

## Protective Effect on Mortality of Active Commuting to Work: A Systematic Review and Meta-analysis

Frédéric Dutheil, Séverine Pélangeon, Martine Duclos, Philippe Vorilhon, Martial Mermillod, Julien Steven Baker, Bruno Pereira, Valentin Navel

### ▶ To cite this version:

Frédéric Dutheil, Séverine Pélangeon, Martine Duclos, Philippe Vorilhon, Martial Mermillod, et al.. Protective Effect on Mortality of Active Commuting to Work: A Systematic Review and Meta-analysis. Sports Medicine, 2020, 50, pp.2237-2250. 10.1007/s40279-020-01354-0. hal-02983302

## HAL Id: hal-02983302 https://hal.science/hal-02983302v1

Submitted on 26 Nov 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

## Protective effect on mortality of active commuting to work:

## A systematic review and meta-analysis

Frédéric Dutheil<sup>1,2\*</sup>, Séverine Pélangeon<sup>3</sup>, Martine Duclos<sup>4</sup>, Philippe Vorilhon<sup>5</sup>, Martial

Mermillod<sup>6,7</sup>, Julien S Baker<sup>8</sup>, Bruno Pereira<sup>9</sup>, Valentin Navel<sup>10</sup>

<sup>1</sup> Université Clermont Auvergne, CNRS, LaPSCo, Physiological and Psychosocial Stress, CHU Clermont-Ferrand, University Hospital of Clermont-Ferrand, Preventive and Occupational Medicine, Witty Fit, F-63000 Clermont-Ferrand, France

<sup>2</sup> Australian Catholic University, Faculty of Health, School of Exercise Science, Melbourne, Australia2 General Medicine, AMUAC, F–63000 Clermont-Ferrand, France

<sup>3</sup> General Medicine, AMUAC, F–63000 Clermont-Ferrand, France

<sup>4</sup> Université Clermont Auvergne, INRA, UMR 1019, CRNH-Auvergne, University Hospital of Clermont–Ferrand, CHU Clermont–Ferrand, Sport Medicine and Functional Explorations, F– 63000 Clermont–Ferrand, France

<sup>5</sup> Université Clermont Auvergne, Faculty of Medicine, General Medicine, PEPRADE EA4681,

F-63000 Clermont-Ferrand, France

<sup>6</sup> Univ. Grenoble Alpes, CNRS, LPNC, Grenoble, France

<sup>7</sup> Institut Universitaire de France, Paris, France

<sup>8</sup> Centre for Health and Exercise Science Research, Department of Sport, Physical Education and Health, Hong Kong Baptist University, Kowloon Tong, Hong Kong

<sup>9</sup> University Hospital of Clermont Ferrand, CHU Clermont–Ferrand, Clinical Research and Innovation Direction, F–63000 Clermont-Ferrand, France

<sup>10</sup> Université Clermont Auvergne, CNRS, INSERM, GReD, Translational Approach to Epithelial Injury and Repair, CHU Clermont-Ferrand, University Hospital of Clermont-Ferrand, Ophthalmology, F-63000 Clermont-Ferrand, France

\*Corresponding author: Frédéric Dutheil, Faculty of Health, School of Exercise Science,

Australian Catholic University, Melbourne, Australia, Tel: +33 6 88 22 48 48, Fax: +33 4 73

27 46 49, frederic.dutheil@acu.edu.au

Running title: Active commuting and mortality

### Abstract

*Background*: Sedentary behaviour is a major risk of mortality. However, data are contradictory regarding the effects of active commuting on mortality.

*Objectives*: To perform a systematic review and meta-analysis on the effects of active commuting on mortality.

*Method:* The PubMed, Cochrane Library, Embase, and Science Direct databases were searched for studies reporting mortality data and active commuting (walking or cycling) to or from work. We computed meta-analysis stratified on type of mortality, type of commuting, and level of commuting, each with two models (based on fully adjusted estimates of risks, and on crude or less adjusted estimates).

Results: 17 studies representing 829 098 workers were included. Using the fully adjusted estimates of risks, active commuting decreased all-cause mortality by 9% (95% confidence intervals 3 to 9%), and cardiovascular mortality by 15% (3 to 27%) (p<0.001). For stratification by type of commuting, walking decreased significantly all-cause mortality by 13% (1 to 25%), and cycling decreased significantly both all-cause mortality by 21% (11 to 31%) and cardiovascular mortality by 33% (10 to 55%) (p<0.001). For stratification by level of active commuting, only high level decreased all-cause mortality by 11% (3 to 19%) and both intermediate and high level decreased cardiovascular mortality. Low level did not decrease any type of mortality. Cancer mortality did not decrease with walking nor cycling, and the level of active commuting had no effect. Low level walking did not decrease any type of mortality, intermediate level of walking decreased only all-cause mortality by 15% (2 to 28%), and high level of walking decreased both all-cause and cardiovascular mortality by 19% (8 to 30%) and by 31% (9 to 52%), respectively. Both low, intermediate and high intensities of cycling decreased all-cause mortality. Meta-analysis based on crude or less fully adjusted estimates retrieved similar results, with also significant reductions of cancer mortality with cycling (23%, 5 to 42%), high level of active commuting (14%, 4 to 24%), and high level of active commuting by walking (16%, 0 to 32%).

*Conclusion*: Active commuting decreases mainly all-cause and cardiovascular mortality, with a dose-response relationship, especially for walking. Preventive strategies should focus on the benefits of active commuting.

## **Key Points**

Physical inactivity is one of the leading causes of death in developed countries increasing notably all-cause, cardiovascular and cancer mortality. There were contradictory findings regarding the effect of sedentary transport to or from work on mortality.

We demonstrated that active commuting decreases both all-cause and cardiovascular mortality, whatever the type of active commuting to or from work, with a dose response relationship.

Preventive strategies should focus on the benefits of active commuting to or from work in the general population.

### **1** Introduction

Sedentary lifestyle is a major public health problem <sup>1-3</sup>. Physical inactivity is one of the leading causes of death in developed countries <sup>4</sup> increasing notably all-cause, cardiovascular and cancer mortality <sup>5.6</sup>. In particular, sedentary transport modes have been described as a factor increasing mortality <sup>7-12</sup>, despite conflicting results <sup>13,14</sup> and relatively few studies focusing solely on workplace displacement <sup>14-16</sup>. Nearly half of the population is working worldwide, i.e. more than 3 billion workers <sup>17</sup>. For available data in some developed countries, less than 10% of workers go to work using active commuting like walking or cycling <sup>14</sup>, whereas 50% of workers live within 8 km of their workplace <sup>18,19</sup>. Demonstrating benefits of active commuting on mortality can be of major importance to promote effective preventive strategies based on changing behavior when going to work <sup>20-23</sup>. Moreover, the benefits of leisure-time physical activity on mortality has been largely demonstrated <sup>2,13,24</sup>, without clear comparisons between walking and cycling. There is also a clear dose-response relationship between level of leisure-time physical activity and mortality reduction <sup>25-29</sup>. These relationships remain to be determined for active commuting to or from work, particularly in light of limitations observed in a previous meta-analyses (see section 4.2) <sup>15</sup>.

Therefore, we aimed to conduct a systematic review and meta-analysis on the effect of active commuting to or from work on mortality, stratified by type of mortality (all-cause, cardiovascular, cancer), type of active commuting (walking or cycling) and level (low, moderate and high). Moreover, articles quantifying risks report very frequently different models of calculation of the same risk (depending on the method of calculation or adjustment models such as crude or adjusted hazard ratio). Thus, we used two models for each meta-analysis: a model using the most adjusted risks listed in included articles, and a model using only crude or less adjusted risks.

### 2 Methods

### 2.1 Literature search

We reviewed all studies reporting a risk of mortality depending on the type of commuting to go to work. The PubMed, Cochrane Library, Science Direct and Embase databases were searched on April 30<sup>th</sup> 2020, using the following keywords: "commuting" or "commute" and "mortality" (details of search strategy is presented in Electronic Supplementary Material Appendix S1). The search was not limited to specific years and no language restrictions were applied. To be included, articles needed to describe our primary outcome variables i.e. mortality data in relation with active commuting. In addition, reference lists from all publications meeting the inclusion criteria, and from reviews retrieved with our keywords, were manually searched to identify any further studies that were not found using the electronic search. The search strategy is presented in Fig 1. Two authors (SP and FD) independently conducted all literature searches, collated and reviewed the abstracts and based on the selection criteria, decided the suitability of the articles for inclusion. A third author (BP) was asked to review the articles where consensus on suitability was debated. All authors then reviewed the eligible articles. We followed the guidelines outlined by PRISMA (Electronic Supplementary Material Appendix S2).

### 2.2 Data collection

The data collected included first author's name, publication year, study design, aims, outcomes of included articles, sample size, number of deaths, mean age, percentage of males, sex, type of mortality (all-cause, cardiovascular, cancer), type of active commuting (walking or cycling), level (low, moderate, high), risks data, type of risk (depending on method of calculation or adjustment model such as crude or adjusted odd ratio), methods of evaluation of active commuting within included studies (such as self-reported questionnaires or interviews), methods of evaluation of mortality within included studies (such as details on death registry), and putative adjustment / explaining factors (such as geographical zone, body mass index (BMI), smoking, or leisure physical activity).

### 2.3 Quality of assessment

The Newcastle-Ottawa Scale (NOS) was used to check the quality of included articles <sup>30</sup>. Two authors (SP and VN) evaluated the methodological quality of each included study using 8 items with a maximum score of 9 stars as points. The following 8 items were assessed in all cohort studies: 4 items on selection bias (representativeness of the exposed and non-exposed cohort, ascertainment of expose), 1 item divided in 2 sub-items on comparability bias (design and analysis) and 3 items on outcome bias (assessment of outcome, length and adequacy of follow-up). Similar items were used to evaluate case control studies. Each item was assigned a judgment of "Yes", "No", "Unclear", or "Not applicable". One point was given for each item within the selection and exposure categories, and a maximum of two points was given for the comparability item involving the control of the most important factor and any specific control for others important factors. Disagreements were addressed by obtaining a consensus with a third author (FD).

### 2.4 Statistical considerations

Statistical analysis was conducted using Stata software (v15, StataCorp, College Station, US). Baseline characteristics were summarized for each study sample and reported as means  $\pm$  standard deviations and number (%) for continuous and categorical variables respectively. Heterogeneity of the study results was evaluated by examining forest plots, confidence intervals (CI) and using formal tests for homogeneity based on the I-squared (I<sup>2</sup>) statistic. I<sup>2</sup> is easily interpretable and the most common metric to measure the magnitude of between-study heterogeneity. I<sup>2</sup> values range between 0% and 100% and are typically considered low for <25%, modest for 25–50%, and high for >50% <sup>31</sup>. For example, a significant heterogeneity may be due to the variability between the characteristics of the studies such as those of workers (age, sex, etc), type of mortality, type of commuting, or level of commuting. Random effects meta-analyses (DerSimonian and Laird approach) were conducted when data could be pooled <sup>32</sup>. P values less than 0.05 were considered statistically significant.

We conducted meta-analysis on the effects of active commuting to or from work on mortality. We stratified these meta-analyses on the type of mortality (all-cause, cardiovascular, and cancer), the type of active commuting (cycling, and walking), and the level of active commuting (low, intermediate, and high). Moreover, we pay a particular attention to avoid the inclusion of the same cohort several times in the same analysis, to avoid that one cohort weights more than other cohorts. Therefore, for each meta-analysis, we computed two models (a model using the most adjusted risks listed in included articles, and a model using only crude or less adjusted risks). Similarly, for articles reported both hazard ratio for walking and hazard ratio for cycling, using the same control group of non-active commuters, we arbitrary chose to present data for cycling only, and to compute sensitivity analyses with walking only, in order to verify the absence of difference for stratification by type of mortality and by level of active commuting. Hazard Ratios were centered at one if the mortality of workers with active commuting did not differ from the mortality of workers without active commuting. Hazard Ratio >1 denoted an increased risk of mortality, and Hazard Ratio <1 reflected a decreased risk of mortality with active commuting to or from work. For rigor, funnel plots of these meta-analyses were used to search for potential publication bias. Visual inspection of funnel plot asymmetry was performed to address for possible small-study effect and Egger's test was used to assess publication bias <sup>33</sup>. A value of p < 0.05 was considered statistically significant. In case of a significant

publication bias, Duval and Tweedie's trim and fill method was used to allow for the estimation of an adjusted effect size <sup>34</sup>. In order to verify the strength of the results, further meta-analyses were then conducted excluding studies that were not evenly distributed around the base of the funnel <sup>35</sup>. Similarly, when some workers may overlap between two studies, we also performed sensitivity analyses using only one cohort. Where possible (sufficient sample size), metaregressions were proposed to study the relationship between active commuting and mortality and clinically relevant parameters such as the workers age (continuous data), and sex, the type of mortality, the type, and level of active commuting to or from work (categorical data). Results were expressed as regression coefficients and 95%CI.

### **3 Results**

An initial search produced 96,124 articles (Fig 1). Removal of duplicates and use of the selection criteria reduced the number of articles reporting mortality and data to 17 articles<sup>7-14,16,22,36-42</sup>. All articles were written in English. All studies reported that ethical approval had been obtained.

### 3.1 Quality of articles

The assessment of the quality of the 17 included studies was performed using the Newcastle Ottawa quality scale, varying from 55.6 <sup>38</sup> to 100% <sup>11</sup>, with a mean score of 75.2±10.1. There was a low risk of bias for all data except for the assessment of exposure and outcomes (mostly self-reported) (Fig 2). To further elucidate risk of bias, we provide details in section 3.2 relating to the representativeness of the population for all studies except three that included only patients with type 2 diabetes <sup>36</sup>, hypertensive individuals <sup>37</sup>, or elderly workers <sup>12</sup>, together with study characteristics.

### **3.2 Population**

Description of the sociodemographic of the workers included in our meta-analyses were lacking for several of the included articles because these data were part of a larger body of data on physical activity and active commuting in general, and most often only the sociodemographic of the entire cohort were described.

**Sample size**: Population sizes ranged from 2 538<sup>13</sup> to 263 450<sup>14</sup>. In total, at least 829 098 workers were included in this meta-analysis. Only one study did not provide a detailed number of workers <sup>11</sup>. The prospective cohorts were representative of the general population, with or without diseases, except one study on workers with type 2 diabetes <sup>36</sup>, one on workers with hypertension <sup>37</sup>, and one on elderly workers <sup>12</sup>.

