Data S1. MOOSE Reporting Checklist for Authors, Editors, and Reviewers of Meta-analyses of Observational Studies (1)

Reporting of background should include:	**Page number:**
Problem definition	5
Hypothesis statement	5
Description of study outcome(s)	5
Type of exposure or intervention used	5
Type of study designs used	5
Study population	5
Reporting of search strategy should include:	**Page number:**
Qualifications of searchers (eg, librarians and investigators)	1
Search strategy, including time period included in the synthesis and keywords	Appendix 1
Effort to include all available studies, including contact with authors	6-7
Databases and registries searched	6-7
Search software used, name and version, including special features used (eg, explosion)	6-7
Use of hand searching (eg, reference lists of obtained articles)	6-7
List of citations located and those excluded, including justification	Figure 1
Method of addressing articles published in languages other than English	-
Method of handling abstracts and unpublished studies	6-7
Description of any contact with authors	-
Reporting of methods should include:	**Page number:**
Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	6-7
Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	6-7
Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	6-7
Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	6-7
Assessment of study quality, including blinding of quality assessors; stratification or regression on possible	6-7

predictors of study results	
Assessment of heterogeneity	6-7
Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	6-7
Provision of appropriate tables and graphics	Tables and Figures
Reporting of results should include:	**Page number:**
Graphic summarizing individual study estimates and overall estimate	Figures
Table giving descriptive information for each study included	Table
Results of sensitivity testing (eg, subgroup analysis)	8-12
Indication of statistical uncertainty of findings	8-12
Reporting of discussion should include:	**Page number:**
Quantitative assessment of bias (eg, publication bias)	13-16
Justification for exclusion (eg, exclusion of non–English-language citations)	-
Assessment of quality of included studies	13-16
Reporting of conclusions should include:	**Page number:**
Consideration of alternative explanations for observed results	16-17
Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	16-17
Guidelines for future research	-
Disclosure of funding source	17

Stroup DF, Berlin JA, Morton SC, Olkin I et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis of Of Observational Studies in Epidiomiology (MOOSE) group. JAMA. 2000;283:2008-12.

Supplementary Table 1: Definition of sleep quality

Study ID	Definition of sleep quality
Chandola 2010 (2)	Restless, disturbed nights not at all, no more than usual and more than usual.
Chen 2013 (3)	Subjective poor sleep quality vs no insomnia and mortality.
Ensrud 2012 (4)	Poor sleep quality defined by Pittsburgh Sleep Quality Index score >5.
Gianfagna 2016 (5)	Moderate or severe sleep disturbance defined with the Jenkin's Sleep Questionnaire.
Helbig 2015 (6)	Difficulty staying asleep.
Hoevenaar-Blom 2011 (7)	Sleep quality poor vs good defined by question "Do you usually rise rested?"
Huang 2013 (8)	Sleep quality poor vs good derived from response to question: "How would you rate your overall sleep quality in the past 3 months?"
Hublin 2007 (9)	Sleep quality poorly/fairly poorly vs well derived from question: "Do you usually sleep well?"
Kojima 2000 (10)	Sleep quality wake up feeling good vs normal, waking up feeling bad vs normal.
Mallon 2002 (11)	Sleep difficulty, difficulty maintaining sleep.
Martin 2011 (12)	Sleep quality defined by Pittsburgh Sleep Quality Index score >7.
Meisinger 2007 (13)	Sleep disturbance defined by difficulty maintaining sleep.
Qui 2011 (14)	Sleep quality poor vs good, fair vs good.
Rod 2014 (15)	Restless, disturbed nights.
Strand 2016 (16)	Sleep problems such as difficulty getting to sleep, easily awoken, dreamed a lot and needing sleeping pills.
Suzuki 2009 (17)	Sleep quality defined by frequent awakening.
Twig 2016 (18)	Poor sleep defined by Mini-Sleep Questionnaire.
Westerlund 2013 (19)	Difficulty maintaining sleep.

Supplementary Table 2: Cardiovascular disease and cardiovascular risk factors in studies

Study ID	CHD or MI	Stroke	Hypertension	Diabetes	Obesity	Hyperlipidaemia	Current smokers	Current alcohol drinkers
Akersted 2017 (20)	-	-	-	-	-	-	7.9%	-
Amagai 2010 (21)	Excluded 0%	Excluded 0%	-	-	-	-	20.2%	38.8%
Aurora 2016 (22)	CVD 18.0%	CVD 18.0%	54.7%	11.7%	-	-	11.1%	-
Ayas 2003 (23)	Excluded 0%	Excluded 0%	23.8%	3.4%	-	11.4%	21.4%	-
Bellavia 2014 (24)	Excluded 0%	Excluded 0%	-	-	-	-	23.9%	87.5%
Burazeri 2003 (25)	13.5%	4.0%	13.2%	13.7%	-	-	19.5%	31.9%
Cai 2015 (26)	-	-	-	-	-	-	25.5%	14.8%
Canivet 2014 (27)	Excluded 0%	Excluded 0%	60.4%	2.6%	12.7%	1.9% (use of lipid lowering drugs)	24.2%	-
Castro-Costa 2011 (28)	-	-	-	15.0%	-	-	17.5%	-
Chandola 2010 (2)	-	-	8.0%	0.9%	-	-	18.3%	-
Chen 2008 (29)	3.5%, CVD 6.4%	-	39.1%	4.2% (treated for diabetes)	25.2%	15.0% (high cholesterol requiring pills)	6.2%	-
Chen 2013 (3)	CVD 19.4%	3.7%	38.9%	12.9%	-	-	17.1%	9.2%
Chien 2010 (30)	CVD 6.7%	-	29.7%	13.0%	-	-	36.6%	30.3%
Cohen-Mansfeld 2012 (31)	-	-	-	-	-	-	-	-
Ensrud 2012 (4)	-	-	-	-	-	-	2.0%	-
Gangwisch 2008 (32)	-	-	58.9%	7.2%	19.9%	-	27.7%	-
Garde 2013 (33)	Excluded MI, angina pectoris 0%	-	1.6%	0.7%	-	-	71.8%	66.2%
Gianfagna 2016 (5)	Excluded 0%	Excluded 0%	48.2%	6.2%	-	-	36.1%	-
Goto 2013 (34)	-	2.6%	35.4%	-	-	-	Ex or current 41.6%	Drinking everyday 12.1%
Hale 2013 (35)	Excluded CHD 0%	-	-	4.5%	71.7%	-	47%	-
Hall 2015 (36)	CHD 16.7%	Cerebrovascular disease 7.1%	44.0%	15.3%	25.5%	-	10.3%	49.8%
Hamazaki 2011 (37)	Excluded previous CVD 0%	Excluded previous CVD 0%	8.5% (medication for hypertension)	0.6% (medication for diabetes)	-	0.9% (medication for hyperlipidaemia)	59.9%	-
Helbig 2015 (6)	History of heart symptoms/disease	Excluded previous stroke	37.8%	3.7%	-	30.1%	26.7%	-

	5.2%	0%						
Heslop 2002 (38)	-	-	-	-	-	-	-	-
Hoevenaar-Blom 2011 (7)	Excluded CVD 0%	Excluded CVD 0%	18.5%	0.9%	10.0%	-	35.1%	86.4%
Huang 2013 (8)	-	-	-	-	-	-	19.8%	24.0%
Hublin 2007 (9)	-	-	-	-	-	-	27.8%	-
Ikehara 2009 (39)	-	-	21.5%	5.0%	-	-	25.9%	-
Jung 2013 (40)	CHD 10.0%	6.6%	39.7%	10.6%	-	-	59.6%	-
Kakizaki 2013 (41)	MI 3.2%	3.3%	29.8%	7.6%	-	-	51.2%	56.7%
Kawachi 2016 (42)	Excluded 0%	Excluded 0%	17.9%	9.7%	-	-	33.2%	-
Kim 2013 (43)	Excluded heart attack 0%	Exclude previous stroke 0%	50.0%	49.6%	33.2%	-	33.3%	-
Kojima 2000 (10)	-	-	-	-	-	-	-	-
Kripke 2002 (44)	-	-	-	-	-	-	-	-
Lan 2007 (45)	Heart disease 18.8%	6.2%	-	-	-	-	-	-
Lee 2014 (46)	Heart disease 17.3%	3.9%	-	14.1%	-	-	5.7%	-
Lee 2017 (47)	-	-	-	-	-	-	19.3%	28.5%
Leng 2015 (48)	Heart attack 3.0%	Excluded previous stroke 0%	21.0% (hypertension drug use)	2.6%	-	-	51.4%	-
Li 2013 (49)	-	-	-	-	-	-	28.9%	35.8%
Liu 2014 (50)	Excluded CHD 0%	-	13.6% (treated hypertension)	3.7%	-	-	36.5%	-
Magee 2011 (51)	Heart disease 11.8%	Stroke 3.0%	35.5%	8.7%	22.2%	-	7.0%	-
Magee 2013 (52)	Heart disease 11.8%	Stroke 3.0%	35.5%	8.7%	22.2%	-	7.0%	-
Mallon 2002 (11)	Cardiac disease 8.2%	-	16.6%	3.8%	-	-	19.7%	-
Martin 2011 (12)	-	-	-	-	-	-	-	-
Meisinger 2007 (13)	Exclude angina pectoris and MI 0%	-	54.7%	7.1%	-	Dyslipidaemia 47.9%	23.8%	-
Mesas 2010 (53)	IHD 7.0%	3.6%	68.8%	15.0%	-	-	10.2%	-
Pan 2014 (54)	CHD 4.1%	1.5%	23.8%	9.0%	-	-	-	-
Patel 2004 (55)	CVD 5.6%	-	25.8%	4.0%	-	-	21.3%	-
Pollak 1990 (56)	-	-	-	-	-	-	-	-
Qiu 2011 (14)	-	-	-	-	-	-	27.7%	24.4%
Qureshi 1997 (57)	Excluded CHD 0%	Excluded stroke 0%	-	2.8%	-	-	27.9%	-
Rhee 2012 (58)	-	-	7.8%	2.7%	-	-	49.4%	64.0%
Rod 2014 (15)	Excluded CVD 0%	0%	-	0%	-	-	48%	-
Ruigomez 1995 (59)	-	-	-	-	-	-	12.9%	61.1%

Ruiter Petrov 2014 (60)	Heart disease 9.1%	Excluded stroke, TIA or stroke symptoms 0%	40.2%	11.5%	27.7%	Dyslipidaemia 48.8%	12.1%	45.4%
Sands-Lincoln 2013 (61)	Excluded CHD 0%	-	-	3.4%	-	Hyperlipidaemia 9.4%	6.2%	-
Shankar 2008 (62)	Excluded CHD 0%	Excluded stroke 0%.	23.7%	8.9%	-	-	19.7%	19.0%
Song 2016 (63)	MI 1.2%	Excluded stroke 0%.	-	-	-	-	39.7%	40.8%
Stone 2009 (64)	-	-	-	-	-	-	-	-
Strand 2016 (16)	Heart disease 3.7%	-	8.4%	-	-	-	22.7%	6.9%
Suzuki 2009 (17)	-	-	31.5%	7.6%	-	-	16.4%	31.9%
Tamakoshi 2004 (65)	MI 3.0%	1.5%	-	-	-	-	25.6%	45.8%
Tsubono 1993 (66)	-	-	-	-	-	-	24.4%	33.4%
Tu 2012 (67)	-	-	-	-	-	-	-	-
Twig 2016 (18)	Excluded CAD 0%	-	-	0%	11.8%	-	26.9%	-
Von Ruesten 2012 (68)	Exclude MI 0%	Exclude stroke 0%	46.1%	0%	15.8%	-	20.5%	-
Wang 2016 (69)	Excluded MI 0%	-	43.8%	9.2%	-	Hyperlipidemia 35.2%	Current or past 39.9%	Current or past 40.9%
Werle 2011 (70)	-	-	93%	17.6%	-	-	-	-
Westerlund 2013 (19)	Exclude CVD 0%	Exclude CVD 0%	11.9%	1.9%	-	Lipid disturbance 3.5%	8.1%	-
Wingard 1983 (71)	-	-	-	-	-	-	-	-
Xiao 2014 (72)	Exclude heart disease 0%	Exclude stroke 0%	35.2%	6.6%	-	-	11.0%	-
Yeo 2013 (73)	CVD 4.0%	CVD 4.0%	12.7%	5.1%	-	High total cholesterol 11.2%	27.2%	38.9%
Zawisza 2015 (74)	-	-	-	-	-	-	-	-
Zuubier 2015 (75)	MI 3.9%	2.6%	-	11.8%	-	-	20.6%	-

CHD=coronary heart disease, IHD=ischaemic heart disease, CAD=coronary artery disease, CVD=cardiovascular disease, MI=myocardial infarction

Table 2: Risk of bias table

Study ID	Ascertainment of sleep	Ascertainment of outcomes	Adjustments	Loss to follow up or exclusions for missing data.
Akersted 2017 (20)	Karolinska Sleep Questionnaire.	Deaths from linkage to Swedish Cause of Death Register.	Adjusted for age, sex, body mass index, smoking status, alcohol consumption, education level, physical activity and major diseases.	10.6% excluded or had missing values.
Amagai 2010 (21)	Interview for sleep duration.	Participants were followed up with visits and subjects who moved away had data taken from municipal government.	Age, systolic blood pressure, total cholesterol, body mass index, smoking habits and alcohol drinking habits.	7 (0.06%) loss to follow up due to no follow up data.
Aurora 2016 (22)	Interview questioning.	Follow-up interviews, written annual questionnaires or telephone contacts, surveillance of local hospital records, community obituaries and Social Security Administrative Death Master File.	Adjusted for age, sex, race, body mass index, smoking status, prevalent hypertension, cardiovascular disease, diabetes, AHI and antidepressant medication.	Unclear.
Ayas 2003 (23)	Mailed self-administered questionnaire.	Medical records, follow-up questionnaire and National Death Index.	Age, shift work, hypercholesterolemia, body mass index, smoking, snoring, exercise level, alcohol consumption, depression, aspirin use, postmenopausal hormone use, family history of myocardial infarction, diabetes and hypertension.	Unclear.
Bellavia 2014 (24)	Self-administered questionnaire.	Swedish National Register of Death Causes at the National Board of Health and Welfare.	Age, sex, body mass index, smoking status, alcohol consumption and educational level.	1,100 (1.5%) excluded for missing values.
Burazeri 2003 (25)	Structured questionnaire.	Deaths from Central Bureau of Statistics.	Age, social class, country of origin, education level, self-appraised health status, activities of daily living, The Cornell Medical Index, a demoralization scale, pre-existing chronic conditions, congestive heart failure, cigarette smoking, alcohol consumption, physical activity, blood pressure, body mass index, serum glucose, thiocyanate, creatinine, albumin, total cholesterol, HDL-	Unclear.

