**Table S1** Participants, Interventions, Comparisons, Outcomes, and Study (PICOS) design criteria.

|  |  |  |
| --- | --- | --- |
| Parameter | Inclusion criteria | Exclusion criteria |
| Participants | Human adults regardless of sex and race/ethnic groups | Children or adolescents |
| Intervention or exposure | -Red meat (processed or unprocessed) consumption  -Fish consumption  -Poultry consumption | -Total meat consumption  -Exposure of interest as a combined exposure |
| Comparison | The highest versus lowest category of exposure |  |
| Outcome | Relative risk estimates (hazard ratios or odds ratios) and 95% confidence intervals for metabolic syndrome | Relative risk estimates and 95% confidence intervals for metabolic syndrome were not reported |
| Study design | Observational studies of any design (e.g., cohort studies, case-control studies, cross-sectional studies) | -Randomized controlled trials  -Conference abstracts reporting the results of observational studies on the topic of interest |

**Table S2** Characteristics of the studies investigating the association between red meat consumption and metabolic syndrome

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference | Mean  age, years | Design; follow-up duration (cohort only), years | Sex | Setting/data source | Total sample  size (cases) | Criteria | Exposure categories | Risk estimate  (95% CI) | Adjustment for  confounders |
| Damiaõ et al. 2006 (3) | 55.4 | Prospective cohort; 7 | M and W | Cohort  of Japanese ancestry, Bauru, Sao Paulo, Brazil | 151 (37) | Modified  NCEP ATP  III | **Total red meat** |  | Age, sex, total energy intake, physical activity, smoking, alcohol, fried foods, and education |
| *All* |  |
| Median 144.2 g/d | 3.18 (0.87, 11.5) |
| Median 73.5 g/d | 1.84 (0.51, 6.67) |
| Median 19.5 g/d | 1.00 (ref.) |
| *Men* |  | Age, sex, total energy intake, physical activity, smoking, alcohol, and education |
| Median 144.2 g/d | 5.38 (1.18, 24.44) |
| Median 73.5 g/d | 3.25 (0.73, 14.48) |
| Median 19.5 g/d | 1.00 (ref.) |
| Azadbakht et al. 2009 (4) | 50.4 | Cross-sectional | W | Survey of Tehrani female teachers, Tehran, Iran | 486 (150) | NCEP ATP  III | **Total red meat** |  | Age, total energy intake, physical activity, current estrogen use, menopausal status, family history of diabetes or stroke, intakes of dietary fiber and cholesterol, percent of energy from fat, fruit, and vegetables, white meats and fish, dairy, partially hydrogenated and nonhydrogenated vegetable oils, and whole- and refined-grains |
| ≥ 63.7 g/d | 1.99 (1.09, 3.89) |
| 50.5–< 63.7 | 1.48 (0.93, 2.98 |
| 35.1–< 50.5 | 1.21 (0.84, 2.66) |
| 27.3–< 35.1 | 1.15 (0.74, 1.75) |
| < 27.3 | 1.00 (ref.) |
| de Oliveira Otto et al. 2012 (5) | 61.8 | Prospective cohort; 4.8 | M and W | The Multi-Ethnic Study of Atherosclerosis, United States | 3828 (Not specified) | JIS | **Total red meat** |  | Age, sex, total energy intake, race/ethnicity,  , field center, education level, active leisure, inactive leisure, smoking, alcohol,  BMI, dietary intakes of fiber, Mg, Zn, heme iron, nonheme iron, b-carotene, vitamin E, and vitamin C, dietary supplement use, and polyunsaturated:saturated fat ratio |
| Highest vs. lowest | 1.29 (1.01, 1.64) |
