

ONLINE SUPPLEMENTARY DOCUMENT

Title: Role of body mass index and weight change in the risk of cancer: A systematic review and meta-analysis of 66 cohort studies.

Table S1. PRISMA 2009 Checklist



PRISMA 2009 Checklist

| Section/topic | # | Checklist item | Reported on page # |
|------------------------------------|----|---|--------------------|
| TITLE | | | |
| Title | 1 | Identify the report as a systematic review, meta-analysis, or both. | 1 |
| ABSTRACT | | | |
| Structured summary | 2 | Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number. | 3-4 |
| INTRODUCTION | | | |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known. | 4-6 |
| Objectives | 4 | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS). | 5-6 |
| METHODS | | | |
| Protocol and registration | 5 | Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number. | 6 |
| Eligibility criteria | 6 | Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale. | 7 |
| Information sources | 7 | Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched. | 6 |
| Search | 8 | Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated. | 6 |
| Study selection | 9 | State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis). | 7 |
| Data collection process | 10 | Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators. | 7 |
| Data items | 11 | List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made. | 7 |
| Risk of bias in individual studies | 12 | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. | 8-9 |
| Summary measures | 13 | State the principal summary measures (e.g., risk ratio, difference in means). | 7 |
| Synthesis of results | 14 | Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis. | 7-8 |



PRISMA 2009 Checklist

| Section/topic | # | Checklist item | Reported on page # |
|-------------------------------|----|--|--------------------|
| Risk of bias across studies | 15 | Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies). | 8 |
| Additional analyses | 16 | Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified. | 7-8 |
| RESULTS | | | |
| Study selection | 17 | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. | 9-10 |
| Study characteristics | 18 | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations. | 10-11 |
| Risk of bias within studies | 19 | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). | 11 |
| Results of individual studies | 20 | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot. | 8 |
| Synthesis of results | 21 | Present results of each meta-analysis done, including confidence intervals and measures of consistency. | 9-17 |
| Risk of bias across studies | 22 | Present results of any assessment of risk of bias across studies (see Item 15). | 17 |
| Additional analysis | 23 | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]). | 12-16 |
| DISCUSSION | | | |
| Summary of evidence | 24 | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers). | 17-21 |
| Limitations | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias). | 21-22 |
| Conclusions | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research. | 22-23 |
| FUNDING | | | |
| Funding | 27 | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. | 23 |

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

Table S2. Search Strategy

| Database | Search strategy |
|----------------|---|
| Pubmed | (cancer[Title/Abstract] or carcinoma[Title/Abstract]) AND (risk[Title]) AND (weight[Title/Abstract] or overweight[Title/Abstract] or obesity[Title/Abstract]) |
| Web of Science | (TI=(obesity) OR TI=(overweight) OR TI=(weight)) AND (TI=(carcinoma) OR TI=(cancer)) AND (TI=(risk)) |

Table S3. Characteristics of the studies included in the meta-analysis.

