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# Co-prevalence of aneurysms in the vasculature, a systemic review and meta-analysis.

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# Disclosure

Speaker name:

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I have the following potential conflicts of interest to report:

☑ I do not have any potential conflict of interest

# Background

- "Most aneurysms are a focal manifestation of a systemic condition" [1]
- Both ESVS & JVS guidelines for AAA mention aneurysm screening in patients with AAA or peripheral aneurysms [2,3]
- No clear insight in risk profile for multiple aneurysms

| Recommendation 16 | | |
|---|---|---|
| Screening for abdominal aortic aneurysm at 5–10 year intervals may be considered for all men and women with a true peripheral arterial aneurysm | | |
| **Class** | **Level** | **References** |
| IIb | C | [167] |

| | |
|---|---|
| In patients with a suspected or known AAA, we recommend performing physical examination that includes an assessment of femoral and popliteal arteries. | |
| In patients with a popliteal or femoral artery aneurysm, we recommend evaluation for an AAA. | |
| Level of recommendation | 1 (Strong) |
| Quality of evidence | A (High) |

**Aim:** Overview of co-prevalence of aneurysms in different vascular beds and examine putative clinical risk factors for multiple aneurysms


*[1] Norman PE, Powel JT. Site specificity of aneurysmal disease. Circulation 2010; 121:560–568*
*[2] Wanhainen A, et al. European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms, EJVES 2018.*
*[3] Chaikof EL, et al. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. J Vasc Surg 2018.*

# Methods

**Literature search Medline, EMBASE & Cochrane library:**

*« Aneurysm* » AND « Co-prevalence » + synonyms*

**Inclusion**

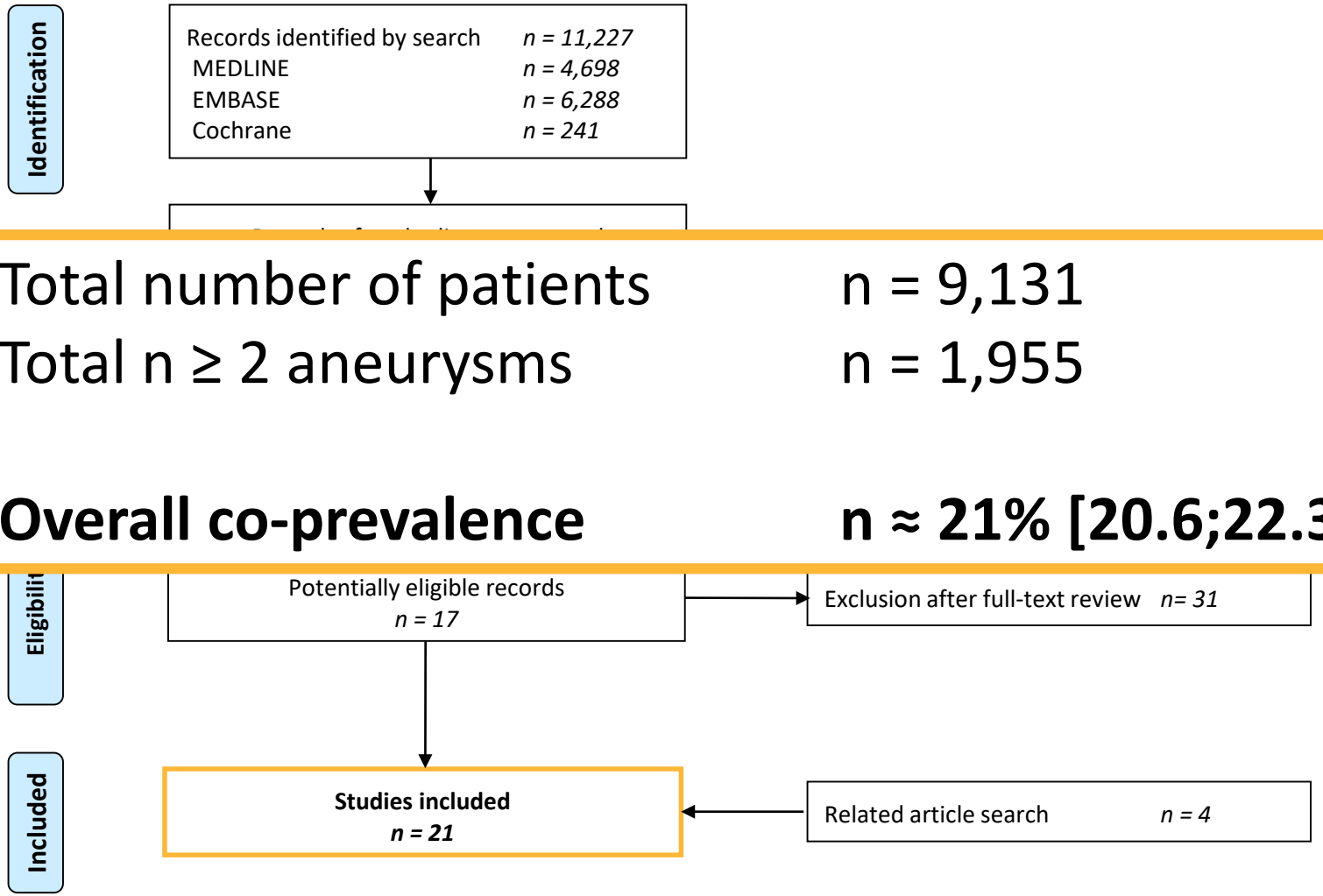
- Original studies of co-prevalence of aneurysms
- ≥ 2 aneurysms described

