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Racial Difference of Prosthesis-Patient Mismatch After TAVR

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Disclosure

- I have no disclosure.

Prosthesis-Patient Mismatch(PPM)

- Was first introduced in 1978 by Rahimtoola.

"Mismatch can be considered to be present when the effective prosthetic valve area, after insertion into the patient, is less than that of a normal human valve"

PPM occurs when the effective orifice area of the prosthesis is too small in relation to the patient's body size resulting in abnormally high postoperative gradients.

Circulation. 1978;58:20-24.

PPM has been the Indexed EOA

$$\textbf{Indexed EOA} = \frac{\text{EOA of the prosthesis}}{\text{Patient's body surface area (BSA)}}$$

EOA (effective orifice area) = a physiologic parameter derived from hydraulic principles and corresponding to the actual area occupied by flow as it exit the valve; directly related to hemodynamic and gradients.

Current Definition of PPM after TAVR

- By VARC-3 Definition

If BMI < 30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	> 0.85
Moderate	0.85-0.66
Severe	≤0.65

If BMI ≥30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	> 0.70
Moderate	0.70 – 0.56
Severe	≤ 0.55

JACC 2021;77(21):2717-46.

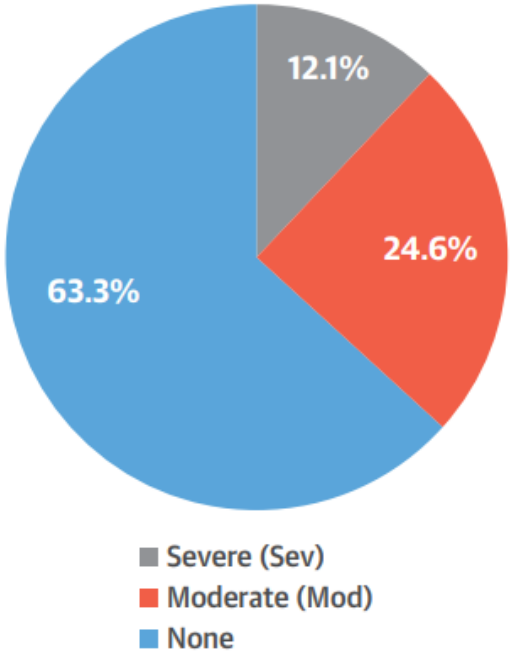
Clinical Impacts of PPM after TAVR

Previous studies

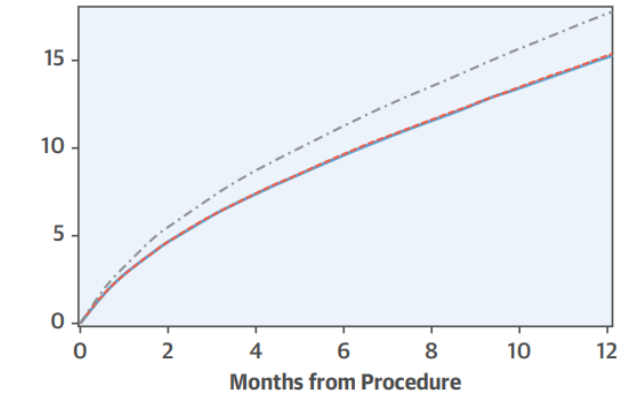
PPM after TAVR in STS/ACC TVT registry

62,125 patients, 2014~2017, USA

Severe PPM 12%
Moderate PPM 25%



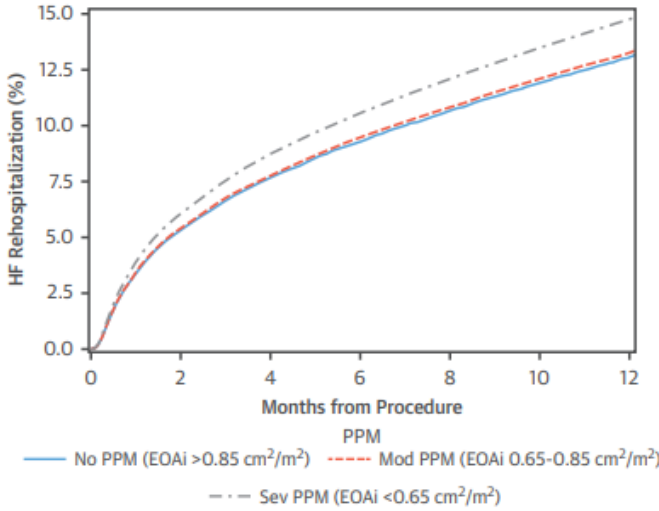
All cause mortality



Number at Risk Adjusting for Baseline Covariates:

	Day 0	Month 4	Month 8	Month 12
No PPM	23,635	21,080	16,734	13,136
Mod PPM	8,983	7,995	6,277	4,831
Sev PPM	4,152	3,626	2,976	2,130

HF Hospitalization



Number at Risk Adjusting for baseline covariates:

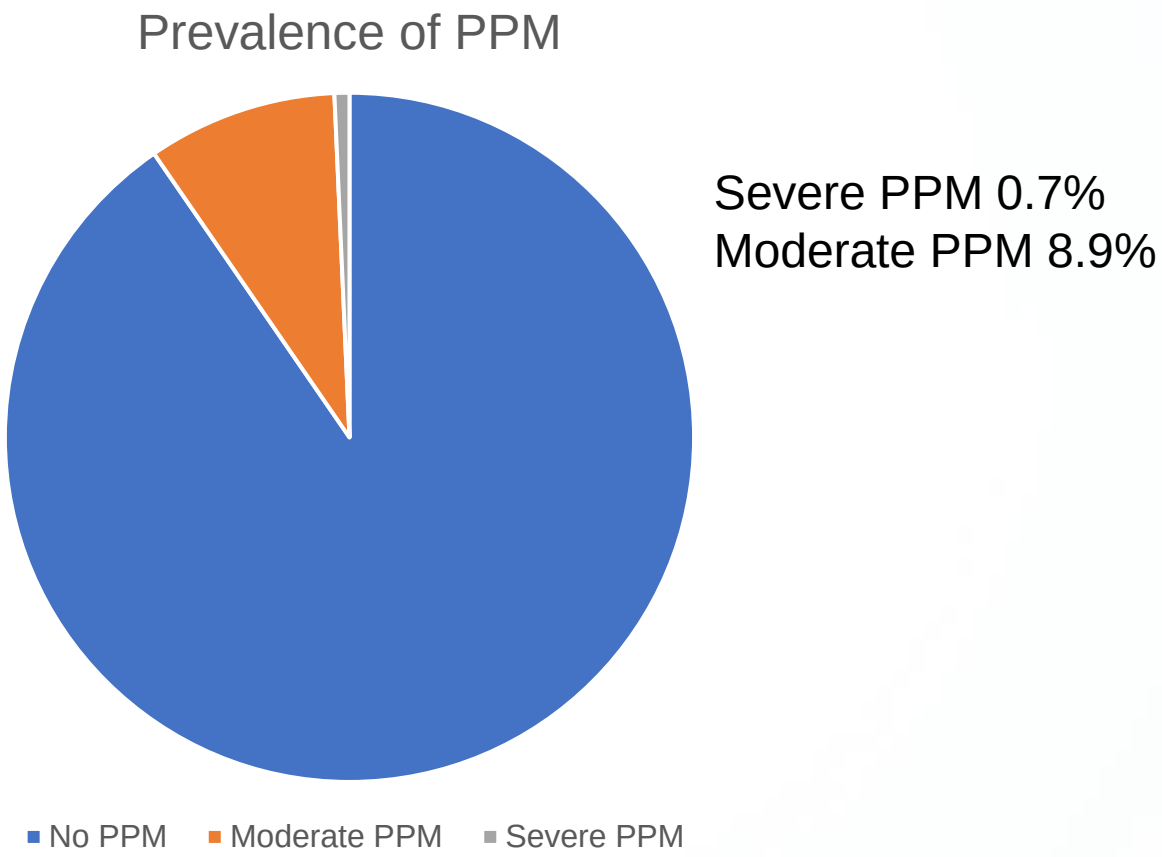
	Day 0	Month 4	Month 8	Month 12
No PPM	23,642	19,561	15,086	11,502
Mod PPM	8,986	7,386	5,581	4,183
Sev PPM	4,153	3,328	2,475	1,819

Severe PPM was associated with higher mortality and HF hospitalization.

JACC 2018;72(22):2701-2711.

