E1: Evidence on physical activity for adults (no upper age limit) living with chronic conditions

Guiding Questions

E1. What is the association between **physical activity** and health-related outcomes?

a. Is there a dose response association (volume, duration, frequency, intensity)?
b. Does the association vary by type or domain of physical activity?

Inclusion Criteria

Population: People living with any of the following conditions:

- Cancer
- Hypertension
- Type 2 diabetes

Exposure: Greater volume, duration, frequency or intensity of physical activity
Comparison: No physical activity or lesser volume, duration, frequency, or intensity of physical activity

Condition	Outcomes	Importance
Cancer	All-cause mortality	Critical
	Cancer-specific mortality	Critical
	Risk of cancer recurrence or second primary cancer	Critical
Hypertension	Risk of co-morbid conditions	Critical
	Physical function	Critical
	Health-related quality of life	Critical
	Cardiovascular disease progression	Critical
Diabetes	Risk of co-morbid conditions	Critical
	Physical function	Critical
	Health-related quality of life	Critical
	Disease progression	Critical

Included Evidence

Thirty-six reviews were initially identified (published from 2016 to 2019) that examined the association between physical activity and health-related outcomes among people with chronic conditions *(1-36)*. However, 14 reviews were excluded from further evaluation given populations, exposures, or outcomes that were out-of-scope or given redundancy with another more comprehensive and credible review. **Table 6.1** presents the reviews that were excluded and their reason for exclusion.

Table 6.1. Excluded Systematic Reviews, with Reasons for Exclusion

Author, Year	Reason for Exclusion	Rationale
People living with cancer		
Blond, 2019 *(3)*	Population	Review is among a general unselected adult population, not among those with a history of cancer
Dinu, 2019 *(11)*	Population	Review is among a general unselected adult population, not among those with a history of cancer
Lee, 2019 *(16)*	Population	Review is among a general unselected adult population, not among those with a history of cancer
Liu, 2018 *(37)*	Population	Review is among a general unselected adult population, not among those with a history of cancer
Qui, 2019 *(26)*	Redundancy	Review by Friedenreich 2019 *(12)* includes same evidence base, is more comprehensive, and better quality
Spei, 2019 *(30)*	Redundancy	Review by Friedenreich 2019 *(12)* includes same evidence base, is more comprehensive, and better quality
People with hypertension		
Chen, 2017 *(6)*	Population	Review among adults with coronary artery disease, not among those with hypertension

Wang, 2017 *(32)*	Population	Review among a general unselected adult population, not among those with hypertension
Zhang, 2018 *(35)*	Population	Results not presented separately for those with hypertension
People with type 2 Diabetes		
Anand 2018 *(1)*	Outcome	Primary outcome is diastolic dysfunction
Bhati 2018 *(2)*	Outcome	Outcomes are measures of cardiac autonomic function (heart rate reserve, heart rate variability, baroreflex sensitivity)
Delevatti 2019 *(10)*	Exposure	Comparison of progressive aerobic training vs. non-progressive aerobic training
Jayawardena 2018 *(14)*	Exposure	Direct comparison between yoga and other forms of exercise
Mosalman Haghighi 2018 *(22)*	Outcome	Primary outcome is measures of physical activity

In general, these reviews had many limitations in their design, execution, and reporting. None of the systematic reviews were rated as having high credibility based on the AMSTAR 2 instrument. Eleven were rated as having moderate credibility, 5 were rated as having low credibility, and the remaining 6 were rated as having critically low credibility. Given concerns regarding the comprehensiveness and the validity of the results presented in reviews rated as having critically low credibility, they were not incorporated into the final Evidence Profiles. **Table 6.2** presents the ratings for each review according to all the AMSTAR 2 main domains.

After appropriate exclusions, 1 review was included among persons with cancer *(12)*, 2 reviews were included among persons with hypertension *(4, 7)*, and 13 reviews were included among those with diabetes *(5, 8, 13, 15, 19, 20, 25, 27, 29, 31, 33, 34, 36)* (**Table 6.3**). None of the reviews included evidence published in 2019; in fact, very few reviews included evidence published in 2017 or 2018. The included bodies of evidence for each review was relatively small ranging from 5 to 39 included studies; one review among persons with a history of cancer included 136 studies. Extracted data for each included review is presented in **Appendix A.** A summary of the U.S. Physical Activity Guidelines evidence relevant to these subgroups is provided in the Evidence Profiles.

Table 6.2. Credibility Ratings (AMSTAR 2)

Author, Year	PICO[1]	A priori Methods[2]	Study Design Selection[3]	Lit Search Strategy[4]	Study Selection[5]	Data Extraction[6]	Excluded Studies[7]	Included Studies[8]	RoB Assessment[9]	Funding Sources[10]	Statistical Methods[11]	Impact of RoB[12]	RoB Results[13]	Heterogeneity[14]	Publication Bias[15]	COI[16]	Overall Rating[17]
People living with cancer																	
Friedenreich, 2019 *(12)*	Y	PY	N	PY	Y	N	PY	PY	PY	N	Y	Y	Y	Y	Y	Y	**Moderate**
People living with hypertension																	
Cao, 2019 *(4)*	Y	N	N	PY	Y	Y	PY	PY	Y	N	Y	N	Y	Y	Y	Y	**Moderate**
Costa, 2018 *(7)*	Y	PY	N	PY	Y	Y	PY	Y	PY	N	Y	N	Y	N	N	Y	**Low**
de Sousa, 2017 *(9)*	Y	N	N	PY	Y	Y	N	PY	N	N	N	N	N	N	N	Y	**Critically Low**
People living with Type 2 diabetes																	
Chao 2018 *(5)*	Y	N	N	PY	Y	Y	PY	PY	PY	N	Y	N	Y	Y	Y	Y	**Moderate**
De Nardi 2018 *(8)*	Y	PY	N	PY	Y	Y	PY	PY	Y	N	Y	N	Y	Y	N	Y	**Moderate**
Jang 2019 *(13)*	Y	N	N	PY	Y	N	PY	PY	Y	N	Y	N	Y	Y	N	Y	**Low**
Lauche 2018 *(15)*	Y	PY	N	PY	Y	Y	PY	PY	Y	N	Y	Y	Y	Y	N	Y	**Moderate**
Lee 2017 *(17)*	Y	N	N	PY	Y	Y	PY	PY	Y	N	Y	N	N	Y	N	Y	**Critically Low**
Liao 2019 *(18)*	Y	N	N	PY	Y	N	PY	PY	PY	N	Y	N	N	N	Y	Y	**Critically Low**
Liu, Zhu, et al. 2019 *(19)*	Y	N	N	PY	Y	Y	PY	PY	Y	N	Y	Y	Y	Y	Y	Y	**Moderate**
Liu, Ye, et al. 2019 *(20)*	Y	N	N	PY	Y	Y	PY	PY	Y	N	Y	Y	Y	Y	Y	Y	**Moderate**
Meng 2018 *(21)*	Y	N	N	PY	Y	Y	N	PY	N	N	Y	N	Y	Y	Y	Y	**Critically Low**
Pan 2018 *(23)*	Y	PY	N	PY	Y	Y	PY	PY	Y	N	N	N	N	N	N	Y	**Critically Low**
Qui 2017 *(25)*	Y	PY	N	PY	N	Y	PY	PY	Y	N	Y	N	N	Y	Y	Y	**Moderate**
Rees 2017 *(27)*	Y	N	N	PY	Y	N	PY	PY	Y	N	Y	N	N	Y	Y	Y	**Low**
Sampath Kumar 2019 *(28)*	Y	PY	N	PY	N	Y	N	PY	N	N	N	N	Y	Y	N	Y	**Critically Low**

Author, Year	PICO[1]	A priori Methods[2]	Study Design Selection[3]	Lit Search Strategy[4]	Study Selection[5]	Data Extraction[6]	Excluded Studies[7]	Included Studies[8]	RoB Assessment[9]	Funding Sources[10]	Statistical Methods[11]	Impact of RoB[12]	RoB Results[13]	Heterogeneity[14]	Publication Bias[15]	COI[16]	Overall Rating[17]
Song 2018 *(29)*	Y	Y	N	PY	Y	Y	PY	PY	Y	N	Y	Y	Y	Y	Y	Y	**Moderate**
Thind 2017 *(31)*	Y	PY	N	PY	N	Y	PY	PY	N	N	Y	N	Y	Y	Y	Y	**Low**
Xia 2019 *(33)*	Y	N	N	PY	Y	Y	PY	Y	Y	N	Y	N	Y	Y	Y	Y	**Low**
Yu 2018 *(34)*	Y	N	N	PY	Y	Y	PY	PY	PY	N	Y	Y	Y	N	Y	N	**Moderate**
Zhou 2019 *(36)*	Y	N	N	PY	Y	Y	PY	PY	PY	N	Y	Y	Y	Y	Y	Y	**Moderate**

Abbreviations: COI = conflict of interest; N = no; N/A = not applicable; PICO = population, intervention, comparator, outcome; PY = partial yes; RoB = risk of bias; Y = yes

[1] Did the research questions and inclusion criteria for the review include the components of PICO?
[2] Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?
[3] Did the review authors explain their selection of the study designs for inclusion in the review?
[4] Did the review authors use a comprehensive literature search strategy?
[5] Did the review authors perform study selection in duplicate?
[6] Did the review authors perform data extraction in duplicate?
[7] Did the review authors provide a list of excluded studies and justify the exclusions?
[8] Did the review authors describe the included studies in adequate detail?
[9] Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?
[10] Did the review authors report on the sources of funding for the studies included in the review?
[11] If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?
[12] If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?
[13] Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review?
[14] Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?
[15] If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?
[16] Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?
[17] Shea et al. 2017. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both.

Table 6.3. Included Systematic Reviews

Author, Year	Outcomes							Last Search Date	# of Included Studies	AMSTAR 2 *(38)*
	All-causer mortality	Cancer-specific mortality	Risk of cancer reoccurrence	Risk of comorbid conditions	Physical function	Quality of life	Disease progression			
People living with cancer										
Friedenreich, 2019 *(12)*	X	X						Jul-2018	136	Moderate
People with hypertension										
Cao, 2019 *(4)*						X	X	Jul-2018	14	Moderate
Costa, 2018 *(7)*					X		X	Apr-2017	9	Low
de Sousa, 2017 *(9)*							X	Nov-2016	5	Critically Low
People with type 2 diabetes										
Chao 2018 *(5)*							X	Jun-2016	14	Moderate
De Nardi 2018 *(8)*							X	Jul-2017	7	Moderate
Jang 2019 *(13)*							X	Aug-2017	23	Low
Lauche 2018 *(15)*				X			X	Jan-2017	6	Moderate
Lee 2017 *(17)*					X		X	Nov-2016	10	Critically Low
Liao 2019 *(18)*							X	Jan-2018	20	Critically Low
Liu, Zhu, et al. 2019 *(19)*							X	Apr-2018	13	Moderate
Liu, Ye, et al. 2019 *(20)*							X	Sep-2018	24	Moderate
Meng 2018 *(21)*							X	Jun-2016	21	Critically Low
Pan 2018 *(23)*							X	Apr-2017	37	Critically Low
Qui 2017 *(25)*							X	Oct-2017	9	Moderate
Rees 2017 *(27)*						X	X	Feb-2017	9	Low
Sampath Kumar 2019 *(28)*							X	Jun-2017	11	Critically Low
Song 2018 *(29)*							X	Sep-2017	39	Moderate
Thind 2017 *(31)*							X	Feb-2016	23	Low
Xia 2019 *(33)*							X	Apr-2018	17	Low
Yu 2018 *(34)*						X	X	Dec-2016	20	Moderate

Zhou 2019 *(36)*					X	X	X	Mar-2018	23	Moderate

E.1. Physical Activity in adults living with chronic conditions

Table E.1.a. People who have been diagnosed with cancer, relationship between physical activity and health-related outcomes

Questions: What is the association between **physical activity** and health-related outcomes? Is there a dose response association (volume, duration, frequency, intensity)? Does the association vary by type or domain of PA?
Population: People who have been diagnosed with cancer
Exposure: Greater volume, duration, frequency, or intensity of physical activity
Comparison: No physical activity or lesser volume, duration, frequency, or intensity of physical activity
Outcome: All-cause mortality, cancer-specific mortality, risk of cancer recurrence or second primary cancer