**Sex**: Similarly, sex was described sometimes only in workers, sometimes only for the general population, and sometimes for none of the study participants. Within the ten studies reporting sex of workers <sup>7,8,13,14,16,37,40</sup>, a total of 342 891 men were included compared to 339 350 women workers. Two studies described sex only for the general population <sup>11,13</sup> and five studies <sup>9,12,36,38,39</sup> did not specify the proportion of men or women both in workers or in the general population. All studies included both men and women except one study which included only women <sup>11</sup> and one only men <sup>16</sup>.

**Age**: All studies gave information on age: eleven studies for workers <sup>9,10,12,14,16,22,36,37,40-42</sup>, and six only for the general population <sup>7,8,11,13,38,39</sup>. Mean age ranged from 41 <sup>40</sup> to 74 years <sup>12</sup>, and from 43 <sup>8</sup> to 62 years <sup>39</sup>, respectively. Among those studies, age by sex was reported in two studies for workers <sup>37,40</sup>, and in three studies for the general population <sup>8,11,13</sup>.

**BMI:** Similarly, fourteen studies reported BMI: nine studies reported BMI for the working population  $^{10,12,14,16,22,36,37,40,42}$  – ranging from 21.9  $^{16}$  to 29.6 kg/m<sup>2</sup>  $^{36}$ , and five studies reported BMI only for the general population  $^{7,8,11,13,38}$  – ranging from 24.0  $^{11}$  to 28.0 kg/m<sup>2</sup>  $^{38}$ . Three studies did not report BMI  $^{9,39,41}$ .

**Smoking status:** Thirteen studies reported smoking status: nine among workers  $^{10,12,14,16,22,36,40-}$  $^{42}$  – with a percentage ranging from 9%  $^{10}$  to 41%  $^{16}$ , and four for the general population  $^{7,8,11,13}$  – ranging from 2%  $^{11}$  to 68%  $^{7}$ . Four studies did not report smoking status  $^{9,37-39}$ .

### 3.3 Aims and outcomes of included articles

In our meta-analyses, we included only mortality data in relationship with active commuting (walking, cycling) to or from work. However, the aim of the majority of the included studies was to examine the relationship between mortality and domain-specific physical activity (i.e. leisure time physical activity <sup>7-9,12,13,36,37,40</sup>, activity at work <sup>7,9,13,40</sup>, occupational physical activity <sup>8,12,36,37,39</sup>, exercise or sports <sup>7,9-11,40</sup>, active commuting in general <sup>10-13,22,38,39</sup>; data on mortality and transportation to and from work were also reported <sup>7-14,16,36-40</sup>. Only three studies focused on the mode of commuting to or from work <sup>14,16,41</sup>. One study aimed to examine the individual, combined and isolated effects of movement-based behavior <sup>38</sup>, and one study aimed to determine whether bicycle commuting was associated with a risk of injury <sup>42</sup>.

### 3.4 Study designs

All the 17 studies included had a prospective cohort design, describing hazard ratios for allcause, cardiovascular and cancer mortality depending on the level of active commuting used. Seven studies were single-site  $^{7,9,10,12,16,39,40}$  and ten were multi-site  $^{8,11,13,14,22,36-38,41,42}$ . The majority of studies were conducted in Europe  $^{7-10,13,14,16,22,36,37,39-42}$ , followed by one in United-Sates  $^{38}$ , one in Japan  $^{12}$  and one in China  $^{11}$ . The mean follow up ranged from 5  $^{38}$  to 25 years  $^{16}$ . Eight studies had a follow up <10 years  $^{10-12,14,22,38,41,42}$ , and nine studies had a follow-up greater than 10 years  $^{7-9,13,16,36,37,39,40}$ .

### 3.5 Evaluation of Active commuting within included studies

Active commuting was reported for both walking and cycling in thirteen studies <sup>8-11,13,14,16,22,36-38,40,42</sup> (among which 4 studies reported separately walking and cycling <sup>10,11,14,42</sup>), only cycling in three studies <sup>7,39,41</sup>, and only walking in one study <sup>12</sup>. All studies collected the type of commuting using self-reported questionnaires, except for one study that used interviews <sup>11</sup>. The questionnaires used in the studies were validated from the MONICA study (Monitoring of Trends and Determinants of Cardiovascular Disease) <sup>43</sup> in seven studies <sup>7-9,13,36,37,40</sup>; the EPIC Physical Activity Questionnaire (EPAQ2) <sup>44</sup> in two studies <sup>10,39</sup>; the Saltin and Grimby questionnaire <sup>45</sup> in one study <sup>9</sup>; the international physical activity questionnaire short form <sup>46</sup> in one study <sup>14</sup>, and a questionnaire specifically designed for other studies <sup>12,16,22,38,41,42</sup>. The level of active commuting was described in most studies by groups of intensity <sup>13,22</sup>, groups of duration in min/day <sup>8,9,16,36,37</sup> or in min/week <sup>10,39</sup>, groups of both intensity and duration (METhour/week) <sup>11,41,42</sup>, or groups of frequency in days/week <sup>12</sup>.

### **3.6 Evaluation of Type of mortality within included studies**

The majority of the studies described the three types of mortality <sup>9,11-14,16,22,39,40</sup>. Three studies described only all-cause and cardiovascular mortality <sup>8,10,36</sup>, one described only data for cardiovascular mortality <sup>37</sup>, and two studies described only data for all-cause mortality.<sup>41,42</sup>.

### 3.7 Evaluation of Mortality within included studies

All studies retrieved mortality from the death registry obtained from health authorities, mostly from nationwide databases: the nationwide death register of Finland <sup>8</sup>, National Health Service Central Registry of the UK <sup>16</sup>, National Patient Registry of Denmark <sup>9,41</sup>, UK Office for National Statistics (ONS) <sup>10,39</sup>, National Health Service (NHS) of England, Wales and Scotland <sup>14,22,42</sup>, statistics Finland <sup>36,37</sup>, Social Security Administration and Medicare / Medicaid of USA <sup>38</sup>, National Vital Statistics Database from the Ministry of Health, Labour and Welfare of Japan <sup>12</sup>,

Swiss National Cohort (SNC) <sup>40</sup>. Local health authorities databases were used in one study <sup>13</sup>, and the unprecise – "vital statistics and cancer registry" – in one study <sup>11</sup>. All the databases used the International Classification of Diseases (ICD) for reporting causes of mortality: the 8<sup>th</sup> revision <sup>16</sup>, the 9<sup>th</sup> revision <sup>11,13</sup>, the 10e revision <sup>12,14,22,42</sup>, the 8 and 9<sup>th</sup> revision <sup>9</sup>, the 9<sup>th</sup> and 10<sup>th</sup> revision <sup>39</sup>, or the 8, 9, and 10<sup>th</sup> revisions <sup>8,36,37,40</sup>. Even if not mentioned within the articles, the three other studies also used the ICD for type of mortality - data from UK Office for National Statistics (ONS), data from health services of the USA, and data from The National Patient Register and National Diabetes Registry of Denmark <sup>10,38,41</sup>. One study did not give how mortality and cause of mortality was retrieved <sup>7</sup>.

### 3.8 Meta-analysis on the effect of active commuting on mortality

**Meta-analysis stratified by type of mortality**: Taking into account only the most adjusted hazard ratio data per study, active commuting decreased significantly both all-cause (HR=0.91, 95% CI 0.85 to 0.97) and cardiovascular (0.85, 95% CI 0.73 to 0.97) mortality, without significant effects for cancer mortality (0.92, 95% CI 0.81 to 1.03) (Fig 3 and Fig 4).

Meta-analysis stratified by type of commuting: Using the same methodology, active commuting by walking decreased significantly all-cause mortality by 13% (HR = 0.87, 95% CI 0.75 to 0.99), and active commuting by cycling decreased both all-cause mortality by 21% (0.79, 95% CI 0.69 to 0.89) and cardiovascular mortality by 33% (0.67, 95% CI 0.45 to 0.90), (Fig 3, and Electronic Supplementary Material Figs S1-S3). Active commuting by walking decreased non significantly cardiovascular and cancer mortality, and active commuting by cycling decreased non significantly cancer mortality.

Meta-analysis stratified by level of active commuting: Only high level decreased significantly all-cause mortality by 11% (HR = 0.89, 95% CI 0.81 to 0.97) and both intermediate and high level decreased cardiovascular mortality by 18 and 11% (0.82, 95% CI

0.66 to 0.98; and 0.89, 95% CI 0.78 to 1.00; respectively). Low level did not decrease any type of mortality (Fig 3 and Fig 5, and Electronic Supplementary Material Figs S4-S6).

**Meta-analysis stratified by level of walking**: Low level walking did not decrease any type of mortality, intermediate level of walking decreased only all-cause mortality by 15% (HR = 0.85, 95% CI 0.72 to 0.98), and high level of walking decreased both all-cause and cardiovascular mortality by 19% (0.81, 95% CI 0.70 to 0.92) and by 31% (0.69, 95% CI 0.48 to 0.91), respectively (Fig 3, and Electronic Supplementary Material Figs S7-S9).

**Meta-analysis stratified by level of cycling**: Both low, intermediate, and high intensities of cycling decreased all-cause mortality (0.86, 95% CI 0.75 to 0.97; 0.72, 95% CI 0.60 to 0.84; and 0.84, 95% CI 0.74 to 0.95; respectively) (Fig 3, and Electronic Supplementary Material Fig S10-S12). Despite some significant results on the effects of active commuting using cycling, the number of studies included precluded robust conclusions for cardiovascular and cancer mortality.

### 3.9 Publication bias and sensitivity analyses

Funnel plots (metafunnels) of meta-analyses (section 3.8) used for analysing potential publication bias are presented in Electronic Supplementary Material Fig S13. Meta-analyses reperformed after the exclusion of studies that were not evenly distributed around the base of the funnel showed similar results (data not shown). Egger's test was non-significant. To further address sensitivity analyses, we also reperformed aforementioned meta-analyses using crude or less adjusted hazard ratio (meta-analysis stratified by type of mortality: Electronic Supplementary Material Fig S14 and S15; meta-analysis stratified by type of commuting: Electronic Supplementary Material Fig S14, and S16-S18; meta-analysis stratified by level of active commuting: Electronic Supplementary Material Fig S14, and S16-S18; meta-analysis stratified by level of stratified by level of walking: Electronic Supplementary Material Fig S14, and S12-S24; meta-analysis

analysis stratified by level of cycling: Electronic Supplementary Material Fig S14, and S25-S27; metafunnels of meta-analyses on crude or less adjusted hazard ratio: Electronic Supplementary Material Fig S28). In addition to all previous significant results using fully adjusted measures of risks, meta-analysis based on crude or less fully adjusted estimates retrieved similar results, with also a significant reduction of cancer mortality with cycling (HR = 0.77, 95% CI 0.56 to 0.95), high level of active commuting (0.86, 0.76 to 0.96), and high level of active commuting by walking (0.84, 0.68 to 1.00). Furthermore, sensitivity analyses using only walking data for studies reporting both hazard ratio for walking and hazard ratio for cycling, using the same control group of non-active commuters, showed similar results (data not shown). Lastly, excluding alternatively one of the two studies <sup>14,42</sup> that may have some degree of overlapping between their population showed similar results (data not shown).

### **3.10 Metaregressions**

There were no effects of age or sex on the reduction of mortality from active commuting. Metaregressions also failed to demonstrate best outcomes depending on type of mortality (all-cause, cardiovascular, or cancer mortality) or level of active commuting (low, intermediate, high) – although we report greater effect sizes for high levels of walking compared to low or intermediate levels. Lack of data precluded further meta-regressions such as comparisons depending on geographical zone (country), body mass index, smoking, or leisure physical activity.

### **4** Discussion

The main findings were that active commuting to or from work decrease mainly all-cause and cardiovascular mortality, with a dose-response relationship, especially for walking.

### 4.1 The benefits of active commuting on mortality

Sedentary lifestyle is a major public health problem<sup>3</sup>. Sedentary behavior in general increases the risk of sleep disturbance <sup>47</sup> and poor mental health <sup>48</sup>, cardiovascular and metabolic diseases <sup>5,6,49</sup>, incidence of colon, breast, and endometrial cancer <sup>50</sup>, and mortality (all-cause, cardiovascular, cancer) <sup>3,6,51,52</sup>. To promote health benefits, national and international campaigns encourage a decrease in overall sedentary behavior by incorporating more physical activity in daily life, especially during commuting <sup>4</sup>. In 1995, the CDC and the American College of Sports Medicine recommended a moderate amount of physical activity (e.g. 30 minutes of brisk walking) preferably every day <sup>53</sup>. Despite existing data regarding causes of mortality due to sedentary behavior <sup>6</sup>, the putative effects of active commuting to and from work on mortality have been poorly studied <sup>14-16</sup>. We demonstrated strong benefits on mortality of active commuting. Considering that most workers used their car for short distance to go to work <sup>18,19</sup>, active commuting could provide a significant change with strong public health benefits <sup>20,23</sup>. Furthermore, commuting by walking or cycling has a negligible cost compared to driving or public transport. Moreover, active commuting could partly reduce the most problematic global warming issue. Considering a mean petrol consumption of 5 liters per 100 km by car, there are 120 to 130 g of  $CO_2$  emitted in the atmosphere per kilometer <sup>54</sup>. Taking into account the number of workers using a car for less than 5 km, commuting to and from work this practice can produce billions of tons of CO<sub>2</sub> emitted per year <sup>55</sup>. Therefore, in addition to health benefits, active commuting should also be promoted as an ecological target <sup>56,57</sup>.

# 4.2 All-cause and cardiovascular mortality are decreased by active commuting

The positive effect of leisure time physical activity on all-cause, cardiovascular and cancer mortality was largely demonstrated <sup>1,24,40</sup>, with conflicting results for active commuting to and from work. We demonstrated that active commuting to or from work decreased mainly all-cause and cardiovascular mortality whatever model was used, and with significant benefits for cancer mortality with crude or less adjusted meta-analyses. Our results do not agree with the previous meta-analysis which reported that active commuting only decreased all-cause mortality but not cardiovascular and cancer mortality <sup>15</sup>. An possible explanation for this may relate to that our search strategy was more rigorous i.e. we included from 22 to 45% more articles (16, 11 and 7 articles instead of 11, 9 and 5 for all-cause mortality, cardiovascular and cancer mortality, respectively). Moreover, our meta-analysis was more rigorous by computing two models: one based on fully adjusted hazard ratio, and one based on crude or less adjusted hazard ratio. All models gave significant findings for all-cause and cardiovascular mortality. Finally, we also detailed a dose response-relationship considering the level of physical activity during active commuting.

