

Supplementary tables 1-13

Supplementary table 1. Example of full search strategy in MEDLINE via EBSCO. Table includes search number, limiters, and result per search.

#	Query	Limiters/Expanders	Last Run Via	Results
S18	S16 AND S17	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	522
S17	S2 OR S3 OR S4 OR S5 OR S6 OR S7	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	10,013
S16	S1 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	2,067,826
S15	SU "cardiovascular disease*"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	123,859
S14	SU "cardiovascular diseases"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	119,927
S13	SU cardiovascular diseases	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	119,935
S12	SU "cardiovascular disease"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	5,566
S11	SU "cardiovascular disease risk factors"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	75
S10	SU cvd risk factor	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	4
S9	SU cvd risk factors	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	25
S8	SU cvd	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	630
S7	SU "commuter cycling"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	1
S6	SU commuter cycling	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	1
S5	SU biking	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	23
S4	SU bicycling	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	8,945
S3	SU cycling	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	1,169
S2	(MH "Bicycling")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	8,908
S1	(MH "Cardiovascular Diseases+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - MEDLINE	

SU, subject; MH, exact subject heading; S1, search number one; S2, search number two etc.

Supplementary table 2: Generation of combined effect estimates for gender when studies have only reported gender specific effect estimates.

Meta	OR	Ci low	Ci high	p-value
Wen et al (2008) ^{31*}	0.340	0.130	0.889	0.028
Wen et al (2008) ^{31†}	0.565	0.302	1.056	0.073
Hu et al (2001) ^{38‡}	0.902	0.662	1.230	0.516
Hu et al (2001) ^{38§}	0.711	0.515	0.983	0.039
Ramirez-Velez et al (2017) ^{39¶}	1.057	0.814	1.373	0.676
Evenson et al (2003) ³⁷	0.712	0.516	0.983	0.039
Ramirez-Velez et al (2017) ^{39**}	1.027	0.825	1.277	0.813

* Combination of obesity men and women

† Combination of overweight or obese men and women

‡ Combination of HDL men and women

§ Combination of triglycerides men and women

¶ Combination of triglycerides boys and girls

|| Combination of >85th and 85-95th percentile middle school and high school

** Combination of HDL boys and girls.

Supplementary table 3: Results after generation of one dose effect estimate for each outcome when studies have reported different levels of cycling.

Meta	RR	Ci low	Ci high	p-value
Blond et al (2016) ^{22*}	0.874	0.821	0.931	0.000
Hoenaar-Blom et al (2011) ^{19†}	0.820	0.734	0.916	0.000
Koolhaas et al (2016) ^{20‡}	0.781	0.671	0.908	0.001
Armstrong et al (2015) ^{21§}	0.837	0.796	0.880	0.000
Besson et al (2008) ^{26¶}	0.769	0.512	1.115	0.206
Blond et al (2016) ²²	0.880	0.721	1.074	0.210
Celis-Morales et al (2017) ^{24**}	0.512	0.323	0.812	0.004
Celis-Morales et al (2017) ^{24††}	0.687	0.383	1.232	0.207
Matthews et al (2007) ^{25‡‡}	0.722	0.423	1.232	0.233
Oja et al (2017) ^{27§§}	0.936	0.762	1.148	0.524
Sahlqvist et al (2013) ^{28¶¶}	0.864	0.744	1.004	0.056
Sahlqvist et al (2013) ²⁸	1.107	0.607	2.020	0.741

* Overall 1-2,5h/wk, >0-1h/wk, and >2,5h/wk

† High and low dose

‡ < and > median

§ 0-2h/wk and >2h/wk

¶ < and > 30 min/wk

|| Commuter >0-1,5h/wk and 1-2,5h/wk

** Morality short and long

†† Incidence short and long

‡‡ <3.4 METShr/day and >3.4 METShr/day

§§ min/wk low and high

¶¶ 1-59 min and > 60 min

||| Commuter 1-59 min and >60 min

Supplementary table 4: Risk factors reported in included studies.

