# Evidence Portfolio – Cardiometabolic Health and Weight Management Subcommittee, Question 3

## In adults without diabetes, what is the relationship between physical activity and type 2 diabetes?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. Does the relationship vary based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

**Sources of Evidence:** Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis

### Conclusion Statements and Grades

Strong evidence demonstrates a significant relationship between a higher volume of physical activity and lower incidence of type 2 diabetes. **PAGAC Grade: Strong.**

Strong evidence demonstrates that an inverse curvilinear dose-response relationship exists between the volume of physical activity and incidence of type 2 diabetes, with a decreasing slope at higher levels of physical activity. **PAGAC Grade: Strong.**

Moderate evidence indicates no effect modification by weight status. An inverse relationship exists between a higher volume of physical activity and lower incidence of type 2 diabetes for people who have normal weight, overweight, or obesity. **PAGAC Grade: Moderate.**

Limited evidence suggests that the relationship between a higher volume of physical activity and lower incidence of type 2 diabetes is not influenced by age, sex, or race/ethnicity. **PAGAC Grade: Limited.**

Insufficient evidence is available to determine whether the relationship between physical activity and the incidence of type 2 diabetes varies by socioeconomic status. **PAGAC Grade: Not assignable.**

Insufficient evidence is available to determine whether the relationship between physical activity and the incidence of type 2 diabetes varies by the frequency, intensity, duration, or type of physical activity, or how physical activity is measured. **PAGAC Grade: Not assignable.**

### Description of the Evidence

An initial search for systematic reviews, meta-analyses, pooled analyses, and reports identified sufficient literature to answer the research question as determined by the Cardiometabolic Health and Weight Management Subcommittee. Additional searches for original research were not needed.

## Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis

### *Overview*

A total of 12 existing reviews were included: 4 systematic reviews,[1-4] 7 meta-analyses,[5-11] and 1 pooled analysis.[12] The reviews were published between 2007 and 2016.

The systematic reviews included a range of 5 to 20 studies that examined physical activity and type 2 diabetes. Reviews covered the following timeframes: 1950 to 2008,[4] 1980 to May 2012,[3] 1990 to May 2009,[1] and 1999 to August 2008.[2]

The meta-analyses included a range of 3 to 81 studies that examined physical activity and type 2 diabetes. The meta-analyses covered an extensive timeframe: inception to March 2015,[5] inception to June 2014,[7] inception to June 2012,[10] inception to March 2006,[8] 1980 to 2016,[9] 1981 to 2014,[11] and 1989 to November 2011.[6]

The pooled analysis included 2 studies that examined physical activity and type 2 diabetes.

### *Exposures*

All included reviews examined physical activity. Four reviews assessed physical activity types such as leisure-time physical activity, active commuting, household, and occupational physical activity.[4-6, 9] One meta-analysis[7] specifically examined leisure-time physical activity and 1 meta-analysis[8] examined physical activity of moderate intensity.

### *Outcomes*

All included reviews examined risk or incidence of type 2 diabetes as an outcome.

## Populations Analyzed

The table below lists the populations analyzed in each article.

***Table 1. Populations Analyzed by All Sources of Evidence***

| | Sex | Race/ Ethnicity | Age | Weight Status | Other |
|---|---|---|---|---|---|
| Aune, 2015 | | | All ages | | |
| Cloostermans, 2015 | | | Adults 25–65 | Normal/healthy weight (BMI: 18.5–24.9), Overweight (BMI: 25–29.9), Obese (BMI: 30 and above) | |
| Fogelholm, 2010, | | | Adults ≥18 | Normal weight vs. overweight vs. obese | |
| Huai, 2016 | | | Not reported | | |
| Jeon, 2007 | Male, Female | | | | U.S. vs. Non-U.S. cohorts |
| Kyu, 2016 | | | Adults | | |
| Merlotti, 2014 | | | Not reported | | |
| Qin, 2010 | | | Not reported | | |
| Reiner, 2013 | | | Adults 18–85 | | |
| Wahid, 2016 | | | Adults 19–79 | | |
| Warburton, 2010 | | | Adults 19–65 | | |
| Xu, 2015 | Male, Female | Asian | Ages 35–49, 50–64, ≥65 | | Urban |

## Supporting Evidence

### Existing Systematic Reviews, Meta-Analyses, and Pooled Analyses

***Table 2. Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis Individual Evidence Summary Tables***

<table>
<tr><td colspan="2">Meta-Analysis<br>Citation: Aune D, Norat T, Leitzmann M, Tonstad S, Vatten LJ. Physical activity and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis. Eur J Epidemiol. 2015;30(7):529-542. doi:10.1007/s10654-015-0056-z.</td></tr>
<tr><td>Purpose: To explore associations with specific types of PA, assess a possible dose-response relationship, and address potential confounding.</td><td rowspan="4">Abstract: We investigated the association between specific types of physical activity and the risk of type 2 diabetes in a systematic review and meta-analysis of published studies. PubMed, Embase and Ovid databases were searched for prospective studies and randomized trials up to 2nd of March 2015. Summary relative risks (RRs) were calculated using a random effects model. Eighty-one studies were included. The summary RRs for high versus low activity were 0.65 (95 % CI 0.59-0.71, I(2) = 18 %, n = 14) for total physical activity, 0.74 (95 % CI 0.70-0.79, I(2) = 84 %, n = 55) for leisure-time activity, 0.61 (95 % CI 0.51-0.74, I(2) = 73 %, n = 8) for vigorous activity, 0.68 (95 % CI 0.52-0.90, I(2) = 93 %, n = 5) for moderate activity, 0.66 (95 % CI 0.47-0.94, I(2) = 47 %, n = 4) for low intensity activity, and 0.85 (95 % CI 0.79-0.91, I(2) = 0 %, n = 7) for walking. Inverse associations were also observed for increasing activity over time, resistance exercise, occupational activity and for cardiorespiratory fitness. Nonlinear relations were observed for leisure-time activity, vigorous activity, walking and resistance exercise (p nonlinearity < 0.0001 for all), with steeper reductions in type 2 diabetes risk at low activity levels than high activity levels. This meta-analysis provides strong evidence for an inverse association between physical activity and risk of type 2 diabetes, which may partly be mediated by reduced adiposity. All subtypes of physical activity appear to be beneficial. Reductions in risk are observed up to 5-7 h of leisure-time, vigorous or low intensity physical activity per week, but further reductions cannot be excluded beyond this range.</td></tr>
<tr><td>Timeframe: Inception–March 2015</td></tr>
<tr><td>Total # of Studies: 87 publications (81 studies)</td></tr>
<tr><td>Exposure Definition: PA. Separate dose-response analyses for studies reporting metabolic equivalent (MET) hours per week and studies reporting on kilocalories of energy expenditure. Subgroups include dose-response analysis of leisure-time PA and total PA; different intensities of PA, including moderate (3–5.9 METs), vigorous (≥6 METs), and low intensity PA (1.6–2.9 METs); walking; resistance exercise; and occupational physical activity.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Risk of type 2 diabetes.<br>Examine Cardiorespiratory Fitness as Outcome: No</td><td></td></tr>
<tr><td>Populations Analyzed: All ages</td><td>Author-Stated Funding Source: Liaison Committee between the Central Norway Regional Health Authority and the Norwegian University of Science and Technology.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis<br>Citation: Cloostermans L, Wendel-Vos W, Doornbos G, et al. Independent and combined effects of physical activity and body mass index on the development of type 2 diabetes—a meta-analysis of 9 prospective cohort studies. Int J Behav Nutr Phys Act. Dec 2015:147. doi:10.1186/s12966-015-0304-3.</td></tr>
<tr><td>Purpose: To examine both the independent and combined effects of PA and body mass index on the development of type 2 diabetes.</td><td rowspan="4">Abstract: BACKGROUND: The aim of this harmonized meta-analysis was to examine the independent and combined effects of physical activity and BMI on the incidence of type 2 diabetes. METHODS: Our systematic literature review in 2011 identified 127 potentially relevant prospective studies of which 9 fulfilled the inclusion criteria (total N = 117,878, 56.2 % female, mean age = 50.0 years, range = 25-65 years). Measures of baseline physical activity (low, intermediate, high), BMI-category [BMI < 18.4 (underweight), 18.5-24.9 (normal weight), 25.0-29.9 (overweight), 30+ (obese)] and incident type 2 diabetes were harmonized across studies. The associations between physical activity, BMI and incident type 2 diabetes were analyzed using Cox regression with a standardized analysis protocol including adjustments for age, gender, educational level, and smoking. Hazard ratios from individual studies were combined in a random-effects meta-analysis. RESULTS: Mean follow-up time was 9.1 years. A total of 11,237 incident type 2 diabetes cases were recorded. In mutually adjusted models, being overweight or obese (compared with normal weight) and having low physical activity (compared with high physical activity) were associated with an increased risk of incident type 2 diabetes (hazard ratios 2.33, 95 % CI 1.95-2.78; 6.10, 95 % CI: 4.63-8.04, and 1.23, 95 % CI: 1.09-1.39, respectively). Individuals who were both obese and had low physical activity had 7.4-fold (95 % CI 3.47-15.89) increased risk of type 2 diabetes compared with normal weight, high physically active participants. CONCLUSIONS: This harmonized meta-analysis shows the importance of maintaining a healthy weight and being physically active in diabetes prevention.</td></tr>
<tr><td>Timeframe: 1989–September 2011</td></tr>
<tr><td>Total # of Studies: 9</td></tr>
<tr><td>Exposure Definition: PA measures (frequency, intensity, and duration), leisure time PA (including walking, gardening, shopping, and home maintenance), and active commuting. Minutes per week spent in low (sum of PA-minutes/week = 0), medium (0 minutes < sum of PA-minutes/week < 150 minutes), and high PA (sum of PA-minutes/week ≥ 150 minutes) categorized.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Incidence of type 2 diabetes: measured glucose levels or self-report.<br>Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 25–65, Normal/healthy weight (BMI: 18.5–24.9), Overweight (BMI: 25–29.9), Obese (BMI: 30 and above)</td><td>Author-Stated Funding Source: Medical Research Council, British Heart Foundation, Economic and Social Research Council (UK); Australian Government Department of Health; American Cancer Society; National Institutes of Health.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review<br>Citation: Fogelholm M. Physical activity, fitness and fatness: relations to mortality, morbidity and disease risk factors. A systematic review. Obes Rev. 2010;11(3):202-221. doi:10.1111/j.1467-789X.2009.00653.x.</td></tr>
<tr><td>Purpose: To study the relative risks, including type 2 diabetes incidence, of physical inactivity in normal-weight people vs. obesity in individuals with high PA.</td><td rowspan="4">Abstract: The purpose of this systematic review was to study the relative health risks of poor cardio-respiratory fitness (or physical inactivity) in normal-weight people vs. obesity in individuals with good cardio-respiratory fitness (or high physical activity). The core inclusion criteria were: publication year 1990 or later; adult participants; design prospective follow-up, case-control or cross-sectional; data on cardio-respiratory fitness and/or physical activity; data on BMI (body mass index), waist circumference or body composition; outcome data on all-cause mortality, cardiovascular disease mortality, cardiovascular disease incidence, type 2 diabetes or cardiovascular and type 2 diabetes risk factors. Thirty-six publications filled the criteria for inclusion. The data indicate that the risk for all-cause and cardiovascular mortality was lower in individuals with high BMI and good aerobic fitness, compared with individuals with normal BMI and poor fitness. In contrast, having high BMI even with high physical activity was a greater risk for the incidence of type 2 diabetes and the prevalence of cardiovascular and diabetes risk factors, compared with normal BMI with low physical activity. The conclusions of the present review may not be applicable to individuals with BMI > 35.</td></tr>
<tr><td>Timeframe: 1990–May 2009</td></tr>
<tr><td>Total # of Studies: 36 (6 with PA exposure and type 2 diabetes outcome)</td></tr>
<tr><td>Exposure Definition: PA.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Type 2 diabetes incidence.<br>Examine Cardiorespiratory Fitness as Outcome: No</td><td></td></tr>
<tr><td>Populations Analyzed: Age ≥18, Normal weight vs. overweight vs. obese</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis<br>Citation: Huai P, Han H, Reilly KH, Guo X, Zhang J, Xu A. Leisure-time physical activity and risk of type 2 diabetes: a meta-analysis of prospective cohort studies. Endocrine. 2016;52(2):226-230. doi:10.1007/s12020-015-0769-5.</td></tr>
<tr><td>Purpose: To determine the relationship between leisure-time physical activity (LTPA) and type 2 diabetes.</td><td rowspan="4">Abstract: Published articles reported controversial results about the association between leisure-time physical activity (LTPA) and risk of type 2 diabetes. A meta-analysis of prospective cohort studies was conducted to explore the effect of LTPA on the incidence of type 2 diabetes. PubMed and Embase databases were searched from its inception to June 13, 2014. Fixed or random effects models were used to calculate the pooled effect sizes based on between-study heterogeneity that was examined by the Q test and I (2) statistic. A total of eight studies, including 296,395 participants and 10,815 incident cases, were included in this study. Both high-level LTPA [high vs. low: hazard ratio (HR) 0.69, 95 % confidence interval (CI) 0.61-0.78] and moderate-level LTPA (moderate vs. low: HR 0.79, 95 % CI 0.70-0.89) were associated with decreased incidence of type 2 diabetes. In conclusion, LTPA was significantly associated with decreased risk of diabetes; high-level LTPA is more beneficial in decreasing the incidence of type 2 diabetes than moderate-level LTPA.</td></tr>
<tr><td>Timeframe: Inception–June 2014</td></tr>
<tr><td>Total # of Studies: 8</td></tr>
<tr><td>Exposure Definition: LTPA. For studies with ≥3 levels of PA, the lowest level was defined as low-level LTPA, the highest level as high-level LTPA, and all categories in-between as moderate level LTPA. For studies that reported 2 levels of LTPA, LTPA was categorized into low-level and high-level.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Type 2 diabetes.<br>Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Not reported</td><td>Author-Stated Funding Source: Risk Factor and Intervention Strategy of Life Expectancy in Shandong Province.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis<br>Citation: Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical activity of moderate intensity and risk of type 2 diabetes: a systematic review. Diabetes Care. 2007;30(3):744-752. doi:10.2337/dc06-1842.</td></tr>
<tr><td>Purpose: To systematically review the epidemiological evidence on the association between PA of moderate intensity and risk of type 2 diabetes.</td><td rowspan="4">Abstract: OBJECTIVE: To systematically evaluate the evidence for an association between physical activity of moderate intensity and risk of type 2 diabetes. RESEARCH DESIGN AND METHODS: We searched EMBASE and Medline through March 2006 and examined reference lists of retrieved articles. We excluded studies that did not assess physical activity of moderate intensity independent of activities of vigorous intensity (more than six times the resting metabolic rate). Information on study design, participant characteristics, assessment of physical activity, and outcomes and estimates of associations were extracted independently by two investigators. We calculated summary relative risks (RRs) using a random-effects model for the highest versus the lowest reported duration of activities. RESULTS: We identified 10 prospective cohort studies of physical activity of moderate intensity and type 2 diabetes, including a total of 301,221 participants and 9,367 incident cases. Five of these studies specifically investigated the role of walking. The summary RR of type 2 diabetes was 0.69 (95% CI 0.58-0.83) for regular participation in physical activity of moderate intensity as compared with being sedentary. Similarly, the RR was 0.70 (0.58-0.84) for regular walking (typically > or = 2.5 h/week brisk walking) as compared with almost no walking. The associations remained significant after adjustment for BMI. Similar associations were observed in men and women and in the U.S. and Europe. CONCLUSIONS: These findings indicate that adherence to recommendations to participate in physical activities of moderate intensity such as brisk walking can substantially reduce the risk of type 2 diabetes.</td></tr>
<tr><td>Timeframe: Inception–March 2006</td></tr>
<tr><td>Total # of Studies: 10</td></tr>
<tr><td>Exposure Definition: Moderately intense PA, defined as requiring a metabolic equivalent task score of 3.0–6.0. Typical activity of moderate intensity is "brisk" walking at 5.6 km/h on a flat surface, playing golf, leisure bicycling at <10 km/h, and gardening.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Incidence and prevalence of type 2 diabetes.<br>Examine Cardiorespiratory Fitness as Outcome: No</td><td></td></tr>
<tr><td>Populations Analyzed: Male, Female,U.S. vs. Non-U.S. cohorts</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

**Meta-Analysis**

**Citation:** Kyu HH, Bachman VF, Alexander LT, et al. Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. *BMJ*. 2016;354:i3857. doi:10.1136/bmj.i3857.

