# Table S1: Inclusion and exclusion criteria for the systematic review and meta-analysis

|  |  |
| --- | --- |
| **Systematic review** | |
| *Inclusion criteria:* | *Exclusion criteria:* |
| 1. Studies including vascular patients that have undergone a defined or previously validated measure of frailty or sarcopenia and; 2. report on either associations of frailty with patient factors and/or outcomes. | 1. Studies that include vascular patients with asymptomatic or sub-threshold (for treatment) disease. 2. Studies in which frailty is only measured post-intervention. 3. Studies that do not report: comparisons between frail and non-frail patients, or average frailty scores in patients experiencing or not experiencing the primary endpoint. 4. Studies that do not include non-frail patients. 5. Studies in which data for vascular patients is not reported separately. 6. Studies that include patients with vascular trauma in which data for these patients is not reported separately. |
| **Meta-analysis** | |
| *Inclusion criteria:* | *Exclusion criteria:* |
| 1. Studies that report data for patient factors (demographics, comorbidities, diagnosis etc.) separately for frail and non-frail patients and/or; 2. report data for outcomes separately for frail and non-frail patients | 1. Studies that define frailty or sarcopenia based on a proportion of their cohort (e.g. quartile, mean) 2. Studies with overlapping patient data   *Further exclusion criterion added after systematic review completed:*   1. Studies that use a frailty tool in which a patient can be classified as frail based on comorbidity alone |

# Table S2: Summary of sarcopenia measures used in included studies

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measures** | **Defined cut-off** | | **Correction factors for cut-off** | | | | **Total number of studies** |
| **No** | **Yes** | **Body composition** | **Sex** | **Both** | **None** |
| **Cross-sectional imaging (Computed tomography)** | | | | | | | |
| TPA | 5 | 9  (○ - 2; x - 7) | 1 | 3\* | 1 | 4 | 14 |
| Lean TPA | 1 | 0 | - | - | - | - | 1 |
| PMD | 4 | 0 | - | - | - | - | 4 |
| SMA | 1 | 6  (○ - 5; x - 1) | 0 | 3 | 3 | 0 | 7 |
| SMD | 1 | 1  (○ - 1) | 0 | 0 | 1 | 0 | 2 |
| MA | 1 | 0 | - | - | - | - | 1 |
| MD | 1 | 0 | - | - | - | - | 1 |
| **Dual energy x-ray absorptiometry** | | | | | | | |
| ALM | 0 | 1  (● - 1) | - | - | 1\* | - | 1 |
| SMM | 1 | 0 | - | - | - | - | 1 |
| **Clinical assessment** | | | | | | | |
| Grip strength | 1 | 1  (● - 1) | 0 | 0 | 1 | 0 | 2 |

*ALM, Appendicular lean mass; MA, Masseter area; MD, Masseter density; PMD, Psoas muscle density; SMA, Skeletal muscle area; SMD, Skeletal muscle density; SMM, Skeletal muscle mass; TPA, Total psoas area.*

*All values represent number of studies. \*Both values include one study each that only recruited male patients.*

*● = measure and sarcopenia definition validated in previous research in healthy/community-dwelling older adults. ○ = measure and sarcopenia definition validated in previous research in a disease-specific cohort. x = measure and/or sarcopenia definition not validated in previous research or based on a proportion of cohort (e.g. lowest tertile).*

# Table S3: Summary of all studies investigating frailty as measured by a frailty assessment tool(s) included in the systematic review

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study details** | | | | | | | | | **Results** | | | **Quality assessment** | | |
| **1st Author** | **Year** | **Country** | **Design** | **Patients** | **Undergoing procedure?** | **Tool(s)** | **Sample size** | **Frail** | | **Follow up (months)** | **Frailty associations (outcomes)** | **Validated?** | **NOS** |
| **Crawford21** | 2010 | USA | Retrospective cohort | All infra-inguinal bypass (LEAD) | Yes | FD | 5639 | 1039 [18.4%] | | <1 [100%]† | ↑30d mortality  ↑30d morbidity | N/A | 9 |
| **Pol61** | 2011 | Netherlands | Prospective cohort | All elective vascular admissions | Both | GFI | 142 | 50 [35.2%] | | <1 [100%]† | ↑delirium  ↑LoS | ● | 7 |
| **Velanovich69** | 2013 | USA | Retrospective cohort | Major surgery for AAA, LEAD & CAD | Yes | mFI | 117,121 | Not reported | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | x | 8 |
| **Karam51** | 2013 | USA | Retrospective cohort | Major surgery for AAA, LEAD & CAD | Yes | mFI | 67,308 | Not reported | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | ○ | 8 |
| **van Eijsden68** | 2015 | Netherlands | Retrospective cohort | Surgery for CLI;  Aged ≥65 (LEAD) | Yes | KI | 92 | 51 [55.4%] | | <1 [100%]† | ↔ delirium | ● | 7 |
| **Scarborough**  **(CEA)33** | 2015 | USA | Retrospective cohort | Elective CEA (CAD) | Yes | FD | 33,468 | 1,675 [5%] | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | N/A | 9 |
| **Scarborough**  **(LE bypass)33** | 2015 | USA | Retrospective cohort | Elective LEB (LEAD) | Yes | FD | 17,929 | 2,523 [14.1%] | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | N/A | 9 |
| **Scarborough**  **(EVAR)33** | 2015 | USA | Retrospective cohort | Elective EVAR (AAA) | Yes | FD | 11,687 | 455 [3.9%] | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | N/A | 9 |
| **Scarborough**  **(OAR)33** | 2015 | USA | Retrospective cohort | Elective OAR (AAA) | Yes | FD | 5,475 | 211 [3.9%] | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | N/A | 9 |
| **Raats62** | 2015 | Netherlands | Retrospective cohort | Elective AAA repair, CEA (CAD), CLI or DFU (LEAD) | Both | KI | 206 | 61 [29.6%] | | <1 [100%]† | ↔ delirium | ● | 6 |
| **Partridge11** | 2015 | UK | Prospective cohort | All surgery for AAA or LEAD; Aged ≥60 | Yes | EFS | 125 | 49 [32.9%] | | <1 [100%]† | ↔post-op complications  ↑LoS ↔ delirium | ● | 9 |
| **Melin56** | 2015 | USA | Retrospective cohort | All CEA (CAD) | Yes | RAI | 44,832 | 5817 [13.0%] | | 1 [100%]† | ↑30d mortality  ↑post-op stroke | ○ | 7 |
| **Arya38** | 2015 | USA | Retrospective cohort | Elective AAA repair | Yes | mFI | 23,027 | 4178 [23.0%] | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | ○ | 9 |
| **Ambler37** | 2015 | UK | Retrospective cohort | All vascular inpatients admitted ≥2 days;  Aged ≥65 | Both | AVFS | 410 | Not defined | | 18\*\* | ↓survival | x | 9 |
| **Srinivasan65** | 2016 | UK | Retrospective cohort | Ruptured AAA;  Aged ≥65 | Yes | RAFS | 184 | Not defined | | 12 [100%]† | ↓survival | x | 6 |
| **O’Neill31** | 2016 | UK | Retrospective cohort | Proposed elective LEAD or AAA surgery | Both | Initial clinical impression | 392 | 120 [30.6%] | | 48 [38-58]\*\* | ↓survival | N/A | 9 |
| **Brahmbhatt40** | 2016 | USA | Retrospective cohort | All revascularisation (LEAD) | Yes | mFI | 24,624 | 14,738 [59.9%] | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | ○ | 9 |
| **Arya39** | 2016 | USA | Retrospective cohort | Elective procedures for AAA, LEAD & CAD; home-dwellers | Yes | mFI | 15,843 | 5914 [37.3%] | | 1 [100%]† | ↑non-home d/c  ↑30d morbidity | ○ | 9 |
| **Morisaki30** | 2017 | Japan | Retrospective cohort | All infra-popliteal revascularisation (LEAD) | Yes | CLI frail  (plus mFI) | 266 | 92 [34.6%] | | 24 [not reported]† | ↑30d mortality  ↑post-op complications  ↓AFS | x | 8 |
| **Harris26** | 2017 | USA | Retrospective cohort | Elective EVAR  (AAA) | Yes | FD | 13,432 | 389 [2.9%] | | 1 [100%]† | ↑30d mortality  ↑post-op complications  ↑LoS ↑non-home d/c | N/A | 9 |
| **Endicott44** | 2017 | USA | Retrospective cohort | All AAA | Yes | FD | 9030 | 475 [5.3%] | | 1 [100%]† | ↑30d mortality  ↑LoS | N/A | 9 |
| **Dinga Madou22** | 2017 | USA | Retrospective cohort | EVT for CLI;  Aged ≥70 (LEAD) | Yes | FD | 1048 | 251 [24.0%] | | 1 [100%]† | ↑30d mortality | N/A | 9 |
| **Takeji17** | 2018 | Japan | Prospective cohort | All revascularisation for CLI (LEAD) | Yes | CFS | 643 | 409 [63.6%] | | 24 [95.8%]† | ↓survival  ↓AFS | ● | 9 |
| **Schaller63** | 2018 | USA | Retrospective cohort | LEAD (Rutherford 1-3); Aged ≥50 | No | mFI | 129 | 19 [14.7%] | | 34 [25-43]\*\* | ↑MACE | ○ | 8 |
| **Mirabelli57** | 2018 | USA | Cross-sectional | All vascular patients (clinic visit) | No | Fried  (plus CFS & FiND) | 159 | 32 [20.1%] | | N/A | N/A | ● | 6 |
| **Kodama52** | 2018 | Japan | Retrospective cohort | Infra-inguinal bypass for CLI (LEAD) | Yes | BI | 107 | 36 [33.6%] | | 23\*\* | ↓survival | x | 8 |
| **Drudi43** | 2018 | Canada | Prospective cohort | All CLI (LEAD) | Yes | EFS, GFI, mFI,  MPI, mEFT, RAI | 149 | 55-104 [37-70%] | | 16\*\* | ↑mortality & worsening disability (composite) | ● | 7 |
| **Donald23** | 2018 | USA | Retrospective cohort | Elective procedures for AAA, TAA, LEAD & CAD | Yes | CFS | 134 | 39 [29.1%] | | 1 [100%]† | ↓likelihood of surgery  ↑MACE ↑LoS  ↑non-home d/c | ● | 9 |
| **Chopra41** | 2018 | USA | Retrospective cohort | MLEA (LEAD) | Yes | FD  (plus mFI) | 206 | 116 [56%] | | 5.9 [8.8]\* | ↔ambulation (FD)  ↓ambulation (mFI) | N/A | 6 |
| **Ali36** | 2018 | USA | Retrospective cohort | All infra-inguinal bypass (LEAD) | Yes | mFI | 4,704 | 2842 [60.4%] | | 1 [100%]† | ↑30d mortality  ↑30d morbidity | ○ | 9 |
| **Ghaffarian24** | 2019 | USA | Retrospective cohort | All vascular patients undergoing CT | Both | CFS | 415 | 104 [25.1%] | | 18 [13-26]\*\* | ↓survival | ● | 8 |
| **Eslami45** | 2019 | USA | Retrospective cohort | Elective LEB (LEAD) | Yes | mFI | 12,677 | Not reported | | 1 [100%]† | ↔30d mortality  ↑30d morbidity | ○ | 9 |