Risk factor	Reported by	Times reported
Obesity	Grøntved (2016) ²⁸ ; Lavery (2013) ²⁹ ; Wen (2008) ³⁰ ; Østergaard (2012) ³¹ ; Bere (2011) ³² ; Salqvist (2012) ³³ ; Millett (2013) ³⁴ ; Berger (2017) ³⁵	8
Overweight or obese	Lavery (2013) ²⁹ ; Wen (2008) ³⁰ ; Østergaard (2012) ³¹ ; Bere (2011) ³² ; Salqvist (2012) ³³ ; Millett (2013) ³⁴ ; Evenson (2003) ³⁶	7
Hypertension	Grøntved (2016) ²⁸ ; Lavery (2013) ²⁹ ; Berger (2017) ³⁵ ; Millett (2013) ³⁴	3
Triglycerides	Grøntved (2016) ²⁸ ; Hu (2001) ³⁷ ; Ramirez-Velez (2017) ³⁸ ; Berger (2017) ³⁵	5
Impaired glucose tolerance	Grøntved (2016) ²⁸	
Total cholesterol	Hu (2001) ³⁷	
HDL cholesterol	Hu (2001) ³⁷ ; Ramirez-Velez (2017) ³⁸ ; Berger (2017) ³⁵	3
LDL cholesterol	Hu (2001) ³⁷	
Cholesterol	Berger (2017) ³⁵	
SLJ	Ramirez-Velez (2017) ³⁸	

Hand grip	Ramirez-Velez (2017) ³⁸
4 x 10 m	Ramirez-Velez (2017) ³⁸
Sit and reach	Ramirez-Velez (2017) ³⁸
20m SRT	Ramirez-Velez (2017) ³⁸
Waist circumference	Ramirez-Velez (2017) ³⁸
Fasting plasma glucose	Ramirez-Velez (2017) ³⁸
Systolic BP	Ramirez-Velez (2017) ³⁸
Diastolic BP	Ramirez-Velez (2017) ³⁸
Metabolic syndrome	Ramirez-Velez (2017) ³⁸
Numbers of risk factors	Berger (2017) ³⁵

HDL, High density lipoprotein; LDL, Low density lipoprotein; SLJ, Standing long jump; 20m SRT, 20m shuttle run test; BP, Blood pressure

Supplementary Table 5a: Sensitivity analysis to investigate the heterogeneity in main analysis between total cycling or commuter cycling and CVD incidence CVD mortality or CVD risk factor

Outcome	Total cycling				Commuter cycling				Combined total and commuter cycling			
	RR	Ci low	Ci high	p-value	RR	Ci low	Ci high	p-value	RR	Ci low	Ci high	p-value
CVD incidence, CVD mortality, and CVD risk factors (fig. 1)	0.816	0.760	0.877	≤ 0.001	0.769	0.720	0.822	≤ 0.001	0.783	0.744	0.824	≤ 0.001
CVD incidence and mortality	0.816	0.760	0.877	≤ 0.001	0.858	0.816	0.903	≤ 0.001	0.840	0.812	0.868	≤ 0.001
CVD incidence	0.800	0.712	0.899	≤ 0.001	0.861	0.851	0.909	≤ 0.001	0.837	0.797	0.880	≤ 0.001
CVD mortality	0.836	0.706	0.989	0.037	0.843	0.736	0.966	0.014	0.827	0.761	0.899	≤ 0.001
CVD Risk factor total	-	-	-		0.749	0.689	0.815	≤ 0.001	-	-	-	
CVD risk factor Overweight or obese	-	-	-		0.635	0.575	0.701	≤ 0.001	-	-	-	
CVD risk factor obesity	-	-	-		0.732	0.574	0.935	0.013	-	-	-	
CVD risk factor hypertension	-	-	-		0.714	0.566	0.900	0.004	-	-	-	
CVD risk factor HDL	-	-	-		0.983	0.822	1.176	0.855	-	-	-	
CVD risk factor triglycerides	-	-	-		0.827	0.712	0.961	0.013	-	-	-	

Supplementary table 5b: Test for heterogeneity in main analysis between total cycling or commuter cycling and CVD incidence CVD mortality or CVD risk factor

Outcome	Total cycling				Commuter cycling				Combined total and commuter cycling			
	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value
CVD incidence, CVD mortality, and CVD risk factors	5.816	4	31.224	0.213	61.430	23	62.559	0.000	67.519	28	58.530	0.00
CVD incidence, and CVD mortality	5.816	4	31.224	0.213	1.664	4	-140.385 => 0	0.797	8.728	9	-3.116 => 0	0.6
CVD incidence	3.641	2	45.070	0.162	0.965	1	-3.627	0.326	5.707	4	29.911	0.22
CVD mortality	2.131	1	53.074	0.144	0.623	2	-221.027 => 0	0.732	2.873	4	-39.227 => 0	0.580
CVD Risk factor total	-	-	-	-	52.691	19	63.941	0.000	-	-	-	-
CVD risk factor Overweight or obese	-	-	-	-	2.831	5	-76.616 => 0	0.726	-	-	-	-
CVD risk factor obesity	-	-	-	-	5.927	2	66.256	0.052	-	-	-	-
CVD risk factor hypertension	-	-	-	-	10.641	3	71.807	0.014	-	-	-	-
CVD risk factor HDL	-	-	-	-	0.450	1	-122.222 => 0	0.502	-	-	-	-
CVD risk factor triglycerides	-	-	-	-	6.303	3	52.404	0.098	-	-	-	-

