# Surgical aortic valve replacement and patient-prosthesis mismatch: a meta-analysis of 108182 patients 

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## Key question

What are the incidence and impact of patientprosthesis mismatch (PPM) on the outcomes of aortic valve replacement?

## Key findings

- The incidence of PPM is high.
- PPM is associated with higher mortality
- Moderate as well as severe PPM poses a problem.


## Take-home message

Implementation of surgical strategies to prevent PPM after surgical aortic valve replacement is necessary.

Odds ratio and 95\% CI
Mortality


Non-significant/No PPM Moderate/Severe PPM


Figure 1: Flow diagram of studies included in data search. CCTR: Cochrane Controlled Trials Register; LILACS: Literatura Latino Americana em Ciências da Saúde; PPM: patient-prosthesis mismatch; SciELO: Scientific Electronic Library Online.

## Moderate/Severe PPM vs Non-significant/No PPM

| Study name | Statistics for each study |  |  |  | Weight (Random) |  |  | Odds ratio and $95 \% \mathrm{Cl}$ <br> Perioperative mortality |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | OddA ratio | Lower limit | Upper limit | P-Value | Relative weight | (\%) |  |  |  |  |
| Fallon 2018 | 1.238 | 1.120 | 1.368 | <0.001 | 9.67 |  |  |  |  |  |
| Thourani 2017 | 1.317 | 0.559 | 3.103 | 0.529 | 2.01 |  |  |  |  |  |
| Mannacio 2017 | 1.421 | 0.760 | 2.656 | 0.271 | 3.21 |  |  |  |  |  |
| Lee 2017 | 1.000 | 0.002 | 464.154 | 1.000 | 0.05 |  |  |  |  |  |
| Kindo 2017 | 19.124 | 0.970 | 377.027 | 0.052 | 0.20 |  |  |  |  |  |
| Guo 2017 | 4.039 | 0.894 | 18.250 | 0.070 | 0.75 |  |  |  |  |  |
| Alizadeh-Ghavidel 2016 | 1.000 | 0.001 | 669.252 | 1.000 | 0.04 |  |  |  |  |  |
| Joshi 2016 | 1.257 | 0.154 | 10.240 | 0.831 | 0.40 |  |  |  |  |  |
| Sportelli 2016 | 0.855 | 0.117 | 6.243 | 0.877 | 0.44 |  |  |  |  |  |
| Zorn 2016 | 1.500 | 0.378 | 5.948 | 0.564 | 0.88 |  |  |  |  |  |
| van Slooten 2016 | 1.000 | 0.042 | 23.658 | 1.000 | 0.18 |  |  |  |  |  |
| Swinkels 2016 | 0.360 | 0.082 | 1.576 | 0.175 | 0.78 |  |  |  |  |  |
| Mizia-Stec 2016 | 1.000 | 0.007 | 134.436 | 1.000 | 0.08 |  |  |  |  |  |
| Dayan 2015 | 1.450 | 0.999 | 2.104 | 0.051 | 5.76 |  |  |  |  |  |
| Dumani 2015 | 1.404 | 0.160 | 12.357 | 0.760 | 0.37 |  |  |  |  |  |
| Hu 2014 | 1.000 | 0.020 | 50.057 | 1.000 | 0.12 |  |  |  |  |  |
| Hoffmann 2014 | 0.221 | 0.044 | 1.101 | 0.065 | 0.66 |  |  |  |  |  |
| Shahzeb 2014 | 6.091 | 2.441 | 15.200 | <0.001 | 1.81 |  |  |  |  |  |
| Koene 2013 | 1.801 | 1.128 | 2.875 | 0.014 | 4.60 |  |  |  |  |  |
| Kitamura 2013 | 0.718 | 0.031 | 16.417 | 0.835 | 0.18 |  |  |  |  |  |
| Kaminishi 2013 | 1.781 | 0.957 | 3.316 | 0.069 | 3.24 |  |  |  |  |  |
| Hong 2013 | 1.782 | 0.354 | 8.964 | 0.483 | 0.66 |  |  |  |  |  |
| Concistrè 2013 | 0.894 | 0.367 | 2.182 | 0.806 | 1.88 |  |  |  |  |  |
| Chacko 2013 | 4.102 | 0.475 | 35.380 | 0.199 | 0.38 |  |  |  |  |  |