*30d, Thirty-day; AAA, Abdominal Aortic Aneurysm; AFS, Amputation Free Survival; AMT, Abbreviated Mental Test; AVFS, Addenbrooke’s Vascular Frailty Score; BI, Barthel Index, CAD, Carotid Artery Disease; CEA, Carotid Endarterectomy, CFS, Clinical Frailty Scale; CLI, Critical limb ischaemia; d/c, Discharge; DFU, Diabetic Foot Ulcer; EFS, Edmonton Frail Scale; EVAR, Endovascular Aneurysm Repair; FD, Functional Dependence; FiND, Frail Non-Disabled; Fr, Frail; GFI, Groningen Frailty Indicator; KI, Katz index; LE, Lower Extremity, LEAD, Lower Extremity Arterial Disease; LoS, Length of Stay; MACE, Major Adverse Cardiovascular Events; mEFT, Modified Essential Frailty Toolset; mFI, Modified Frailty Index; MLEA, Major Lower Extremity Amputation; MPI, Multidimensional Prognostic Index; MUST, Malnutrition Universal Screening Tool; RAFS, Ruptured Aneurysm Frailty Score; NOS, Newcastle-Ottawa Scale; OAR, Open Aneurysm Repair; RAI, [Frailty] Risk Analysis Index; TAA, Thoracic Abdominal Aneurysm.*

*\*Values are means [standard deviation] (where reported). \*\*Values are medians [interquartile range] (where reported). †Values are minimum follow-up period [%included patients completing follow-up].*

*Outcomes: ↑statistically significant associated increase. ↓statistically significant associated decrease. ↔ no statistically significant association.*

*Quality assessment: ● = tool and frailty definition validated in previous research in healthy/community-dwelling older adults. ○ = tool and frailty definition validated in previous research in a disease-specific cohort. x = tool and/or frailty definition not validated in previous research; N/A = not applicable (not a multi-domain tool).*

# Table S4: Summary of all studies investigating frailty as measured clinically or radiologically (computed tomography or dual energy x-ray absorptiometry) determined sarcopenia included in the systematic review

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study details** | | | | | | | | **Results** | | | | **Quality**  **assessment** | |
| **1st Author** | **Year** | **Country** | **Design** | **Patients** | **Undergoing procedure?** | **Measure** | **Cut-off** | **Sample size** | **Frail** | **Follow-up (months)** | **Frailty associations (outcomes)** | **Validated?** | **NOS** |
| Clinically determined sarcopenia studies | | | | | | | | | | | | | |
| **Griffith46** | 1989 | UK | Prospective cohort | Major surgery for LEAD & AAA | Yes | Non-dominant hand grip strength (kg) | Not defined | 61 | N/A | <1 [100%]† | ↔post-op mortality  ↔post-op complications | x | 6 |
| **Reeve32** | 2018 | USA | Cross-sectional | AAA, LEAD or CAD (clinic visit) | No | Dominant hand grip strength (kg) | Sex & BMI adjusted | 311 | 86 [27.7%] | N/A | N/A | ● | 8 |
| Computed tomography determined sarcopenia studies | | | | | | | | | | | | | |
| **Lee53** | 2011 | USA | Retrospective cohort | Elective OAR (AAA) | Yes | TPA (L4) | Lowest tertile (not further defined) | 262 | N/A | 28\* | ↓survival | x | 9 |
| **Matsubara29** | 2015 | Japan | Retrospective cohort | All revascularisation for CLI (LEAD) | Yes | SMA (L3) | ♂: <114.0cm2;  ♀: <89.9cm2 | 64 | 28 [43.8%] | 42 [25]\* | ↓survival | ○ | 8 |
| **Hale25** | 2016 | USA | Retrospective cohort | Elective EVAR (AAA) | Yes | SMA (L3) | ♂: <114.0cm2;  ♀: <89.9cm2 | 200 | 25 [12.5%] | 100 [64-140]\*\* | ↓survival | ○ | 8 |
| **Drudi42** | 2016 | Canada | Retrospective cohort | OAR or EVAR for intact AAA;  Aged ≥50 | Yes | TPA (L4) | Lowest sex-adjusted tertile (♂: <21.7cm2;  ♀: <13.5cm2) | 149 | N/A | 22.4\* | ↓survival | x | 8 |
| **Sugai66** | 2017 | Japan | Retrospective cohort | All EVT for LEAD | Yes | TPA/height2 & PMD (L3) | Not defined | 290 | N/A | 35\*\* | ↔MACCE (TPA/height2)  ↑MACCE (PMD) | x | 7 |
| **Shah64** | 2017 | UK | Retrospective cohort | Elective AAA repair | Yes | Multiple  (L3 & L4) | Not defined | 137 | N/A | 46 [38-53]\*\* | ↔survival  ↔LoS (Hospital)  ↔LoS (ICU) | x | 9 |
| **Nyers59** | 2017 | USA | Retrospective cohort | Elective revascularisation (LEAD) | Yes | TPA/VBA & PMD (L4) | Not defined | 188 | N/A | 12 [3-24]\*\* | ↔AFS | x | 7 |
| **Matsubara55** | 2017 | Japan | Retrospective cohort | All revascularisation for CLI (LEAD) | Yes | SMA (L3) | ♂: <114.0cm2;  ♀: <89.9cm2 | 114 | 53 [46.5%] | >24 [not reported]† | ↓cardiac-event free survival | ○ | 7 |
| **Thurston34** | 2018 | Australia | Retrospective cohort | Elective EVAR (AAA); Age ≥50 | Yes | TPA/height2 (L3) | <500mm2/m2 | 191 | 30 [15.7%] | 60 [75.4%]† | ↓survival  ↑LoS | ○ | 9 |
| **Tanaka (OSR)67** | 2018 | USA | Retrospective cohort | All OSR of TAA | Yes | TPA/BSA (L3) | Estimate of central tendency  (<6.5cm2/m2) | 211 | 120 [56.9%] | >24 [not reported]† | ↑non-home d/c  ↔30d mortality ↑30d morbidity  ↑LoS ↓survival | x | 8 |
| **Tanaka (TEVAR)67** | 2018 | USA | Retrospective cohort | All TEVAR (TAA) | Yes | TPA/BSA(L3) | Estimate of central tendency  (<6.5cm2/m2) | 71 | 34 [47.9%] | >24 [not reported]† | ↑non-home d/c  ↔30d mortality ↔30d morbidity ↔LoS ↔survival | x | 8 |
| **Oksala60** | 2018 | Finland | Retrospective cohort | All CEA (CAD) | Yes | MA & MD | Not defined | 242 | N/A | 68\*\* | ↓survival (MA)  ↔survival (MD) | x | 8 |
| **Newton58** | 2018 | USA | Retrospective cohort | Elective EVAR (AAA) | Yes | TPA (L4) | Lowest tertile (<2406mm2) | 135 | N/A | 27 [18-40]\*\* | ↔post-op complications ↓survival ↔LoS | x | 8 |
| **Kays28** | 2018 | USA | Retrospective cohort | All OAR or EVAR (AAA) | Yes | SMA/height2 & SMD (L3) | ♂: <52.4cm2/m2  ♀:<38.5cm2/m2 | 505 | 294 | >24 [not reported]† | ↔30d mortality ↔30d morbidity  ↓survival | ○ | 7 |
| **Lindström54** | 2018 | Finland | Retrospective cohort | All OAR or EVAR (AAA) | Yes | Multiple  (L2-5) | Not defined | 301 | N/A | 32 [11-54]\*\* | ↓survival (Lean TPA L2 & L3)  ↔survival (others) | x | 7 |
| **Juszczak50** | 2018 | UK | Retrospective cohort | All surgical revascularisation (LEAD) | Yes | TPA (L4) | Lowest sex-adjusted quartile  (♂: <1793mm2;  ♀: <1287mm2) | 263 | N/A | 21\*\* | ↔post-op complications ↔LoS ↓survival | x | 8 |
| **Indrakusuma (AAA repair)49** | 2018 | Netherlands | Retrospective cohort | All asymptomatic AAA repair | Yes | TPA (L3) | Lowest tertile (≤14.56cm2) | 124 | N/A | ≥44 [99%]† | ↔survival | x | 8 |
| **Indrakusuma (No AAA repair)49** | 2018 | Netherlands | Retrospective cohort | Asymptomatic AAA not repaired | No | TPA (L3) | Lowest tertile (≤14.56cm2) | 104 | N/A | ≥44 [99%]† | ↔survival | x | 8 |
| **Huber48** | 2018 | USA | Retrospective cohort | All EVAR (AAA) | Yes | TPA (L4) | Lowest quartile (<1422mm2) | 407 | N/A | 38.7 [33.5]\* | ↓survival | x | 7 |
| **Heard27** | 2018 | UK | Retrospective cohort | All vascular admissions | Both | SMA/height2 & SMD (L3) | <53cm2/m2  or <38.5cm2/m2§ | 314 | 129 [41.1%] | ≥36 [not reported] | ↔survival  ↔non-home d/c | ○ | 7 |
| **Chowdhury10** | 2018 | UK | Retrospective cohort | All vascular inpatients admitted ≥2 days; Aged ≥65 | Both | TPA & PMD (L4) | Not defined | 166 | N/A | 18\*\* | ↔survival | x | 9 |
| **Waduud35** | 2019 | UK | Retrospective cohort | Elective OAR or EVAR (AAA) | Yes | TPA/height2 (L3) | ♂: <5.5cm2/m2  ♀:<4cm2/m2 | 380 | 110 | 48 [32.4]\* | ↔survival | ○ | 9 |
| **Ghaffarian24** | 2019 | USA | Retrospective cohort | All vascular patients undergoing CT | Both | SMA/height2 (L3) | ♂: <52.4cm2/m2;  ♀: <38.5cm2/m2 | 415 | 168 [40.5%] | 18 [13-26]\*\* | ↓survival (CFS +/- sarcopenia)  ↔survival (sarcopenia only) | ○ | 8 |
| Dual-energy x-ray absorptiometry determined sarcopenia studies | | | | | | | | | | | | | |
| **Hassen47** | 2007 | Australia | Prospective cohort | Major surgery for LEAD & AAA | Yes | SMM | Not defined | 68 | N/A | 1 [100%]† | ↑SIRS  ↑LoS | x | 6 |
| **Addison20** | 2018 | USA | Cross-sectional | LEAD patients (clinic visit);  Aged ≥50 | No | ALM/height2 | <7.26kg/m2 | 80 | 28 [35%] | N/A | N/A | ● | 8 |