Supplementary table 6: Test for publication bias, tested with Egger's test, in main analysis

Std_Eff	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
Slope	-.117951	.0301342	-3.91	0.001	-.1796781 -.0562239
bias	-1.361338	.4064258	-3.35	0.002	-2.193863 -.5288125

Supplementary table 7a: Test of dose-response relationship for CVD incidence and CVD mortality for two levels of total cycling and commuter cycling

Outcome	Total and commuter cycling low dose			Total and commuter cycling high dose			Beta-coefficient (metareg)	p-value
	RR	Ci low	Ci high	RR	Ci low	Ci high		
CVD incidence and CVD mortality	0.852	0.815	0.890	0.833	0.790	0.879	-0.021	0.543
CVD incidence	0.849	0.811	0.888	0.834	0.786	0.884	-0.017	0.638
CVD mortality	0.902	0.747	1.090	0.815	0.692	0.960	-0.081	0.489

Supplementary table 7b: Test for Heterogeneity in dose-response relationship for CVD incidence and CVD mortality, total cycling and commuter cycling

Outcome	Total cycling low dose				Total cycling high dose			
	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value
CVD incidence and CVD mortality	4.272	10	-134.082 => 0	0.934	6.779	10	-47.514 => 0	0.746
CVD incidence	1.966	4	-103.459 => 0	0.742	1.238	4	-223.102 => 0	0.872
CVD mortality*	1.93	5	-159.067 => 0	0.859	5.539	5	9.731	0.354

Supplementary table 8a: Test of dose-response relationship for CVD incidence and CVD mortality for two levels of total cycling

Outcome	Total cycling low dose			Total cycling high dose			Beta-coefficient (metareg)	p-value
	RR	Ci low	Ci high	RR	Ci low	Ci high		
CVD incidence and CVD mortality	0.841	0.794	0.890	0.824	0.762	0.892	-0.019	0.693
CVD incidence	0.836	0.788	0.886	0.819	0.755	0.888	-0.020	0.694
CVD mortality*	0.970	0.730	1.289	0.900	0.670	1.209	-	-

*only reported by one study

Supplementary table 8b: Test for Heterogeneity in dose-response relationship for CVD incidence and CVD mortality, total cycling

Outcome	Total cycling low dose				Total cycling high dose			
	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value
CVD incidence and CVD mortality	1.526	3	-96.592 => 0	0.676	0.995	3	-201.508 => 0	0.802
CVD incidence	0.513	2	-289.864 => 0	0.774	0.63	2	-217.460 => 0	0.73
CVD mortality*	-	-	-	-	-	-	-	-

*only reported by one study

Supplementary table 9a: Test of dose-response relationship for CVD incidence and CVD mortality for two levels of commuter cycling

Outcome	Commuter cycling low dose			Commuter cycling high dose			Beta-coefficient (metareg)	p-value
	RR	Ci low	Ci high	RR	Ci low	Ci high		
CVD incidence and CVD mortality	0.867	0.810	0.928	0.841	0.781	0.906	-0.029	0.559
CVD incidence	0.868	0.809	0.932	0.850	0.781	0.926	-0.020	0.711
CVD mortality	0.851	0.661	1.907	0.737	0.554	0.967	-0.443	0.768

Supplementary table 11a: Subgroup analysis to investigate the heterogeneity of analysis total cycling and CVD incidence, CVD mortality, and CVD risk factors with gender difference

Outcome	Men and women				Men				Women			
	RR/OR	Ci low	Ci high	p-value	RR/OR	Ci low	Ci high	p-value	RR/OR	Ci low	Ci high	p-value
CVD incidence and CVD mortality and CVD risk factors	0.806	0.741	0.877	≤ 0.001	-	-	-	-	0.837*	0.796*	0.880*	≤ 0.001
CVD incidence	0.800	0.712	0.899	≤ 0.001	-	-	-	-	0.837*	0.796*	0.880*	≤ 0.001
CVD mortality	0.802	0.653	0.985	0.035	-	-	-	-	-	-	-	-
Overweight or obese†	na	na	na		na	na	na		na	na	na	
Obesity†	na	na	na		na	na	na		na	na	na	
HDL†	na	na	na		na	na	na		na	na	na	
Triglycerides†	na	na	na		na	na	na		na	na	na	
Hypertension†	na	na	na		na	na	na		na	na	na	

