced reviewers.

To reduce disagreements in the selection process between the two reviewers, a pilot screening will be performed by selecting 20 articles randomly. For that, each article will be jointly reviewed by the reviewers to improve decision making. Afterwards, the selection process will be started with all references, which will be carried out in two levels: (i) the reviewers will read all titles and abstracts of the articles; (ii) the reviewers will read all articles in full.

In the first level, a screening based on the reading of the title/abstract of the articles will be performed according to the eligibility criteria. After that, a consensus meeting will be performed to evaluate the selection of articles to be screened at the second level (full text reading) and any divergences will be resolved by consulting a third reviewer. Following this meeting, the full text of the articles will be downloaded and stored in two folders (one for each reviewer) and two spreadsheets with identical contents will be for full post-read selection.

In the second level, the reviewers will read the full texts. At this stage, the reviewers will evaluate the defined eligibility criteria. Exclusions will be justified within the Rayyan software and a third reviewer will be used to resolve disagreements. After this selection, another consensus meeting will be held to review which articles will be considered eligible for review. If necessary, a third reviewer will also be used to resolve disagreements. After the selection process in electronic databases, complementary search strategies (author contact and reference list screening) will be employed by one reviewer to identify additional studies. The research development process flow diagram is presented in Figure 1, according to the PRISMA guidelines[24].

All stages of data extraction, management, risk of bias, level of evidence rating, and synthesis will be independently implemented by two reviewers. In the case of disagreement, a third reviewer will be consulted.

Reviewers will receive a spreadsheet (elaborated by the authors) in Excel format with all the variables to be filled by them (Supplementary file 3). Briefly, the extracted data will include the study descriptive information (year of publication, study design, country in which the study was conducted, number of participants, sex, age range), relevant intervention/exposure (method used to assess time spent in the movement be-