### 4.3 Level of active commuting: a dose response relationship?

A large body of evidence suggests an independent dose-response between the level of leisure time, physical activity and mortality <sup>9,58,59</sup>. We also demonstrated that the highest intensities of active commuting in general had the strongest benefits, with also a dose-response relationship for active commuting by walking. Low, intermediate and high active commuting had a reduction of 4, 5, and 11% respectively for all-cause mortality. Interestingly, for cardiovascular mortality, we showed that even a low level tended to decrease mortality, in line with the literature showing that small amounts of physical activity (minutes) can also reduce mortality

<sup>60</sup>. Consequently, going to work actively, even at a low level of activity during short periods, may have strong health benefits. Secondly, it can be noted that the decrease in cardiovascular mortality seemed to follow a U-shape, with stronger benefits for intermediate intensities. Although physical activity at work is confounded by socioeconomic status, this could be consistent with the literature showing that physical activity at work can be detrimental to life expectancy <sup>61,62</sup>. Similarly, intense physical activity at work can produce anxiety for workers, despite leisure time physical activity having benefits on mental health which also displays a dose-response relationship <sup>63</sup>. Whatever the mode of active commuting to and from work, it might follow the same logic with high intensities not necessarily having the strongest benefits – even in the model using crude or less adjusted hazard ratio.

### 4.4 Walking and cycling for active commuting

Walking at a brisk/fast pace demonstrated a stronger reduction of all-cause, cardiovascular or cancer mortality compared with walking at a slower pace <sup>64</sup>, we report for the first-time similar benefits of walking (of up to 41%, depending on level of active commuting and type of mortality) during active commuting to or from work. Being bipedal is an intrinsic characteristic within the evolution of human beings <sup>65</sup>. Furthermore, walking is free <sup>66</sup> and can provide social connections <sup>67</sup>. Moreover, walking has strong psychological and mental health benefits <sup>68</sup>. Being more relaxed when arriving at work may also have economic advantages for companies <sup>69</sup>. Reduction of mortality is also related to active commuting by cycling (up to 33%). We also demonstrated a dose-response relationship for walking, but the reduction of mortality provided by active commuting by cycling follows more of a U shape. However, we can note that when both walking and cycling were assessed in the same study <sup>14</sup>, adding cycling to walking seemed more protective. Since there is a win-win relationships for workers and companies whatever the type of active commuting (a healthy worker is a more profitable worker) <sup>70</sup>, it would be

necessary to encourage the installation of showers in the workplace to promote active commuting in general, and to permit active commuting at a high level for those who are willing cycle or walk to work. Infrastructure should also include other facilities such as changing rooms, lockers or bicycle garages. Some companies and government departments have experimented with allocation of incentives/bonuses to workers actively commuting to and from the workplace <sup>71</sup>.

### 4.5 Limitations and Strengths

Our study has some limitations. A limited number of studies were included. However, we included a large sample size of 829 098 workers, promoting the generalisability of our results. Our meta-analysis inherited the limitations of the 17 individual studies that contributed to the study and met the inclusion criteria. Therefore, the study was subjected to the bias of included studies such as the bias of exposure ascertainment and the bias of outcome assessment. Even if all individual studies included in our meta-analyses were excellent and published in very wellknown high-quality journals, description of active commuting was mainly self-reported, limiting the quality of the reported data. Conditions of fulfilment (e.g. at home or at work, in occupational medicine departments) were not always reported, which has been shown to influence results from self-reported questionnaires <sup>72</sup>. Similarly, the level of physical activity was also self-reported by questionnaires. Ideally, a rigorous analysis of intensity should have been adjusted for fitness <sup>73-75</sup>, but measuring heart rate during exercise and performing VO<sub>2</sub> max tests is deemed impossible for such large-scale cohort studies. While most studies attempted to assess dose response effects, our groups of levels of physical activity were heterogeneous because of the variability of the parameters retrieved within each included study (intensity  $^{13,22}$ , duration per day  $^{8,9,16,36,37}$  or week  $^{10,39}$ , MET-hour/week  $^{11,41,42}$ , or frequency  $^{12}$ ). However, mortality was assessed mainly with the use of National mortality databases

guaranteeing accuracy of data. All included studies had a prospective cohort design. Though there were similarities between the populations' characteristics within each included article were not identical. Although data were collected in several countries, emerging countries are not represented. Moreover, the majority of studies were conducted in Europe 7-10,13,14,16,36,37,39,40, with only one study from the United-Sates <sup>38</sup>, one from Japan <sup>12</sup> and one from China <sup>11</sup>. However, all ethnicities were included <sup>14</sup>. Generalisability of our results may also suffer from some single-site studies <sup>7,9,10,12,16,39,40</sup>, even if half of the included studies were multi-site <sup>8,11,13,14,36-38</sup>. We computed sensitivity analyses (data not shown) demonstrating similar results whatever the study design. Even if having more effect sizes within each meta-analysis than constituent studies that can be found in several articles published in high ranked journals <sup>76,77</sup>, our meta-analysis followed a rigorous methodology and only once did we include the same population in our meta-analysis. We manipulated the different data for the same outcome depending on the adjustment model by computing a meta-analysis using only fully adjusted estimates of risks, and we computed a sensitivity analyses based on crude or less adjusted risks. Therefore, the weight of studies did not require further ponderings <sup>78</sup>. Moreover, Egger's test was non-significant highlighting the absence of major publication bias. A major limitation of our meta-analysis is the lack of data on characteristics of workers because several studies were part of larger cohorts evaluating the effects of physical activity in general. However, the fact that most included studies assessed leisure physical activity to adjust risk calculation, limits bias of confusion. This was the case even if leisure physical activity was assessed on selfreported questionnaires - as well as for active commuting. Most studies adjusted risk calculations based on adequate models considering several putative confounding factors and included workers representative of the general population. However, we noted that no article adjusted risk calculation on pre-existing illness. Causality should also be discussed as a

limitation in the context of observational studies. Another limitation is the absence of significant results from meta-regressions.

## **5** Conclusion

We demonstrated that active commuting decreases mainly all-cause and cardiovascular mortality, with a dose response relationship, especially for walking. Preventive strategies should focus on the benefits of active commuting.

### Data Availability Statement

All relevant data are included within this article and its Electronic supplementary material.

#### **Compliance with Ethical Standards**

### Funding

No sources of funding were used to assist in the preparation of this article.

#### **Conflicts of interests**

Frédéric Dutheil, Séverine Pélangeon, Martine Duclos, Philippe Vorilhon, Martial Mermillod, Julien S Baker, Bruno Pereira and Valentin Navel declare that they have no conflicts of interest relevant to the content of this review.

#### **Author contributions**

Frédéric Dutheil conceived and designed the analysis. Frédéric Dutheil, Séverine Pélangeon and Valentin Navel conducted the systematic literature search. Frédéric Dutheil, Séverine Pélangeon, Martine Duclos, Philippe Vorilhon, Martial Mermillod, Julien Baker, Bruno Pereira and Valentin Navel gave final approval for the eligibility of all articles included in the analysis and provided critical revision of the article. Frédéric Dutheil and Bruno Pereira analysed the data. Séverine Pélangeon and Frédéric Dutheil wrote the first draft of the manuscript and were responsible for the integrity of the data analysis.

#### Reference

1. Ekelund U, Steene-Johannessen J, Brown WJ, et al. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A

harmonised meta-analysis of data from more than 1 million men and women. Lancet. 2016;388(10051):1302-1310.

- 2. Schnohr P, O'Keefe JH, Lange P, Jensen GB, Marott JL. Impact of persistence and non-persistence in leisure time physical activity on coronary heart disease and all-cause mortality: The Copenhagen City Heart Study. Eur J Prev Cardiol. 2017;24(15):1615-1623.
- 3. Kim Y, Wilkens LR, Park SY, Goodman MT, Monroe KR, Kolonel LN. Association between various sedentary behaviours and all-cause, cardiovascular disease and cancer mortality: the Multiethnic Cohort Study. Int J Epidemiol. 2013;42(4):1040-1056.
- 4. Waxman A. WHO global strategy on diet, physical activity and health. Food Nutr Bull. 2004;25(3):292-302.
- 5. Grontved A, Hu FB. Television viewing and risk of type 2 diabetes, cardiovascular disease, and all-cause mortality: a meta-analysis. JAMA. 2011;305(23):2448-2455.
- 6. Patterson R, McNamara E, Tainio M, et al. Sedentary behaviour and risk of all-cause, cardiovascular and cancer mortality, and incident type 2 diabetes: a systematic review and dose response meta-analysis. Eur J Epidemiol. 2018;33(9):811-829.
- 7. Andersen LB, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch Intern Med. 2000;160(11):1621-1628.
- 8. Barengo NC, Hu G, Lakka TA, Pekkarinen H, Nissinen A, Tuomilehto J. Low physical activity as a predictor for total and cardiovascular disease mortality in middle-aged men and women in Finland. Eur Heart J. 2004;25(24):2204-2211.
- 9. Bauman AE, Grunseit AC, Rangul V, Heitmann BL. Physical activity, obesity and mortality: does pattern of physical activity have stronger epidemiological associations? BMC Public Health. 2017;17(1):788.
- 10. Besson H, Ekelund U, Brage S, et al. Relationship between subdomains of total physical activity and mortality. Med Sci Sports Exerc. 2008;40(11):1909-1915.
- 11. Matthews CE, Jurj AL, Shu XO, et al. Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. Am J Epidemiol. 2007;165(12):1343-1350.
- 12. Ueshima K, Ishikawa-Takata K, Yorifuji T, et al. Physical activity and mortality risk in the Japanese elderly: a cohort study. Am J Prev Med. 2010;38(4):410-418.
- 13. Autenrieth CS, Baumert J, Baumeister SE, et al. Association between domains of physical activity and all-cause, cardiovascular and cancer mortality. Eur J Epidemiol. 2011;26(2):91-99.
- 14. Celis-Morales CA, Lyall DM, Welsh P, et al. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. BMJ. 2017;357:j1456.
- 15. Dinu M, Pagliai G, Macchi C, Sofi F. Active commuting and multiple health outcomes: a systematic review and meta-analysis. Sports Med. 2019;49(3):437-452.
- 16. Batty GD, Shipley MJ, Marmot M, Smith GD. Physical activity and cause-specific mortality in men: further evidence from the Whitehall study. Eur J Epidemiol. 2001;17(9):863-869.
- 17. Ryder G. World of Work Report 2014 Developing with jobs International Labour Organization Research Department;2014.
- 18. Baccaini B, Sémécurbe F, Thomas G. Les déplacements domicile-travail amplifiés par la périurbanisation. INSEE Premiere; 2007 2007.
- 19. Shuttleworth I, Gould M. Distance between home and work: a multilevel analysis of individual workers, neighbourhoods, and employment sites in Northern Ireland. Environment and Planning A: Economy and Space. 2010;42(5):1221-1238.

- 20. Sadik-Khan J, Solomonow S. Improving public health by making cities friendly to walking and biking: safer, more active transportation starts with the street. JAMA Intern Med. 2017;177(5):613-614.
- 21. Menai M, Charreire H, Feuillet T, et al. Walking and cycling for commuting, leisure and errands: relations with individual characteristics and leisure-time physical activity in a cross-sectional survey (the ACTI-Cites project). Int J Behav Nutr Phys Act. 2015;12:150.
- 22. Panter J, Mytton O, Sharp S, et al. Using alternatives to the car and risk of all-cause, cardiovascular and cancer mortality. Heart. 2018;104(21):1749-1755.
- 23. Flint E, Webb E, Cummins S. Change in commute mode and body-mass index: prospective, longitudinal evidence from UK Biobank. Lancet Public Health. 2016;1(2):e46-e55.
- 24. Oja P, Kelly P, Pedisic Z, et al. Associations of specific types of sports and exercise with all-cause and cardiovascular-disease mortality: a cohort study of 80 306 British adults. Br J Sports Med. 2017;51(10):812-817.
- 25. Wen CP, Wai JP, Tsai MK, Chen CH. Minimal amount of exercise to prolong life: to walk, to run, or just mix it up? J Am Coll Cardiol. 2014;64(5):482-484.
- 26. Wen CP, Wai JP, Tsai MK, et al. Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. Lancet. 2011;378(9798):1244-1253.
- 27. Lee IM, Hsieh CC, Paffenbarger RS, Jr. Exercise intensity and longevity in men. The Harvard Alumni Health Study. JAMA. 1995;273(15):1179-1184.
- 28. Moore SC, Patel AV, Matthews CE, et al. Leisure time physical activity of moderate to vigorous intensity and mortality: a large pooled cohort analysis. PLoS medicine. 2012;9(11):e1001335.
- 29. Sabia S, Dugravot A, Kivimaki M, Brunner E, Shipley MJ, Singh-Manoux A. Effect of intensity and type of physical activity on mortality: results from the Whitehall II cohort study. Am J Public Health. 2012;102(4):698-704.
- 30. Wells GA, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2017; <u>http://www.ohri.ca/programs/clinical\_epidemiology/oxford.asp</u>. Accessed March 19, 2019.
- 31. Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med. 2002;21(11):1539-1558.
- 32. DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials. 1986;7(3):177-188.
- 33. Sterne JA, Egger M, Smith GD. Systematic reviews in health care: Investigating and dealing with publication and other biases in meta-analysis. BMJ. 2001;323(7304):101-105.
- 34. Duval S, Tweedie R. Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. Biometrics. 2000;56(2):455-463.
- 35. Russo MW. How to review a meta-analysis. Gastroenterology & hepatology. 2007;3(8):637-642.
- 36. Hu G, Eriksson J, Barengo NC, et al. Occupational, commuting, and leisure-time physical activity in relation to total and cardiovascular mortality among Finnish subjects with type 2 diabetes. Circulation. 2004;110(6):666-673.
- 37. Hu G, Jousilahti P, Antikainen R, Tuomilehto J. Occupational, commuting, and leisure-time physical activity in relation to cardiovascular mortality among finnish subjects with hypertension. Am J Hypertens. 2007;20(12):1242-1250.