*30d, Thirty-day; AAA, Abdominal Aortic Aneurysm; AFS, Amputation Free Survival; ALM, Appendicular Lean Mass; BMI, Body-Mass Index; BSA, Body Surface Area; CAD, Carotid Artery Disease; CEA, Carotid Endarterectomy, CLI, Critical limb ischaemia; d/c, Discharge; EVAR, Endovascular Aneurysm Repair; LEAD, Lower Extremity Arterial Disease; L3, level of the 3rd lumbar vertebra; L4, level of the 4th lumbar vertebra; LoS, Length of Stay; MACCE, Major Adverse Cardiovascular and Cerebrovascular Events; NOS, Newcastle-Ottawa Scale; OAR, Open aneurysm repair; OSR, Open Surgical Repair; PMD, Psoas Muscle Density; SIRS, Systemic Inflammatory Response Syndrome; SMA, Skeletal Muscle Area; SMD, Skeletal muscle density; SMM, Skeletal Muscle Mass; TAA, Thoracic Abdominal Aneurysm; TEVAR, Thoracic Endovascular Aneurysm Repair; TPA, Total Psoas Area; VBA, Vertebral Body Area;* ♂, Male; ♀, Female.

*\*Values are means [standard deviation] (where reported). \*\*Values are medians [interquartile range] (where reported). †Values are minimum follow-up period [%included patients completing follow-up]. §Cut-off for sarcopenia in Heard et al.: <53cm2/m2 (overweight males); <41cm2/m2 (non-overweight males and women).*

*Outcomes: ↑statistically significant associated increase. ↓statistically significant associated decrease. ↔ no statistically significant association.*

*Quality assessment: ● = measure and sarcopenia definition validated in previous research in healthy/community-dwelling older adults. ○ = measure and sarcopenia definition validated in previous research in a disease-specific cohort. x = measure and/or sarcopenia definition not validated in previous research or based on a proportion of cohort (e.g. lowest tertile).*

# **Table S5:** Cross-over of studies including data from the American College of Surgeons National Surgical Quality Improvement Programme (ACS-NSQIP) database

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study details** | | **Year** | | | | | | | | | |
| **1st Author (Year)** | **Frailty assessment tool** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** |
| **Crawford (2010)21** | FD | LEB | | |  |  |  |  |  |  |  |
| **Karam (2013)51** | mFI | CEA | | | |  |  |  |  |  |  |
|  |  | EVAR | | | |  |  |  |  |  |  |
|  |  | OSR of AAA | | | |  |  |  |  |  |  |
|  |  | LEB | | | |  |  |  |  |  |  |
|  |  | MLEA | | | |  |  |  |  |  |  |
| **Velanovich (2013)69** | mFI | CEA | | | | |  |  |  |  |  |
|  |  | EVAR | | | | |  |  |  |  |  |
|  |  | OSR of AAA | | | | |  |  |  |  |  |
|  |  | LEB | | | | |  |  |  |  |  |
|  |  | MLEA | | | | |  |  |  |  |  |
| **Scarborough (2015)33** | FD | CEA | | | | | |  |  |  |  |
|  |  | EVAR | | | | | |  |  |  |  |
|  |  | OSR of AAA | | | | | |  |  |  |  |
|  |  | LEB | | | | | |  |  |  |  |
| **Ali (2018)36** | mFI |  |  |  |  |  | LEB |  |  |  |  |
| **Melin (2015)56** | RAI | CEA | | | | | | |  |  |  |
| **Arya (2015)38** | mFI | EVAR | | | | | | | |  |  |
|  |  | OSR of AAA | | | | | | | |  |  |
| **Brahmbhatt (2016)40** | mFI | LEB | | | | | | | |  |  |
|  |  |  |  |  |  |  |  | EVT for LEAD | |  |  |
| **Eslami (2019)45** | mFI | LEB | | | | | | | |  |  |
| **Arya (2016)39** | mFI |  |  |  |  |  |  | CEA | |  |  |
|  |  |  |  |  |  |  |  | EVAR | |  |  |
|  |  |  |  |  |  |  |  | OSR of AAA | |  |  |
|  |  |  |  |  |  |  |  | LEB | |  |  |
|  |  |  |  |  |  |  |  | EVT for LEAD | |  |  |
| **Dinga Madou (2017)22** | FD |  |  |  |  |  |  | EVT for LEAD | | |  |
| **Harris (2017)26** | FD |  |  |  |  |  | EVAR | | | | |

*FD, Functional Dependence; mFI, Modified Frailty Index; RAI, [Frailty] Risk Analysis Index.*

*Procedure type:*  *CEA* *= Carotid Endarterectomy; EVAR\_ = Endovascular Aneurysm Repair;*  *OSR of AAA*  *= Open Surgical Repair of Abdominal Aortic Aneurysm; LEB = Lower Extremity Bypass; EVT for LEAD = Endovascular Treatment for Lower Extremity Arterial Disease; MLEA = Major Lower Extremity Amputation.*

# Table S6: Quality assessment of included studies using the Newcastle-Ottawa score for cohort and cross-sectional studies