**Purpose:** To quantify the dose-response associations between total PA and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events.

**Timeframe:** 1980–2016

**Total # of Studies:** 174 (55 for diabetes)

**Exposure Definition:** Total PA in metabolic equivalent (MET) minutes/week were estimated from all included studies. Continuous and categorical dose-response between PA and outcomes conducted. Categorical compared insufficiently active (<600 MET minutes/week), low active (600–3,999 MET minutes), moderately active (4,000–7,999 MET minutes), and highly active (≥8,000 MET minutes).
**Measures Steps:** No
**Measures Bouts:** No
**Examines HIIT:** No

**Outcomes Addressed:** Diabetes
**Examine Cardiorespiratory Fitness as Outcome:** No

**Populations Analyzed:** Adults

**Abstract:** OBJECTIVE: To quantify the dose-response associations between total physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events. DESIGN: Systematic review and Bayesian dose-response meta-analysis. DATA SOURCES: PubMed and Embase from 1980 to 27 February 2016, and references from relevant systematic reviews. Data from the Study on Global AGEing and Adult Health conducted in China, Ghana, India, Mexico, Russia, and South Africa from 2007 to 2010 and the US National Health and Nutrition Examination Surveys from 1999 to 2011 were used to map domain specific physical activity (reported in included studies) to total activity. ELIGIBILITY CRITERIA FOR SELECTING STUDIES: Prospective cohort studies examining the associations between physical activity (any domain) and at least one of the five diseases studied. RESULTS: 174 articles were identified: 35 for breast cancer, 19 for colon cancer, 55 for diabetes, 43 for ischemic heart disease, and 26 for ischemic stroke (some articles included multiple outcomes). Although higher levels of total physical activity were significantly associated with lower risk for all outcomes, major gains occurred at lower levels of activity (up to 3000-4000 metabolic equivalent (MET) minutes/week). For example, individuals with a total activity level of 600 MET minutes/week (the minimum recommended level) had a 2% lower risk of diabetes compared with those reporting no physical activity. An increase from 600 to 3600 MET minutes/week reduced the risk by an additional 19%. The same amount of increase yielded much smaller returns at higher levels of activity: an increase of total activity from 9000 to 12 000 MET minutes/week reduced the risk of diabetes by only 0.6%. Compared with insufficiently active individuals (total activity <600 MET minutes/week), the risk reduction for those in the highly active category (>/=8000 MET minutes/week) was 14% (relative risk 0.863, 95% uncertainty interval 0.829 to 0.900) for breast cancer; 21% (0.789, 0.735 to 0.850) for colon cancer; 28% (0.722, 0.678 to 0.768) for diabetes; 25% (0.754, 0.704 to 0.809) for ischemic heart disease; and 26% (0.736, 0.659 to 0.811) for ischemic stroke. CONCLUSIONS: People who achieve total physical activity levels several times higher than the current recommended minimum level have a significant reduction in the risk of the five diseases studied. More studies with detailed quantification of total physical activity will help to find more precise relative risk estimates for different levels of activity.

**Author-Stated Funding Source:** Bill and Melinda Gates Foundation.

<table>
<tr><td colspan="2">Meta-Analysis<br>Citation: Merlotti, C, Morabito, A, Pontiroli, AE. Prevention of type 2 diabetes; a systematic review and meta-analysis of different intervention strategies. Diabetes Obes Metab. 2014. 16(8):719-27</td></tr>
<tr><td>Purpose: To evaluate the effectiveness of different strategies in prevention of type 2 diabetes mellitus.</td><td rowspan="4">Abstract: AIM: Different intervention strategies can prevent type 2 diabetes (T2DM). Aim of the present systematic review and meta-analysis was to evaluate the effectiveness of different strategies. METHODS: Studies were grouped into 15 different strategies: 1: diet plus physical activity; 2: physical activity; 3-6: anti-diabetic drugs [glitazones, metformin, beta-cell stimulating drugs (sulphanylureas, glinides), alfa-glucosidase inhibitors]; 7-8: cardiovascular drugs (ACE inhibitors, ARB, calcium antagonists); 9-14 [diets, lipid-affecting drugs (orlistat, bezafibrate), vitamins, micronutrients, estrogens, alcohol, coffee]; 15: bariatric surgery. Only controlled studies were included in the analysis, whether randomized, non-randomized, observational studies, whether primarily designed to assess incident cases of diabetes, or performed with other purposes, such as control of hypertension, of ischemic heart disease or prevention of cardiovascular events. Appropriate methodology [preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement] was used. Seventy-one studies (490 813 subjects), published as full papers, were analysed to identify predictors of new cases of T2DM, and were included in a meta-analysis (random-effects model) to study the effect of different strategies. Intervention effect (new cases of diabetes) was expressed as odds ratio (OR), with 95% confidence intervals (C.I.s). Publication bias was formally assessed. RESULTS: Body mass index was in the overweight range for 13 groups, obese or morbidly obese in lipid-affecting drugs and in bariatric surgery. Non-surgical strategies, except for beta-cell stimulating drugs, estrogens and vitamins, were able to prevent T2DM, with different effectiveness, from 0.37 (C.I. 0.26-0.52) to 0.85 (C.I. 0.77-0.93); the most effective strategy was bariatric surgery in morbidly obese subjects [0.16 (C.I. 0.11,0.24)]. At meta-regression analysis, age of subjects and amount of weight lost were associated with effectiveness of intervention. CONCLUSIONS: These data indicate that several strategies prevent T2DM, making it possible to make a choice for the individual subject.</td></tr>
<tr><td>Timeframe: Inception–June 2012</td></tr>
<tr><td>Total # of Studies: 71 (20 with PA)</td></tr>
<tr><td>Exposure Definition: PA (grouped into diet + PA and PA or education).<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Incidence of type 2 diabetes (as a means to develop an odds ratio and evaluate likelihood of development as a product of exposure effectiveness).<br>Examine Cardiorespiratory Fitness as Outcome: No</td><td></td></tr>
<tr><td>Populations Analyzed: Not reported</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

**Systematic Review**

**Citation:** Qin L, Knol MJ, Corpeleijn E, Stolk RP. Does physical activity modify the risk of obesity for type 2 diabetes: a review of epidemiological data. *Eur J Epidemiol.* 2010;25(1):5-12. doi:10.1007/s10654-009-9395-y.

**Purpose:** To summarize the evidence on the interaction between obesity and physical inactivity as they contribute to risk of type 2 diabetes.

**Timeframe:** 1999–August 2008

**Total # of Studies:** 8

**Exposure Definition:** Self-reported physical inactivity and PA (in tandem with obesity status) were reported in categories or metabolic equivalent (MET) hours. Physically active was defined as ≥ 21.8 MET hours/week and physically inactive was defined as <2.1 MET hours/week.
**Measures Steps:** No
**Measures Bouts:** No
**Examines HIIT:** No

**Outcomes Addressed:** Relative risk of type 2 diabetes mellitus: relative risk representing the individual effect of obesity (the risk in obese and physically active individuals relative to the risk in normal weight and physically active individuals), the relative risk representing the individual effect of physical inactivity (the risk in normal weight and physically inactive individuals relative to the risk in normal weight and physically active individuals), the relative risk representing the joint effect of obesity and physical inactivity (the risk in obese and physically inactive individuals relative to the risk in normal weight and physically active individuals).
**Examine Cardiorespiratory Fitness as Outcome:** No

**Populations Analyzed:** Not reported

**Abstract:** Obesity and physical inactivity are both risk factors for type 2 diabetes. Since they are strongly associated, it has been suggested that they might interact. In this study, we summarized the evidence on this interaction by conducting a systematic review. Two types of interaction have been discerned, statistical and biological interaction, which could give different results. Therefore, we calculated both types of interaction for the studies in our review. Cohort studies, published between 1999 and 2008, that investigated the effects of obesity and physical activity on the risk of type 2 diabetes were included. We calculated both biological and statistical interaction in these studies. Eight studies were included of which five were suitable to calculate interaction. All studies showed positive biological interaction, meaning that the joint effect was more than the sum of the individual effects. However, there was inconsistent statistical interaction; in some studies the joint effect was more than the product of the individual effects, in other studies it was less. The results show that obesity and physical inactivity interact on an additive scale. This means that prevention of either obesity or physical inactivity, not only reduces the risk of diabetes by taking away the independent effect of this factor, but also by preventing the cases that were caused by the interaction between both factors. Furthermore, this review clearly showed that results can differ depending on what method is used to assess interaction.

**Author-Stated Funding Source:** Not reported.

| | |
|---|---|
| **Systematic Review**<br>**Citation:** Reiner M, Niermann C, Jekauc D, Woll A. Long-term health benefits of physical activity—a systematic review of longitudinal studies. *BMC Public Health.* Sept 2013:813. doi:10.1186/1471-2458-13-813. | |
| **Purpose:** To review long-term effects of PA on the development of weight gain and obesity, coronary heart disease, and type 2 diabetes mellitus in healthy adults. | **Abstract:** BACKGROUND: The treatment of noncommunicable diseases (NCD), like coronary heart disease or type 2 diabetes mellitus, causes rising costs for the health system. Physical activity is supposed to reduce the risk for these diseases. Results of cross-sectional studies showed that physical activity is associated with better health, and that physical activity could prevent the development of these diseases. The purpose of this review is to summarize existing evidence for the long-term (>5 years) relationship between physical activity and weight gain, obesity, coronary heart disease, type 2 diabetes mellitus, Alzheimer's disease and dementia. METHODS: Fifteen longitudinal studies with at least 5-year follow up times and a total of 288,724 subjects (>500 participants in each study), aged between 18 and 85 years, were identified using digital databases. Only studies published in English, about healthy adults at baseline, intentional physical activity and the listed NCDs were included. RESULTS: The results of these studies show that physical activity appears to have a positive long-term influence on all selected diseases. CONCLUSIONS: This review revealed a paucity of long-term studies on the relationship between physical activity and the incidence of NCD. |
| **Timeframe:** 1980–May 2012 | |
| **Total # of Studies:** 18 (5 type 2 diabetes mellitus outcome) | |
| **Exposure Definition:** Self-reported intentional PA or intentional activities of daily living over the long term (5 or more years).<br>**Measures Steps:** No<br>**Measures Bouts:** No<br>**Examines HIIT:** No | |
| **Outcomes Addressed:** Incident risk of type 2 diabetes mellitus.<br>**Examine Cardiorespiratory Fitness as Outcome:** No | |
| **Populations Analyzed:** Adults 18–85 | **Author-Stated Funding Source:** Not reported. |

<table>
<tr><td colspan="2">Meta-Analysis<br>Citation: Wahid A, Manek N, Nichols M, et al. Quantifying the association between physical activity and cardiovascular disease and diabetes: a systematic review and meta-analysis. J Am Heart Assoc. 2016;5(9). pii:e002495. doi:10.1161/JAHA.115.002495.</td></tr>
<tr><td>Purpose: Draw together the epidemiological studies that assesses the independent association between PA levels and both cardiovascular disease and type 2 diabetes mellitus outcomes, using a single continuous metric and adjusting for body weight.</td><td rowspan="5">Abstract: BACKGROUND: The relationships between physical activity (PA) and both cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM) have predominantly been estimated using categorical measures of PA, masking the shape of the dose-response relationship. In this systematic review and meta-analysis, for the very first time we are able to derive a single continuous PA metric to compare the association between PA and CVD/T2DM, both before and after adjustment for a measure of body weight. METHODS AND RESULTS: The search was applied to MEDLINE and EMBASE electronic databases for all studies published from January 1981 to March 2014. A total of 36 studies (3 439 874 participants and 179 393 events, during an average follow-up period of 12.3 years) were included in the analysis (33 pertaining to CVD and 3 to T2DM). An increase from being inactive to achieving recommended PA levels (150 minutes of moderate-intensity aerobic activity per week) was associated with lower risk of CVD mortality by 23%, CVD incidence by 17%, and T2DM incidence by 26% (relative risk [RR], 0.77 [0.71-0.84]), (RR, 0.83 [0.77-0.89]), and (RR, 0.74 [0.72-0.77]), respectively, after adjustment for body weight. CONCLUSIONS: By using a single continuous metric for PA levels, we were able to make a comparison of the effect of PA on CVD incidence and mortality including myocardial infarct (MI), stroke, and heart failure, as well as T2DM. Effect sizes were generally similar for CVD and T2DM, and suggested that the greatest gain in health is associated with moving from inactivity to small amounts of PA.</td></tr>
<tr><td>Timeframe: 1981–2014</td></tr>
<tr><td>Total # of Studies: 36 (3 related to type 2 diabetes)</td></tr>
<tr><td>Exposure Definition: Exposure data for PA was converted to a common continuous metric of metabolic equivalent hours per week.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Type 2 diabetes mellitus<br>Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 19–79</td><td>Author-Stated Funding Source: British Heart Foundation.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review<br>Citation: Warburton DE, Charlesworth S, Ivey A, Nettlefold L, Bredin SS. A systematic review of the evidence for Canada's Physical Activity Guidelines for Adults. Int J Behav Nutr Phys Act. 2010;7:39. doi:10.1186/1479-5868-7-39.9</td></tr>
<tr><td>Purpose: Examine critically the current literature to determine whether or not a dose-response relationship exists between habitual PA and chronic disease.</td><td rowspan="5">Abstract: This systematic review examines critically the scientific basis for Canada's Physical Activity Guide for Healthy Active Living for adults. Particular reference is given to the dose-response relationship between physical activity and premature all-cause mortality and seven chronic diseases (cardiovascular disease, stroke, hypertension, colon cancer, breast cancer, type 2 diabetes (diabetes mellitus) and osteoporosis). The strength of the relationship between physical activity and specific health outcomes is evaluated critically. Literature was obtained through searching electronic databases (e.g., MEDLINE, EMBASE), cross-referencing, and through the authors' knowledge of the area. For inclusion in our systematic review articles must have at least 3 levels of physical activity and the concomitant risk for each chronic disease. The quality of included studies was appraised using a modified Downs and Black tool. Through this search we identified a total of 254 articles that met the eligibility criteria related to premature all-cause mortality (N = 70), cardiovascular disease (N = 49), stroke (N = 25), hypertension (N = 12), colon cancer (N = 33), breast cancer (N = 43), type 2 diabetes (N = 20), and osteoporosis (N = 2). Overall, the current literature supports clearly the dose-response relationship between physical activity and the seven chronic conditions identified. Moreover, higher levels of physical activity reduce the risk for premature all-cause mortality. The current Canadian guidelines appear to be appropriate to reduce the risk for the seven chronic conditions identified above and all-cause mortality.</td></tr>
<tr><td>Timeframe: 1950–2008</td></tr>
<tr><td>Total # of Studies: 254 (70 with type 2 diabetes as an outcome)</td></tr>
<tr><td>Exposure Definition: Any form of PA/exercise measurement (e.g., self-report, pedometer, accelerometer, maximal aerobic power [VO2 max]) was eligible for inclusion. High vs. lower levels of PA/fitness were used as exposure.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Type 2 diabetes<br>Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 19–65</td><td>Author-Stated Funding Source: Public Health Agency of Canada.</td></tr>
</table>