- 38. Loprinzi PD, Davis RE. Effects of individual, combined, and isolated physical activity behaviors on all-cause mortality and CVD-specific mortality: Prospective cohort study among U.S. adults. Physiol Behav. 2015;151:355-359.
- 39. Sahlqvist S, Goodman A, Simmons RK, et al. The association of cycling with allcause, cardiovascular and cancer mortality: findings from the population-based EPIC-Norfolk cohort. BMJ Open. 2013;3(11):e003797.
- 40. Wanner M, Tarnutzer S, Martin BW, et al. Impact of different domains of physical activity on cause-specific mortality: a longitudinal study. Prev Med. 2014;62:89-95.
- 41. Østergaard L, Jensen MK, Overvad K, Tjønneland A, Grøntved A. Associations between changes in cycling and all-cause mortality risk. Am J Prev Med. 2018;55(5):615-623.
- 42. Welsh C, Celis-Morales CA, Ho F, et al. Association of injury related hospital admissions with commuting by bicycle in the UK: prospective population based study. BMJ. 2020;368:m336.
- 43. Vincent W. Théorie et pratique de l'échantillonnage: l'exemple de l'enquête MONICA. Sozial- und Präventivmedizin. 1987;32(2):52-62.
- 44. Wareham NJ, Jakes RW, Rennie KL, et al. Validity and repeatability of a simple index derived from the short physical activity questionnaire used in the European Prospective Investigation into Cancer and Nutrition (EPIC) study. Public Health Nutr. 2003;6(4):407-413.
- 45. Saltin B, Grimby G. Physiological analysis of middle-aged and old former athletes. Comparison with still active athletes of the same ages. Circulation. 1968;38(6):1104-1115.
- 46. Guo W, Bradbury KE, Reeves GK, Key TJ. Physical activity in relation to body size and composition in women in UK Biobank. Ann Epidemiol. 2015;25(6):406-413 e406.
- 47. Yang Y, Shin JC, Li D, An R. Sedentary behavior and sleep problems: a systematic review and meta-analysis. Int J Behav Med. 2017;24(4):481-492.
- 48. Edwards MK, Loprinzi PD. Effects of a sedentary behavior-inducing randomized controlled intervention on depression and mood profile in active young adults. Mayo Clin Proc. 2016;91(8):984-998.
- 49. Lemes IR, Sui X, Fernandes RA, et al. Association of sedentary behavior and metabolic syndrome. Public Health. 2019;167:96-102.
- 50. Jochem C, Wallmann-Sperlich B, Leitzmann MF. The influence of sedentary behavior on cancer risk: epidemiologic evidence and potential molecular mechanisms. Curr Nutr Rep. 2019;8(3):167-174.
- 51. Evenson KR, Wen F, Herring AH. Associations of accelerometry-assessed and selfreported physical activity and sedentary behavior with all-cause and cardiovascular mortality among US adults. Am J Epidemiol. 2016;184(9):621-632.
- 52. Seguin R, Buchner DM, Liu J, et al. Sedentary behavior and mortality in older women: the Women's Health Initiative. Am J Prev Med. 2014;46(2):122-135.
- 53. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA. 1995;273(5):402-407.
- 54. Fontaras G, Zacharof N-G, Ciuffo B. Fuel consumption and CO2 emissions from passenger cars in Europe Laboratory versus real-world emissions. Progress in Energy and Combustion Science. 2017;60:97-131.
- 55. Kakouei A, Vatani A, Idris AK. An estimation of traffic related CO2 emissions from motor vehicles in the capital city of, Iran. Iranian J Environ Health Sci Eng. 2012;9(1):13.

- 56. Johansson C, Lovenheim B, Schantz P, et al. Impacts on air pollution and health by changing commuting from car to bicycle. Sci Total Environ. 2017;584-585:55-63.
- 57. Mueller N, Rojas-Rueda D, Cole-Hunter T, et al. Health impact assessment of active transportation: A systematic review. Prev Med. 2015;76:103-114.
- 58. Alzahrani H, Mackey M, Stamatakis E, Zadro JR, Shirley D. The association between physical activity and low back pain: a systematic review and meta-analysis of observational studies. Sci Rep. 2019;9(1):8244.
- 59. Kelly P, Kahlmeier S, Gotschi T, et al. Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship. Int J Behav Nutr Phys Act. 2014;11:132.
- 60. Wen CP, Wai JPM, Tsai MK, et al. Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. The Lancet. 2011;378(9798):1244-1253.
- 61. Holtermann A, Marott JL, Gyntelberg F, et al. Self-reported occupational physical activity and cardiorespiratory fitness: Importance for cardiovascular disease and all-cause mortality. Scand J Work Environ Health. 2016;42(4):291-298.
- 62. Harari G, Green MS, Zelber-Sagi S. Combined association of occupational and leisure-time physical activity with all-cause and coronary heart disease mortality among a cohort of men followed-up for 22 years. Occup Environ Med. 2015;72(9):617-624.
- 63. Harvey SB, Hotopf M, Overland S, Mykletun A. Physical activity and common mental disorders. Br J Psychiatry. 2010;197(5):357-364.
- 64. Stamatakis E, Williamson C, Kelly P, et al. Infographic. Self-rated walking pace and all-cause, cardiovascular disease and cancer mortality: individual participant pooled analysis of 50 225 walkers from 11 population British cohorts. Br J Sports Med. 2019;53(21):1381-1382.
- 65. Bramble DM, Lieberman DE. Endurance running and the evolution of Homo. Nature. 2004;432(7015):345-352.
- 66. Audrey S, Fisher H, Cooper A, et al. Evaluation of an intervention to promote walking during the commute to work: a cluster randomised controlled trial. BMC Public Health. 2019;19(1):427.
- 67. Berke EM, Choudhury T, Ali S, Rabbi M. Objective measurement of sociability and activity: mobile sensing in the community. Ann Fam Med. 2011;9(4):344-350.
- 68. Kelly P, Williamson C, Niven AG, Hunter R, Mutrie N, Richards J. Walking on sunshine: scoping review of the evidence for walking and mental health. Br J Sports Med. 2018;52(12):800-806.
- 69. Bize R, Johnson JA, Plotnikoff RC. Physical activity level and health-related quality of life in the general adult population: a systematic review. Prev Med. 2007;45(6):401-415.
- 70. Dutheil F, Duclos M, Naughton G, et al. WittyFit-Live your work differently: study protocol for a workplace-delivered health promotion. JMIR Res Protoc. 2017;6(4):e58.
- 71. Dorairaj P, Shuchi A, Thomas A, Mbanya J, Nugent R. Disease Control Priorities, Third Edition. Vol 5: World Bank Publications; 2017.
- 72. Short ME, Goetzel RZ, Pei X, et al. How accurate are self-reports? Analysis of self-reported health care utilization and absence when compared with administrative data. J Occup Environ Med. 2009;51(7):786-796.
- 73. Boudet G, Walther G, Courteix D, et al. Paradoxical dissociation between heart rate and heart rate variability following different modalities of exercise in individuals with

metabolic syndrome: The RESOLVE study. European journal of preventive cardiology. 2017;24(3):281-296.

- 74. Dutheil F, Lac G, Lesourd B, et al. Different modalities of exercise to reduce visceral fat mass and cardiovascular risk in metabolic syndrome: the RESOLVE randomized trial. Int J Cardiol. 2013;168(4):3634-3642.
- 75. Dutheil F, Marhar F, Boudet G, et al. Maximal tachycardia and high cardiac strain during night shifts of emergency physicians. Int Arch Occup Environ Health. 2017;90(6):467-480.
- Aldridge RW, Nellums LB, Bartlett S, et al. Global patterns of mortality in international migrants: a systematic review and meta-analysis. Lancet. 2018;392(10164):2553-2566.
- 77. Fellmeth G, Rose-Clarke K, Zhao C, et al. Health impacts of parental migration on left-behind children and adolescents: a systematic review and meta-analysis. Lancet. 2018;392(10164):2567-2582.
- 78. Higgins J. Cochrane Handbook for Systematic Review of Interventions. 2011.

## **Figures Legends**

Fig 1. Flow Diagram according with PRISMA Guidelines

**Fig 2.** Methodological quality of included articles using Newcastle – Ottawa Quality Assessment Scale

For each item, criteria fulfilled: No: 0, Yes: 1 (\*: 2 subitems), Unclear: ?, Not applicable: NA

**Fig 3.** Summary of meta-analysis showing the effects of active commuting by type of mortality (all cause, cardiovascular and cancer mortality), by type of active commuting (walking, cycling or both), by level of active commuting, by level of active commuting by walking, and by level of active commuting by cycling, based on data from adjusted hazard ratio

**Fig 4.** Meta-analysis showing the effects of active commuting by type of mortality (all cause, cardiovascular and cancer mortality), based on data from adjusted hazard ratio

**Fig 5.** Meta-analysis showing the effects of active commuting by level of active commuting, based on data from adjusted hazard ratio



Fig. 2 Methodological quality of included articles using Newcastle— Ottawa Quality Assessment Scale. For each item, criteria fulfilled: No: 0, Yes: 1 (\*: 2 subitems), Unclear: ?, Not applicable: NA



**Fig. 3** Summary of meta-analysis showing the effects of active commuting by type of mortality (all cause, cardiovascular and cancer mortality), by type of active commuting (walking, cycling or both), by level of active commuting, by level of active commuting by walking, and by level of active commuting by cycling, based on data from adjusted hazard ratio

	n studies	I-squared		Effect size
	(subgroups)	(%)		(95% CI)
By cause of mortality				
All cause mortality	16 (17)	75.6		0.91 (0.85 to 0.97)
Cardiovascular mortality	11 (12)	63.9	— <u> </u>	0.85 (0.73 to 0.97)
Cancer mortality	7 (7)	44.6		0.92 (0.81 to 1.03)
By type of active commuting				
Ali cause mortality				
Walking	5 (5)	62.3		0.87 (0.75 to 0.99)
Cycling	7 (7)	38.9	-~-	0.79 (0.69 to 0.89)
Cardiovascular mortality			-	
Walking	3 (3)	58.3		0.74 (0.47 to 1.01)
Cycling	3 (3)	8.8		0.67 (0.45 to 0.9)
Cancer mortality				
Walking	3 (3)	17.7		0.93 (0.75 to 1.1)
Cycling	3 (3)	48.6		0.79 (0.57 to 1.01)
By level of active commuting	1			
All cause mortality	44 (40)		2	
Low	11 (12)	64.6		0.96 (0.88 to 1.05)
Intermediate	10 (10)	74.0		0.95 (0.88 to 1.02)
High Condiaves avian mantality	10 (11)	68.2		0.89 (0.81 to 0.97)
Cardiovascular mortality	0 (40)	20.0		0.04 (0.04 h 4.04)
LOW	9 (10)	29.9		0.91 (0.81 to 1.01)
Intermediate	7 (7)	62.4		0.62 (0.66 to 0.96)
Cancor mortality	7 (6)	52.6		0.69 (0.76 to 1.00)
	6 (6)	25.7		1.04.(0.99 + 1.10)
Intermediate	6 (6) 5 (5)	0.00		1.04 (0.00 (0.1.19) 0.08 (0.01 to 1.05)
High	3 (3)	0.00		0.90 (0.91 to 1.03)
By level of walking	4 (4)	0.00		0.00 (0.00 to 1.01)
Ali cause mortality				
Low	4 (4)	49 1		0.92 (0.80 to 1.05)
Intermediate	4 (4)	70.5		0.85 (0.72 to 0.98)
High	4 (4)	34.2		0.81 (0.70 to 0.92)
Cardiovascular mortality			-	,
Low	3 (3)	20.3		0.86 (0.62 to 1.09)
Intermediate	3 (3)	55.6		0.75 (0.50 to 1.01)
High	3 (3)	14.1		0.69 (0.48 to 0.91)
Cancer mortality				, ,
Low	3 (3)	22.2		1.09 (0.88 to 1.29)
Intermediate	3 (3)	0.00	<u> </u>	0.94 (0.81 to 1.06)
High	3 (3)	0.00		0.89 (0.72 to 1.06)
By level of cycling				
Ali cause mortality				
Low	4 (4)	15.5	<b>——</b> –	0.86 (0.75 to 0.97)
Intermediate	3 (3)	16.6		0.72 (0.60 to 0.84)
High	5 (5)	39.5	_~_	0.84 (0.74 to 0.95)
Cardiovascular mortality				
Low	2 (2)	0.00		0.80 (0.53 to 1.08)
Intermediate	1 (1)	(4)).		0.48 (0.15 to 0.81)
High	2 (2)	17.0		0.83 (0.65 to 1.01)
Cancer mortality	e (e)			
Low	2 (2)	0.00		0.90 (0.69 to 1.10)
Intermediate	1 (1)	CE 1		0.60 (0.35 to 0.85)
пign	2(2)	v <b>5</b> .4	~	0.80 (0.44 to 1.15)
			D.2 0.4 0.6 D.8 1 1.2	

Study ID	ES (95% CI)	% Weight
All causes of mortality		
Andersen 2000 [7], men & women	0.72 (0.57, 0.91)	5.63
Autenrieth 2011 [13], men & women	◆> 1.16 (1.00, 1.35)	5.48
Barengo 2004 [8], men	<b>→</b> 1.01 (0.92, 1.11)	8.15
Barengo 2004 [8], women	0.89 (0.78, 1.02)	7.27
Batty 2002 [16], men	+ 1.02 (1.00, 1.10)	9.55
Bauman 2017 [9], men & women	$\rightarrow$ 1.09 (0.89, 1.32)	4.43
Besson 2008 [10], men & women	→ 1.02 (0.77, 1.35)	3.03
Celis-Morales 2017 [14], men & women	0.59 (0.42, 0.83)	4.67
Hu 2004 [44], men & women	0.95 (0.81, 1.12)	6.09
l oprinzi 2015 [46] men & women	→ 0.88 (0.60, 1.31)	2.24
Matthews 2007 [11] women		4 80
Ostergaard 2018 men & women		5.34
Panter 2018 men & women		7 44
Sahlavist 2013 [47] men & women		4 93
Lleshima 2010 [12] men & women		5.03
Wanner 2014 [49] man & woman		0.09
Wallier 2014 [40], men & women		5.90
Subtotal (Leguerad = $75.6\%$ n = 0.000)		100 00
	0.91 (0.05, 0.97)	100.00
Cardiovascular mortality		
Autenrieth 2011 [13], men & women	→ 1.23 (0.98, 1.55)	7.97
Barengo 2004 [8], men	→ → 1.08 (0.95, 1.23)	11.99
Barengo 2004 [8], women	• 0.78 (0.62, 0.97)	11.00
Batty 2002 [16], men	• 0.91 (0.70, 1.10)	10.28
Bauman 2017 [9], men & women	→ 0.98 (0.72, 1.32)	7.61
Celis-Morales 2017 [14], men & women	• 0.48 (0.25, 0.92)	6.82
Hu 2004 [44], men & women	→ 0.97 (0.79, 1.20)	10.13
Loprinzi 2015 [46], men & women	• 0.60 (0.31, 1.16)	5.17
Matthews 2007 [11], women	• 0.75 (0.41, 1.37)	4.40
Panter 2018, men & women	0.70 (0.51, 0.95)	9.70
Sahlqvist 2013 [47], men & women	→ 0.83 (0.56, 1.24)	6.71
Ueshima 2010 [12], men & women	• 0.59 (0.37, 0.92)	8.22
Subtotal (I-squared = 63.9%, p = 0.001)	0.85 (0.73, 0.97)	100.00
Cancer mortality		
Autenrieth 2011 [13] men & women	<b>1 19 (0 91 1 56)</b>	8.56
Batty 2002 [16] men		27 76
Celis-Morales 2017 [14] men & women		12 44
Matthews 2007 [11] women		10 93
Panter 2018 men & women		23 27
Sablaviet 2013 [17] man & woman		23.21
Jachima 2010 [12] man & woman		3.42 7.62
Subtotal (I-squared = $44.6\%$ p = $0.094$ )		7.03 100.00
NOTE: Weights are from random effects analysis		