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cohort studies** | | | | | | | | | | |
| **Study** | **Selection** | | | | **Comparability** | | **Outcome** | | | **Score** |
| **Representativeness** | **Selection of non-exposed** | **Ascertainment of exposure** | **Outcome of interest** | **Controls for age** | **Controls for other factor(s)** | **Assessment** | **Duration of follow-up** | **Adequacy of follow-up** |
| **Griffith (1989)46** |  | + | + | + |  | + | + | + |  | 6 |
| **Hassen (2007)47** |  | + | + | + |  | + | + | + |  | 6 |
| **Crawford (2010)21** | + | + | + | + | + | + | + | + | + | 9 |
| **Pol (2011)61** | + | + | + |  | + | + | + | + |  | 7 |
| **Lee (2011)53** | + | + | + | + | + | + | + | + | + | 9 |
| **Velanovich (2013)69** | + | + | + | + |  | + | + | + | + | 8 |
| **Karam (2013)51** | + | + | + | + | + | + | + | + |  | 8 |
| **van Eijsden (2015)68** |  | + | + |  | + | + | + | + | + | 7 |
| **Scarborough (2015)33** | + | + | + | + | + | + | + | + | + | 9 |
| **Raats (2015)62** |  | + | + |  | + | + | + |  | + | 6 |
| **Partridge (2015)11** | + | + | + | + | + | + | + | + | + | 9 |
| **Melin (2015)56** | + | + | + | + |  |  | + | + | + | 7 |
| **Matsubara (2015)29** |  | + | + | + | + | + | + | + | + | 8 |
| **Arya (2015)38** | + | + | + | + | + | + | + | + | + | 9 |
| **Ambler (2015)37** | + | + | + | + | + | + | + | + | + | 9 |
| **Srinivasan (2016)65** |  | + | + | + |  | + | + | + |  | 6 |
| **O’Neill (2016)31** | + | + | + | + | + | + | + | + | + | 9 |
| **Hale (2016)25** |  | + | + | + | + | + | + | + | + | 8 |
| **Drudi (2016)42** | + | + | + | + | + | + | + | + |  | 8 |
| **Brahmbhatt (2016)40** | + | + | + | + | + | + | + | + | + | 9 |
| **Arya (2016)39** | + | + | + | + | + | + | + | + | + | 9 |
| **Sugai (2017)66** |  | + | + | + | + | + | + | + |  | 7 |
| **Shah (2017)64** | + | + | + | + | + | + | + | + | + | 9 |
| **Nyers (2017)59** |  | + | + | + | + | + | + | + |  | 7 |
| **Morisaki (2017)30** | + | + | + | + | + | + | + | + |  | 8 |
| **Matsubara (2017)55** |  | + | + | + |  | + | + | + | + | 7 |
| **Harris (2017)26** | + | + | + | + | + | + | + | + | + | 9 |
| **Endicott (2017)44** | + | + | + | + | + | + | + | + | + | 9 |
| **Dinga Madou (2017)22** | + | + | + | + | + | + | + | + | + | 9 |
| **Thurston (2018)34** | + | + | + | + | + | + | + | + | + | 9 |
| **Tanaka (2018)67** | + | + | + | + | + | + | + | + |  | 9 |
| **Takeji (2018)17** | + | + | + | + | + | + | + | + | + | 9 |
| **Schaller (2018)63** |  | + | + | + | + | + | + | + | + | 8 |
| **Oksala (2018)60** |  | + | + | + | + | + | + | + | + | 8 |
| **Newton (2018)58** | + | + | + | + | + | + | + | + |  | 8 |
| **Lindström (2018)54** |  | + | + | + | + | + | + | + |  | 7 |
| **Kodama (2018)52** | + | + | + | + | + | + | + | + |  | 8 |
| **Kays (2018)28** |  | + | + | + | + | + | + | + |  | 7 |
| **Juszczak (2018)50** | + | + | + | + | + | + | + | + |  | 8 |
| **Indrakusuma (2018)49** | + | + | + | + |  | + | + | + | + | 8 |
| **Huber (2018)48** |  | + | + | + | + | + | + | + |  | 7 |
| **Heard (2018)27** |  | + | + | + | + | + | + | + |  | 7 |
| **Drudi (2018)43** |  | + | + | + | + | + | + | + |  | 7 |
| **Donald (2018)23** | + | + | + | + | + | + | + | + | + | 9 |
| **Chowdhury (2018)10** | + | + | + | + | + | + | + | + | + | 9 |
| **Chopra (2018)41** | + | + | + |  | + | + | + |  |  | 6 |
| **Ali (2018)36** | + | + | + | + | + | + | + | + | + | 9 |
| **Waduud (2019)35** | + | + | + | + | + | + | + | + | + | 9 |
| **Ghaffarian (2019)24** |  | + | + | + | + | + | + | + | + | 8 |
| **Eslami (2019)45** | + | + | + | + | + | + | + | + | + | 9 |
| **Cross-sectional studies** | | | | | | | | | | |
| **Study** | **Selection** | | | | **Comparability** | | **Outcome** | | | **Score** |
|  | **Representativeness** | **Sample size** | **Non-respondents** | **Ascertainment of exposure** | **Controls for age** | **Controls for other factor(s)** | **Assessment of outcome** | | **Statistical test** |  |
| **Reeve (2017)32** |  | + |  | ++ | + | + | ++ | | + | 8 |
| **Addison (2017)20** |  | + |  | ++ | + | + | ++ | | + | 8 |
| **Mirabelli (2018)57** | + |  |  | ++ |  |  | ++ | | + | 6 |

*Maximum score for cohort studies = 9; maximum score for cross-sectional studies = 10.*

# Table S7: Risk of bias assessment using the Risk of Bias In Non-randomized Studies – of Exposures (ROBINS-E) tool

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **Sources of bias** | | | | | | | **Overall risk of bias** |
| **Confounding** | **Selection** | **Classification of frailty** | **Change in frailty status\*** | **Missing data** | **Measurement of outcomes** | **Reporting** |
| Crawford (2010)21 | ● | ● | ● | ● | ● | ● | ● | ● |
| Scarborough (2015)33 | ● | ● | ● | ● | ● | ● | ● | ● |
| Partridge (2015)11 | ● | ● | ● | ● | ● | ● | ● | ● |
| Matsubara (2015)29 | ● | ● | ● | ● | ● | ● | ● | ● |
| O’Neill (2016)31 | ● | ● | ● | ● | ● | ● | ● | ● |
| Hale (2016)25 | ● | ● | ● | ● | ● | ● | ● | ● |
| Thurston (2017)34 | ● | ● | ● | ● | ● | ● | ● | ● |
| Reeve (2017)32 | ● | ● | ● | ● | ● | ● | ● | ● |
| Morisaki (2017)30 | ● | ● | ● | ● | ● | ● | ● | ● |
| Harris (2017)26 | ● | ● | ● | ● | ● | ● | ● | ● |
| Dinga Madou (2017)22 | ● | ● | ● | ● | ● | ● | ● | ● |
| Takeji 201817 | ● | ● | ● | ● | ● | ● | ● | ● |
| Kays (2018)28 | ● | ● | ● | ● | ● | ● | ● | ● |
| Heard (2018)27 | ● | ● | ● | ● | ● | ● | ● | ● |
| Donald (2018)23 | ● | ● | ● | ● | ● | ● | ● | ● |
| Addison (2018)20 | ● | ● | ● | ● | ● | ● | ● | ● |
| Waduud (2019)35 | ● | ● | ● | ● | ● | ● | ● | ● |
| Ghaffarian (2019)24 | ● | ● | ● | ● | ● | ● | ● | ● |

*\*Equivalent to bias due to departures from intended exposures in the ROBINS-E tool*

●*= Low risk of bias (comparable to a well-performed randomised trial);* ●*= Moderate risk of bias (sound for a non-randomised study);* ●*= Serious risk of bias (important problem in this domain).*

# Table S8: Quality of evidence assessment using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) criteria

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Outcome** | **Number of studies** | **Study design** | **Risk of bias** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **Certainty** |
| **Associations of patient factors with frailty** | | | | | | | | |
| **Age** | 12 | Observational | ● | ● | ● | ● | Strong association | Moderate |
| **BMI** | 3 | Observational | ● | ● | ● | ● | - | Very low |
| **Sex** | 13 | Observational | ● | ● | ● | ● | - | Very low |
| **Current smoking** | 9 | Observational | ● | ● | ● | ● | - | Very low |
| **Hypertension** | 9 | Observational | ● | ● | ● | ● | - | Very low |
| **Ischaemic heart disease** | 8 | Observational | ● | ● | ● | ● | - | Very low |
| **Respiratory disease** | 6 | Observational | ● | ● | ● | ● | - | Very low |
| **Diabetes** | 11 | Observational | ● | ● | ● | ● | - | Very low |
| **Renal impairment** | 4 | Observational | ● | ● | ● | ● | - | Very low |
| **Dialysis** | 7 | Observational | ● | ● | ● | ● | - | Very low |
| **Cerebrovascular disease** | 8 | Observational | ● | ● | ● | ● | - | Very low |
| **Associations of frailty with outcomes (unadjusted)** | | | | | | | | |
| **Pneumonia** | 4 | Observational | ● | ● | ● | ● | Very strong association | Low |
| **MI/ACS** | 3 | Observational | ● | ● | ● | ● | - | Very low |
| **Stroke/TIA** | 3 | Observational | ● | ● | ● | ● | - | Very low |
| **Surgical site infection** | 3 | Observational | ● | ● | ● | ● | Strong association | Very low |
| **Post-op complications\*** | 8 | Observational | ● | ● | ● | ● | Strong association | Very low |
| **Non-home discharge** | 3 | Observational | ● | ● | ● | ● | Strong association | Very low |
| **30-day mortality** | 6 | Observational | ● | ● | ● | ● | Strong association | Very low |
| **Associations of frailty with outcomes (adjusted for confounders)** | | | | | | | | |
| **Post-op complications\*** | 3 | Observational | ● | ● | ● | ● | Strong association | Very low |
| **30-day mortality** | 3 | Observational | ● | ● | ● | ● | Strong association | Low |
| **Long-term mortality** | 9 | Observational | ● | ● | ● | ● | - | Very low |

*ACS, Acute coronary syndrome; BMI, Body-mass index; MI, Myocardial infarction; TIA, Transient ischaemic attack.*

