**Supplementary Materials**

**Association of sleep duration and sleep quality with the risk of metabolic syndrome in adults: A systematic review and meta-analysis**

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**Table S1 The Newcastle-Ottawa Scale (NOS) used to assess the quality of the 50 studies included in the meta-analysis**

|  |  |  |  |
| --- | --- | --- | --- |
| Author (Year) | Design | Newcastle-Ottawa Scale | Quality of study |
| Selection | Comparability | Exposure/Outcome |
| Santos a, 2007[39] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Santos b, 2007[39] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Choi, 2008[40] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Hall, 2008[41] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Kobayashi, 2011[42] | Cross- sectional  | ★★ | ★ | ★★ | 5 |
| Najafian, 2011[43] | Cross- sectional  | ★★ | ★ | ★★ | 5 |
| Arora, 2011[44] | Cross- sectional  | ★★ | ★★ | ★★ | 6 |
| McCanlies, 2012[45] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Sabanayagam, 2012[46] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Wu a, 2012[47] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Wu b, 2012[47] | Cross- sectional  | ★★★ | ★★ | ★★ | 6 |
| Lee, 2013[48] | Cross- sectional  | ★★★ | ★★ | ★★★ | 8 |
| Yoo, 2013[49] | Cross- sectional  | ★★ | ★★ | ★★★ | 7 |
| Chaput, 2013[50] | Cross- sectional  | ★★★ | ★★ | ★★★ | 8 |
| Stefani, 2013[51] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Ikeda, 2014[52] | Cross- sectional  | ★★ | ★★ | ★★ | 6 |
| Yu, 2014[53] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Saleh, 2014[54] | Cross- sectional  | ★★★ | ★★ | ★★★ | 8 |
| Okubo a, 2014[55] | Cross- sectional  | ★★★ | ★ | ★★★ | 7 |
| Okubo b, 2014[55] | Cross- sectional  | ★★★ | ★★ | ★★★ | 7 |
| Chang, 2015[56] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Canuto, 2015[57] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Wu a, 2015[58] | Cross- sectional  | ★★ | ★★ | ★★ | 6 |
| Wu b, 2015[58] | Cross- sectional  | ★★ | ★★ | ★★ | 6 |
| Haba-Rubio, 2015[59] | Cross- sectional  | ★★★ | ★★ | ★★★ | 8 |
| Lim, 2015[60] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Xiao, 2016[61] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Min, 2016[62] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Lin, 2016[63] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Rao, 2016[64] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Yoon, 2016[65] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Cole, 2017[66] | Cross- sectional  | ★★★ | ★★ | ★★★ | 8 |
| Suliga, 2017[67] | Cross- sectional  | ★★★★ | ★★ | ★★ | 8 |
| Zohal, 2017[68] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Kim a, 2018[69] | Cross- sectional  | ★★★★ | ★★ | ★★ | 8 |
| Kim b, 2018[69] | Cross- sectional  | ★★★★ | ★★ | ★★ | 8 |
| van der Pal, 2018[70] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Titova, 2018[71] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Ostadrahimi, 2018[72] | Cross- sectional  | ★★★ | ★★ | ★★★ | 8 |
| Kim a, 2019[73] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Kim b, 2019[73] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Qian, 2019[74] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Gaston a, 2019[75] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Gaston b, 2019[75] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Fan, 2020[76] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Xu, 2020[77] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Lu, 2020[78] | Cross- sectional  | ★★ | ★★ | ★★ | 6 |
| Ghazizadeh, 2020[79] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Wang, 2021[80] | Cross- sectional  | ★★★ | ★★ | ★★ | 7 |
| Aryannejad, 2021[81] | Cross- sectional | ★★★ | ★ | ★★ | 6 |
| Li, 2021[82] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Feng, 2021[83] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Katsuura-Kamano a, 2021[84] | Cross- sectional  | ★★★ | ★ | ★★ | 6 |
| Katsuura-Kamano b, 2021[84] | Cross- sectional | ★★★ | ★ | ★★ | 6 |
| Choi a, 2011[32] | Cohort | ★★★★ | ★★ | ★★★ | 9 |
| Choi b, 2011[32] | Cohort | ★★★★ | ★★ | ★★★ | 9 |
| Kim, 2015[33] | Cohort | ★★★ | ★★ | ★★ | 7 |
| Li, 2015[34] | Cohort | ★★★★ | ★★ | ★★★ | 9 |
| Song, 2016[35] | Cohort | ★★★ | ★★ | ★★ | 7 |
| Itani, 2017[36] | Cohort | ★★★★ | ★ | ★★ | 7 |
| Deng, 2017[37] | Cohort | ★★★★ | ★★ | ★★★ | 9 |
| Wang, 2021[38] | Cohort | ★★★★ | ★★ | ★★ | 8 |