| Baik et al. 2013 (6) | 51.2 | Prospective cohort; 6 | M and W | The Korean Genome Epidemiology Study, Ansan, South Korea | 5,251 (1,325) | JIS | **Total red meat** |  | Age, sex, total energy intake, physical activity, smoking, alcohol, intakes of refined grains and starches, mixed grain rice and cereal, fish and other seafood, poultry, eggs, legumes, nuts, vegetables and seaweed, fruits, dairy, sweetened carbonated beverage, green tea, and coffee, study sites, income, occupation, education, and FTO genotypes |
| Median 1 serving/d | 1.01 (0.79, 1.29) |
| Median 0.6 servings/d | 0.96 (0.75, 1.24) |
| Median 0.4 servings/d | 1.17 (0.95, 1.45) |
| Median 0.2 servings/d | 1.05 (0.88, 1.26) |
| None | 1.00 (ref.) |
| Cocate et al. 2015 (7) | 50.5 | Cross-sectional | M | Male staff at the  Federal University of Viçosa, Viçosa, Brazil | 296 (73) | JIS | **Total red meat** |  | Age, total energy intake, physical activity, smoking, and alcohol |
| ≥ 81.5 g/d | 1.90 (1.06, 3.44) |
| 56.0–81.5 g/d | 1.15 (1.06, 3.44) |
| < 56.0 g/d | 1.00 (ref.) |
| Becerra-Tomás et al. 2016 (8) | 66.9 | Prospective cohort; 3.2 | M and W | The PREDIMED study, Spain | 1,868 (980) | JIS | **Total red meat** |  | Age, sex, total energy intake, physical activity, smoking, alcohol, intakes of vegetables, fruits, legumes, cereals, fish, dairy, biscuits, olive oil, and nuts, intervention group, BMI, abdominal obesity, hypertriglyceridemia, low HDL-cholesterol, hypertension, and high fasting plasma glucose |
| Median 67.5 g/d | 1.46 (1.22, 1.74) |
| Median 39.3 g/d | 0.98 (0.82, 1.17) |
| Median 19.5 g/d | 1.00 (ref.) |
| **Unprocessed red meat** |  |
| Median 67.5 g/d | 1.27 (1.06, 1.52) |
| Median 39.3 g/d | 0.86 (0.72, 1.02) |
| Median 19.5 g/d | 1.00 (ref.) |
| **Processed red meat** |  |
| Median 35.3 g/d | 1.37 (1.15, 1.62) |
| Median 22.4 g/d | 1.06 (0.89, 1.26) |
| Median 12.3 g/d | 1.00 (ref.) |
| Guo et al. 2017 (9) | ≥18 | Cross-sectional | M and W | Survey of multi-ethnic adults in rural  areas in Xinjiang, China | 15,020 (4,305) | JIS | **Fresh (unprocessed) red meat** |  | Age, alcohol, smoking, intakes of fruits, vegetables, and milk, education, and minority |
| ≥ 2 kg/wk | 1.31 (1.12, 1.54) |
| 1–2 kg/wk | 1.14 (0.98, 1.32) |
| < 1 kg/wk | 1.00 (ref.) |
| Kim et al. 2017 (10) | 48.7 | Cross-sectional | M and W | The Korea National  Health and Nutritional Examination Survey (2008–2011), South Korea | 11,029 (3,143) | JIS | **Total red meat** |  | Age, education, sex, total energy intake, and diet modification |
| *All* |  |
| T3 | 0.89 (0.79, 1.00) |
| T2 | 0.96 (0.86, 1.07) |
| T1 | 1.00 (ref.) |
| *Men* |  |
| T3 | 1.08 (0.91, 1.29) |
| T2 | 1.10 (0.94, 1.30) |
| T1 | 1.00 (ref.) |
| *Women* |  |
| T3 | 0.76 (0.65, 0.90) |
| T2 | 0.91 (0.79, 1.05) |
| T1 | 1.00 (ref.) |
| Kim and Je 2018 (11) | 19─64 (range) | Cross-sectional | M and W | The Korea National  Health and Nutritional Examination Survey (2012–2015), South Korea | 8,387 (1,325) | JIS | **Total red meat** |  | Age, sex, total energy intake, physical activity, alcohol, smoking, BMI, intakes of coffee, green tea, soda, vegetables, legumes, whole grains, fish, poultry, nuts, and dairy, education, and income survey year |
| *All* |  |
| 9.6 servings/wk | 0.84 (0.59, 1.21) |
| 5.4 servings/wk | 0.99 (0.74, 1.32) |
| 3.5 servings/wk | 1.00 (0.76, 1.32) |
| 2.1 servings/wk | 0.97 (0.75, 1.27) |
| 0.8 servings/wk | 1.00 (ref.) |
| *Men* |  |
| 11.9 servings/wk | 0.64 (0.38, 1.08) |
| 6.6 servings/wk | 0.84 (0.56, 1.27) |
| 4.5 servings/wk | 0.89 (0.60, 1.31) |
| 2.8 servings/wk | 0.89 (0.62, 1.29) |
| 1.2 servings/wk | 1.00 (ref.) |
| *Women* |  |