| Bonderman 2013 | 2.481 | 1.042 | 5.907 | 0.040 | 1.97 |  |  |  |  |  |
| Tully 2013 | 1.098 | 0.496 | 2.429 | 0.818 | 2.27 |  |  |  |  |  |
| Yottasurodom 2012 | 1.582 | 0.420 | 5.964 | 0.498 | 0.95 |  |  |  |  |  |
| Astudillo 2012 | 2.965 | 0.819 | 10.727 | 0.098 | 1.00 |  |  |  |  |  |
| Hernandez-Vaquero 2011 | 0.411 | 0.124 | 1.362 | 0.146 | 1.13 |  |  |  |  |  |
| Garatti 2011 | 0.256 | 0.029 | 2.241 | 0.218 | 0.38 |  |  |  |  |  |
| Cotoni 2011 | 1.968 | 0.411 | 9.414 | 0.397 | 0.70 |  |  |  |  |  |
| Urso 2010 | 0.580 | 0.180 | 1.873 | 0.363 | 1.18 |  |  |  |  |  |
| Jamieson 2010 | 1.028 | 0.707 | 1.496 | 0.885 | 5.73 |  |  |  |  |  |
| Howell 2010 | 1.729 | 0.552 | 5.411 | 0.347 | 1.24 |  |  |  |  |  |
| Rabus 2009 | 2.748 | 1.331 | 5.677 | 0.006 | 2.60 |  |  |  |  |  |
| Qiam 2009 | 1.976 | 0.315 | 12.373 | 0.467 | 0.52 |  |  |  |  |  |
| Mrówczynski 2009 | 2.655 | 0.571 | 12.344 | 0.213 | 0.72 |  |  |  |  |  |
| Moon 2009 | 1.024 | 0.699 | 1.499 | 0.904 | 5.64 |  |  |  |  |  |
| Mannacio 2009 | 0.952 | 0.154 | 5.866 | 0.957 | 0.53 |  |  |  |  |  |
| Ferreira 2009 | 2.764 | 0.727 | 10.505 | 0.135 | 0.94 |  |  |  |  |  |
| Kohsaka 2008 | 1.359 | 0.721 | 2.564 | 0.343 | 3.15 |  |  |  |  |  |
| Mascherbauer 2008 | 1.970 | 0.871 | 4.453 | 0.103 | 2.17 |  |  |  |  |  |
| Ryomoto 2008 | 1.200 | 0.269 | 5.351 | 0.811 | 0.76 |  |  |  |  |  |
| Vicchio 2008 | 7.236 | 2.159 | 24.257 | 0.001 | 1.12 |  |  |  |  |  |
| Tsutsumi 2008 | 2.114 | 0.490 | 9.117 | 0.316 | 0.79 |  |  |  |  |  |
| Tao 2007 | 11.129 | 1.118 | 110.744 | 0.040 | 0.34 |  |  |  |  |  |
| Nozohoor 2007 | 0.825 | 0.459 | 1.482 | 0.519 | 3.51 |  |  |  |  |  |
| Monin 2007 | 1.225 | 0.445 | 3.374 | 0.695 | 1.52 |  |  |  |  |  |
| Kato 2007 | 1.000 | 0.038 | 26.459 | 1.000 | 0.17 |  |  |  |  |  |
| Fuster 2007 (Cohort A) | 1.951 | 0.641 | 5.939 | 0.239 | 1.29 |  |  |  |  |  |
| Fuster 2007 (Cohort B) | 1.553 | 0.542 | 4.449 | 0.413 | 1.42 |  |  |  |  |  |
| Walther 2006 | 1.529 | 1.208 | 1.935 | $<0.001$ | 7.80 |  |  |  |  |  |
| Kulik 2006 | 1.607 | 0.303 | 8.524 | 0.577 | 0.62 |  |  |  |  |  |
| Penta de Peppo 2005 | 1.000 | 0.008 | 125.326 | 1.000 | 0.08 |  |  |  |  |  |
| Gelsomino 2004 | 4.455 | 0.258 | 76.848 | 0.304 | 0.22 |  |  |  |  |  |
| Hanayama 2002 | 18.676 | 1.673 | 208.433 | 0.017 | 0.31 |  |  |  |  |  |
| Blais 2003 | 2.506 | 1.457 | 4.310 | 0.001 | 3.87 |  |  |  |  |  |
| Rao 2000 | 1.779 | 1.051 | 3.011 | 0.032 | 4.02 |  |  |  |  |  |
| Pibarot 1998 | 0.797 | 0.221 | 2.869 | 0.728 | 1.01 |  |  |  |  |  |
| Overall effect | 1.491 | 1.302 | 1.707 | $<0.001$ |  |  |  |  |  |  |
| Total (95\% CI): 55394 (PPM); 45924 (No PPM) |  |  |  |  |  |  | 0.01 | 0.1 | 10 | 100 |
| Total events: 2146 (PPM); Test for heterogeneity: Chi Test for overall random effe | 1465 (No $=81.31$ $c t:$ $Z=5$ | PPM) df $=58$ 77 ( $\mathrm{P}<0$ | $\begin{aligned} & =0.023 \text { ); } \\ & 001 \text { ) } \end{aligned}$ | $12=28.6^{\circ}$ |  |  | Non-significant/No PPM |  | Moderate/Severe P |  |