<table>
<tr><td colspan="2">Pooled Analysis<br>Citation: Xu F, Wang Y, Ware RS, et al. Joint impact of physical activity and family history on the development of diabetes among urban adults in Mainland China: a pooled analysis of community-based prospective cohort studies. Asia Pac J Public Health. 2015;27(2):NP372-381. doi:10.1177/1010539512443700.</td></tr>
<tr><td>Purpose: To examine the joint effect of PA and parental history of diabetes on the risk of developing type II diabetes by pooling data from 2 community-based cohorts of urban adults living in a large regional city in Mainland China.</td><td rowspan="4">Abstract: To examine the joint influences of physical activity (PA) and family history (FH) of diabetes on subsequent type 2 diabetes (T2D), the authors pooled and analyzed data from 2 community-based urban adult prospective cohort studies in 2011 in Nanjing, China. Among 4550 urban participants, the 3-year cumulative incidence of T2D was 5.1%. After adjustment for potential confounders, compared with those with FH+ and insufficient PA, the adjusted odds ratio (95% confidence interval) of developing T2D was 0.42 (0.18, 0.98) for participants with sufficient PA and FH+, 0.32 (0.22, 0.46) for participants with insufficient PA and FH-, and 0.15 (0.08, 0.28) for participants with sufficient PA and FH-. Such significant graduated associations between PA/FH and risk of developing T2D were also identified in either men or women, separately. Sufficient PA and FH- may jointly reduce the risk of developing T2D in urban Chinese adults.</td></tr>
<tr><td>Total # of Studies: 2</td></tr>
<tr><td>Exposure Definition: Self-reported frequency and duration of PA using Chinese short version of International Physical Activity Questionnaire. Total PA time was calculated as the sum of the time spent performing moderate PA plus double the time spent in vigorous PA. Total PA time equal to or greater than 150 minutes/week was classified as sufficient PA, and less than 150 minutes/week was classified as insufficient PA.<br>Measures Steps: No<br>Measures Bouts: No<br>Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Type II diabetes mellitus; odds ratio of incident risk of type II diabetes.<br>Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Male; Female; Asian; Ages 35–49, 50–64, ≥65; Urban</td><td>Author-Stated Funding Source: Nanjing Medical Science and Technique Development Foundation and Jiangsu Provincial Science and Technology Foundation.</td></tr>
</table>

***Table 3. Existing Systematic Reviews, Meta-Analyses, and Pooled Analyses Quality Assessment Chart***

| **AMSTARExBP: SR/MA** | | | | | | |
|---|---|---|---|---|---|---|
| | Aune, 2015 | Clooster mans, 2015 | Fogelholm, 2010 | Huai, 2016 | Jeon, 2007 | Kyu, 2016 |
| Review questions and inclusion/exclusion criteria delineated prior to executing search strategy. | Yes | Yes | Yes | Yes | Yes | Yes |
| Population variables defined and considered in methods. | Yes | Yes | No | No | Yes | Yes |
| Was a comprehensive literature search performed? | Yes | Partially Yes | Partially Yes | Yes | Yes | Yes |
| Duplicate study selection and data extraction performed. | No | No | No | Yes | Yes | Yes |
| Search strategy clearly described. | Yes | Yes | Yes | Yes | Yes | Yes |
| Relevant grey literature included in review. | No | No | No | No | No | No |
| List of studies (included and excluded) provided. | Yes | No | No | No | No | No |
| Characteristics of included studies provided. | Yes | Yes | Yes | No | Yes | Yes |
| FITT defined and examined in relation to outcome effect sizes. | Yes | No | N/A | No | No | Yes |
| Scientific quality (risk of bias) of included studies assessed and documented. | Yes | No | No | Partially Yes | No | Yes |
| Results depended on study quality, either overall, or in interaction with moderators. | Yes | N/A | N/A | No | N/A | Yes |
| Scientific quality used appropriately in formulating conclusions. | Yes | N/A | N/A | No | N/A | Yes |
| Data appropriately synthesized and if applicable, heterogeneity assessed. | Yes | Yes | N/A | Yes | Yes | Yes |
| Effect size index chosen justified, statistically. | Yes | Partially Yes | N/A | Yes | Yes | Yes |
| Individual-level meta-analysis used. | No | No | N/A | No | No | No |
| Practical recommendations clearly addressed. | Yes | Yes | Yes | Yes | Yes | Yes |
| Likelihood of publication bias assessed. | Yes | No | No | Yes | Yes | Yes |
| Conflict of interest disclosed. | Yes | Yes | No | Yes | No | Yes |

| AMSTARExBP: SR/MA | Merlotti, 2014 | Qin, 2010 | Reiner, 2013 | Wahid, 2016 | Warburton, 2010 | Xu, 2015 |
|---|---|---|---|---|---|---|
| Review questions and inclusion/exclusion criteria delineated prior to executing search strategy. | Yes | Yes | Yes | Yes | Yes | Yes |
| Population variables defined and considered in methods. | Yes | Yes | No | Yes | Yes | Yes |
| Was a comprehensive literature search performed? | Yes | Partially Yes | Partially Yes | Yes | Yes | N/A |
| Duplicate study selection and data extraction performed. | Yes | No | No | Yes | Yes | N/A |
| Search strategy clearly described. | Yes | Yes | Yes | Yes | Yes | N/A |
| Relevant grey literature included in review. | Yes | No | No | No | No | N/A |
| List of studies (included and excluded) provided. | No | No | No | Yes | No | N/A |
| Characteristics of included studies provided. | Yes | Yes | Yes | Yes | Yes | No |
| FITT defined and examined in relation to outcome effect sizes. | No | N/A | N/A | No | N/A | No |
| Scientific quality (risk of bias) of included studies assessed and documented. | Yes | No | No | Yes | Yes | No |
| Results depended on study quality, either overall, or in interaction with moderators. | No | N/A | N/A | Yes | Yes | N/A |
| Scientific quality used appropriately in formulating conclusions. | Yes | N/A | N/A | Yes | Yes | N/A |
| Data appropriately synthesized and if applicable, heterogeneity assessed. | Yes | N/A | N/A | Yes | N/A | No |
| Effect size index chosen justified, statistically. | Yes | N/A | N/A | Yes | N/A | No |
| Individual-level meta-analysis used. | No | N/A | N/A | No | N/A | No |
| Practical recommendations clearly addressed. | Yes | Yes | Yes | Yes | Yes | Yes |
| Likelihood of publication bias assessed. | Yes | No | No | Yes | No | N/A |
| Conflict of interest disclosed. | No | No | No | Yes | Yes | Yes |

## Appendices

### Appendix A: Analytical Framework

**Topic Area**

Cardiometabolic Health and Weight Management

**Systematic Review Question**

In adults without diabetes, what is the relationship between physical activity and type 2 diabetes?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. Does the relationship vary based on frequency, duration, intensity, type (mode), or how physical activity is measured?

**Population**

Adults, ages 18 and older without diabetes

**Exposure**

All types and intensities of physical activity, including lifestyle activities, leisure activities, and sedentary behavior

**Comparison**

Adults who participate in varying levels of physical activity, including no reported physical activity

**Endpoint Health Outcomes**

Type 2 diabetes

**Key Definitions**

- Non-diabetic/normal: Having an A1C below 5.7%, fasting blood glucose less than 100 mg/dL, and an OGTT 2-hour blood glucose lower than 140 mg/dL.
- Prediabetes: Having an A1C of 5.7%–6.4%, fasting blood glucose of 100–125 mg/dl, and an OGTT 2-hour blood glucose of 140 mg/dL–199 mg/dL.
- Diabetes: Having an A1C of 6.5% or higher, fasting blood glucose of 126 mg/dL or higher, and an OGTT 2-hour blood glucose of 200 mg/dL or higher.

## Appendix B: Final Search Strategy

**Search Strategy: PubMed (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)**

Database: PubMed; Date of Search: 5/11/17; 972 results

| Set | Search Strategy |
|---|---|
| Limit: Language | (English[lang]) |
| Limit: Exclude animal only | NOT ("Animals"[mh] NOT ("Animals"[mh] AND "Humans"[mh])) |
| Limit: Exclude child only | NOT (("infant"[mh] OR "child"[mh] OR "child, preschool"[mh] OR "adolescent"[mh]) NOT (("infant"[mh] OR "child"[mh] OR "child, preschool"[mh] OR "adolescent"[mh]) AND "adult"[mh])) |
| Limit: Publication Date (Systematic Reviews/Meta-Analyses) | AND ("2006/01/01"[PDAT] : "3000/12/31"[PDAT]) |
| Limit: Publication Type Include (Systematic Reviews/Meta-Analyses) | AND (systematic[sb] OR meta-analysis[pt] OR "systematic review"[tiab] OR "systematic literature review"[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR metanalyses[tiab] OR "meta analyses"[tiab] OR "pooled analysis"[tiab] OR "pooled analyses"[tiab] OR "pooled data"[tiab]) |
| Limit: Publication Type Exclude (Systematic Reviews/Meta-Analyses) | NOT ("comment"[Publication Type] OR "editorial"[Publication Type]) |
| Physical Activity | AND (("Aerobic endurance"[tiab] OR "Bicycl*"[tiab] OR "Endurance training"[tiab] OR "Exercise"[mh] OR "Exercise"[tiab] OR "Exercises"[tiab] OR "Free living activities"[tiab] OR "Free living activity"[tiab] OR "Functional training"[tiab] OR "Leisure-time physical activity"[tiab] OR "Lifestyle activities"[tiab] OR "Lifestyle activity"[tiab] OR "Muscle stretching exercises"[mh] OR "Physical activity"[tiab] OR "Qi gong"[tiab] OR "Recreational activities"[tiab] OR "Recreational activity"[tiab] OR "Resistance training"[tiab] OR "Running"[tiab] OR "Sedentary lifestyle"[mh] OR "Speed training"[tiab] OR "Strength training"[tiab] OR "Tai chi"[tiab] OR "Tai ji"[mh] OR "Tai ji"[tiab] OR "Training duration"[tiab] OR "Training frequency"[tiab] OR "Training intensity"[tiab] OR "Treadmill"[tiab] OR "Walking"[tiab] OR "Weight lifting"[tiab] OR "Weight training"[tiab] OR "Yoga"[mh] OR "Yoga"[tiab]) OR (("Aerobic activities"[tiab] OR "Aerobic activity"[tiab] OR "Cardiovascular activities"[tiab] OR "Cardiovascular activity"[tiab] OR "Endurance activities"[tiab] OR "Endurance activity"[tiab] OR "Physical activities"[tiab] OR "Physical conditioning"[tiab] OR "Sedentary"[tiab]) NOT medline[sb])) |
| Outcome | AND ("Diabetes"[tiab] OR "diabetes mellitus"[mh]) |

**Search Strategy: CINAHL (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)**

Database: CINAHL; Date of Search: 5/11/17; 29 results
Terms searched in title or abstract

| Set | Search Terms |
|---|---|
| Physical Activity | ("Aerobic endurance" OR "Bicycl*" OR "Endurance training" OR "Exercise" OR "Exercises" OR "Free living activities" OR "Free living activity" OR "Functional training" OR "Leisure-time physical activity" OR "Lifestyle activities" OR "Lifestyle activity" OR "Muscle stretching exercises" OR "Physical activity" OR "Qi gong" OR "Recreational activities" OR "Recreational activity" OR "Resistance training" OR "Running" OR "Sedentary lifestyle" OR "Speed training" OR "Strength training" OR "Tai chi" OR "Tai ji" OR "Tai ji" OR "Training duration" OR "Training frequency" OR "Training intensity" OR "Treadmill" OR "Walking" OR "Weight lifting" OR "Weight training" OR "Yoga" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Physical activities" OR "Physical conditioning" OR "Sedentary") |
| Outcomes | AND ("Diabetes" OR “diabetes mellitus”) |
| Systematic Reviews and Meta-Analyses | (“systematic review” OR “systematic literature review” OR metaanalysis OR "meta analysis" OR metanalyses OR "meta analyses" OR "pooled analysis" OR “pooled analyses” OR "pooled data") |
| Limits | 2006–present<br>English language<br>Peer reviewed<br>Exclude Medline records<br>Human |

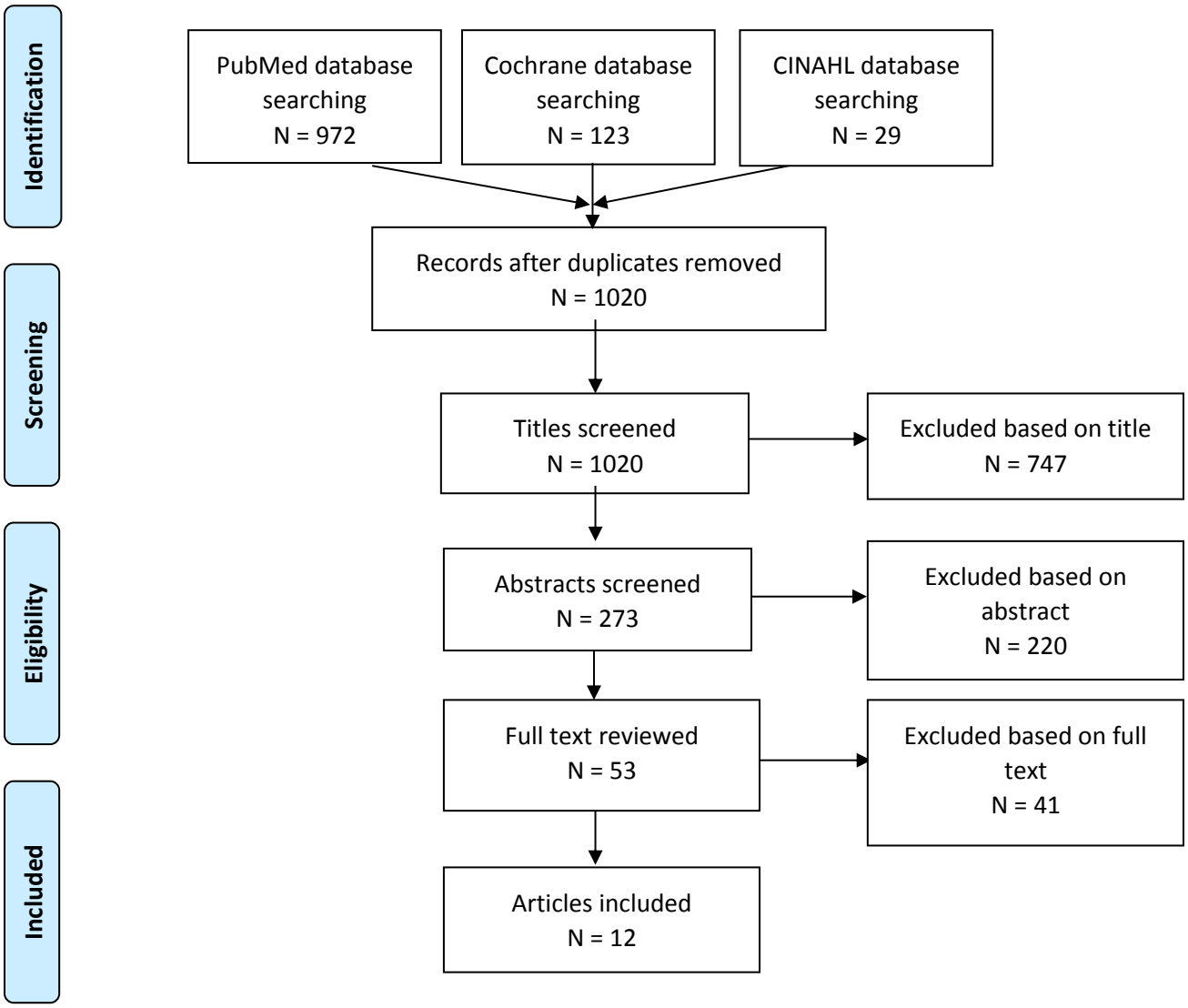
**Search Strategy: Cochrane (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)**