PPM after TAVR in OCEAN-TAVI registry

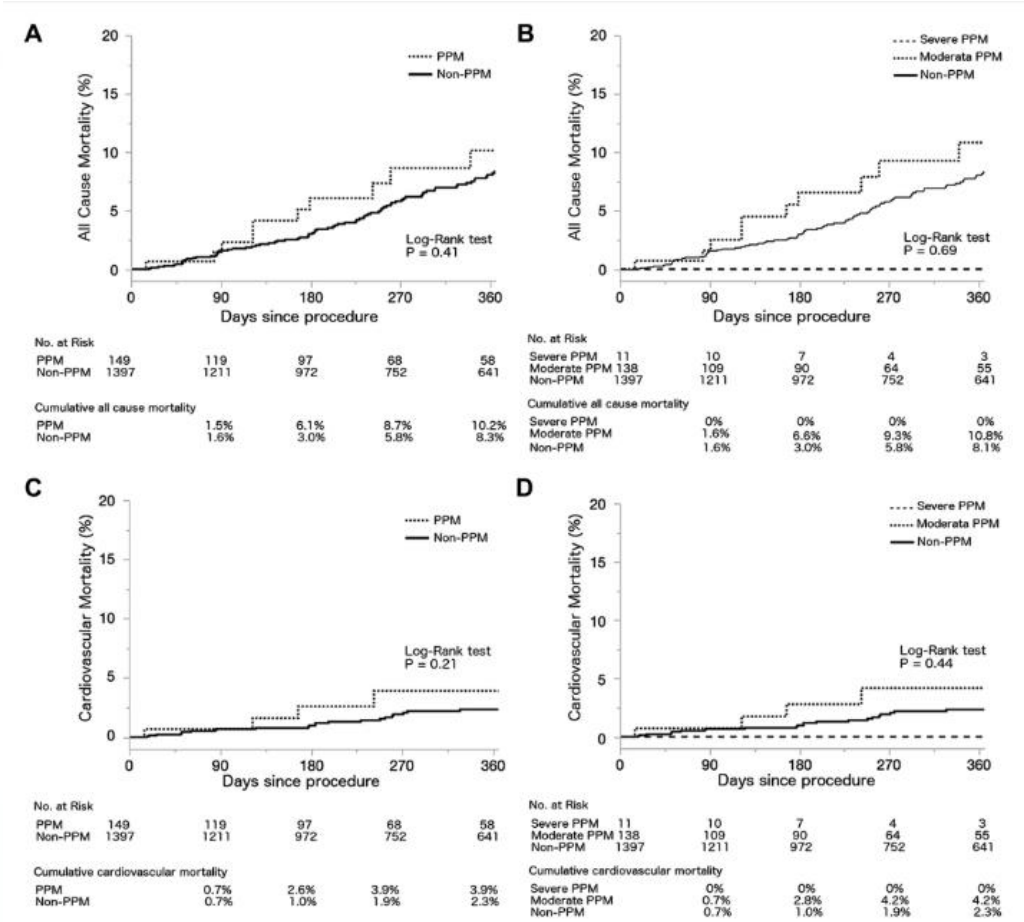
1,558 patients, Japan



JACC Intv 2018;11:771-80.

Clinical impacts of PPM

1,558 patients, Japan

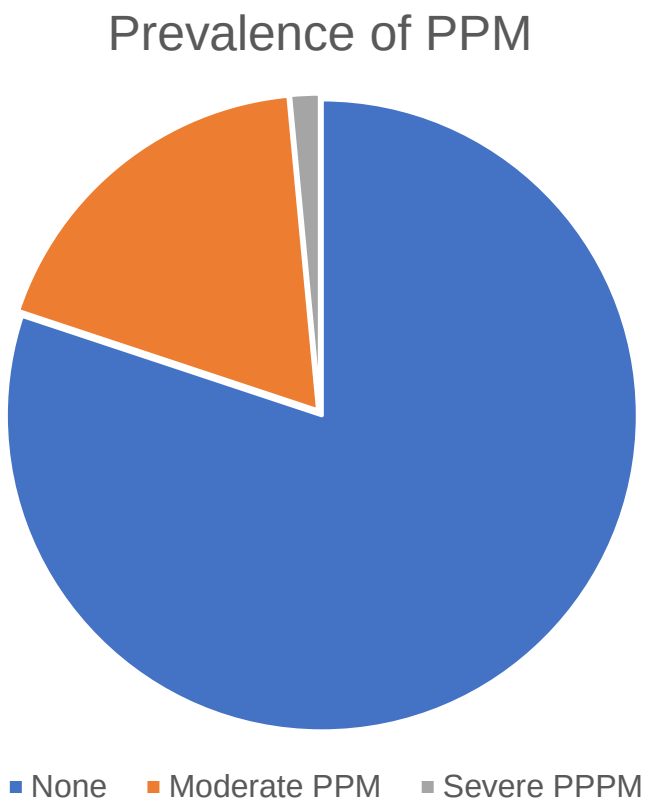


PPM was not associated with poor clinical outcomes.

JACC Intv 2018;11:771-80.