| 8.1 servings/wk | 1.05 (0.65, 1.69) |
| 4.6 servings/wk | 1.19 (0.78, 1.80) |
| 3.0 servings/wk | 1.08 (0.74, 1.55) |
| 1.8 servings/wk | 1.02 (0.74, 1.41) |
| 0.7 servings/wk | 1.00 (ref.) |
| **Processed red meat** |  |
| *All* |  |
| 3.1 servings/wk | 1.18 (0.90, 1.56) |
| 1.4 servings/wk | 0.99 (0.76, 1.28) |
| 0.7 servings/wk | 1.03 (0.82, 1.30) |
| 0.2 servings/wk | 1.14 (0.83, 1.56) |
| None | 1.00 (ref.) |
| *Men* |  |
| 3.6 servings/wk | 1.03 (0.69, 1.52) |
| 1.6 servings/wk | 1.02 (0.72, 1.45) |
| 0.7 servings/wk | 1.23 (0.87, 1.75) |
| 0.3 servings/wk | 1.05 (0.72, 1.52) |
| None | 1.00 (ref.) |
| *Women* |  |
| 3.0 servings/wk | 1.42 (0.94, 2.15) |
| 1.2 servings/wk | 1.08 (0.75, 1.57 |
| 0.6 servings/wk | 0.87 (0.62, 1.23) |
| 0.2 servings/wk | 1.06 (0.67, 1.68) |
| None | 1.00 (ref.) |
| Xu et al. (2018) (12) | 45.5 | Cross-sectional | M and W | Sichuan, China | 7,131 (1,697) | JIS | Total red meat |  | Age, sex, region, ethnic, heart rate, LDL cholesterol, physical activity, alcohol, smoking, and intakes of salt, poultry, and fruit juice |
| >100 g/d vs. ≤100 g/d | 1.28 (1.01, 1.62) |
| Esfandiar et al. (2019) (13) | 40.6 | Prospective cohort; 3.8 | M and W | The Tehran Lipid and Glucose Study, Tehran, Iran | 4,654 (1,106) | NCEP ATP  III | **Total red meat** |  | Age, sex, total energy intake, smoking, intakes of fiber, saturated fat, sodium, vitamin C, and magnesium, BMI, and education |
| > 49.9 | 0.87 (0.56, 1.24) |
| 36.4–49.9 | 0.96 (0.68, 1.28) |
| 30.5–36.3 | 0.86 (0.55, 1.26) |
| < 30.5 | 1.00 (ref.) |
| Luan et al. (2019) (14) | 58.2 | Cross-sectional | M and W | The Costa Rican Heart Study, Costa Rica | 2,058 (875) | JIS | **Total red meat** |  | Age, sex, total energy intake, physical activity, alcohol, smoking, intakes of fruits, vegetables, fish, chicken, and income |
| Median 101 g/d | 1.19 (1.01, 1.39) |
| Median 70.5 g/d | 1.16 (0.99, 1.35) |
| Median 51.9 g/d | 1.11 (0.95, 1.30) |
| Median 37.5 g/d | 1.04 (0.89, 1.23) |
| Median 18.1 g/d | 1.00 (ref.) |
| **Unprocessed red meat** |  |
| Median 80.7 g/d | 1.05 (0.89, 1.23) |
| Median 53.6 g/d | 1.07 (0.92, 1.25) |
| Median 38 g/d | 0.96 (0.81, 1.12) |
| Median 25.4 g/d | 0.94 (0.80, 1.10) |
| Median 10.6 g/d | 1.00 (ref.) |
| **Processed red meat** |  |
| Median 30.6 g/d | 1.04 (0.88, 1.23) |
| Median 17.5 g/d | 1.06 (0.90, 1.25) |
| Median 11.2 g/d | 1.00 (0.85, 1.18) |
| Median 6.5 g/d | 0.92 (0.78, 1.08) |
| Median 0.0 | 1.00 (ref.) |
| Huang et al. (2020) (15) | 18–75 (range) | Prospective cohort; 6 | M and W | The China  Health and Nutrition Survey (1989–2015), China | 2,797 (not reported) | JIS | **Total red meat** |  | Age, sex, total energy intake, physical activity, alcohol, smoking, intakes of fiber, carbohydrate, fat, vegetables, and fruits regions, BMI, urbanicity index, and household income level |
| Q4 | 1.41 (1.05, 1.90) |
| Q3 | 1.14 (0.87, 1.49) |
| Q2 | 1.03 (0.79, 1.34) |
| Q1 | 1.00 (ref.) |
| **Fresh (unprocessed) red meat** |  |
| Q4 | 1.37 (1.02, 1.85) |
| Q3 | 1.24 (0.95, 1.63) |
| Q2 | 1.03 (0.79, 1.34) |
| Q1 | 1.00 (ref.) |
| **Processed red meat** |  |
| Q3 | 1.13 (0.90, 1.42) |
| Q2 | 1.14 (0.90, 1.45) |
| Q1 | 1.00 (ref.) |
| Pandar et al. (2020) (16) | 30–65 (range) | Cross-sectional | M | Kermanshah Province, Iran | 112 (52) | IDF | **Total red meat** |  | Age, physical activity, and BMI |
| > 5 times/wk | 0.65 (0.21, 1.99) |
| 2–5 times/wk | 0.99 (0.28, 3.48) |
| <2 times/wk | 1.00 (ref.) |