| Study | Year | Country or Region | No. of Participants | Sex (M/F) | Age at entry (years) | Outcome | Study Quality | Included Data Type of Cancer incidence | Figure | | | Supplementary Figure | | |
|----------------------------------|------|----------------------|---------------------|-----------|----------------------|---|---------------|--|--------|---|---|----------------------|---|---|
| | | | | | | | | | 2 | 3 | 4 | 2 | 3 | 4 |
| Pasqual E, 2023 ¹ | 2023 | USA | 47739 | F | 35-74 | Thyroid cancer | 8 | Event/Total | √ | √ | | | | |
| Safizadeh F, 2023 ² | 2023 | UK | 453049 | M/F | 40-69 | Colorectal cancer | 7 | Event/Total | √ | √ | | | | |
| Nguyen DN, 2022 ³ | 2022 | Korea | 160650 | M/F | 40-79 | Thyroid Cancer | 8 | Event/Total | √ | √ | | | | |
| Lee HW, 2022 ⁴ | 2022 | Korea | 134130 | M/F | 40-69 | Gastric Cancer | 9 | Event/Total | √ | | | | | |
| Mao D, 2022 ⁵ | 2022 | Hong Kong SAR, China | 15281 | M/F | NA | Liver Cancer | 6 | Event/Total | √ | √ | | | | |
| Miyata H, 2021 ⁶ | 2021 | Japan | 33,801 | M/F | 40-79 | Endometrial Cancer | 9 | Event/Total | √ | √ | √ | | | √ |
| Abe SK, 2021 ⁷ | 2021 | Japan | 92098 | M/F | 40-69 | Liver Cancer | 8 | Event/Total | √ | √ | | | | |
| Smith SG, 2021 ⁸ | 2021 | United Kingdom | 10653 | M/F | 35–70 | Breast Cancer | 8 | Event/Total | √ | √ | | | | |
| Baumeister SE, 2021 ⁹ | 2021 | Germany | 145575 | F | 50-72 | Ovarian Cancer | 8 | HR | | | | | | √ |
| Maliniak ML, 2021 ¹⁰ | 2021 | USA | 43795 | F | 63.5 (mean) | Breast Cancer, Endometrial Cancer, Colon Cancer | 9 | Event/Total | √ | √ | | | | √ |
| Sanikini H, 2020 ¹¹ | 2020 | United Kingdom | 458713 | M/F | 40-69 | Esophageal Adenocarcinoma | 9 | Event/Total | √ | √ | | | | √ |
| Luo J, 2020 ¹² | 2020 | USA | 70379 | F | 50-79 | Breast Cancer | 9 | Event/Total | √ | √ | | | | √ |
| Minami CA, 2020 ¹³ | 2020 | USA | 1222 | M/F | NA | Lobular Carcinoma In Situ | 4 | HR | | | | | | √ |
| Rehnan AG, 2020 ¹⁴ | 2020 | United Kingdom | 47042 | F | 47-73 | Breast Cancer | 8 | Event/Total | √ | √ | | | | |
| Sanikini H, 2020 ¹⁵ | 2020 | United Kingdom | 476160 | M/F | 25-70 | Esophagus Cancer, Gastric Cancer | 9 | Event/Total | √ | √ | | | | √ |

| | | | | | | | | | | | |
|---|------|----------------------------------|---------|-----|------------------|---|---|-------------|---|---|---|
| Everatt R, 2019 ¹⁶ | 2019 | Lithuania | 6849 | M | 45-59 | Kidney Cancer | 8 | Event/Total | √ | √ | |
| Hirabayashi M, 2019 ¹⁷ | 2019 | Japan | 92056 | M/F | 40-69 | Gastric Cancer | 9 | Event/Total | √ | √ | |
| Kawachi A, 2019 ¹⁸ | 2019 | Japan | 53651 | F | 40-69 | Endometrial Cancer | 9 | Event/Total | √ | √ | |
| Wakamatsu M, 2019 ¹⁹ | 2019 | Japan | 78743 | M/F | 40-79 | Obesity Related Cancer | 9 | Event/Total | √ | | |
| Zohar L, 2019 ²⁰ | 2019 | Israel | 1794570 | M/F | 16-19 | Pancreatic Cancer | 8 | Event/Total | √ | √ | √ |
| Schoemaker MJ, 2018 ²¹ | 2018 | United Kingdom | 758592 | F | 40-69 | Breast Cancer | 8 | Event/Total | √ | | |
| Xu HL, 2018 ²² | 2018 | People's Republic of China | 51004 | M/F | 61.39(mean) | Stomach, Colorectal, Pancreas, Trachea, Bronchus & Lung, Breast, Prostate , Bladder, Thyroid Cancer | 9 | Event/Total | √ | √ | √ |
| Dickerman BA, 2017 ²³ | 2017 | USA | 5158 | M | 40-75 | Prostatic Cancer | 9 | Event/Total | √ | √ | |
| Leiba A, 2017 ²⁴ | 2017 | Israel | 2516256 | M/F | 16-19 | Bone Marrow Proliferative Tumor (MPN) | 7 | HR | | | √ |
| Yamamoto-Honda R, 2016 ²⁵ | 2016 | Japan | 2334 | M/F | 62.0 (median) | Oropharynx, Submandibular Gland, Larynx, Esophageal (Squamous Cell Cancer), Stomach, Duodenum, Colorectal, Liver, Gall Bladder, Biliary Tract, Pancreas, Lung, Breast (Postmenopausal), Endometrial, Ovary, | 9 | Event/Total | √ | √ | |