PPM after TAVR in Taiwan

201 patients, Taiwan

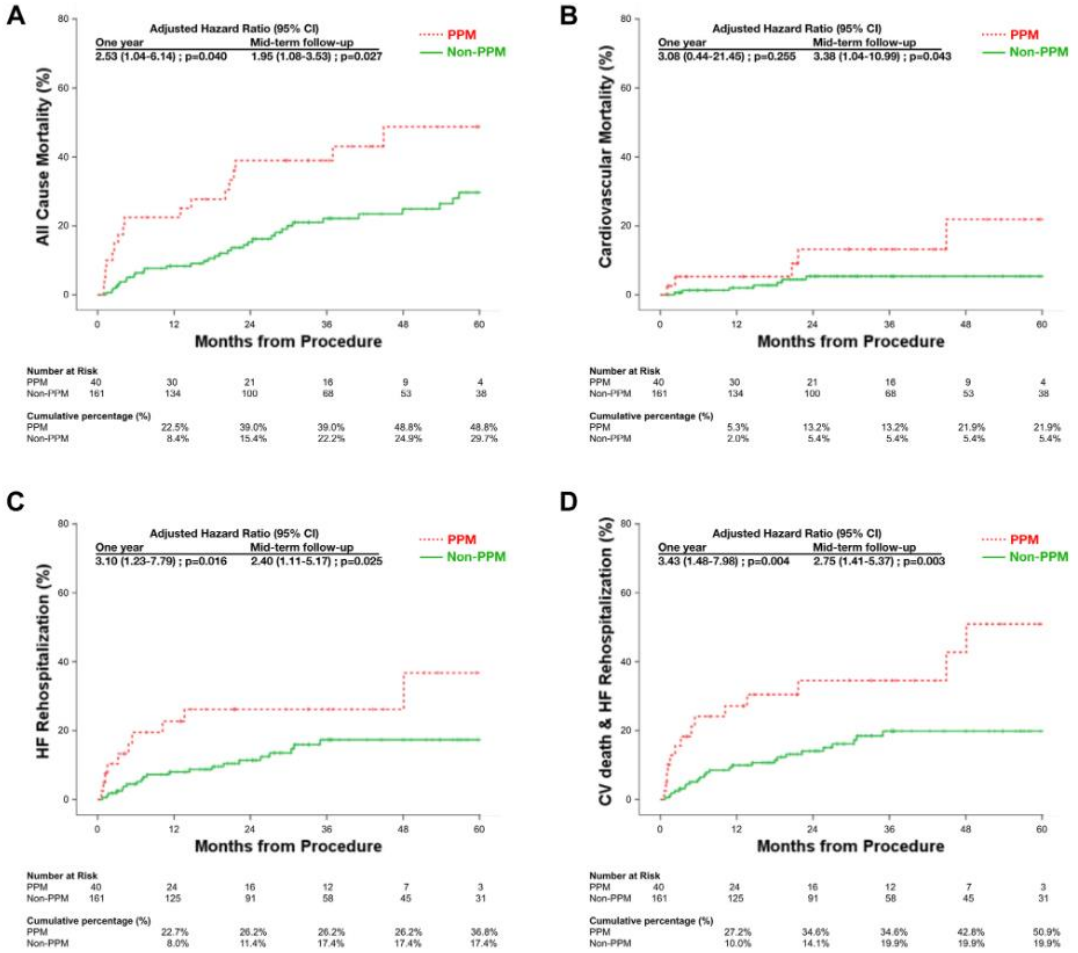


Severe PPM 1.5%
Moderate PPM 18.4%

Ann Thorac Surg 2021.

Clinical impacts of PPM

201 patients, Taiwan



PPM was associated with all-cause mortality and HF hospitalization

Ann Thorac Surg 2021.

Summary of previous studies

	STS/ACC-TVT USA (N=62,125)	OCEAN-TAVI Japan (N=1,558)	Taiwan (N=201)
Overall PPM	37%	10%	20%
Moderate PPM	25%	9%	18%
Severe PPM	12%	1%	2%
Clinical impact of Severe PPM			

Asian population had a relative low prevalence of PPM than the Western population.
Clinical impact of PPM is still controversial.

Summary of previous studies

- PPM after TAVR might be of more concern in Asian populations considering their relatively smaller annular size and valve implant size compared with Western populations.

- However, Evidences from the Asian population on PPM after TAVR are still limited compared with Western population.

- There are no studies directly comparing inter-racial differences about PPM after TAVR.

Racial Differences in the Incidence and Impact of Prosthesis-Patient Mismatch After Transcatheter Aortic Valve Replacement

Hanbit Park, MD,[a,*] Jung-Min Ahn, MD,[a,*] Do-Yoon Kang, MD,[a] Juyong Brian Kim, MD,[b] Alan C. Yeung, MD,[b] Takeshi Nishi, MD,[b] William F. Fearon, MD,[b] Eric Page Cantey, MD,[c] James D. Flaherty, MD,[c] Charles J. Davidson, MD,[c] S. Christopher Malaisrie, MD,[c] Sehee Kim, PhD,[d] Sung-Cheol Yun, PhD,[d] Euihong Ko, MD,[a] Seung-Ah Lee, MD,[a] Dae-Hee Kim, MD,[a] Ho Jin Kim, MD,[e] Joon Bum Kim, MD,[e] Suk Jung Choo, MD,[e] Duk-Woo Park, MD,[a] Seung-Jung Park, MD[a]

JACC Intv 2021;14(24):2670-2681.

TransPacific-TAVR registry

- International, multi center, observational cohort
- All consecutive patients with symptomatic severe AS who have undergone TAVR.

Asan Medical Center
Republic of Korea

Northwestern Hospital
USA

Stanford Hospital
USA

Definition of PPM

By VARC-2 Definition

If BMI < 30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	> 0.85
Moderate	0.85-0.66
Severe	≤0.65

If BMI ≥30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	> 0.70
Moderate	0.70 – 0.61
Severe	≤ 0.60

Definition of PPM

By Chinese Society of Echocardiology = VARC-3

If BMI < 30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	> 0.85
Moderate	0.85-0.66
Severe	≤0.65