Fig. 4 Meta-analysis showing the effects of active commuting by type of mortality (all cause, cardiovascular and cancer mortality), based on data from adjusted hazard ratio. ES effect size

D	ES (95% CI)	% Weigl
Low		
Autenrieth 2011 [13], men & women	→ 1.08 (0.85, 1.37)	5.96
Barengo 2004 [8], men	◆ 1.01 (0.92, 1.11)	12.21
Barengo 2004 [8], women	0.89 (0.78, 1.02)	11.14
Batty 2002 [16], men	→ 1.06 (1.00, 1.20)	12.00
Bauman 2017 [9], men & women	→ 1.44 (1.17, 1.78)	4.88
Besson 2008 [10], men & women	→ 1.02 (0.77, 1.35)	5.21
Celis-Morales 2017 [14], men & women	→→ 1.17 (0.89, 1.54)	4.47
Hu 2004 [44], men & women	0.95 (0.81, 1.12)	9.62
Matthews 2007 [11], women	• 0.79 (0.61, 1.01)	7.85
Ostergaard 2018 , men & women	• 0.78 (0.63, 0.96)	9.21
Sahlqvist 2013 [47], men & women	0.96 (0.78, 1.17)	8.04
Jeshima 2010 [12], men & women	0.77 (0.63, 0.95)	9.41
Subtotal (I-squared = 64.6%, p = 0.001)	0.96 (0.88, 1.05)	100.0
	-	
ntermediate		
Autenrieth 2011 [13], men & women	→ 1.16 (1.00, 1.35)	8.06
Batty 2002 [16], men	♦ 1.02 (1.00, 1.10)	16.62
Bauman 2017 [9], men & women	→ 1.09 (0.89, 1.32)	6.27
Celis-Morales 2017 [14], men & women	0.96 (0.86, 1.07)	12.5
-oprinzi 2015 [46], men & women	♦ 0.88 (0.60, 1.31)	2.93
Ostergaard 2018 , men & women	• 0.80 (0.64, 1.00)	7.81
Panter 2018 , men & women	1.00 (0.89, 1.12)	11.8
Jeshima 2010 [12], men & women	0.66 (0.52, 0.84)	8.88
Wanner 2014 [48], men & women	1.01 (0.98, 1.04)	17.69
Welsh 2020, men & women -	• 0.75 (0.59, 0.97)	7.33
Subtotal (I-squared = 74.0%, p = 0.000)	0.95 (0.88, 1.02)	100.0
ligh		
Andersen 2000 [7], men & women	0.72 (0.57, 0.91)	9.24
Autenrieth 2011 [13], men & women	• 0.95 (0.80, 1.14)	9.24
3arengo 2004 [8], men	1.07 (0.98, 1.17)	12.74
Barengo 2004 [8], women	• 0.98 (0.88, 1.09)	12.2
Besson 2008 [10], men & women	→ 1.01 (0.76, 1.36)	5.01
Celis-Morales 2017 [14], men & women	→ 0.88 (0.64, 1.21)	5.36
Hu 2004 [44], men & women	0.96 (0.80, 1.15)	9.02
Matthews 2007 [11], women	• 0.66 (0.40, 1.07)	4.29
Dstergaard 2018 , men & women	0.83 (0.67, 1.04)	8.61
Sahlqvist 2013 [47], men & women	0.91 (0.84, 0.99)	13.62
Jeshima 2010 [12], men & women	0.68 (0.55, 0.83)	10.60
Subtotal (I-squared = 68.2%, p = 0.000)	0.89 (0.81, 0.97)	100.0
NOTE: Weights are from random effects analysis		
I		
4 6	S 8 1 12	

Fig. 5 Meta-analysis showing the effects of active commuting by level of active commuting, based on data from adjusted hazard ratio. ES effect size

### **Electronic Supplementary Material**

**Electronic Supplementary Material Figure S1.** Benefits of active commuting on all-cause mortality stratified by type of commuting – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S2.** Benefits of active commuting on cardiovascular mortality stratified by type of commuting – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S3.** Benefits of active commuting on cancer mortality stratified by type of commuting – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S4.** Benefits of active commuting on all-cause mortality stratified by level of active commuting – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S5.** Benefits of active commuting on cardiovascular mortality stratified by level of active commuting – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S6.** Benefits of active commuting on cancer mortality stratified by level of active commuting – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S7.** Benefits of active commuting by walking on all-cause mortality – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S8.** Benefits of active commuting by walking on cardiovascular mortality – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S9.** Benefits of active commuting by walking on cancer mortality – Adjusted Hazard Ratio

Electronic Supplementary Material Figure S10. Benefits of active commuting by cycling on

all-cause mortality – Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S11.** Benefits of active commuting by cycling on cardiovascular mortality – Adjusted Hazard Ratio

Electronic Supplementary Material Figure S12. Benefits of active commuting by cycling on

cancer mortality - Adjusted Hazard Ratio

**Electronic Supplementary Material Figure S13.** Funnel plot (meta-funnel), based on data from Adjusted Hazard Ratio

Each dot represents a single study, with its corresponding effect size (x axis) and its associated standard error of the effect estimate (y-axis). Large high-powered studies are placed towards the top, and smaller low-powered studies towards the bottom. The plot should ideally resemble a pyramid or inverted funnel, with scatter due to sampling variation. Studies outside funnel plot are likely to present bias <sup>33</sup>.

**Electronic Supplementary Material Figure S14.** Summary of meta-analysis showing the effects of active commuting by type of mortality (all cause, cardiovascular and cancer mortality), by type of active commuting (walking, cycling or both), by level of active commuting by walking, and by level of active commuting by cycling, based on data from crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S15.** Meta-analysis showing the effects of active commuting by type of mortality (all cause, cardiovascular and cancer mortality), based on data from crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S16.** Benefits of active commuting on all-cause mortality stratified by type of commuting – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S17.** Benefits of active commuting on cardiovascular mortality stratified by type of commuting – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S18.** Benefits of active commuting on cancer mortality stratified by type of commuting – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S19.** Benefits of active commuting on all-cause mortality stratified by level of active commuting – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S20.** Benefits of active commuting on cardiovascular mortality stratified by level of active commuting – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S21.** Benefits of active commuting on cancer mortality stratified by level of active commuting – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S22.** Benefits of active commuting by walking on all-cause mortality – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S23.** Benefits of active commuting by walking on cardiovascular mortality – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S24.** Benefits of active commuting by walking on cancer mortality – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S25.** Benefits of active commuting by cycling on all-cause mortality – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S26.** Benefits of active commuting by cycling on cardiovascular mortality – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S27.** Benefits of active commuting by cycling on cancer mortality – Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Figure S28.** Funnel plot (meta-funnel) from Crude or less adjusted Hazard Ratio

**Electronic Supplementary Material Appendix S1.** Details for the search strategy used within each database.

Electronic Supplementary Material Appendix S2. PRISMA Checklist.

## Benefits of active commuting on all-cause mortality

Stratified by type of active commuting - Adjusted hazard ratio



Benefits of active commuting on cardiovascular mortality

Stratified by type of active commuting - Adjusted hazard ratio



Benefits of active commuting on Cancer mortality

Stratified by type of active commuting - Adjusted hazard ratio



## Benefits of active commuting on all-cause mortality Stratified by level of active commuting - Adjusted hazard ratio

Study ID		ES (95% CI)	% Weight
Low Autenrieth 2011 [13], men & women Barengo 2004 [8], men Barengo 2004 [8], women Batty 2002 [16], men Bauman 2017 [9], men & women Besson 2008 [10], men & women Celis-Morales 2017 [14], men & women Hu 2004 [44], men & women Matthews 2007 [11], women Ostergaard 2018 , men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 64.6%, p = 0.001)		1.08 (0.85, 1.37) 1.01 (0.92, 1.11) 0.89 (0.78, 1.02) 1.06 (1.00, 1.20) 1.44 (1.17, 1.78) 1.02 (0.77, 1.35) 1.17 (0.89, 1.54) 0.95 (0.81, 1.12) 0.79 (0.61, 1.01) 0.78 (0.63, 0.96) 0.96 (0.78, 1.17) 0.77 (0.63, 0.95) 0.96 (0.88, 1.05)	5.96 12.21 11.14 12.00 4.88 5.21 4.47 9.62 7.85 9.21 8.04 9.41 100.00
Intermediate Autenrieth 2011 [13], men & women Batty 2002 [16], men Bauman 2017 [9], men & women Celis-Morales 2017 [14], men & women Loprinzi 2015 [46], men & women Ostergaard 2018, men & women Ueshima 2010 [12], men & women Wanner 2014 [48], men & women Welsh 2020, men & women Subtotal (I-squared = 74.0%, p = 0.000)		$\begin{array}{c} 1.16 \ (1.00, \ 1.35) \\ 1.02 \ (1.00, \ 1.10) \\ 1.09 \ (0.89, \ 1.32) \\ 0.96 \ (0.86, \ 1.07) \\ 0.88 \ (0.60, \ 1.31) \\ 0.80 \ (0.64, \ 1.00) \\ 1.00 \ (0.89, \ 1.12) \\ 0.66 \ (0.52, \ 0.84) \\ 1.01 \ (0.98, \ 1.04) \\ 0.75 \ (0.59, \ 0.97) \\ 0.95 \ (0.88, \ 1.02) \end{array}$	8.06 16.62 6.27 12.57 2.93 7.81 11.83 8.88 17.69 7.33 100.00
High         Andersen 2000 [7], men & women         Autenrieth 2011 [13], men & women         Barengo 2004 [8], men         Barengo 2004 [8], women         Besson 2008 [10], men & women         Celis-Morales 2017 [14], men & women         Hu 2004 [44], men & women         Matthews 2007 [11], women         Ostergaard 2018 , men & women         Ueshima 2010 [12], men & women         Subtotal (I-squared = 68.2%, p = 0.000)         NOTE: Weights are from random effects analysis		0.72 (0.57, 0.91) 0.95 (0.80, 1.14) 1.07 (0.98, 1.17) 0.98 (0.88, 1.09) 1.01 (0.76, 1.36) 0.88 (0.64, 1.21) 0.96 (0.80, 1.15) 0.66 (0.40, 1.07) 0.83 (0.67, 1.04) 0.91 (0.84, 0.99) 0.68 (0.55, 0.83) 0.89 (0.81, 0.97)	9.24 9.24 12.74 12.27 5.01 5.36 9.02 4.29 8.61 13.62 10.60 100.00
.4 .6 .8	1 1.2	2	

## **Benefits of active commuting on cardiovascular mortality** Stratified by level of active commuting - Adjusted hazard ratio

Study		%
ID	ES (95% CI)	Weight
Autoprioth 2011 [12] mon 8 women	> 0.04 (0.63, 1.30)	5.04
Baranga 2004 [8] mon	$\rightarrow$ 0.94 (0.05, 1.39) $\rightarrow$ 1.08 (0.05, 1.23)	0.94 01 / 2
Barengo 2004 [9], men	-7 1.00 (0.95, 1.25)	21.43
Barengo 2004 [o], women	0.70(0.02, 0.97)	17.42
Bauman 2017 [0], man 8 waman	1.03(0.00, 1.10)	11.3U
Bauman 2017 [9], men & women	$\rightarrow$ 1.19 (0.80, 1.03)	0.01
Cells-Morales 2017 [14], men & women	$\rightarrow$ 0.70 (0.38, 1.29)	4.30
Hu 2004 [44], men & women	$\rightarrow$ 0.97 (0.79, 1.20)	14.59
Mattnews 2007 [11], women	$\rightarrow$ 0.75 (0.41, 1.37)	3.97
Saniqvist 2013 [47], men & women	$\rightarrow$ 0.83 (0.56, 1.24)	7.13
	$\rightarrow$ 0.75 (0.59, 1.22)	8.05
Subtotal (I-squared = $29.9\%$ , p = $0.170$ )	0.91 (0.81, 1.01)	100.00
Later and Pate		
Intermediate		40.07
Autenrieth 2011 [13], men & women	→ 1.23 (0.98, 1.55)	13.67
Batty 2002 [16], men	0.91 (0.70, 1.10)	17.41
Bauman 2017 [9], men & women	$\rightarrow$ 0.98 (0.72, 1.32)	13.08
Celis-Morales 2017 [14], men & women	0.69 (0.50, 0.95)	16.26
Loprinzi 2015 [46], men & women	0.60 (0.31, 1.16)	9.01
Panter 2018, men & women	0.70 (0.51, 0.95)	16.49
Ueshima 2010 [12], men & women <	0.59 (0.37, 0.92)	14.08
Subtotal (I-squared = 62.4%, p = 0.014)	0.82 (0.66, 0.98)	100.00
Lliab		
Autoprioth 2011 [12] mon 8 women	> 1 02 (0 78 1 34)	0.04
Raterine in 2014 [8], men & wonien	- 1.02 (0.70, 1.34) - 1.05 (0.03, 1.10)	9.94
Barengo 2004 [9], men	-1.03(0.93, 1.19)	19.40
Calia Maralas 2017 [11] man 8 wama	0.97 (0.02, 1.15)	10.77 E EO
	- 0.04 (0.21, 1.03)	0.09 40.76
Hu 2004 [44], men & women	- 0.94 (0.74, 1.19)	12.70 5.00
September 2007 [11], women	0.03(0.20, 1.01)	0.9Z
	0.87 (0.74, 1.02)	10.00
Outshima 2010 [12], men & women	0.68 (0.47, 0.99)	10.88
Subtotal (I-squared = $52.8\%$ , p = $0.038$ )	0.89 (0.78, 1.00)	100.00
NOTE: Weights are from random effects analysis		
.4 .6 .8 1	1.2	