Database: Cochrane; Date of Search: 5/11/17; 123 results
Terms searched in title, abstract, or keywords

| Set | Search Terms |
|---|---|
| Physical Activity | ("Aerobic endurance" OR "Bicycl*" OR "Endurance training" OR "Exercise" OR "Exercises" OR "Free living activities" OR "Free living activity" OR "Functional training" OR "Leisure-time physical activity" OR "Lifestyle activities" OR "Lifestyle activity" OR "Muscle stretching exercises" OR "Physical activity" OR "Qi gong" OR "Recreational activities" OR "Recreational activity" OR "Resistance training" OR "Running" OR "Sedentary lifestyle" OR "Speed training" OR "Strength training" OR "Tai chi" OR "Tai ji" OR "Tai ji" OR "Training duration" OR "Training frequency" OR "Training intensity" OR "Treadmill" OR "Walking" OR "Weight lifting" OR "Weight training" OR "Yoga" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Physical activities" OR "Physical conditioning" OR "Sedentary") |
| Outcomes | AND ("Diabetes" OR "diabetes mellitus") |
| Limits | 2006–present<br>Word variations not searched<br>Cochrane Reviews and Other Reviews |

## Appendix C: Literature Tree

***Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports Literature Tree***



## Appendix D: Inclusion/Exclusion Criteria

**Cardiometabolic Health and Weight Management Subcommittee**

**Systematic Review Question:** In adults without diabetes, what is the relationship between physical activity and type 2 diabetes?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. Does the relationship vary based on frequency, duration, intensity, type (mode), or how physical activity is measured?

| Category | Inclusion/Exclusion Criteria | Notes/Rationale |
|---|---|---|
| **Publication Language** | **Include:**<br>• Studies published with full text in English | |
| **Publication Status** | **Include:**<br>• Studies published in peer-reviewed journals<br>• Reports determined to have appropriate suitability and quality by PAGAC<br><br>**Exclude:**<br>• Grey literature, including unpublished data, manuscripts, abstracts, conference proceedings | |
| **Research Type** | **Include:**<br>• Original research: Prospective (concurrent; longitudinal) cohort studies; randomized controlled trials<br>• Meta-analyses<br>• Systematic reviews<br>• Pooled analyses<br>• Reports determined to have appropriate suitability and quality by PAGAC | |
| **Study Subjects** | **Include:**<br>• Human subjects | |
| **Age of Study Subjects** | **Include:**<br>• Adults ages 18 and older<br>• When data are analyzed by age groups, only data with lower age range of 18 may be included (e.g., in a study with individuals 13–21 where data are presented for multiple age groups, only data for 18 and older may be included) | |
| **Health Status of Study Subjects** | **Include:**<br>• Healthy adults without diabetes<br>• People who are overweight or obese<br>• Adults with pre-diabetes or impaired glucose tolerance<br>**Exclude:** | |

| | | |
|---|---|---|
| | • Studies of adults with any chronic condition (obesity is ok)<br>• Hospitalized patients<br>• Smokers only | |
| **Comparison** | **Include:**<br>• Adults who participate in varying levels of physical activity, including no reported physical activity<br>• Recreational athletes (marathons ok as long as the study looks at a diverse group of runners—not just the elites)<br><br>**Exclude:**<br>• High-performance athletes<br>• Studies comparing athletes to non-athletes<br>• Studies comparing athlete types (e.g., comparing runners to soccer players) | |
| **Date of Publication** | **Include:**<br>• Original research published from 2006 to 2017<br>• Systematic reviews and meta-analyses published from 2006 to 2017 | |
| **Study Design** | **Include:**<br>• Randomized trials<br>• Prospective cohort studies<br>• Systematic reviews<br>• Meta-analyses<br>• Pooled analyses<br>• PAGAC approved reports<br><br>**Exclude:**<br>• Non-randomized trials<br>• Retrospective cohort studies<br>• Case-control studies<br>• Before-After studies<br>• Narrative reviews<br>• Commentaries<br>• Editorials<br>• Cross-sectional studies<br>• Time series | |
| **Intervention/ Exposure** | **Include studies in which the exposure or intervention is:**<br>• All types and intensities of physical activity, including lifestyle activities, leisure activities, and sedentary behavior<br>**Exclude:** | |

| | | |
|---|---|---|
| | • Studies that do not include physical activity (or the lack thereof) as the primary exposure variable or used solely as a confounding variable<br>• Studies missing physical activity (mental games such as Sudoku instead of physical activities) | |
| **Outcome** | **Include studies in which the outcome is:**<br>• Type 2 diabetes | |
| **Study Duration (Original Research)** | • Minimum 1 year for observational studies | |

## Appendix E: Rationale for Exclusion at Abstract or Full-Text Triage for Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports

The table below lists the excluded articles with at least one reason for exclusion, but may not reflect all possible reasons.