BMI, body mass index; CI, confidence interval; IDF, International Diabetes Federation; JIS, Joint Interim Statement; M, men; NCEP ATP III, National Cholesterol Education Program Adult Treatment Panel III; W, women.

**Table S3** Characteristics of the studies investigating the association between fish consumption and metabolic syndrome

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference | Mean  age, years | Design; follow-up duration (cohort only), years | Sex | Setting/data source | Total sample  size (cases) | Criteria | Exposure categories | Risk estimate  (95% CI) | Adjustment for  confounders |
| Mennen et al. 2000 (17) | 47.8 | Cross-sectional | M and W | The Data from an Epidemiological Study on the Insulin Resistance syndrome, France | 4,976 (1,601) | Two or more of the following four characteristics: serum triglycerides, diastolic blood  pressure or fasting glucose in the upper quartile of the distribution or HDL cholesterol in the lowest quartile | **Total fish** |  | Age, total energy intake, and waist-to-hip ratio |
| *Men* |  |
| > 4 servings/wk | 1.27 (0.75, 2.88) |
| 2─4 servings/wk | 1.04 (0.84, 1.54) |
| < 2 servings/wk | 1.00 (ref.) |
| *Women* |  |
| > 4 servings/wk | 0.92 (0.62, 2.19) |
| 2─4 servings/wk | 0.98 (0.81, 1.48) |
| < 2 servings/wk | 1.00 (ref.) |
| Yen et al. 2006 (18) | 46.6 | Cross-sectional | M | The Keelung Community-based Integrated Screening Program, Keelung, Taiwan | 19,839 (3,957) | Modified NCEP ATP III | **Total fish** |  | Age, physical activity, alcohol, smoking, intakes of fish, vegetables, fruits, bean, milk, and coffee, education, occupation, betel-quid chewing habit, family history of diabetes, hypertension, cerebrovascular and CVD in second degree relatives |
| ≥ 3 times/d | 1.00 (0.97, 1.03) |
| Never or seldom | 1.00 (ref.) |
| Ruidavets et al. 2007 (19) | 55.1 | Cross-sectional | M | Three French  MONICA centers (Lille, Strasbourg, and Toulouse), France | 912 (214) | NCEP ATP III | **Total fish** |  | Age, total energy intake, physical activity, alcohol, smoking, education, drugs for hypertension and dyslipidaemia, center, dieting, and diet quality index |
| T3 | 0.57 (0.38, 0.86) |
| T2 | 0.69 (0.45, 1.03) |
| T1 | 1.00 (ref.) |
| Shin et al. 2009 (20) | ≥ 30 | Cross-sectional | M | The Center for Cancer Prevention and  Detection at the National Cancer Center, South Korea | 5,337 (891) | NCEP ATP III | **Total fish** |  | Age, physical activity, smoking, and family history of type 2 diabetes |
| ≥ 4-6 times/wk | 0.92 (0.75, 1.14) |
| Between once a week and 2-3 times/week | 0.94 (0.80, 1.12) |
| < 2-3 times/month | 1.00 (ref.) |
| Baik et al. 2010 (21) | 48.4 | Prospective cohort; 4 | M and W | The Korean Genome Epidemiology Study, Ansan, South Korea | 3,504 (602) | JIS | **Total fish** |  | Age, total energy intake, physical activity, alcohol, smoking, BMI, income, occupation, marital status, education, intakes of fat, fiber, red meat, dairy, and sweetened carbonated beverage, use of multivitamin supplements, and baseline report of a physician diagnosis of diabetes or hypertension |
