Supplementary table 1. Characteristics of included studies regarding association between circulating levels of 25-hydroxy (OH) vitamin D and risk of stroke.

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| Study/Year | Study type | Country | n | Mean age  (years) | Gender  (female%) | Subgroups | Median follow-up time | Endpoint | Cases | Adjustment | Result  (high vs low) |
| Berghout et al (2019) [[1](#_ENREF_1)] | Cohort | Netherlands | 9680 | 65.1 | 56.8 | Serum 25(OH)D:  Lowest tertile  Middle tertile  Highest tertile | 10.6 | Incident stroke | 735 | age, sex, study cohort, ethnicity, BMI, education, physical activity, hypertension, hypercholesterolemia, kidney function, smoking, heart failure, myocardial infarction, season of sampling, serum calcium | RR:  Highest vs Lowest: 0.91 (0.75-1.11)  Highest vs Middle: 1.02 (0.84-1.25) |
| Judd et al (2016) [[2](#_ENREF_2)] | Cohort | USA  50% black, 50% white | 26325 | 64.7 | 55.4 | 25(OH)D:  Q1: >30 ng/ml  Q2: 20–30 ng/ml  Q3: <20 ng/ml | 3.1 | Incident stroke | 167 | age, race, sex, season of blood draw, systolic blood pressure, BMI, diabetes, left ventricular hypertrophy, current smoking, atrial fibrillation, coronary heart disease, estimated glomerular filtration rate, log-transformed albumin to creatinine ratio, anti-hypertensive medications, statins, aspirin use, serum calcium, phosphorus, intact parathyroid hormone, high-density lipoprotein, low-density lipoprotein, total cholesterol and triglyceride concentrations | RR:  Q1 vs Q2: 0.75 (0.51-1.12)  Q1 vs Q3: 0.54 (0.34-0.85);  Black: 0.38 (0.17,0.85); white: 0.61 (0.31, 1.20) |
| 213 |
| 230 |
| Leung et al (2017) [[3](#_ENREF_3)] | Cohort | China, Hong kong | 3458 | 63.2 | 62.3 | Quartile1: <42.64 nmol/l  Quartile2: 42.64-50.96 nmol/l  Quartile3: 50.96-58.59 nmol/l  Quartile4: 58.59-69.05 nmol/l  Quartile5: ≥69.05nmol/l | 10.3 | Incident stroke | 61 | age, sex, BMI, lifestyle factors (smoking, drinking, physical activity, education levels), biomarkers of vitamin D (season, eGFR, serum calcium, serum phosphate, serum alkaline phosphatase, serum parathyroid hormone levels), history of lipid lowering medications, and history of antihypertensive drugs | RR:  Q5 vs Q1: 0.56 (0.36–0.86)  Q5 vs Q2: 0.83 (0.53–1.32)  Q5 vs Q3: 0.77 (0.50–1.19)  Q5 vs Q4: 0.62 (0.41–0.93) |
| 39 |
| 46 |
| 59 |
| 39 |
| Guo et al (2017) [[4](#_ENREF_4)] | Cohort | UK | 452 | 51.7 | 0 | Vitamin D Intake:  Q1: 0.1-9.9µg/week  Q2: 10.0-15.1µg/week  Q3: 15.2-27.2µg/week  Q4: ≥27.3µg/week | 20 | Incident stroke | 14 | age, BMI, social class, alcohol intake, smokers, leisure activity, food energy intake, Ca intake | RR:  Q2 vs Q1: 1.67 (0.79-3.57)  Q3 vs Q1: 1.48 (0.68-3.20)  Q4 vs Q1: 1.41 (0.64-3.13) |
| 21 |
| 19 |
| 18 |
| Schneider et al (2015) [[5](#_ENREF_5)] | Cohort | USA  (23%black, 77% white) | 12158 | 57 | 57 | Quartile1: <17.2 ng/ml  Quartile2: 17.2-21.7 ng/ml  Quartile3: 21.7-26.0 ng/ml  Quartile4: 26.0-31.0 ng/ml  Quartile5: ≥31.0 ng/ml | 20 | Incident stroke | 203 | age, sex, race/center, education, physical activity, smoking status, BMI | RR:  Q5 vs Q1: 0.75 (0.58–0.94)  Q5 vs Q2: 0.93 (0.74–1.18)  Q5 vs Q3: 0.98 (0.76–1.25)  Q5 vs Q4: 0.94 (0.75–1.19)  Blacks: Q5 vs Q1: 0.72 (0.41-1.25); Q5 vs Q2: 0.97 (0.55-1.69); Q5 vs Q3: 1.03 (0.56-1.89); Q5 vs Q4: 0.8 (0.43-1.47);  White: Q5 vs Q1: 0.79 (0.58-1.06); Q5 vs Q2: 0.89 (0.68-1.18); Q5 vs Q3: 0.97 (0.75-1.25); Q5 vs Q4: 0.98 (0.76-1.27) |
| 167 |
| 148 |
| 150 |
| 136 |