			cholesterol, plasma homocysteine, siesta and duration.	
Cai 2015 (26)	Structured questionnaire.	Deaths from active follow-up and record linkage.	Education, income, smoking, alcohol consumption, tea consumption, comorbidity score, history of night-shift work, participation in regular exercise, body mass index and waist-to-hip ratio.	14 men were lost to follow up.
Canivet 2014 (27)	Interview questioning.	Death and cause of death from Swedish Hospital Discharge Register and Swedish Cause of Death Register.	Age, socioeconomic position, marital status, social participation, smoking status, low physical activity, obesity, hypertension, diabetes mellitus, neck, shoulder and lumbar pain.	14,555 (52%) had incomplete sleep data.
Castro-Costa 2011 (28)	Interview questioning.	Death from next of kin and Brazilian System of Information on Mortality.	Age, schooling marital status, working status, education, alcohol consumption, coffee consumption, smoking, physical exercises, depressive symptoms, cognitive functioning, psychoactive medications, physical functioning, arthritis ascertainment, systolic blood pressure, high-density lipoprotein cholesterol ratio, diabetes mellitus and body mass index.	5.2% unable to ascertain death for those who moved away.
Chandola 2010 (2)	Postal self-administered questionnaire.	Questionnaire and clinical records.	Age, sex, ethnicity, employment grade, car access, housing tenure, self rated health status, total cholesterol concentration, hypertension, body mass index, diabetes, smoking, alcohol consumption, vigorous and moderate exercise and fruit and vegetable consumption.	Unclear.
Chen 2008 (29)	Interview questioning.	Data from medical records and death certificate with central review and adjudication.	Age, race, education, family income, employment status, depression, smoking, exercise, use of hormone therapy, prior cardiovascular disease, diabetes mellitus, hypertension, high cholesterol level requiring pills and body mass index.	Unclear.
Chen 2013 (3)	Interview questioning.	Death from national death registry and ICD codes.	Age, sex, living status, marital status, education, body mass index, insomnia, excessive daytime sleepiness, pain, smoking, alcohol drinking, snorers, diabetes mellitus, hypertension, cardiovascular disease, stroke, gouty arthritis, depression, hypnotics, total sleep time.	1,832 (31%) refused interview.
Chien 2010 (30)	Questionnaire.	Death certificates verified by house-to-house visits and neurologists and internists.	Age, sex, body mass index, smoking, current alcohol drinking, marital status, education level, occupation, regular exercise, family history of coronary heart disease, hypertension, diabetes, cholesterol, high density lipoprotein, triglycerides, glucose and uric acid level.	172 (4.8%) missing data on sleep.
Cohen-Mansfeld	Interview	Death from Israeli National	Age, sex, origin, marital status, education, income,	Unclear.

2012 (31)	questioning.	Population Register.	children, medications, comorbidity, subjective health, activity of daily living limitation, instrumental activities of daily living, cognitive difficulties, depressed affect.	
Ensrud 2012 (4)	Questionnaire.	Death from death certificate.	Age, race, site, health status, body mass index, education, social support, alcohol intake, smoking, antidepressant, benzodiazepine, sedative hypnotic use, medical conditions, cognition and baseline frailty status.	191 (7%) had missing repeat frailty status.
Gangwisch 2008 (32)	Interview questioning.	Death from death certificates or proxy interviews.	Age, physical activity, smoking, depression, sex, education, living alone, low income, daytime sleepiness, nighttime awakening, ethnicity, sleeping pill use, body weight, diabetes, hypertension, general health and cancer.	Missing data 2% on body weight and <1% for other covariates.
Garde 2013 (33)	Questionnaire for sleep duration which was clarified during an interview.	Official national register with ICD codes.	Age, alcohol use, smoking, leisure-time physical activity, body mass index, systolic blood pressure, diastolic blood pressure, diabetes, hypertension, physical fitness, alcohol use, smoking, leisure-time physical activity and social class.	0-2.7% missing values.
Gianfagna 2016 (5)	Questionnaire.	Direct follow up.	Age, blood pressure, cholesterol, diabetes, smoking habits, education level, sleep disturbances, leisure time physical activity and depression.	6% of data imputed. Follow up 97.6% complete.
Goto 2013 (34)	Interview and questionnaire.	Deaths from Ohgimi Village Office and Japanese Vital Statistics.	Age, spouse, education, working status, past history of cerebrovascular disease, hypertension, fracture, subjective health, activities of daily living, hearing vision, body mass index, haemoglobin, albumin, cholesterol, creatinine, blood pressure and electrocardiographic abnormalities.	Participation rate 88.6%.
Hale 2013 (35)	Participants were asked about their sleep.	Annual follow up contact, medical records and death certificates.	Body mass index, low physical exercise, high alcohol intake, ever smoke, elevated blood pressure, diabetes, depression, general health and life satisfaction scale.	Unclear.
Hall 2015 (36)	Interview-administered questionnaire.	In-person assessments or telephone interviews and hospital records, death certificates, informant interviews and autopsy data.	Age, gender, race, inflammatory markers, education, body mass index, smoking status, alcohol consumption, physical activity, study site, arthritis, hypertension, diabetes, depression, coronary heart disease, corticosteroid use, anti-inflammatory use.	62 participants were not follow up.
Hamazaki 2011 (37)	Self-administered questionnaire.	Questionnaires, annual checkups, medical records and death certificates.	Age, type of job, working hours, mental workload, body mass index, mean blood pressure, HbA1c, total cholesterol, current smoking habit, drinking habit, leisure-time physical activity, medication for hypertension, diabetes, hypercholesterolemia.	27 (1%) loss to follow up.
Helbig 2015 (6)	Interview	Interview, postal surveys,	Age, survey, education , physical activity, alcohol	533 were excluded for

	questioning.	hospital records, information from attending physicians, population registries and death certificates.	consumption, current smoking activity, body mass index, hypertension, diabetes and dyslipidemia.	missing values.
Heslop 2002 (38)	Questionnaire.	Deaths from NHS central registry and death certificates with ICD codes.	Age, marital status, social class, risk factors and stress.	50% loss to follow up.
Hoevenaar-Blom 2011 (7)	Self-administered questionnaire.	Linkage to National Medical Registry and municipal population registry and Statistics Netherlands and ICD codes.	Age, sex, sleep duration or quality, smoking, alcohol, coffee, subjective health, education level, BMI, total/HDL cholesterol ratio, systolic blood pressure, CVD risk factor medication and prevalence of type 2 diabetes.	1,658 (20%) responded don't know to sleep quality.
Huang 2013 (8)	Self-reported sleep questionnaire.	Death registry linkage.	Age, education, body mass index, physical activity and sleeping pill use.	Unclear.
Hublin 2007 (9)	Questionnaire.	Data from Statistics Finland with ICD codes.	Age, education, marital status, working status, social class, body mass index, smoking status, binge drinking, grams of alcohol consumed daily, conditioning physical activity, life satisfaction, sleep length and use of hypnotics/tranquilizers.	Unclear.
Ikehara 2009 (39)	Self-administered questionnaire.	Review of death certificates, National Vital Statistics and ICD codes.	Age, body mass index, history of hypertension, history of diabetes, alcohol consumption, smoking, education level, hours of exercise, hours of walking, regular employment, perceived mental stress, depressive symptoms and frequency of fresh fish intake.	5,376 (4.9%) excluded because of missing information on sleep duration.
Jung 2013 (40)	Questionnaire.	Annual mail or telephone follow up, death certificates and notice from family member or published obituary.	Age, nap duration, Beck Depression Inventory, education, exercise, smoking, alcohol consumption, hypertension, diabetes, coronary heart disease, stroke, cancer and sleep related medications.	Nearly 80% of older adults were followed up. Vital status ascertained for 96% of sample.
Kakizaki 2013 (41)	Questionnaire.	Review of NHI withdrawal history files, death certificates and ICD codes.	Age, sex, total caloric intake, body mass index, marital status, level of education, job status, history of myocardial infarction, history of cancer, history of stroke, history of hypertension, history of diabetes, smoking status, alcohol drinking, time spent walking, perceived mental stress, self-rated health, physical function, cardiovascular disease and ischemic heart disease.	1,783 (3.5%) had missing sleep duration.
Kawachi 2016	Questionnaire.	Deaths from death	Age, sex, education years, marital status, hypertension,	4.1% missing

(42)		certificates.	diabetes, body mass index, physical activity score, smoking status, and alcohol consumption.	information on sleep. 1912 subjects moved away from study area.
Kim 2013 (43)	Self-administered questionnaire.	Death certificates and ICD codes.	Age, ethnicity, education, marital status, hypertension, diabetes, alcohol consumption, energy intake, body mass index, physical activity, hours spent watching television and smoking history.	18,874 (12%) missing information on sleep or physical activity.
Kojima 2000 (10)	Self-administered questionnaire.	Death certificates.	Age, hypertension, cerebrovascular, heart and renal disease, diabetes and use of sleeping pills.	292 (5.5%) loss to follow up.
Kripke 2002 (44)	Participants completed health questionnaire.	Death certificates.	Age, race, education, occupation, marital status, exercise level, smoking, churchgoing, fat in diet, fiber in diet, sleep, insomnia, health, body mass index, leg pain, history of heart disease, history of hypertension, history of cancer, history of diabetes, history of stroke, history of bronchitis, history of emphysema, history of kidney disease and medications.	Yes, <2% loss to follow up.
Lan 2007 (45)	Interview.	Death from interviews and national death registry with ICD codes.	Age, heart disease, stroke, cancer, depression and afternoon nap.	970 (24%) loss to follow up.
Lee 2014 (46)	Self-reported average nighttime sleep duration.	Mortality from death registry.	Age, smoking, mood, overweight, diabetes, heart disease, history of cancer, chronic obstructive pulmonary disease, history of stroke and frailty.	Unclear.
Lee 2017 (47)	Interview.	Death from national death registry.	Age, sex, body mass index, education years, smoking, drinking, chronic diseases, frailty states and log interleukin-6.	9.6% had incomplete data.
Leng 2015 (48)	Questionnaire.	Stroke from linkages to National Health Services district database and UK office of National Statistics.	Age, sex, social class, education, marital status, smoking, alcohol intake, hypnotic drug use, family history of stroke, body mass index, physical activity, depression, systolic blood pressure, diastolic blood pressure, preexisting diabetes, myocardial infarction, cholesterol level and hypertension drug use.	Unclear.
Li 2013 (49)	Self-administered questionnaire.	Continuous surveillance, death certificates and ICD codes.	Age, body mass index, systolic blood pressure, diastolic blood pressure, smoking status, drinking habits and physical activity.	246 (2.6%) lost to follow up.
Liu 2014 (50)	Questionnaire.	Data from Biologic Specimen and Data Repository Information Coordinating Center.	Age, gender, current cigarette smoking, weekly alcohol drinking, systolic blood pressure, total cholesterol and body mass index , diabetes and CRP.	Unclear.

Magee 2011 (51)	Self-reported questionnaire.	Participants were asked if they had heart disease or stroke.	Age, sex, country of birth, marital status, education, employment status, remoteness, body mass index, physical activity, smoking, alcohol and screen time.	18% had missing data on sleep duration.
Magee 2013 (52)	Mailed self-administered questionnaire.	Death from New South Wales Registry of Births and Deaths and Marriages.	Age, sex, marital status, private health insurance, smoking status, alcohol consumption, body mass index, sufficient physical activity and baseline health status.	14,134 (5.8%) missing data.
Mallon 2002 (11)	Postal questionnaire.	Death from Death certificates from National Cause of Death Register in Sweden.	Age.	Unclear.
Martin 2011 (12)	Self-reported questionnaire and actigraphy.	Death from next of kin, electronic medical records and Los Angeles County Death records.	Amount of rehabilitation therapy, CIRS-G, reason for rehabilitation admission and sex.	Unclear.
Meisinger 2007 (13)	Participants were interviewed.	MI from population registries and death certificates with ICD codes.	Age, survey, body mass index, education, dyslipidemia, alcohol intake, parental history of myocardial infarction, physical activity and regular smoking.	328 participants have incomplete data.
Mesas 2010 (53)	Participants took part in home-based interviewed.	Death from National Death Index in Spain.	Age, sex, body mass index, educational level, municipality of residence, physical activity, smoking, alcohol consumption, coffee consumption, perceived health, mini-Examen Cognoscitivo score, depression, Medical Outcomes Study 36-item Short Form Survey Physical Component Summary, Mental Component Summary, instrumental activity of daily living limitations, hypertension, ischemic heart disease, stroke, diabetes mellitus, cancer at any site, chronic obstructive pulmonary disease, Parkinson's disease, arousal from sleep at night and use of anxiolytic medications.	Unclear.
Pan 2014 (54)	Participants were interviewed.	Stroke mortality from Singapore Registry of Births and Deaths and cause of death from ICD codes and questionnaire.	Age, year of recruitment, sex, dialect, education body mass index, alcohol drinking, years of smoking, dose of smoking, moderate activity, energy intake, dietary intake of vegetables, fruits, fiber, polyunsaturated fatty acids, hypertension, diabetes mellitus, stroke, coronary heart disease and history of cancer.	Unclear.
Patel 2004 (55)	Mailed questionnaire.	Death from next of kin, postal system or National Death Index and ICD codes.	Age, smoking status, alcohol consumption, physical activity, depression, history of snoring, body mass index, history of cancer, cardiovascular disease, hypertension, diabetes and shirt-working history.	Unclear.