Figure 2: Odds ratio and conclusions plot of perioperative mortality. The summary effect of moderate/severe PPM on perioperative mortality is shown. Cl: confidence interval; PPM: patient-prosthesis mismatch.

## Moderate/Severe PPM vs Non-significant/No PPM



Figure 3: Odds ratio and conclusions plot of 1-year mortality. The summary effect of moderate/severe PPM on 1-year mortality is shown. CI: confidence interval; PPM: patient-prosthesis mismatch.

## Moderate/Severe PPM vs Non-significant/No PPM

| Study name | Statistics for each study |  |  |  | Weight (Random) |  | Odds ratio and $95 \% \mathrm{Cl}$ 5-year mortality |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Odds ratio | Lower limit | Upper limit | P-Value | Relative weight | (\%) |  |  |  |
| Fallon 2018 | 1.131 | 1.088 | 1.177 | <0.001 | 5.21 |  |  |  |  |
| Mannacio 2017 | 2.157 | 1.618 | 2.876 | <0.001 | 3.84 |  |  |  |  |
| Lee 2017 | 0.808 | 0.307 | 2.126 | 0.666 | 1.02 |  |  |  |  |
| Sportelli 2016 | 0.503 | 0.259 | 0.977 | 0.042 | 1.78 |  |  |  |  |
| Swinkels 2016 | 0.963 | 0.630 | 1.471 | 0.861 | 2.92 |  |  |  |  |
| Dayan 2015 | 1.521 | 1.229 | 1.882 | <0.001 | 4.37 |  |  | 들 |  |
| Hu 2014 | 0.479 | 0.155 | 1.477 | 0.200 | 0.79 |  |  |  |  |
| Hernandez-Vaquero 2014 | 2.460 | 1.085 | 5.575 | 0.031 | 1.33 |  |  |  |  |
| Tully 2013 | 0.845 | 0.636 | 1.123 | 0.245 | 3.86 |  |  |  |  |
| Koene 2013 | 1.078 | 0.793 | 1.467 | 0.631 | 3.70 |  |  |  |  |
| Kitamura 2013 | 0.138 | 0.026 | 0.746 | 0.021 | 0.39 |  |  |  |  |
| Kandler 2013 | 0.728 | 0.309 | 1.718 | 0.469 | 1.23 |  |  |  |  |
| Hong 2013 | 2.817 | 1.120 | 7.089 | 0.028 | 1.10 |  |  |  |  |
| Concistrè 2013 | 0.894 | 0.367 | 2.182 | 0.806 | 1.16 |  |  |  |  |
| Bonderman 2013 | 1.417 | 0.858 | 2.338 | 0.173 | 2.49 |  |  |  |  |
| Hernandez-Vaquero 2011 | 0.830 | 0.399 | 1.730 | 0.620 | 1.55 |  |  |  |  |
| Cotoni 2011 | 1.220 | 0.575 | 2.591 | 0.604 | 1.50 |  |  |  |  |
| Sakamoto 2010 | 1.505 | 0.420 | 5.390 | 0.530 | 0.64 |  |  |  |  |
| Jamieson 2010 | 1.140 | 0.958 | 1.357 | 0.139 | 4.63 |  |  |  |  |
| Howell 2010 | 0.786 | 0.528 | 1.169 | 0.234 | 3.09 |  |  |  |  |
| Bleiziffer 2010 | 1.752 | 1.085 | 2.829 | 0.022 | 2.60 |  |  |  |  |
| Urso 2009 | 0.764 | 0.376 | 1.550 | 0.455 | 1.63 |  |  |  |  |