| Leu Agelii et al (2017) [[6](#_ENREF_6)] | Cohort | Sweden | 1227 | 47.0 | 100 | Low 25D: ≤51.45 nmol/l  High 25D: >51.45 nmol/l | 32 | Incident stroke | 37 | season of 25D measurement, baseline waist circumference, leisure time physical activity, education, age, smoking, occupational class | RR:  1.19 (0.79-1.79) |
| 127 |
| Kojima et al (2012) [[7](#_ENREF_7)] | Cohort | USA | 7385 | 54.4 | 0 | Vitamin D Intake(µg/day):  Quartile1:0-1.12  Quartile2:1.12-2.23  Quartile3:2.23-4.13  Quartile4:4.13-211.60 | 34 | Incident stroke | 276 | age, total kilocalories, BMI, hypertension, diabetes mellitus, pack-years smoking, PAI, serum cholesterol, alcohol intake | RR:  Q4 vs Q1: 0.82 (0.68-0.99)  Q4 vs Q2: 1.03 (0.85-1.25)  Q4 vs Q3: 0.88 (0.73-1.06) |
| 216 |
| 246 |
| 222 |
| Li et al (2017) [[8](#_ENREF_8)] | Case-control | USA  (Non-Hispanic white 72.5%, Non-Hispanic black 10.7%, Hispanic: 7.6%, Others: 9.2%) | 13642 | ≥20 | 51.9 | Deﬁciency: <12 ng/ml  Inadequacy: 12-20 ng/ml  Adequacy: ≥20 ng/ml | NA | Incident stroke | 496 | age, gender, ethnicity or race, body weight status, educational level, smoking, alcohol consumption, usual daily physical activity level, season at the examination, survey year, diabetes, systolic blood pressure, diastolic blood pressure, total cholesterol | OR:  Q4 vs Q1: 0.82 (0.53, 1.28);  Q3 vs Q1: 0.63 (0.42, 0.94);  Q2 vs Q1: 0.72 (0.49, 1.06) |
| Bolland et al (2010) [[9](#_ENREF_9)] | Cohort | New Zealand | 1471 | 74 | 100 | 25(OH)D concentration: <50 nmol/l  25(OH)D concentration: ≥50 nmol/l | 5 | Incident stroke | 37 | treatment allocation (calcium or placebo) and baseline age, body weight, smoking status, systolic blood pressure, and history of ischemic heart disease, stroke or transient ischemic attack, dyslipidemia, diabetes | RR:  0.71 (0.40-1.25) |
| 22 |
| Kühn et al (2013) [[10](#_ENREF_10)] | Cohort | Germany | 2132 | 50.6 | 57.9 | Sufficiency: ≥50 nmol/l  Mild deficiency:25-49.9 nmol/l  Moderate to severe deficiency: <25 nmol/l | 7.6 | Incident stroke | 171 | BMI, sex, stratified by center, age at baseline, waist circumference, alcohol intake, education level, physical activity, smoking | RR:  0.80 (0.59, 1.09) |
| 240 |
| 60 |
| Schierbeck et al (2012) [[11](#_ENREF_11)] | Cohort | Denmark | 2016 | 50 | 100 | Vitamin D deﬁciency: <50 nmol/l  Vitamin D replete: ≥50 nmol/l | 16 | Incident stroke | 47 | age, smoking, blood pressure, family history of MI, education, hip/waist ratio | RR:  0.60 (0.39-0.91) |
| 42 |
| Marniemi et al (2005) [[12](#_ENREF_12)] | Cohort | Finland | Patients: 70 | 65-69 | 51.4 | Intake：  Lowest tertile; Middle tertile;  Highest terile  Serum：  Lowest tertile; Middle tertile;  Highest terile | 10 | Incident stroke |  | age, gender, smoking, functional capacity | RR:  Intake:  Middle vs lowest: 0.467 (0.26-0.84)  Highest vs lowest: 0.455 (0.23-0.90) |
| Controls: 590 | 52.2 | Serum:  Middle vs lowest: 1.13 (0.62-2.05)  Highest vs lowest: 0.999 (0.51-1.94) |
| Drechsler et al (2010) [[13](#_ENREF_13)] | Cohort | Germany | 1108 | 66 | 46 | Vitamin D concentration: Q1: ≤25 nmol/l  Q2: 25-50 nmol/l  Q3: 50-75 nmol/l  Q4: >75 nmol/l | 4 | Incident stroke | 89 | age, sex, atorvastatin treatment, season, coronary artery disease, congestive heart failure, systolic blood pressure, smoking, duration of dialysis, ultraﬁltration volume, body mass index, levels of LDL, HDL cholesterol, C-reactive protein, HbA1c, use of beta-blockers, ACE inhibitors, and diuretics, levels of parathyroid hormone, calcium, and phosphate | RR:  Q4 vs Q1: 0.33 (0.15-0.73);  Q4 vs Q2: 0.56 (0.17–1.82)  Q4 vs Q3: 0.31 (0.09–1.04) |
| Zittermann et al (2016) [[14](#_ENREF_14)] | Cohort | Germany | 154 | 57.8 | 13.0 | 25OHD <25 nmol/l  25OHD ≥25 nmol/l | 1 | Incident stroke | 25 |  | RR:  0.41 (0.18-0.92) |