**Table S2** **Subgroup meta-analyses of short sleep duration**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Subgroups** | **N**  | **OR/RR (95% CI)** | ***P* a** | **I2 (%)** | ***P* b** |
| **Cross-sectional studies** |  |  |  |  |  |
| **MetS criteria** a |  |  |  |  |  |
| NCEP ATP Ⅲ | 4 | 0.81 (0.59-1.11) | 0.191  | 57.80 | 0.068 |
| NCEP ATP Ⅲ (modified) | 12 | 1.15 (1.06-1.26) | 0.001  | 82.00 | <0.001 |
| AHA/NHLBI | 20 | 1.11 (1.06-1.18) | <0.001 | 75.20 | <0.001 |
| AHA/NHLBI (modified) | 2 | 1.29 (0.70-2.37) | 0.418  | 21.50 | 0.259 |
| IDF | 3 | 1.01 (0.82-1.25) | 0.910  | 61.80 | 0.073 |
| Japanese criteria | 4 | 1.27 (0.72-2.23) | 0.408  | 63.50 | 0.042  |
| Chinese criteria | 3 | 1.22 (0.88-1.70) | 0.238 | 83.20 | 0.003 |
| **Reference of sleep duration** |  |  |  |  |  |
| ≥5h | 1 | 1.70 (1.19-2.44) | 0.004  | 0.00 | 0.000 |
| ≥6h | 2 | 1.29 (0.64-2.60) | 0.478  | 55.60 | 0.133 |
| 6-7h | 2 | 1.08 (0.74-1.58) | 0.695  | 66.30 | 0.085 |
| 6-8h | 9 | 1.10 (1.01-1.19) | 0.022  | 63.80 | 0.005  |
| 6-9h | 2 | 1.15 (0.82-1.61) | 0.426  | 90.00  | 0.002 |
| 7h | 6 | 1.20 (0.93-1.55) | 0.166  | 87.30 | <0.001 |
| >7h | 2 | 3.88 (0.35-43.16) | 0.271  | 53.10 | 0.144 |
| 7-8h | 17 | 1.14 (1.05-1.24) | 0.003  | 74.70 | <0.001 |
| 7.2-8.6h | 1 | 0.91 (0.62-1.33) | 0.628  | 0.00 | 0.000 |
| 7-9h | 3 | 1.17 (1.05-1.30) | 0.005  | 53.30 | 0.117 |
| ≥8h | 1 | 1.42 (1.20-1.68) | <0.001 | 0.00 | 0.000 |
| ≥9h | 2 | 0.62 (0.32-1.21) | 0.164  | 62.00  | 0.105 |

N, number. CI, confidence interval. OR, odds ratio (for cross-sectional studies. RR, risk ratio (for cohort study). MetS, metabolic syndrome. h, hour.

*P* a, *P* value for Z test. *P* b, *P* value based on Q test for heterogeneity.

a NCEP ATPIII, National Cholesterol Education Program Adult Treatment Panel III criteria. NCEP ATPIII (modified), National Cholesterol Education Program Adult Treatment Panel III criteria (abdominal obesity assessed by Asian criteria, WHO criteria, BMI≥25kg/m2, BMI≥30 kg/m² or others; FPG≥7.0mmol/L or with a history of diabetes mellitus; diabetes mellitus defined as a casual plasma glucose ≥ 200mg/dl (11.1mmol/L) or a self-reported history of physician-diagnosed diabetes). AHA/NHLBI, Scientific Statement of American Heart Association/National Heart, Lung, and Blood Institute. AHA/NHLBI (modified), Scientific Statement of American Heart Association/National Heart, Lung, and Blood Institute (abdominal obesity assessed by Asian criteria, Korean criteria). IDF, International Diabetes Federation. Japanese criteria, CEDSMS (the diagnostic criteria set by the Japanese Committee to Evaluate Diagnostic Standards for Metabolic Syndrome) and JASSO (Japan Society for the Study of Obesity). Chinese criteria, Dyslipidemia Prevention and Cure Guidelines of China in 2007 and CDS (Chinese diabetes society).