| Mrówczynski 2009 | 2.170 | 1.286 | 3.663 | 0.004 | 2.37 |  |  |  |  |
| Moon 2009 | 0.901 | 0.722 | 1.125 | 0.358 | 4.31 |  |  |  |  |
| Mohty 2009 | 1.252 | 1.010 | 1.551 | 0.040 | 4.36 |  |  |  |  |
| Mannacio 2009 | 0.615 | 0.171 | 2.221 | 0.458 | 0.63 |  |  |  |  |
| Florath 2008 | 1.696 | 0.977 | 2.945 | 0.060 | 2.24 |  |  |  |  |
| Kohsaka 2008 | 1.755 | 1.121 | 2.747 | 0.014 | 2.78 |  |  |  |  |
| Mascherbauer 2008 | 1.612 | 0.772 | 3.366 | 0.204 | 1.55 |  |  |  |  |
| Ryomoto 2008 | 1.658 | 0.661 | 4.160 | 0.281 | 1.11 |  |  |  |  |
| Vicchio 2008 | 2.521 | 1.372 | 4.633 | 0.003 | 1.99 |  |  |  |  |
| Tsutsumi 2008 | 2.114 | 0.490 | 9.117 | 0.316 | 0.50 |  |  |  |  |
| Tao 2007 | 2.271 | 0.760 | 6.786 | 0.142 | 0.83 |  |  |  |  |
| Nozohoor 2007 | 1.713 | 1.380 | 2.127 | <0.001 | 4.34 |  |  |  |  |
| Monin 2007 | 1.021 | 0.515 | 2.025 | 0.952 | 1.71 |  |  |  |  |
| Kato 2007 | 1.500 | 0.694 | 3.241 | 0.302 | 1.45 |  |  |  |  |
| Fuster 2007 (Cohort A) | 2.947 | 1.419 | 6.117 | 0.004 | 1.56 |  |  |  |  |
| Flameng 2006 | 1.377 | 0.853 | 2.224 | 0.191 | 2.60 |  |  |  |  |
| Tasca 2006 | 3.078 | 1.468 | 6.454 | 0.003 | 1.53 |  |  | - |  |
| Ruel 2006 (Cohort A) | 2.843 | 1.487 | 5.436 | 0.002 | 1.84 |  |  |  |  |
| Ruel 2006 (Cohort B) | 3.287 | 1.641 | 6.583 | 0.001 | 1.68 |  |  |  |  |
| Mohty-Echaidi 2006 | 1.627 | 0.949 | 2.792 | 0.077 | 2.29 |  |  |  |  |
| Kulik 2006 | 2.063 | 0.726 | 5.868 | 0.174 | 0.90 |  |  |  |  |
| Penta de Peppo 2005 | 1.810 | 0.282 | 11.599 | 0.532 | 0.32 |  |  |  |  |
| Hanayama 2002 | 1.609 | 0.654 | 3.959 | 0.301 | 1.14 |  |  |  |  |
| Rao 2000 | 1.776 | 1.110 | 2.844 | 0.017 | 2.65 |  |  |  |  |
| Pibarot 1998 | 1.215 | 0.734 | 2.012 | 0.448 | 2.47 |  |  |  |  |
| Overall effect | 1.358 | 1.218 | 1.515 | <0.001 |  |  |  | 1 |  |
| Total ( $95 \% \mathrm{CI}$ ): 52990 (PPM); 38751 (No PPM) <br> Total events: 13020 (PPM); 7591 (No PPM) <br> Test for heterogeneity: $\mathrm{Chi}^{2}=139.06 ; \mathrm{df}=46(\mathrm{P}<0.001) ; \mathrm{I}^{2}=66.9 \%$ <br> Test for overall random effect: $Z=5.51(P<0.001)$ |  |  |  |  |  |  | Non-significant/No PPM Moderate/Severe PPM |  |  |

Figure 4: Odds ratio and conclusions plot of 5-year mortality. The summary effect of moderate/severe PPM on 5-year mortality is shown. CI: confidence interval; PPM: patient-prosthesis mismatch.