Pollak 1990 (56)	Participants were interviewed.	Unclear.	Age, activity of daily living problems, fair-poor health, low income, cognitive impairment, depressed, lives alone, insomnia, restless legs, sleep apnea and frequent hypnotics.	Unclear.
Qiu 2011 (14)	Participants were interviewed.	Death from death certificates, next of kin and local residential committees.	Age, ethnicity, urban-rural residence, geographic region, SES, family/social support, health practices and health conditions.	2,967 (19%) loss to follow up.
Qureshi 1997 (57)	Participants were interviewed.	ICD codes.	Age, sex, race, education, cigarette smoking, systolic blood pressure, serum cholesterol level, diabetes and body mass index.	Unclear.
Rhee 2012 (58)	Self-administered questionnaire.	Death from death certificates.	Unclear.	Unclear.
Rod 2014 (15)	Questionnaire.	NHS Central Registry, death certificates and ICD codes.	Age, employment grade, ethnicity and marital status.	10 (0.1%) loss to follow up.
Ruigomez 1995 (59)	Face-to-face interview.	Vital status ascertained from Local Census Register.	Age, sex, education level and self-perceived health status.	28 could moved or could not be traced.
Ruiter Petrov 2014 (60)	Participants were questioned on sleep.	6 monthly telephone contact.	Demographics, stroke risk factors, psychological symptoms, health behaviours and diet quality.	Unclear.
Sands-Lincoln 2013 (61)	Self-reported response to questions.	Annual follow up contacts and verified through medical records and death certificates.	Age, race, education, income, smoking, body mass index, physical activity, alcohol intake, depression, diabetes, high blood pressure, hyperlipidemia, comorbid conditions.	Unclear.
Shankar 2008 (62)	Participants were questioned on sleep.	Death from the Singapore Registry of Births and Deaths with ICD codes.	Age, sex, dialect group, education, year of recruitment, body mass index, smoking, alcohol intake, moderate physical activity, dietary intake of total calories, fruits, vegetables, fiber, total fat and cholesterol, weekly use of vitamin/mineral supplements, menopausal status and use of hormone replacement therapy.	5,213 (8%) loss to follow up.
Song 2016 (63)	Self-reported sleep.	Interviews, death certificates, discharge summaries and medical records.	Age, sex, marital status, income, education level, smoking status, physical activity, family history of stroke, body mass index, blood pressure, blood glucose, total cholesterol, lipid-lowering drug use, hypoglycemic drug use, history of myocardial infarction, snoring status, C-reactive protein and atrial fibrillation.	Unclear.
Stone 2009 (64)	Sleep duration from wrist actigraphy.	Death certificates.	Age, clinic site, race, body mass index, physical activity, smoking status, functional status, comorbidities, depression and anti-depressant use.	Unclear.

Strand 2016 (16)	Questioning.	Death from Taiwanese cause-of-death register.	Age, sex, education, marital status, smoking, alcohol consumption, physical activity, hypertension, diabetes, heart disease, body mass index, blood pressure, glucose, cholesterol, triglycerides and use of hypnotics/sedatives.	Unclear.
Suzuki 2009 (17)	Self-administered questionnaire.	Records linked to National Vital Statistics Database with ICD codes.	Age, sex, body mass index, smoking status, alcohol consumption, physical activity, socioeconomic status, mental health, hypertension and diabetes mellitus.	1,206 (10%) loss to follow up.
Tamakoshi 2004 (65)	Self-administered questionnaire.	Death certificates.	Age, body mass index, current smoker, current drinker, physical activity, having a spouse, college or higher education, high mental stress, stroke, myocardial infarction and cancer.	6,782 (6%) loss to follow up.
Tsubono 1993 (66)	Self-administered questionnaire.	Vital and residential status from residents' registration of the town.	Age, sex, past history of disease and participants in the health examination.	58 (1%) moved out of town.
Tu 2012 (67)	Participants were questioned on sleep	Follow up survey.	Age, education level, occupational status, night-shift work, annual income, menopausal status, marital status, number of live births, physical activity, passive smoking tea consumption, energy intake, time spend watching TV and vitamin supplement use.	Unclear.
Twig 2016 (18)	Questionnaire.	All participants referred to a treadmill exercise test and pathological stress test referred for coronary angiography.	Age, body mass index, family history of coronary artery disease, smoking status, physical activity, systolic and diastolic blood pressure, LDL cholesterol, triglyceride level and white cell count.	4,415 follow up <2 years.
Von Ruesten 2012 (68)	Participants were interviewed about their sleep.	Medical reports, treating physician, cancer registry and death certificates with ICD codes.	Age, sex, sleeping disorders, alcohol intake, smoking status, walking cycling sports, employment status, education, body mass index, waist-to-hip ratio, hypertension, high blood lipid, caffeinated beverages, satisfaction with life, satisfaction with health and intake of antidepressants.	3,928 (14%) loss to follow up.
Wang 2016 (69)	Questioning.	Death from death certificates and state vital statistics offices.	Age, sex, income, education level, marital status, smoking status, drinking status, physical activity, hypertension, diabetes mellitus, and hyperlipidemia.	Unclear.
Werle 2011 (70)	Unclear, Sleep quality from Pittsburgh Sleep Quality Index.	Home visits, death certificates and interviews with family members and physicians with ICD codes for death.	Age, sex, current smokers, body mass index, LDL cholesterol, HDL cholesterol, ApoA-I, glucose, diabetes and blood pressure ≤140/.90 mmHg.	6 (3%) loss to follow up.

Westerlund 2013 (19)	Questionnaire.	Swedish National Patient Register and Swedish Cause of Death Register with ICD codes.	Age, sex, education, employment status, smoking, alcohol, snoring, work schedule, depressive symptoms, self-rated health, physical activity, body mass index, diabetes, lipid disturbance and hypertension.	Unclear.
Wingard 1983 (71)	Questionnaire.	Follow up response survey and death certificate.	Age.	97% response rate.
Xiao 2014 (72)	Questionnaire.	Linkage to Social Security Administration Death Master File and National Death Index Plus.	Age, sex, race/ethnicity, marital status, education, self-reported health, smoking dose, alcohol drinking, MVPA, TV viewing, baseline BMI.	8 were withdrawn or moved out of the study area.
Yeo 2013 (73)	Self-administered questionnaire.	Death certificates from the National Statistical Office with ICD codes.	Age, sex, educational attainment, body mass index, cigarette smoking, alcohol consumption, past history of hypertension, type 2 diabetes, cardiovascular disease and metabolic syndrome.	Unclear.
Zawisza 2015 (74)	Interview questionnaire.	National death register.	Age, gender, education, life-weariness, low functional activity, chronic diseases.	52 (2.1%) loss to follow up.
Zuubier 2015 (75)	Actigraphy and sleep diary and Pittsburgh Sleep Quality Index.	Records of general practitioners and hospitals and death certificates.	Age, sex, activities of daily living, current smoking, diabetes, myocardial infarction, stroke, cognitive function, depressive symptoms, body mass index, use of sleep medication, possible sleep apnea and napping.	Unclear.

Supplementary Table 4: Study reference groups and analyses

Study ID	Sleep hours used as reference group	Mortality	CHD mortality	Stroke mortality	CVD mortality	CHD	Stroke	CVD	Sleep quality
Akersted 2017 (20)	7 hours	*							
Amagai 2010 (21)	7-7.9 hours					*	*	*	
Aurora 2016 (22)	7-8 hours	*							
Ayas 2003 (23)	8 hours					*			
Bellavia 2014 (24)	6.6-7.4 hours	*			*				
Burazeri 2003 (25)	6-8 hours	*							
Cai 2015 (26)	7 hours	*		*	*				
Canivet 2014 (27)	7-8 hours							*	
Castro-Costa 2011 (28)	7-8 hours	*							
Chandola 2010 (2)	7 hours								*
Chen 2008 (29)	7 hours				*		*		
Chen 2013 (3)	7 hours	*			*				*
Chien 2010 (30)	7 hours	*						*	
Cohen-Mansfeld 2012 (31)	7-9 hours	*							
Ensrud 2012 (4)	Sleep quality analysis.								*
Gangwisch 2008 (32)	7 hours	*							
Garde 2013 (33)	6-7 hours		*						
Gianfagna 2016 (5)	7-8 hours					*		*	*
Goto 2013 (34)	6-7 hours	*							
Hale 2013 (35)	7-8 hours	*				*			
Hall 2015 (36)	7 hours	*							
Hamazaki 2011 (37)	7-7.9 hours					*	*	*	
Helbig 2015 (6)	7-8 hours						*		*
Heslop 2002 (38)	7-8 hours	*			*				
Hoevenaar-Blom 2011 (7)	7 hours					*		*	*
Huang 2013 (8)	Sleep quality analysis.								*
Hublin 2007 (9)	7-8 hours	*							*
Ikehara 2009 (39)	7 hours	*	*	*	*				
Jung 2013 (40)	7-7.9 hours	*							
Kakizaki 2013 (41)	7 hours	*	*	*	*				
Kawachi 2016 (42)	7 hours								
Kim 2013 (43)	7 hours	*	*	*	*				
Kojima 2000 (10)	7-8.9 hours	*							*
Kripke 2002 (44)	7 hours	*							
Lan 2007 (45)	7 hours	*			*				
Lee 2014 (46)	<10 hours	*							
Lee 2017 (47)	6-7 hours	*							
Leng 2015 (48)	6-8 hours						*		
Li 2013 (49)	7 hours	*			*				
Liu 2014 (50)	7-8 hours					*			
Magee 2011 (51)	7 hours					*	*		
Magee 2013 (52)	7 hours	*							
Mallon 2002 (11)	7-8 hours	*	*						*
Martin 2011 (12)	Sleep quality analysis.								*
Meisinger 2007 (13)	8 hours					*			*
Mesas 2010 (53)	7 hours	*							
Pan 2014 (54)	7 hours			*					
Patel 2004 (55)	7 hours	*			*				
Pollak 1990 (56)	Incremental	*							

	increase in sleep.								
Qiu 2011 (14)	8 hours	*							*
Qureshi 1997 (57)	6-8 hours					*	*		
Rhee 2012 (58)	6-7 hours	*							
Rod 2014 (15)	7 hours	*			*				*
Ruigomez 1995 (59)	7-9 hours	*							
Ruiter Petrov 2014 (60)	7 hours						*		
Sands-Lincoln 2013 (61)	7-8 hours					*		*	
Shankar 2008 (62)	7 hours		*						
Song 2016 (63)	6-8 hours						*		
Stone 2009 (64)	7-8 hours	*							
Strand 2016 (16)	6-8 hours		*						*
Suzuki 2009 (17)	7 hours	*			*				*
Tamakoshi 2004 (65)	7 hours	*							
Tsubono 1993 (66)	7 hours	*							
Tu 2012 (67)	7-8 hours					*	*		
Twig 2016 (18)	Sleep quality analysis.								*
Von Ruesten 2012 (68)	7 hours					*	*		
Wang 2016 (69)	7 hours	*				*			
Werle 2011 (70)	Incremental increase in sleep.	*							
Westerlund 2013 (19)	7 hours				*	*	*	*	*
Wingard 1983 (71)	7-8 hours	*							
Xiao 2014 (72)	7-8 hours	*			*				
Yeo 2013 (73)	7 hours	*			*				
Zawisza 2015 (74)	Incremental increase in sleep.	*							
Zuubier 2015 (75)	6-7.5 hours	*							

Supplementary Table 5: Summary of meta-analysis results

A) Sleep duration and risk of all-cause mortality

Hours of sleep	All participants	Women only	Men only
3 hours	1.26 (1.08-1.46), n=1	1.31 (1.06-1.61), n=1	1.19 (0.96-1.47), n=1
4 hours	1.17 (1.08-1.28), n=7	1.27 (1.02-1.58), n=3	1.18 (1.08-1.29), n=3
5 hours	1.13 (1.09-1.16), n=4	1.09 (0.99-1.20), n=11	1.10 (1.05-1.15), n=11
6 hours	1.06 (1.04-1.09), n=35	1.10 (1.04-1.15), n=16	1.12 (1.16-1.33), n=16
7-8 hours	1.00 (ref)	1.00 (ref)	1.00 (ref)
9 hours	1.27 (1.22-1.32), n=34	1.29 (1.18-1.41), n=17	1.25 (1.16-1.33), n=17
10 hours	1.52 (1.38-1.68), n=12	1.67 (1.37-2.03), n=9	1.45 (1.26-1.67), n=9
11 hours	1.66 (1.23-2.24), n=1	-	-

B) Sleep duration and cause specific mortality

Hours of sleep	CHD mortality	Stroke mortality	CVD mortality
4 hours	1.44 (0.73-2.83), n=2	1.27 (0.83-1.96), n=1	1.17 (0.90-1.53), n=2
5 hours	1.29 (1.10-1.51), n=5	1.06 (0.94-1.21), n=4	1.19 (1.13-1.25), n=11
6 hours	1.12 (0.98-1.27), n=4	1.02 (0.94-1.12), n=4	1.07 (1.04-1.11), n=15
7-8 hours	1.00 (ref)	1.00 (ref)	1.00 (ref)
9 hours	1.36 (1.17-1.59), n=6	1.33 (1.22-1.46), n=5	1.29 (1.19-1.39), n=15
10 hours	1.24 (1.00-1.53), n=2	1.83 (1.45-2.30), n=3	1.62 (1.48-1.76), n=6

C) Sleep duration and risk of adverse cardiovascular events

Hours of sleep	CHD	Stroke	CVD
4 hours	1.46 (1.26-1.70), n=1	1.75 (1.48-2.06), n=1	-
5 hours	1.49 (1.17-1.89), n=12	1.29 (1.13-1.47), n=10	1.15 (0.95-1.40), n=5
6 hours	1.08 (1.02-1.14), n=14	1.08 (0.98-1.18), n=10	1.07 (0.97-1.18), n=8
7-8 hours	1.00 (ref)	1.00 (ref)	1.00 (ref)
9 hours	1.11 (1.00-1.23), n=14	1.36 (1.22-1.50), n=11	1.17 (1.01-1.35), n=7
10 hours	1.39 (1.20-1.62), n=2	1.41 (0.96-2.07), n=2	1.23 (0.89-1.70), n=1