Prostate, Kidney, Renal
Pelvis, Urinary Bladder,
Hematopoietic, Gastric
Gastrointestinal Stromal
Tumor

| | | | | | | | | | | | |
|----------------------------------|------|----------------|--------|-----|-----------|----------------------------------|---|-------------|---|---|---|
| Sponholtz TR, 2016 ²⁶ | 2016 | USA | 47557 | F | 21-69 | Endometrial Cancer | 9 | Event/Total | √ | | |
| White AJ, 2015 ²⁷ | 2015 | USA | 50884 | F | 35-74 | Breast Cancer | 9 | Event/Total | √ | | √ |
| Moller H, 2015 ²⁸ | 2015 | United Kingdom | 26944 | M | 50-64 | Prostatic Cancer | 8 | Event/Total | √ | √ | |
| de Mutsert R, 2014 ²⁹ | 2014 | Singapore | 39909 | M/F | 40-75 | Obesity-related Cancer | 8 | Event/Total | √ | | |
| Lam TK, 2013 ³⁰ | 2013 | USA | 158415 | M/F | 50-71 | Lung Cancer | 8 | Event/Total | √ | √ | |
| Patel AV, 2013 ³¹ | 2013 | USA | 152423 | M/F | 50-74 | Diffuse Large B cell Lymphoma | 8 | Event/Total | √ | | |
| Renehan AG, 2012 ³² | 2012 | United Kingdom | 273679 | M/F | 50-71 | Colorectal Cancer | 8 | Event/Total | √ | √ | √ |
| Smith L, 2012 ³³ | 2012 | USA | 448732 | M/F | 50-71 | Lung Cancer | 9 | Event/Total | √ | √ | |
| Cecchini RS, 2012 ³⁴ | 2012 | USA | 12243 | F | NA | Breast Cancer | 8 | Event/Total | √ | √ | |
| Laake I, 2010 ³⁵ | 2010 | Norway | 21687 | M/F | 35-49 | Colon Cancer | 9 | Event/Total | √ | √ | √ |
| Sawada N, 2010 ³⁶ | 2010 | Japan | 99462 | M/F | 40-59 | Kidney Cancer | 9 | Event/Total | √ | √ | |
| Mijovic T, 2009 ³⁷ | 2009 | Canada | 253 | M/F | 19-85 | Cancer of Thyroid gland | 4 | Event/Total | √ | √ | |
| Rod NH, 2009 ³⁸ | 2009 | Denmark | 5054 | F | 62 (mean) | Breast Cancer | 9 | Event/Total | √ | √ | √ |
| Leitzmann MF, 2009 ³⁹ | 2009 | USA | 94525 | F | 50-71 | Ovarian Cancer | 7 | Event/Total | √ | √ | |