If BMI ≥30 kg/m²

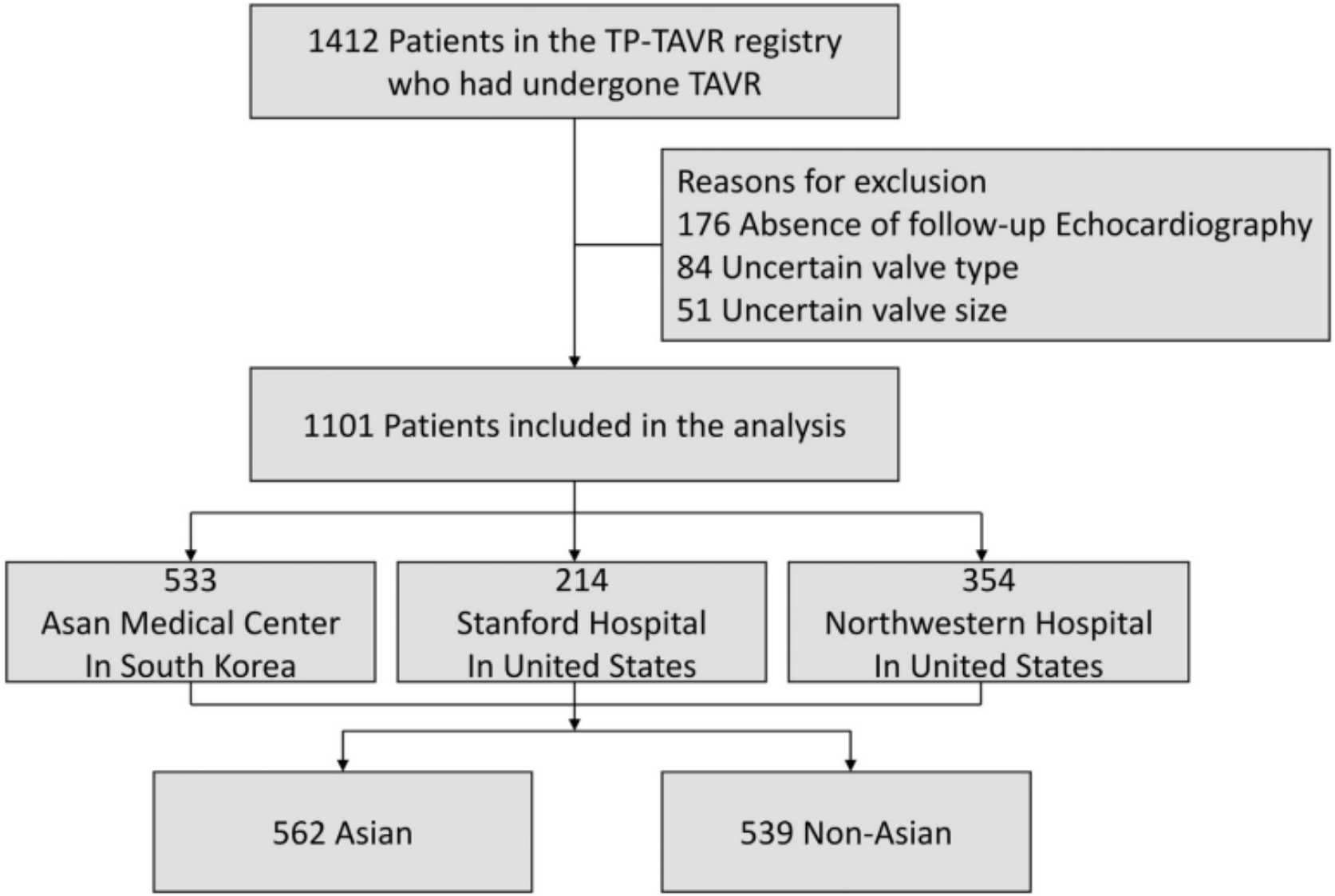
Severity	Indexed EOA (cm²/m²)
Insignificant	> 0.70
Moderate	0.70 – 0.56
Severe	≤ 0.55

Study outcomes

- **Primary outcome**: a composite of death from any cause, stroke or rehospitalization at 1 year

- **Secondary outcomes**
  - ✓ Each component of the primary outcome
  - ✓ Procedural complications
  - ✓ In-hospital Events

2015 ~ 2019


1412 Patients in the TP-TAVR registry who had undergone TAVR
Reasons for exclusion
176 Absence of follow-up Echocardiography
84 Uncertain valve type
51 Uncertain valve size
1101 Patients included in the analysis
533
Asan Medical Center
In South Korea
214
Stanford Hospital
In United States
354
Northwestern Hospital
In United States
562 Asian
539 Non-Asian

Baseline characteristics

	Asian	Non-Asian	P value
Age, year	80.1 ± 5.6	78.8 ± 9.5	0.22
Male	285 (50.9)	310 (57.5)	0.03
BMI, kg/m^2	24.0 ± 3.6	28.5 ± 6.6	<0.001
BSA, m^2	1.60 ± 0.17	1.91 ± 0.29	<0.001
STS score, %	3.3 (2.9-4.9)	4.1 (3.0-6.8)	<0.001
Diabetes	297 (52.8)	186 (34.5)	<0.001
Hypertension	490 (87.2)	445 (82.6)	0.03
Hyperlipidemia	421 (74.9)	382 (70.9)	<0.001
Prior stroke	76 (13.5)	56 (10.4)	0.11
Atrial fibrillation	65 (11.6)	213 (39.5)	<0.001
Peripheral artery disease	18 (3.2)	113 (21.0)	<0.001
Chronic kidney disease	421 (74.9)	158 (29.3)	<0.001
Chronic lung disease	61 (10.9)	82 (15.2)	0.03

Echocardiography/CT findings

	Asian	Non-Asian	P value
Echocardiographic findings			
Bicuspid AV	57 (10.1)	25 (4.6)	0.001
Aortic valve area, mm^2	0.60 (0.50-0.71)	0.70 (0.59-0.84)	<0.001
Mean PG, mmHg	57 ± 21	45 ± 14	<0.001
LV ejection fraction, %	58 ± 11	58 ± 13	0.48
Moderate to severe AR	107 (19.0)	58 (10.8)	<0.001
Moderate to severe MR	66 (11.7)	113 (21.0)	<0.001
Moderate to severe TR	34 (6.0)	84 (15.6)	<0.001
CT findings			
Annular perimeter, mm	75.7 ± 7.5	78.4 ± 8.4	<0.001
Annular area, mm^2	441 ± 87	461 ± 95	<0.001

Procedural characteristics

	Asian	Non-Asian	P value
Valve-in-valve procedure	17 (3.0)	28 (5.2)	0.07
Transfemoral approach	539 (95.9)	517 (95.9)	0.99
Valve type			0.12
Balloon expandable	466 (82.9)	465 (86.3)	
Self expandable	96 (17.1)	74 (13.7)	
Size of the SAPIEN series			0.80
20 mm	8 (1.4)	17 (3.2)	
23 mm	142 (25.3)	149 (27.6)	
26 mm	233 (41.5)	194 (36.0)	
29 mm	81 (14.4)	105 (19.5)	
Conscious sedation	445 (79.2)	292 (54.2)	<0.001
Post-dilation performed	365 (64.9)	120 (22.3)	<0.001