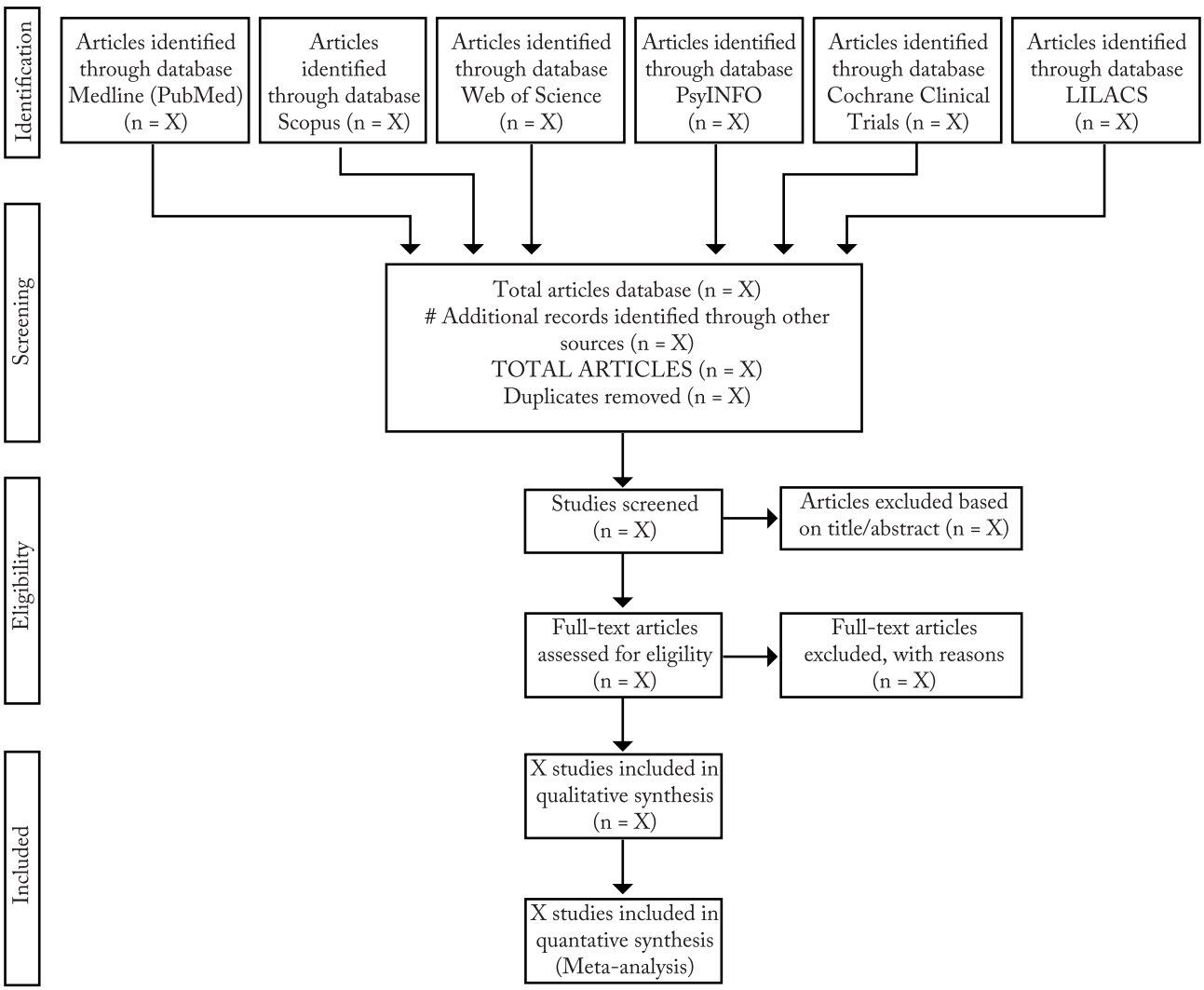


**Figure 1 –** Research development process according to the PRISMA flow diagram

haviours [self-reported, accelerometry] and method for operationalizing the combination of the behaviours), health outcome details, statistical procedures, as well as study results. When studies presented unadjusted and adjusted results, extraction data will include the results from the unadjusted model and the most fully adjusted one. Likewise, for the purpose of this review, statistical significance will be defined as p-value less than 0.05 regardless of how individual studies have defined it.

The study quality tool of the US National Heart, Lung, and Blood Institute [URL:www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools], which provide appropriate tools for each study design (ie. intervention studies, cohort, and cross-sectional studies), will be employed (Supplementary file 4).

The tool includes 14 items for assessing potential flaws in study methods or implementation, including sources of bias (ie. participants' selection, performance, attrition, and detection), confounding, study power, the strength of causality in the association between interventions/exposures and outcomes, and other factors. The possible answers to the 14 questions are "yes", "no", or "cannot determine/not reported/not applicable". Whenever the answer "no", "CD, or "NR" is selected, it will be considered that a potential risk of bias could be introduced by that flaw in the study design or implementation.

Two independent reviewers will critically assess the risk of bias in studies referred in the synthesis. A consensus meeting will take part and, when necessary, a third reviewer will be consulted for resolution of doubts, agreement, or consensus. No study will be excluded based on assessment of the risk of bias; on the contrary, the methodological rigor of each study will be considered for the confidence assessments of each finding in the review. Nevertheless, the strengths and methodological limitations of the studies will be discussed among the authors until a consensus is reached. This will be done based on each item and its impact on the main inferences from the studies and the review. In other words, the use of the total scores or the classification of the methodological quality of the included studies will not be applied.

The meta-analyses will be performed in R program (http://cran-r-project.org) using the robumeta, metaphor and dplyr packages. We will synthesize the data using random effects meta-analysis for results that are sufficiently homogeneous in terms of statistical, clinical, and methodological characteristics[28]. If not, then a narrative synthesis for each outcome will be conducted. If the data allow it, our narrative syntheses or meta-analyses will be conducted, with all studies weighted equally and structured by health outcome, study design, and combination of movement behavior (ie. sleep and sedentary behavior). Anticipating a high heterogeneity in study designs, protocols of measurement and combination of the movement behaviors, as well as statistical procedures, meta-regression analyses will be conducted to verify each potential moderator, when possible.