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|----------------------------------|------|-------------|--------|-----|-------------|--|---|-------------|---|---|---|---|---|
| Iwasaki M, 2007 ⁴⁰ | 2007 | Japan | 55537 | F | 40-69 | Breast Cancer | 9 | Event/Total | √ | | | | |
| Nothlings U, 2007 ⁴¹ | 2007 | USA | 167430 | M/F | 45-75 | Prostatic Cancer | 9 | Event/Total | √ | √ | | √ | |
| Rodriguez C, 2007 ⁴² | 2007 | USA | 69991 | M | 50-74 | Prostatic Cancer | 9 | Event/Total | √ | √ | | | |
| N'Kontchou G, 2006 ⁴³ | 2006 | France | 771 | M/F | 61.4 (mean) | Hepatocellular Carcinoma | 8 | Event/Total | √ | √ | | | |
| Niwa Y, 2005 ⁴⁴ | 2005 | Japan | 36456 | F | 40-79 | Ovarian Cancer | 8 | Event/Total | √ | √ | | √ | |
| Patel AV, 2005 ⁴⁵ | 2005 | USA | 145627 | M/F | 50-74 | Pancreatic Cancer | 8 | Event/Total | √ | √ | | | |
| Kuriyama S, 2005 ⁴⁶ | 2005 | Japan | 27539 | M/F | ≥40 | Esophageal Cancer, Gastric Cancer, Colorectal Cancer, Liver Cancer, Gallbladder Cancer, Pancreatic Cancer, Lung Cancer, Kidney Cancer, Breast Cancer, Endometrial Cancer, Cervical Cancer, Ovarian Cancer | 8 | Event/Total | √ | √ | | √ | √ |
| Lin J, 2004 ⁴⁷ | 2004 | USA | 37671 | M/F | ≥45 | Breast Cancer | 8 | Event/Total | √ | √ | | | |
| Moore LL, 2004 ⁴⁸ | 2004 | USA | 7566 | M/F | 30-79 | Colon Cancer | 9 | Event/Total | √ | √ | | √ | √ |
| Park B, 2022 ⁴⁹ | 2022 | South Korea | 184931 | F | ≥40 | Breast Cancer | 9 | Event/Total | | | √ | | |
| Kim SJ, 2021 ⁵⁰ | 2021 | Canada | 3853 | F | 18 | Ovarian Cancer | 7 | Event/Total | | | √ | | |
| da Silva M, 2018 ⁵¹ | 2018 | Norway | 80930 | M/F | 30-70 | Breast, Colon, Rectal, Ovarian, Pancreatic, Kidney, Endometrial Cancer | 9 | Event/Total | | | √ | | |

| | | | | | | | | | | | |
|-----------------------------------|------|--------------------------------|---------|-----|-------------|---|---|-------------|---|---|---|
| Chadid S, 2018 ⁵² | 2018 | USA | 3850 | M/F | ≥60 | Female reproductive (postmenopausal, Breast, Uterine/Endometrial and Ovarian), Colon, Rectum, Stomach, Liver, Gallbladder, Pancreas, Kidney, Thyroid, Esophageal Adenocarcinoma, Leukaemia, Non Hodgkin Lymphoma and Multiple Myeloma | 7 | Event/Total | √ | | |
| Kim SJ, 2018 ⁵³ | 2018 | Canada & Poland | 3493 | F | 18 | Breast Cancer | 7 | Event/Total | √ | | |
| Rosner B, 2017 ⁵⁴ | 2017 | USA | 74177 | F | 30-55 | Breast Cancer | 7 | Event/Total | √ | | |
| Alsaker MD, 2013 ⁵⁵ | 2013 | Norway | 28153 | F | ≥20 | Breast Cancer | 9 | Event/Total | √ | | |
| Chamberlain C, 2011 ⁵⁶ | 2011 | United Kingdom | 20991 | M | ≥20 | Prostatic Cancer | 9 | Event/Total | √ | | |
| Bassett JK, 2010 ⁵⁷ | 2010 | Australia | 39626 | M/F | 40-69 | Colon Cancer | 9 | Event/Total | √ | | |
| Thygesen LC, 2008 ⁵⁸ | 2008 | USA | 46349 | F | 40-75 | Colon Cancer(male) | 8 | Event/Total | √ | | |
| Klintman M, 2022 ⁵⁹ | 2022 | Sweden | 35412 | F | 62 (median) | Breast Cancer | 7 | Event/Total | √ | √ | √ |
| Shao F, 2022 ⁶⁰ | 2022 | the People's Republic of China | 450482 | M/F | 40-69 | Lung Cancer | 8 | Event/Total | √ | √ | |
| Song H, 2022 ⁶¹ | 2022 | Korea | 40432 | F | ≥40 | Breast Cancer | 7 | Event/Total | √ | √ | √ |
| Urbute A, 2022 ⁶² | 2022 | Denmark | 461646 | F | ≤49 | Ovarian Cancer | 7 | Event/Total | √ | √ | √ |
| Park B, 2022 ⁶³ | 2022 | Korea | 6097686 | F | ≥40 | Endometrial Cancer | 7 | Event/Total | √ | √ | √ |