## Benefits of active commuting on Cancer mortality

Stratified by level of active commuting - Adjusted hazard ratio



on all-cause mortality - Adjusted hazard ratio



on cardiovascular mortality - Adjusted hazard ratio



on all-cause mortality - Adjusted hazard ratio



on cancer mortality - Adjusted hazard ratio



on cardiovascular mortality - Adjusted hazard ratio



on cancer mortality - Adjusted hazard ratio





	n studies	I-squared		Effect size
	(subgroups)	(%)		(95% CI)
By cause of mortality			I	
All cause mortality	16 (17)	86.3	-0-	0.87 (0.80 to 0.94)
Cardiovascular mortality	11 (12)	68.7		0.77 (0.66 to 0.89)
Cancer mortality	7 (7)	55.8		0.90 (0.79 to 1.02)
By type of active commuting	3			<b>.</b>
All cause mortality				
Walking	5 (5)	83.9		0.85 (0.67 to 1.03)
Cycling	7 (7)	21.2		0.77 (0.69 to 0.85)
Cardiovascular mortality				
Walking	3 (3)	74.1		0.69 (0.38 to 1.00)
Cycling	3 (3)	0.00		0.64 (0.44 to 0.84)
Cancer mortality				
Walking	3 (3)	27.5		0.91 (0.73 to 1.09)
Cycling	3 (3)	30.0	<u> </u>	0.77 (0.58 to 0.95)
By level of active commuting	g			
All cause mortality				
Low	11 (12)	89.2		0.93 (0.82 to 1.05)
Intermediate	10 (10)	87.1		0.93 (0.84 to 1.01)
High	10 (11)	84.9	<b>_</b>	0.81 (0.71 to 0.92)
Cardiovascular mortality				
Low	9 (10)	38.3	<b>_</b>	0.81 (0.72 to 0.90)
Intermediate	7 (7)	75.2		0.79 (0.59 to 0.98)
High	7 (8)	75.2	<u> </u>	0.75 (0.63 to 0.88)
Cancer mortality				
Low	6 (6)	44.2	<u> </u>	1.04 (0.87 to 1.21)
Intermediate	5 (5)	20.7		0.98 (0.90 to 1.06)
High	4 (4)	0.00		0.86 (0.76 to 0.96)
By level of walking				
All cause mortality				
Low	4 (4)	78.0		0.91 (0.72 to 1.09)
Intermediate	4 (4)	88.1		0.82 (0.63 to 1.01)
High	4 (4)	86.6	O	0.77 (0.54 to 1.00)
Cardiovascular mortality				
Low	3 (3)	53.4		0.80 (0.51 to 1.08)
Intermediate	3 (3)	75.2		0.71 (0.40 to 1.03)
High	3 (3)	52.5		0.59 (0.32 to 0.85)
Cancer mortality				
Low	3 (3)	33.5		1.07 (0.85 to 1.29)
Intermediate	3 (3)	12.4		0.92 (0.78 to 1.05)
High Bulayal of availing	3 (3)	0.00		0.84 (0.68 to 1.00)
By level of cycling				
All cause mortality	4 (4)	0.00		0.00 (0.74 ( 0.00)
Low	4 (4)	0.00		0.83 (0.74 to 0.93)
Intermediate	3 (3)	16.6		0.72 (0.60  to  0.84)
High Candiausa autor mantality	5 (5)	23.2	I	0.82 (0.74 to 0.91)
	0 (0)	0.00		0.74 (0.40 + 0.00)
	2 (2)	0.00		0.74 (0.48 to 0.99)
	(1)	-		0.48 (0.15 to 0.81)
riign Cancor mortality	2 (2)	0.00		0.19 (0.67 to 0.92)
	2 (2)	0.00	~	0.96 (0.67 + 4.00)
LOW	$\angle (\angle)$	0.00		0.00 (0.07 to 1.00)
	(1)	-		0.00 (0.35 (0 0.85))
ngn	2 (2)	0.10		0.10 (0.41 to 1.09)