In the presentation of data, the results will be first organized in alphabetical order by the main authors; if the first author is repeated, we will organize the articles in chronological order by the year of publication. All forest plots will also be grouped by the type of study. In the case of modification of the protocol in the completed publication of the results of this systematic review, the authors will clarify and justify all modifications in a specific section. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework will be used to assess quality of evidence across studies. Quality of evidence will be rated as "very low", "low", "moderate", or "high" based on five criteria: risk of bias, inconsistency, indirectness, imprecision, and other (ie. dose-response evidence) [29]. Except for randomized controlled trials that will start at "high" rating, all studies will start will "low" quality. Subsequently, quality of evidence will be downgraded regardless of study design if studies have limitations in any of the five criteria. If no downgrading occurred, non-randomized and observational study designs presenting large or very large effect sizes and/or dose-responses could be upgraded to "moderate" or "high" quality of evidence. However, as dose-response evidence cannot be determined for cross-sectional studies, so the quality of evidence in these studies will be upgraded only if there is a gradient of higher exposure with higher/lower health indicator.

## Discussion

To the best of our knowledge, this systematic review protocol is the first that proposes to summarize the literature on the relationship between combinations of sleep, SB, and physical activity with health parameters in older adults. Although there is compelling evidence demonstrating the individual health impact of the movement behaviours (sleep, SB, LIPA, and MVPA) in older adults, whether different combinations of these behaviours could affect health in this age group remains poorly understood. This information will con-

tribute to the understanding of how these movement behaviors can be associated with health later in life.

There is a growing body of evidence reinforcing the need for an integrated view of time-use behaviours over the 24-hours cycle, rather than an individual behavior approach[2]. This paradigm now widely accepted and guidelines incorporating 24-hours recommendations have been recently released[17,19-22]. Considering that, even anticipating a lack of evidence, the results of this review may provide insights into future directions of research investigating the combined effects of sleep, SB, LIPA, and MVPA in older individuals.

## Conflict of interest

The authors declare no conflict of interest.

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## Author contribution

Germano-Soares AH and Tassitano RM participated in the conceptualization and original draft preparation. Germano-Soares AH, Tassitano RM and Barbosa Filho VC participated in the methodology. Germano-Soares AH, Tassitano RM, Barbosa Filho VC, Lins-Filho OL, Silva CRM, Silva JF, Hardman CM, Barros MVG participated in the review and editing. All authors have read and agreed to the published version of the manuscript.

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# Supplementary materials

## Supplementary Material 1 - PRISMA-P Checklist

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 | Page |
|---|---|---|---|
| Administrative Information | | | |
| Title: | | | |
| Identification | 1a | | 1 |
| Update | 1b | If the protocol is for an update of a previous systematic review, identify as such | NA |
| Registration | 2 | If registered, provide the name of the registry (such as PROSPERO) and registration number | 3, 6 |
| Authors: | | | |
| Contact | 3a | Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author | 1 |
| Contributions | 3b | Describe contributions of protocol authors and identify the guarantor of the review | 2 |
| 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 | NA |
| Support: | | | |
| Sources | 5a | Indicate sources of financial or other support for the review | 2 |
| Sponsor | 5b | Provide name for the review funder and/or sponsor | 2 |
| Role of sponsor or funder | 5c | Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol | 2 |
| Introduction | | | |
| Rationale | 6 | Describe the rationale for the review in the context of what is already known | 4 |
| Objectives | 7 | Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO) | 5 |
| 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 | 6-8 |
| 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 | 8-9 |
| 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 | Supplementary file 2 |
| Study records: | | | |
| Data management | 11a | Describe the mechanism(s) that will be used to manage records and data throughout the review | 9-11 |
| 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) | 10 |
| 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 | 9-11 |
| 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 | 9-11 |
| Outcomes and prioritization | 13 | List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale | 9 |
| 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 | 11-13 |
| Data synthesis | 15a | Describe criteria under which study data will be quantitatively synthesised | 12-13 |
| | 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 $\tau$) | 12 |
| | 15c | Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression) | 12 |
| | 15d | If quantitative synthesis is not appropriate, describe the type of summary planned | 12 |
| Meta-bias(es) | 16 | Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies) | 12 |

To be conbinued 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 | Page |
|---|---|---|---|
| Confidence in cumulative evidence | 17 | Describe how the strength of the body of evidence will be assessed (such as GRADE) | 12-13 |

NA = not applicable
* 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. From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349(jan02 1):g7647.