*\*Composite post-operative complications*

# Table S9: Summary of sensitivity analysis (meta-analysis) results: associations of patient factors with frailty

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Patient factor** | **Studies** | **Patients** | **Effect estimate†** | **I2** | **GRADE score** |
| **Continuous variables (MD; inverse variance method; random effects model)** | | | | | |
| Age (years) | 6 | 20787 | **4.34 (3.75, 4.93)** | 18% | Moderate |
| BMI | 3 | 19486 | **-1.81 (-2.94, -0.68)** | 81% | Very low |
| **Categorical variables (Mantel-Haeszel method; random effecs model)** | | | | | |
| Sex (female)\* | 8 | 21960 | **RR 1.30 (1.12, 1.51)** | 75% | Very low |
| Current smoking | 4 | 20762 | **RR 0.72 (0.58, 0.89)** | 75% | Very low |
| Hypertension | 6 | 16014 | RR 1.28 (0.90, 1.82) | 87% | Very low |
| Ischaemic heart disease | 4 | 1426 | RR 1.10 (0.80, 1.51) | 78% | Very low |
| Respiratory disease | 5 | 20659 | **RR 1.52 (1.21, 1.93)** | 77% | Very low |
| Diabetes | 8 | 21960 | RR 1.24 (0.95, 1.62) | 92% | Very low |
| Renal impairment | 3 | 1183 | RR 1.14 (1.00, 1.30) | 0% | Very low |
| Dialysis | 5 | 8011 | RR 1.34 (0.86, 2.10) | 96% | Very low |
| Cerebrovascular disease | 6 | 7480 | **RR 1.39 (1.03, 1.89)** | 91% | Very low |

*BMI, Body-mass index; GRADE, Grading of recommendations assessment, development and evaluations; RR, Risk ratio.*

*\*Effect estimate >1 = increased risk of frailty in females vs males*

*†Values are difference in means frail vs non-frail (continuous variables) or risk ratios (categorical variables with 95% confidence intervals in parentheses. Values* ***underlined in bold*** *highlight factors with significant associations with frailty.*

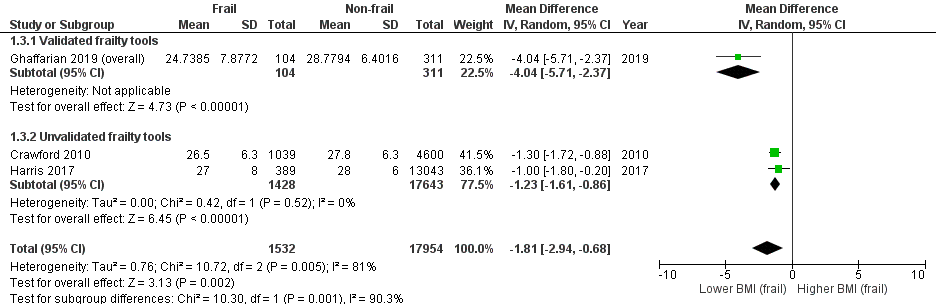
# Table S10: Summary of sensitivity analysis (meta-analysis) results: associations of frailty with outcomes

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Outcome measure** | **Studies** | **Patients** | | **Effect estimate†** | | **I2** | **GRADE score** |
| **Unadjusted variables (Mantel-Haeszel method; random effecs model)** | | | | | | | |
| Pneumonia | 3 | 14605 | **OR 5.80 (3.71, 9.06)** | | 0% | | Low |
| MI/ACS | 3 | 14605 | OR 1.48 (0.55, 3.94) | | 51% | | Very low |
| Stroke/TIA | 2 | 14480 | OR 1.86 (0.37, 9.41) | | 51% | | Very low |
| SSI | 2 | 13557 | **OR 2.88 (1.36, 6.10)** | | 0% | | Very low |
| Composite post-op complications | 6 | 58273 | **OR 2.89 (2.08, 4.02)** | | 90% | | Very low |
| Non-home discharge | 2 | 13407 | **OR 6.18 (4.79, 7.97)** | | 0% | | Low |
| 30-day mortality | 6 | 59105 | **OR 4.81 (4.02, 5.75)** | | 0% | | Very low |
| **Adjusted variables (generic inverse variance method; random effects model)** | | | | | | | |
| Composite post-op complications | 3 | 19196 | **OR 2.16 (1.55, 3.02)** | | 58% | | Very low |
| 30-day mortality | 3 | 20028 | **OR 2.77 (2.01, 3.81)** | | 13% | | Low |
| Long-term mortality | 4 | 1450 | **HR 2.46 (1.64, 3.68)** | | 52% | | Low |

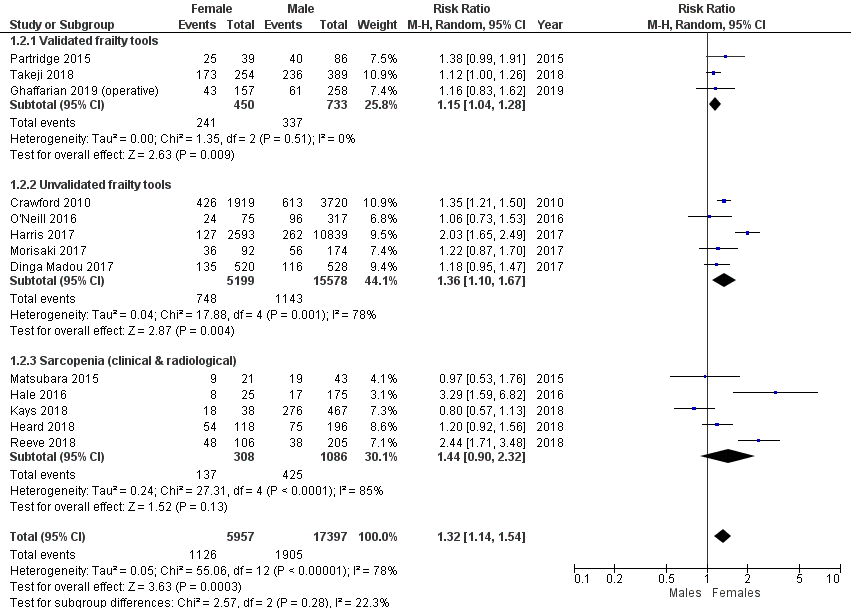
*ACS, Acute coronary syndrome; GRADE, Grading of recommendations assessment, development and evaluation; HR, Hazards ratio; MI, Myocardial infarction; OR, Odds ratio; SSI, Surgical site infection; TIA, Transient ischaemic attack.*

*†Values are odds or hazard ratio for outcome event in frail vs non-frail patients with 95% confidence intervals in parentheses. Values* ***underlined in bold*** *highlight events with significant associations with frailty.*

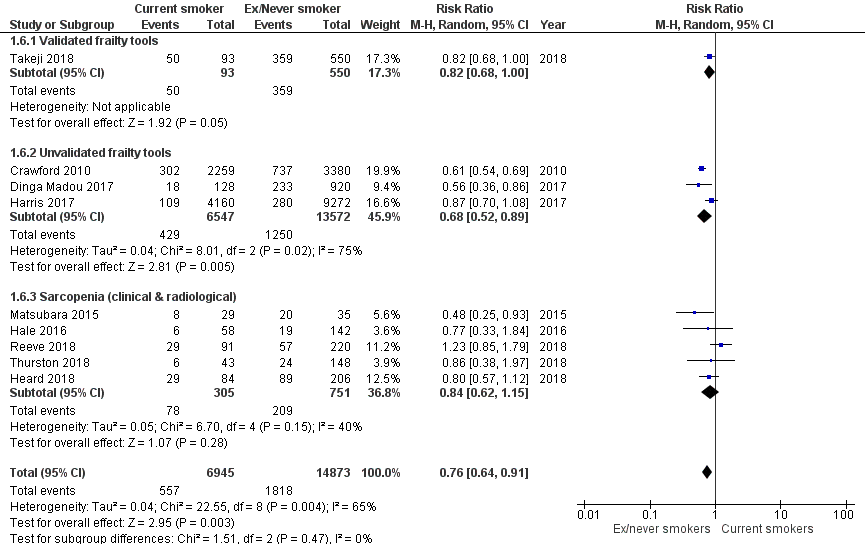
# **Figure S1:** Association of body-mass index (BMI) with frailty (forest plot of comparisons): right shift denotes increased BMI amongst frail patients.



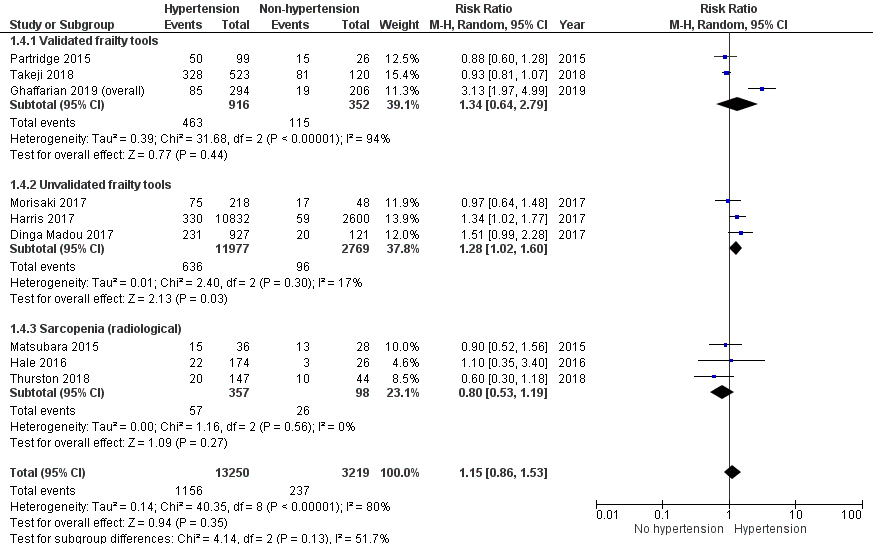
# **Figure S2:** Association of sex with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among female patients.