## Benefits of active commuting stratified by type of mortality

-- Crude or less adjusted hazard ratio --

All causes of mortality Andersen 2000 [7], men & women Barengo 2004 [8], wen Barengo 2004 [8], wen Basengo 2004 [9], men & women Besson 2008 [10], men & women Loginal 2015 [46], men & women Datatives 2007 [11], wen & women Callis-Morales 2017 [14], men & women Barengo 2004 [8], wen Barengo 2004 [9], men & women Callis-Morales 2017 [14], men & women Barengo 2004 [8], women Barengo 2004 [8], wen Barengo 2004 [9], wen & women Callis-Morales 2017 [14], men & women Barengo 2004 [8], wen Barengo 2004 [9], wen Barengo 20	Study ID	ES (95% CI)	% Weight
Andersen 2000 [7], meñ & women Autenrieh 2011 [13], meñ & women Barengo 2004 [8], weme Barengo 2004 [8], weme Barengo 2004 [8], wemen Barengo 2004 [8], wemen Barengo 2004 [8], wemen Barengo 2004 [8], wemen Bauman 2017 [9], meñ & women Celis-Morales 2017 [14], meñ & women Desson 2006 [13], women Barengo 2004 [9], wemen Barengo 2004 [9], wemen Barengo 2004 [9], wemen Barengo 2004 [9], wemen Barengo 2004 [9], wemen Celis-Morales 2017 [14], meñ & women Barengo 2004 [9], wemen Barengo 2004 [9], wemen Celis-Morales 2017 [14], meñ & women Barengo 2004 [9], wemen Barengo 2004 [9], wemen Barendo 2007 [11], wemen Barendo 2007 [11], wemen Barendo 200	All causes of mortality		
Autenetiel 2011 [13], men & women Barengo 2004 [8], wene Barengo 2004 [8], wene Barengo 2004 [8], women Baty 2002 [16], men Besson 2008 [10], men & women Cells-Morales 2017 [14], wene & women Up (168, 124) [15], wene & women Catergaard 2018, men & women Uselsma 2010 [12], men & women Barengo 2004 [8], wene Wanner 2018, men & women Catergaard 2014 [74], men & women Uselsma 2010 [12], men & women Barengo 2004 [8], wene Wanner 2011 [13], men & women Barengo 2004 [8], wene Wanner 2014 [44], men & women Catergaard 2014 [74], wene & women Barengo 2004 [8], wene Wanner 2014 [46], men & women Catergaard 2014 [47], wene & women Barengo 2004 [8], wene Wanner 2014 [13], men & women Barengo 2004 [8], wene Barengo 2004 [9], wene Barengo 2	Andersen 2000 [7] men & women	0 70 (0 55 0 89)	5 70
Barengo 2004 [8], men Barengo 2004 [8], men Barengo 2004 [8], men Barengo 2004 [8], men Barengo 2004 [8], men Bauma 2017 [9], men & women Bauman 2017 [9], men & women Hu 2004 [4], men & women Loprinz 2015 [46], men & women Parlier 2018, men & women Parlier 2018, men & women Parlier 2018, men & women Barengo 2004 [8], men Subtrati (-1420, men & women Destrograved 2013, men & women Subtrati (-1420, men & women Destrograved 2013, men & women Subtrati (-1420, men & women Destrograved 2013, men & women Destrograved 2013, men & women Destrograved 2018, men & women Destrograved 2016 [9], men & women Destrograved 2016 [9], men & women Destrograved 2017 [14], men & wo	Autenrieth 2011 [13] men & women	$\rightarrow$ 1.16 (1.00, 1.35)	5.60
Daringo 2004 [6], women       0.33 (0.73, 0.67, 0.27, 0.26)         Baringo 2004 [8], women       0.33 (0.73, 0.27, 0	Barengo 2004 [8] men		743
Label 2002 (Fig), men & women       Does (10, 0.5.0)       Does (10, 0.5.0) </td <td>Barengo 2004 [8] women</td> <td>0.31 (0.03, 1.00)</td> <td>6.96</td>	Barengo 2004 [8] women	0.31 (0.03, 1.00)	6.96
Daty 2002 [10], men & women       109 (106, 1.31)       1.30       1.31       1.30       1.33       1.30       1.31       1.30       1.31       1.30       1.31       1.31       1.31       1.31       1.31       1.31       1.31       1	Batty 2002 [16], women		7.06
Data and 2017 [9], linel & women       102 (0.35, 1.32)       4.05         Desson 2006 [10], linen & women       0.59 (0.42, 0.83)       4.99         Loprinzi 2015 [46], men & women       0.59 (0.42, 0.83)       4.99         Matthews 2007 [11], women       0.88 (0.60, 1.31)       2.79         Ostergaard 2018, men & women       0.89 (0.64, 1.00)       5.09         Panier 2018, men & women       0.80 (0.64, 1.00)       5.09         Sahiqvist 2013 [47], men & women       0.86 (0.60, 1.31)       2.79         Weish 2020, men & women       0.96 (0.86, 1.06)       7.16         Subtotal (I-squared = 86.3%, p = 0.000)       0.87 (0.80, 0.94)       100.00         Cardiovascular montality       0.94 (0.72, 1.22)       8.16         Autenrieth 2011 [13], men & women       0.94 (0.83, 1.08)       1.83         Barengo 2004 [8], women       0.94 (0.72, 1.22)       8.16         Barengo 2004 [8], women       0.94 (0.72, 1.22)       8.16         Deprinzi 2015 [14], men & women       0.94 (0.83, 1.08)       1.83         Celis-Morales 2017 [14], women       0.94 (0.74), 2.93       1.23         Panier 2018, men & women       0.96 (0.64, 0.89)       9.79         Sahlyvist 2013 [47], men & women       0.96 (0.40, 0.89)       9.79         Sahlyvist 2013 [47], men & women<	Bauman 2017 [0], man 8 woman	$\rightarrow$ 1.07 (1.00, 1.10)	1.90
Desciol 2006 [10], line & women       0.2007, 12, 30, 30, 30, 30, 00, 00, 12, 10, 30, 30, 30, 00, 12, 10, 30, 10, 10, 10, 10, 10, 10, 10, 10, 10, 1	Bauman 2017 [9], men & women	$\rightarrow$ 1.09 (0.09, 1.32) $\rightarrow$ 1.02 (0.77, 1.25)	4.00 2.50
Calle-Molaries 2017 [14], linef a women Loprinz 2015 [46], men & women Other women Calle-Molaries 2017 [17], women Ostergaard 2018, men & women Ostergaard 2018, men & women Parter 2018, men & women Parter 2018, men & women Wahner 2014 [43], men & women Wahner 2014 [43], men & women Carliovascular mortality Autenrieth 2011 [13], men & women Carliovascular mortality Autenrieth 2017 [14], women Celis-Morales 2017 [14], women Carliovascular women	Celia Marelea 2017 [14] man 8 women	- 1.02 (0.77, 1.33)	3.00
In 2 004 [44], field, men & women       0.75 (0.08, 0.37)       0.58         Ostergaar 2018, men & women       0.78 (0.08, 0.37)       0.59         Ostergaar 2018, men & women       0.79 (0.61, 1.01)       5.09         Sahlqvist 2013 [47], men & women       0.86 (0.61, 1.31)       5.99         Ueshima 2010 [12], men & women       0.86 (0.61, 1.31)       5.49         Usehima 2010 [12], men & women       0.86 (0.51, 1.07)       5.49         Usehima 2010 [13], men & women       0.87 (0.59, 0.37)       5.29         Subtotal (I-squared = 86.3%, p = 0.000)       0.87 (0.80, 0.94)       100.00         .       0.87 (0.80, 0.94)       100.00         .       0.88 (0.71, 1.07)       5.49         Usehima 2017 [13], men & women       0.98 (0.75, 1.02)       8.16         Sarrop 2004 [8], women       0.98 (0.75, 1.02)       8.16         Barengo 2004 [8], women       0.98 (0.72, 1.32)       7.20         Barengo 2004 [8], women       0.98 (0.72, 1.32)       7.20         Loprinzi 2015 [46], men & women       0.48 (0.25, 0.92)       6.44         Loprinzi 2015 [46], men & women       0.66 (0.49, 0.89)       9.73         Usehima 2017 [13], men & women       0.66 (0.49, 0.89)       9.73         Subtotal (I-squared = 68.7%, p = 0.000)       0.77 (0.66, 0.89) <td></td> <td>0.09 (0.42, 0.03)</td> <td>4.99</td>		0.09 (0.42, 0.03)	4.99
Lopiniz 2015 [46], men & women         Parter 2018, men & women         Sahlqvist 2013 [47], men & women         Weish 2020, men & women         Subtotal (I-squared = 86.3%, p = 0.000)         Cardiovascular mortality         Autenrieft 2017 [1], men & women         Barengo 2004 [8], men         Barengo 2004 [8], women         Batty 2002 [16], men & women         Colsi-Lopiniz 2015 [46], men & women         Subtotal (I-squared = 86.3%, p = 0.000)         Cardiovascular mortality         Autenrieft 2020 [16], men         Barengo 2004 [8], women         Batty 2002 [16], men & women         Lopiniz 2015 [46], men & women         Subtotal (I-squared = 88.7%, p = 0.000)         Cancer mortality         Autenrieft 2017 [114], men & women         Subtotal (I-squared = 68.7%, p = 0.000)         Cancer mortality         Autenrieft 2017 [114], men & women         Subtotal (I-squared = 58.7%, p = 0.035)         NOTE: Weights are from		0.79(0.09, 0.91)	0.90
Mathews 2007 [11], work women       0.19 (0.81, 1.01)       5.09         Ostergaard 2018, men & women       0.96 (0.81, 1.01)       5.09         Panter 2018, men & women       0.96 (0.86, 1.06)       7.16         Sahlqvist 2013 [47], men & women       0.96 (0.71, 1.07)       5.49         Ueshima 2010 [12], men & women       0.96 (0.71, 1.07)       5.49         Wanner 2014 [48], men & women       0.55 (0.44, 0.70)       6.55         Wathers 2000, men & women       0.57 (0.59, 0.57)       5.29         Subtotal (I-squared = 86.3%, p = 0.000)       0.87 (0.80, 0.94)       100.00         Cardioascular mortality       1.23 (0.98, 1.55)       7.55         Barengo 2004 [8], women       0.94 (0.72, 1.32)       7.20         Bauman 2017 [9], men & women       0.94 (0.72, 1.32)       7.20         Celis-Morales 2017 [14], men & women       0.86 (0.71, 1.17)       4.18         Loprinzi 2015 [46], men & women       0.86 (0.72, 1.32)       7.20         Subtotal (I-squared = 68.7%, p = 0.000)       0.77 (0.66, 0.89)       1.19 (0.91, 1.56)       9.01         Loprinzi 2015 [46], men & women       0.46 (0.30, 0.72)       9.50       0.77 (0.66, 0.89)       10.00         Carcer mortality       0.46 (0.30, 0.72)       9.50       0.77 (0.66, 0.89)       1.19 (0.91, 1.56)       9.01 <td>Lopinzi 2015 [40], men &amp; women</td> <td>- 0.88 (0.80, 1.31)</td> <td>Z.19 E 00</td>	Lopinzi 2015 [40], men & women	- 0.88 (0.80, 1.31)	Z.19 E 00
Obsergaard 2016, men & women       0.80 (0.84, 1.00)       3.49         Panter 2018, men & women       0.60 (0.84, 1.00)       3.49         Usehima 2010 [12], men & women       0.86 (0.86, 1.06)       7.16         Usehima 2010 [12], men & women       0.85 (0.44, 0.70)       6.55         Wanner 2014 [48], men & women       0.87 (0.80, 0.94)       100.00         Cardiovascular mortality       0.87 (0.80, 0.94)       100.00         Autenrieth 2011 [13], men & women       0.94 (0.70, 1.20)       8.42         Barengo 2004 [8], women       0.94 (0.70, 1.20)       8.42         Barengo 2004 [8], women       0.94 (0.70, 1.20)       8.42         Bauma 2017 [9], men & women       0.94 (0.83, 1.08)       11.87         Dayle (14], men & women       0.94 (0.70, 1.20)       8.42         Doyle (14], men & women       0.94 (0.70, 1.20)       8.42         Doyle (14], men & women       0.96 (0.71, 1.10)       4.82         Matthews 2007 [11], women       0.75 (0.41, 1.37)       4.13         Deficit (154), men & women       0.75 (0.41, 1.37)       4.13         Othorales 2017 [14], men & women       0.66 (0.49, 0.69)       9.79         Subtotal (1-squared = 68.7%, p = 0.000)       0.77 (0.66, 0.89)       1.19 (0.91, 1.56)         Celis-Morales 2017 [14], men & women <td>Mallnews 2007 [11], women</td> <td>0.79(0.01, 1.01)</td> <td>5.09</td>	Mallnews 2007 [11], women	0.79(0.01, 1.01)	5.09
Parter 2018, men & women Ueshima 2010 [12], men & women Ueshima 2010 [12], men & women Weish 2020, men & women Subtotal (I-squared = 86.3%, p = 0.000) Cardiovascular mortality Autenrieth 2011 [13], men & women Barengo 2004 [8], women Barengo 2004 [8], women Lu 2004 [8], women Hu 2004 [8], men Hu 2004 [8], men Hu 2004 [8], men Hu 2004 [8], men Hu 2004 [8], men Barengo 2004 [8], women Celis-Morales 2017 [14], men & women Luprinzi 2015 [46], men & women Luprinzi 2015 [46], men & women Carcer mortality Autenrieth 2011 [13], men & women Celis-Morales 2017 [14], men & women Carcer mortality Autenrieth 2011 [13], men & women Carcer mortality Autenrieth 2011 [13], men & women Carcer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Cancer mortality Autenrieth 2011 [13], men & women Sahlqvist 2013 [47], men & women Sahlqvist 2010 [12], men & women Sahlqv	Ostergaard 2018, men & women	0.80 (0.64, 1.00)	5.49
Sandysiz 2013 [47], men & women Welshing 2010 [12], men & women Welsh 2020, men & women Subtotal (I-squared = 86.3%, p = 0.000) Cardiovascular mortality Autenrieth 2011 [13], men & women Barengo 2004 [8], women Bataman 2017 [9], men & women Celis-Morales 2017 [14], men & women Mathews 2007 [11], women Panter 2018 [11], men & women Subtotal (I-squared = 68.7%, p = 0.000) Carcer mortality Autenrieth 2011 [13], men & women Celis-Morales 2017 [14], men & women Celis-Morales 2017 [14], men & women Carcer mortality Autenrieth 2011 [13], men & women Celis-Morales 2017 [14], men & women Celis-Morales 2017 [14], men & women Carcer mortality Autenrieth 2011 [13], men & women Carcer mortality Autenrieth 2011 [13], men & women Carcer mortality Autenrieth 2011 [13], men & women Cancer mortality Autenrieth 2011 [13], men & women Subtotal (I-squared = 58.%, p = 0.000) Autenrieth 2011 [13], men & women Cancer mortality Autenrieth 2011 [13], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Panter 2018, men & women	0.96 (0.86, 1.06)	7.10
Useshima 2010 [12], men & women       0.55 (0.44, 0.70)       0.55         Wanner 2014 [48], men & women       0.99 (0.96, 1.02)       8.16         Weish 2020, men & women       0.75 (0.59, 0.97)       5.29         Subtotal (I-squared = 86.3%, p = 0.000)       0.87 (0.80, 0.94)       100.00         Cardiovascular mortality       1.23 (0.98, 1.55)       7.55         Barengo 2004 [8], women       0.94 (0.83, 1.06)       11.87         Batty 2002 [16], men & women       0.98 (0.72, 1.32)       7.20         Celis-Morales 2017 [14], men & women       0.66 (0.63, 0.21)       1.60         Matthews 2007 [11], women       0.60 (0.31, 1.16)       4.86         Nuterrieth 2011 [13], men & women       0.66 (0.49, 0.89)       0.73         Subtotal (I-squared = 68.7%, p = 0.000)        0.77 (0.66, 0.89)       0.73         Cacer mortality         1.19 (0.91, 1.56)       9.01         Autenrieth 2011 [13], men & women         0.82 (0.59, 1.14)       11.22         Subtotal (I-squared = 68.7%, p = 0.000)         0.94 (0.40, 0.90)       1.56       9.01         Celis-Morales 2017 [14], men & women         0.96 (0.40, 0.90)       1.22       9.00       0.77 (0.66, 0.89)       100.00	Saniqvist 2013 [47], men & women	0.86 (0.71, 1.07)	5.49
Wanner 2014 [43], men & women       0.99 (0.96, 1.02)       8.16         Subtotal (I-squared = 86.3%, p = 0.000)       0.87 (0.80, 0.94)       100.00         Cardiovascular mortality       1.23 (0.98, 1.55)       7.55         Barengo 2004 [8], men       9.94 (0.83, 1.06)       11.87         Barengo 2004 [8], women       0.94 (0.05, 0.84)       0.94 (0.05, 0.84)         Bauma 2017 [9], men & women       0.94 (0.05, 0.84)       0.98 (0.72, 1.32)         Cells-Morales 2017 [14], men & women       0.98 (0.72, 1.32)       7.20         Cells-Morales 2017 [14], men & women       0.98 (0.27, 1.32)       7.20         Matthews 2007 [11], women       0.66 (0.49, 0.89)       9.79         Subtotal (I-squared = 68.7%, p = 0.000)        0.76 (0.50, 0.27)       4.30             0.66 (0.49, 0.89)       9.79         Subtotal (I-squared = 68.7%, p = 0.000)         0.77 (0.66, 0.89)       100.00             1.19 (0.91, 1.56)       9.01         Leshina 2010 [12], men & women         0.90 (0.79, 1.03)       22.53         Sahlqvist 2013 [47], men & women         0.90 (0.79, 1.03)       22.53         Sahlqvist		0.55 (0.44, 0.70)	6.55
Weish 2020, men & women       0.75 (0.59, 0.97)       5.29         Subtotal (I-squared = 86.3%, p = 0.000)       0.87 (0.80, 0.94)       100.00         Cardiovascular mortality       123 (0.98, 1.55)       7.55         Barengo 2004 [8], men       0.94 (0.70, 1.20)       8.42         Bauman 2017 [9], men & women       0.94 (0.70, 1.20)       8.42         Deprinzi 2015 [46], men & women       0.98 (0.72, 1.32)       7.20         Loprinzi 2015 [46], men & women       0.68 (0.65, 0.92)       11.60         Loprinzi 2015 [47], men & women       0.66 (0.49, 0.89)       9.79         Sahlqvist 2013 [47], men & women       0.75 (0.68, 0.92)       11.60         Loprinzi 2015 [46], men       0.60 (0.31, 1.16)       4.86         Matthews 2007 [11], women       0.75 (0.48, 0.89)       9.79         Sahlqvist 2013 [47], men & women       0.75 (0.48, 0.89)       9.79         Sahlqvist 2013 [47], men & women       0.60 (0.49, 0.89)       9.79         Sahlqvist 2013 [47], men & women       0.82 (0.59, 1.14)       11.22         Velter and a women       0.90 (0.79, 1.32)       2.58         Sahlqvist 2013 [47], men & women       0.91 (0.68, 1.24)       10.97         Ueshima 2010 [12], men & women       0.91 (0.68, 1.24)       10.97         Ueshida 2010 [12], men & wome	Wanner 2014 [48], men & women	0.99 (0.96, 1.02)	8.16
Subtolal (I-squared = 86.3%, p = 0.000)       0.87 (0.80, 0.94)       100.00         Cardiovascular mortality       1.23 (0.98, 1.55)       7.55         Barengo 2004 [8], women       0.94 (0.83, 1.08)       11.87         Barengo 2004 [8], women       0.94 (0.70, 1.20)       8.42         Bauman 2017 [9], men & women       0.98 (0.25, 0.92)       6.44         Hu 2004 [44], men & women       0.98 (0.25, 0.22)       11.60         Loprinzi 2015 [46], men & women       0.48 (0.25, 0.92)       6.44         Hu 2004 [44], men & women       0.75 (0.41, 1.37)       4.13         Subtotal (I-squared = 68.7%, p = 0.000)       0.75 (0.41, 1.37)       4.13         Carcer mortality       0.46 (0.30, 0.72)       9.50         Subtotal (I-squared = 68.7%, p = 0.000)       0.77 (0.66, 0.89)       100.00         Calies-Morales 2017 [14], men & women       0.60 (0.40, 0.90)       12.58         Batty 2002 [16], men       0.90 (0.79, 1.02)       9.01         Batty 2002 [16], men & women       0.91 (0.68, 1.24)       10.97         Subtotal (I-squared = 55.8%, p = 0.035)       0.91 (0.68, 1.24)       10.97         NOTE: Weights are from random effects analysis       0.90 (0.79, 1.02)       100.00	Welsh 2020, men & women	0.75 (0.59, 0.97)	5.29
Cardiovascular mortality         Autenrieth 2011 [13], men & women         Barengo 2004 [8], women         Barengo 2004 [8], women         Barengo 2004 [8], women         Bauengo 2004 [8], women         Celis-Morales 2017 [14], men & women         Lopiniz 2015 [46], men & women         Hu 2004 [44], men & women         Hu 2004 [44], men & women         Hu 2004 [44], men & women         Hu 2005 [11], women         Parter 2018, men & women         Sahlqvist 2013 [47], men & women         Sahlqvist 2013 [47], men & women         Veshima 2010 [12], men & women         Sahlqvist 2013 [47], men & women         Autenrieth 2011 [13], men & women         Sahlqvist 2013 [47], men & women         Subtotal (I-squared = 68.7%, p = 0.000)         Celis-Morales 2017 [14], men & women         Matthews 2007 [11], wome         Parter 2018, men & women         Subtotal (I-squared = 55.8%, p = 0.035)         NOTE: Weights are from random effects analysis	Subtotal (I-squared = 86.3%, p = 0.000)	0.87 (0.80, 0.94)	100.00
Autenrieth 2011 [13], men & women Barengo 2004 [8], women Barengo 2004 [8], women Batry 2002 [16], men Barengo 2004 [8], women Batry 2002 [16], men Celis-Morales 2017 [14], men & women Hu 2004 [44], men & women Matthews 2007 [11], women Panter 2018, men & women Sahlqvist 2013 [47], men & women Batry 2002 [16], men Cancer mortality Autenrieth 2011 [13], men & women Batry 2002 [16], men Celis-Morales 2017 [14], men & women Batry 2002 [16], men Celis-Morales 2017 [14], men & women Batry 2002 [16], men Batry 2002 [16], men Celis-Morales 2017 [14], men & women Batry 2002 [16], men Celis-Morales 2017 [14], men & women Celis-Morales 2017 [14], men	Cardiovascular mortality		
Barengo 2004 [8], men Barengo 2004 [8], women Batry 2002 [16], men Bauman 2017 [9], men & women Celis-Morales 2017 [14], men & women Hu 2004 [44], men & women Loprinzi 2015 [46], men & women Matthews 2007 [11], women Sahlqvist 2013 [47], men & women Cels-Morales 2017 [14], men & women Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Cancer mortality Autenrieth 2011 [13], men & women Celis-Morales 2017 [14], men & women Logshing 2010 [12], men & women Celis-Morales 2017 [14], men & women Celis-Morales 2010 [12], men & women Celis-Morales 2017 [14], men & women Celis-Morales 2010 [12], men &	Autenrieth 2011 [13], men & women	→ 1.23 (0.98, 1.55)	7.55
Barengo 2004 [8], women Batry 2002 [16], men Autthews 2007 [11], women Batry 2002 [16], men & women Batry 2004 [44], men & women Cancer mortality Autthems 2007 [11], women Batry 2002 [16], men & women Batry 2002 [11], women Batry 2002 [12], men & women Batry 2002 [13], women Batry 2002 [14], men & women Batry 2002 [14], men & women Batry 2002 [14], men & women Batry 2002 [16], men Batry 2002 [16], men & women Batry 2002 [16], men	Barengo 2004 [8], men	0.94 (0.83, 1.08)	11.87
Batty 2002 [16], men Bauman 2017 [9], men & women Celis-Morales 2017 [14], men & women Luprinzi 2015 [46], men & women Danter 2018, men & women Sahlqvist 2013 [47], men & women Batty 2002 [16], men Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Cuperinzi 2015 [47], men & women Subtotal (I-squared = 68.7%, p = 0.000) Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Cuperinzi 2015 [47], men & women Batty 2002 [16], men Cuperinzi 2013 [47], men & women Batty 2002 [16], men Cuperinzi 2013 [47], men & women Sahlqvist 2013 [47], men & women Sahlqvist 2013 [47], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Barengo 2004 [8], women	0.68 (0.55, 0.84)	11.33
Bauman 2017 [9], men & women Celis-Morales 2017 [14], men & women Hu 2004 [44], men & women Lucprinzi 2015 [46], men & women Matthews 2007 [11], women Panter 2018, men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Batty 2002 [16], men	→ 0.94 (0.70, 1.20)	8.42
Celis-Morales 2017 [14], men & women       0.48 (0.25, 0.92)       6.44         Hu 2004 [44], men & women       0.60 (0.31, 1.16)       4.86         Loprinzi 2015 [46], men & women       0.66 (0.31, 1.17)       4.13         Matthews 2007 [11], women       0.60 (0.31, 1.16)       4.86         Panter 2018, men & women       0.75 (0.41, 1.37)       4.13         Ueshima 2010 [12], men & women       0.46 (0.30, 0.72)       9.50         Subtotal (I-squared = 68.7%, p = 0.000)       0.77 (0.66, 0.89)       100.00         .       .       .       0.46 (0.30, 0.72)       9.50         Subtotal (I-squared = 68.7%, p = 0.000)       .       .       .       .         .       .       .       .       .       .       .         Autenrieth 2011 [13], men & women       .       .       .       .       .       .       .       .         Matthews 2007 [14], men & women       .	Bauman 2017 [9], men & women	→ 0.98 (0.72, 1.32)	7.20
Hu 2004 [44], men & women Loprinzi 2015 [46], men & women Matthews 2007 [11], women Panter 2018, men & women Subtotal (I-squared = 68.7%, p = 0.000) Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Matthews 2007 [11], women Panter 2018, men & women Sahlqvist 2013 [47], men & women Matthews 2007 [11], men & women Matthews 2007 [12], men & women Matthews 2007 [14], men & women Matthews 2007 [13], men & women Matthews 2007 [14], men & women Matthews 2007 [14], men & women Matthews 2007 [12], men & women Matthews 2007 [13], women Matthews 2010 [12], men & women Matthews 2007 [14], men & women Matthews 2007 [14], men & women Matthews 2007 [14], men & women Matthews 2010 [12], men & women Matthews 2010 [12], men & women Matthews 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Celis-Morales 2017 [14], men & women	0.48 (0.25, 0.92)	6.44
Loprinzi 2015 [46], men & women Matthews 2007 [11], women Panter 2018, men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 68.7%, p = 0.000) Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Celis-Morales 2017 [14], men & women Panter 2018, men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Hu 2004 [44], men & women	0.78 (0.65, 0.92)	11.60
Matthews 2007 [11], women Panter 2018, men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 68.7%, p = 0.000) Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Celis-Morales 2017 [14], men & women Matthews 2007 [11], women Panter 2018, men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis 2 4 4 6 8 1 0.75 (0.41, 1.37) 4.13 0.66 (0.49, 0.89) 9.79 0.73 (0.49, 1.08) 7.31 0.46 (0.30, 0.72) 9.50 0.77 (0.66, 0.89) 100.00 1.19 (0.91, 1.56) 9.01 1.02 (0.90, 1.10) 24.29 0.60 (0.40, 0.90) 12.58 0.82 (0.59, 1.14) 11.22 0.90 (0.79, 1.03) 22.53 0.91 (0.68, 1.24) 10.97 0.82 (0.56, 1.19) 9.40 0.90 (0.79, 1.02) 100.00 NOTE: Weights are from random effects analysis	Loprinzi 2015 [46], men & women	0.60 (0.31, 1.16)	4.86
Panter 2018 , men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 68.7%, p = 0.000) Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Celis-Morales 2017 [14], men & women Matthews 2007 [11], women Panter 2018 , men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Matthews 2007 [11], women	→ 0.75 (0.41, 1.37)	4.13
Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 68.7%, p = 0.000) Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Celis-Morales 2017 [14], men & women Matthews 2007 [11], women Panter 2018, men & women Sahlqvist 2013 [47], men & women Sahlqvist 2013 [47], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Panter 2018, men & women	0.66 (0.49, 0.89)	9.79
Ueshima 2010 [12], men & women       0.46 (0.30, 0.72) 9.50         Subtotal (I-squared = 68.7%, p = 0.000)       0.77 (0.66, 0.89) 100.00         .       .         Cancer mortality       1.19 (0.91, 1.56) 9.01         Autenrieth 2011 [13], men & women       1.02 (0.90, 1.10) 24.29         Batty 2002 [16], men       0.60 (0.40, 0.90) 12.58         Matthews 2007 [11], women       0.90 (0.79, 1.03) 22.53         Panter 2018, men & women       0.91 (0.68, 1.24) 10.97         Ueshima 2010 [12], men & women       0.91 (0.68, 1.24) 10.97         Subtotal (I-squared = 55.8%, p = 0.035)       0.91 (0.68, 1.24) 10.97         NOTE: Weights are from random effects analysis       1.2	Sahlqvist 2013 [47], men & women	0.73 (0.49, 1.08)	7.31
Subtotal (I-squared = 68.7%, p = 0.000) Cancer mortality Autenrieth 2011 [13], men & women Batty 2002 [16], men Celis-Morales 2017 [14], men & women Panter 2018, men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Ueshima 2010 [12], men & women	0.46 (0.30, 0.72)	9.50
Cancer mortality         Autenrieth 2011 [13], men & women         Batty 2002 [16], men         Celis-Morales 2017 [14], men & women         Matthews 2007 [11], women         Panter 2018, men & women         Sahlqvist 2013 [47], men & women         Ueshima 2010 [12], men & women         Subtotal (I-squared = 55.8%, p = 0.035)         NOTE: Weights are from random effects analysis	Subtotal (I-squared = 68.7%, p = 0.000)	0.77 (0.66, 0.89)	100.00
Cancer mortality         Autenrieth 2011 [13], men & women         Batty 2002 [16], men         Celis-Morales 2017 [14], men & women         Matthews 2007 [11], women         Panter 2018, men & women         Sahlqvist 2013 [47], men & women         Ueshima 2010 [12], men & women         Subtotal (I-squared = 55.8%, p = 0.035)         NOTE: Weights are from random effects analysis		- (,,	
Autenrieth 2011 [13], men & women Batty 2002 [16], men Celis-Morales 2017 [14], men & women Matthews 2007 [11], women Panter 2018 , men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Cancer mortality		
Batty 2002 [16], men Celis-Morales 2017 [14], men & women Matthews 2007 [11], women Panter 2018, men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis 2 4 6 8 1 12	Autenrieth 2011 [13], men & women	→ 1.19 (0.91, 1.56)	9.01
Celis-Morales 2017 [14], men & women Matthews 2007 [11], women Panter 2018, men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis 2 4 6 8 1 12	Batty 2002 [16], men	1.02 (0.90, 1.10)	24.29
Matthews 2007 [11], women Panter 2018, men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis 2 4 6 8 1 12	Celis-Morales 2017 [14], men & women	0.60 (0.40, 0.90)	12.58
Panter 2018 , men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Matthews 2007 [11], women	0.82 (0.59, 1.14)	11.22
Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 55.8%, p = 0.035) NOTE: Weights are from random effects analysis	Panter 2018 , men & women	0.90 (0.79, 1.03)	22.53
Ueshima 2010 [12], men & women       0.82 (0.56, 1.19) 9.40         Subtotal (I-squared = 55.8%, p = 0.035)       0.90 (0.79, 1.02) 100.00         NOTE: Weights are from random effects analysis       1         .2       .4       .6       .8       1       1.2	Sahlqvist 2013 [47], men & women	→ 0.91 (0.68, 1.24)	10.97
Subtotal (I-squared = 55.8%, p = 0.035)       0.90 (0.79, 1.02) 100.00         NOTE: Weights are from random effects analysis       1         I       I       I         .2       .4       .6       .8       1       1.2	Ueshima 2010 [12], men & women	<ul> <li>0.82 (0.56, 1.19)</li> </ul>	9.40
NOTE: Weights are from random effects analysis	Subtotal (I-squared = 55.8%, p = 0.035)	0.90 (0.79, 1.02)	100.00
	NOTE: Weights are from random effects analysis		
.2 .4 .6 .8 1 1.2			
	.2 .4 .6 .8 1	1.2	