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Abdulameer SA, Sulaiman SA, Hassali MA, Subramaniam K, Sahib MN. Osteoporosis and type 2 diabetes mellitus: what do we know, and what we can do? *Patient Prefer Adherence*. 2012;6:435-448. doi:10.2147/PPA.S32745. | | X | | | | |
| Abubakari AR, Bhopal RS. Systematic review on the prevalence of diabetes, overweight/obesity and physical inactivity in Ghanaians and Nigerians. *Public Health*. 2008;122(2):173-182. doi:10.1016/j.puhe.2007.06.012. | | | | X | | |
| Abubakari AR, Lauder W, Jones MC, Kirk A, Agyemang C, Bhopal RS. Prevalence and time trends in diabetes and physical inactivity among adult West African populations: the epidemic has arrived. *Public Health*. 2009;123(9):602-614. doi:10.1016/j.puhe.2009.07.009. | | | | X | | |
| Adeniyi AF, Adeleye JO, Adeniyi CY. Diabetes, sexual dysfunction and therapeutic exercise: a 20 year review. *Curr Diabetes Rev*. 2010;6(4):201-206. doi:10.2174/157339910791658907. | | X | | | | |
| Afable A, Karingula NS. Evidence based review of type 2 diabetes prevention and management in low and middle income countries. *World J Diabetes*. 2016;7(10):209-229. doi:10.4239/wjd.v7.i10.209. | | X | | | | |
| Aguiar EJ, Morgan PJ, Collins CE, Plotnikoff RC, Callister R. Efficacy of interventions that include diet, aerobic and resistance training components for type 2 diabetes prevention: a systematic review with meta-analysis. *Int J Behav Nutr Phys Act*. Jan 2014:2. doi:10.1186/1479-5868-11-2. | | | | X | | |
| Ahmad S, Shanmugasegaram S, Walker KL, Prince SA. Examining sedentary time as a risk factor for cardiometabolic diseases and their markers in South Asian adults: a systematic review. *Int J Public Health*. 2017;62(4):503-515. doi:10.1007/s00038-017-0947-8. | | | | X | | |
| Al Tunaiji H, Davis JC, Mackey DC, Khan KM. Population attributable fraction of type 2 diabetes due to physical inactivity in adults: | X | | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| a systematic review. *BMC Public Health*. May 2014:469. doi:10.1186/1471-2458-14-469. | | | | | | |
| Aljasir B, Bryson M, Al-Shehri B. Yoga practice for the management of type II diabetes mellitus in adults: a systematic review. *Evid Based Complement Alternat Med*. 2010;7(4):399-408. doi:10.1093/ecam/nen027. | | X | | | | |
| Alothman S, Yahya A, Rucker J, Kluding PM. Effectiveness of interventions for promoting objectively measured physical activity of adults with type 2 diabetes: a systematic review. *J Phys Act Health*. 2017;14(5):408-415. doi:10.1123/jpah.2016-0528. | | X | | | | |
| Alouki K, Delisle H, Bermudez-Tamayo C, Jhori M. Lifestyle interventions to prevent type 2 diabetes: a systematic review of economic evaluation studies. *J Diabetes Res*. Jan 2016:2159890. doi:10.1155/2016/2159890. | X | | | | | |
| Alsairafi ZK, Taylor KM, Smith FJ, Alattar AT. Patients' management of type 2 diabetes in Middle Eastern countries: review of studies. *Patient Prefer Adherence*. June 2016:1051-1062. doi:10.2147/PPA.S104335. | X | | | | | |
| American Diabetes Association. Prevention or delay of type 2 diabetes. *Diabetes Care*. 2015;(38)(suppl 1):S31-S32. doi:10.2337/dc15-S008. | | | X | | | |
| Angermayr L, Melchart D, Linde K. Multifactorial lifestyle interventions in the primary and secondary prevention of cardiovascular disease and type 2 diabetes mellitus—a systematic review of randomized controlled trials. *Ann Behav Med*. 2010;40(1):49-64. doi:10.1007/s12160-010-9206-4. | | | | X | | |
| Antunes LC, Levandovski R, Dantas G, Caumo W, Hidalgo MP. Obesity and shift work: chronobiological aspects. *Nutr Res Rev*. 2010;23(1):155-168. doi:10.1017/S0954422410000016. | | | | X | | |
| Appuhamy JA, Kebreab E, Simon M, Yada R, Milligan LP, France J. Effects of diet and exercise interventions on diabetes risk factors in adults without diabetes: meta-analyses of controlled trials. *Diabetol Metab Syndr*. Nov 2014:127. doi:10.1186/1758-5996-6-127. | | | | X | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Arambepola C, Ricci-Cabello I, Manikavasagam P, Roberts N, French DP, Farmer A. The impact of automated brief messages promoting lifestyle changes delivered via mobile devices to people with type 2 diabetes: a systematic literature review and meta-analysis of controlled trials. *J Med Internet Res*. 2016;18(4):e86. doi:10.2196/jmir.5425. | | X | | | | |
| Avery L, Flynn D, Dombrowski SU, van Wersch A, Sniehotta FF, Trenell MI. Successful behavioural strategies to increase physical activity and improve glucose control in adults with type 2 diabetes. *Diabet Med*. 2015;32(8):1058-1062. doi:10.1111/dme.12738. | | X | | | | |
| Avery L, Flynn D, Wersch A, Sniehotta FF, Trenell MI. Changing physical activity behavior in type 2 diabetes: a systematic review and meta-analysis of behavioral interventions. *Diabetes Care*. 2012;35(12):2681-2689. doi:10.2337/dc11-2452. | | X | | | | |
| Baskerville R, Ricci-Cabello I, Roberts N, Farmer A. Impact of accelerometer and pedometer use on physical activity and glycaemic control in people with type 2 diabetes: a systematic review and meta-analysis. *Diabetic Medicine*. 2017;34(5):612-620. doi:10.1111/dme.13331. | | X | | | | |
| Bhurji N, Javer J, Gasevic D, Khan NA. Improving management of type 2 diabetes in South Asian patients: a systematic review of intervention studies. *BMJ Open*. 2016;6(4):e008986. doi:10.1136/bmjopen-2015-008986. | | X | | | | |
| Bian RR, Piatt GA, Sen A, et al. The effect of technology-mediated diabetes prevention interventions on weight: a meta-analysis. *J Med Internet Res*. 2017;19(3):e76. doi:10.2196/jmir.4709. | | | | X | | |
| Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. *Ann Intern Med*. 2015;162(2):123-132. doi:10.7326/M14-1651. | | | | X | | |
| Blaha MJ, Bansal S, Rouf R, Golden SH, Blumenthal RS, Defilippis AP. A practical "ABCDE" approach to the metabolic syndrome. *Mayo Clin Proc*. 2008;83(8):932-941. doi:10.4065/83.8.932. | | | | X | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Bosomworth NJ. Approach to identifying and managing atherogenic dyslipidemia: a metabolic consequence of obesity and diabetes. *Can Fam Physician*. 2013;59(11):1169-1180. | | | | X | | |
| Bravata DM, Smith-Spangler C, Sundaram V, et al. Using pedometers to increase physical activity and improve health: a systematic review. *JAMA*. 2007;298(19):2296-2304. doi:10.1001/jama.298.19.2296. | X | | | | | |
| Brinks R, Hoyer A, Kuss O, Rathmann W. Projected effect of increased active travel in German urban regions on the risk of type 2 diabetes. *PLoS One*. 2015;10(4):e0122145. doi:10.1371/journal.pone.0122145. | | | X | | | |
| Brocklebank LA, Falconer CL, Page AS, Perry R, Cooper AR. Accelerometer-measured sedentary time and cardiometabolic biomarkers: a systematic review. *Prev Med*. 2015;76:92-102. doi:10.1016/j.ypmed.2015.04.013. | X | | | | | |
| Brown SA, Garcia AA, Brown A, et al. Biobehavioral determinants of glycemic control in type 2 diabetes: a systematic review and meta-analysis. *Patient Educ Couns*. 2016;99(10):1558-1567. doi:10.1016/j.pec.2016.03.020. | | X | | | | |
| Brunton SA, Rolla AR. Implementing intensified treatment strategies for patients with type 2 diabetes mellitus. *J Fam Pract*. 2007;56(11)(suppl):S9-S16. | | X | | | | |
| Brunton SA. The changing shape of type 2 diabetes. *Medscape J Med*. 2008;10(6):143; quiz 143. | | X | | | | |
| Byrne H, Caulfield B, De Vito G. Effects of self-directed exercise programmes on individuals with type 2 diabetes mellitus: a systematic review evaluating their effect on HbA1c and other metabolic outcomes, physical characteristics, cardiorespiratory fitness and functional outcomes. *Sports Med.* 2017;47(4):717-733. doi:10.1007/s40279-016-0593-y. | | X | | | | |
| Caffrey MK. Evidence builds on yoga, but no reimbursement yet. *Am J Manag Care*. 2014;20(8 Spec No.):E5. | | | X | | | |
| Cai H, Li G, Zhang P, Xu D, Chen L. Effect of exercise on the quality of life in type 2 diabetes mellitus: a systematic review. *Qual Life Res*. 2017;26(3):515-530. doi:10.1007/s11136-016-1481-5. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Cai X, Qiu SH, Yin H, et al. Pedometer intervention and weight loss in overweight and obese adults with type 2 diabetes: a meta-analysis. *Diabet Med*. 2016;33(8):1035-1044. doi:10.1111/dme.13104. | | X | | | | |
| Cayley WE. The role of exercise in patients with type 2 diabetes. *Am Fam Physician*. 2007;75(3):335-336. | | X | | | | |
| Ceysens G, Rouiller D, Boulvain M. Exercise for diabetic pregnant women. *Cochrane Database Syst Rev*. 2006;(3):Cd004225. doi:10.1002/14651858.CD004225.pub2. | | X | | | | |
| Chapman A, Meyer C, Renehan E, Hill KD, Browning CJ. Exercise interventions for the improvement of falls-related outcomes among older adults with diabetes mellitus: a systematic review and meta-analyses. *J Diabetes Complications*. 2017;31(3):631-645. doi:10.1016/j.jdiacomp.2016.09.015. | | X | | | | |
| Chen L, Pei JH, Kuang J, et al. Effect of lifestyle intervention in patients with type 2 diabetes: a meta-analysis. *Metabolism*. 2015;64(2):338-347. doi:10.1016/j.metabol.2014. | | X | | | | |
| Christensen J, Valentiner LS, Petersen RJ, Langberg H. The effect of game-based interventions in rehabilitation of diabetics: a systematic review and meta-analysis. *Telemed J E Health*. 2016;22(10):789-797. doi:10.1089/tmj.2015.0165. | | X | | | | |
| Chudyk A, Petrella RJ. Effects of exercise on cardiovascular risk factors in type 2 diabetes: a meta-analysis. *Diabetes Care*. 2011;34(5):1228-1237. doi:10.2337/dc10-1881. | | X | | | | |
| Cigolle CT, Blaum CS, Halter JB. Diabetes and cardiovascular disease prevention in older adults. *Clin Geriatr Med*. 2009;25(4):607-641, vii-viii. doi:10.1016/j.cger.2009.09.001. | | X | | | | |
| Colberg SR, Grieco CR. Exercise in the treatment and prevention of diabetes. *Curr Sports Med Rep*. 2009;8(4):169-175. doi:10.1249/JSR.0b013e3181ae0654. | | X | | | | |
| Colberg SR, Sigal RJ, Fernhall B, et al.; American College of Sports Medicine; American Diabetes Association. Exercise and type 2 diabetes: the American College of Sports Medicine and the American Diabetes Association: joint position statement executive summary. *Diabetes Care*. 2010;33(12):2692-2696. doi:10.2337/dc10-1548. | X | | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Conn VS, Hafdahl AR, Cooper PS, Brown LM, Lusk SL. Meta-analysis of workplace physical activity interventions. *Am J Prev Med*. 2009;37(4):330-339. doi:10.1016/j.amepre.2009.06.008. | X | | | | | |
| Conn VS, Hafdahl AR, Mehr DR, LeMaster JW, Brown SA, Nielsen PJ. Metabolic effects of interventions to increase exercise in adults with type 2 diabetes. *Diabetologia*. 2007;50(5):913-921. doi:10.1007/s00125-007-0625-0. | | X | | | | |
| Conn VS, Koopman RJ, Ruppar TM, Phillips LJ, Mehr DR, Hafdahl AR. Insulin sensitivity following exercise interventions: systematic review and meta-analysis of outcomes among healthy adults. *J Prim Care Community Health*. 2014;5(3):211-222. doi:10.1177/2150131913520328. | X | | | | | |
| Cradock KA, ÓLaighin G, Finucane FM, Gainforth HL, Quinlan LR, Ginis KA. Behaviour change techniques targeting both diet and physical activity in type 2 diabetes: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act*. 2017;14(1):18. doi:10.1186/s12966-016-0436-0. | | X | | | | |
| Cramer H, Lauche R, Haller H, Steckhan N, Michalsen A, Dobos G. Effects of yoga on cardiovascular disease risk factors: a systematic review and meta-analysis. *Int J Cardiol*. 2014;173(2):170-183. doi:10.1016/j.ijcard.2014.02.017. | X | X | | | | |
| Cramer H, Langhorst J, Dobos G, Lauche R. Yoga for metabolic syndrome: a systematic review and meta-analysis. *Eur J Prev Cardiol*. 2016;23(18):1982-1993. doi:10.1177/2047487316665729. | X | | | | | |
| Cui J, Yan JH, Yan LM, Pan L, Le JJ, Guo YZ. Effects of yoga in adults with type 2 diabetes mellitus: a meta-analysis. *J Diabetes Investig*. 2017;8(2):201-209. doi:10.1111/jdi.12548. | | X | | | | |
| Davies B, Cramp F, Gauntlett-Gilbert J, Wynick D, McCabe CS. The role of physical activity and psychological coping strategies in the management of painful diabetic neuropathy—a systematic review of the literature. *Physiotherapy*. 2015;101(4):319-326. doi:10.1016/j.physio.2015.04.003. | | X | | | | |
| de Rezende LF, Rodrigues Lopes M, Rey-Lopez JP, Matsudo VK, Luiz Odo C. Sedentary behavior and health outcomes: an overview of systematic reviews. *PLoS* | | | | X | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| *One*. 2014;9(8):e105620. doi:10.1371/journal.pone.0105620. | | | | | | |
| Dempsey PC, Owen N, Biddle SJ, Dunstan DW. Managing sedentary behavior to reduce the risk of diabetes and cardiovascular disease. *Curr Diab Rep*. 2014;14(9):522. doi:10.1007/s11892-014-0522-0. | | | X | | | |
| Desveaux L, Beauchamp M, Goldstein R, Brooks D. Community-based exercise programs as a strategy to optimize function in chronic disease: a systematic review. *Med Care*. 2014;52(3):216-226. doi:10.1097/MLR.0000000000000065. | X | | | | | |
| Drab SR. Recognizing the rising impact of diabetes in seniors and implications for its management. *Consult Pharm*. 2009;24(suppl B):5-10. | | | | X | | |
| Duan-Porter W, Goldstein K, McDuffie J, et al. Mapping the evidence: sex effects in high-impact conditions for women veterans—depression, diabetes, and chronic pain. *VA Evidence-Based Synthesis Program Reports.* Washington, DC: Department of Veterans Affairs; 2015. | X | | | | | |
| Duan-Porter W, Goldstein KM, McDuffie JR, et al. Reporting of sex effects by systematic reviews on interventions for depression, diabetes, and chronic pain. *Ann Intern Med*. 2016;165(3):184-193. doi:10.7326/M15-2877. | X | | | | | |
| Duclos M, Oppert JM, Verges B, et al.; SFD diabetes and physical activity working group. Physical activity and type 2 diabetes. Recommendations of the SFD (Francophone Diabetes Society) diabetes and physical activity working group. *Diabetes Metab*. 2013;39(3):205-216. doi:10.1016/j.diabet.2013.03.005. | | | X | | | |
| Duclos M, Virally ML, Dejager S. Exercise in the management of type 2 diabetes mellitus: what are the benefits and how does it work? *Phys Sportsmed*. 2011;39(2):98-106. doi:10.3810/psm.2011.05.1899. | | X | X | | | |
| Dunkley AJ, Bodicoat DH, Greaves CJ, et al. Diabetes prevention in the real world: effectiveness of pragmatic lifestyle interventions for the prevention of type 2 diabetes and of the impact of adherence to guideline recommendations: a systematic review and meta-analysis. *Diabetes Care*. 2014;37(4):922-933. doi:10.2337/dc13-2195. | X | | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Dunkley AJ, Charles K, Gray LJ, Camosso-Stefinovic J, Davies MJ, Khunti K. Effectiveness of interventions for reducing diabetes and cardiovascular disease risk in people with metabolic syndrome: systematic review and mixed treatment comparison meta-analysis. *Diabetes Obes Metab*. 2012;14(7):616-625. doi:10.1111/j.1463-1326.2012.01571.x. | | | | X | | |
| Ekelund U, Brage S, Griffin SJ, Wareham NJ, ProActive UK Research Group. Objectively measured moderate- and vigorous-intensity physical activity but not sedentary time predicts insulin resistance in high-risk individuals. *Diabetes Care*. 2009;32(6):1081-1086. doi:10.2337/dc08-1895. | | | X | | | |
| Everson-Hock ES, Johnson M, Jones R, et al. Community-based dietary and physical activity interventions in low socioeconomic groups in the UK: a mixed methods systematic review. *Prev Med*. 2013;56(5):265-272. doi:10.1016/j.ypmed.2013.02.023. | X | | | | | |
| Fasanmade OA, Dagogo-Jack S. Diabetes Care in Nigeria. *Ann Glob Health*. 2015;81(6):821-829. doi:10.1016/j.aogh.2015.12.012. | X | | | | | |
| Field T. Yoga research review. *Complement Ther Clin Pract*. Aug 2016:145-161. doi:10.1016/j.ctcp.2016.06.005. | | | X | | | |
| Figueira FR, Umpierre D, Cureau FV, et al. Association between physical activity advice only or structured exercise training with blood pressure levels in patients with type 2 diabetes: a systematic review and meta-analysis. *Sports Med*. 2014;44(11):1557-1572. doi:10.1007/s40279-014-0226-2. | | X | | | | |
| Franz MJ, Boucher JL, Rutten-Ramos S, VanWormer JJ. Lifestyle weight-loss intervention outcomes in overweight and obese adults with type 2 diabetes: a systematic review and meta-analysis of randomized clinical trials. *J Acad Nutr Diet*. 2015;115(9):1447-1463. doi:10.1016/j.jand.2015.02.031. | | X | | | | |
| Freire MD, Alves C. Therapeutic Chinese exercises (qigong) in the treatment of type 2 diabetes mellitus: a systematic review. *Diabetes Metab Syndr*. 2013;7(1):56-59. doi:10.1016/j.dsx.2013.02.009. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Frost J, Garside R, Cooper C, Britten N. A qualitative synthesis of diabetes self-management strategies for long term medical outcomes and quality of life in the UK. *BMC Health Serv Res*. 2014;14:348. doi:10.1186/1472-6963-14-348. | | X | | | | |
| Funk M, Taylor EL. Pedometer-based walking interventions for free-living adults with type 2 diabetes: a systematic review. *Curr Diabetes Rev*. 2013;9(6):462-471. doi:10.2174/15733998113096660084. | | X | | | | |
| Gallagher R, Armari E, White H, Hollams D. Multi-component weight-loss interventions for people with cardiovascular disease and/or type 2 diabetes mellitus: a systematic review. *Eur J Cardiovasc Nurs*. 2013;12(4):320-329. doi:10.1177/1474515112471002. | | | | X | | |
| Gilinsky AS, Kirk AF, Hughes AR, Lindsay RS. Lifestyle interventions for type 2 diabetes prevention in women with prior gestational diabetes: a systematic review and meta-analysis of behavioural, anthropometric and metabolic outcomes. *Prev Med Rep*. 2015;2:448-461. doi:10.1016/j.pmedr.2015.05.009. | | X | | | | |
| Gillett M, Royle P, Snaith A, et al. Non-pharmacological interventions to reduce the risk of diabetes in people with impaired glucose regulation: a systematic review and economic evaluation. *Health Technol Assess*. 2012;16(33):1-236, iii-iv. doi:10.3310/hta16330. | | | | X | | |
| Gkrania-Klotsas E, Ye Z, Cooper AJ, et al. Differential white blood cell count and type 2 diabetes: systematic review and meta-analysis of cross-sectional and prospective studies. *PLoS One*. 2010;5(10):e13405. doi:10.1371/journal.pone.0013405. | | | | X | | |
| Gong QH, Kang JF, Ying YY, et al. Lifestyle interventions for adults with impaired glucose tolerance: a systematic review and meta-analysis of the effects on glycemic control. *Intern Med*. 2015;54(3):303-310. doi:10.2169/internalmedicine.54.2745. | X | | | | | |
| Gonnelli S, Caffarelli C, Giordano N, Nuti R. The prevention of fragility fractures in diabetic patients. *Aging Clin Exp Res*. 2015;27(2):115-124. doi:10.1007/s40520-014-0258-3. | | X | | | | |
| Gordon BA, Benson AC, Bird SR, Fraser SF. Resistance training improves metabolic health in type 2 diabetes: a systematic review. *Diabetes Res Clin Pract*. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| 2009;83(2):157-175. doi:10.1016/j.diabres.2008.11.024. | | | | | | |
| Gorman E, Chudyk AM, Madden KM, Ashe MC. Bone health and type 2 diabetes mellitus: a systematic review. *Physiother Can*. 2011;63(1):8-20. doi:10.3138/ptc.2010-23bh. | | X | | | | |
| Grace A, Chan E, Giallauria F, Graham PL, Smart NA. Clinical outcomes and glycaemic responses to different aerobic exercise training intensities in type II diabetes: a systematic review and meta-analysis. *Cardiovasc Diabetol*. 2017;16(1):37. doi:10.1186/s12933-017-0518-6. | | X | | | | |
| 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. doi:10.1001/jama.2011.812. | | | | X | | |
| Gu Y, Dennis SM. Are falls prevention programs effective at reducing the risk factors for falls in people with type-2 diabetes mellitus and peripheral neuropathy: a systematic review with narrative synthesis. *J Diabetes Complications*. 2017;31(2):504-516. doi:10.1016/j.jdiacomp.2016.10.004. | | X | | | | |
| Guo J, Chen JL, Whittemore R, Whitaker E. Postpartum lifestyle interventions to prevent type 2 diabetes among women with history of gestational diabetes: a systematic review of randomized clinical trials. *J Womens Health (Larchmt)*. 2016;25(1):38-49. doi:10.1089/jwh.2015.5262. | | X | | | | |
| Hamilton MT, Hamilton DG, Zderic TW. Sedentary behavior as a mediator of type 2 diabetes. *Med Sport Sci.* 2014;60:11-26. doi:10.1159/000357332. | | | X | | | |
| Hayashino Y, Jackson JL, Fukumori N, Nakamura F, Fukuhara S. Effects of supervised exercise on lipid profiles and blood pressure control in people with type 2 diabetes mellitus: a meta-analysis of randomized controlled trials. *Diabetes Res Clin Pract*. 2012;98(3):349-360. doi:10.1016/j.diabres.2012.10.004. | | X | | | | |
| Hayashino Y, Jackson JL, Hirata T, et al. Effects of exercise on C-reactive protein, inflammatory cytokine and adipokine in patients with type 2 diabetes: a meta-analysis of randomized controlled trials. *Metabolism*. 2014;63(3):431-440. doi:10.1016/j.metabol.2013.08.018. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Hayes C, Kriska A. Role of physical activity in diabetes management and prevention. *J Am Diet Assoc*. 2008;108(4)(suppl 1):S19-S23. doi:10.1016/j.jada.2008.01.016. | | | X | | | |