# Moderate/Severe PPM vs Non-significant/No PPM 



Figure 5: Odds ratio and conclusions plot of 10-year mortality. The summary effect of moderate/severe PPM on 10-year mortality is shown. CI: confidence interval; PPM: patient-prosthesis mismatch.


Figure 6: Publication bias. Funnel plot analysis of the outcomes on perioperative mortality, 1-year mortality, 5-year mortality and 10-year mortality.

Table 1: Sensitivity analysis

| Perioperative mortality | Studies ( $N$ ) | Patients ( $N$ ) | Summary measures |  |  | Heterogeneity |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | OR | 95\% Cl | $P$-value | $1^{2}$ (\%) | $\chi^{2} P$-value |
| Moderate PPM ${ }^{\text {a }}$ |  |  |  |  |  |  |  |
| Perioperative | 32 | 76540 | 1.283 | 1.095-1.503 | <0.001 | 25.9 | 0.002 |
| 1 year | 30 | 76494 | 1.232 | 1.020-1.489 | 0.031 | 66.3 | <0.001 |
| 5 years | 27 | 75446 | 1.231 | 1.091-1.388 | 0.001 | 65.4 | <0.001 |
| 10 years | 18 | 67842 | 1.310 | 1.028-1.668 | 0.029 | 92.6 | <0.001 |
| Severe PPM ${ }^{\text {a }}$ |  |  |  |  |  |  |  |
| Perioperative | 26 | 40723 | 2.284 | 1.566-3.329 | <0.001 | 61.4 | <0.001 |
| 1 year | 24 | 38480 | 2.136 | 1.575-2.897 | <0.001 | 65.0 | <0.001 |
| 5 years | 18 | 36659 | 1.841 | 1.401-2.418 | <0.001 | 78.1 | <0.001 |
| 10 years | 13 | 35152 | 1.963 | 1.173-3.285 | <0.001 | 94.3 | <0.001 |
| Severe PPM versus moderate PPM |  |  |  |  |  |  |  |
| Perioperative | 23 | 50924 | 1.736 | 1.252-2.406 | 0.001 | 51.2 | 0.003 |
| 1 year | 20 | 48532 | 1.532 | 1.169-2.006 | 0.002 | 53.5 | 0.003 |
| 5 years | 17 | 47536 | 1.412 | 1.165-1.710 | <0.001 | 56.7 | 0.002 |
| 10 years | 13 | 46555 | 1.476 | 1.103-1.952 | 0.009 | 79.3 | <0.001 |

${ }^{\text {a }}$ Compared with non-significant/no PPM.
CI: confidence interval; OR: odds ratio; PPM: patient-prosthesis mismatch.

Table 2: Sensitivity analysis

| Perioperative mortality | Studies (N) | Patients ( $N$ ) | Summary measures |  |  | Heterogeneity |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | OR | 95\% Cl | $P$-value | $1^{2}$ (\%) | $\chi^{2} P$-value |
| Patients included only within the last 10 years ${ }^{\text {a }}$ | 10 | 7245 | 1.750 | 1.167-2.623 | 0.007 | 0.0 | 0.886 |
| Type of valve ${ }^{\text {a }}$ |  |  |  |  |  |  |  |
| Only mechanical | 14 | 3431 | 1.678 | 1.145-2.457 | 0.008 | 40.8 | 0.088 |
| Only bioprosthesis | 9 | 6251 | 1.330 | 0.858-2.060 | 0.203 | 0.0 | 0.491 |
| iEOA measurement ${ }^{\text {a }}$ |  |  |  |  |  |  |  |
| In vitro | 10 | 15241 | 1.787 | 1.450-2.203 | <0.001 | 9.9 | 0.350 |
| In vivo | 32 | 77286 | 1.272 | 1.071-1.512 | 0.006 | 27.6 | 0.077 |
| Doppler echocardiography | 17 | 8791 | 1.799 | 1.309-2.472 | <0.001 | 0.0 | 0.565 |

${ }^{\text {a Comparing moderate/severe PPM with non-significant/no PPM. }}$
Cl : confidence interval; iEOA: indexed effective orifice area; OR: odds ratio; PPM: patient-prosthesis mismatch.