## Benefits of active commuting on all-cause mortality

Stratified by type of active commuting - Crude or less adjusted hazard ratio



Benefits of active commuting on cardiovascular mortality

Stratified by type of active commuting - Crude or less adjusted hazard ratio



## Benefits of active commuting on Cancer mortality

Stratified by type of active commuting - Crude or less adjusted hazard ratio



## Benefits of active commuting on all-cause mortality

## Stratified by level of active commuting - Crude or less adjusted hazard ratio

Study ID	ES (95% CI)	% Weight
Low Autenrieth 2011 [13], men & women Barengo 2004 [8], men Barengo 2004 [8], women Batty 2002 [16], men Bauman 2017 [9], men & women Besson 2008 [10], men & women Celis-Morales 2017 [14], men & women Hu 2004 [44], men & women Matthews 2007 [11], women Ostergaard 2018, men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 89.2%, p = 0.000)	1.08 (0.85, 1.37) 0.91 (0.83, 1.00) 0.83 (0.73, 0.95) 1.14 (1.10, 1.20) 1.44 (1.17, 1.78) 1.02 (0.77, 1.35) 1.17 (0.89, 1.54) 0.79 (0.69, 0.91) 0.79 (0.61, 1.01) 0.78 (0.63, 0.96) 0.86 (0.71, 1.07) 0.67 (0.55, 0.82) 0.93 (0.82, 1.05)	7.02 10.00 9.67 10.34 6.24 6.49 5.91 9.67 8.13 8.77 8.50 9.28 100.00
Intermediate Autenrieth 2011 [13], men & women Batty 2002 [16], men Bauman 2017 [9], men & women Celis-Morales 2017 [14], men & women Loprinzi 2015 [46], men & women Panter 2018 , men & women Ueshima 2010 [12], men & women Welsh 2020 , men & women Welsh 2020 , men & women Subtotal (I-squared = 87.1%, p = 0.000)	$\begin{array}{c} 1.16 \ (1.00, \ 1.35) \\ 1.07 \ (1.00, \ 1.10) \\ 1.09 \ (0.89, \ 1.32) \\ 0.96 \ (0.86, \ 1.07) \\ 0.88 \ (0.60, \ 1.31) \\ 0.80 \ (0.64, \ 1.00) \\ 0.96 \ (0.86, \ 1.06) \\ 0.55 \ (0.44, \ 0.70) \\ 0.99 \ (0.96, \ 1.02) \\ 0.75 \ (0.59, \ 0.97) \\ 0.93 \ (0.84, \ 1.01) \end{array}$	9.01 13.51 7.61 11.74 4.23 8.83 11.93 10.76 13.91 8.46 100.00
High Andersen 2000 [7], men & women Autenrieth 2011 [13], men & women Barengo 2004 [8], men Barengo 2004 [8], women Besson 2008 [10], men & women Celis-Morales 2017 [14], men & women Hu 2004 [44], men & women Matthews 2007 [11], women Ostergaard 2018 , men & women Sahlqvist 2013 [47], men & women Ueshima 2010 [12], men & women Subtotal (I-squared = 84.9%, p = 0.000)	0.70 (0.55, 0.89) 0.95 (0.80, 1.14) 0.98 (0.90, 1.06) 0.89 (0.80, 0.99) 1.01 (0.76, 1.36) 0.88 (0.64, 1.21) 0.71 (0.61, 0.83) 0.66 (0.40, 1.07) 0.83 (0.67, 1.04) 0.86 (0.79, 0.94) 0.51 (0.42, 0.62) 0.81 (0.71, 0.92)	9.14 9.14 11.33 11.02 5.99 6.30 10.68 5.32 8.74 11.42 10.91 100.00
NOTE: Weights are from random effects analysis		
I         I <thi< th=""> <thi< th=""> <thi< th=""> <thi< th=""></thi<></thi<></thi<></thi<>	2	

## Benefits of active commuting on Cancer mortality

## Stratified by level of active commuting - Crude or less adjusted hazard ratio



## Benefits of active commuting on cardiovascular mortality

## Stratified by level of active commuting - Crude or less adjusted hazard ratio



on all-cause mortality - Crude or less adjusted hazard ratio



on cardiovascular mortality - Crude or less adjusted hazard ratio



on cancer mortality - Crude or less adjusted hazard ratio



on all-cause mortality - Crude or less adjusted hazard ratio



on cardiovascular mortality - Crude or less adjusted hazard ratio odds ratio



on cancer mortality - Crude or less adjusted hazard ratio





## **Electronic Supplementary Material Appendix S1.**

Details for the search strategy used within each database.

### PubMed

(commuting OR commute)

### AND

mortality

NOT (animals [MH])

**NOT** (child [Title] OR childs [Title] OR children [Title] OR Offspring [Title] OR minor [Title] OR adolescent [Title] OR adolescents [Title] OR teens [Title] OR teenagers [Title] OR teenager [Title] OR adolescence [Title] OR teen [Title])

Filter Language = none Filter Dates = none

### CENTRAL

commuting:ti,ab,kw OR commute:ti,ab,kw

### AND

mortality:ti,ab,kw

### NOT

child:ti OR childs:ti OR children:ti OR Offspring:ti OR minor:ti OR adolescent:ti OR adolescents:ti OR teens:ti OR teenagers:ti OR teenager:ti OR adolescence:ti OR teen:ti

Filter Language = not available in CENTRAL Filter Dates = none

### Web of science (WOS)

TS=(commuting OR commute)

### AND

TI=(mortality)

### ΝΟΤ

TI=(child OR childs OR children OR Offspring OR minor OR adolescent OR adolescents OR teens OR teenagers OR teenager OR adolescence OR teen)

Filter Language = none Filter Dates = none Databased restricted to:

Science Citation Index Expanded (SCI-EXPANDED) Conference Proceedings Citation Index- Science (CPCI-S) Book Citation Index- Science (BKCI-S) Emerging Sources Citation Index (ESCI)

### Embase

(commuting OR commute)

### AND

mortality

### Electronic Supplementary Material Appendix S2. PRISMA Checklist.

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT	_		
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	5-6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5-6 and Fig1
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5-6 and Fig1
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5-6 and Fig1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-6 and Fig1
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5-6 and Fig1
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5-6 and Fig1
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5-6 and Fig2
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ ) for each meta-analysis.	5-8

Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	5-6 and Fig2
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	6-8
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8-12 and Fig1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8-12 and Fig + SFig
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	8-10 and Fig2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	10-14 and Fig + SFig
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	10-14 and Fig + SFig
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-10 and Fig2
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	12-14 and Fig + SFig
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	14-18
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	18-20
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	24

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: <u>www.prisma-statement.org</u>.