Procedural complications

	Asian	Non-Asian	P value
Moderate to severe PVL	20 (3.6)	1 (0.2)	<0.001
Conversion to open heart surgery	0 (0.0)	3 (0.6)	0.12
Life-threatening/disabling bleeding	23 (4.1)	4 (0.7)	<0.001
Major vascular complication	24 (4.3)	8 (1.5)	0.006
New requirement for dialysis	7 (1.2)	0 (0.0)	0.02
New permanent pacemaker	32 (5.7)	69 (12.8)	<0.001
Myocardial infarction	6 (1.1)	3 (0.6)	0.51
New-onset atrial fibrillation	11 (2.0)	19 (3.5)	0.11
Major or disabling stroke	15 (2.7)	11 (2.0)	0.49
In-hospital death	3 (0.5)	0 (0.0)	0.25

Post-Procedural Echo

30 days after index TAVR

TABLE 3 Postprocedural Echocardiographic Data and Pattern of PPM According to Racial Groups

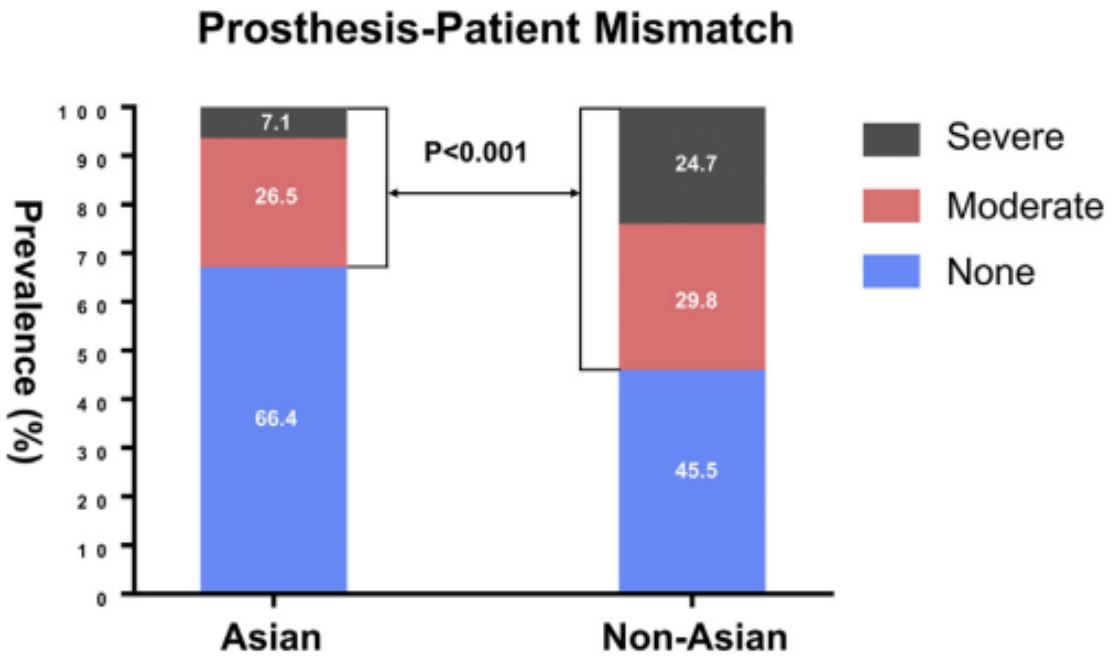
	Asian Group				Non-Asian Group				
	Overall (N = 562)	PPM (n = 189)	No PPM (n = 373)	*P* Value	Overall (n = 539)	PPM (n = 294)	No PPM (n = 245)	*P* Value	*P* Value[a]
LV ejection fraction, %	59 ± 9	59 ± 9	60 ± 9	0.16	58 ± 12	57 ± 12	59 ± 12	0.04	0.02
EOA, cm^2	1.50 ± 0.37	1.18 ± 0.18	1.67 ± 0.33	<0.001	1.52 ± 0.49	1.22 ± 0.25	1.88 ± 0.45	<0.001	0.56
Indexed EOA, cm^2/m^2	0.94 ± 0.22	0.73 ± 0.10	1.05 ± 0.18	<0.001	0.80 ± 0.25	0.63 ± 0.12	1.01 ± 0.20	<0.001	<0.001
Moderate PPM[a]	149 (26.5)	149 (78.8)	0	NA	161 (29.8)	161 (54.8)	0	NA	NA
Severe PPM[a]	40 (7.1)	40 (21.2)	0	NA	144 (24.7)	133 (45.2)	0	NA	NA
Peak velocity, m/s	2.5 ± 0.5	2.7 ± 0.5	2.4 ± 0.4	<0.001	2.4 ± 0.5	2.5 ± 0.5	2.2 ± 0.5	<0.001	<0.001
Pressure gradient, mm Hg	13 ± 5	16 ± 6	12 ± 4	<0.001	12 ± 6	14 ± 6	10 ± 4	<0.001	<0.001
≥20	68 (12.1)	43 (22.8)	25 (6.7)	<0.001	47 (8.7)	41 (13.9)	6 (2.4)	<0.001	0.70
≥40	1 (0.2)	1 (0.5)	0 (0.0)	0.34	0 (0.0)	0 (0.0)	0 (0.0)	>0.99	0.51
Paravalvular leakage, moderate to severe	20 (3.6)	4 (2.1)	16 (4.3)	0.19	1 (0.2)	0 (0.0)	1 (0.4)	0.46	0.45
Moderate to severe MR	28 (5.0)	10 (5.3)	18 (4.8)	0.81	26 (4.8)	13 (4.4)	13 (5.3)	0.63	0.28
Moderate to severe TR	26 (4.6)	9 (4.8)	17 (4.6)	0.91	34 (6.3)	19 (6.5)	15 (6.1)	0.87	0.51

Values are mean ± SD or n (%). [a]*P* value for comparison between the Asian group and the non-Asian group.