Systematic review evidence Review credibility	No. of studies/ Study design No. of participants	Quality Assessment					Description of evidence Summary of findings	Certainty	US PAGAC evidence and conclusions *(39)*
		Risk of bias	Inconsistency	Indirectness †	Imprecision	Other			
All-cause mortality									
Friedenreich 2019 *(12)* Moderate	136 RCTs and observational studies[a] N=NR[a]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	Dose-response relationship between prediagnosis PA dose and ACM for breast cancer	Higher **prediagnosis** PA was protective for ACM among those with breast (HR = 0.82 [95% CI 0.76 to 0.87], 19 studies), colorectal (HR = 0.80 [95% CI, 0.74 to 0.87], 10 studies), hematologic ((HR = 0.84 [95% CI 0.79 to 0.89], 3 studies), and prostate cancer (HR = 0.89 [95% CI0.82 to 0.98), 2 studies). No statistically significant association between prediagnosis PA and ACM was found for esophagus, female reproductive, melanoma, or stomach cancer. Higher **postdiagnosis** PA was protective for ACM following breast cancer (HR = 0.58 [95% CI, 0.58 [95% CI 0.52 to 0.65], 17 studies), childhood cancer (HR = 0.79 [95% CI 0.62 to 1.00], 1 study), colorectal cancer (HR = 0.63 [95% CI 0.050 to 0.78], 10 studies), gynecologic cancer (HR = 0.66 [95% CI, 0.49 to 0.88], 4 studies), glioma (HR = 0.64 [95% CI	MODERATE[b]	11 ESRs Moderate evidence indicates that greater amounts of physical activity after diagnosis are associated with lower risks of breast cancer-specific mortality and all-cause mortality in **female breast cancer survivors**. **PAGAC Grade: Moderate** 8 ESRs Moderate evidence indicates that greater amounts of physical activity after diagnosis are associated with lower risks of colorectal cancer-specific mortality and all-cause mortality in **colorectal cancer survivors**. **PAGAC Grade: Moderate.** 2 ESRs Limited evidence suggests an inverse association between

							0.46 to 0.91], 1 study), hematologic cancer (HR = 0.60 p95% CI 0.51 to 0.69], 2 studies), kidney cancer (HR = 0.60 [95% CI 0.38 to 0.95], 1 study), lung cancer (HR = 0.76 [95% CI 0.60 to 0.97], 2 studies), prostate cancer (HR = 0.60 [95% CI, 0.46 to 0.79], 5 studies), and stomach cancer (HR = 0.75 [95% CI 0.61 to 0.93], 1 study). No statistically significant association between postdiagnosis PA and ACM was found was esophagus cancer.		highest versus lowest levels of physical activity after diagnosis and all-cause mortality in prostate cancer survivors. **PAGAC Grade: Limited.**
Systematic review evidence **Review credibility**	**No. of studies/ Study design** **No. of participants**	**Quality Assessment**					**Description of evidence** **Summary of findings**	**Certainty**	**US PAGAC evidence and conclusions *(39)***
		Risk of bias	**Inconsistency**	**Indirectness**	**Imprecision**	**Other**			
Cancer-specific mortality									
Friedenreich 2019 *(12)* Moderate	136 RCTs and observational studies N=	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	Evidence of small study's effect for postdiagnosis PA and colorectal cancer-specific mortality	Meta-analysis found reduced hazards of mortality for those in the highest vs. lowest levels of **prediagnosis** total recreational PA for all cancers combined (cancer-specific mortality (HR = 0.82 [95% CI; 0.79 to 0.86], 33 studies), breast cancer (HR = 0.86 [95% CI, 0.78 to 0.94], 23 studies), colorectal cancer (HR = 0.80 [95% CI, 0.74 to 0.87], 14 studies), hematologic cancer (HR = 0.82 [95% CI 0.76 to 0.90], 6 studies), liver cancer (HR = 0.78 [95% CI 0.66 to 0.92], 3 studies), lung cancer (HR = 0.81 [95% CI 0.75 to 0.87], 5 studies), and stomach cancer (HR = 0.74 [95% CI 0.58 to 0.95], 4 studies). No statistically significant relationship was found between prediagnosis PA levels and cancer-specific mortality for bladder, brain, esophagus, gynecologic, kidney, melanoma, pancreas, or prostate cancer. Meta-analysis found reduced hazards of mortality for those in the highest vs.	MODERATE[b]	11 ESRs Moderate evidence indicates that greater amounts of physical activity after diagnosis are associated with lower risks of breast cancer-specific mortality and all-cause mortality in female breast cancer survivors. **PAGAC Grade: Moderate** 8 ESRs Moderate evidence indicates that greater amounts of physical activity after diagnosis are associated with lower risks of colorectal cancer-specific mortality and all-cause mortality in colorectal cancer survivors. **PAGAC Grade: Moderate.** 2 ESRs Moderate evidence indicates an inverse association between highest versus lowest levels of physical activity after diagnosis and

							lowest levels of **postdiagnosis** total recreational PA for all cancers combined (cancer-specific mortality (HR = 0.63 [95% CI 0.53 to 0.75], 4 studies), breast cancer (HR = 0.63 [95% CI 0.50 to 0.75], 13 studies), colorectal cancer (HR = 0.62 [95% CI 0.44 to 0.86], 6 studies), and prostate cancer (HR = 0.70 [95% CI 0.55 to 0.90], 4 studies).		prostate cancer-specific mortality in prostate cancer survivors. **PAGAC Grade: Moderate.**
Risk of cancer recurrence or second primary cancer									
No systematic review identified									Insufficient evidence is available to determine whether physical activity after diagnosis is associated with risk of breast cancer recurrence or second primary breast cancer. **PAGAC Grade: Not assignable.** Insufficient evidence is available to determine whether physical activity after diagnosis is associated with risk of colorectal cancer recurrence or second primary colorectal cancer. **PAGAC Grade: Not assignable.** Insufficient evidence is available on the association between physical activity level and prostate cancer recurrence or progression. **PAGAC Grade: Not assignable.**

Abbreviations: ACM = all-cause mortality; CI = confidence interval; HR = hazards ratio; NR = not reported; PA = physical activity; PAGAC = physical activity guidelines advisory committee

[†] Serious indirectness indicates measurement of intermediate/indirect outcomes or heterogeneity in exposures and comparisons assessed; certainty of evidence was not always downgraded for indirectness if it was not judged to impact the certainty in the findings for the outcome evaluated in the review

[s] 136 total studies included; each analysis includes fewer studies

[b] Certainty of evidence downgraded given combination of experimental and observational designs

Table E.1.b. People with hypertension, relationship between physical activity and health-related outcomes

Questions: What is the association between **physical activity** and health-related outcomes? Is there a dose response association (volume, duration, frequency, intensity)? Does the association vary by type or domain of PA?
Population: People with hypertension
Exposure: Greater volume, duration, frequency, or intensity of physical activity
Comparison: No physical activity or lesser volume, duration, frequency, or intensity of physical activity
Outcome: Risk of co-morbid conditions, physical function, health-related QOL, cardiovascular disease progression, cardiovascular mortality

Systematic review evidence **Review credibility**	**No. of studies/ Study design** **No. of participants**	**Quality Assessment**					**Description of evidence** **Summary of findings**	**Certainty**	**US PAGAC evidence and conclusions *(39)***
		Risk of bias	**Inconsistency**	**Indirectness †**	**Imprecision**	**Other**			
Risk of co-morbid conditions									
No systematic review identified									Insufficient evidence is available to determine whether a relationship exists between physical activity and risk of co-morbid conditions among adults with hypertension. **PAGAC Grade: Not assignable.**
Physical function									
Costa 2018 *(7)* Low	9 RCTs N=245	No serious risk of bias	No serious inconsistency	Serious indirectness	No serious imprecision	None	Nine studies compared the effects of HIIT (60% men, mean age 57.8 years, mean BMI 30.6 kg/m^2) versus MICT (49% men, mean age 56.1 years, mean BMI 30.4 kg/m^2) including patients with chronic heart failure, coronary heart disease, MetS, abdominal obesity, and prediabetes on resting BP. Most studies included a 12- to 16-week intervention and were conducted in laboratory settings or cardiac rehabilitation centers under direct supervision.	HIGH[a]	Insufficient evidence is available to determine whether a relationship exists between physical activity and physical function among adults with hypertension. **PAGAC Grade: Not assignable.**

							Pooled analyses suggested significant differences in **VO2max** in favour of HIIT interventions (MD 2.13 ml/kg/min [95% CI, 1.00 to 3.27], *p*<0.01).		

Systematic review evidence Review credibility	No. of studies/ Study design No. of participants	Quality Assessment					Description of evidence Summary of findings	Certainty	US PAGAC evidence and conclusions *(39)*
		Risk of bias	Inconsistency	Indirectness †	Imprecision	Other			
Health-related QOL									
Cao 2019 *(4)* Moderate	1 RCT N=103	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	Mean age of participants was 51 years; exercise intervention was 12 weeks vs. no exercise control group. Significant improvements were observed in the exercise group in all domains of the WHOQoL-BREF (physical health: +23.33, p<0.05; psychological health +18.17, p<0.05; social relationships; +14.51, p<0.05; environment: +11.51, p<0.05). The control group also showed improvements in physical health, psychological health, and social relationship domains.	HIGH[b]	Insufficient evidence is available to determine whether a relationship exists between physical activity and health-related quality of life among adults with hypertension. **PAGAC Grade: Not assignable.**
CVD progression									
Cao 2019 *(4)* Moderate	14 RCTs N=860	No serious risk of bias	Serious inconsistency	No serious indirectness	No serious imprecision	None	Mean age ranged from 40 to 83 years. SBP at baseline ranged from 130.3 to 170.5 mm Hg and DBP at baseline ranged from 67.5 to 95.2 mm Hg. Duration of exercise interventions ranged from 40 minutes to 6 months. Compared with no exercise control groups, **SBP** and **DBP** were significantly reduced in pooled analysis among the exercise groups (SBP MD = -12.26 mm Hg [95% CI, -15.17 to -9.34] p<0.05; DBP MD = -6.12 mm Hg [95% CI, -7.76 to -4.48], p<0.05). Subgroup analyses found that interventions of shorter duration (with shorter follow-up, <8 weeks) achieved greater reductions in BP than those of longer duration (>12 weeks).	HIGH[b]	15 ESRs Strong evidence demonstrates that physical activity reduces the risk of progression of cardiovascular disease among adults with hypertension. **PAGAC Grade: Strong.** Strong evidence demonstrates that, among adults with hypertension, physical activity reduces the disease progression indicator of blood pressure. **PAGAC Grade: Strong.**
Costa 2018 *(7)* Low	9 RCTs N=245	No serious risk of bias	Serious inconsistency	No serious indirectness	No serious imprecision	None	Nine studies compared the effects of HIIT (60% men, mean age 57.8 years, mean BMI 30.6 kg/m^2) versus MICT (49% men, mean age 56.1 years, mean BMI 30.4 kg/m^2) including patients with chronic heart failure, coronary heart disease, MetS, abdominal obesity, and prediabetes on resting BP. Most studies included a 12- to 16-week intervention and were conducted in laboratory settings or cardiac rehabilitation centers under direct supervision.	MODERATE[c]	

							Pooled analyses found no differences between HITT vs. MICT groups in **SBP** (MD - 0.22 mmHg [CI 95%, -5.36 to 4.92], *p* = 0.93) or **DBP** (MD - 0.38 mmHg [CI 95%, - 3.31 to 2.54], *p* = 0.74).		