## Supplementary Material 2 – Search strategy (PROSPERO register: CRD 42018086713)

**Draft search strategy for each electronic databases queried: PubMed (including MEDLINE), Scopus, Lilacs, PsyINFO, Web of Science, and CENTRAL (Cochrane Central Register of Controlled Trials).**
For each search listed below, no start date and language were applied, and databases were searched from their inception or date of the earliest available publication.

| | Database | PubMed (including MEDLINE) | Number of articles reached |
|---|---|---|---|
| | Descriptors/keywords | | |
| **1#** | ((((((acceleromet*[Title/Abstract]) OR (pedometer [Title/Abstract])) OR ("active lifestyle"[Title/Abstract])) OR (physical activity [MeSH Terms])) OR ("physical inactivity"[Title/Abstract])) OR (walking [Title/Abstract])) OR cycling [Title/Abstract]) OR "movement behav*" [Title/Abstract]) | | |
| 2# | ((((((((((sedentar*[Title/Abstract]) OR computer [Title/Abstract]) OR "television viewing"[Title/Abstract]) OR "tv viewing"[Title/Abstract]) OR sitting [Title/Abstract]) OR "seated time"[Title/Abstract]) OR sedentary lifestyle [MeSH Terms]) OR "screen time"[Title/Abstract]) OR "video game"[Title/Abstract]) OR driving [Title/Abstract]) | | |
| **3#** | (((((("sleep duration"[Title/Abstract]) OR acceleromet*[Title/Abstract]) OR actigra*[Title/Abstract]) OR polysomnogr*[Title/Abstract]) | | |
| **4#** | ((((((("older individual*"[Title/Abstract]) OR ("older people"[Title/Abstract])) OR (elder*[Title/Abstract])) OR (elderly [MeSH Terms])) OR ("older adult*"[Title/Abstract])) OR (senior*[Title/Abstract])) NOT ((((((adolesc*[Title/Abstract]) OR (infant*[Title/Abstract])) OR (child*[Title/Abstract])) OR (youth [MeSH Terms])) OR (adolescent [MeSH Terms])) OR (children [MeSH Terms])) | | |
| **5#** | ((((((((((systematic [Filter]) OR (meta-analysis [Publication Type])) OR ("systematic review"[Title/Abstract])) OR ("systematic literature review"[Title/Abstract])) OR (metanalyses [Title/Abstract])) OR ("meta-analyses" [Title/Abstract])) OR ("pooled analysis"[Title/Abstract])) OR ("pooled analyses"[Title/Abstract])) OR ("pooled data"[Title/Abstract])) OR ("meta-analysis"[Title/Abstract])) OR (metanalysis [Title/Abstract]) | | |
| **6#** | (1# **AND** 2#) **OR** (1# **AND** 3#) **OR** (2# **AND** 3#) | | |
| **7#** | #4 AND #6 | | |
| **8#** | #7 NOT #5 | | |
| 9# | Filter: humans | | |

| | Database | CENTRAL (Cochrane Central Register of Controlled Trials) | Number of articles reached |
|---|---|---|---|
| | Descriptors/keywords | | |
| 1# | "physical activit*" OR walking OR pedometer OR cycling OR "active lifestyle" or "physical inactivity" | | |
| 2# | sedentar* OR computer OR television OR "TV viewing" OR "screen time" OR videogame OR "video game" OR driving OR sitting OR "seated time" | | |
| 3# | "sleep duration" OR accelerom* OR actigra* polysomnog* | | |
| 4# | (older adult* OR "older people" OR "older individual*" elder* OR senior) NOT (infant OR child* OR adolesc* OR youth) | | |
| 5# | "systematic review" OR meta-analysis OR "systematic literature review" OR "pooled analysis" OR "pooled analyses" OR "pooled analysis" OR "pooled data" OR metanalyses OR metaanalysis | | |
| 6# | animal OR (human AND animal) | | |
| 7# | (1# **AND** 2#) **OR** (1# **AND** 3#) **OR** (2# **AND** 3#) | | |
| 8# | 4# **AND** 7# | | |
| 9# | 8# **NOT** (5# OR 6#) | | |