*reported by one study only

† Only analysed for commuter cycling

Supplementary table 11b: Test for heterogeneity of analysis total cycling and CVD incidence, CVD mortality, and CVD risk factors with gender difference

Outcome	Men and women				Men				Women			
	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value
CVD incidence and CVD mortality	8.467	5	40.947	0.132	-	-	-	-	-	-	-	-
CVD incidence	3.641	2	45.070	0.162	-	-	-	-	-	-	-	-
CVD mortality	4.630	2	56.803	0.099	-	-	-	-	-	-	-	-
Overweight or obese	na	na	na	na	na	na	na	na	na	na	na	na
Obesity	na	na	na	na	na	na	na	na	na	na	na	na
HDL	na	na	na	na	na	na	na	na	na	na	na	na
Triglycerides	na	na	na	na	na	na	na	na	na	na	na	na
Hypertension	na	na	na	na	na	na	na	na	na	na	na	na

Supplementary table 12a: Subgroup analysis to investigate the heterogeneity of analysis commuter cycling and CVD incidence, CVD mortality, and CVD risk factors with gender difference

Outcome	Men and women				Men				Women			
	RR/OR	Ci low	Ci high	p-value	RR/OR	Ci low	Ci high	p-value	RR/OR	Ci low	Ci high	p-value
CVD incidence, CVD mortality and risk factors	0.769	0.725	0.816	≤ 0.001	0.818	0.599	1.118	0.208	0.838	0.699	1.005	0.057
CVD incidence	0.859	0.814	0.907	≤ 0.001	-	-	-	-	-	-	-	-
CVD mortality	0.755	0.606	0.940	0.012	-	-	-	-	0.722*	0.423*	1.232*	0.232
CVD risk factors total	0.757	0.705	0.814	≤ 0.001	0.818	0.599	1.118	0.208	0.855	0.704	1.037	0.112
Overweight or obese	0.633	0.574	0.699	≤ 0.001	0.490*	0.310*	0.775*	0.002	1.160*	0.270*	4.984*	0.842
Obesity	0.722	0.631	0.826	≤ 0.001	0.340*	0.130*	0.889*	0.028	-	-	-	-
HDL	0.983	0.822	1.176	0.855	1.041	0.824	1.315	0.737	0.909	0.690	1.198	0.498
Triglycerides	0.827	0.712	0.961	0.013	1.018	0.696	1.489	0.926	0.784	0.558	1.103	0.162
Hypertension	0.714	0.566	0.900	0.004	-	-	-	-	-	-	-	-

*reported only by one study

Supplementary table 12b: Test for heterogeneity subgroup analysis of commuter cycling and CVD risk factors, gender difference

Outcome	Men and women				Men				Women			
	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value	Cohens Q	df	I ²	p-value
CVD incidence, CVD mortality and risk factors	95.84	45	53.047	0.000	16.233	5	69.199	0.006	2.447	5	-104.332 => 0	0.784
CVD incidence	1.532	2	-30.548 => 0	0.465	-	-	-	-	-	-	-	-
CVD mortality	4.765	3	37.041	0.190	-	-	-	-	-	-	-	-
CVD risk factors total	82.826	38	54.120	0.000	16.233	5	69.19	0.006	2.109	4	-89.66 => 0	0.716
Overweight or obese	2.961	6	-102.634 => 0	0.814	-	-	-	-	-	-	-	-
Obesity	8.499	6	29.403	0.204	-	-	-	-	-	-	-	-
HDL	0.450	1	-122.222 => 0	0.502	0.651	1	-53.610 => 0	0.42	0.006	1	-16566.667 => 0	0.938
Triglycerides	6.303	3	52.404	0.098	1.942	1	48.507	0.163	1.477	1	32.295	0.224
Hypertension	10.641	3	71.807	0.014	-	-	-	-	-	-	-	-

*reported by one study only

Supplementary table 13. Additional information for table 2. This table include the adjustments for each included study.