D) Sleep quality and risk of mortality and adverse cardiovascular events

Sleep quality poor vs good	No. of studies	Risk ratio (95% CI)
All-cause mortality	10	1.03 (0.93-1.14)
CHD mortality	2	1.03 (0.85-1.26)
CVD mortality	4	0.96 (0.82-1.13)
CHD	3	1.44 (1.09-1.90)
Stroke	1	0.97 (0.80-1.18)
CVD	2	1.29 (0.76-2.19)
Composite (CHD mortality, myocardial infarction and angina)	1	1.36 (1.10-1.68)

E) Incremental decrease in sleep hour and adverse outcomes

Incremental decrease in hour of sleep	No. of studies	Risk ratio (95% CI)
All-cause mortality	3	0.99 (0.93-1.06)
CVD mortality	1	1.20 (1.03-1.41)

CHD=coronary heart disease, CVD=cerebrovascular disease

Supplementary Table 6: Sensitivity analysis of meta-analysis including studies which excluded patients with baseline cardiovascular disease, adjusted for cardiovascular risk factors and adjusted for obstructive sleep apnoea or snoring

A) Sleep duration and adverse outcomes among studies that excluded baseline cardiovascular disease

Hours of sleep	All-cause mortality	CHD mortality	Stroke mortality	CVD mortality	CHD	Stroke	CVD
4 hours	1.28 (1.09-1.51), n=1	1.02 (0.14-7.47), n=1	1.27 (0.83-1.96), n=1	1.22 (0.90-1.64), n=1	-	-	-
5 hours	1.15 (1.11-1.19), n=7	1.39 (1.23-1.58), n=4	1.03 (0.87-1.20), n=2	1.21 (1.13-1.29), n=5	1.59 (1.07-2.35), n=10	1.22 (1.03-1.45), n=7	1.23 (0.98-1.54), n=4
6 hours	1.05 (1.03-1.06), n=8	1.13 (0.98-1.31), n=3	1.05 (0.92-1.19), n=2	1.08 (1.03-1.13), n=6	1.05 (0.97-1.15), n=12	0.99 (0.86-1.14), n=5	1.09 (0.99-1.20), n=6
7-8 hours	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
9 hours	1.19 (1.14-1.25), n=9	1.35 (1.11-1.65), n=4	1.28 (1.15-1.42), n=3	1.20 (1.12-1.29), n=6	1.06 (0.95-1.19), n=12	1.47 (1.26-1.71), n=6	1.22 (1.04-1.44), n=6
10 hours	1.43 (1.33-1.53), n=2	1.24 (1.00-1.53), n=2	1.63 (1.40-1.90), n=2	1.52 (1.39-1.67), n=2	1.33 (0.94-1.88), n=1	-	1.23 (0.89-1.70), n=1

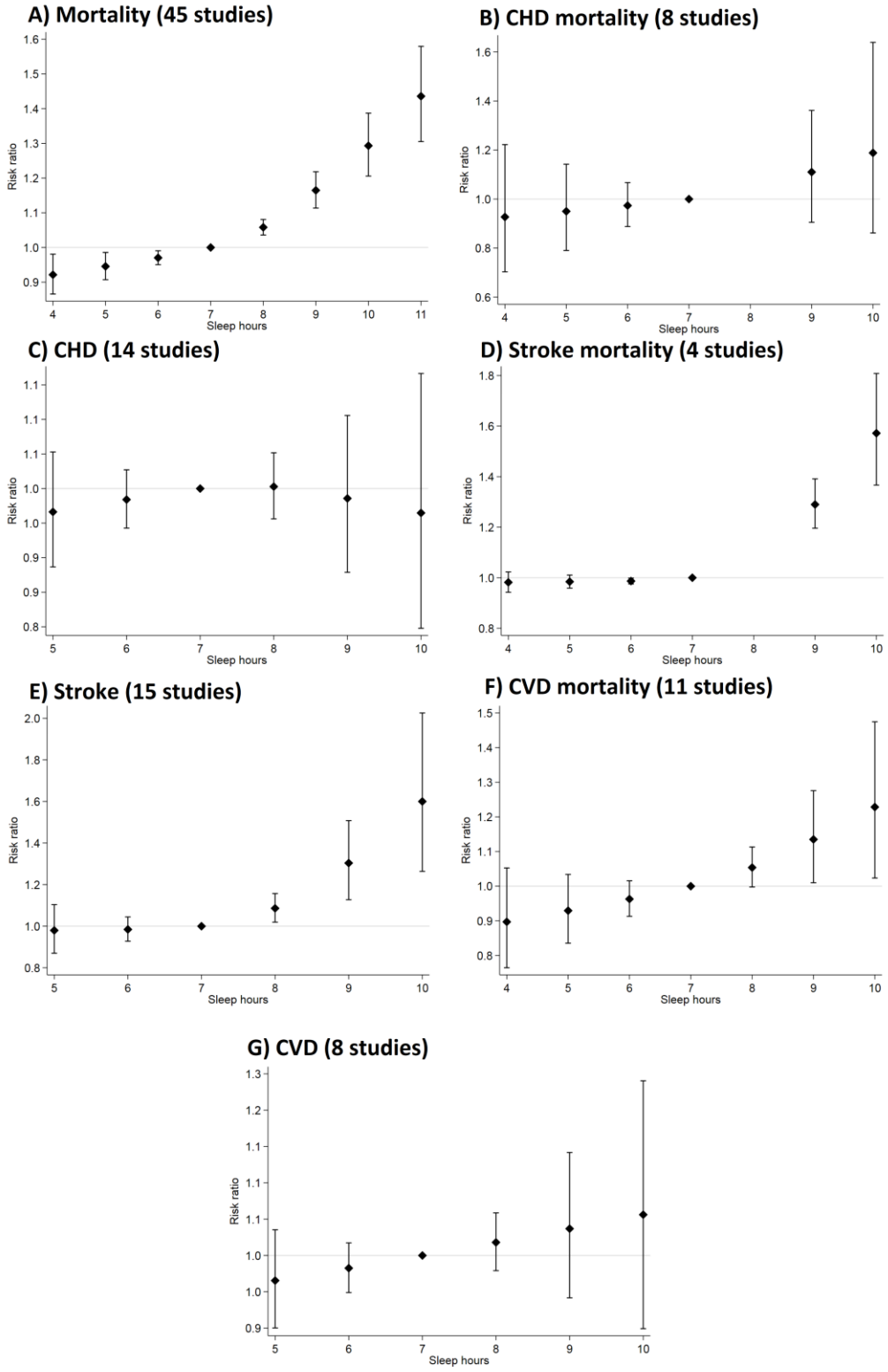
B) Sleep duration and adverse outcomes among studies which adjusted for cardiovascular risk factors

Hours of sleep	All-cause mortality	CHD mortality	Stroke mortality	CVD mortality	CHD	Stroke	CVD
3 hours	1.26 (1.08-1.46), n=1	-	-	-	-	-	-
4 hours	1.15 (1.08-1.22), n=3	1.44 (0.73-2.83), n=2	1.27 (0.83-1.96), n=1	1.17 (0.90-1.53), n=2	-	-	-
5 hours	1.10 (1.07-1.13), n=14	1.20 (1.05-1.39), n=4	1.11 (0.98-1.26), n=3	1.15 (1.07-1.23), n=7	1.49 (0.85-2.60), n=7	1.15 (0.94-1.40), n=6	1.17 (0.79-1.75), n=3
6 hours	1.04 (1.01-1.07), n=15	1.14 (0.90-1.46), n=2	1.03 (0.93-1.14), n=3	1.05 (0.99-1.11), n=8	1.07 (0.95-1.20), n=9	1.01 (0.92-1.11), n=6	1.09 (0.97-1.22), n=5
7-8 hours	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
9 hours	1.27 (1.22-1.33), n=16	1.26 (1.12-1.42), n=4	1.34 (1.22-1.47), n=4	1.31 (1.21-1.41), n=8	1.13 (0.95-1.34), n=9	1.38 (1.20-1.59), n=7	1.27 (1.04-1.54), n=5
10 hours	1.40 (1.25-1.56), n=5	1.24 (1.00-1.53), n=2	1.63 (1.40-1.90), n=2	1.53 (1.40-1.67), n=4	-	1.17 (0.79-1.74), n=1	-

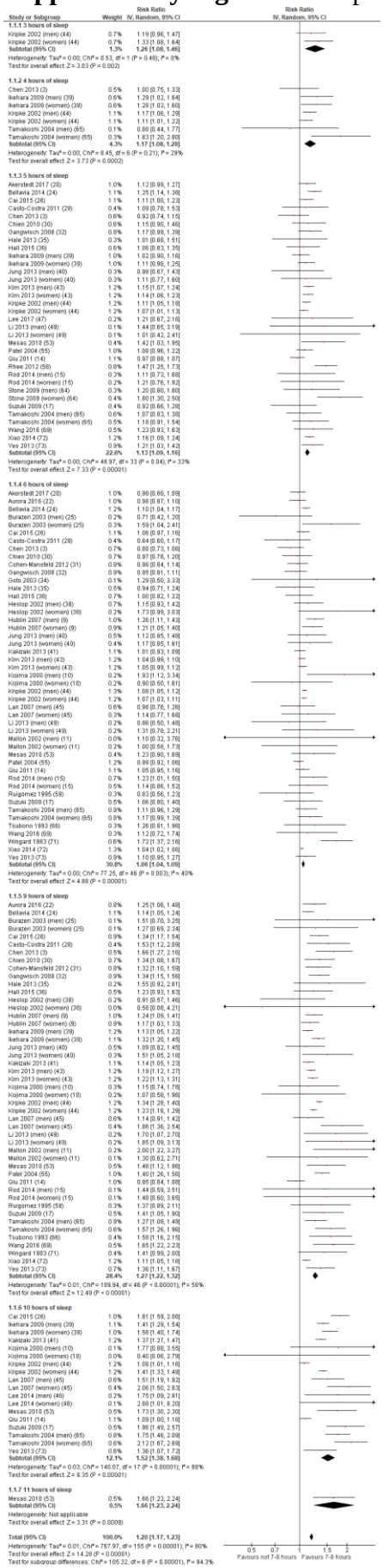
C) Sleep duration and adverse outcomes among studies which adjusted for obstructive sleep apnoea or snoring

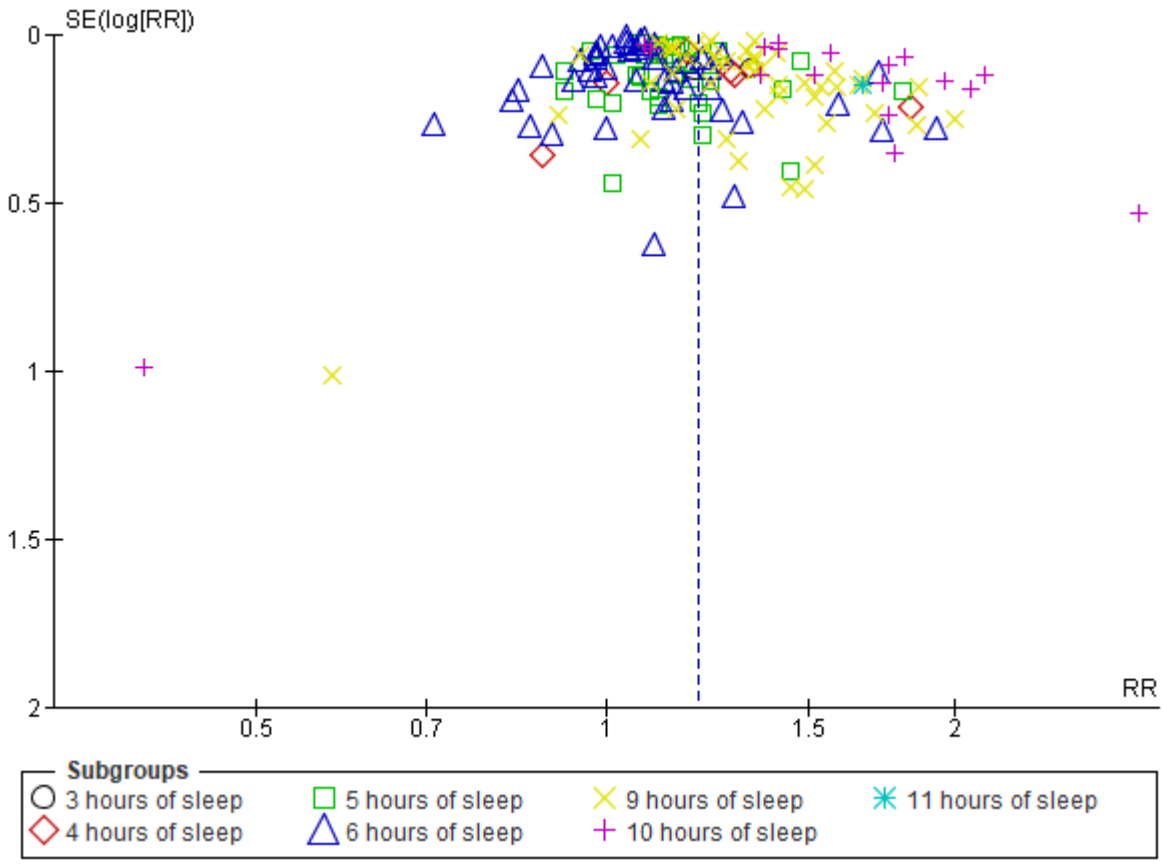
Hours of sleep	All-cause mortality	CHD mortality	Stroke mortality	CVD mortality	CHD	Stroke	CVD
4 hours	1.00 (0.75-1.33), n=1	-	-	1.05 (0.61-1.80), n=1	-	-	-
5 hours	1.02 (0.88-1.19), n=2	-	-	1.04 (0.85-1.26), n=3	1.28 (1.06-1.55), n=2	1.05 (0.80-1.37), n=1	1.05 (0.88-1.26), n=1
6 hours	0.96 (0.88-1.06), n=2	-	-	1.04 (0.88-1.23), n=3	1.11 (0.97-1.26), n=2	0.95 (0.79-1.14), n=1	1.00 (0.95-1.06), n=1
7-8 hours	1.00 (ref)	-	-	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
9 hours	1.46 (1.26-1.68), n=2	-	-	1.81 (1.23-2.68), n=2	1.37 (1.02-1.85), n=1	-	-

Supplementary Figure 1: Cubic splines models for mortality and adverse cardiovascular events