Abbreviations: BMI = body mass index; BP = blood pressure; CI = confidence interval; CVD = cardiovascular disease; DBP = diastolic blood pressure; ESR = existing systematic review; HIIT = hight-intensity interval training; kg/m = kilograms per meter; MD = mean difference; MetS = metabolic syndrome mm Hg = millimeters of mercury; MICT = moderate-intensity continuous training; NR = not reported; PAGAC = Physical Activity Guidelines Advisory Committee; QOL = quality-of-life; RCT = randomized clinical trial; SBP = systolic blood pressure

[†] Serious indirectness indicates measurement of intermediate/indirect outcomes or heterogeneity in exposures and comparisons assessed; certainty of evidence was not always downgraded for indirectness if it was not judged to impact the certainty in the findings for the outcome evaluated in the review

[a] Certainty of evidence not downgraded (certainty graded for **effects** on VO2max)
[b] Certainty of evidence not downgraded
[c] Certainty of evidence downgraded given serious inconsistency (inconsistency in direction of effects across studies)

Table E.1.d. People with Type 2 Diabetes, relationship between physical activity and health-related outcomes

Questions: What is the association between **physical activity** and health-related outcomes? Is there a dose response association (volume, duration, frequency, intensity)? Does the association vary by type or domain of PA?
Population: People with Type 2 Diabetes
Exposure: Greater volume, duration, frequency, or intensity of physical activity
Comparison: No physical activity or lesser volume, duration, frequency, or intensity of physical activity
Outcome: Risk of co-morbid conditions, physical function, health-related QOL, disease progression

Systematic review evidence Review credibility	No. of studies/ Study design No. of participants	Quality Assessment					Description of evidence Summary of findings	Certainty	US PAGAC evidence and conclusions *(39)*
		Risk of bias	Inconsistency	Indirectness †	Imprecision	Other			
Risk of co-morbid conditions									
Lauche 2017 *(15)* Moderate	0 RCTs	NA	NA	NA	NA	NA	No trials were identified that examined the effects of Tai Chi/qigong on stroke incidence among those with diabetes.	NA	3 ESRs Strong evidence demonstrates an inverse association between volume of physical activity and risk of cardiovascular mortality among adults with type 2 diabetes. **PAGAC Grade: Strong.**
Physical function									
Zhou 2019 *(36)* Moderate	2 RCTs N=NR	No serious risk of bias	No serious inconsistency	Serious indirectness	Serious imprecision	None	Studies evaluated **Tai Chi** among adults with T2D, mean age range 36 to 70 years. Mean sessions of exercise ranged from 15 to 120 min with 2 to 14 sessions per week. Total intervention duration ranged from 4 to 24 weeks. There were no effects of Tai Chi on measures of **balance** compared with controls (MD = 2.17 secs [single-leg stance] [95% CI, -3.29 to 8.71], 2 RCTs).	LOW[b]	1 ESR Insufficient evidence was available to determine the relationship between physical activity and physical function in adults with type 2 diabetes. **PAGAC Grade: Not assignable.**

Systematic review evidence Review credibility	No. of studies/ Study design No. of participants	Quality Assessment					Description of evidence Summary of findings	Certainty	US PAGAC evidence and conclusions *(39)*
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Health-related QOL									
Rees 2017 *(27)* Moderate	2 pre-post N=40	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	Studies evaluated effect of **aquatic exercise** vs. land-based exercises or no-exercise control groups. No significant differences was found before and after aquatic exercise for the physical function domain (SMD = 0.08 [95% CI, -2.80 to 2.96], 2 studies, n=40) or mental health domain (SMD = -0.36 [95% CI, -2.85 to 2.12], 2 studies, n=40) of the SF-36 or SF-12 forms.	LOW[c]	6 ESRs Insufficient evidence was available to determine the relationship between physical activity and health-related quality of life in adults with type 2 diabetes. **PAGAC Grade: Not assignable.**
Yu 2018 *(34)* Moderate	6 RCTs N=NR	Serious risk of bias	No serious inconsistency	No serious indirectness	Serious imprecision	None	Studies evaluated **traditional Chinese exercises** (Tai Chi, Ba duan jin, qigong) for patients with T2D, mean age range 49-70 years. Tai Chi was associated with greater improvements in the physical function domain (MD = 5.92 [95% CI 0.68 to 11.16], 5 RCTs), but not on the mental health domain of the SF-36 form. There was no effect of ba duan jin on QOL as reported by 2 studies.	LOW[d]	
Zhou 2019 *(36)* Moderate	5 RCTs N=NR	No serious risk of bias	Serious inconsistency	Serious indirectness	Serious imprecision	None	Studies evaluated **Tai Chi** among adults with T2D, mean age range 36 to 70 years. Mean sessions of exercise ranged from 15 to 120 min with 2 to 14 sessions per week. Total intervention duration ranged from 4 to 24 weeks. Tai Chi was associated with significant improvement in the physical function domain (MD = 7.07 [95% CI, -0.79 to 13.35], 5 RCTs), bodily pain domain (MD = 4.30 [95% CI, 0.83 to 7.77], 5 RCTs), and social function domain (MD = 13.84 [95% CI, 6.22 to 21.47], 5 RCTs) of the SF-36, but not the other 5 components of QOL.	LOW[e]	

Systematic review evidence Review credibility	No. of studies/ Study design No. of participants	Quality Assessment					Description of evidence Summary of findings	Certainty	US PAGAC evidence and conclusions *(39)*
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Disease progression[a]									
Jang 2019 *(13)* Low	23 RCTs or CCTs N=723	Serious risk of bias	Serious inconsistency	Serious indirectness	No serious imprecision	See next column	Studies compared **any exercise intervention** with no intervention among adults with diabetes in Korea, mean age 60 years. Compared with non-exercise control groups, exercise interventions were associated with a statistically significant difference in **HbA1c** (MD = -0.58% [95% CI, -0.80 to -0.27], 17 studies, n=425) at post-test. Greater reductions in HbA1c seen among those with higher HbA1c values at baseline. Studies of aerobic exercise or combined aerobic exercise and resistance training showed bigger effects on HbA1c than those testing resistance training only. No differences in effects according to exercise duration	LOW[f]	34 ESRs Insufficient evidence was available to determine the relationship between physical activity and indicators of progression of neuropathy, nephropathy, retinopathy, and foot disorders. **PAGAC Grade: Not assignable.** Strong evidence demonstrates an inverse association between aerobic activity, muscle-strengthening activity, and aerobic plus muscle-strengthening activity with risk of progression among adults with type 2 diabetes, as assessed by overall effects of physical activity on four indicators of risk of progression: glycated hemoglobin A1C, blood pressure, body mass index, and lipids. **PAGAC Grade: Strong.**
Liu, Ye, et al. 2019 *(20)* Moderate	24 RCTs N=962	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	Dose-response effect[g]	Trials compared **resistance training** vs. control groups among persons with T2D (mean age range 45 to 71 years) with interventions ranging from 6 to 52 weeks. Resistance training was associated with greater reduction in **HbA1c** vs. control groups (MD = -0.45 [95% CI, -0.65 to -0.25], 20 trials, n=824). No differences were found in **fasting insulin** or **FBG** measures for all interventions; significant effects were found for high-intensity resistance training vs. control groups on fasting insulin (MD = -4.60 [95% CI, -7.53 to -1.67], 5 trials, n=174).	HIGH[h]	
Song 2018 *(29)* Moderate	39 RCTs N=2,917	No serious risk of bias	Serious inconsistency	No serious indirectness	No serious imprecision	None	Studies evaluated **traditional Chinese exercises** (Tai Ji Quan, Qigong, Ba Duan Jin) vs. no exercise intervention with T2D patients aged 41 to 80 years (mean age 59 years). Traditional Chinese exercises were associated with significantly greater reduction of percentage	MODERATE[i]	

							HbA1c (MD = -0.67% [95% CI -086% to -0.48%], 35 RCTS, n=2,940) and **FBG** (MD = -0.66 mmol/L [95% CI -0.95 to -0.37], 18 RCTS, n=1,433).		Insufficient evidence was available to determine the relationship between tai chi, qigong, and yoga exercise on four indicators of risk of progression: hemoglobin A1C, blood pressure, body mass index, and lipids. **PAGAC Grade: Not assignable.**
Systematic review evidence **Review credibility**	**No. of studies/ Study design** **No. of participants**	**Quality Assessment**					**Description of evidence** **Summary of findings**	**Certainty**	**US PAGAC evidence and conclusions *(39)***
		Risk of bias	**Inconsistency**	**Indirectness**	**Imprecision**	**Other**			
Chao 2018 *(5)* Moderate	14 RCTs N=798	Serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	Evidence of small studies effect	Trials evaluated the effects of **Tai Chi** on markers of diabetes compared with non-exercise or exercise control groups. Mean age ranged from 48-64 years. Interventions ranged from 3 to 7 days/week for 4 to 24 weeks total duration. In pooled analysis, compared with non-exercise control groups, participants in the Tai Chi interventions had statistically significantly lower **FBG** (MD = -1.39 [95% CI, -1.95 to -0.84], 10 trials, n=489), **HbA1c** (MD = -0.73 [95% CI, -95 to -0.52), 7 trials, n=293), and **2hPBG** (MD = -2.07 [95% CI -2.89 to -1.26], 5 trials, n=82).	LOW[j]	
Lauche 2017 *(15)* Moderate	7 RCTs N = 361	Serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	Studies evaluated the effects of **Tai Chi or qigong** for the treatment of diabetes compared with no intervention, conventional exercise, sham exercise, or resistance training. Intervention duration ranged from 6 weeks to 6 months (median 12 weeks), with median sessions of 2 days/week. Pooled results showed statistically significant benefits of Tai Chi/qigong vs. no exercise control for **FBG** (MD = -8.88 mg/dL [95% CI, -16.73 to -1.03], 2 trials, n=85) and **HOMA** (MD = -2.86%	MODERATE[k]	

							[95% CI, 5.35 to -0.38], 2 trials, n=60). There was no effect on measures of **HbA1c** (MD = -0.46% [95% CI, -0.96 to 0.03), 4 trials, n=161). No differences were found when comparing Tai Chi/qiqong with other forms of exercise.		
Systematic review evidence **Review credibility**	**No. of studies/ Study design** **No. of participants**	**Quality Assessment**					**Description of evidence** **Summary of findings**	**Certainty**	**US PAGAC evidence and conclusions *(39)***
		Risk of bias	**Inconsistency**	**Indirectness**	**Imprecision**	**Other**			
Xia 2019 *(33)* Low	17 RCTs N=NR	Serious risk of bias	Serious inconsistency	No serious indirectness	No serious imprecision	None	Studies evaluated the effects of **Tai Chi** vs. active or non-active control among individuals with T2D. Number of Tai Chi sessions ranged from 36 to 336, with most having 2 to 7 sessions weekly with 30-60 min per session. Tai Chi was associated with a significant effect on **FBG** (SMD = -0.54 [95% CI, -0.91 to -0.16], 13 RCTS, n=616) and **HbA1c** (SMD = -0.68 [95% CI, -1.17 to 0.19], 9 RCTs, n=517).	MODERATE[l]	
Yu 2018 *(34)* Moderate	22 RCTs 2 CCTs N=NR	Serious risk of bias	Serious inconsistency	No serious indirectness	Serious imprecision	None	Studies evaluated **traditional Chinese exercises** (Tai Chi, Ba duan jin, qigong) for patients with T2D, mean age range 49-70 years. Tai Chi practice for at least 150 min/week was associated with lowered **HbA1c** (MD = -1.48 [95% CI, -2.58% to -0.39%], 6 RCTs) and **FBG** (MD = -1.14 mmol/L [95% CI, -1.78 to -0.50], 6 RCTs). Ba duan jin was significantly associated with **HbA1c** (MD = -0.77 [95% CI -0.97 to -0.56], 12 RCTS) and **FBG** (MD = MD = -0.82 mmol/L [95% CI, -1.005 to -0.59], 12 RCTs).	VERY LOW[m]	
Zhou 2019 *(36)* Moderate	23 RCTs N=1,234	No serious risk of bias	Serious inconsistency	No serious indirectness	No serious imprecision	None	Studies evaluated **Tai Chi** among adults with T2D, mean age range 36 to 70 years. Mean sessions of exercise ranged from 15 to 120 min with 2 to 14 sessions per week. Total intervention duration ranged from 4 to 24 weeks. Tai Chi was associated with significant improvement in **HbA1c** (MD=-0.88% [95% CI, -1.45 to -0.31], 14 RCTs) and **FBG** (SMD = -0.67 [95% CI, -0.87 to -0.47], 21 RCTs)	MODERATE[n]	