**Exclusion**

- Case reports
- Case series <20 patients
- Animal studies
- Reviews

- Intervention papers described concomitant treatment
- Solely bilateral disease
- Mycotic, traumatic, iatrogenic, connective tissue disorder, post-dissection aneurysms

# Results (1) – Search flowchart




Total number of patients n = 9,131

Total n ≥ 2 aneurysms n = 1,955

**Overall co-prevalence** **n ≈ 21% [20.6;22.3]**

# Results (2) – Quality assessment

| | | Directness of Evidence (DoE) | | | | | Risk of Bias (RoB) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Outcome | | | | | | | | | | | |
| | Study (year) | Domain | Determinant | Co-prevalence | Patient characteristics | DoE Total * | Sampling frame | Random selection and in-/exclusion | Aneurysm definition | Imaging modality | Consistent data collection | Reproducibility | Incomplete patient data | Co-prevalence and 95% CI | RoB Total ** |
| 1. | Agricola (2013) | ● | ◉ | ● | ◉ | M | ● | ● | ◉ | ○ | ● | ○ | ○ | ○ | H (3.5) |
| 2. | Armon (1998) | ● | ◉ | ◉ | ○ | L | ● | ● | ○ | ● | ● | ○ | n/a | ● | M (5) |
| 3. | Balderston (2015) | ● | ● | ● | ● | H | ● | ◉ | ● | ● | ● | ◉ | ◉ | ● | L (6.5) |
| 4. | Chaer (2012) | ● | ● | ● | ● | H | ● | ● | ● | ○ | ○ | ○ | ● | ● | M (5) |
| 5. | Chapman (2017) | ● | ● | ● | ● | H | ● | ● | ◉ | ● | ● | ● | ● | ● | L (7.5) |
| 6. | DeFreitas (2016) | ● | ● | ● | ● | H | ● | ● | ◉ | ● | ● | ○ | ● | ● | L (6.5) |
| 7. | Diwan (2000) | ● | ● | ● | ● | H | ● | ● | ● | ● | ● | ○ | ● | ● | L (7) |
| 8. | Goyal (2015) | ● | ● | ● | ○ | M | ● | ◉ | ● | ○ | ○ | ○ | n/a | ● | H (3.5) |
| 9. | Hultgren (2012) | ● | ● | ● | ● | H | ● | ● | ◉ | ● | ○ | ● | ● | ● | L (6.5) |
| 10. | Kuzmik (2010) | ● | ● | ● | ● | H | ● | ◉ | ○ | ○ | ○ | ○ | ● | ● | H (3.5) |
| 11. | Laine (2017) | ● | ◉ | ● | ○ | M | ○ | ● | ● | ○ | ● | ○ | n/a | ● | M (4) |
| 12. | Larsson (2011) | ● | ● | ● | ● | H | ● | ● | ● | ● | ○ | ● | ● | ● | L (7) |
| 13. | Lee (2017) | ● | ● | ● | ● | H | ● | ● | ○ | ● | ○ | ● | ● | ● | L (6) |
| 14. | Miyazawa (2007) | ● | ● | ● | ● | H | ● | ● | ◉ | ● | ○ | ○ | ○ | ● | M (4.5) |
| 15. | Pourier (2017) | ● | ◉ | ● | ○ | M | ● | ● | ◉ | ● | ○ | ◉ | n/a | ● | M (5) |
| 16. | Ravn (2008) | ● | ● | ● | ● | H | ● | ● | ◉ | ○ | ○ | ◉ | ● | ● | M (5) |
| 17. | Rouchaud (2016) | ● | ● | ● | ● | H | ● | ● | ◉ | ● | ○ | ◉ | ● | ● | L (6) |
| 18. | Shin (2015) | ● | ● | ● | ◉ | H | ● | ● | ◉ | ○ | ○ | ○ | ○ | ● | H (3.5) |
| 19. | Studzińska (2019) | ● | ◉ | ● | ◉ | M | ● | ● | ◉ | ● | ● | ◉ | ● | ● | L (7) |
| 20. | Tuveson (2016) | ● | ● | ● | ● | H | ● | ● | ● | ○ | ○ | ● | ◉ | ● | M (5.5) |
| 21. | Wallinder (2018) | ● | ◉ | ● | ○ | M | ○ | ● | ◉ | ○ | ○ | ○ | n/a | ● | H (2.5) |