Supplementary Figure 2: Sleep duration and risk of all-cause mortality and funnel plot

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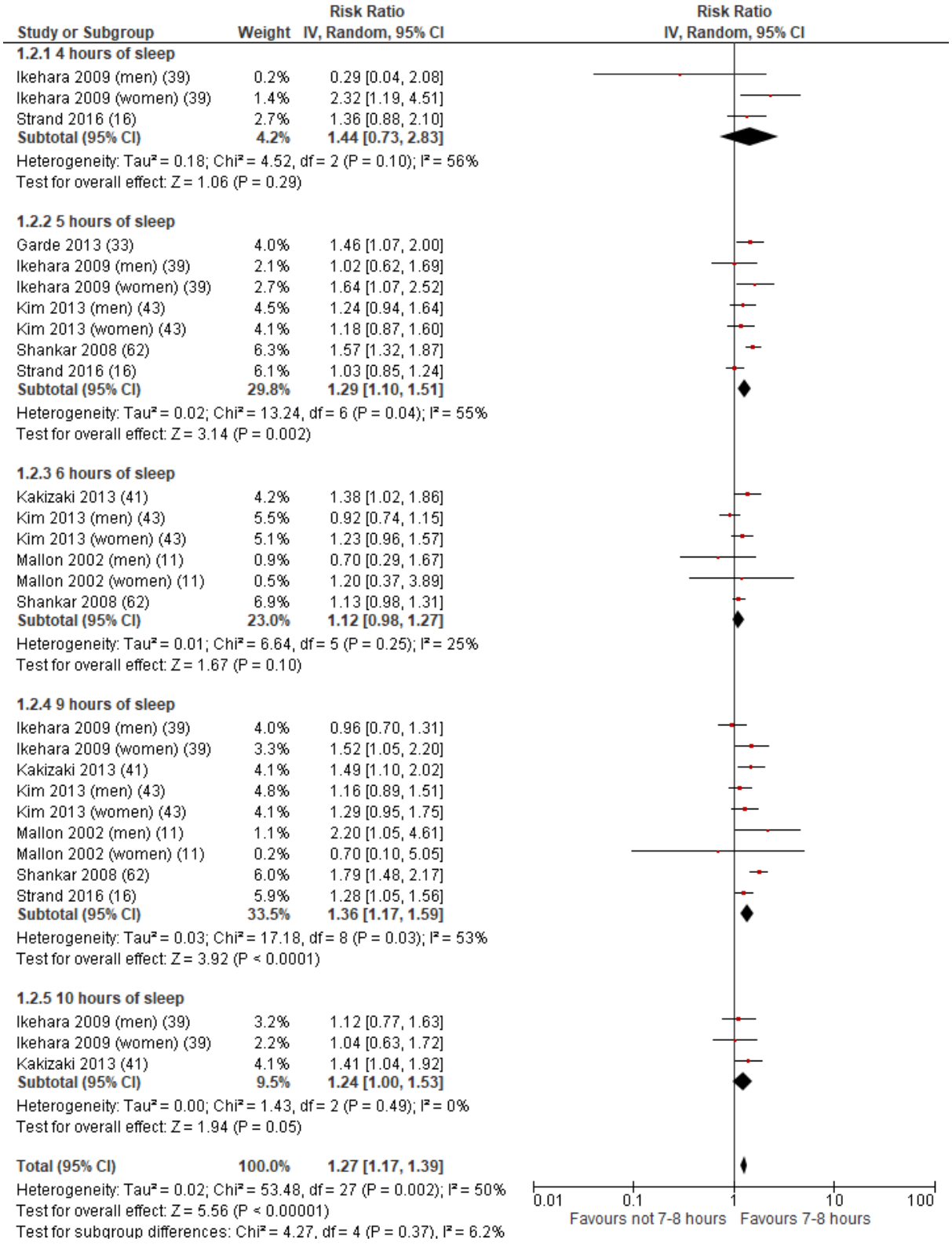
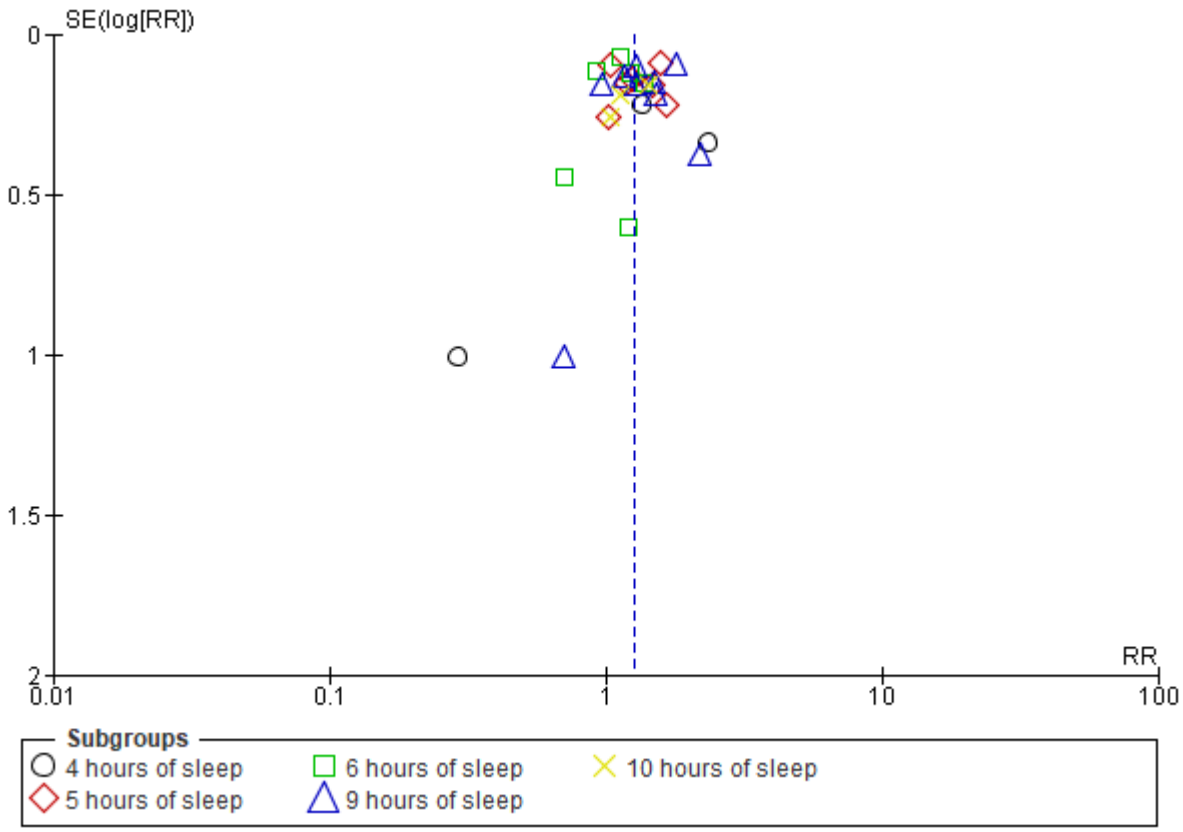
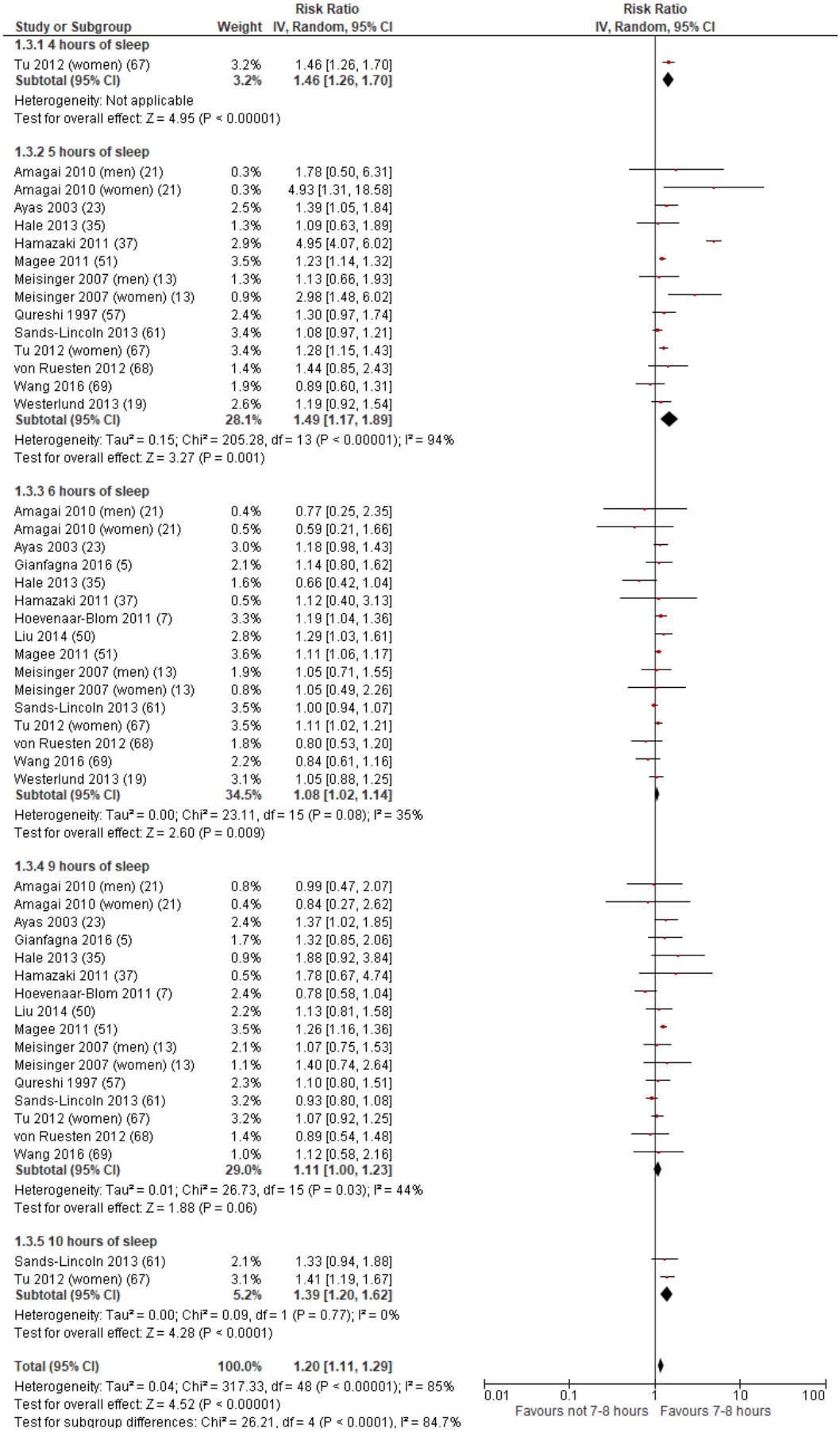
0.5
1
1.5
2
0.5
0.7
1
1.5
2
RR
Subgroups
3 hours of sleep
4 hours of sleep
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep
11 hours of sleep

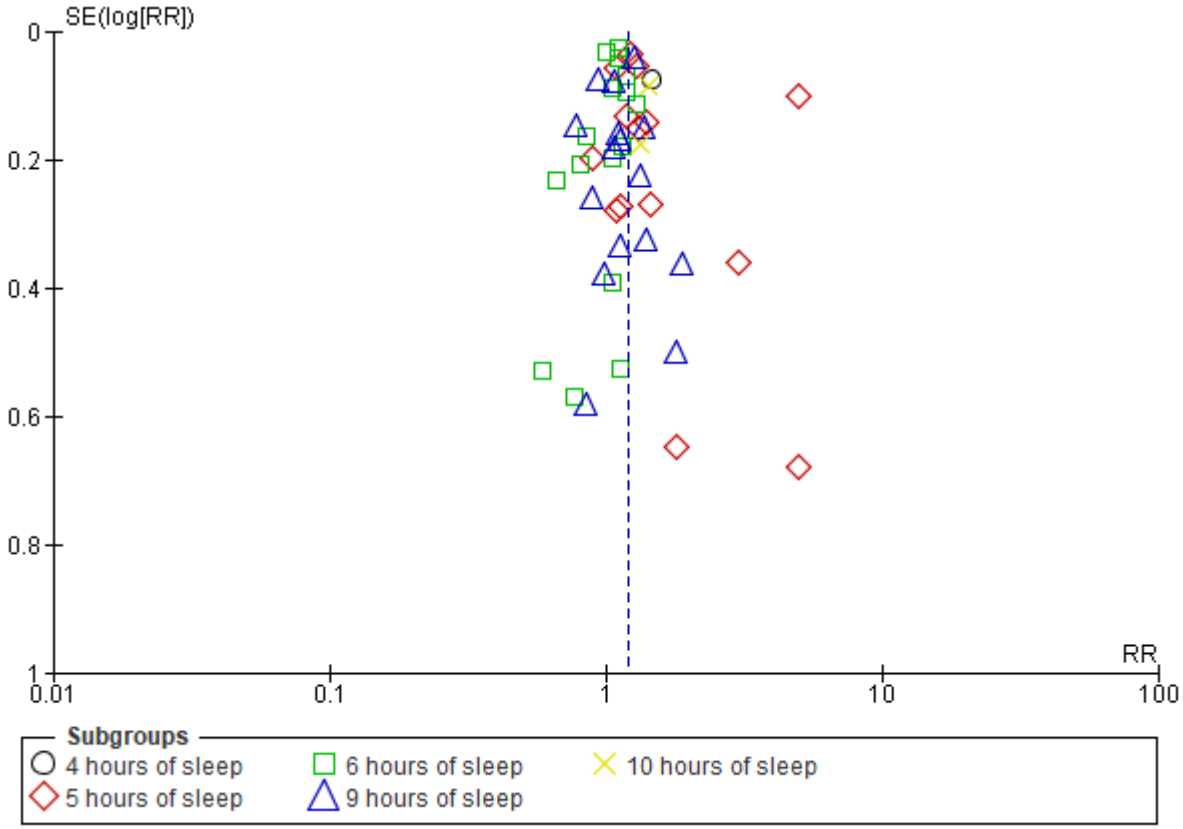
Supplementary Figure 3: Sleep duration and coronary heart disease mortality and funnel plot