Systematic review evidence Review credibility	No. of studies/ Study design No. of participants	Quality Assessment					Description of evidence Summary of findings	Certainty	US PAGAC evidence and conclusions *(39)*
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Thind 2017 *(31)* Low	23 RCTs N=2,473	NR	Serious inconsistency	No serious indirectness	Serious imprecision	None	Studies evaluated the effects of **yoga** on adults with T2D (mean age, 53 years). Median number of yoga sessions was 50 with median duration of each session of 60 minutes. Intervention duration ranged from <1 week to 6 months. Yoga was associated with significant differences in **HbA1c** (ES = 0.36 [95% CI, 0.16 to 0.56], 16 RCTs) and **FBG** (ES = 0.58 [95% CI, 0.40 to 0.76), 20 RCTs) at 8 weeks or longer followup.	LOW[m]	
De Nardi *(8)*2018 Moderate	7 RCTs N=184	Serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	Trials comparing effects of **HIIT vs. MICT** in individuals with prediabetes (2 trials, n=64, mean age 52 years) and T2D (5 trials, n=120, mean age 61 years). Duration of interventions ranged from 12 to 16 weeks for trials among persons with T2D and 2 to 4 weeks for trials among persons with prediabetes. No differences were found between HIIT and MICT on measures of **FBG** (MD = 0.11 [95% CI, -0.45 to 0.67], 4 trials, n=82) or **HbA1c** (MD = -0.17 [95% CI -0.36 to 0.02], 5 trials, n=119) among patients with T2D. One study among patients with prediabetes found greater reduction in **FBG** among those in the MICT vs. HIIT groups.	MODERATE[k]	
Liu, Zhu, et al. 2019 *(19)* Moderate	13 RCTs N=345	No serious risk of bias	Serious inconsistency	No serious indirectness	Serious imprecision	None	Trials comparing effects of **HIIT vs. MICT or no intervention** in individuals with T2D. HIIT interventions ranged from 11 to 16 weeks with a median of 3 sessions/week with total training per session ranging from 30 seconds to 4 minutes. Statistically significant greater difference in changes in **HbA1c** among those in HIIT vs. MICT intervention groups (MD = -0.37 [95% CI, -0.55 to -0.19], 10 trials, n=220). No difference was found between HITT and no exercise control groups on HbA1c (MD =-0.39 (-0.81 to 0.02), 3 trials, n=63). No differences were found between HIIT vs. MICT	LOW[o]	

							or HIIT vs. non-exercise control groups on measures of **FBG, fasting insulin, or HOMA.**		
Systematic review evidence **Review credibility**	**No. of studies/ Study design** **No. of participants**	**Quality Assessment**					**Description of evidence** **Summary of findings**	**Certainty**	**US PAGAC evidence and conclusions *(39)***
		Risk of bias	**Inconsistency**	**Indirectness**	**Imprecision**	**Other**			
Qui 2017 *(25)* Moderate	7 RCTs N=189	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	Patients with type 2 diabetes, mean age 59 years, mean BMI 30.4 kg/m^2. Studies evaluated **HIIT vs. MICT or no-exercise control groups**. Frequency of HITT ranged from 2 to 5 times per week, with total length (maximal exercise plus recovery interval) ranged from 20 to 60 minutes with most intervals lasting 1 to 4 minutes. Intervention duration ranged from 12 to 16 weeks. INT was associated with statistically significantly decreased **HbA1c** by 0.26% (95% CI, -0.46 to -0.07%, 5 RCTs) compared with MICT and by 0.83% (95% CI, -1.39% to -0.27%, 4 RCTs) compared with no-exercise control groups.	HIGH[h]	
Rees 2017 *(27)* Moderate	5 RCTs 4 pre-post N=222	No serious risk of bias	No serious inconsistency	Serious indirectness	Serious imprecision	None	Studies evaluated effect of **aquatic exercise** vs. land-based exercises or no-exercise control groups. Most interventions lasted 8-12 weeks. No significant difference was found between land exercise and aquatic exercise on **HbA1c** (MD = -0.02% [95% CI, -0.71 to 0.66], 3 trials, n=83) or **FBG** (MD = -5.06 mg/dL [95% I, -12.32 to 2.21], 5 studies. There was a significant difference between aquatic exercise and no-exercise in **HbA1c** (MD = -0.96% [95% CI -1.87 to -0.05), 2 trials, n=60).	MODERATE[p]	

Abbreviations: 1RM = 1 repetition maximum; 2hPBG = two-hour postprandial blood glucose; BMI = body mass index; CCT = controlled clinical trial; CI = confidence interval; ES = effect size (Hedge's g); FBG = fasting blood glucose; HbA1C = hemoglobin A1c; HIIT = high-intensity interval training; HOMA = Homeostatic model assessment; INT = aerobic interval training; kg/m = kilograms per meter; MD = mean difference; mg/dL = milligrams per deciliter; MICT = moderate-intensity continuous training; NA = not applicable; SF-36 = short-form QOL questionnaire; SMD = standardized mean difference; T2D = type 2 diabetes

[†] Serious indirectness indicates measurement of intermediate/indirect outcomes or heterogeneity in exposures and comparisons assessed; certainty of evidence was not always downgraded for indirectness if it was not judged to impact the certainty in the findings for the outcome evaluated in the review

[a] Included measures of glycemic control; did not include measures of other cardiometabolic risk factors (i.e., blood pressures, lipids, adiposity)
[b] Certainty of evidence downgraded given serious indirectness in measures of effect and imprecision in effect estimates
[c] Certainty of evidence upgraded given no major limitations
[d] Certainty of evidence downgraded given serious risk of bias and imprecision in effect estimates

[e] Certainty of evidence downgraded given serious inconsistency, indirectness (subscales of SF-36 rather than domain-specific scores), and imprecision (very wide confidence intervals)
[f] Certainty of evidence downgraded given serious risk of bias, serious inconsistency (heterogeneity) of effects, and serious indirectness (comparison of measures of HbA1c at post-test only)
[g] High-intensity interventions (intensity between 75% and 100% 1RM) were associated with greater differences in HbA1c vs. low-to-moderate intensity interventions (intensity between 20% and 75% 1RM)
[h] Certainty of evidence not downgraded
[i] Certainty of evidence downgraded given substantial heterogeneity in pooled analysis (I^2>80%)
[j] Certainty of evidence downgraded given serious risk of bias and possible publication bias
[k] Certainty of evidence downgraded given serious risk of bias for most included trials
[l] Certainty of evidence downgraded given serious risk of bias and inconsistency (I^2>70%)
[m] Certainty of evidence downgraded due to serious risk of bias, inconsistency, and imprecision in effect estimates
[n] Certainty of evidence downgraded given serious inconsistency (heterogeneity) of effects
[o] As assigned by review authors. Certainty of evidence downgraded due to inconsistency and imprecision
[p] Certainty of evidence downgraded given serious imprecision (wide confidence interval in effect estimates)

APPENDIX A. DATA EXTRACTIONS OF INCLUDED REVIEWS

Cancer

SR/MA **Citation:** Friedenreich CMS, C.R.; Cheung, W.Y.; Hayes, S.C. Physical activity and mortality in cancer survivors: A systematic review and meta-analysis. JNCI Cancer Spectrum 2019. https://doi.org/10.1093/jncics/pkz080	
Purpose: To evaluate the association between pre-diagnosis and postdiagnosis PA and survival for all cancer and by specific cancer sites	**Abstract:** **Background:** Recommendations for improved survival after cancer through physical activity (PA) exist, although the evidence is still emerging. Our primary objective was to conduct a systematic review and meta-analysis of the association between pre- and post-diagnosis PA and survival (cancer-specific, all-cause and cardiovascular disease mortality) for all-cancers and by tumour site. Secondary objectives were to examine the associations within population subgroups, by PA domain, and to determine the optimal dose of PA related to survival. **Methods:** PubMed, EMBASE and SportsDiscus databases were searched to November 1, 2018. DerSimonian-Laird random-effects models were used to estimate the summary hazards ratios (HRs) and 95% confidence intervalsfor primary and secondary analyses, and to conduct dose-response analyses. **Results:** Evidence from 136 studies showed improved survival outcomes with highest versus lowest levels of pre- or post-diagnosis total/recreational PA for all-cancers combined (cancer-specific mortality: HR = 0.82, 95% CI = 0.79-0.86; and HR = 0.63, 95% CI = 0.53-0.75 respectively) as well as for 11 specific cancer sites. For breast and colorectal cancers, greater reductions were observed for post-diagnosis PA (HRs=0.58-0.63) compared with pre-diagnosis PA (HRs=0.80-0.86), for cancer-specific and all-cause mortality. Survival benefits through PA were observed in most subgroups (within sex, body mass index, menopausal status, colorectal subtypes and PA domain) examined. Inverse dose-response relationships between PA and breast cancer-specific and all-cause mortality were observed, with steep reductions in hazards to 10-15 MET-hours/week. **Conclusion:** Higher pre- and post-diagnosis levels of PA were associated with improved survival outcomes for at least 11 cancer types, providing support for global promotion of PA guidelines following cancer.
Timeframe: Nov 1, 2018	
Total # studies included: 136	
Other details (e.g. definitions used, exclusions etc) Data from available observational epidemiologic studies and RCTs	
Outcomes addressed: Cancer- and all-cause mortality	

Hypertension

SR/MA **Citation:** Cao L, Li X, Yan P, Wang X, Li M, Li R, Shi X, Liu X, Yang K. The effectiveness of aerobic exercise for hypertensive population: A systematic review and meta-analysis. The Journal of Clinical Hypertension. 2019 Jun 6.	
Purpose: duration of aerobic exercise on blood pressure and heart rate **Timeframe: inception to July 2018** **Total # studies included: 14** **Other details (e.g. definitions used, exclusions etc)** **Outcomes addressed:** **Diastolic BP** **Systolic BP** **Heart Rate** **Amubulator DBP** **Abulatory SBP**	**Abstract:** The study aims to evaluate the effectiveness of different durations of aerobic exercise on hypertensive patients. Four electronic databases (PubMed, Embase, Cochrane Library, and Web of Science) were searched from their inception until July 2018. English publications and randomized controlled trials involving aerobic exercise treatment for hypertensive population were included. Two reviewers independently extracted the data. The Cochrane's Risk of Bias tool was used to assess the quality of included studies. In this systematic review, a total of 14 articles were included, involving 860 participants. The quality of the included studies ranged from moderate to high. The results of the meta-analysis showed that compared with the control group,significant effects of aerobic exercise were observed on reducing systolic blood pressure (SBP) (mean difference [MD] = −12.26 mm Hg, 95% confidence interval [CI] = −15.17 to −9.34, $P < 0.05$), diastolic blood pressure (DBP; MD = −6.12 mm Hg, 95% CI = −7.76 to −4.48, $P < 0.05$), and heart rate (MD = −4.96 bpm, 95% CI = −6.46 to −3.43, $P < 0.05$). In addition, significant reductions were observed in ambulatory DBP (MD = −4.90 mm Hg, 95% CI = −8.55 to −1.25, $P < 0.05$) and ambulatory SBP (MD = −8.77mm Hg, 95% CI = −13.97 to −3.57, $P < 0.05$). Therefore, aerobic exercise might be an effective treatment for blood pressure improvement in hypertensive patients. However, the effectiveness between the duration of different treatment needs to be well-designed and rigorous studies will be required to verify the dataset.

SR/MA

Citation: Costa EC, Hay JL, Kehler DS, Boreskie KF, Arora RC, Umpierre D, Szwajcer A, Duhamel TA. Effects of high-intensity interval training versus moderate-intensity continuous training on blood pressure in adults with pre-to established hypertension: a systematic review and meta-analysis of randomized trials. Sports Medicine. 2018 Sep 1;48(9):2127-42.