| *Men* |  |
| Daily | 0.43 (0.23, 0.83) |
| 5-6 times/wk | 0.66 (0.37, 1.19) |
| 1-4 times/wk | 0.82 (0.52, 1.32) |
| 1 time/wk | 1.00 (ref.) |
| *Women* |  |
| Daily | 1.26 (0.64, 2.49) |
| 5-6 times/wk | 0.91 (0.49, 1.70) |
| 1-4 times/wk | 1.13 (0.70, 1.82) |
| 1 time/wk | 1.00 (ref.) |
| Kouki et al. 2011 (22) | 66.3 | Cross-sectional | M and W | The Dose Responses to Exercise Training Study, Kuopio, Finland | 1,334 (351) | NCEP ATP III | **Total fish** |  | Age, alcohol, smoking, education, and VO2max |
| *Men* |  |
| >59.5 g/d | 0.63 (0.40, 1.00) |
| 18.5–59.5 g/d | 0.52 (0.32, 0.83) |
| <18.5 g/d | 1.00 (ref.) |
| *Women* |  |
| >59.5 g/d | 1.00 (0.63, 1.59) |
| 18.5–59.5 g/d | 0.89 (0.56, 1.41) |
| <18.5 g/d | 1.00 (ref.) |
| Lai et al. 2013 (23) | 52.1 | Cross-sectional | M and W | The National Heart, Lung, and Blood Institute  Family Heart Study, USA | 4,941 (1,035) | NCEP ATP III | **Total fish** |  | Age, sex, total energy intake, physical activity, alcohol, smoking, fruits and vegetables intake, fiber intake, race, TV watching, multivitamin use, and risk group |
| ≥ 3 servings/wk | 1.30 (1.00, 1.68) |
| 2 servings/wk | 1.00 (0.80, 1.26) |
| 1 serving/wk | 1.00 (0.84, 1.18) |
| None | 1.00 (ref.) |
| Zaribaf et al. 2014 (24) | 35.2 | Cross-sectional | W | Survey of Isfahani female nurses, Isfahan, Iran | 420 (105) | NCEP ATP III | **Total fish** |  | Age, total energy intake, physical activity, intakes of red meat, whole and refined grains, fruits, vegetables, legume and nuts, dairy, fiber, and oils, BMI, socioeconomic status, medication use, and marital and menopausal status |
| T3 | 0.04 (0.004, 0.61) |
| T2 | 0.11 (0.01, 1.00) |
| T1 | 1.00 (ref.) |
| Kim et al. 2016 (25) | 24.9 | Prospective cohort; 25 | M and W | The CARDIA study, United States | 4,356 (1,069) | NCEP ATP III | **Non-fried fish** |  | Age, sex, total energy intake, physical activity, alcohol, smoking, intakes of protein, saturated fatty acid, and polyunsaturated fatty  acid, family history of diabetes, BMI, fried fish consumption, ethnicity, education, and center |
| ≥5 servings/wk | 0.69 (0.55, 0.88) |
| 2–4 servings/wk | 0.65 (0.51, 0.83) |
| 1 serving/wk | 0.70 (0.53, 0.93) |
| 1–3 servings/month | 0.68 (0.50, 0.93) |
| <1 servings/month | 1.00 (ref.) |
| Tørris et al. 2016 (26) | 41.8 | Cross-sectional | M and W | The Tromsø 6  survey (1994–1995), Tromsø, Norway | 23,907 (1,927) | JIS | **Total fish** |  | Sex, physical activity, education, living with a spouse, and parity and lactation (women) |
| *< 45 years* |  |
| ≥ once/wk vs < once/wk | 0.87 (0.52, 1.45) |
| *45─59 years* |  |
| ≥ once/wk vs < once/wk | 1.11 (0.72, 1.70) |
| *60─70 years* |  |
| ≥ once/wk vs < once/wk | 0.87 (0.51, 1.49) |
| **Fatty fish** |  |
| *< 45 years* |  |
| ≥ once/wk vs < once/wk | 1.38 (0.87, 2.20) |
| *45─59 years* |  |
| ≥ once/wk vs < once/wk | 1.20 (0.91, 1.57) |