| | | | | | | | | | | | |
|-----------------------------|------|--------------------------------|---------|-----|-------|------------------------------------|---|-------------|---|---|---|
| Yang W, 2022 ⁶⁴ | 2022 | the People's Republic of China | 138 922 | M/F | 20-50 | Liver Cancer, Biliary Tract Cancer | 8 | Event/Total | √ | √ | √ |
| Choi IY, 2021 ⁶⁵ | 2021 | Korea | 6272367 | M/F | ≥40 | Gastric Cancer | 9 | Event/Total | √ | √ | √ |
| Shin CM, 2017 ⁶⁶ | 2017 | Korea | 408931 | M/F | ≥20 | Colorectal Cancer | 7 | Event/Total | √ | √ | √ |

Abbreviation: M, male; F, female; NA, not available; HR, hazard ratio.

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doi:10.1097/DCR.0000000000000876

Figure S1. The result of the quality of the included studies assessed by the Newcastle-Ottawa Scale

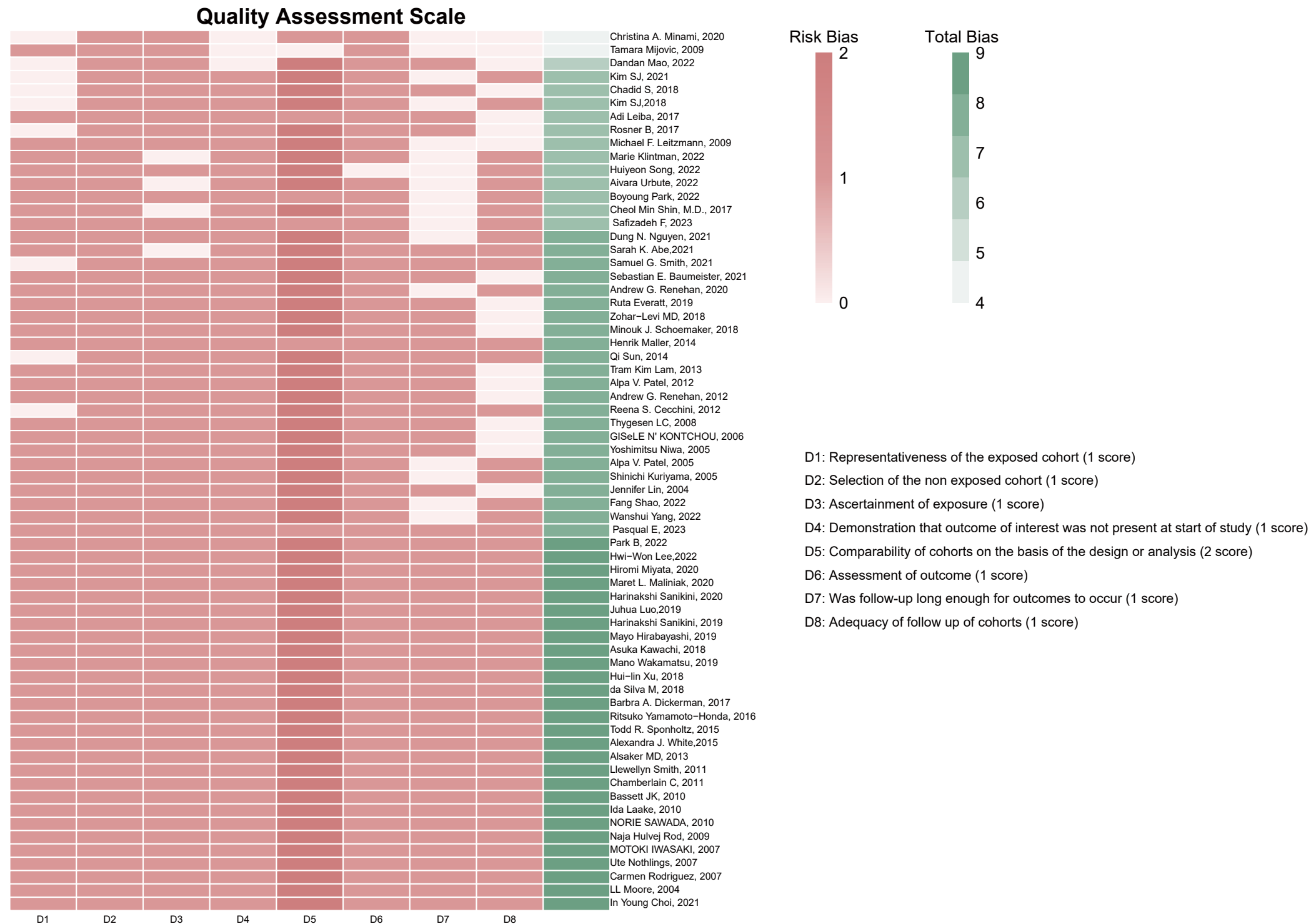


Figure S2: Forest plots of the studies(pooling the HRs) analyzing the risk of overall cancer.

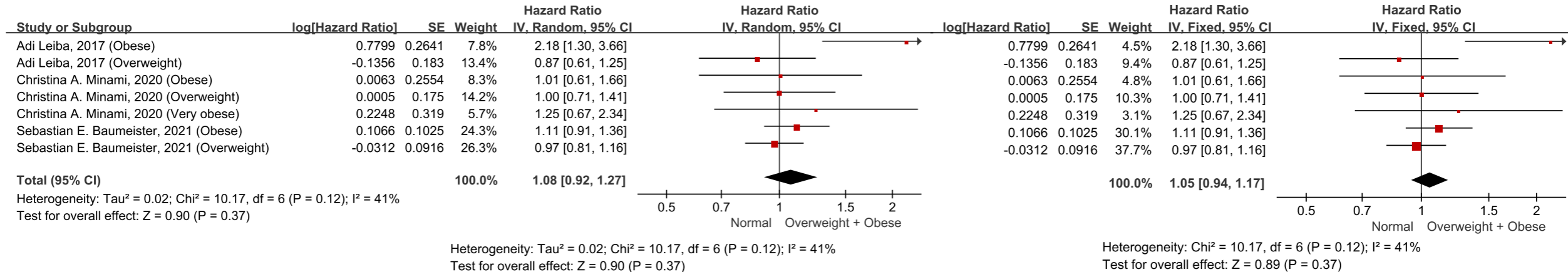


Figure S3. Summary risk estimated by different BMI comparisons in Panel A. digestive system cancer and Panel B. female reproductive system cancer. Abbreviations: RR, relative risk; CI, confidence interval.

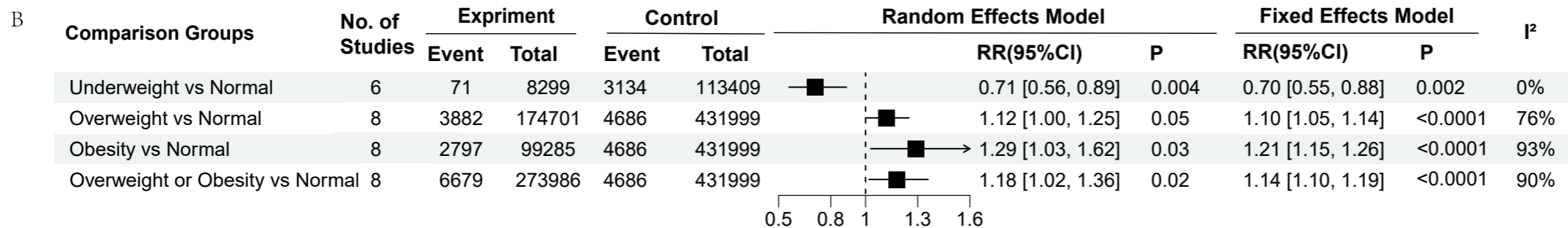
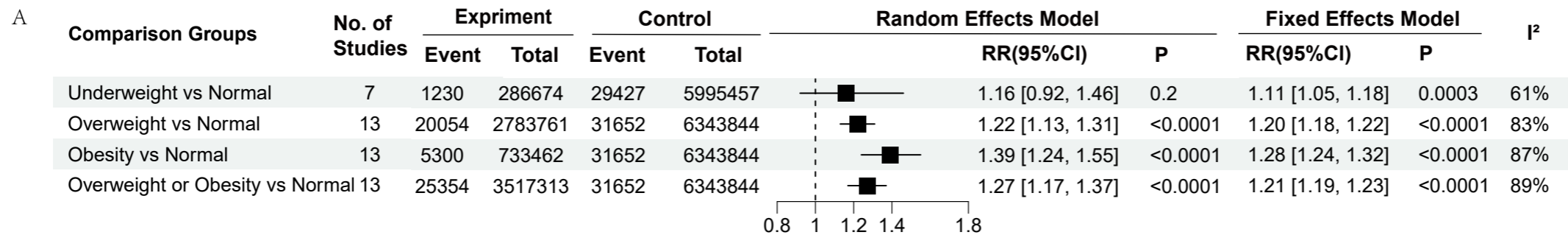