| Health Quality Ontario. Behavioural interventions for type 2 diabetes: an evidence-based analysis. *Ont Health Technol Assess Ser*. 2009;9(21):1-45. | | X | | | | |
| Heinrich E, Schaper NC, de Vries NK. Self-management interventions for type 2 diabetes: a systematic review. *European Diabetes Nursing*. 2010;7(2):71-76. doi:10.1002/edn.160. | | X | | | | |
| Heiss V, Petosa R. Correlates of physical activity among adults with type 2 diabetes: a systematic literature review. *J Health Educ.* 2014;45(5):278-287. doi:10.1080/19325037.2014.933139. | | X | | | | |
| Helou N, Dwyer A, Shaha M, Zanchi A. Multidisciplinary management of diabetic kidney disease: a systematic review and meta-analysis. *JBI Database System Rev Implement Rep*. 2016;14(7):169-207. doi:10.11124/JBISRIR-2016-003011. | | X | | | | |
| Henson J, Dunstan DW, Davies MJ, Yates T. Sedentary behaviour as a new behavioural target in the prevention and treatment of type 2 diabetes. *Diabetes Metab Res Rev*. 2016;32(suppl 1):213-220. doi:10.1002/dmrr.2759. | | | X | | | |
| Hopper I, Billah B, Skiba M, Krum H. Prevention of diabetes and reduction in major cardiovascular events in studies of subjects with prediabetes: meta-analysis of randomised controlled clinical trials. *Eur J Cardiovasc Prev Rehabil*. 2011;18(6):813-823. doi:10.1177/1741826711421687. | | | | X | | |
| Hovanec N, Sawant A, Overend TJ, Petrella RJ, Vandervoort AA. Resistance training and older adults with type 2 diabetes mellitus: strength of the evidence. *J Aging Res*. 2012;2012:284635. doi:10.1155/2012/284635. | | X | | | | |
| Howells L, Musaddaq B, McKay AJ, Majeed A. Clinical impact of lifestyle interventions for the prevention of diabetes: an overview of systematic reviews. *BMJ Open*. 2016;6(12):e013806. doi:10.1136/bmjopen-2016-013806. | | | | X | | |
| Htoo ZW, Hsu WW, Rosenkranz R. Systematic review and meta-analysis: is lifestyle modification effective for glycemic control among adults with type II diabetes in Southeast Asia? *Diabetes Res Clin Pract*. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| 2016;122:148-153. doi:10.1016/j.diabres.2016.10.008. | | | | | | |
| Huang JP, Yeh ML. The qigong effect on blood glucose control in people with type 2 diabetes: a systematic review and meta-analysis. *Journal of Nursing and Healthcare Research*. 2013;9(3):199-209. | | | | | | X |
| Huang XL, Pan JH, Chen D, Chen J, Chen F, Hu TT. Efficacy of lifestyle interventions in patients with type 2 diabetes: a systematic review and meta-analysis. *Eur J Intern Med*. 2016;27:37-47. doi:10.1016/j.ejim.2015.11.016. | | X | | | | |
| Hudon C, Fortin M, Soubhi H. Single risk factor interventions to promote physical activity among patients with chronic diseases: systematic review. *Can Fam Physician*. 2008;54(8):1130-1137. | | X | | | | |
| Humphreys BR, McLeod L, Ruseski JE. Physical activity and health outcomes: evidence from Canada. *Health Econ*. 2014;23(1):33-54. doi:10.1002/hec.2900. | | | X | | | |
| Hwang MH, Kim S. Type 2 diabetes: endothelial dysfunction and exercise. *J Exerc Nutrition Biochem*. 2014;18(3):239-247. doi:10.5717/jenb.2014.18.3.239. | | X | | | | |
| Innes KE, Selfe TK. Yoga for adults with type 2 diabetes: a systematic review of controlled trials. *J Diabetes Res*. 2016;2016:6979370. doi:10.1155/2016/6979370. | | X | | | | |
| Innes KE, Vincent HK. The influence of yoga-based programs on risk profiles in adults with type 2 diabetes mellitus: a systematic review. *Evid Based Complement Alternat Med*. 2007;4(4):469-486. doi:10.1093/ecam/nel103. | | X | | | | |
| Irvine C, Taylor NF. Progressive resistance exercise improves glycaemic control in people with type 2 diabetes mellitus: a systematic review. *Aust J Physiother*. 2009;55(4):237-246. | | X | | | | |
| Ishiguro H, Kodama S, Horikawa C, et al. In search of the ideal resistance training program to improve glycemic control and its indication for patients with type 2 diabetes mellitus: a systematic review and meta-analysis. *Sports Med*. 2016;46(1):67-77. doi:10.1007/s40279-015-0379-7. | | X | | | | |
| Ites KI, Anderson EJ, Cahill ML, Kearney JA, Post EC, Gilchrist LS. Balance interventions for diabetic peripheral neuropathy: a systematic review. *J Geriatr Phys Ther*. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| 2011;34(3):109-116. doi:10.1519/JPT.0b013e318212659a. | | | | | | |
| Jadhav RA, Hazari A, Monterio A, Kumar S, Maiya AG. Effect of physical activity intervention in prediabetes: a systematic review with meta-analysis. *J Phys Act Health*. 2017;14(9):745-755. doi:10.1123/jpah.2016-0632. | X | | | | | |
| Jelleyman C, Yates T, O'Donovan G, et al. The effects of high-intensity interval training on glucose regulation and insulin resistance: a meta-analysis. *Obes Rev*. 2015;16(11):942-961. doi:10.1111/obr.12317. | X | | | | | |
| Jenkins F, Jenkins C, Gregoski MJ, Magwood GS. Interventions promoting physical activity in African American women: an integrative review. *J Cardiovasc Nurs*. 2017;32(1):22-29. doi:10.1097/JCN.0000000000000298. | X | | | | | |
| Jiang Y, Ben Q, Shen H, Lu W, Zhang Y, Zhu J. Diabetes mellitus and incidence and mortality of colorectal cancer: a systematic review and meta-analysis of cohort studies. *Eur J Epidemiol*. 2011;26(11):863-876. doi:10.1007/s10654-011-9617-y. | | X | | | | |
| Johnson M, Jones R, Freeman C, et al. Can diabetes prevention programmes be translated effectively into real-world settings and still deliver improved outcomes? A synthesis of evidence. *Diabet Med*. 2013;30(1):3-15. doi:10.1111/dme.12018. | | | | X | | |
| Johnson ST, Newton AS, Chopra M, et al. In search of quality evidence for lifestyle management and glycemic control in children and adolescents with type 2 diabetes: a systematic review. *BMC Pediatr*. 2010;10:97(2). doi:10.1186/1471-2431-10-97. | | X | | | | |
| Jones EJ, Fraley HE, Mazzawi J. Appreciating recent motherhood and culture: a systematic review of multimodal postpartum lifestyle interventions to reduce diabetes risk in women with prior gestational diabetes. *Matern Child Health J*. 2017;21(1):45-57. doi:10.1007/s10995-016-2092-z. | | | | X | | |
| Joseph LM, Berry D, Jessup A. Management of type 2 diabetes in Asian Indians: a review of the literature. *Clin Nurs Res*. 2015;24(2):188-210. doi:10.1177/1054773814531600. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Kavookjian J, Elswick BM, Whetsel T. Interventions for being active among individuals with diabetes: a systematic review of the literature. *Diabetes Educ*. 2007;33(6):962-988; discussion 989-990. doi:10.1177/0145721707308411. | | X | | | | |
| Kelley GA, Kelley KS. Effects of aerobic exercise on lipids and lipoproteins in adults with type 2 diabetes: a meta-analysis of randomized-controlled trials. *Public Health*. 2007;121(9):643-655. doi:10.1016/j.puhe.2007.02.014. | | X | | | | |
| Kitahara CM, Platz EA, Beane Freeman LE, et al. Physical activity, diabetes, and thyroid cancer risk: a pooled analysis of five prospective studies. *Cancer Causes Control.* 2012;23(3):463-471. doi:10.1007/s10552-012-9896-y. | | X | | | | |
| Kivimaki M, Virtanen M, Kawachi I, et al. Long working hours, socioeconomic status, and the risk of incident type 2 diabetes: a meta-analysis of published and unpublished data from 222 120 individuals. *Lancet Diabetes Endocrinol*. 2015;3(1):27-34. doi:10.1016/S2213-8587(14)70178-0. | | | | X | | |
| Kodama S, Tanaka S, Heianza Y, et al. Association between physical activity and risk of all-cause mortality and cardiovascular disease in patients with diabetes: a meta-analysis. *Diabetes Care*. 2013;36(2):471-479. doi:10.2337/dc12-0783. | | X | | | | |
| Koivula RW, Tornberg AB, Franks PW. Exercise and diabetes-related cardiovascular disease: systematic review of published evidence from observational studies and clinical trials. *Curr Diab Rep*. 2013;13(3):372-380. doi:10.1007/s11892-013-0373-0. | | X | | | | |
| Korczak D, Dietl M, Steinhauser G. Effectiveness of programmes as part of primary prevention demonstrated on the example of cardiovascular diseases and the metabolic syndrome. *GMS Health Technol Assess.* 2011;7:Doc02. doi:10.3205/hta000093. | X | | | | | |
| Krass I, Hebing R, Mitchell B, et al. Diabetes management in an Australian primary care population. *J Clin Pharm Ther*. 2011;36(6):664-672. doi:10.1111/j.1365-2710.2010.01221.x. | | | X | | | |
| Kriska AM, Hawkins M, Richardson CR. Physical activity and the prevention of type II diabetes. *Curr Sports Med Rep*. | | | X | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| 2008;7(4):182-184. doi:10.1249/JSR.0b013e31817ec0b4. | | | | | | |
| Kujala UM. Evidence on the effects of exercise therapy in the treatment of chronic disease. *Br J Sports Med*. 2009;43(8):550-555. doi:10.1136/bjsm.2009.059808. | | X | | | | |
| Kumar V, Jagannathan A, Philip M, Thulasi A, Angadi P, Raghuram N. Role of yoga for patients with type II diabetes mellitus: a systematic review and meta-analysis. *Complement Ther Med*. 2016;25:104-112. doi:10.1016/j.ctim.2016.02.001. | | X | | | | |
| Laaksonen MA, Knekt P, Rissanen H, et al. The relative importance of modifiable potential risk factors of type 2 diabetes: a meta-analysis of two cohorts. *Eur J Epidemiol*. 2010;25(2):115-124. doi:10.1007/s10654-009-9405-0. | | | | X | | |
| Lam DW, LeRoith D. In: De Groot LJ, Chrousos G, Dungan K, et al., eds. *Metabolic Syndrome*. Endotext. South Dartmouth, MA: MDtext.com; 2000. | | | X | | | |
| Lee J, Kim D, Kim C. Resistance training for glycemic control, muscular strength, and lean body mass in old type 2 diabetic patients: a meta-analysis. *Diabetes Ther*. 2017;8(3):459-473. doi:10.1007/s13300-017-0258-3. | | X | | | | |
| Lee MS, Chen KW, Choi TY, Ernst E. Qigong for type 2 diabetes care: a systematic review. *Complement Ther Med*. 2009;17(4):236-242. doi:10.1016/j.ctim.2009.05.001. | | X | | | | |
| Lee MS, Choi TY, Lim HJ, Ernst E. Tai chi for management of type 2 diabetes mellitus: a systematic review. *Chin J Integr Med*. 2011;17(10):789-793. doi:10.1007/s11655-011-0812-1. | | X | | | | |
| Lee MS, Ernst E. Systematic reviews of t'ai chi: an overview. *Br J Sports Med*. 2012;46(10):713-718. doi:10.1136/bjsm.2010.080622. | X | | | | | |
| Lee MS, Jun JH, Lim HJ, Lim HS. A systematic review and meta-analysis of tai chi for treating type 2 diabetes. *Maturitas*. 2015;80(1):14-23. doi:10.1016/j.maturitas.2014.09.008. | | X | | | | |
| Lee MS, Pittler MH, Kim MS, Ernst E. Tai chi for type 2 diabetes: a systematic review. *Diabet Med*. 2008;25(2):240-241. doi:10.1111/j.1464-5491.2007.02325.x. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Lin JS, O'Connor EA, Evans CV, Senger CA, Rowland MG, Groom HC. Behavioral counseling to promote a healthy lifestyle for cardiovascular disease prevention in persons with cardiovascular risk factors: an updated systematic evidence review for the U.S. Preventive Services Task Force. *U.S. Preventive Services Task Force Evidence Syntheses, formerly Systematic Evidence Reviews.* Rockville, MD: Agency for Healthcare Research and Quality; 2014. 13-05179-EF-1. | | | | X | | |
| Lin X, Zhang X, Guo J, et al. Effects of exercise training on cardiorespiratory fitness and biomarkers of cardiometabolic health: a systematic review and meta-analysis of randomized controlled trials. *J Am Heart Assoc*. 2015;4(7):pii: e002014. doi:10.1161/JAHA.115.002014. | X | | | | | |
| Lirussi F. The global challenge of type 2 diabetes and the strategies for response in ethnic minority groups. *Diabetes Metab Res Rev*. 2010;26(6):421-432. doi:10.1002/dmrr.1105. | X | | | | | |
| Liubaoerjijin Y, Terada T, Fletcher K, Boule NG. Effect of aerobic exercise intensity on glycemic control in type 2 diabetes: a meta-analysis of head-to-head randomized trials. *Acta Diabetol*. 2016;53(5):769-781. doi:10.1007/s00592-016-0870-0. | | X | | | | |
| Longo-Mbenza B, Nkongo Mvindu H, Kasiam On'kin JB, et al. The deleterious effects of physical inactivity on elements of insulin resistance and metabolic syndrome in Central Africans at high cardiovascular risk. *Diabetes Metab Syndr*. 2011;5(1):1-6. doi:10.1016/j.dsx.2010.05.001. | | | X | | | |
| MacLeod SF, Terada T, Chahal BS, Boule NG. Exercise lowers postprandial glucose but not fasting glucose in type 2 diabetes: a meta-analysis of studies using continuous glucose monitoring. *Diabetes Metab Res Rev*. 2013;29(8):593-603. doi:10.1002/dmrr.2461. | | X | | | | |
| Madden SG, Loeb SJ, Smith CA. An integrative literature review of lifestyle interventions for the prevention of type II diabetes mellitus. *J Clin Nursing*. 2008;17(17):2243-2256. doi:10.1111/j.1365-2702.2008.02335.x. | | | X | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Maglione MA, Gibbons MM, Livhits M, et al. Bariatric surgery and nonsurgical therapy in adults with metabolic conditions and a body mass index of 30.0 to 34.9 kg/m2. *AHRQ Comparative Effectiveness Reviews.* Rockville, MD: Agency for Healthcare Research and Quality; 2013. 12(13)-EHC139-EF. | | | | X | | |
| Mann S, Beedie C, Balducci S, et al. Changes in insulin sensitivity in response to different modalities of exercise: a review of the evidence. *Diabetes Metab Res Rev*. 2014;30(4):257-268. doi:10.1002/dmrr.2488. | X | | | | | |
| Manne-Goehler J, Atun R, Stokes A, et al. Diabetes diagnosis and care in sub-Saharan Africa: pooled analysis of individual data from 12 countries. *Lancet Diabetes Endocrinol.* 2016;4(11):903-912. doi:10.1016/S2213-8587(16)30181-4. | X | | | X | | |
| Marwick TH, Hordern MD, Miller T, et al. Exercise training for type 2 diabetes mellitus: impact on cardiovascular risk: a scientific statement from the American Heart Association. *Circulation.* 2009;119(25):3244-3262. doi:10.1161/CIRCULATIONAHA.109.192521 | | X | | | | |
| Mathis RA, Taylor DJ, Fletcher JP, Rainey J, Cade WT, Bandy WD. Time course of exercise training-induced muscle strength changes in type 2 diabetes. *Cardiopulmonary Physical Therapy Journal*. 2016;27(4):133-139. doi:10.1097/CPT.0000000000000032. | | X | X | | | |
| Mayor S. Moderate exercise cuts type 2 diabetes risk but more is better, review finds. *Bmj.* Oct 2016:i5605 doi:10.1136/bmj.i5605. | | | X | | | |
| McGinley SK, Armstrong MJ, Boule NG, Sigal RJ. Effects of exercise training using resistance bands on glycaemic control and strength in type 2 diabetes mellitus: a meta-analysis of randomised controlled trials. *Acta Diabetol*. 2015;52(2):221-230. doi:10.1007/s00592-014-0594-y. | | X | | | | |
| McMillan KA, Kirk A, Hewitt A, MacRury S. A systematic and integrated review of mobile-based technology to promote active lifestyles in people with type 2 diabetes. *J Diabetes Sci Technol*. 2017;11(2):299-307. doi:10.1177/1932296816656018. | | X | | | | |
| Meader N, King K, Wright K, et al. Multiple risk behavior interventions: meta-analyses | X | | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| of RCTs. *Am J Prev Med*. 2017;53(1):e19-e30. doi:10.1016/j.amepre.2017.01.032. | | | | | | |
| Melo LC, Dativo-Medeiros J, Menezes-Silva CE, Barbosa CT, de Sousa-Rodrigues CF, Rabelo LA. Physical exercise on inflammatory markers in type 2 diabetes patients: a systematic review of randomized controlled trials. *Oxid Med Cell Longev*. 2017:8523728. doi:10.1155/2017/8523728. | | X | | | | |
| Mendes R, Sousa N, Almeida A, et al. Exercise prescription for patients with type 2 diabetes-a synthesis of international recommendations: narrative review. *Br J Sports Med*. 2016;50(22):1379-1381. doi:10.1136/bjsports-2015-094895. | | X | | | | |
| Merlotti C, Morabito A, Ceriani V, Pontiroli AE. Prevention of type 2 diabetes in obese at-risk subjects: a systematic review and meta-analysis. *Acta Diabetol*. 2014;51(5):853-863. doi:10.1007/s00592-014-0624-9. | | | | X | | |
| Milton K, Macniven R, Bauman A. Review of the epidemiological evidence for physical activity and health from low- and middle-income countries. *Glob Public Health*. 2014;9(4):369-381. doi:10.1080/17441692.2014.894548. | | | | | X | |
| Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. *J Clin Endocrinol Metab*. 2008;93(11)(suppl 1):S9-S30. doi:10.1210/jc.2008-1595. | | | X | | | |
| Misra A, Nigam P, Hills AP, et al. Consensus physical activity guidelines for Asian Indians. *Diabetes Technol Ther*. 2012;14(1):83-98. doi:10.1089/dia.2011.0111. | | | X | | | |
| Montero D, Walther G, Benamo E, Perez-Martin A, Vinet A. Effects of exercise training on arterial function in type 2 diabetes mellitus: a systematic review and meta-analysis. *Sports Med*. 2013;43(11):1191-1199. doi:10.1007/s40279-013-0085-2. | | X | | | | |
| Musaiger AO, Al-Hazzaa HM. Prevalence and risk factors associated with nutrition-related noncommunicable diseases in the Eastern Mediterranean region. *Int J Gen Med*. Feb 2012:199-217. doi:10.2147/IJGM.S29663. | X | | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| National Clinical Guideline Centre (UK). *Hypertension: the clinical management of primary hypertension in adults: update of clinical guidelines 18 and 34.* London: Royal College of Physicians (UK); 2011. | X | | | | | |
| Nerat T, Locatelli I, Kos M. Type 2 diabetes: cost-effectiveness of medication adherence and lifestyle interventions. *Patient Prefer Adherence*. Oct 2016:2039-2049. doi:10.2147/PPA.S114602. | | X | | | | |
| Nielsen PJ, Hafdahl AR, Conn VS, Lemaster JW, Brown SA. Meta-analysis of the effect of exercise interventions on fitness outcomes among adults with type 1 and type 2 diabetes. *Diabetes Res Clin Pract*. 2006;74(2):111-120. doi:10.1016/j.diabres.2006.03.033. | | X | | | | |
| Nunan D, Mahtani KR, Roberts N, Heneghan C. Physical activity for the prevention and treatment of major chronic disease: an overview of systematic reviews. *Syst Rev*. July 2013:56. doi:10.1186/2046-4053-2-56. | | | X | | | |
| O'Donovan G, Blazevich AJ, Boreham C, et al. The ABC of physical activity for health: a consensus statement from the British Association of Sport and Exercise Sciences. *J Sports Sci*. 2010;28(6):573-591. doi:10.1080/02640411003671212. | X | | | | | |
| Oliveira C, Simoes M, Carvalho J, Ribeiro J. Combined exercise for people with type 2 diabetes mellitus: a systematic review. *Diabetes Res Clin Pract*. 2012;98(2):187-198. doi:10.1016/j.diabres.2012.08.004. | | X | | | | |
| Orlando G, Balducci S, Bazzucchi I, Pugilese G, Sacchetti M. Neuromuscular dysfunction in type 2 diabetes: underlying mechanisms and effect of resistance training. *Diabetes Metab Res Rev.* 2016;32(1):40-50. doi:10.1002/dmrr.2658. | | X | | | | |
| Orozco LJ, Buchleitner AM, Gimenez-Perez G, Roqué I Figuls M, Richter B, Mauricio D. Exercise or exercise and diet for preventing type 2 diabetes mellitus. *Cochrane Database Syst Rev*. 2008;(3):Cd003054. doi:10.1002/14651858.CD003054.pub3. | | | | | X | |
| Pai LW, Chang PY, Chen W, Hwu YJ, Lai CH. The effectiveness of physical leisure time activities on glycaemic control in adult patients with diabetes type 2: a systematic review. *JBI Libr Syst Rev*. 2012;10(42)(suppl):1-20. doi:10.11124/jbisrir-2012-251. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Pai LW, Li TC, Hwu YJ, Chang SC, Chen LL, Chang PY. The effectiveness of regular leisure-time physical activities on long-term glycemic control in people with type 2 diabetes: a systematic review and meta-analysis. *Diabetes Res Clin Pract*. 2016;113:77-85. doi:10.1016/j.diabres.2016.01.011. | | X | | | | |
| Pandey A, Tripathi P, Pandey R, Srivatava R, Goswami S. Alternative therapies useful in the management of diabetes: a systematic review. *J Pharm Bioallied Sci*. 2011;3(4):504-512. doi:10.4103/0975-7406.90103. | | X | | | | |
| Paulweber B, Valensi P, Lindstrom J, et al. A European evidence-based guideline for the prevention of type 2 diabetes. *Horm Metab Res*. 2010;42(suppl 1):S3-S36. doi:10.1055/s-0029-1240928. | | | X | | | |
| Pedersen BK, Saltin B. Exercise as medicine—evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scand J Med Sci Sports*. 2015;(25)(suppl 3):1-72. doi:10.1111/sms.12581. | | X | | | | |
| Phillips SM, Winett RA. Uncomplicated resistance training and health-related outcomes: evidence for a public health mandate. *Curr Sports Med Rep*. 2010;9(4):208-213. doi:10.1249/JSR.0b013e3181e7da73. | | | X | | | |
| Plotnikoff RC, Costigan SA, Karunamuni ND, Lubans DR. Community-based physical activity interventions for treatment of type 2 diabetes: a systematic review with meta-analysis. *Front Endocrinol (Lausanne)*. 2013;4:3. doi:10.3389/fendo.2013.00003. | | X | | | | |
| Plotnikoff RC, Karunamuni ND, Johnson JA, Kotovych M, Svenson LW. Health-related behaviours in adults with diabetes: associations with health care utilization and costs. *Can J Public Health*. 2008;99(3):227-231. | | X | | | | |
| Prasad VG, Abraham P. Management of chronic constipation in patients with diabetes mellitus. *Indian J Gastroenterol*. 2017;36(1):11-22. doi:10.1007/s12664-016-0724-2. | | X | | | | |