| *60─70 years* |  |
| ≥ once/wk vs < once/wk | 1.24 (0.91, 1.67) |
| **Lean fish** |  |
| *< 45 years* |  |
| ≥ once/wk vs < once/wk | 0.90 (0.55, 1.46) |
| *45─59 years* |  |
| ≥ once/wk vs < once/wk | 0.96 (0.66, 1.38) |
| *60─70 years* |  |
| ≥ once/wk vs < once/wk | 0.77 (0.49, 1.20) |
| Tørris et al. 2016 (27) | 55.1 | Cross-sectional | M and W | The Tromsø 6  survey (2007–2008), Tromsø, Norway | 12,981 (2,927) | JIS | **Total fish** |  | Age, physical activity, cod liver oil use, and parity and lactation (women) |
| *All* |  |
| ≥ once/wk vs < once/wk | 0.83 (0.74, 0.93) |
| *Men* |  |
| ≥ once/wk vs < once/wk | 0.85 (0.73, 0.99) |
| *Women* |  |
| ≥ once/wk vs < once/wk | 0.82 (0.68, 0.98) |
| **Fatty fish** |  |
| *All* |  |
| ≥ once/wk vs < once/wk | 0.97 (0.89, 1.07) |
| *Men* |  |
| ≥ once/wk vs < once/wk | 0.99 (0.87, 1.12) |
| *Women* |  |
| ≥ once/wk vs < once/wk | 0.98 (0.85, 1.13) |
| **Lean fish** |  |
| *All* |  |
| ≥ once/wk vs < once/wk | 0.86 (0.77, 0.95) |
| *Men* |  |
| ≥ once/wk vs < once/wk | 0.88 (0.76, 1.01) |
| *Women* |  |
| ≥ once/wk vs < once/wk | 0.85 (0.72, 0.99) |
| Karlsson et al. 2017 (28) | 46─49 (range) | Cross-sectional | M and W | The Hordaland Health Study, Hordaland, Norway | 2,874 (862) | JIS | **Total fish** |  | Sex, total energy intake, physical activity, alcohol, smoking, , intakes of fiber and vegetable, BMI, and education |
| Q4 | 0.72 (0.56, 0.93) |
| Q3 | 0.85 (0.66, 1.09) |
| Q2 | 0.92 (0.72, 1.19) |
| Q1 | 1.00 (ref.) |
| **Fatty fish** |  |
| Q4 | 0.76 (0.59, 0.99) |
| Q3 | 0.86 (0.67, 1.12) |
| Q2 | 0.90 (0.70, 1.17) |
| Q1 | 1.00 (ref.) |
| **Lean fish** |  |
| Q4 | 0.81 (0.63, 1.06) |
| Q3 | 1.08 (0.84, 1.39) |
| Q2 | 0.96 (0.74, 1.24) |
| Q1 | 1.00 (ref.) |
| **Fish products** |  |
| Q4 | 0.91 (0.70, 1.17) |
| Q3 | 0.86 (0.67, 1.12) |
| Q2 | 0.95 (0.74, 1.23) |
| Q1 | 1.00 (ref.) |
| Li et al. 2017 (29) | 52.1 | Cross-sectional | M and W | The China National Nutrition and Health Survey (2010─2012), China | 98,042 (30,591) | JIS | **Total fish** |  | Age, physical activity, alcohol, smoking, BMI, area, education, and income |
| *Men* |  |
| High | 1.06 (0.94, 1.20) |
| Moderate | 0.99 (0.88,1.12) |
| Low | 1.00 (ref.) |
| *Women* |  |
| High | 1.04 (0.94, 1.15) |
| Moderate | 0.94 (0.85, 1.04) |
| Low | 1.00 (ref.) |
| Mirmiran et al. 2019 (30) | 35 | Prospective cohort; 3.6 | M and W | The Tehran Lipid and Glucose Study, Tehran, Iran | 3,382 (444) | JIS | **Total fish** |  | Age, sex, total energy intake, physical activity, smoking, intakes of legumes, dairy products, vegetables, fruits, poultry, and total nuts, BMI, education, and family history of diabetes |
| > 45 g/wk | 0.73(0.56, 0.95) |
| 30─45 g/wk | 0.87(0.62, 1.23) |
| <30 g/wk | 1.00 (ref.) |
| **Non-canned fish** |  |
| > 45 g/wk | 0.86(0.67, 1.10) |
| 30─45 g/wk | 0.88(0.54, 1.42) |
| <30 g/wk | 1.00 (ref.) |
| **Canned fish** |  |
| > 45 g/wk | 0.91(0.64, 1.29) |
| 30─45 g/wk | 0.87(0.61, 1.24) |
| <30 g/wk | 1.00 (ref.) |