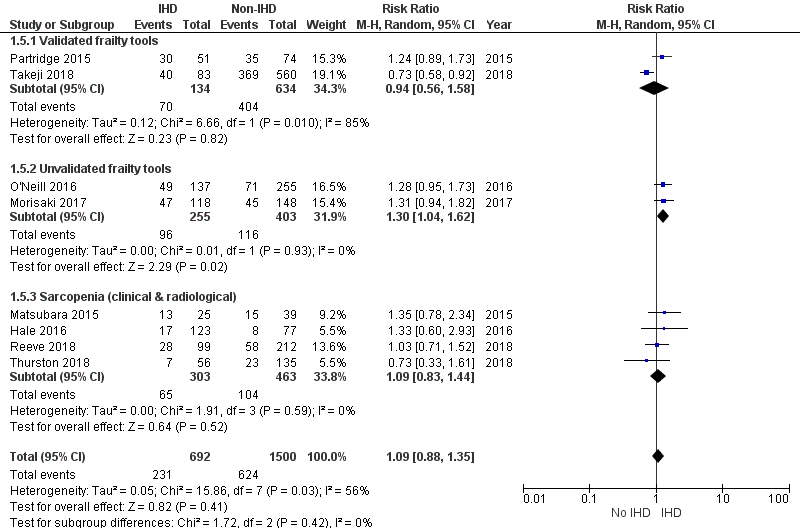
# **Figure S3:** Association of current smoking with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients who currently smoke.



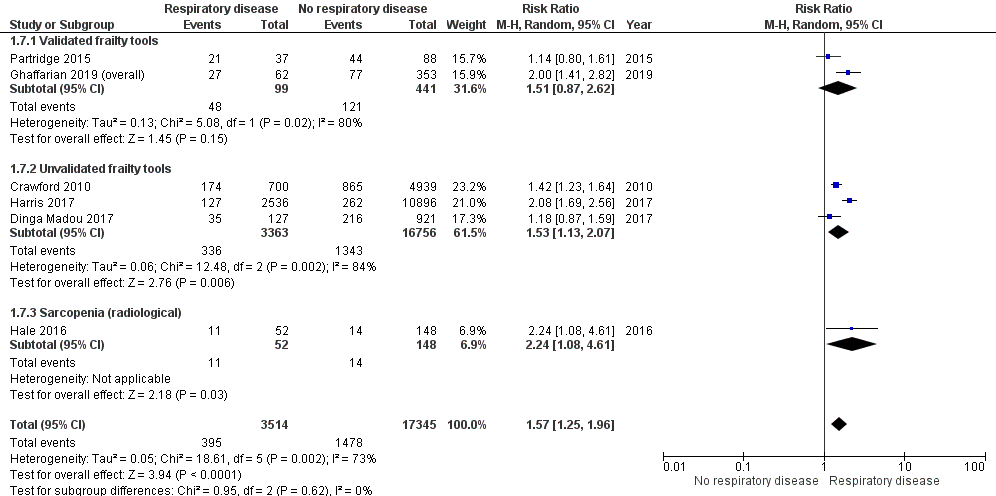
# **Figure S4:** Association of hypertension with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients with hypertension.



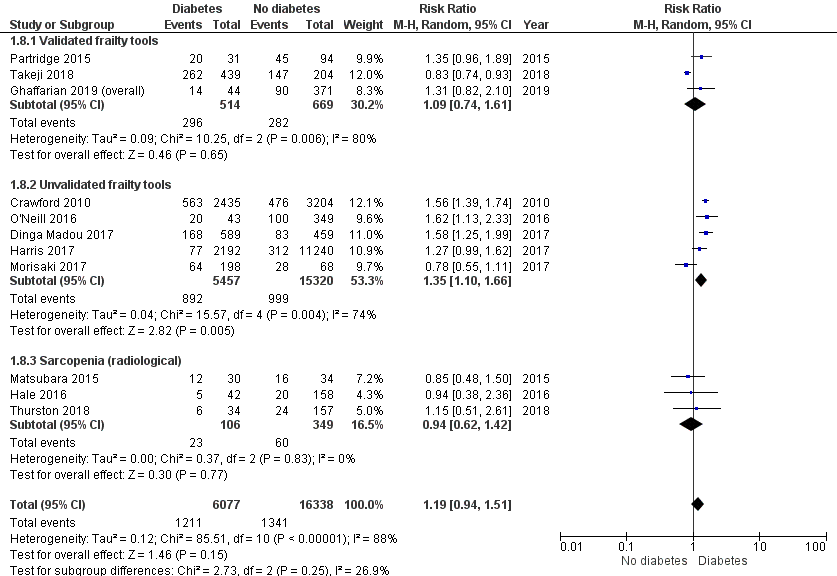
# **Figure S5:** Association of ischaemic heart disease (IHD) with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients with IHD.



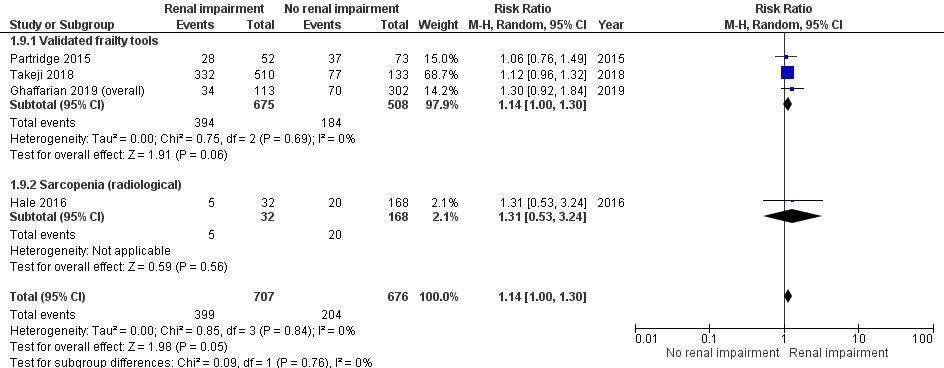
# Figure S6: Association of respiratory disease with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients with respiratory disease.



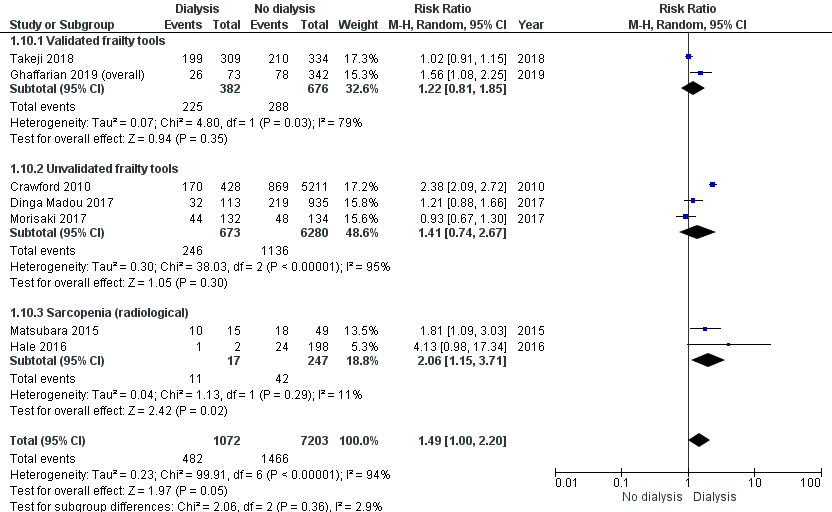
# Figure S7: Association of diabetes with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients with diabetes.



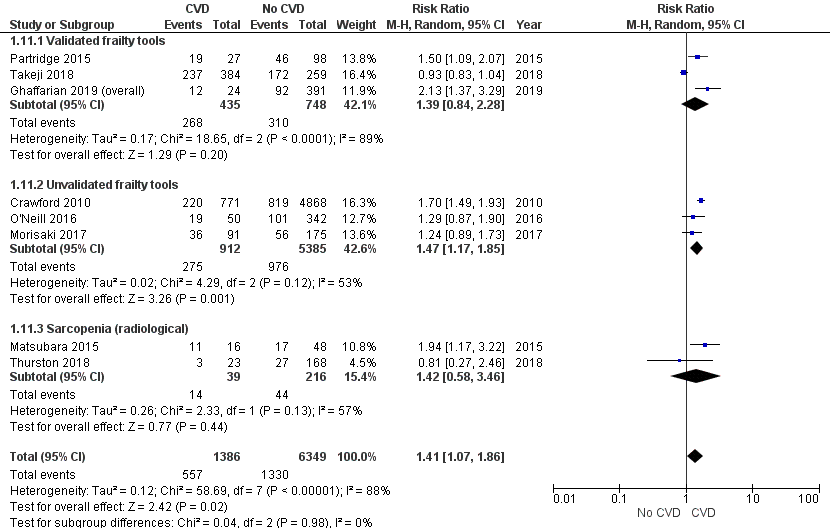
# Figure S8: Association of renal impairment with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients with renal impairment.