Purpose: high intensity vs. moderate intensity for reducing BP in adults with pre or established hypertension	**Abstract:** **Background** Aerobic exercise reduces blood pressure (BP), but it is unknown whether a high-intensity training approach can elicit a greater BP reduction in populations with elevated BP. This systematic review compared the efficacy of high-intensity interval training (HIIT) versus moderate-intensity continuous training (MICT) for reducing BP in adults with pre- to established hypertension.
Timeframe: June 1996 to June 2016	**Methods** Five electronic databases (MEDLINE, EMBASE, CENTRAL, PEDro, and SPORTDiscus) were searched for randomized trials comparing the chronic effects of HIIT versus MICT on BP in individuals with resting systolic BP C 130 mmHg and/or diastolic BP C 85 mmHg and/or under antihypertensive medication. Random-effects modelling was used to compare changes from pre- to post-intervention in resting and ambulatory BP between HIIT and MICT. Changes from pre- to post-intervention in maximal oxygen uptake (_V O2max) between HIIT and MICT were also meta-analyzed. Data were reported as weighted mean difference (MD) and 95% confidence interval (CI).
Total # studies included: 9	
Other details (e.g. definitions used, exclusions etc)	
Outcomes addressed: **Systolic BP** **Diastolic BP** **VO2 max**	**Results** Ambulatory BP was excluded from the metaanalysis due to the limited number of studies (two studies). Comparing changes from pre- to post-intervention, no differences in resting systolic BP (MD - 0.22 mmHg [CI 95%, - 5.36 to 4.92], p = 0.93, I2 = 53%) and diastolic BP (MD - 0.38 mmHg [CI 95%, - 3.31 to 2.54], p = 0.74, I2 = 0%) were found between HIIT and MICT (seven studies; 164 participants). HIIT improved _V O2max to a greater magnitude than MICT (MD 2.13 ml/kg/min [CI 95%, 1.00 to 3.27], p\0.01, I2 = 41%) with similar completion rates of the intervention and attendance at the exercise training sessions (nine studies; 245 participants). Limited data were available to compare the incidence of adverse events between HIIT and MICT. **Conclusion** HIIT and MICT provided comparable reductions in resting BP in adults with pre- to established hypertension. HIIT was associated with greater improvements in VO2max when compared to MICT. Future randomized trials should investigate the efficacy of HIIT versus MICT for reducing ambulatory BP in adults with pre- to established hypertension. Registration PROSPERO registration

SR/MA **Citation:** De Sousa EC, Abrahin O, Ferreira AL, Rodrigues RP, Alves EA, Vieira RP. Resistance training alone reduces systolic and diastolic blood pressure in prehypertensive and hypertensive individuals: meta-analysis. Hypertension Research. 2017 Nov;40(11):927.	
Purpose: Resistance training along on blood pressure **Timeframe: inception to Nov 2016** **Total # studies included: 5** **Other details (e.g. definitions used, exclusions etc)** **Outcomes addressed: Diastolic BP Systolic BP**	**Abstract:** The purpose of this study was to evaluate the effects of resistance training alone on the systolic and diastolic blood pressure in prehypertensive and hypertensive individuals. Our meta-analysis, followed the guidelines of PRISMA. The search for articles was realized by November 2016 using the following electronic databases: BIREME, PubMed, Cochrane Library, LILACS and SciELO and a search strategy that included the combination of titles of medical affairs and terms of free text to the key concepts: 'hypertension' 'hypertensive', 'prehypertensive', 'resistance training', 'strength training', and 'weight-lifting'. These terms were combined with a search strategy to identify randomized controlled trials (RCTs) and identified a total of 1608 articles: 644 articles BIREME, 53 SciELO, 722 PubMed, 122 Cochrane Library and 67 LILACS. Of these, five RCTs met the inclusion criteria and provided data on 201 individuals. The results showed significant reductions for systolic blood pressure (−8.2 mm Hg CI − 10.9 to − 5.5; I2: 22.5% P valor for heterogeneity=0.271 and effect size=− 0.97) and diastolic blood pressure (−4.1 mm Hg CI − 6.3 to − 1.9; I2: 46.5% P valor for heterogeneity=0.113 and effect size=− 0.60) when compared to group control. In conclusion, resistance training alone reduces systolic and diastolic blood pressure in prehypertensive and hypertensive subjects. The RCTs studies that investigated the effects of resistance training alone in prehypertensive and hypertensive patients support the recommendation of resistance training as a tool for management of systemic hypertension.

Diabetes

<table>
<tr><td colspan="2">Citation:
Chao M, Wang C, Dong X, et al. The Effects of Tai Chi on Type 2 Diabetes Mellitus: A Meta-Analysis. J Diabetes Res. 2018;2018:7350567. PMID: 30116744. 10.1155/2018/7350567</td></tr>
<tr><td>Purpose:</td><td rowspan="4">Abstract:
Objective: To investigate the effects of Tai chi in type 2 diabetes mellitus (type-2 DM) patients using systematic review and meta-analysis. Methods: Seven electronic resource databases were searched, and randomized controlled trials on the role of Tai chi in type-2 DM patients were retrieved. The meta-analysis was performed with RevMan 5.3, and research quality evaluation was conducted with the modified Jadad scale. Results: Fourteen studies, with 798 individuals related to the intervention of Tai chi on diabetes, were included. The results showed that, compared with nonexercise, Tai chi had the effect of lowering fasting blood glucose [MD = -1.39, 95% CI (-1.95, -0.84), P < 0.0001] and the subgroup effect size decreased with the increase of total exercise amount, there is no significant difference between Tai chi and other aerobic exercises [MD = -0.50, 95% CI (-1.02, 0.02), P = 0.06]; compared with nonexercise, Tai chi could reduce HbA1c [MD = -0.21, 95% CI (-0.61, 0.19), P = 0.31], and the group effect size decreased with the increase of total exercise amount. The reducing HbA1c effect of Tai chi was better than that of other aerobic exercises, but the difference was at the margin of statistical significance [MD = -0.19, 95% CI (-0.37, 0.00), P = 0.05]; compared with nonexercise, Tai chi had the effect of reducing 2 h postprandial blood glucose [MD = -2.07, 95% CI (-2.89, -1.26), P = 0.0002], there is no significant difference between Tai chi and other aerobic exercises in reducing 2 h postprandial blood glucose [MD = -0.44, 95% CI (-1.42, 0.54), P = 0.38]. Conclusion: Tai chi can effectively affect the management of blood glucose and HbA1c in type-2 DM patients. Long-term adherence to Tai chi has a better role in reducing blood glucose and HbA1c levels in type 2 DM patients.</td></tr>
<tr><td>Last Search Date:
Jun-16</td></tr>
<tr><td>Total # studies included:
14 RCTs</td></tr>
<tr><td>Other details (e.g. definitions used, exclusions etc)</td></tr>
<tr><td>Outcomes addressed:
Glycemic control</td><td></td></tr>
<tr><td>Populations Analyzed:
Type-2 DM (no restrictions on age or gender) without serious DM-related complications</td><td>Author-Stated Funding Source:</td></tr>
</table>

<table>
<tr><td colspan="2">Citation:
De Nardi AT, Tolves T, Lenzi TL, et al. High-intensity interval training versus continuous training on physiological and metabolic variables in prediabetes and type 2 diabetes: A meta-analysis. Diabetes Res Clin Pract. 2018;137:149-59. PMID: 29329778. 10.1016/j.diabres.2017.12.017</td></tr>
<tr><td>Purpose:
Last Search Date:
Jul-17
Total # studies included:
7 RCTs
Other details (e.g. definitions used, exclusions etc)
Outcomes addressed:
Glycemic control, cardiorespiratory fitness, body composition, blood pressure, or lipid profiles</td><td>Abstract:
AIMS: To compare the effects of high-intensity interval training (HIIT) versus moderate-intensity continuous training (MICT) on functional capacity and cardiometabolic markers in individuals prediabetes and type 2 diabetes (T2D). METHODS: The search was performed in PubMed (MEDLINE), EMBASE, PEDro, CENTRAL, Scopus, LILACS database, and Clinical Trials from the inception to July 2017, included randomized clinical trials that compared the use of HIIT and MICT in prediabetes and T2D adults. The risk of bias was defined by Cochrane Handbook and quality of evidence by GRADE. RESULTS: From 818 relevant records, seven studies were included in systematic review (64 prediabetes and 120 T2D patients) and five with T2D were meta-analyzed. HIIT promoted significantly increased of 3.02mL/kg/min (CI95% 1.42-4.61) of VO2max, measured for functional capacity, compared to MICT. No differences were found between two modalities of exercises considering the outcomes HbA1c, systolic and diastolic blood pressure, total cholesterol, HDL and LDL cholesterol, triglycerides, BMI, and waist-to-hip ratio. Most of the studies presented unclear risk of bias, and low and very low quality of evidence. CONCLUSION: HIIT induces cardiometabolic adaptations similar to those of MICT in prediabetes and T2D, and provides greater benefits to functional capacity in patients with T2D. PROSPERO: CRD42016047151.</td></tr>
<tr><td>Populations Analyzed:
T2D adults aged 18+</td><td>Author-Stated Funding Source:</td></tr>
</table>

<table>
<tr><td colspan="2">Citation:
Jang JE, Cho Y, Lee BW, et al. Effectiveness of Exercise Intervention in Reducing Body Weight and Glycosylated Hemoglobin Levels in Patients with Type 2 Diabetes Mellitus in Korea: A Systematic Review and Meta-Analysis. Diabetes Metab J. 2019;43(3):302-18. PMID: 30604592. 10.4093/dmj.2018.0062</td></tr>
<tr><td>Purpose:</td><td rowspan="4">Abstract:
BACKGROUND: This study aimed to assess the effectiveness of exercise intervention in reducing body weight and glycosylated hemoglobin (HbA1c) level in patients with type 2 diabetes mellitus (T2DM) in Korea. METHODS: Cochrane, PubMed, Embase, KoreaMed, KMbase, NDSL, KCI, RISS, and DBpia databases were used to search randomized controlled trials and controlled clinical trials that compared exercise with non-exercise intervention among patients with non-insulin-treated T2DM in Korea. The effectiveness of exercise intervention was estimated by the mean difference in body weight changes and HbA1c level. Weighted mean difference (WMD) with its corresponding 95% confidence interval (CI) was used as the effect size. The pooled mean differences of outcomes were calculated using a random-effects model. RESULTS: We identified 7,692 studies through literature search and selected 23 articles (723 participants). Compared with the control group, exercise intervention (17 studies) was associated with a significant decline in HbA1c level (WMD, -0.58%; 95% CI, -0.89 to -0.27; I(2)=73%). Although no significant effectiveness on body weight was observed, eight aerobic training studies showed a significant reduction in body weight (WMD, -2.25 kg; 95% CI, -4.36 to -0.13; I(2)=17%) in the subgroup analysis. CONCLUSION: Exercise significantly improves glycemic control; however, it does not significantly reduce body weight. Aerobic training can be beneficial for patients with non-insulin-treated T2DM in Korea.</td></tr>
<tr><td>Last Search Date:
Aug-17</td></tr>
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23 RCTs</td></tr>
<tr><td>Other details (e.g. definitions used, exclusions etc)</td></tr>
<tr><td>Outcomes addressed:
HbA1c levels and weight</td></tr>
<tr><td>Populations Analyzed:
Patients with T2DM who are not on insulin therapy</td><td>Author-Stated Funding Source:</td></tr>
</table>