| Proper KI, Singh AS, van Mechelen W, et al. Sedentary behaviors and health outcomes among adults: a systematic review of prospective studies. *Am J Prev Med*. 2011;40(2):174-182. doi:10.1016/j.amepre.2010.10.015. | | | | X | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Psaltopoulou T, Ilias I, Alevizaki M. The role of diet and lifestyle in primary, secondary, and tertiary diabetes prevention: a review of meta-analyses. *Rev Diabet Stud*. 2010;7(1):26-35. doi:10.1900/RDS.2010.7.26. | | | | | X | |
| Qiu S, Cai X, Chen X, Yang B, Sun Z. Step counter use in type 2 diabetes: a meta-analysis of randomized controlled trials. *BMC Med*. Feb 2014:36. doi:10.1186/1741-7015-12-36. | | X | | | | |
| Qiu S, Cai X, Schumann U, Velders M, Sun Z, Steinacker JM. Impact of walking on glycemic control and other cardiovascular risk factors in type 2 diabetes: a meta-analysis. *PLoS One*. 2014;9(10):e109767. doi:10.1371/journal.pone.0109767. | | X | | | | |
| Ramsey Buchanan L, Rooks-Peck CR, Finnie RK, et al. Reducing recreational sedentary screen time: a community guide systematic review. *Am J Prev Med*. 2016;50(3):402-415. doi:10.1016/j.amepre.2015.09.030. | X | | | | | |
| Rattay KT, Rosenthal M. Reversing the diabetes epidemic: a role for primary care in identifying pre-diabetes and referral to an evidence-based program. *Del Med J.* 2014;86(10):307-13; quiz 317. | | | X | | | |
| Renzaho AM, Mellor D, Boulton K, Swinburn B. Effectiveness of prevention programmes for obesity and chronic diseases among immigrants to developed countries—a systematic review. *Public Health Nutr.* 2010;13(3):438-450. doi:10.1017/S136898000999111X. | | | | X | | |
| Riva JJ, Wong JJ, Brunarski DJ, et al. Consideration of chronic pain in trials to promote physical activity for diabetes: a systematic review of randomized controlled trials. *PLoS One*. 2013;8(8):e71021. doi:10.1371/journal.pone.0071021. | | X | | | | |
| Rodrigues AL, Ball J, Ski C, Stewart S, Carrington MJ. A systematic review and meta-analysis of primary prevention programmes to improve cardio-metabolic risk in non-urban communities. *Prev Med*. June 2016:22-34. doi:10.1016/j.ypmed.2016.02.011. | | | | X | | |
| Rohling M, Herder C, Roden M, Stemper T, Mussig K. Effects of long-term exercise interventions on glycaemic control in type 1 and type 2 diabetes: a systematic review. *Exp Clin Endocrinol Diabetes*. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| 2016;124(8):487-494. doi:10.1055/s-0042-106293. | | | | | | |
| Roine E, Roine RP, Rasanen P, Vuori I, Sintonen H, Saarto T. Cost-effectiveness of interventions based on physical exercise in the treatment of various diseases: a systematic literature review. *Int J Technol Assess Health Care*. 2009;25(4):427-454. doi:10.1017/S0266462309990353. | | X | | | | |
| Rosenzweig JL, Ferrannini E, Grundy SM, et al. Primary prevention of cardiovascular disease and type 2 diabetes in patients at metabolic risk: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab*. 2008;93(10):3671-3689. doi:10.1210/jc.2008-0222. | | | | X | | |
| Russell JW, Zilliox LA. Diabetic neuropathies. *Continuum (Minneap Minn).* 2014;20(5 Peripheral Nervous System Disorders):1226-1240. doi:10.1212/01.CON.0000455884.29545.d2. | | X | | | | |
| Ryden L, Grant PJ, Anker SD, et al. ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD: the Task Force on diabetes, pre-diabetes, and cardiovascular diseases of the European Society of Cardiology (ESC) and developed in collaboration with the European Association for the Study of Diabetes (EASD*). Eur Heart J*. 2013;34(39):3035-3087. doi:10.1093/eurheartj/eht108. | | | | X | | |
| Sabag A, Way KL, Keating SE, et al. Exercise and ectopic fat in type 2 diabetes: a systematic review and meta-analysis. *Diabetes Metab*. 2017;43(3):195-210. doi:10.1016/j.diabet.2016.12.006. | | X | | | | |
| Sacco IC, Sartor CD. From treatment to preventive actions: improving function in patients with diabetic polyneuropathy. *Diabetes Metab Res Rev*. 2016;32(suppl 1):206-212. doi:10.1002/dmrr.2737. | | | X | | | |
| Sadarangani KP, Hamer M, Mindell JS, Coombs NA, Stamatakis E. Physical activity and risk of all-cause and cardiovascular disease mortality in diabetic adults from Great Britain: pooled analysis of 10 population-based cohorts. *Diabetes Care*. 2014;37(4):1016-1023. doi:10.2337/dc13-1816. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Sato Y, Nagasaki M, Kubota M, Uno T, Nakai N. Clinical aspects of physical exercise for diabetes/metabolic syndrome. *Diabetes Res Clin Pract*. 2007;77(suppl 1):S87-S91. doi:10.1016/j.diabres.2007.01.039. | | | X | | | |
| Saunders LE, Green JM, Petticrew MP, Steinbach R, Roberts H. What are the health benefits of active travel? A systematic review of trials and cohort studies. *PLoS One.* 2013;8(8):e69912. doi:10.1371/journal.pone.0069912. | | | | X | | |
| Scarton LJ, de Groot M. Emotional and behavioral aspects of diabetes in American Indians/Alaska Natives. *Health Educ Behav*. 2017;44(1):70-82. doi:10.1177/1090198116639289. | | X | | | | |
| Schellenberg ES, Dryden DM, Vandermeer B, Ha C, Korownyk C. Lifestyle interventions for patients with and at risk for type 2 diabetes: a systematic review and meta-analysis. *Ann Intern Med*. 2013;159(8):543-551. doi:10.7326/0003-4819-159-8-201310150-00007. | | | | X | | |
| Schellenberg ES, Dryden DM, Vandermeer B, Ha C, Korownyk C. Lifestyle interventions for patients with and at risk for type 2 diabetes: a systematic review and meta-analysis. *Ann Intern Med*. 2013;159(8):543-551. doi:10.7326/0003-4819-159-8-201310150-00007. | | | | X | | |
| Schmid D, Behrens G, Jochem C, Keimling M, Leitzmann M. Physical activity, diabetes, and risk of thyroid cancer: a systematic review and meta-analysis. *Eur J Epidemiol*. 2013;28(12):945-958. doi:10.1007/s10654-013-9865-0. | X | | | | | |
| Schwingshackl L, Missbach B, Dias S, Konig J, Hoffmann G. Impact of different training modalities on glycaemic control and blood lipids in patients with type 2 diabetes: a systematic review and network meta-analysis. *Diabetologia*. 2014;57(9):1789-1797. doi:10.1007/s00125-014-3303-z. | | X | | | | |
| Scott RA, Chu AY, Grarup N, et al. No interactions between previously associated 2-hour glucose gene variants and physical activity or BMI on 2-hour glucose levels. *Diabetes*. 2012;61(5):1291-1296. doi:10.2337/db11-0973. | | | | X | | |
| Sigal RJ, Armstrong MJ, Colby P, et al. Physical activity and diabetes. *Can J Diabetes*. 2013;37(suppl 1):S40-S44. doi:10.1016/j.jcjd.2013.01.018. | | | X | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. Physical activity/exercise and type 2 diabetes: a consensus statement from the American Diabetes Association. *Diabetes Care*. 2006;29(6):1433-1438. doi:10.2337/dc06-9910. | | X | | | | |
| Singh K, Ansari M, Galipeau J, et al. An evidence map of systematic reviews to inform interventions in prediabetes. *Can J Diabetes*. 2012;36(5):281-291. doi:10.1016/j.jcjd.2012.06.004. | | | X | | | |
| Sluik D, Buijsse B, Muckelbauer R, et al. Physical activity and mortality in individuals with diabetes mellitus: a prospective study and meta-analysis. *Arch Intern Med*. 2012;172(17):1285-1295. doi:10.1001/archinternmed.2012.3130. | | X | | | | |
| Smith AD, Crippa A, Woodcock J, Brage S. Physical activity and incident type 2 diabetes mellitus: a systematic review and dose-response meta-analysis of prospective cohort studies. *Diabetologia*. 2016;59(12):2527-2545. doi:10.1007/s00125-016-4079-0. | | X | | | | |
| Smith S, Wallace EM, O'Dowd T, Fortin M. Interventions for improving outcomes in patients with multimorbidity in primary care and community settings. *Cochrane Database of Syst Rev*. 2016;14(3):CD006560. doi:10.1002/14651858.CD006560.pub3. | | X | | | | |
| Smith SA, Ansa B. A systematic review of lifestyle interventions for chronic diseases in rural communities. *J Ga Public Health Assoc*. 2016;5(4):304-313. doi:10.21663/jgpha.5.404. | X | | | | | |
| Snowling NJ, Hopkins WG. Effects of different modes of exercise training on glucose control and risk factors for complications in type 2 diabetic patients: a meta-analysis. *Diabetes Care*. 2006;29(11):2518-2527. doi:10.2337/dc06-1317. | | X | | | | |
| Soderlund PD. The social ecological model and physical activity interventions for Hispanic women with type 2 diabetes: a review. *J Transcult Nurs*. 2016;28(3):306-314. doi:10.1177/1043659616649671. | | X | | | | |
| Solomon TP, Thyfault JP. Type 2 diabetes sits in a chair. *Diabetes Obes Metab*. 2013;15(11):987-992. doi:10.1111/dom.12105. | | | X | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Spratt KA. Managing diabetic dyslipidemia: aggressive approach. *J Am Osteopath Assoc*. 2009;109(5)(suppl):S2-S7. | | X | | | | |
| Staimez LR, Weber MB, Gregg EW. The role of lifestyle change for prevention of cardiovascular disease in diabetes. *Curr Atheroscler Rep*. 2014;16(12):460. doi:10.1007/s11883-014-0460-y. | | X | | | | |
| Standl E, Erbach M, Schnell O. Glycemic control: a combination of lifestyle management and the use of drugs. *Cardiol Ther*. 2013;2(1):1-16. doi:10.1007/s40119-012-0007-7. | | | X | | | |
| Stephens NA, Sparks LM. Resistance to the beneficial effects of exercise in type 2 diabetes: are some individuals programmed to fail? *J Clin Endocrinol Metab*. 2015;100(1):43-52. doi:10.1210/jc.2014-2545. | | X | | | | |
| Stevens JW, Khunti K, Harvey R, et al. Preventing the progression to type 2 diabetes mellitus in adults at high risk: a systematic review and network meta-analysis of lifestyle, pharmacological and surgical interventions. *Diabetes Res Clin Pract*. 2015;107(3):320-331. doi:10.1016/j.diabres.2015.01.027. | | | | X | | |
| Strasser B, Siebert U, Schobersberger W. Resistance training in the treatment of the metabolic syndrome: a systematic review and meta-analysis of the effect of resistance training on metabolic clustering in patients with abnormal glucose metabolism. *Sports Med*. 2010;40(5):397-415. doi:10.2165/11531380-000000000-00000. | X | | | | | |
| Sukala WR, Page R, Cheema BS. Exercise training in high-risk ethnic populations with type 2 diabetes: a systematic review of clinical trials. *Diabetes Res Clin Pract*. 2012;97(2):206-216. doi:10.1016/j.diabres.2012.02.001. | | X | | | | |
| Sukala WR, Page R, Lonsdale C, et al. Exercise improves quality of life in indigenous Polynesian peoples with type 2 diabetes and visceral obesity. *J Phys Act Health*. 2013;10(5):699-707. | | X | X | | | |
| Sukala WR, Page R, Rowlands DS, et al. South Pacific Islanders resist type 2 diabetes: comparison of aerobic and resistance training. *Eur J Appl Physiol*. 2012;112(1):317-325. doi:10.1007/s00421-011-1978-0. | | | X | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Sumlin LL, Garcia TJ, Brown SA, et al. Depression and adherence to lifestyle changes in type 2 diabetes: a systematic review. *Diabetes Educ*. 2014;40(6):731-744. doi:10.1177/0145721714538925. | | X | | | | |
| Sun Y, You W, Almeida F, Estabrooks P, Davy B. The effectiveness and cost of lifestyle interventions including nutrition education for diabetes prevention: a systematic review and meta-analysis. *J Acad Nutr Diet*. 2017;117(3):404-421.e36. doi:10.1016/j.jand.2016.11.016. | | | | X | | |
| Swanson A, Watrin K, Wilder L. Clinical inquiries: how can we keep impaired glucose tolerance and impaired fasting glucose from progressing to diabetes? *J Fam Pract*. 2010;59(9):532-533. | | | X | | | |
| Tanaka S, Tanaka S, Iimuro S, et al.; Japan Diabetes Complications Study Group and the Japanese Elderly Diabetes Intervention Trial Group. Body mass index and mortality among Japanese patients with type 2 diabetes: pooled analysis of the Japan diabetes complications study and the Japanese elderly diabetes intervention trial. *J Clin Endocrinol Metab*. 2014;99(12):E2692-E2696. doi:10.1210/jc.2014-1855. | | X | | | | |
| Tanaka S, Tanaka S, Iimuro S, et al.; Japan Diabetes Complications Study Group; Japanese Elderly Diabetes Intervention Trial Group. Predicting macro- and microvascular complications in type 2 diabetes: the Japan Diabetes Complications Study/the Japanese Elderly Diabetes Intervention Trial risk engine. *Diabetes Care*. 2013;36(5):1193-1199. doi:10.2337/dc12-0958. | | | | X | | |
| Taylor J, Stubbs B, Hewitt C, et al. The effectiveness of pharmacological and non-pharmacological interventions for improving glycaemic control in adults with severe mental illness: a systematic review and meta-analysis. *PLoS One*. 2017;12(1):e0168549. doi:10.1371/journal.pone.0168549. | | X | | | | |
| Terranova CO, Brakenridge CL, Lawler SP, Eakin EG, Reeves MM. Effectiveness of lifestyle-based weight loss interventions for adults with type 2 diabetes: a systematic review and meta-analysis. *Diabetes Obes Metab*. 2015;17(4):371-378. doi:10.1111/dom.12430. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Thent ZC, Das S, Henry LJ. Role of exercise in the management of diabetes mellitus: the global scenario. *PLoS One*. 2013;8(11):e80436. doi:10.1371/journal.pone.0080436. | | X | | | | |
| Thibault V, Belanger M, LeBlanc E, et al. Factors that could explain the increasing prevalence of type 2 diabetes among adults in a Canadian province: a critical review and analysis. *Diabetol Metab Syndr*. Nov 2016:71. doi:10.1186/s13098-016-0186-9. | | | X | | | |
| Thomas DE, Elliott EJ, Naughton GA. Exercise for type 2 diabetes mellitus. *Cochrane Database Syst Rev.* 2006;(3):Cd002968. doi:10.1002/14651858.CD002968.pub2 | | X | | | | |
| Thomas GN, Jiang CQ, Taheri S, et al. A systematic review of lifestyle modification and glucose intolerance in the prevention of type 2 diabetes. *Curr Diabetes Rev*. 2010;6(6):378-387. | | | | X | | |
| Toledo FG, Goodpaster BH. The role of weight loss and exercise in correcting skeletal muscle mitochondrial abnormalities in obesity, diabetes and aging. *Mol Cell Endocrinol*. 2013;379(1-2):30-34. doi:10.1016/j.mce.2013.06.018. | | | X | | | |
| Tschentscher M, Niederseer D, Niebauer J. Health benefits of Nordic walking: a systematic review. *Am J Prev Med*. 2013;44(1):76-84. doi:10.1016/j.amepre.2012.09.043. | X | | | | | |
| Umpierre D, Ribeiro PA, Kramer CK, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. *JAMA.* 2011;305(17):1790-1799. doi:10.1001/jama.2011.576. | | X | | | | |
| Umpierre D, Ribeiro PA, Schaan BD, Ribeiro JP. Volume of supervised exercise training impacts glycaemic control in patients with type 2 diabetes: a systematic review with meta-regression analysis. *Diabetologia*. 2013;56(2):242-251. doi:10.1007/s00125-012-2774-z. | | X | | | | |
| Vaes AW, Cheung A, Atakhorrami M, et al. Effect of 'activity monitor-based' counseling on physical activity and health-related outcomes in patients with chronic diseases: a systematic review and meta-analysis. *Ann Med*. 2013;45(5-6):397-412. doi:10.3109/07853890.2013.810891. | | X | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| van der Heijden MM, van Dooren FE, Pop VJ, Pouwer F. Effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in type 2 diabetes mellitus: a systematic review. *Diabetologia*. 2013;56(6):1210-1225. doi:10.1007/s00125-013-2871-7. | | X | | | | |
| van der Heijden MM, van Dooren FE, Pop VJ, Pouwer F. Effects of exercise training on quality of life, symptoms of depression, symptoms of anxiety and emotional well-being in type 2 diabetes mellitus: a systematic review. *Diabetologia*. 2013;56(6):1210-1225. doi:10.1007/s00125-013-2871-7. | | X | | | | |
| Van Huffel L, Tomson CR, Ruige J, Nistor I, Van Biesen W, Bolignano D. Dietary restriction and exercise for diabetic patients with chronic kidney disease: a systematic review. *PLoS One*. 2014;9(11):e113667. doi:10.1371/journal.pone.0113667. | | X | | | | |
| van Nieuwaal PA, Wittink HM, de Valk HW. Effectiveness of supervised exercise programmes versus exercise advice in individuals with diabetes mellitus type 2: a systematic review. *Database of Abstracts of Reviews of Effects*. 2009;119(6):198-205. | | | | | | X |
| Vancampfort D, Stubbs B. Physical activity and metabolic disease among people with affective disorders: Prevention, management and implementation. *J Affect Disord*. 2016;9(11):e113667. doi:10.1371/journal.pone.0113667. | | | X | | | |
| Vijgen SM, Hoogendoorn M, Baan CA, de Wit GA, Limburg W, Feenstra TL. Cost effectiveness of preventive interventions in type 2 diabetes mellitus: a systematic literature review. *Pharmacoeconomics*. 2006;24(5):425-441. | | | | X | | |
| Vizcaino M, Stover E. The effect of yoga practice on glycemic control and other health parameters in type 2 diabetes mellitus patients: a systematic review and meta-analysis. *Complement Ther Med*. 2016;28:57-66. doi:10.1016/j.ctim.2016.06.007. | | X | | | | |
| Walker KZ, O'Dea K, Gomez M, Girgis S, Colagiuri R. Diet and exercise in the prevention of diabetes. *J Hum Nutr Diet*. 2010;23(4):344-352. doi:10.1111/j.1365-277X.2010.01061.x. | | | | X | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Wang X, Pi Y, Chen B, et al. Effect of traditional Chinese exercise on the quality of life and depression for chronic diseases: a meta-analysis of randomised trials. *Sci Rep*. Nov 2015:15913. doi:10.1038/srep15913. | | X | | | | |
| Way KL, Hackett DA, Baker MK, et al. The effect of regular exercise on insulin sensitivity in type 2 diabetes mellitus: a systematic review and meta-analysis. *Diabetes Metab J*. 2016;40(4):253-271. doi:10.4093/dmj.2016.40.4.253. | | X | | | | |
| Way KL, Keating SE, Baker MK, Chuter VH, Johnson NA. The effect of exercise on vascular function and stiffness in type 2 diabetes: a systematic review and meta-analysis. *Curr Diabetes Rev*. 2016;12(4):369-383. | | X | | | | |
| Wilmot EG, Edwardson CL, Achana FA, et al. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. *Diabetologia*. 2012;55(11):2895-2905. doi:10.1007/s00125-012-2677-z. | | | | X | | |
| Xin L, Miller YD, Brown WJ. A qualitative review of the role of qigong in the management of diabetes. *J Altern Complement Med*. 2007;13(4):427-433. doi:10.1089/acm.2006.6052. | | X | | | | |
| Yamamoto-Kabasawa K, Hosojima M, Yata Y, et al. Benefits of a 12-week lifestyle modification program including diet and combined aerobic and resistance exercise on albuminuria in diabetic and non-diabetic Japanese populations. *Clin Exp Nephrol*. 2015;19(6):1079-1089. doi:10.1007/s10157-015-1103-5. | | | | X | | |
| Yan JH, Gu WJ, Pan L. Lack of evidence on tai chi-related effects in patients with type 2 diabetes mellitus: a meta-analysis. *Exp Clin Endocrinol Diabetes*. 2013;121(5):266-271. doi:10.1055/s-0033-1334932. | | X | | | | |
| Yang GY, Wang LQ, Ren J, et al. Evidence base of clinical studies on tai chi: a bibliometric analysis. *PLoS One*. 2015;10(3):e0120655. doi:10.1371/journal.pone.0120655. | | X | | | | |
| Yang K. A review of yoga programs for four leading risk factors of chronic diseases. *Evid Based Complement Alternat Med*. 2007;4(4):487-491. doi:10.1093/ecam/nem154. | | | | | X | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Yang Z, Scott CA, Mao C, Farmer AJ. Resistance exercise versus aerobic exercise for type 2 diabetes: a systematic review and meta-analysis. *Sports Med*. 2014;44(4):487-499. doi:10.1007/s40279-013-0128-8. | | X | | | | |
| Yardley JE, Colberg SR. Update on management of type 1 diabetes and type 2 diabetes in athletes. *Curr Sports Med Rep.* 2017;16(1):38-44. doi:10.1249/JSR.0000000000000327. | | X | | | | |
| Yates T, Khunti K, Bull F, Gorely T, Davies MJ. The role of physical activity in the management of impaired glucose tolerance: a systematic review. *Diabetologia*. 2007;50(6):1116-1126. doi:10.1007/s00125-007-0638-8. | | | X | | | |
| Yu TT, Yu XL, Zeng LM, Zhou X, Zhao RH. Baduanjin for diabetes: a systematic review. *Chinese Journal of Evidence-Based Medicine*. 2014;14(3):341-348. | | X | | | | |
| Zaccardi F, O'Donovan G, Webb DR, et al. Cardiorespiratory fitness and risk of type 2 diabetes mellitus: a 23-year cohort study and a meta-analysis of prospective studies. *Atherosclerosis*. 2015;243(1):131-137.doi:10.1016/j.atherosclerosis.2015.09.016 | | | | X | | |
| Zanuso S, Jimenez A, Pugliese G, Corigliano G, Balducci S. Exercise for the management of type 2 diabetes: a review of the evidence. *Acta Diabetol*. 2010;47(1):15-22. doi:10.1007/s00592-009-0126-3. | | | X | | | |
| Zhang X, Imperatore G, Thomas W, et al. Effect of lifestyle interventions on glucose regulation among adults without impaired glucose tolerance or diabetes: a systematic review and meta-analysis. *Diabetes Res Clin Pract*. Jan 2017:149-164. doi:10.1016/j.diabres.2016.11.020. | X | | | | | |
| Zheng L, Wu J, Wang G, et al. Comparison of control fasting plasma glucose of exercise-only versus exercise-diet among a pre-diabetic population: a meta-analysis. *Eur J Clin Nutr*. 2016;70(4):424-430. doi:10.1038/ejcn.2015.128. | X | | | | | |
| Zou Z, Cai W, Cai M, Xiao M, Wang Z. Influence of the intervention of exercise on obese type II diabetes mellitus: a meta-analysis. *Prim Care Diabetes*. 2016;10(3):186-201. doi:10.1016/j.pcd.2015.10.003. | X | | | | | |