EOA = effective orifice area; NA = not available; other abbreviations as in Table 1.

Prevalence of PPM

By VARC-2 criteria

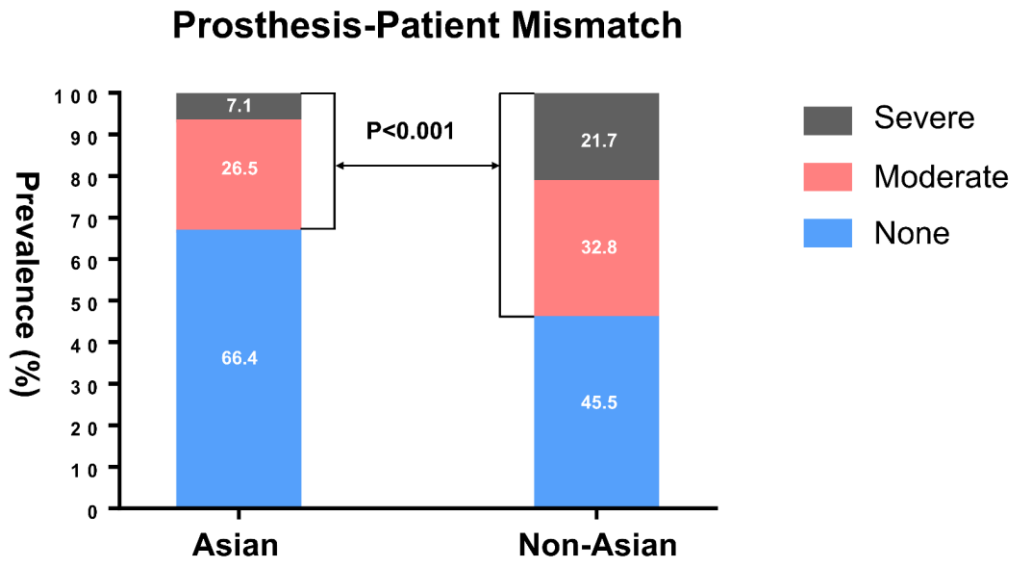


Asian **Severe PPM 7%**
Moderate PPM 27%

Non-Asian **Severe PPM 25%**
Moderate PPM 30%

Prevalence of PPM

By Chinese society of echocardiology criteria = VARC-3 criteria



Asian **Severe PPM 7%**
Moderate PPM 27%

Non-Asian **Severe PPM 22%**
Moderate PPM 33%

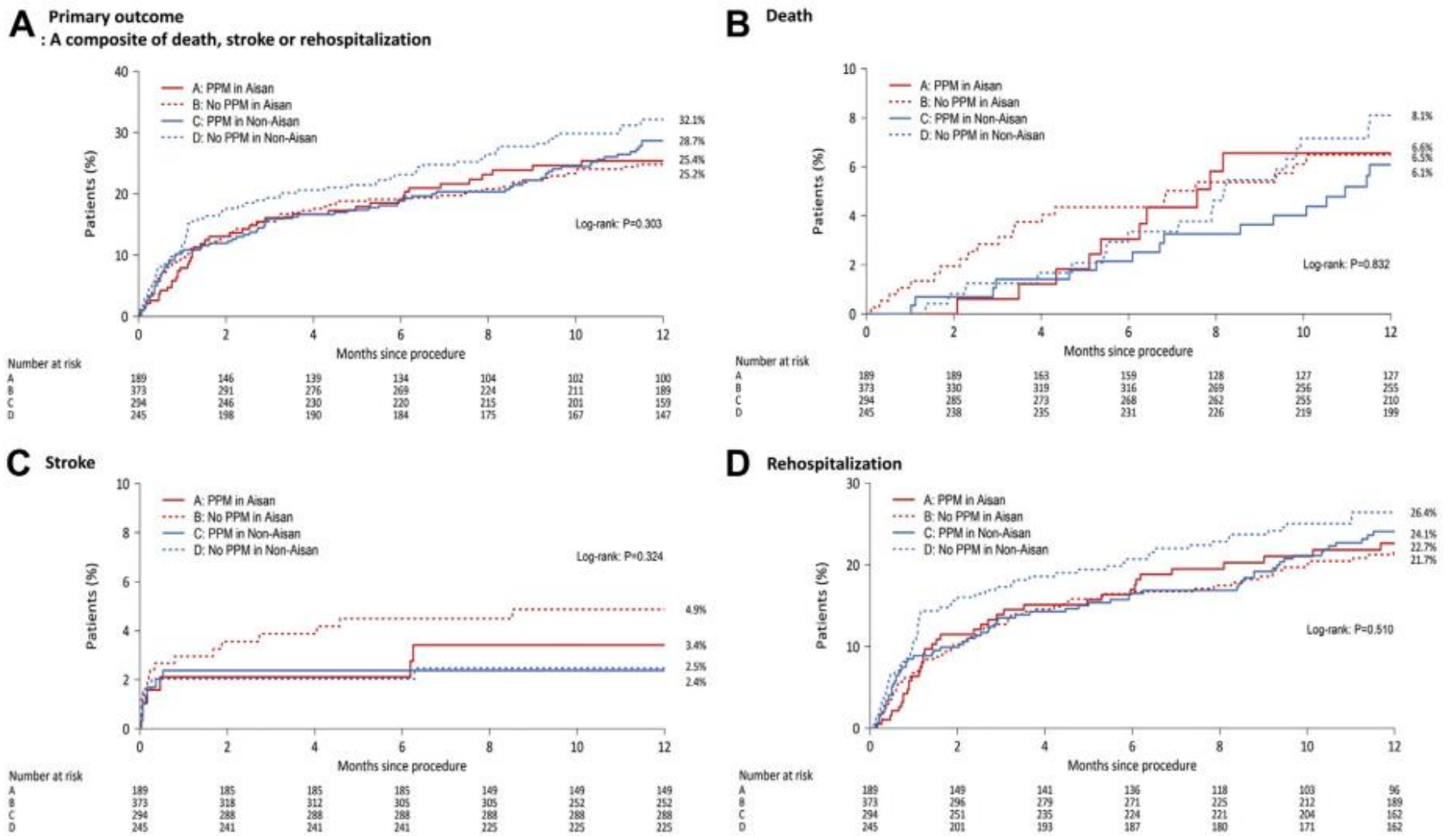
Predictors for PPM

TABLE 4 Multivariate Analyses for Independent Predictors of Moderate or Severe Prosthesis-Patient Mismatch

	Overall Group (N = 1,101)		Asian Group (n = 562)		Non-Asian Group (n = 539)	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Race: Asian vs non-Asian (referent)	0.43 (0.31-0.60)	<0.001	–	–	–	–
Age ≥80 y	0.81 (0.61-1.06)	0.12	0.98 (0.66-1.46)	0.92	0.66 (0.45-0.98)	0.04
BMI	1.03 (1.01-1.05)	0.046	1.06 (1.01-1.12)	0.03	1.00 (0.97-1.03)	0.87
BSA, per 0.1 m^2	1.43 (1.30-1.56)	<0.001	1.56 (1.36-1.79)	<0.001	1.37 (1.22-1.53)	<0.001
Prior CABG	1.52 (1.01-2.30)	0.047	1.71 (0.75-3.91)	0.21	1.44 (0.88-2.45)	0.14
Atrial fibrillation or flutter	1.26 (0.92-1.72)	0.15	0.90 (049-1.64)	0.73	1.47 (1.00-2.15)	0.05
Chronic kidney disease	0.97 (0.73-1.30)	0.85	0.74 (0.47-1.16)	0.18	1.27 (0.85-1.89)	0.24
Aortic valve area	0.27 (0.12-0.60)	0.001	0.22 (0.05-1.02)	0.053	0.29 (0.11-0.75)	0.01
Mean pressure gradient, per 10 mm Hg	0.99 (0.91-1.07)	0.79	0.94 (0.84-1.05)	0.29	1.09 (0.95-1.26)	0.23