Quality assessment for prevalence studies by Hoy et al [4]

| * | | DoE |
|---|---|---|
| L | Low | (0 - 2) |
| M | Moderate | (2.5 - 3) |
| H | High | (3.5 - 4) |

| ** | | RoB |
|---|---|---|
| H | High | (0 - 3.5) |
| M | Moderate | (4 - 5.5) |
| L | Low | (6 - 8) |

# Results (3) – Study characteristics

| | Study (year) | Study design | Study period (years) | Geographical location | Sample size (n) | Index aneurysm | Concurrent aneurysm | Co-prevalence | | Imaging modality |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | **Laine (2017)** | R | 2002 – 2015 | MultiCenter (EU + AUS) | 63 | IIAA | AAA, CIAA | 71% | (45/63) | CT |
| 2. | **Ravn (2008)** | P | 1987 - 2002 | Sweden | 190 | PAA | AAA, CIAA, FAA | 69% | (131/190) | DUS, CT |
| 3. | **Studzińska (2019)** | R | 2010 - 2017 | Poland | 933 | AAA | CIAA, IIAA, RAA, VAA | 61% | (566/933) | CTA (32-slice) |
| 4. | **Wallinder (2018)** | R | 1982 - 2013 | Sweden | 339 | AAA | TAA, CIAA, CFAA, PAA | 32% | (108/339) | CT, DUS |
| 5. | **Larsson (2011)** | R | 2004 - 2008 | Sweden | 354 | AAA | TAA | 28% | (100/354) | CTA (4-,16-, 64-slice) |
| 6. | **Hultgren (2012)** | R | 2004 - 2008 | Sweden | 354 | AAA | TAA | 27% | (94/354) | CTA (4-, 16-, or 64-slice) |
| 7. | **Armon (1998)** | R | 1994 - 1996 | United Kingdom | 215 | AAA | CIAA | 28% | (60/215) | CTA |
| 8. | **Balderston (2015)** | R | 2007 - 2013 | Virginia (US) | 477 | TAAA<br>AAA | CAA | 21%<br>23% | (84/403)<br>(17/74) | CA |
| 9. | **Chaer (2012)** | R | 2000 - 2008 | Pittsburgh (US) | 1,082 | AAA | TAA | 23% | (253/1,082) | CT, MRA, MRI, DUS |
| 10. | **DeFreitas (2016)** | R | 2008 - 2013 | Michigan (US) | 462 | TAA | AAA | 23% | (104/462) | CTA (64-slice) |
| 11. | **Lee (2017)** | R | 2009 - 2014 | South Korea | 133 | AA | IA | 20% | (27/133) | CTA (64-slice) |
| 12. | **Tuveson (2016)** | R | 2011 - 2013 | Sweden | 225 | AAA | PAA | 19% | (43/225) | CTA, DUS |
| 13. | **Diwan (2000)** | P | 1995 - 1998 | Michigan (US) | 313 | AAA | FAA, PAA | 12% | (36/313) | DUS |
| 14. | **Rouchaud (2016)** | R | 2001 - 2015 | Minnesota (US) | 1,081 | AA | IA | 12% | (128/1,081) | CTA (16-, 32-, or 64-slice), MRA (1.5T or 3.0T), DSA |
| 15. | **Shin (2015)** | R | 2005 - 2014 | South Korea | 611 | AA | IA | 12% | (71/611) | MRA, CTA |
| 16. | **Chapman (2017)** | R | 2008 - 2013 | Michigan (US) | 371 | TAA | Pelvic AA | 11% | (41/371) | CTA (64-slice) |
| 17. | **Kuzmik (2010)** | R | 1997 – 2009 | New York (US) | 212 | TAA | IA | 9% | (19/212) | CTA, MRA |
| 18. | **Miyazawa (2007)** | R | 1997 - 2003 | Japan | 181 | IA | AAA | 7% | (13/181) | MRA (0.5T), CT, DUS |