| | Database | Scopus | Number of articles reached |
|---|---|---|---|
| | Descriptors/keywords | | |
| 1# | TITLE-ABS-KEY (accelerometer* OR "physical activity" OR walking OR pedometer OR cycling OR "physical inactivity" OR "active lifestyle" OR "movement behav*") | | |
| 2# | TITLE-ABS-KEY (sedentar* OR computer OR television OR "TV viewing" OR "screen time" OR "video game" OR videogame OR driving OR sitting OR "seated time") | | |
| 3# | TITLE-ABS-KEY (sleep duration OR accelerom* OR actigra* polysomnog*) | | |
| 4# | TITLE-ABS-KEY ("older adult*" OR "older individual*" OR "older people" OR elder* OR senior) AND NOT (infant OR child* OR adolesc* OR youth) | | |
| 5# | TITLE-ABS-KEY (animal OR (animal AND human)) | | |
| 6# | TITLE-ABS-KEY ("systematic review" OR meta-analysis OR "systematic literature review" OR "pooled analysis" OR "pooled analyses" OR "pooled data" OR metanalyses OR metaanalysis) | | |
| 7# | (1# AND 2#) OR (1# AND 3#) OR (2# AND 3#) | | |
| 8# | 7# AND 4# | | |
| 9# | 8# NOT (5# OR 6#) | | |
| 10# | Limits: Document type (article) | | |

| | Database | **Web of Science** | Number of articles reached |
|---|---|---|---|
| | Descriptors/keywords | | |
| 1# | (TS= ("physical activity" OR walking OR pedometer OR cycling OR "physical inactivity" OR "active lifestyle")) | | |
| 2# | (TS= ("screen time" OR computer OR videogame OR sedentar* OR "sedentary lifestyle" OR driving OR "tv viewing" OR television OR "seated time" OR sitting) | | |
| 3# | (TS= ("sleep duration" OR accelerometer* OR actigra* OR polysomnogr*)) | | |
| 4# | **TS=** (older adult* OR older people OR elder* OR senior) NOT (infant* OR child* OR adolescent* OR youth) | | |
| 5# | TS= "systematic review" OR meta-analysis OR "systematic literature review" OR "pooled analysis" OR "pooled analyses" OR "pooled data" OR metanalyses OR metaanalysis | | |
| 6# | TS= (animal OR (animal AND human)) | | |
| 7# | (1# **AND** 2#) **OR** (1# **AND** 3#) **OR** (2# **AND** 3#) | | |
| 8# | 4# **AND** 7# | | |
| **9#** | 7# **NOT** 5# | | |
| **10#** | 9# NOT 6# | | |

| | Database | **LILACS** | Number of articles reached |
|---|---|---|---|
| | Descriptors/keywords | | |
| 1# | Title, abstract, subject = (physical activity or sleep or sedentary behavior or screen time) | | |
| 2# | Title, abstract, subject = (older adults or elderly) | | |
| 3# | 1# AND 2# | | |
| 4# | Filter; document type (article) | | |

| | Database | PsycINFO | Number of articles reached |
|---|---|---|---|
| | Descriptors/keywords | | |
| 1# | Title: accelerometer OR Title: pedometer OR MeSH: physical activity OR Title: cycling OR Title: walking OR Title: "physical activity" OR Title: "active lifestyle*" OR Title: "physical inactivity" | | |
| 2# | Title: sedentar* OR Title: computer OR Title: "television viewing" OR Title: "tv viewing" OR Title: sitting OR Title: "seated time" OR MeSH: sedentary lifestyle OR Title: "screen time" OR Title: "video game" OR Title: videogame OR Title: driving | | |
| 3# | Title: "sleep duration" OR Title: accelerom* OR Title: actigra* OR Title: polysomnogr* | | |
| 4# | Title: "older individual*" OR Title: "older people" OR MeSH: elderly OR Title: elder* OR Title: "older adult*" OR Title: senior* NOT MeSH: infant NOT MeSH: child NOT MeSH: adolescent | | |
| 5# | (1# **AND** 2#) **OR** (1# **AND** 3#) **OR** (2# **AND** 3#) | | |
| 6# | 4# **AND** 5# | | |