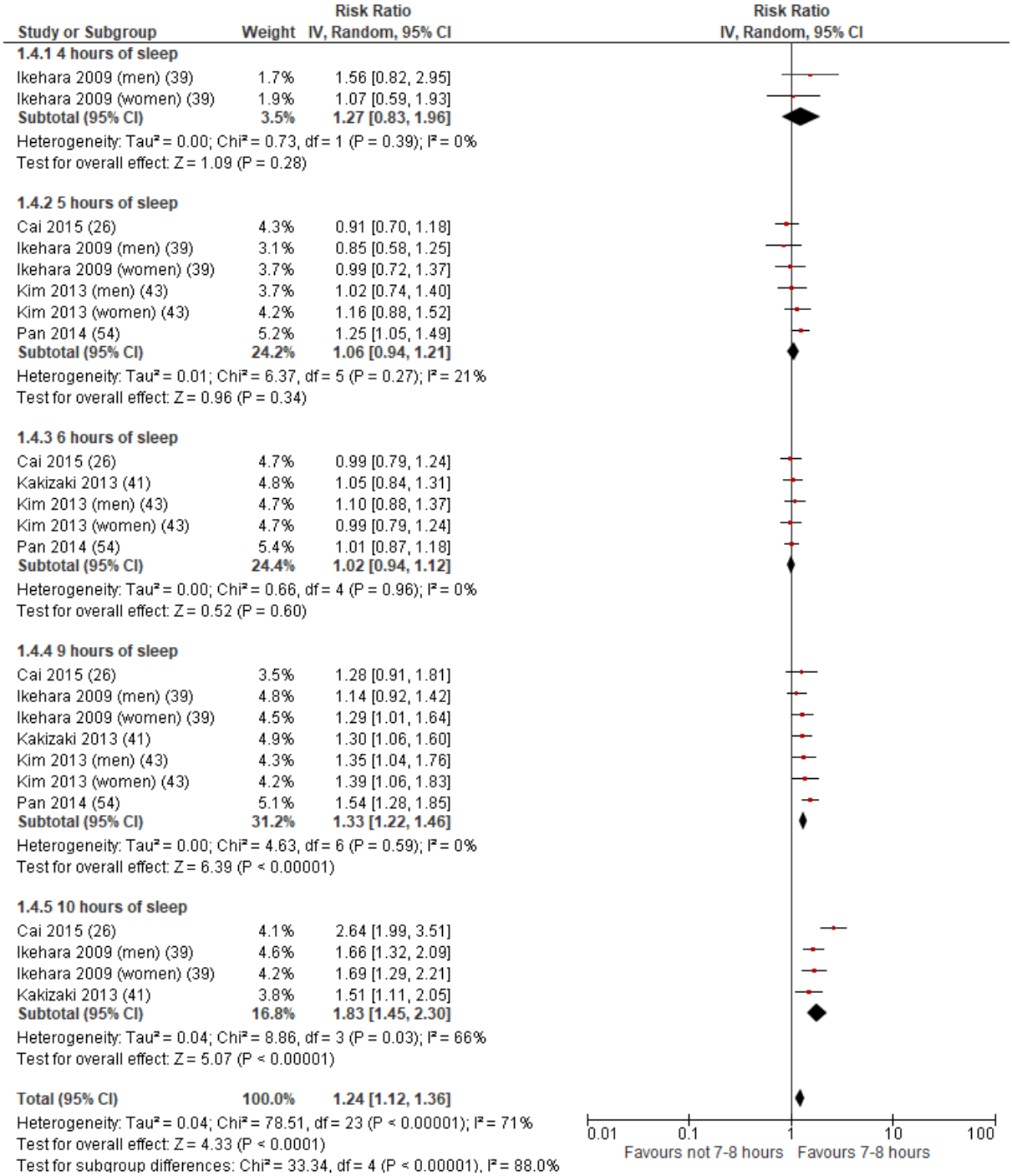

SE(log[RR])
0
0.5
1
1.5
2
0.01
0.1
1
10
100
RR
Subgroups
4 hours of sleep
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep

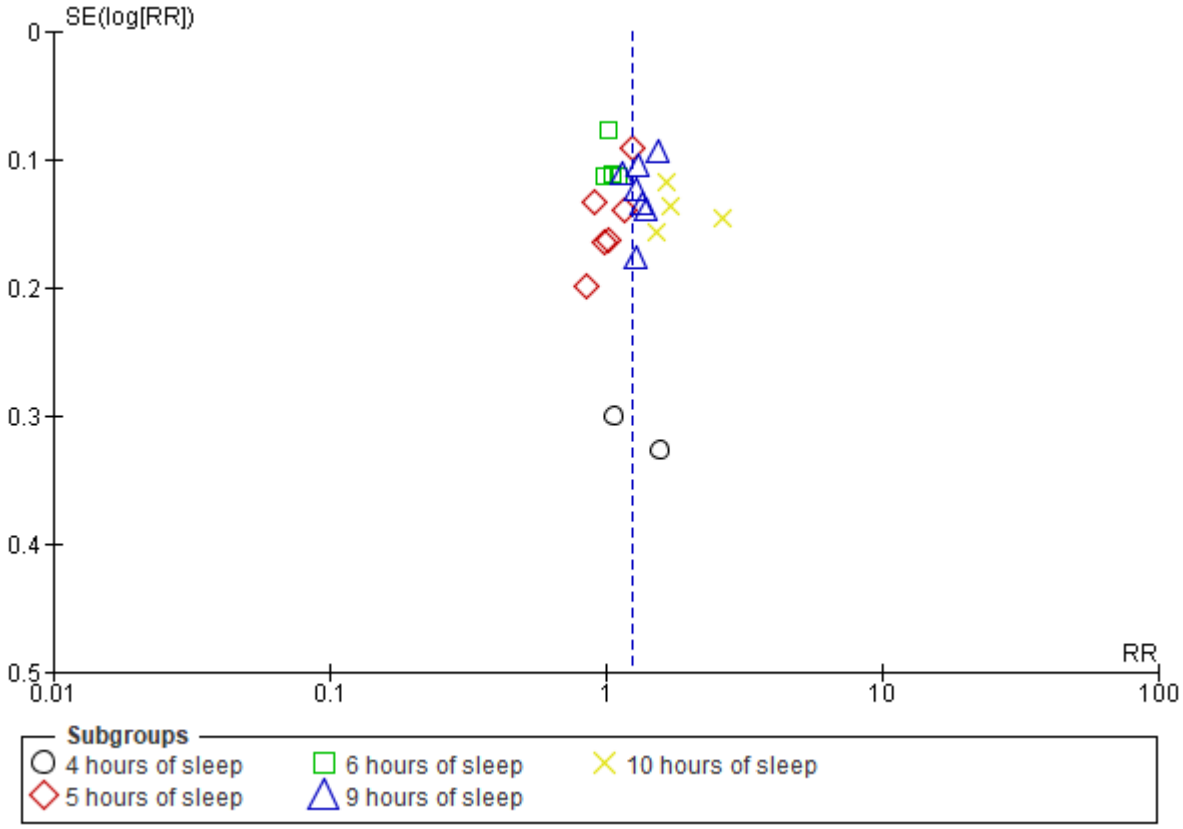
Supplementary Figure 4: Sleep duration and coronary heart disease and funnel plot



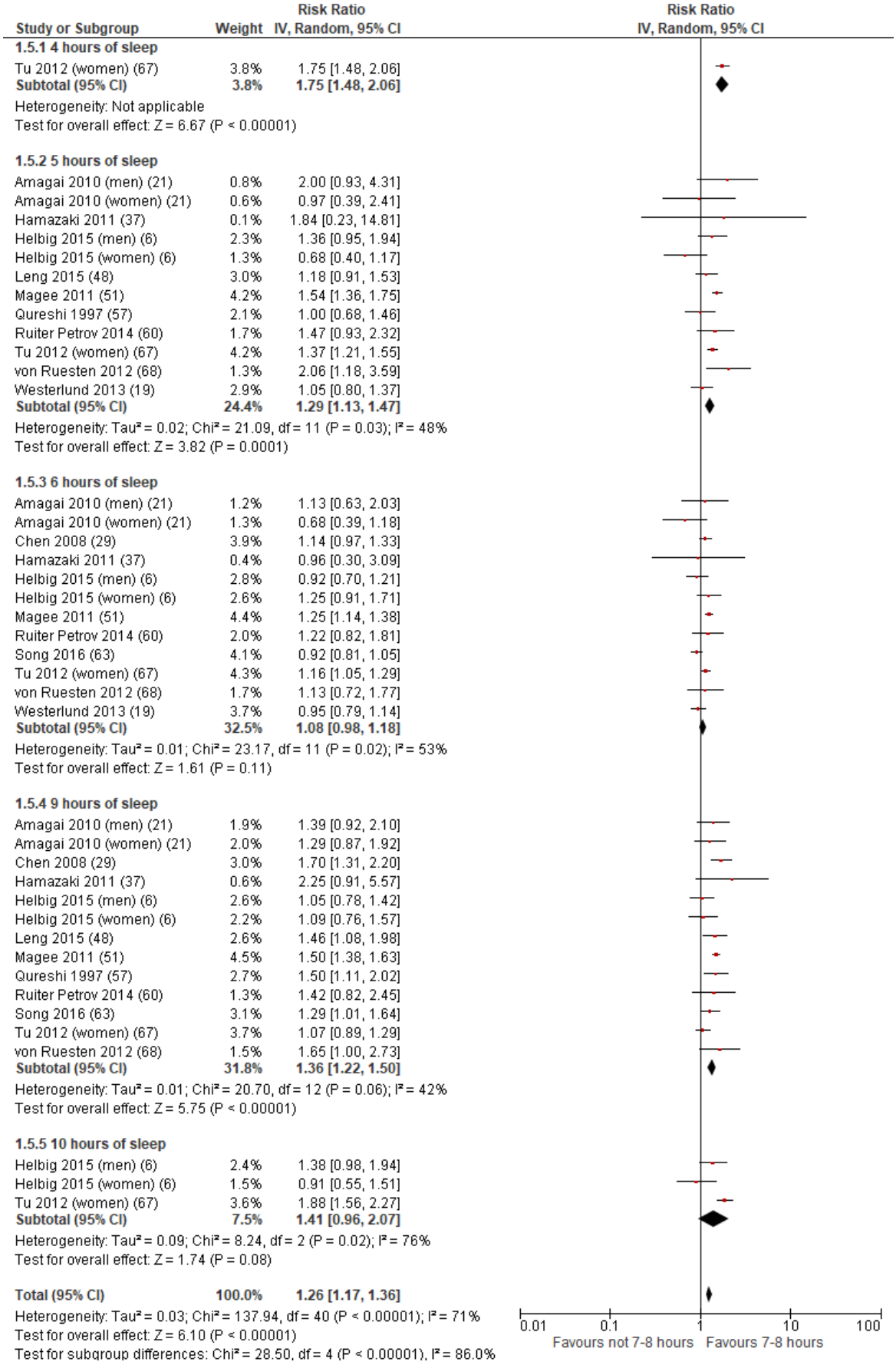

SE(log[RR])
0
0.2
0.4
0.6
0.8
1
0.01
0.1
1
10
100
RR
Subgroups
4 hours of sleep
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep

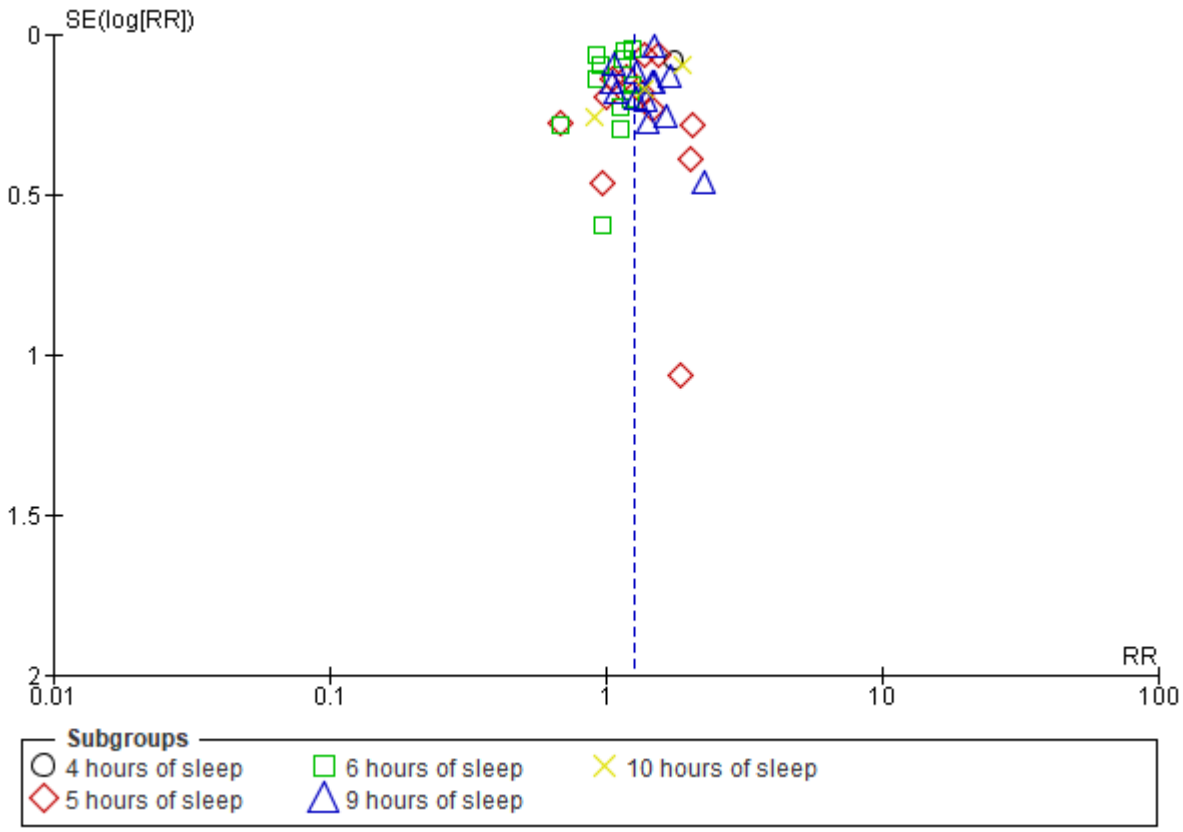
Supplementary Figure 5: Sleep duration and stroke mortality and funnel plot