<table>
<tr><td colspan="2">Citation:
Lauche R, Peng W, Ferguson C, et al. Efficacy of Tai Chi and qigong for the prevention of stroke and stroke risk factors: A systematic review with meta-analysis. Medicine (Baltimore). 2017;96(45):e8517. PMID: 29137055. 10.1097/md.0000000000008517</td></tr>
<tr><td>Purpose:
Last Search Date:
1-Jan-17
Total # studies included:
6 RCTs
Other details (e.g. definitions used, exclusions etc)
Outcomes addressed:
Stroke incidence, gylcemic control, behavioral outcomes, safety</td><td>Abstract:
BACKGROUND: This review aims to summarize the evidence of Tai Chi and qigong interventions for the primary prevention of stroke, including the effects on populations with major stroke risk factors. METHODS: A systematic literature search was conducted on January 16, 2017 using the PubMed, Scopus, Cochrane Library, and CINAHL databases. Randomized controlled trials examining the efficacy of Tai Chi or qigong for stroke prevention and stroke risk factors were included. Risk of bias was assessed using the Cochrane Risk of Bias tool. RESULTS: Twenty-one trials with n = 1604 patients with hypertension, hyperlipidaemia, diabetes, overweight or obesity, or metabolic syndrome were included. No trials were found that examined the effects of Tai Chi/qigong on stroke incidence. Meta-analyses revealed significant, but not robust, benefits of Tai Chi/qigong over no interventions for hypertension (systolic blood pressure: -15.55 mm Hg (95% CI: -21.16; -9.95); diastolic blood pressure: -10.66 mm Hg (95% CI: -14.90, -6.43); the homeostatic model assessment (HOMA) index (-2.86%; 95% CI: -5.35, -0.38) and fasting blood glucose (-9.6 mg/dL; 95% CI: -17.28, -1.91), and for the body mass index compared with exercise controls (-1.65 kg/m; 95% CI: -3.11, -0.20). Risk of bias was unclear or high for the majority of trials and domains, and heterogeneity between trials was high. Only 6 trials adequately reported safety. No recommendation for the use of Tai Chi/qigong for the prevention of stroke can be given. CONCLUSION: Although Tai Chi and qigong show some potential more robust studies are required to provide conclusive evidence on the efficacy and safety of Tai Chi and qigong for reducing major stroke risk factors.</td></tr>
<tr><td>Populations Analyzed:
Diagnosed with type 2 diabetes mellitus</td><td>Author-Stated Funding Source:</td></tr>
</table>

Citation: 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):459-73. PMID: 28382531. 10.1007/s13300-017-0258-3	
Purpose: **Last Search Date:** Nov-16 **Total # studies included:** 10 RCTs **Other details (e.g. definitions used, exclusions etc)** **Outcomes addressed:** Glycemic control, muscular strength	**Abstract:** INTRODUCTION: Type 2 diabetes (T2D) in elderly patients is associated with accelerated loss of skeletal muscle mass and strength. However, there are few meta-analysis reviews which investigate the effects of resistance training (RT) on glycemic control and skeletal muscle in the patients. METHODS: Three electronic databases were searched (from the earliest date available to November 2016). Studies were included according to the inclusion criteria: T2D patients at least 60 years old, fasting plasma glucose of at least 7.0, and at least 8 weeks of RT. RESULTS: Fifteen cohorts of eight studies (360 patients, average age 66 years) met the inclusion criteria. RT groups lowered glycosylated hemoglobin (HbA1c) (mean ES = -0.37, 95% CI = -0.55 to -0.20, P < 0.01) but did not result in a significant effect on lean body mass (LBM) (mean ES = 0.08, 95% CI = -0.15 to 0.30, P = 0.50). Homogeneity was shown between studies regarding HbA1c and LBM (Q = 15.70, df = 9, P = 0.07 and Q = 0.12, df = 4, P = 0.998, respectively). High-intensity subgroups showed a slight tendency to improve (rather than duration, frequency, and weekly volume) and to decrease HbA1c levels more than low-intensity subgroups (P = 0.37). RT increased muscular strength (mean ES = 1.05, 95% CI = 0.26-1.84, P = 0.01). No training components explained the heterogeneity between studies with changes in muscle strength. CONCLUSION: RT improves glycemic control and muscle strength in elderly patients with T2D. RT with high intensity can be a strategy to treat patients with T2D and sarcopenia associated with aging.
Populations Analyzed: Participants were at least 60 years old and had T2D	**Author-Stated Funding Source:**

<table>
<tr><td colspan="2">Citation:
Liao F, An R, Pu F, et al. Effect of Exercise on Risk Factors of Diabetic Foot Ulcers: A Systematic Review and Meta-Analysis. Am J Phys Med Rehabil. 2019;98(2):103-16. PMID: 30020090. 10.1097/phm.0000000000001002</td></tr>
<tr><td>Purpose:
Last Search Date:
Jan-18
Total # studies included:
20 RCTs
Other details (e.g. definitions used, exclusions etc)
Outcomes addressed:
HbA1c, peripheral neuropathy, and vascular structure or function or cutaneous microvascular function of the lower limbs</td><td>Abstract:
The objectives of this study were to examine the effectiveness of different types of exercise on risk factors of diabetic foot ulcers, including glycated hemoglobin, peripheral arterial disease, and diabetic peripheral neuropathy, in people with type 2 diabetes mellitus. PubMed, Web of Science, Cochrane Library, Scopus, and CINAHL were searched from inception to January 2018 for relevant articles. Eligible studies were randomized controlled trials that examined effects of exercise on the selected risk factors. Twenty randomized controlled trials with 1357 participants were included in the meta-analyses. The differences in postintervention values of glycated hemoglobin and ankle brachial index between exercise and control groups were synthesized, yielding mean differences of -0.45% (P < 0.00001) and 0.03 (P = 0.002), respectively; the differences in within-group changes in glycated hemoglobin were synthesized, yielding mean differences of -0.19% (P = 0.1), -0.25% (P = 0.0006), and -0.64% (P = 0.006) for aerobic versus resistance, combined versus aerobic, and combined versus resistance exercise, respectively. Exercise has a significant effect on reducing glycated hemoglobin, whereas combined exercise is more effective compared with aerobic or resistance exercise alone. Exercise also improves ankle brachial index. However, evidence regarding the association between exercise and peripheral neuropathy and risks of diabetic foot ulcers in people with type 2 diabetes mellitus remains insufficient.</td></tr>
<tr><td>Populations Analyzed:
T2DM 18 yrs and older</td><td>Author-Stated Funding Source:</td></tr>
</table>

Citation: Liu JX, Zhu L, Li PJ, et al. Effectiveness of high-intensity interval training on glycemic control and cardiorespiratory fitness in patients with type 2 diabetes: a systematic review and meta-analysis. Aging Clin Exp Res. 2019;31(5):575-93. PMID: 30097811. 10.1007/s40520-018-1012-z	
Purpose:	**Abstract:**
Last Search Date: Sep-18	We investigated the influence of resistance exercise (RE) with different intensities on HbA1c, insulin and blood glucose levels in patients with type 2 diabetes (T2D). Diabetes trials that compared RE group with a control were included in meta-analysis. Exercise intensities were categorized into low-to-moderate-intensity and high-intensity subgroups. Intensity effect on glycemic control was determined by meta-regression analysis, and risk-of-bias was assessed using Cochrane Collaboration tool. 24 trials met the inclusion criteria, comprised of 962 patients of exercise (n = 491) and control (n = 471). Meta-regression analysis showed decreased HbA1c (p = 0.006) and insulin (p = 0.015) after RE was correlated with intensity. Subgroup analysis revealed decreased HbA1c was greater with high intensity (-0.61; 95% CI -0.90, -0.33) than low-to-moderate intensity (-0.23; 95% CI -0.41, -0.05). Insulin levels were significantly decreased only with high intensity (-4.60; 95% CI -7.53, -1.67), not with low-to-moderate intensity (0.07; 95% CI -3.28, 3.42). Notably, values between the subgroups were statistically significant for both HbA1c (p = 0.03) and insulin (p = 0.04), indicative of profound benefits of high-intensity RE. Pooled outcomes of 15 trials showed only a decreased trend in blood glucose with RE (p = 0.09), and this tendency was not associated with intensity. Our meta-analysis provides additional evidence that high-intensity RE has greater beneficial effects than low-to-moderate-intensity in attenuation of HbA1c and insulin in T2D patients.
Total # studies included: 24 RCTs	
Other details (e.g. definitions used, exclusions etc)	
Outcomes addressed: Glycemic control	
Populations Analyzed: Patients with definite T2D	**Author-Stated Funding Source:**

Citation: Liu Y, Ye W, Chen Q, et al. Resistance Exercise Intensity is Correlated with Attenuation of HbA1c and Insulin in Patients with Type 2 Diabetes: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2019;16(1). PMID: 30621076. 10.3390/ijerph16010140	
Purpose: **Last Search Date:** Apr-18 **Total # studies included:** 13 RCTs **Other details (e.g. definitions used, exclusions etc)** **Outcomes addressed:** Glycemic control, body composition, cardiorespiratory fitness	**Abstract:** AIMS: The aim of this systematic review and meta-analysis was to quantify the effect of high-intensity interval training (HIIT) on glycemic control and cardiorespiratory fitness compared with moderate-intensity training (MICT) and no training at all in patients with type 2 diabetes (T2D). METHODS: Relevant articles were sourced from PubMed, Embase, the Web of Science, EBSCO, and the Cochrane Library. Randomized-controlled trials were included based upon the following criteria: participants were clinically diagnosed with T2D, outcomes that included glycemic control (e.g., hemoglobin A1c); body composition (e.g., body weight); cardiorespiratory fitness (e.g., VO2peak) are measured at baseline and post-intervention and compared with either a MICT or control group. RESULTS: Thirteen trials involving 345 patients were finally identified. HIIT elicited a significant reduction in BMI, body fat, HbA1c, fasting insulin, and VO2peak in patients with type 2 diabetes. Regarding changes in the body composition of patients, HIIT showed a great improvement in body weight (mean difference: - 1.22 kg, 95% confidence interval [CI] - 2.23 to - 0.18, P = 0.02) and body mass index (mean difference: - 0.40 kg/m(2), 95% CI - 0.78 to - 0.02, P = 0.04) than MICT did. Similar results were also found with respect to HbA1c (mean difference: - 0.37, 95% CI - 0.55 to - 0.19, P < 0.0001); relative VO2peak (mean difference: 3.37 ml/kg/min, 95% CI 1.88 to 4.87, P < 0.0001); absolute VO2peak (mean difference: 0.37 L/min, 95% CI 0.28 to 0.45, P < 0.00001). CONCLUSIONS: HIIT may induce more positive effects in cardiopulmonary fitness than MICT in T2D patients.
Populations Analyzed: Clinically diagnosed with type 2 diabetes	**Author-Stated Funding Source:**

<table>
<tr><td colspan="2">Citation:
Meng D, Chunyan W, Xiaosheng D, et al. The Effects of Qigong on Type 2 Diabetes Mellitus: A Systematic Review and Meta-Analysis. Evid Based Complement Alternat Med. 2018;2018:8182938. PMID: 29507593. 10.1155/2018/8182938</td></tr>
<tr><td>Purpose:</td><td rowspan="4">Abstract:
Objective. The purpose of this study was to investigate the effects of Qigong on type 2 diabetes mellitus (DM) using the systematic review and meta-analysis. Methods. All prospective, randomized, controlled clinical trials published in English or Chinese and involving the use of Qigong by patients with DM were searched in 7 electronic databases from their respective inception to June 2016. The meta-analysis was conducted using the Revman 5.2. The quality of the included trials was assessed using the Jadad rating scale. Two researchers independently completed the inclusion, data extraction, and quality assessment. Results. Twenty-one trials with 1326 patients met the inclusion criteria and were reviewed. The meta-analysis demonstrated that, compared with no exercise, the Qigong had significant effects on fasting blood glucose (MD = −0.99, 95% CI (−1.23, 0.75), P<0.0001), HbA1c (MD = −0.84, 95% CI (−1.02, −0.65), P<0.0001), and postprandial blood glucose (MD = −1.55, 95% CI (−2.19, −0.91), P<0.00001). Conclusion. The Qigong training can improve the blood glucose status of the type 2 DM patients and has positive effects on the management of type 2 DM. However, future research with better quality still needs to be conducted to address the effects of Qigong on type 2 DM.</td></tr>
<tr><td>Last Search Date:
Jun-16</td></tr>
<tr><td>Total # studies included:
21 RCTs</td></tr>
<tr><td>Other details (e.g. definitions used, exclusions etc)</td></tr>
<tr><td>Outcomes addressed:
Glycemic control</td><td></td></tr>
<tr><td>Populations Analyzed:
Diabetic patients (assume T2DM) without serious DM related complications.</td><td>Author-Stated Funding Source:</td></tr>
</table>