| 19. | **Agricola (2013)** | R | n/a | Italy | 1,305 | AAA | TAAA<br>AArA | 4%<br>7% | (52/1,305)<br>(85/1,305) | TTE |
| 20. | **Goyal (2015)** | R | 2002 - 2011 | Missouri (US) | 317 | IA | TAAA | 5% | (15/317) | TTE, TEE, CT |
| 21. | **Pourier (2017)** | R | 1978 - 2015 | The Netherlands | 638 | IA | ECAA | 2% | (12/638) | CTA (64-slice), MRA (1.5T or 3.0T), DSA, DUS |

- Post hoc analyses in retrospective cohorts
- Cohorts from Europe (48%) and US (38%)
- Mostly aortic aneurysms as index
- Co-prevalence 2-71%
- Different imaging modalities used

# Results (4) – Putative clinical risk factors

| | Study (year) | Sample size (n) | Index aneurysm | Concurrent aneurysm | Age | Gender | Hypertension | POAD | Diabetes Mellitus | Smoking history | Additional aneurysm elsewhere | Family history of aneurysm | Aneurysm size | Aneurysm location | Adjusted for confounding |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | **Laine (2017)** | 63 | IIAA | AAA, CIAA | | | | | | | | | | | - |
| 2. | **Ravn (2008)** | 190 | PAA | AAA, CIAA, FAA | + | | + | | | | | | | | ● |
| 3. | **Studzińska (2019)** | 933 | AAA | CIAA, IIAA, RAA, VAA | | | | | | | | | | + | ○ |
| 4. | **Wallinder (2018)** | 339 | AAA | TAA, CIAA, CFAA, PAA | | | | | | | | | | | - |
| 5. | **Larsson (2011)** | 354 | AAA | TAA | | Female | | | | | | | | | ● |
| 6. | **Hultgren (2012)** | 354 | AAA | TAA | + | Female | | | | | | | | | ● |
| 7. | **Armon (1998)** | 215 | AAA | CIAA | | | | | | | | | | | - |
| 8. | **Balderston (2015)** | 477 | TAAA, AAA | CAA | + | Male | | | | | | | | | ● |
| 9. | **Chaer (2012)** | 1,082 | AAA | TAA | | | + | | - | - | | + | + | - | ● |
| 10. | **DeFreitas (2016)** | 462 | TAA | AAA | + | | + | | | + | | | | | ● |
| 11. | **Lee (2017)** | 133 | AA | IA | NS | Female NS | | | | | | | | NS | ● |
| 12. | **Tuveson (2016)** | 225 | AAA | PAA | | | | + | | | | | | | ○ |
| 13. | **Diwan (2000)** | 313 | AAA | FAA, PAA | | Male | | + | | | | | | | ○ |
| 14. | **Rouchaud (2016)** | 1,081 | AA | IA | | Female | | | | | | | | | ● |
| 15. | **Shin (2015)** | 611 | AA | IA | | | | | | | | | | + | ○ |
| 16. | **Chapman (2017)** | 371 | TAA | Pelvic AA | + | Male | | | | | + | | | | ● |
| 17. | **Kuzmik (2010)** | 212 | TAA | IA | | + | | | | | | | | + | ○ |
| 18. | **Miyazawa (2007)** | 181 | IA | AAA | + | | | | | + | + | | + | | ● |
| 19. | **Agricola (2013)** | 1,305 | AAA | TAAA, AArA | | Female | | | | | | | | | ○ |
| 20. | **Goyal (2015)** | 317 | IA | TAAA | | Male | + | | | | | | | | ○ |
| 21. | **Pourier (2017)** | 638 | IA | ECAA | | | | | | | | | | | - |