## Supplementary material 3 - Template for data extraction

| Category | Variables | Content | Category of answers |
|---|---|---|---|
| Study profile | Reference | First author and date of publication | ex: Germano-Soares, AH et al 2019 |
| | Study_type | Study design | 1- Randomized clinical trial<br>2- Cohort study<br>3- Cross-sectional study<br>4- Longitudinal study |
| Population | Country_study | Country of study | Open |
| | n_study | Number of participants | In numbers |
| | sex | % of men | In percentage |
| | Chronic_diseases | Prevalence of each chronic disease | In percentage |
| | Range_age_sample | The age range of the study participants | Categories of age range, mean and median age will be accepted |
| | Treatment | Medication in use for each chronic disease | Percentage of individuals taking anti-hypertensive, anti-diabetic, antiplatelet, lipid lowering, etc. |
| Intervention/Exposures | Physical_activity | PA measure | Open |
| | Sedentary_behavior | SB measure | Open |
| | Sleep | Sleep measure | Open |
| | Behaviors_combination | Which combinations were used | 1- PA + SB<br>2- PA + sleep<br>3- SB + sleep<br>4- PA + SB + sleep |
| | Intervention_combination | Which combination of behaviors were focus of the intervention | 1- PA + SB<br>2- PA + sleep<br>3- SB + sleep<br>4- PA + SB + sleep |
| Statistical procedure | Statistical_analysis | Which statistical procedure was employed to analyze the combinations | Open<br>Ex: linear regression models, cluster analysis, compositional data analysis |
| Outcomes | Health_outcomes | Which outcomes were evaluated | Open |
| Main results | Descriptive_synthesis | Descriptive synthesis of the results for each outcome | Open |
| | Outcome_measurement | Whether the method used for assessment of the outcome was validated | 1 – Yes<br>2 - No |
| | Statistical_significance | Whether the analysis reached statistical significance, $p \leq 0.05$ | 1 – Not significant<br>2 – Statistically significant |
| | Effect size | Effect size for the associations and the interventions effect | 1 – Negligible<br>2 – Small<br>3 – Medium<br>4 – High |
| | Subgroup_analysis | Description of the subgroup analysis, if performed | Open |

PA = physical activity; SB = sedentary behaviour

## Supplementary Material 4 - Risk of bias (methodological quality) assessment

| Quality Assessment Tool for Cohort and Cross-Sectional Studies | Yes | No | Other (CD, NR, NA) |
|---|---|---|---|
| Was the research question or objective in this study clearly stated? | | | |
| Was the study population clearly specified and defined? | | | |
| Was the participation rate of eligible persons at least 50%? | | | |
| Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants? | | | |
| Was a sample size justification, power description, or variance and effect estimates provided? | | | |
| For the analyses in this study, were the exposures of interest measured prior to the outcome(s) being measured? | | | |
| For the analyses in this study, were the exposures of interest measured prior to the outcome(s) being measured? | | | |
| For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as a continuous variable)? | | | |
| Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? | | | |
| Were the exposures assessed more than once over time? | | | |
| Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? | | | |
| Were the outcome assessors blinded to the exposure status of participants? | | | |
| Was loss to follow-up after baseline 20% or less? | | | |
| Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposures and outcomes? | | | |

CD = cannot determine; NR = not reported; NA = not applicable

| Quality Assessment Tool for Controlled Intervention Studies | Yes | No | Other (CD, NR, NA) |
|---|---|---|---|
| Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT? | | | |
| Was the method of randomization adequate (i.e., use of randomly generated assignment)? | | | |
| Was the treatment allocation concealed (so that assignments could not be predicted)? | | | |
| Were study participants and providers blinded to treatment group assignment? | | | |
| Were the people assessing the outcomes blinded to the participants' group assignments? | | | |
| Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, risk factors, co-morbid conditions)? | | | |
| Was the overall dropout rate from the study at its endpoint 20% or less than the number originally allocated to treatment? | | | |
| Was the differential drop-out rate between groups at the study's endpoint 15% or less? | | | |
| Was there high adherence to the intervention protocols for each treatment group? | | | |
| Were other interventions avoided or similar in the groups (e.g., similar background treatments)? | | | |
| Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants? | | | |
| Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power? | | | |
| Were outcomes reported or subgroups analyzed prespecified (i.e., identified before analyses were conducted)? | | | |
| Were all randomized participants analyzed in the group to which they were originally assigned (i.e., did they use an intention-to-treat analysis)? | | | |

**Note**: CD = cannot determine; NR = not reported; NA = not applicable