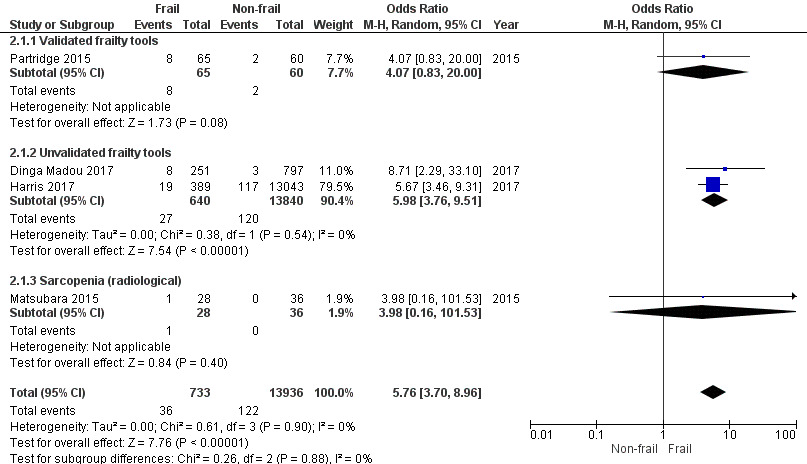
# Figure S9: Association of dialysis dependence with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients with dialysis dependence.



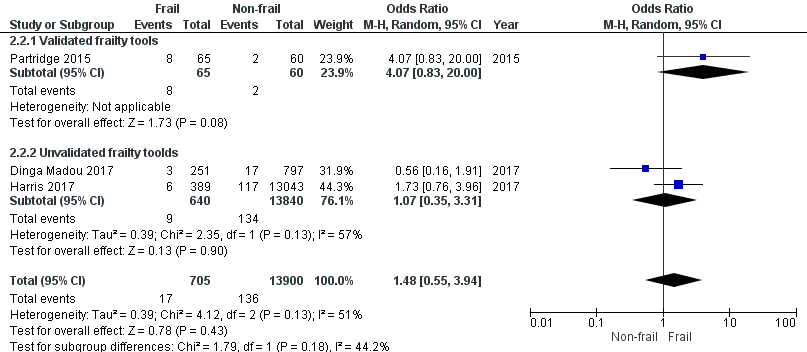
# Figure S10: Association of cerebrovascular disease (CVD) with frailty (forest plot of comparisons): right shift denotes increased risk of frailty among patients with CVD.



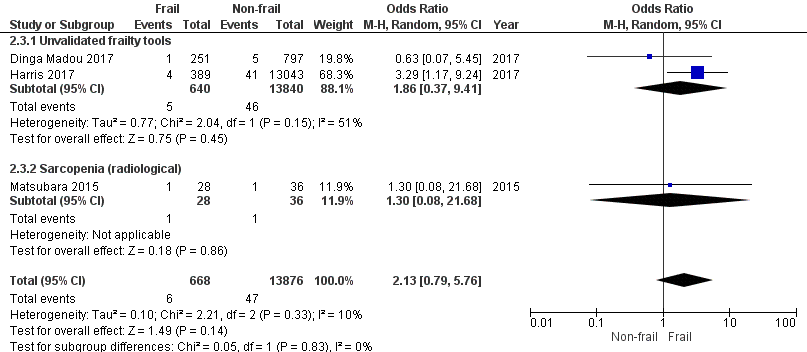
# Figure S11: Association of frailty with post-operative pneumonia (unadjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of post-operative pneumonia among frail patients.



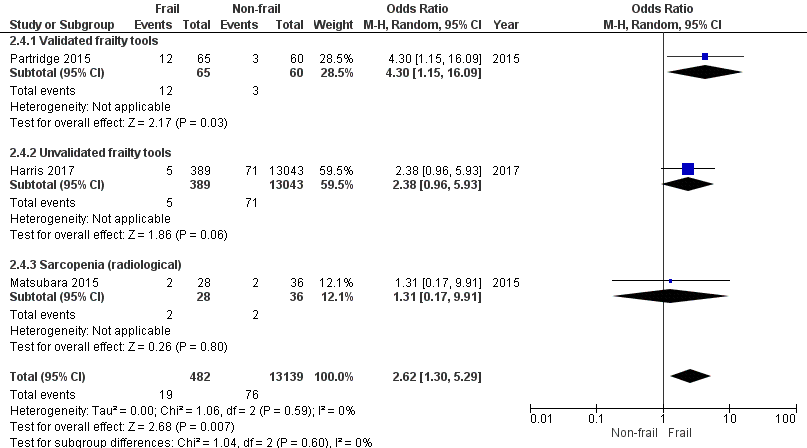
# Figure S12: Association of frailty with post-operative myocardial infarction/acute coronary syndrome (MI/ACS) (unadjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of post-operative MI/ACS among frail patients.



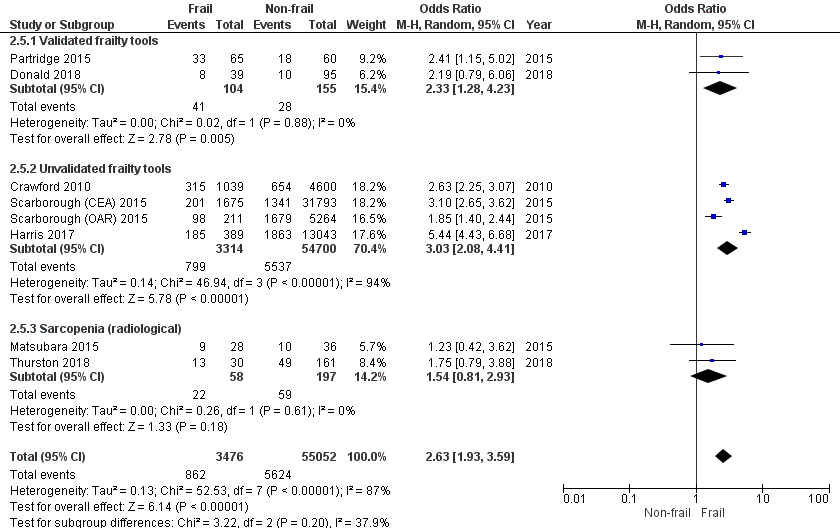
# Figure S13: Association of frailty with post-operative stroke/transient ischaemic attack (TIA) (unadjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of post-operative stroke/TIA among frail patients.



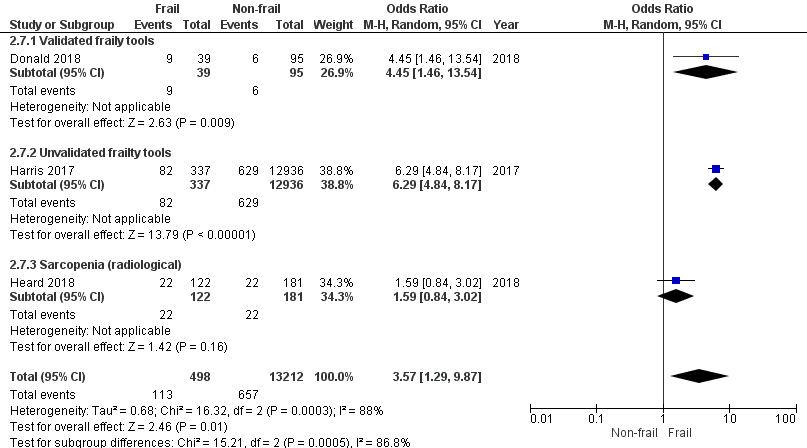
# Figure S14: Association of frailty with post-operative surgical site infection (SSI) (unadjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of post-operative SSI among frail patients.



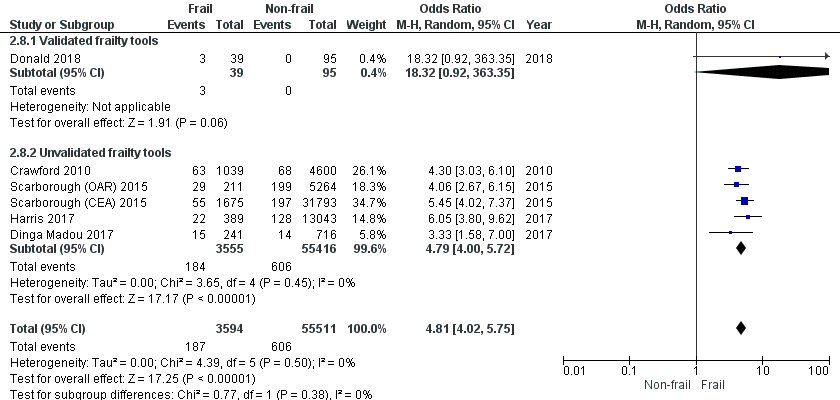
# Figure S15: Association of frailty with composite post-operative complications (unadjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of post-operative complications among frail patients.