# Meta-analysis

**Putative clinical risk factors for multiple aneurysms**

- Majority report only significant ORs
- 3/7 centers response
- 1,674 index : 343 concurrent (18%)

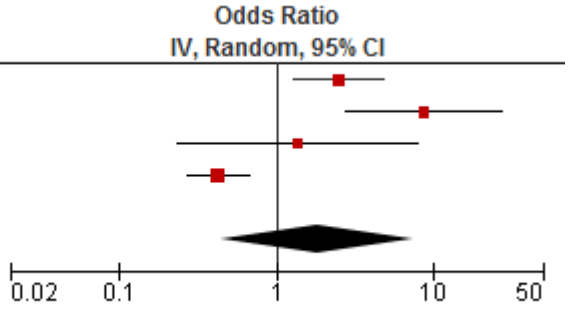
- **Random effect meta-analysis**
  - ✓ Male gender
  - ✓ Age
  - ✓ Hypertension
  - ✓ Smoking

# Results (6) – Pooled data

## Male gender

| Study or Subgroup | log[Odds Ratio] | SE | Weight | Odds Ratio IV, Random, 95% CI |
|---|---|---|---|---|
| Balderston 2015 | 0.914 | 0.333 | 27.4% | 2.49 [1.30, 4.79] |
| DeFreitas 2016 | 2.168 | 0.582 | 24.4% | 8.74 [2.79, 27.35] |
| Ravn 2008 | 0.316 | 0.902 | 20.0% | 1.37 [0.23, 8.04] |
| Rouchaud 2015 | -0.861 | 0.232 | 28.2% | 0.42 [0.27, 0.67] |
| **Total (95% CI)** | | | **100.0%** | **1.82 [0.44, 7.49]** |

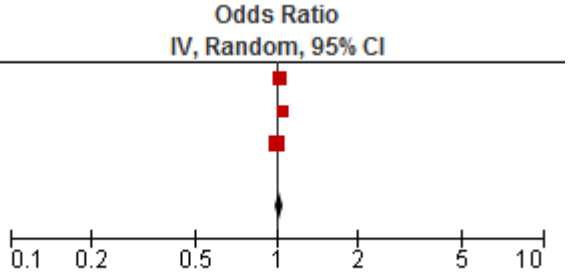
Heterogeneity: $Tau^2 = 1.79$; $Chi^2 = 35.28$, $df = 3$ ($P < 0.00001$); $I^2 = 91\%$
Test for overall effect: $Z = 0.83$ ($P = 0.41$)