BMI, body mass index; CI, confidence interval; JIS, Joint Interim Statement; M, men; NCEP ATP III, National Cholesterol Education Program Adult Treatment Panel III; W, women.

**Table S4** Characteristics of the studies investigating the association between poultry consumption and metabolic syndrome

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference | Mean  age, years | Design; follow-up duration (cohort only), years | Sex | Setting/data source | Total sample  size (cases) | Criteria | Exposure categories | Risk estimate  (95% CI) | Adjustment for  confounders |
| Damiaõ et al. 2006 (3) | 55.4 | Prospective cohort; 7 | M and W | Cohort  of Japanese ancestry, Bauru, Sao Paulo, Brazil | 151 (37) | Modified  NCEP ATP  III | *All* |  | Age, sex, total energy intake, physical activity, smoking, alcohol, fried foods, and education |
| Median 28.7 g/d | 1.36 (0.48, 4.78) |
| Median 13 g/d | 2.57 (0.75, 8.83) |
| Median 4.6 g/d | 1.00 (ref.) |
| *Men* |  | Age, sex, total energy intake, physical activity, smoking, alcohol, and education |
| Median 28.7 g/d | 1.35 (0.37, 4.88) |
| Median 13 g/d | 2.39 (0.71, 8.07) |
| Median 4.6 g/d | 1.00 (ref.) |
| Baik et al. 2013 (6) | 51.2 | Prospective cohort; 6 | M and W | The Korean Genome Epidemiology Study, Ansan, South Korea | 5,251 (1,325) | JIS | 0.4 servings/d | 0.88 (0.71, 1.09) | Age, sex, total energy intake, physical activity, smoking, alcohol, intakes of refined grains and starches, mixed grain rice and cereal, fish and other seafood, red meat and processed meat, eggs, legumes, nuts, vegetables and seaweed, fruits, dairy, sweetened carbonated beverage, green tea, and coffee, study sites, income, occupation, education, and FTO genotypes |
| 0.2 servings/d | 1.08 (0.93, 1.25) |
| None | 1.00 (ref.) |
| Kim and Je 2018 (11) | 19─64 | Cross-sectional | M and W | The Korea National  Health and Nutritional Examination Survey (2012–2015), South Korea | 8,387 (1,325) | JIS | All |  | Age, sex, total energy intake, physical activity, alcohol, smoking, BMI, intakes of coffee, green tea, soda, vegetables, legumes, whole grains, fish, red meat, nuts, and dairy, education, and income survey year |
| 3.8 servings/d | 0.80 (0.58, 1.09) |
| 2.2 servings/d | 0.91 (0.69, 1.21) |
| 1.4 servings/d | 0.83 (0.64, 1.08) |
| 0.7 servings/d | 0.94 (0.73, 1.22) |
| None | 1.00 (ref.) |
| Men |  |
| 4.4 servings/d | 0.91 (0.59, 1.41) |
| 2.4 servings/d | 0.97 (0.67, 1.41) |
| 1.6 servings/d | 0.78 (0.54, 1.12) |
| 0.9 servings/d | 0.96 (0.69, 1.36) |
| None | 1.00 (ref.) |
| Women |  |
| 3.8 servings/d | 0.80 (0.50, 1.29) |
| 2.2 servings/d | 0.87 (0.61, 1.25) |
| 1.4 servings/d | 0.92 (0.64, 1.31) |
| 0.7 servings/d | 0.92 (0.65, 1.30) |
| None | 1.00 (ref.) |
| Li et al. 2018 (29) | 52.1 | Cross-sectional | M and W | The China National Nutrition and Health Survey (2010─2012), China | 98,042 (30,591) | JIS | *Men* |  | Age, physical activity, alcohol, smoking, BMI, area, education, and income |
| High | 1.07 (0.95, 1.21) |
| Moderate | 0.99 (0.87, 1.12) |
| Low | 1.00 (ref.) |
| *Women* |  |
| High | 1.09 (0.98, 1.22) |
| Moderate | 0.95 (0.85, 1.06) |
| Low | 1.00 (ref.) |