| Citation | Outcome | Population | Study Design | Exposure | Not ideal fit for replacement of de novo search | Other |
|---|---|---|---|---|---|---|
| Zwald M, Elliott L, Brownson RC, Skala M. Evidence-based diabetes prevention and control programs and policies in local health departments. *Diabetes Educ*. 2015;41(6):755-762. doi:10.1177/0145721715601736. | | | X | | | |

**References**


1. Fogelholm M. Physical activity, fitness and fatness: relations to mortality, morbidity and disease risk factors. A systematic review. *Obes Rev*. 2010;11(3):202-221. doi:10.1111/j.1467-789X.2009.00653.x.

2. Qin L, Knol MJ, Corpeleijn E, Stolk RP. Does physical activity modify the risk of obesity for type 2 diabetes: a review of epidemiological data. *Eur J Epidemiol*. 2010;25(1):5-12. doi:10.1007/s10654-009-9395-y.

3. Reiner M, Niermann C, Jekauc D, Woll A. Long-term health benefits of physical activity—a systematic review of longitudinal studies. *BMC Public Health*. 2013;813. doi:10.1186/1471-2458-13-813.

4. Warburton DE, Charlesworth S, Ivey A, Nettlefold L, Bredin SS. A systematic review of the evidence for Canada's Physical Activity Guidelines for Adults. *Int J Behav Nutr Phys Act*. 2010;7:39. doi:10.1186/1479-5868-7-39.

5. Aune D, Norat T, Leitzmann M, Tonstad S, Vatten LJ. Physical activity and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis. *Eur J Epidemiol*. 2015;30(7):529-542. doi:10.1007/s10654-015-0056-z.

6. Cloostermans L, Wendel-Vos W, Doornbos G, et al. Independent and combined effects of physical activity and body mass index on the development of type 2 diabetes—a meta-analysis of 9 prospective cohort studies. *Int J Behav Nutr Phys Act*. 2015:147. doi:10.1186/s12966-015-0304-3.

7. Huai P, Han H, Reilly KH, Guo X, Zhang J, Xu A. Leisure-time physical activity and risk of type 2 diabetes: a meta-analysis of prospective cohort studies. *Endocrine*. 2016;52(2):226-230. doi:10.1007/s12020-015-0769-5.

8. Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical activity of moderate intensity and risk of type 2 diabetes: a systematic review. *Diabetes Care*. 2007;30(3):744-752. doi:10.2337/dc06-1842.

9. Kyu HH, Bachman VF, Alexander LT, et al. Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. *BMJ*. 2016;354:i3857. doi:10.1136/bmj.i3857.

10. Merlotti C, Morabito A, Pontiroli AE. Prevention of type 2 diabetes; a systematic review and meta-analysis of different intervention strategies. *Diabetes Obes Metab*. 2014;16(8):719-727. doi:10.1111/dom.12270.

11. Wahid A, Manek N, Nichols M, et al. Quantifying the association between physical activity and cardiovascular disease and diabetes: a systematic review and meta-analysis. *J Am Heart Assoc*. 2016;5(9). pii:e002495. doi:10.1161/JAHA.115.002495.

12. Xu F, Wang Y, Ware RS, et al. Joint impact of physical activity and family history on the development of diabetes among urban adults in Mainland China: a pooled analysis of community-based prospective cohort studies. *Asia Pac J Public Health*. 2015;27(2):NP372-381. doi:10.1177/1010539512443700.