| Michos et al (2012) [[15](#_ENREF_15)] | Cohort | USA (white 5001, black 2980) | 7981 | 48.8 | 54.2 | 25(OH)D levels <15 ng/ml  25(OH)D levels ≥15 ng/ml | 14.1 | Incident stroke | 176 | age, sex, race, income, education, BMI, smoking, physical activity, alcohol use, season, CRP, diabetes, hypertension, hypercholesterolemia | RR:  0.57 (0.31-1.06);  whites (HR 0.47, 0.22–0.99); blacks (HR 1.08,  0.56–2.04) |
| Skaaby et al (2013) [[16](#_ENREF_16)] | Cohort | Denmark | 8131 | 48.8 | 50.5 | Serum Vitamin D：  First  Second  Third  Fourth | 10.1 | Incident stroke | 316 | study group, gender, education, season of blood sample, intake of ﬁsh, physical activity, smoking habits, body mass index, alcohol consumption | RR:  Q2 vs Q1: 1.08 (0.79-1.49)  Q3 vs Q1: 1.18 (0.86-1.63)  Q4 vs Q1: 1.13 (0.80-1.59) |
| Afzal et al (2017) [[17](#_ENREF_17)] | Cohort | Denmark | 35517 | 58.4 | 58.4 | 25(OH)D concentration: Deficient: <25 nmol/l  Insufficient: 25-49 nmol/l  Sufficient: ≥50 nmol/l | 9.3 | Incident ischemic stroke | 362 | age, sex, smoking status, cumulative tobacco consumption,  alcohol consumption, leisure time physical activity, BMI, income, diabetes mellitus, ratio of non–high-density lipoprotein to HDL cholesterol, stroke in parents, atrial fibrillation, estimated glomerular filtration rate, antihypertensive medication, month and year of blood sample, study | RR:  Deficient vs Sufficient: 0.81 (0.70-0.94) |
| 672 |
| 626 |
| Perna et al (2013) [[18](#_ENREF_18)] | Cohort | Germany | 7709 | 50-74 | 59.3 | 25(OH)D concentration: Deficiency: <30 nmol/l  Insufficiency: 30-50 nmol/l  Sufficient: ≥50 nmol/l | 6.8 | Incident stroke | 353 | age, sex and season of blood draw, BMI, smoking, physical activity,  total cholesterol, CRP, family history of cardiovascular disease, fish consumption, regular multivitamin supplement intake, hypertension, diabetes mellitus, chronic kidney disease | RR:  Sufficient vs Deficiency: 0.76 (0.55-1.05)  Sufficient vs Insufficiency:  0.93 (0.65-1.06) |
| Welles et al (2014) [[19](#_ENREF_19)] | Cohort | USA (white 49%, black 33%, Hispanic: 9%, Asian: 7%; Other:2%) | 946 | 66.4 | 18.9 | 25(OH)D concentration: <20 ng/ml  ≥20 ng/ml | 8 | Incident stroke | 49 | age, sex, white race/ethnicity, season of blood draw, college graduation, tobacco use, multivitamin use, and physical activity, diabetes, hypertension, depression, BMI, systolic blood pressure, diastolic blood pressure, hemoglobin A 1c , triglycerides, high-density lipoprotein cholesterol, C-reactive protein, phosphorus, parathyroid hormone, fibroblast growth factor 23 | RR: 0.93 (0.46-1.85) |
| Anderson et al (2010) [[20](#_ENREF_20)] | Cohort | USA | 26025 | 55 | 74.8 | 25(OH)D concentration: Low vs Normal (16–30  vs 30 ng/ml) | 1.3 | Incident stroke | 208 | Age, gender, hypertension, hyperlipidemia, diabetes mellitus, peripheral vascular disease | RR: 0.56 (0.38, 0.84) |

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| Sheerah et al (2018) [[21](#_ENREF_21)] | Cohort | Japan | 58646 | Range: 40-79 | 60.6 | Vitamin D intake:  highest (≥440  IU/d) versus lowest (<110 IU/D) categories of vitamin D intake | 19.3 | Incident stroke | 1514 | Age, sex, body mass index, past history of diabetes mellitus and hypertension, hours of physical activity, smoking status, alcohol intake, multivitamin supplementation, calorie-adjusted intakes of carbohydrate, meat, calcium, sodium, potassium, saturated fatty acids | RR: 0.66 (0.49, 0.89) |

Abbreviations: 25(OH)D, 25-hydroxy (OH) vitamin D; BMI, body mass index; CI, confidence interval; OR, odds ratio; RR, relative risk; UK, united kingdom; USA, united states.