Citation: Pan B, Ge L, Xun YQ, et al. Exercise training modalities in patients with type 2 diabetes mellitus: a systematic review and network meta-analysis. Int J Behav Nutr Phys Act. 2018;15(1):72. PMID: 30045740. 10.1186/s12966-018-0703-3	
Purpose: **Last Search Date:** Apr-17 **Total # studies included:** 37 RCTs **Other details (e.g. definitions used, exclusions etc)** **Outcomes addressed:** Glycemic control, body composition, blood pressure, or lipid profiles	**Abstract:** INTRODUCTION: Current international guidelines recommend aerobic, resistance, and combined exercises for the management of type 2 diabetes mellitus (T2DM). In our study, we conducted a network meta-analysis to assess the comparative impact of different exercise training modalities on glycemic control, cardiovascular risk factors, and weight loss in patients with T2DM. METHODS: We searched five electronic databases to identify randomized controlled trials (RCTs) that compared the differences between different exercise training modalities for patients with T2DM. The risk of bias in the included RCTs was evaluated according to the Cochrane tool. Network meta-analysis was performed to calculate mean difference the ratio of the mean and absolute risk differences. Data were analyzed using R-3.4.0. RESULTS: A total of 37 studies with 2208 patients with T2DM were included in our study. Both supervised aerobic and supervised resistance exercises showed a significant reduction in HbA1c compared to no exercise (0.30% lower, 0.30% lower, respectively), however, there was a less reduction when compared to combined exercise (0.17% higher, 0.23% higher). Supervised aerobic also presented more significant improvement than no exercise in fasting plasma glucose (9.38 mg/dl lower), total cholesterol (20.24 mg/dl lower), triacylglycerol (19.34 mg/dl lower), and low-density lipoprotein cholesterol (11.88 mg/dl lower). Supervised resistance showed more benefit than no exercise in improving systolic blood pressure (3.90 mmHg lower]) and total cholesterol (22.08 mg/dl lower]. In addition, supervised aerobic exercise was more powerful in improving HbA1c and weight loss than unsupervised aerobic (HbA1c: 0.60% lower; weight loss: 5.02 kg lower) and unsupervised resistance (HbA1c: 0.53% lower) exercises. CONCLUSION: Compared with either supervised aerobic or supervised resistance exercise alone, combined exercise showed more pronounced improvement in HbA1c levels; however, there was a less marked improvement in some cardiovascular risk factors. In terms of weight loss, there were no significant differences among the combined, supervised aerobic, and supervised resistance exercises. TRIAL REGISTRATION: Our study protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO); registration number: CRD42017067518 .
Populations Analyzed: T2DM aged ≥18 years	**Author-Stated Funding Source:**

Citation: Qiu S, Cai X, Sun Z, et al. Aerobic Interval Training and Cardiometabolic Health in Patients with Type 2 Diabetes: A Meta-Analysis. Front Physiol. 2017;8:957. PMID: 29218018. 10.3389/fphys.2017.00957	
Purpose: **Last Search Date:** Oct-17 **Total # studies included:** 9 RCTs **Other details (e.g. definitions used, exclusions etc)** **Outcomes addressed:** Cardiorespiratory fitness, glycemic control, body composition, blood pressure, or lipid profiles	**Abstract:** Vigorous to maximal aerobic interval training (INT) has received remarkable interest in improving cardiometabolic outcomes for type 2 diabetes patients recently, yet with inconsistent findings. This meta-analysis was aimed to quantify its effectiveness in type 2 diabetes. Randomized controlled trials (RCTs) were identified by searches of 3 databases to October 2017, which evaluated the effects of INT with a minimal training duration of 8 weeks vs. moderate-intensity continuous training (MICT) or non-exercise training (NET) among type 2 diabetes patients on outcomes including cardiorespiratory fitness, glycemic control, body composition, blood pressure, and lipid profiles. Weighted mean differences with 95% confidence intervals (CIs) were calculated with the random-effects model. Nine datasets from 7 RCTs with 189 patients were included. Compared with MICT, INT improved maximal oxygen consumption (VO2max) by 2.60 ml/kg/min (95% CI: 1.32 to 3.88 ml/kg/min, P <0.001) and decreased hemoglobin A1c (HbA1c) by 0.26% (95% CI: -0.46% to -0.07%, P = 0.008). These outcomes for INT were also significant vs. energy expenditure-matched MICT, with VO2max increased by 2.18 ml/kg/min (P = 0.04) and HbA1c decreased by 0.28% (P = 0.01). Yet their magnitudes of changes were larger compared with NET, with VO2max increased by 6.38 ml/kg/min (P <0.001) and HbA1c reduced by 0.83% (P = 0.004). Systolic blood pressure could be lowered by INT compared with energy expenditure-matched MICT or NET (both P <0.05), but other cardiometabolic markers and body composition were not significantly altered in general. In conclusion, despite a limited number of studies, INT improves cardiometabolic health especially for VO2max and HbA1c among patients with type 2 diabetes, and might be considered an alternative to MICT. Yet the optimal training protocols still require to be established.
Populations Analyzed: Patients with T2DM	**Author-Stated Funding Source:**

Citation: Rees JL, Johnson ST, Boule NG. Aquatic exercise for adults with type 2 diabetes: a meta-analysis. Acta Diabetol. 2017;54(10):895-904. PMID: 28691156. 10.1007/s00592-017-1023-9	
Purpose:	**Abstract:**
Last Search Date: Feb-17	AIMS: The purpose of this systematic review and meta-analysis was to examine the effects of aquatic exercise (AquaEx) on indicators of glycemic control (i.e., glycated hemoglobin [A1c] and fasting plasma glucose) in adults with type 2 diabetes mellitus (T2DM). It was hypothesized that AquaEx would improve glycemic control to a similar extent as land-based exercise (LandEx), but to a greater extent than non-exercise control (Ctrl). METHODS: A literature search was completed in February 2017 for studies examining AquaEx training in adults with T2DM. Assessment of glycemic control was necessary for inclusion, while secondary outcomes such as quality of life and cardiometabolic risk factors (i.e., blood pressure, triglycerides and total cholesterol) were considered, but not required for inclusion. Outcomes were measured before and after at least 8 weeks of AquaEx, and data were analyzed using weighted mean differences (WMDs) and fixed effect models, when appropriate. RESULTS: Nine trials including 222 participants were identified. Three trials compared AquaEx to LandEx, two compared AquaEx to Crtl, and four had a pre-/post-design without a comparison group. Results indicate no difference in A1c between LandEx and AquaEx (WMD = -0.02%, 95% confidence interval = [-0.71, 0.66]). Post-intervention A1c was lower in AquaEx when compared to Crtl (WMD = -0.96%, [-1.87, -0.05]). Post-AquaEx A1c was lower compared to baseline (WMD = -0.48%, [-0.66, -0.30]). CONCLUSIONS: A1c can be reduced after eight-twelve weeks of AquaEx. However, at this time few studies have examined whether changes in A1c are different from LandEx or Crtl.
Total # studies included: 9	
Other details (e.g. definitions used, exclusions etc)	
Outcomes addressed: HBA1c	
Populations Analyzed: Adults with T2DM	**Author-Stated Funding Source:**

<table>
<tr><td colspan="2">Citation:
Sampath Kumar A, Maiya AG, Shastry BA, et al. Exercise and insulin resistance in type 2 diabetes mellitus: A systematic review and meta-analysis. Ann Phys Rehabil Med. 2019;62(2):98-103. PMID: 30553010. 10.1016/j.rehab.2018.11.001</td></tr>
<tr><td>Purpose:
Last Search Date:
Jun-17
Total # studies included:
11 RCT or CCT
Other details (e.g. definitions used, exclusions etc)
Outcomes addressed:
Glycemic control, BMI</td><td>Abstract:
BACKGROUND: Insulin resistance is a determining factor in the pathophysiology of type 2 diabetes mellitus (T2DM). Exercise is known to improve insulin resistance, but a systematic review of the literature is lacking. OBJECTIVE: This systematic review and meta-analysis focused on identifying evidence for the effectiveness of a structured exercise intervention program for insulin resistance in T2DM. METHODS: We searched MEDLINE via PubMed, CINHAL, Scopus and Web of Science, and the Cochrane Central Register of Controlled Trials for reports of studies on fasting insulin, homeostatic model assessment for insulin resistance (Homa-IR), fasting blood sugar, glycated hemoglobin and body mass index in patients with T2DM and healthy controls that were published between 1990 and 2017. Data are reported as the standardized mean difference or mean difference with 95% confidence intervals (CIs). RESULTS: Among 2242 records retrieved, only 11 full-text articles were available for meta-analysis. Data for 846 participants were analyzed, 440 in the intervention group, and 406 in the control group. The mean difference for fasting insulin level was-1.64 (95% CI; -3.38 to 0.10), Homa-Ir 0.14 (-1.48 to 1.76), fasting blood sugar-5.12 (-7.78 to-2.45), hemoglobin A1c 0.63 (-0.82 to 2.08) and body mass index-0.36 (-1.51 to 0.79). CONCLUSION: The evidence highlights the effectiveness of a structured exercise intervention program for insulin resistance in T2DM with a moderate level 2 of evidence.</td></tr>
<tr><td>Populations Analyzed:
T2DM in people 18 years or older</td><td>Author-Stated Funding Source:</td></tr>
</table>

Citation: Song G, Chen C, Zhang J, et al. Association of traditional Chinese exercises with glycemic responses in people with type 2 diabetes: A systematic review and meta-analysis of randomized controlled trials. J Sport Health Sci. 2018;7(4):442-52. PMID: 30450253. 10.1016/j.jshs.2018.08.004	
Purpose: **Last Search Date:** Sep-17 **Total # studies included:** 39 RCTs **Other details (e.g. definitions used, exclusions etc)** **Outcomes addressed:** Glycemic control, body composition, blood pressure, or lipid profiles	**Abstract:** Background: There is increasing evidence showing the health benefits of various forms of traditional Chinese exercises (TCEs) on the glycemic profile in people with type 2 diabetes. However, relatively little is known about the combined clinical effectiveness of these traditional exercises. This study was designed to perform a systematic review and meta-analysis of the overall effect of 3 common TCEs (Tai Ji Quan, Qigong, Ba Duan Jin) on glycemic control in adults with type 2 diabetes. Methods: We conducted an extensive database search in Cochrane Library, EMBASE, PubMed, Web of Science, EBSCO, and China National Knowledge Infrastructure on randomized controlled trials published between April 1967 and September 2017 that compared any of the 3 TCEs with a control or comparison group on glycemic control. Data extraction was performed by 2 independent reviewers. Study quality was evaluated using the Cochrane Handbook for Systematic Reviews of Interventions, which assessed the risk of bias, including sequence generation, allocation concealment, blinding, completeness of outcome data, and selective outcome reporting. The resulting quality of the reviewed studies was characterized in 3 grades representing the level of bias: low, unclear, and high. All analyses were performed using random effects models and heterogeneity was quantified. We a priori specified changes in biomarkers of hemoglobin A1c (in percentage) and fasting blood glucose (mmol/L) as the main outcomes and triglycerides, total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein-cholesterol, 2-h plasma glucose, and fasting plasma glucose as secondary outcomes. Results: A total of 39 randomized, controlled trials (Tai Ji Quan=11; Qigong=6; Ba Duan Jin=22) with 2917 type 2 diabetic patients (aged 41-80 years) were identified. Compared with a control or comparison group, pooled meta-analyses of TCEs showed a significant decrease in hemoglobin A1c (mean difference (MD)=-0.67%; 95% confidence interval (CI): -0.86% to -0.48%; $p < 0.00001$) and fasting blood glucose (MD=-0.66 mmol/L; 95%CI: -0.95 to -0.37 mmol/L; $p < 0.0001$). The observed effect was more pronounced for interventions that were medium range in duration (i.e., >3-<12 months). TCE interventions also showed improvements in the secondary outcome measures. A high risk of bias was observed in the areas of blinding (i.e., study participants and personnel, and outcome assessment). Conclusion: Among patients with type 2 diabetes, TCEs were associated with significantly lower hemoglobin A1c and fasting blood glucose. Further studies to better understand the dose and duration of exposure to TCEs are warranted.
Populations Analyzed: Adults with type 2 diabetes	**Author-Stated Funding Source:**