Figure S4. Summary risk of colorectal cancer estimated by different BMI comparisons in men and women.

Abbreviations: RR, relative risk; CI, confidence interval.

| Comparison Groups and Sex | No. of Studies | Expriment | | Control | | I ² | Random Effects Model | | | Subgroup Differences | | Fixed Effects Model | | Subgroup Differences | |
|--|----------------|-----------|--------|---------|--------|----------------|----------------------|-------------------|----------------|----------------------|-----------|---------------------|----------------|----------------------|------|
| | | Event | Total | Event | Total | | RR(95%CI) | P | I ² | P | RR(95%CI) | P | I ² | P | |
| Underweight or Normal vs Overweight or Obesity | | | | | | | | | | | | | | | |
| Men | 5 | 2470 | 141626 | 1127 | 83134 | 68% | | 1.30 [1.06, 1.59] | 0.01 | 0% | 0.63 | 1.21 [1.13, 1.30] | <0.0001 | 0% | 0.37 |
| Women | 5 | 1068 | 78084 | 883 | 84453 | 81% | | 1.41 [1.08, 1.86] | 0.01 | | | 1.28 [1.17, 1.40] | <0.0001 | | |
| Overweight vs Normal | | | | | | | | | | | | | | | |
| Men | 4 | 1615 | 121415 | 872 | 81452 | 46% | | 1.30 [1.11, 1.51] | 0.0008 | 0% | 0.79 | 1.25 [1.15, 1.36] | <0.0001 | 0% | 0.74 |
| Women | 4 | 576 | 49815 | 744 | 82735 | 62% | | 1.34 [1.09, 1.64] | 0.005 | | | 1.28 [1.15, 1.43] | <0.0001 | | |
| Obesity vs Normal | | | | | | | | | | | | | | | |
| Men | 4 | 322 | 19612 | 872 | 81452 | 73% | | 1.68 [1.19, 2.39] | 0.003 | 0% | 0.85 | 1.50 [1.32, 1.70] | <0.0001 | 0% | 0.35 |
| Women | 4 | 328 | 27976 | 744 | 82735 | 89% | | 1.78 [1.10, 2.87] | 0.02 | | | 1.37 [1.21, 1.56] | <0.0001 | | |
| Overweight or Obesity vs Normal | | | | | | | | | | | | | | | |
| Men | 4 | 1937 | 141027 | 872 | 81452 | 62% | | 1.35 [1.13, 1.61] | 0.001 | 0% | 0.72 | 1.29 [1.19, 1.40] | <0.0001 | 0% | 0.69 |
| Women | 4 | 2841 | 218818 | 1616 | 164187 | 83% | | 1.43 [1.09, 1.88] | 0.009 | | | 1.33 [1.20, 1.46] | <0.0001 | | |

0.8 1 1.2 1.4 1.8 2

Figure S5. Funnel Plots. Panel A. Overweight vs. Normal Weight; Panel B. Overweight or Obesity vs. Normal Weight; Panel C. Overweight or Obesity vs. Underweight or Normal Weight; Panel D. Obesity vs. Normal Weight; Panel E. Weight Gain vs. Weight Loss; Panel F. Weight Gain vs. Weight Loss; Panel F. Underweight vs. Normal Weight.