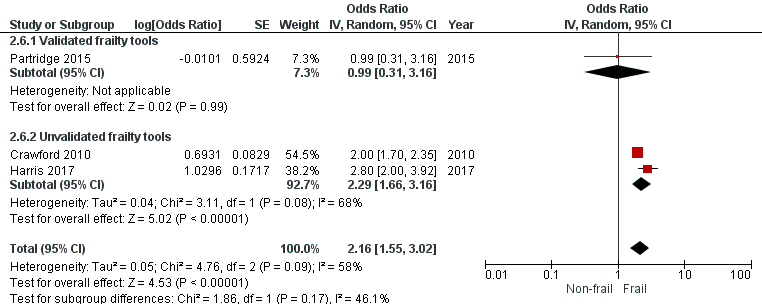
# Figure S16: Association of frailty with non-home discharge (unadjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of non-home discharge among frail patients.



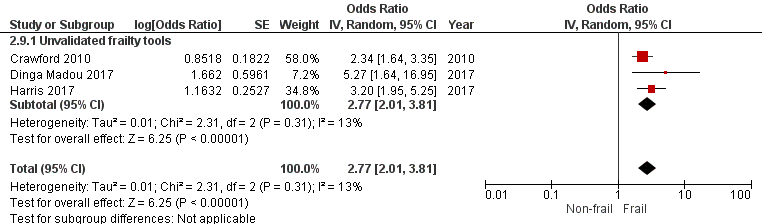
# Figure S17: Association of frailty with 30-day mortality (unadjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of 30-day mortality among frail patients.



# Figure S18: Association of frailty with composite post-operative complications (adjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of post-operative complications among frail patients.



# Figure S19: Association of frailty with 30-day mortality (adjusted for confounders) (forest plot of comparisons): right shift denotes increased odds of 30-day mortality among frail patients.



# Appendix 1: Search Strategies for Frailty & Vascular Surgery

Medline search strategy (performed in the Healthcare Databases Advanced Search: <https://hdas.nice.org.uk/>)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Medline | ((vascular OR aort\* OR aneurysm OR carotid) ADJ3 (repair OR procedur\* OR surg\* OR operat\*)).af | 113003 |
| 2 | Medline | exp "VASCULAR SURGICAL PROCEDURES"/ | 231158 |
| 3 | Medline | PERIPHERAL VASCULAR DISEASES/ | 12311 |
| 4 | Medline | exp AORTIC ANEURYSM, ABDOMINAL/ | 17356 |
| 5 | Medline | exp AORTIC ANEURYSM, THORACIC/ | 10898 |
| 6 | Medline | exp ENDARTERECTOMY, CAROTID/ | 8132 |
| 7 | Medline | AMPUTATION/ | 19403 |
| 8 | Medline | (AORTA, ABDOMINAL/ OR AORTA, THORACIC/) AND (surgery).af | 23541 |
| 9 | Medline | exp CAROTID STENOSIS/ | 14561 |
| 10 | Medline | exp INTERMITTENT CLAUDICATION/ | 7629 |
| 11 | Medline | ((abdominal OR thoracic OR thoracoabdominal OR endovascular) ADJ3 aneurysm\*).af | 39049 |
| 12 | Medline | (femoropopliteal ADJ3 (bypass\* OR graft\*)).af | 1299 |
| 13 | Medline | ("carotid endarterectom\*").af | 9991 |
| 14 | Medline | ("peripheral revascularisation\*").af | 19 |
| 15 | Medline | ("infrainguinal bypass\*").af | 700 |
| 16 | Medline | (amputation).af | 42532 |
| 17 | Medline | ANGIOSCOPY/ OR ANGIOPLASTY/ OR "ENDOVASCULAR PROCEDURES"/ | 21346 |
| 18 | Medline | (endovascular).af | 55290 |
| 19 | Medline | exp "ARTERIAL OCCLUSIVE DISEASES"/ | 219659 |
| 21 | Medline | "ANEURYSM, DISSECTING"/ | 15914 |
| 22 | Medline | "ILIAC ANEURYSM"/ | 1275 |
| 23 | Medline | "CAROTID ARTERY DISEASES"/ | 20986 |
| 24 | Medline | FRAILTY/ | 601 |
| 25 | Medline | "FRAIL ELDERLY"/ | 9665 |
| 26 | Medline | (frail\*).af | 22877 |
| 27 | Medline | (sarcopenia).af | 7531 |
| 28 | Medline | SARCOPENIA/ | 2715 |
| 29 | Medline | (rockwood ADJ7 scale\*).af | 29 |
| 30 | Medline | ("PRISMA 7").af | 14 |
| 32 | Medline | "GERIATRIC ASSESSMENT"/ | 24235 |
| 33 | Medline | ("geriatric assessment").af | 25511 |
| 34 | Medline | ("grip strength\*").af | 9558 |
| 35 | Medline | (dyna?ometer).af | 6369 |
| 36 | Medline | (1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 21 OR 22 OR 23) | 556894 |
| 37 | Medline | (24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 32 OR 33 OR 34 OR 35) | 64587 |
| 38 | Medline | (36 AND 37) | 1116 |

# Appendix 2: Search Strategies for Frailty Assessments & Vascular Surgery

Medline search strategy (performed in the Healthcare Databases Advanced Search: <https://hdas.nice.org.uk/>)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Medline | ((vascular OR aort\* OR aneurysm OR carotid) ADJ3 (repair OR procedur\* OR surg\* OR operat\*)).af | 113003 |
| 2 | Medline | exp "VASCULAR SURGICAL PROCEDURES"/ | 231158 |
| 3 | Medline | PERIPHERAL VASCULAR DISEASES/ | 12311 |
| 4 | Medline | exp AORTIC ANEURYSM, ABDOMINAL/ | 17356 |
| 5 | Medline | exp AORTIC ANEURYSM, THORACIC/ | 10898 |
| 6 | Medline | exp ENDARTERECTOMY, CAROTID/ | 8132 |
| 7 | Medline | AMPUTATION/ | 19403 |
| 8 | Medline | (AORTA, ABDOMINAL/ OR AORTA, THORACIC/) AND (surgery).af | 23541 |
| 9 | Medline | exp CAROTID STENOSIS/ | 14561 |
| 10 | Medline | exp INTERMITTENT CLAUDICATION/ | 7629 |
| 11 | Medline | ((abdominal OR thoracic OR thoracoabdominal OR endovascular) ADJ3 aneurysm\*).af | 39049 |
| 12 | Medline | (femoropopliteal ADJ3 (bypass\* OR graft\*)).af | 1299 |
| 13 | Medline | ("carotid endarterectom\*").af | 9991 |
| 14 | Medline | ("peripheral revascularisation\*").af | 19 |
| 15 | Medline | ("infrainguinal bypass\*").af | 700 |
| 16 | Medline | (amputation).af | 42532 |
| 17 | Medline | ANGIOSCOPY/ OR ANGIOPLASTY/ OR "ENDOVASCULAR PROCEDURES"/ | 21346 |
| 18 | Medline | (endovascular).af | 55290 |
| 19 | Medline | exp "ARTERIAL OCCLUSIVE DISEASES"/ | 219659 |
| 20 | Medline | exp "ARTERIAL OCCLUSIVE DISEASES"/ | 219659 |
| 21 | Medline | "ANEURYSM, DISSECTING"/ | 15914 |
| 22 | Medline | "ILIAC ANEURYSM"/ | 1275 |
| 23 | Medline | "CAROTID ARTERY DISEASES"/ | 20986 |
| 24 | Medline | FRAILTY/ | 601 |
| 25 | Medline | "FRAIL ELDERLY"/ | 9665 |
| 26 | Medline | (frail\*).af | 22877 |
| 27 | Medline | (sarcopenia).af | 7531 |
| 28 | Medline | SARCOPENIA/ | 2715 |
| 29 | Medline | (rockwood ADJ7 scale\*).af | 29 |
| 30 | Medline | ("PRISMA 7").af | 14 |
| 31 | Medline | (frail\* ADJ5 (tool\* OR assess\* OR score\* OR index\* OR identif\* OR scale\* OR questionnaire\* OR survey\* OR indicator\* OR system\* OR test\* OR screen\* OR evaluat\*)).af | 4292 |
| 32 | Medline | "GERIATRIC ASSESSMENT"/ | 24235 |
| 33 | Medline | ("geriatric assessment").af | 25511 |
| 34 | Medline | ("grip strength\*").af | 9558 |
| 35 | Medline | (dyna?ometer).af | 6369 |
| 36 | Medline | "SURVEYS AND QUESTIONNAIRES"/ | 405178 |
| 37 | Medline | (questionnaire\*).af | 640863 |
| 38 | Medline | (reliability).af | 142880 |
| 39 | Medline | (validity).af | 152010 |
| 40 | Medline | "VALIDATION STUDIES"/ OR "VALIDATION STUDIES AS TOPIC"/ | 1918 |
| 41 | Medline | "SEVERITY OF ILLNESS INDEX"/ | 218195 |
| 42 | Medline | "REPRODUCIBILITY OF RESULTS"/ | 361208 |
| 43 | Medline | (scor\* ADJ5 (system\* OR scale\*)).af | 109437 |
| 44 | Medline | (1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23) | 556790 |
| 45 | Medline | (24 OR 25 OR 26 OR 27 OR 28) | 29270 |
| 46 | Medline | (29 OR 30 OR 31 OR 32 OR 33 OR 34 OR 35) | 42749 |
| 47 | Medline | (36 OR 37 OR 38 OR 39 OR 40 OR 41 OR 42 OR 43) | 1369200 |
| 48 | Medline | (45 AND 47) | 3599 |
| 49 | Medline | (46 OR 48) | 44656 |
| 50 | Medline | (44 AND 49) | 748 |