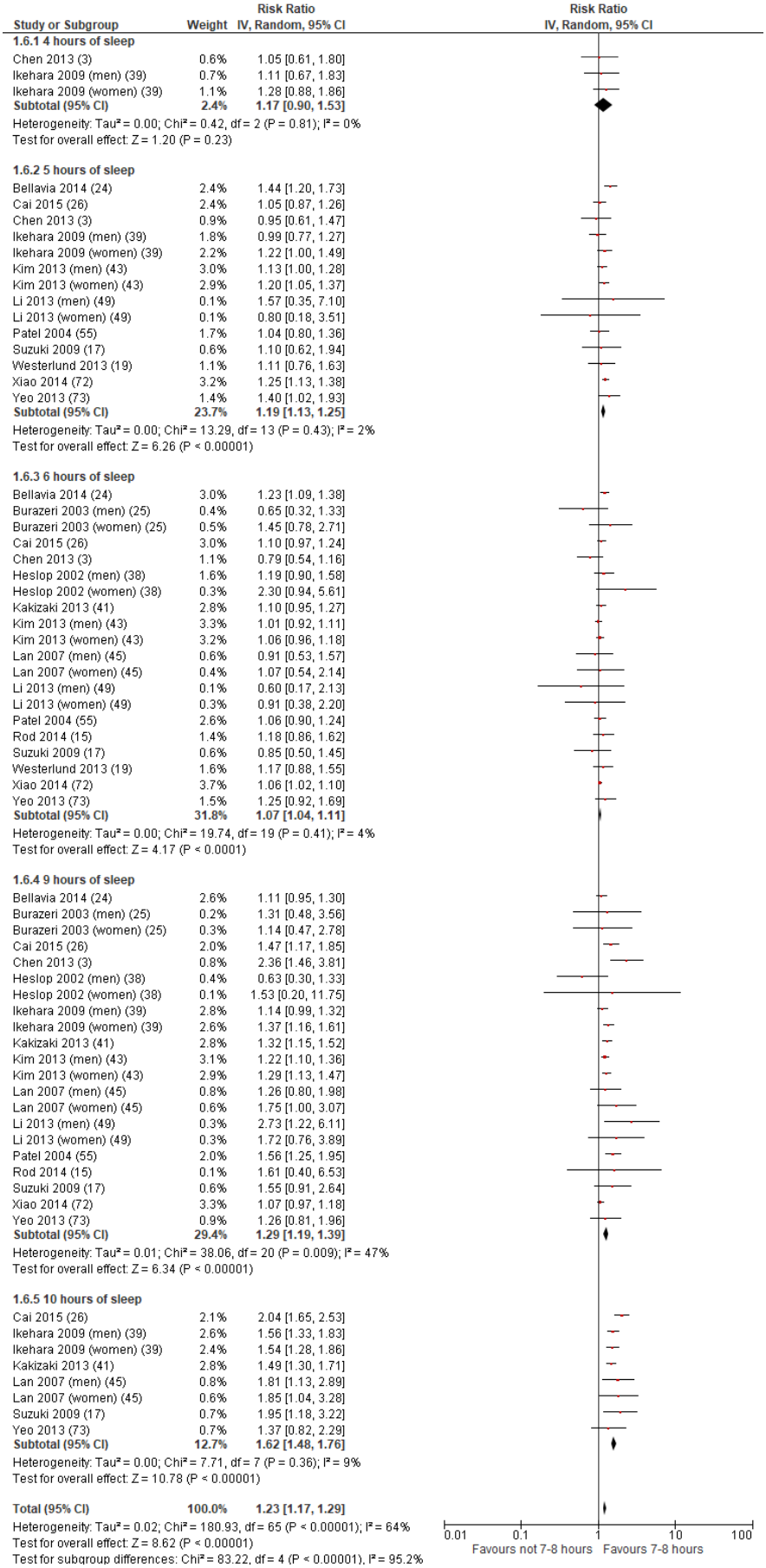

SE(log[RR])
0
0.1
0.2
0.3
0.4
0.5
0.01
0.1
1
10
100
RR
Subgroups
4 hours of sleep
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep

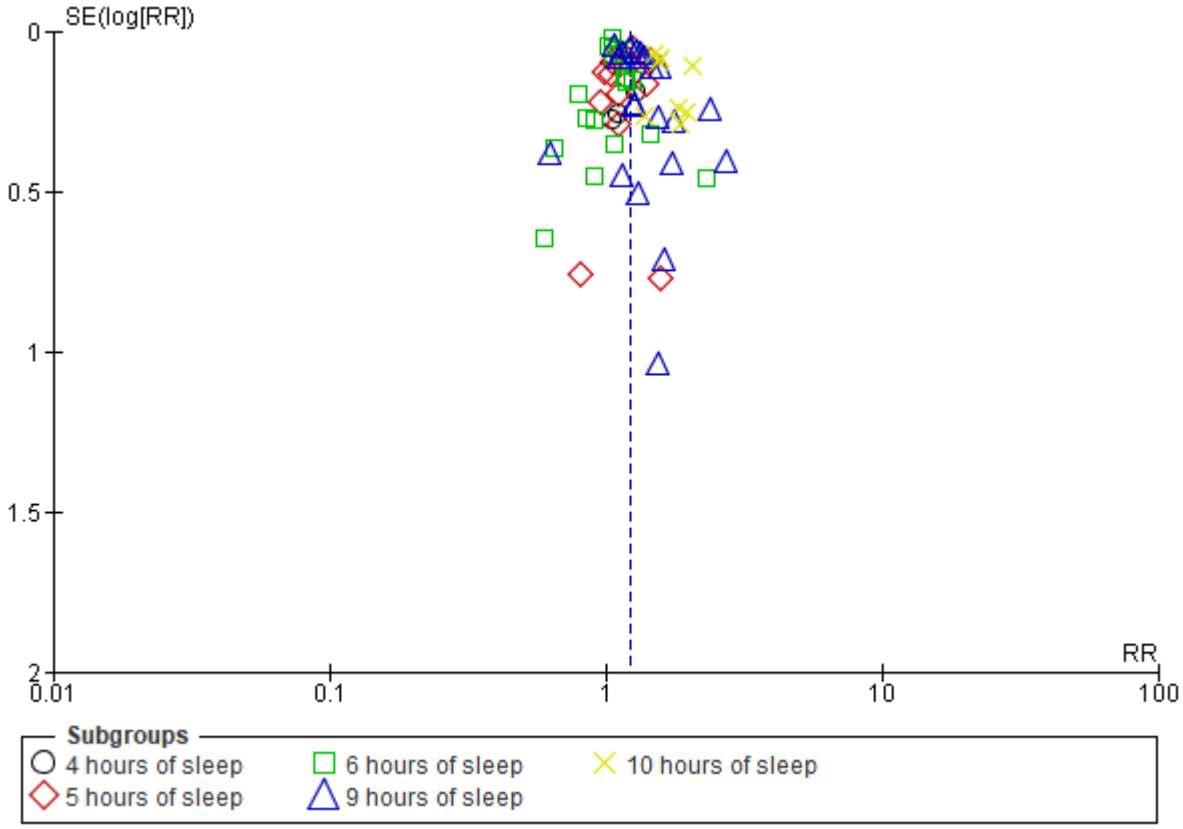
Supplementary Figure 6: Sleep duration and stroke and funnel plot



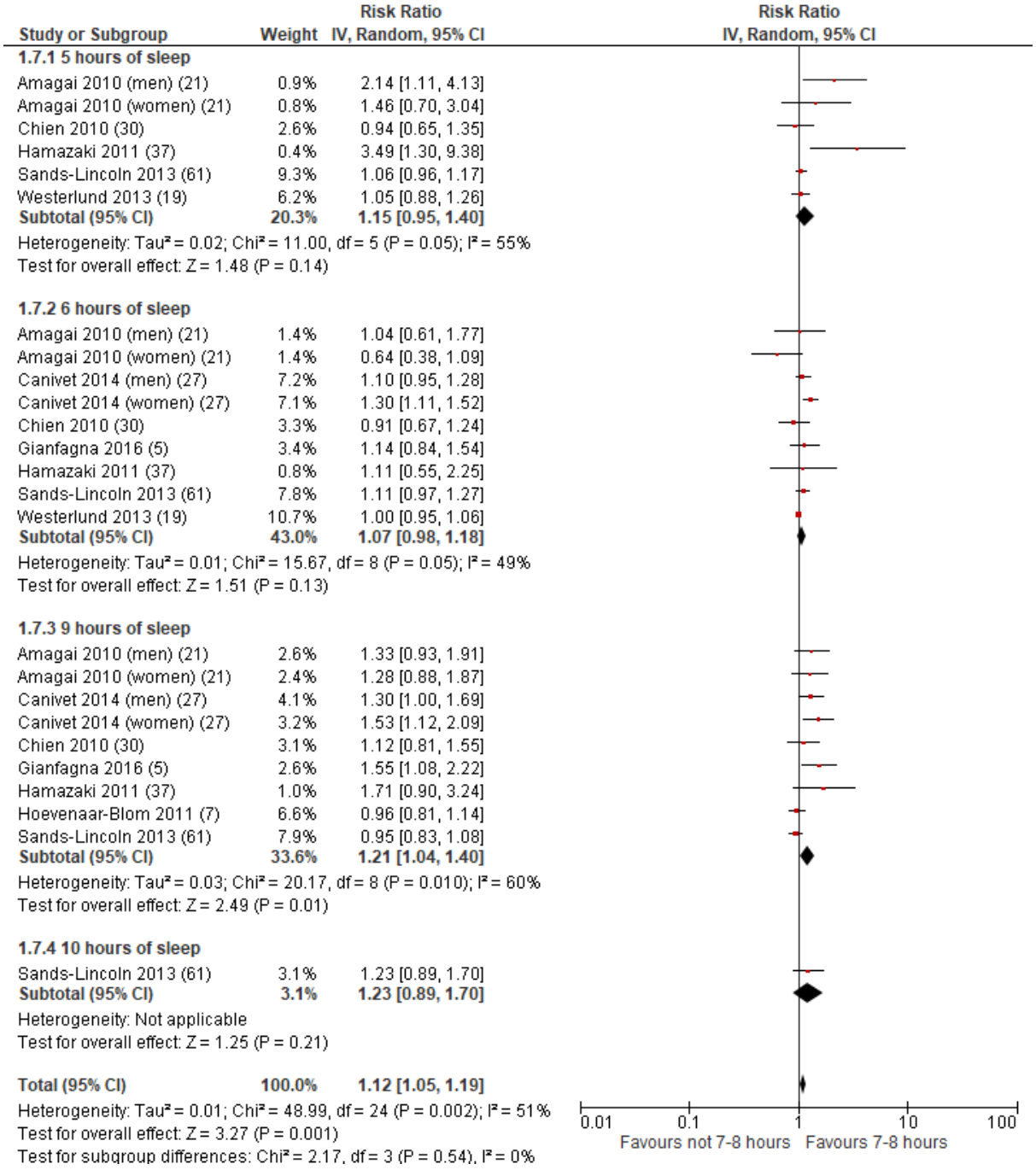

SE(log[RR])
0
0.5
1
1.5
2
0.01
0.1
1
10
100
RR
Subgroups
4 hours of sleep
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep

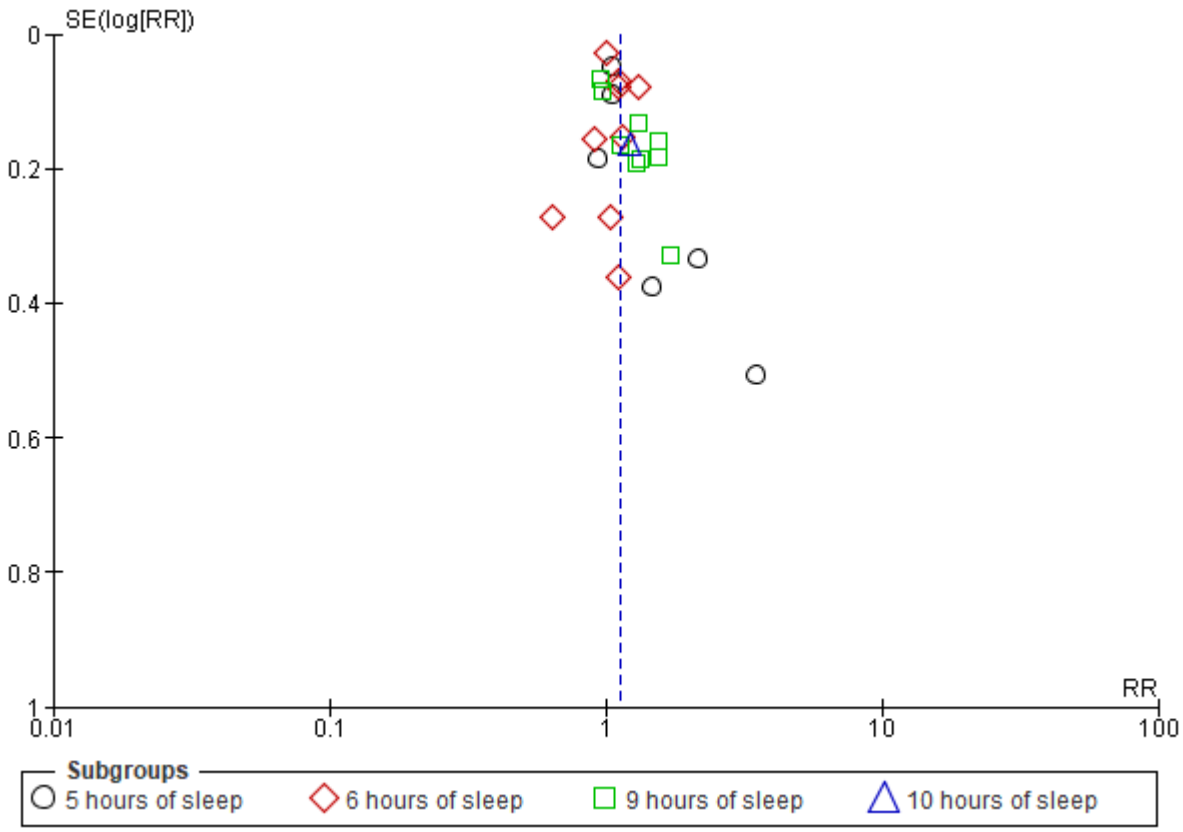
Supplementary Figure 7: Sleep duration and cardiovascular mortality and funnel plot