Study	Adjustments
Hoevenaer-Blom et al (2011) ¹⁹	Age, Sex, Other PA (both occupational and leisure) than the one under study, Current smoking Alcohol consumption and educational level.
Koolhaas et al (2016) ²⁰	Age, sex, all other PA types, smoking, alcohol consumption, diet, education, BMI, TC, HDL, diabetes, lipid-reducing agent, SBP, hypertension.
Armstrong et al (2015) ²¹	BMI-by-age, smoking-by-age, and stratified by socioeconomic status and region.
Blond et al (2016) ²²	Age, gender, years of school, educational level, smoking, frequency of alcohol intake, coffee intake, total energy intake, cereal whole grain intake, fruit intake, vegetable intake, glycemic load, ratio of polyunsaturated to saturated fat, occupational PA, leisure time PA, family history of CHD, BMI, diabetes, hypercholesterolemia medication, hypertension medication.
Andersen ZJ et al (2015) ²³	NO ₂ , sex, calendar year, mutually for other three PAs, occupational PA, smoking status, smoking intensity, smoking duration, alcohol intake, environmental tobacco smoke, education, fruit and vegetable intake, fat intake, risk occupation, mean income in municipality, stratified by marital status
Celis-Morales et al (2017) ²⁴	Sex, age, ethnicity, Townsend deprivation index, comorbidities (long-standing illness, diabetes, hypertension, CVD, cancer and depression), BMI (coded as categorical variable based on the WHO classification), smoking, dietary intake (alcohol, fruit and vegetable, red meat, oily fish, poultry, and processed meat), time spent walking for pleasure, time spent undertaking strenuous sport, time spent in light and heavy DIY, level of occupational PA, and sedentary behavior.
Matthews et al (2007) ²⁵	Age, marital status (yes/no), education (elementary school or less, high school, college or more), household income (low, middle, high), smoking (ever, never), alcohol drinking (ever/never), number of pregnancies, oral contraceptive use (ever/never), menopausal status (yes/no), other types of PA, several chronic medical condition, such as diabetes (yes/no), hypertension (yes/no), respiratory disease (yes/no; asthma, chronic bronchitis, tuberculosis, chronic hepatitis (yes/no).
Besson et al (2008) ²⁶	Baseline age, sex, social class, alcohol consumption, smoking status, history of cancer, history of CVD and stroke, activity at home, sport or exercise, at work and walking.
Oja et al (2017) ²⁷	Age, sex, long-standing illness, alcohol drinking frequency, psychological distress (GHQ score), BMI, smoking status, education level, doctor-diagnosed CVD (IHD, angina, stroke) or cancer, and weekly volume of other PA (MET-hours, excluding the volume of the sport that was the main exposure in the corresponding model).
Sahlqvist et al (2013) ²⁸	Age, sex, education level, social class, smoking status, family history of cancer or CVD, and other PA (walking and other exercise).
Grøntved et al (2016) ²⁹	Age at baseline, follow-up time, baseline levels of risk factors, sex, leisure time exercise, occupational PA, smoking status, educational status, alcohol consumption, intake of coffee, total energy, vegetables, trans fat, and fiber.
Laverty et al (2013) ³⁰	Age, gender, ethnic group, education level, NS-SEC Social Class, place of residence.
Wen et al (2008) ³¹	Level of PA, age group, marital status, level of education, main language spoken at home
Østergaard et al (2012) ³²	Age, gender, ethnicity, parental occupational status, leisure time PA.
Bere et al (2011) ³³	Overweight at baseline.
Sahlqvist et al (2012) ³⁴	Sex, age, education, employment, SEIFA, residential location, children under 18 living at home, BMI, number of cars in household, years cycling as an adult, motivators for cycling.
Millett et al (2013) ³⁵	Age, sex, caste, standard of living, factory location, leisure time PA, fat intake, smoking status, alcohol intake with an individual-specific random effect of sib-pair.
Berger et al (2017) ³⁶	Age, sex, race, smoking status, alcohol consumption, and noncycling PA.
Evenson et al (2003) ³⁷	Sex, grade in school, race, days of physical education class per week, parental education level, adult at home after school.
Hu et al (2001) ³⁸	Age, education, smoking, BMI and occupation.
Ramirez-Velez et al (2017) ³⁹	Age, Tanner stage, and parent educational level.

PA, physical activity; TC, total cholesterol; HDL, high density lipoprotein; SBP, systolic blood pressure; CHD, coronary heart disease; BMI, body mass index; NO₂, nitrogen dioxide; CVD, cardiovascular disease; DIY, do-it-yourself; GHQ, general health questionnaire; IHD, ischemic heart disease; NS- SEC, national statistics socio-economical classification.