<table>
<tr><td colspan="2">Citation:
Thind H, Lantini R, Balletto BL, et al. The effects of yoga among adults with type 2 diabetes: A systematic review and meta-analysis. Prev Med. 2017;105:116-26. PMID: 28882745. 10.1016/j.ypmed.2017.08.017</td></tr>
<tr><td>Purpose:</td><td rowspan="4">Abstract:
The purpose of this meta-analysis was to examine the effects of yoga for glycemic control among adults with type 2 diabetes (T2DM). Comprehensive electronic databases searches located 2559 unique studies with relevant key terms. Studies were included if they (1) evaluated a yoga intervention to promote T2DM management, (2) used a comparison group, (3) reported an objective measure of glycemic control at post-intervention, and (4) had follow-up length or post-test of at least 8weeks from baseline. Independent raters coded participant, design and methodological characteristics and intervention content. Summary effect sizes and 95% confidence intervals (CI) were calculated. Twenty-three studies with 2473 participants (mean age=53years; 43% women) met eligibility criteria. Compared with controls, yoga participants were successful in improving their HbA1c (d+=0.36, 95% CI=0.16, 0.56; k=16), FBG (d+=0.58, 95% CI=0.40, 0.76; k=20), and PPBG (d+=0.40, 95% CI=0.23, 0.56; k=14). Yoga was also associated with significant improvements in lipid profile, blood pressure, body mass index, waist/hip ratio and cortisol levels. Overall, studies satisfied an average of 41% of the methodological quality (MQ) criteria; MQ score was not associated with any outcome (Ps >0.05). Yoga improved glycemic outcomes and other risk factors for complications in adults with T2DM relative to a control condition. Additional studies with longer follow-ups are needed to determine the long-term efficacy of yoga for adults with T2DM.</td></tr>
<tr><td>Last Search Date:
Feb-16</td></tr>
<tr><td>Total # studies included:
23</td></tr>
<tr><td>Other details (e.g. definitions used, exclusions etc)</td></tr>
<tr><td>Outcomes addressed:
Glycemic control, body composition, blood pressure, or lipid profiles</td></tr>
<tr><td>Populations Analyzed:
T2DM adults≥18 years of age</td><td>Author-Stated Funding Source:</td></tr>
</table>

<table>
<tr><td colspan="2">Citation:
Xia TW, Yang Y, Li WH, et al. Different training durations and styles of tai chi for glucose control in patients with type 2 diabetes: a systematic review and meta-analysis of controlled trials. BMC Complement Altern Med. 2019;19(1):63. PMID: 30871517. 10.1186/s12906-019-2475-y</td></tr>
<tr><td>Purpose:
Last Search Date:
Apr-18
Total # studies included:
17 RCTs
Other details (e.g. definitions used, exclusions etc)
Outcomes addressed:
Glycemic control, body composition, blood pressure, or lipid profiles</td><td>Abstract:
BACKGROUND: Physical activity is an important part of the diabetes management plan. However, the effects caused by different training durations and styles of Tai Chi have not been evaluated. We conducted an updated systematic review of the effects of Tai Chi on patients with type 2 diabetes based on different training durations and styles. METHODS: We performed a search for Chinese and English studies in 8 databases. Two reviewers independently selected the eligible trials and conducted a critical appraisal of the methodological quality. RESULTS: Seventeen trials were included. Tai Chi was found to have reduced fasting blood glucose (FBG) [SMD = - 0.54, 95% CI (- 0.91, - 0.16), P = 0.005] and HbA1c [SMD = - 0.68, 95% CI (- 1.17, - 0.19), P = 0.006] overall, compared with a control group. Considering the subgroup analysis, the pooled results showed that 24 movements or Yang-style Tai Chi did not significantly reduce FBG after a duration of </=3 months [SMD = - 0.46, 95% CI (- 1.42, 0.50), P = 0.35] or > 3 months [SMD = - 0.50, 95% CI (- 1.49, 0.49), P = 0.32], nor did it reduce HbA1c [SMD = - 1.22, 95% CI (- 2.90, 0.47), P = 0.16] after a duration > 3 months in all studies. However, other styles of Tai Chi significantly reduced FBG [SMD = - 0.90, 95% CI (- 1.28, - 0.52), P < 0.00001] and HbA1c [SMD = - 0.90, 95% CI (- 1.28, - 0.52), P < 0.00001] after a duration > 3 months, while no significant reduction in FBG [SMD = - 0.34, 95% CI (- 0.76, 0.08), P = 0.12] or HbA1c [SMD = - 0.34, 95% CI (- 0.76, 0.08), P = 0.12] was found after a duration </=3 months. CONCLUSIONS: Tai Chi seems to be effective in treating type 2 diabetes. Different training durations and styles result in variable effectiveness. The evidence was insufficient to support whether long-term Tai Chi training was more effective.</td></tr>
<tr><td>Populations Analyzed:
Clear diagnosis of T2D</td><td>Author-Stated Funding Source:</td></tr>
</table>

Citation:
Yu X, Chau JPC, Huo L. The effectiveness of traditional Chinese medicine-based lifestyle interventions on biomedical, psychosocial, and behavioral outcomes in individuals with type 2 diabetes: A systematic review with meta-analysis. Int J Nurs Stud. 2018;80:165-80. PMID: 29471267. 10.1016/j.ijnurstu.2018.01.009

Purpose:	**Abstract:**
Last Search Date: Dec-16	BACKGROUND: Integrative diabetes care, which combines conventional diabetes therapy with traditional Chinese medicine (TCM)-based interventions, has gained popularity worldwide. Numerous TCM-based lifestyle modification approaches have been proposed for individuals with type 2 diabetes (T2DM). OBJECTIVES: To synthesize and present the best available evidence on the effectiveness of TCM-based lifestyle interventions in individuals with T2DM. DESIGN: We undertook a systematic review of randomized controlled trials or controlled clinical trials. DATA SOURCES: Six English and four Chinese electronic databases were searched from their inceptions to December 2016. REVIEW METHODS: Trials investigating the effectiveness of various TCM-based lifestyle interventions among adults with T2DM were reviewed. Studies were excluded if TCM-based lifestyle interventions were only part of the intervention regimen. Two reviewers independently selected studies according to pre-specified inclusion and exclusion criteria and appraised the risk of bias of the included studies. One reviewer extracted details of the included studies and the second reviewer checked the extracted data critically. When feasible, data were statistically pooled for meta-analysis. Otherwise, narrative summaries were used. RESULTS: Twenty-four studies were included. The pooled analysis of the eight studies on tai chi showed tai chi practice for at least 150min per week was beneficial in lowering glycosylated hemoglobin (mean difference, -1.48%; 95%CI, -2.58% to -0.39%; p<0.001). Tai chi was effective in reducing fasting blood glucose (mean difference, -1.14mmol/L; 95%CI, -1.78 to -0.50mmol/L; p<0.001) and body mass index (mean difference, -0.62; 95%CI, -1.14 to -0.11; p=0.02), and improving quality of life. The effects of tai chi on blood pressure and waist circumference were inconclusive due to the limited number of studies. The meta-analysis of the 12 studies on ba duan jin demonstrated beneficial effects on glycosylated hemoglobin (mean difference, -0.77%; 95%CI, -0.97% to -0.56%; p<0.001), fasting blood glucose (mean difference, -0.82mmol/L; 95%CI, -1.05 to -0.59mmol/L; p<0.001), body mass index (mean difference, -2.77; 95%CI, -4.11 to -1.43; p<0.001), and depression (mean difference, -4.53; 95%CI, -7.12 to -1.94; p<0.001). Conclusions on the effects of ba duan jin on quality of life cannot be drawn because only two studies measured the outcome. Evidence regarding the effectiveness of other TCM-based lifestyle interventions is limited. CONCLUSIONS: Tai chi and ba duan jin are potentially effective options for individuals with T2DM to improve biomedical and psychosocial well-being. Further well-designed studies are needed to explore the optimal intervention dose and to investigate the effectiveness of other TCM-based lifestyle interventions.
Total # studies included: 20 RCTs or CCTs	
Other details (e.g. definitions used, exclusions etc)	
Outcomes addressed: Glycemic control, body composition, blood pressure, or lipid profiles; QOL and depression measures; behavioral outcomes	
Populations Analyzed: Adults (≥18 years old) with a clinical diagnosis of T2DM	**Author-Stated Funding Source:**

<table>
<tr><td colspan="2">Citation:
Zhou Z, Zhou R, Li K, et al. Effects of tai chi on physiology, balance and quality of life in patients with type 2 diabetes: A systematic review and meta-analysis. J Rehabil Med. 2019;51(6):405-17. PMID: 30968941. 10.2340/16501977-2555</td></tr>
<tr><td>Purpose:
Last Search Date:
Mar-18
Total # studies included:
23 RCTs
Other details (e.g. definitions used, exclusions etc)
Outcomes addressed:
Glycemic control, body composition, blood pressure, or lipid profiles, QOL</td><td>Abstract:
OBJECTIVE: To systematically synthesize and critically evaluate evidence on the effects of tai chi for patients with type 2 diabetes mellitus. DATA SOURCES: Seven electronic databases (Wan Fang, SinoMed, China National Knowledge Infrastructure, VIP, PubMed, Embase, and Cochrane Library) were systematically searched from their inception to March 2018. STUDY SELECTION: Randomized controlled trials investigating the effects of tai chi on individuals with type 2 diabetes mellitus were eligible. DATA EXTRACTION: Biomedical outcomes (fasting plasma glucose, glycosylated haemoglobin (HbA1c), fasting insulin, insulin resistance, body mass index, total cholesterol, blood pressure) as well as balance and quality of life-related outcomes were extracted independently by 2 reviewers. Stata 12.0 software was used to synthesize data if there was no or moderate heterogeneity across studies. Otherwise, narrative summaries were performed. DATA SYNTHESIS: A total of 23 studies (25 articles) involving 1,235 patients were included in this meta-analysis. Significant changes in tai chi-related effects were observed in lowering fasting plasma glucose (standardized mean difference; SMD -0.67; 95% confidence interval (95% CI) -0.87 to -0.47; p <0.001), HbA1c (mean difference; MD-0.88%; 95% CI -1.45% to -0.31%; p =0.002) and insulin resistance (MD -0.41; 95% CI -0.78 to -0.04; p = 0.029). Beneficial effects of tai chi were also found in decreasing body mass index (MD -0.82 kg/m2; 95% CI -1.28 to -0.37 kg/m2; p < 0.001) and total cholesterol (SMD -0.59; 95% CI -0.90 to -0.27; p < 0.001). In addition, tai chi reduced blood pressure (systolic blood pressure (MD -10.03 mmHg; 95% CI -15.78 to -4.29 mmHg; p = 0.001), diastolic blood pressure (MD -4.85 mmHg; 95% CI -8.23 to -1.47 mmHg; p = 0.005)) and improved quality of life-related outcomes (physical function (MD 7.07; 95% CI 0.79-13.35; p = 0.027), bodily pain (MD 4.30; 95% CI 0.83-7.77; p = 0.015) and social function (MD 13.84; 95% CI 6.22-21.47; p < 0.001)). However, no impact was exerted on fasting insulin (SMD -0.32; 95% CI -0.71 to 0.07; p = 0.110) or balance (MD 2.71 s; 95% CI -3.29 to 8.71 s; p = 0.376). CONCLUSION: Tai chi is effective in controlling biomedical outcomes and improving quality of life-related outcomes in individuals with type 2 diabetes mellitus, although no effects were observed on balance and fasting insulin. Further high-quality research is needed to elucidate the effects of different types of tai chi, the long-term effects of tai chi, the impact on respiratory function, and the association between tai chi and the risk of developing type 2 diabetes mellitus in healthy individuals.</td></tr>
<tr><td>Populations Analyzed:
Patients diagnosed with T2DM age > 18 years</td><td>Author-Stated Funding Source:</td></tr>
</table>

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