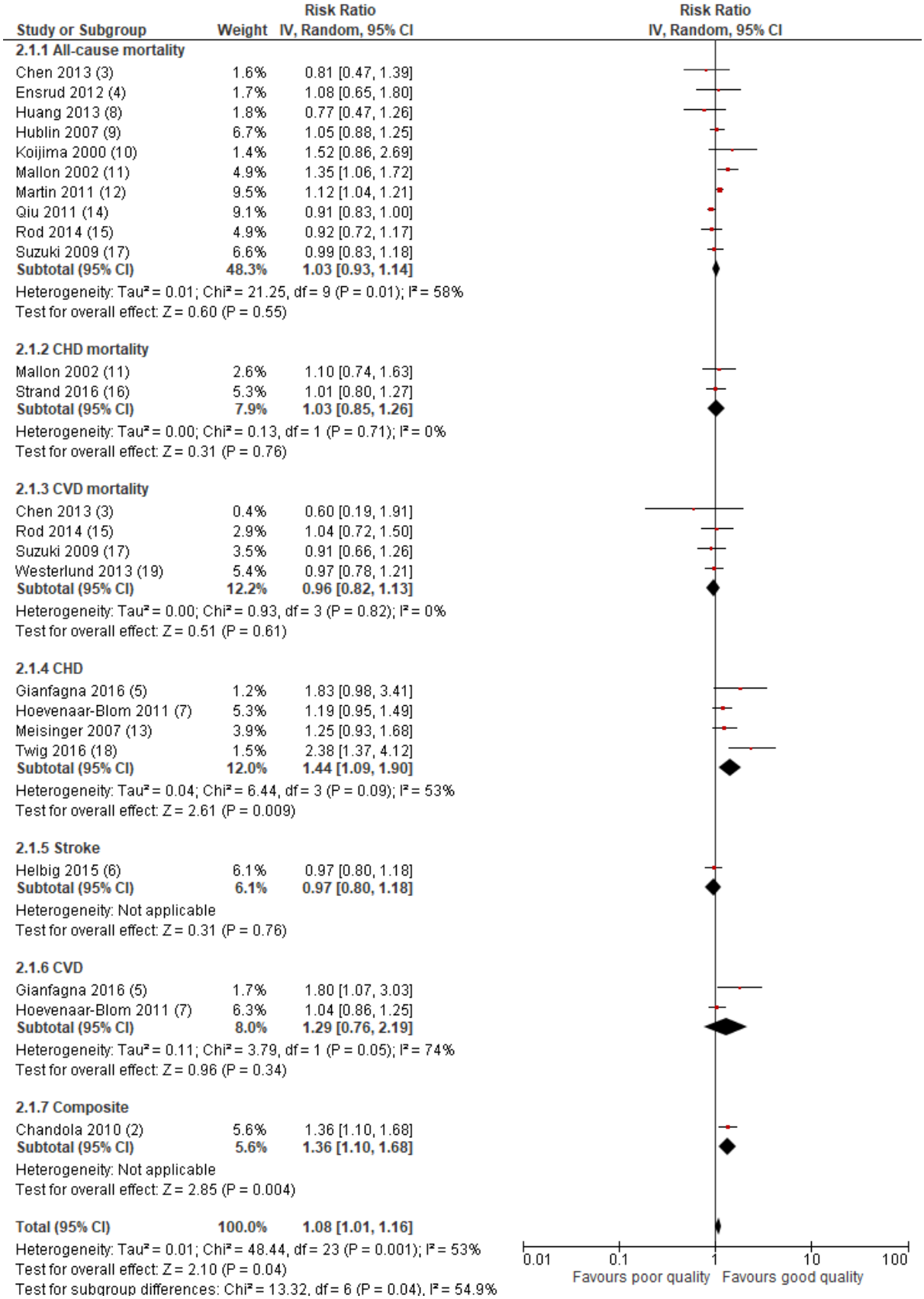

SE(log[RR])
0
0.5
1
1.5
2
0.01
0.1
1
10
100
RR
Subgroups
4 hours of sleep
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep

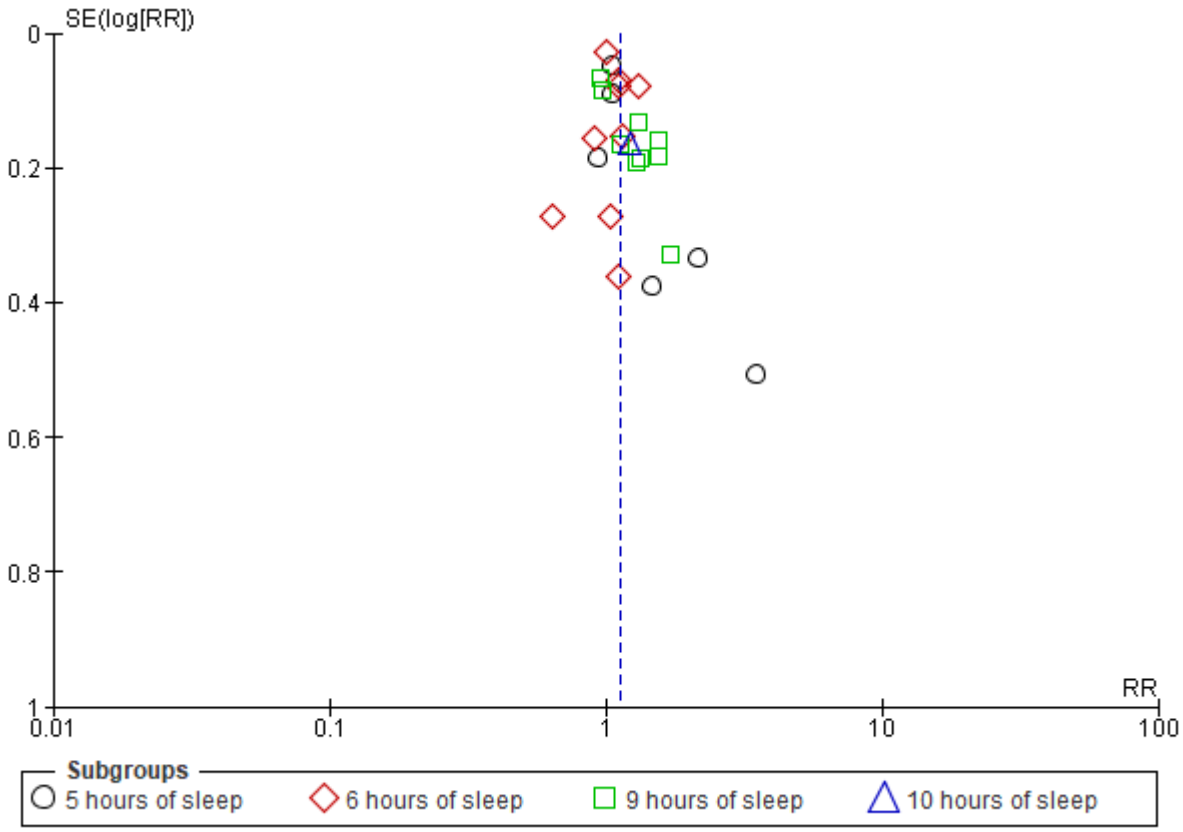
Supplementary Figure 8: Sleep duration and cardiovascular disease and funnel plot




SE(log[RR])
0
0.2
0.4
0.6
0.8
1
0.01
0.1
1
10
100
RR
Subgroups
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep

Supplementary Figure 9: Sleep quality and adverse outcomes and funnel plot




SE(log[RR])
0
0.2
0.4
0.6
0.8
1
0.01
0.1
1
10
100
RR
Subgroups
5 hours of sleep
6 hours of sleep
9 hours of sleep
10 hours of sleep

Appendix 1: Inclusion criteria and search strategy

Inclusion criteria

Included studies had to report on the association between shorter or longer sleep durations and adverse outcomes against a referent category of 7-8 hours. There were no restrictions based on the definition of sleep quality and we included restless, disturbed nights, subjective poor sleep quality, subjective sleep problems, sleep difficulties, difficulty maintaining sleep and sleep complaints as measures of sleep quality. The primary outcome was all-cause mortality and specific secondary outcomes included coronary heart disease (CHD) (coronary heart disease, ischemic heart disease, myocardial infarction and acute coronary syndrome), CHD mortality, stroke, stroke mortality, any composite of cardiovascular events, and cardiovascular mortality. Eligible studies included those that presented one of the following: odds ratio, relative risk, hazard ratio or sufficient raw data to enable calculation of the risk ratio where not otherwise reported.

Search strategy

Database: Embase, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R)

Search Strategy:

1. (Myocardial infarction or Ischemic heart disease or Ischaemic heart disease or acute coronary syndrome or coronary artery disease or stroke or cerebrovascular disease or cerebrovascular accident or death or mortality).ab,ti.
2. sleep duration.mp. or sleep quality.ab,ti.
3. ((Myocardial infarction or Ischemic heart disease or Ischaemic heart disease or acute coronary syndrome or coronary artery disease or stroke or cerebrovascular disease or cerebrovascular accident or death or mortality) and (sleep duration or sleep quality)).ab,ti.
4. remove duplicates from 3

Appendix 2: Full description of methods and data analysis

Study selection and data extraction

Two reviewers (CSK and AM) checked all titles and abstracts for studies that could potentially meet the inclusion criteria. We retrieved full reports of these potentially eligible studies for detailed assessment by at least two reviewers (CSK, GK or MG) who independently extract information on study design, study location, characteristics of participants and relevant outcomes on to a preformatted spreadsheet. We also collected information about prevalent cardiovascular disease and cardiovascular risk factors for the cohorts. For sleep quality, we collected information on the definition of quality of sleep. Any uncertainties or discrepancies between the reviewers were resolved through consensus after rechecking the original source data and consultation with another reviewer (YKL or MAM).

Risk of bias

The risk of bias was assessed by considering the methods of ascertaining sleep duration or quality, ascertainment of outcomes, use of adjustments for outcome estimates, and loss to follow up or exclusions due to missing data.(76) The possibility of publication or reporting bias was assessed using funnel plots where there were more than 10 studies in an analysis with low degree of statistical heterogeneity.(77)

Data analysis

We collected study results for each of the seven outcomes of interest: mortality, CHD, stroke, CVD, CHD mortality, stroke mortality and CVD mortality. We prioritized adjusted results (e.g. for relevant covariates) when both adjusted and unadjusted results were available. When results from a single study were only reported by-sex, data were

incorporated into the analytic models as two separate studies. When sex aggregate and by-sex results were provided, we only included the former in the models.

We used Stata version 14 to perform regression analysis at an alpha level of 5%. We implemented random-effects dose-response meta-analysis models to estimate the association between hours of sleep and the seven outcomes, using 7 hours of sleep as the reference category. Both linear and non-linear models were constructed. For each set of models, we constructed linear and cubic splines respectively, with knots at specified points using the *mkspline* command. For the linear splines, the knots were set at 5, 6 and 8 hours for all outcomes and additionally at 9 hours for mortality alone. For the cubic splines the knots were set at 6, 8 and 9 hours for all outcomes. Analyses were performed with the *glst* command in Stata,(78) a generalized least squares log-linear dose-response regression model. It uses the Greenland and Longnecker 1992(79) approach to estimate a variance-covariance matrix of the beta coefficients, to provide a trend estimate of multiple summarized dose-response epidemiological studies. We assumed random-effects for the dose coefficient and all identified studies were included as incidence-rate in the models. The model estimates were plotted using the xblc post-estimation command.(80) The linear model represents the primary analysis and the cubic model was included as a supplemental analysis.

As a sensitivity analysis, conventional random effects meta-analysis was performed as a secondary analysis using RevMan 5.3 (Nordic Cochrane Centre). The risk of each adverse outcomes for individual hours of sleep compared to a reference group of either 7 hours, 8 hours or 7 to 8 hours of sleep. The inverse variance method for pooling risk ratios was used so as to allow pooled of adjusted results. We assumed similarity between risk ratio and other relative measures such as odds ratios, rate ratios or hazard ratios because cardiovascular events and death are rare events.(81) Where possible, we aimed to pool adjusted risk ratios from primary studies; otherwise we used raw data to calculate unadjusted risk ratios [RR] and

associated 95% confidence intervals [CI]. Statistical heterogeneity was assessed using the I^2 statistic. Where the reference group of a particular analysis was not 7 or 8 hours of sleep, we performed adjusted indirect comparison(82) (Bucher's method) using ITC software (Canadian Health Authority)(83) to make 7 or 8 hours of sleep the reference group. When both 7 and 8 hours of sleep estimates for outcome were reported, we used 8 hours of sleep as the reference group and omitted the 7 hours of sleep group from the analysis. Analysis was divided into the risk of adverse outcomes for each hour of sleep, and below and above 7 to 8 hours of sleep. We assumed similarity between ≤4 and 4 hours, ≤5 and 5 hours, ≤6 and 6 hours and ≥9 and 9 hours and ≥10 and 10 hours of sleep because we observed there was a significant decrease in sample size per unit deviation from 7 or 8 hours of sleep. The reason for this assumption is that even if ≥9 hours or ≤4 hours the majority of the risk estimate is derived from participants who slept 9 or 4 hours respectively. A sensitivity analysis was performed by excluding studies that enrolled participants with existing cardiovascular disease or sleep apnea. We also conducted a sensitivity analysis by excluding studies that did not adjust for 5 key cardiovascular risk factors (i) hypertension or blood pressure, (ii) diabetes, (iii) hyperlipidemia, dyslipidemia, obesity, body mass index or serum cholesterol, (iv) smoking status and (v) sleep apnea or snoring. We also performed analysis of sleep quality in relation to mortality and cardiovascular outcomes. The definitions for sleep quality are shown in Supplementary Table 1.

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