**Table S3 Subgroup meta-analyses of long sleep duration**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Subgroups** | **N** | **OR/RR (95% CI)** | ***P* a** | **I2 (%)** | ***P* b** |
| **Cross-sectional studies** |  |  |  |  |  |
| **MetS criteria** a |  |  |  |  |  |
| NCEP ATP Ⅲ | 3 | 1.08 (0.88-1.32) | 0.488 | 16.30 | 0.303 |
| NCEP ATP Ⅲ (modified) | 16 | 1.20 (1.05-1.37) | 0.007 | 83.70 | <0.001 |
| AHA/NHLBI | 16 | 1.13 (1.05-1.22) | 0.001 | 60.50  | 0.001 |
| AHA/NHLBI (modified) | 2 | 2.34 (0.73-7.56) | 0.155 | 60.80 | 0.110  |
| IDF | 3 | 1.13 (0.95-1.35) | 0.164 | 73.70 | 0.022 |
| Japanese criteria | 1 | 1.12 (0.86-1.46) | 0.401 | 0.00 | 0.000 |
| Chinese criteria | 3 | 1.07 (0.80-1.44) | 0.640 | 74.00 | 0.022 |
| **Reference of sleep duration** |  |  |  |  |  |
| <5h | 1 | 2.52 (0.83-7.69) | 0.104 | 0.00 | 0.000 |
| ≤5h | 1 | 0.76 (0.66-0.87) | <0.001 | 0.00 | <0.001 |
| <6h | 2 | 1.23 (0.46-3.34) | 0.680  | 81.70 | 0.019 |
| 6-7h | 2 | 1.30 (1.05-1.60) | 0.015 | 56.60 | 0.129 |
| 6-8h | 9 | 1.16 (1.01-1.32) | 0.030 | 71.60 | <0.001 |
| 6-9h | 2 | 1.15 (1.06-1.25) | 0.001 | 0.00 | 0.545 |
| 7h | 6 | 1.31 (1.19-1.45) | <0.001 | 44.90 | 0.106 |
| ≤7h | 2 | 1.17 (1.06-1.29) | 0.001 | 0.00 | 0.862 |
| 7-8h | 17 | 1.14 (1.04-1.26) | 0.005 | 67.50 | <0.001 |
| 7.2-8.6h | 1 | 0.95 (0.66-1.38) | 0.787 | 0.00 | 0.000 |
| 7-9h | 1 | 0.92 (0.75-1.13) | 0.429 | 0.00 | 0.000 |

N, number. CI, confidence interval. OR, odds ratio (for cross-sectional studies. RR, risk ratio (for cohort study). MetS, metabolic syndrome. h, hour.

*P* a, *P* value for Z test. *P* b, *P* value based on Q test for heterogeneity.

a NCEP ATPIII, National Cholesterol Education Program Adult Treatment Panel III criteria. NCEP ATPIII (modified), National Cholesterol Education Program Adult Treatment Panel III criteria (abdominal obesity assessed by Asian criteria, WHO criteria, BMI≥25kg/m2, BMI≥30 kg/m² or others; FPG≥7.0mmol/L or with a history of diabetes mellitus; diabetes mellitus defined as a casual plasma glucose ≥ 200mg/dl (11.1mmol/L) or a self-reported history of physician-diagnosed diabetes). AHA/NHLBI, Scientific Statement of American Heart Association/National Heart, Lung, and Blood Institute. AHA/NHLBI (modified), Scientific Statement of American Heart Association/National Heart, Lung, and Blood Institute (abdominal obesity assessed by Asian criteria, Korean criteria). IDF, International Diabetes Federation. Japanese criteria, CEDSMS (the diagnostic criteria set by the Japanese Committee to Evaluate Diagnostic Standards for Metabolic Syndrome) and JASSO (Japan Society for the Study of Obesity). Chinese criteria, Dyslipidemia Prevention and Cure Guidelines of China in 2007 and CDS (Chinese diabetes society).



**Figure S1 Funnel plot for assessing the association between sleep duration and metabolic syndrome.**

(a) Short sleep duration (Begg’s test, *P* = 0.445); (b) Long sleep duration (Begg’s test, *P* = 0.673).