BMI, body mass index; CI, confidence interval; JIS, Joint Interim Statement; M, men; NCEP ATP III, National Cholesterol Education Program Adult Treatment Panel III; W, women.

**Table S5** The Newcastle Ottawa scale for cohort study

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Study | **Selection** | | | | **Comparability** | **Outcome** | | | **Total stars** |
| Representativeness of exposed cohort | Selection of the non-  exposed  cohort | Ascertainment of exposure | Demonstration that outcome of interest was not present at start of study | Comparability  of cohorts on the basis of the design or analysis\*\* | Assessment of outcome | Was follow-  up long enough for  outcomes to  occur | Adequacy  of follow  up of  cohorts |
| Damiaõ et al. 2006 (3) | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 8 |
| de Oliveira Otto et al. 2012 (5) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |
| Baik et al. 2013 (6) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |
| Becerra-Tomás et al. 2016 (8) | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 8 |
| Esfandiar et al. (2019) (13) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |
| Huang et al. (2020) (15) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |
| Baik et al. 2010 (21) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |
| Kim et al. 2016 (25) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |
| Mirmiran et al. 2019 (30) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |

\*\*A maximum of two stars can be awarded.

**Table S6** The Newcastle Ottawa scale adapted for cross-sectional study

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Study | **Selection** | | | | **Comparability** | **Outcome** | | **Total stars** |
| Representativeness of the sample | Sample size | Non-respondents | Ascertainment of the exposure\*\* | Comparability of subjects in different outcome groups on the basis of design or analysis\*\* | Assessment of outcome\*\* | Statistical test |
| Azadbakht et al. 2009 (4) | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 7 |
| Cocate et al. 2015 (7) | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 7 |
| Guo et al. 2017 (9) | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 9 |
| Kim et al. 2017 (10) | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 10 |
| Kim and Je 2018 (11) | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 9 |
| Xu et al. (2018) (12) | 1 | 1 | 0 | 2 | 1 | 2 | 1 | 8 |
| Luan et al. (2019) (14) | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 9 |
| Pasdar et al. (2020) (16) | 0 | 0 | 0 | 2 | 1 | 2 | 1 | 6 |
| Mennen et al. 2000 (17) | 1 | 1 | 0 | 1 | 2 | 2 | 1 | 8 |
| Yen et al. 2006 (18) | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 9 |
| Ruidavets et al. 2007 (19) | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 9 |
| Shin et al. 2009 (20) | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 9 |
| Kouki et al. 2011 (22) | 1 | 0 | 0 | 1 | 2 | 1 | 1 | 6 |
| Lai et al. 2013 (23) | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 9 |
| Zaribaf et al. 2014 (24) | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 7 |
| Tørris et al. 2016 (26) | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 7 |
| Tørris et al. 2016 (27) | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 7 |
| Karlsson et al. 2017 (28) | 1 | 1 | 0 | 1 | 2 | 2 | 1 | 8 |
| Li et al. 2017 (29) | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 7 |

\*\*A maximum two stars can be awarded.