## Age

| Study or Subgroup | log[Odds Ratio] | SE | Weight | Odds Ratio IV, Random, 95% CI |
|---|---|---|---|---|
| Balderston 2015 | 0.026 | 0.013 | 33.7% | 1.03 [1.00, 1.05] |
| Ravn 2008 | 0.056 | 0.019 | 26.0% | 1.06 [1.02, 1.10] |
| Rouchaud 2015 | 0.002 | 0.008 | 40.3% | 1.00 [0.99, 1.02] |
| **Total (95% CI)** | | | **100.0%** | **1.02 [1.00, 1.05]** |

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 7.99$, $df = 2$ ($P = 0.02$); $I^2 = 75\%$
Test for overall effect: $Z = 1.63$ ($P = 0.10$)



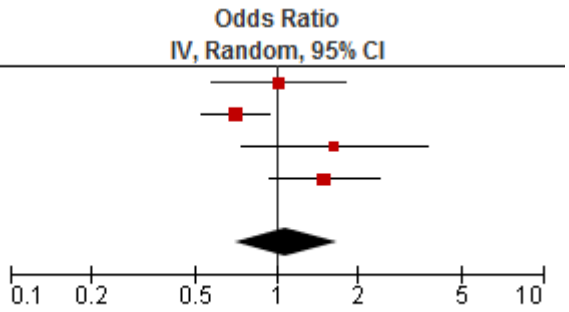
# Results (7) – Pooled data

## Smoking

| Study or Subgroup | log[Odds Ratio] | SE | Weight | Odds Ratio IV, Random, 95% CI |
|---|---|---|---|---|
| Balderston 2015 | 0.022 | 0.294 | 23.4% | 1.02 [0.57, 1.82] |
| Chaer 2012 | -0.357 | 0.153 | 32.6% | 0.70 [0.52, 0.94] |
| Ravn 2008 | 0.502 | 0.412 | 17.1% | 1.65 [0.74, 3.70] |
| Rouchaud 2015 | 0.413 | 0.24 | 26.9% | 1.51 [0.94, 2.42] |
| **Total (95% CI)** | | | **100.0%** | **1.09 [0.70, 1.71]** |

Heterogeneity: $Tau^2 = 0.14$; $Chi^2 = 9.59$, df = 3 (P = 0.02); $I^2 = 69\%$

Test for overall effect: Z = 0.37 (P = 0.71)

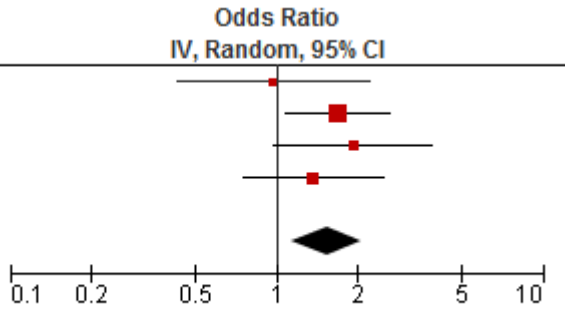



## Hypertension

| Study or Subgroup | log[Odds Ratio] | SE | Weight | Odds Ratio IV, Random, 95% CI |
|---|---|---|---|---|
| Balderston 2015 | -0.026 | 0.424 | 12.8% | 0.97 [0.42, 2.24] |
| Chaer 2012 | 0.531 | 0.228 | 44.2% | 1.70 [1.09, 2.66] |
| Ravn 2008 | 0.664 | 0.349 | 18.9% | 1.94 [0.98, 3.85] |
| Rouchaud 2015 | 0.322 | 0.309 | 24.1% | 1.38 [0.75, 2.53] |
| **Total (95% CI)** | | | **100.0%** | **1.54 [1.15, 2.08]** |

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 1.92$, df = 3 (P = 0.59); $I^2 = 0\%$

Test for overall effect: Z = 2.87 (P = 0.004)



# Conclusion

- Majority of papers perform a post-hoc analysis of a retrospective cohort
- Overall co-prevalence of 21% (95% CI 20.6-22.3)
- Due to the large heterogeneity in studies, obtaining a clinical risk tool for multiple aneurysm disease is at this point not feasible
- Sub-analyses might reveal aligned risk profiles for specific aneurysm co-prevalence

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# Thank you for your attention

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