Bicuspid aortic valve	0.67 (0.40-1.13)	0.13	0.79 (0.40-1.57)	0.50	0.63 (0.27-1.45)	0.28
LV ejection fraction ≤40%	0.76 (0.49-1.18)	0.22	0.76 (0.39-1.48)	0.43	0.80 (0.44-1.46)	0.47
Moderate to severe TR at baseline	1.29 (0.84-1.99)	0.24	2.52 (1.16-5.46)	0.02	0.97 (0.58-1.63)	0.91
Valve perimeter	0.94 (0.88-1.01)	0.10	0.97 (0.87-1.09)	0.64	0.94 (0.86-1.02)	0.11
Valve area, per 100 mm^2	1.22 (0.67-2.23)	0.52	0.81 (0.30-2.21)	0.68	1.45 (0.70-2.97)	0.31
Balloon-expandable THV	1.37 (0.94-2.02)	0.11	1.31 (0.76-2.26)	0.32	1.60 (0.92-2.78)	0.10
Postdilation performed	0.74 (0.55-0.99)	0.049	0.87 (0.58-1.33)	0.53	0.72 (0.46-1.12)	0.14

OR = odds ratio; THV = transcatheter heart valve; other abbreviations as in Table 1.

Clinical impacts of PPM



No significant difference between PPM and no PPM group regardless of racial group.

Clinical impacts of severe PPM

By VARC-2 criteria

	Unadjusted HR (95% CI)			
	Marginal analysis	Interaction analysis		
	Overall	Asian	Non-Asian	Interaction P
Primary outcome				0.76
No PPM	Reference	Reference	Reference	
Moderate PPM	0.93(0.71-1.22)	0.99(0.67-1.48)	0.88(0.61-1.27)	
Severe PPM	0.88(0.62-1.24)	1.07(0.54-2.14)	0.81(0.54-1.21)	
Death				0.30
No PPM	Reference	Reference	Reference	
Moderate PPM	0.75(0.41-1.36)	1.08(0.49-2.36)	0.50(0.20-1.25)	
Severe PPM	0.96(0.48-1.92)	0.46(0.06-3.45)	1.02(0.47-2.20)	

No significant difference between severe PPM and no PPM group regardless of racial group.

Clinical impacts of severe PPM

By VARC-2 criteria

	Unadjusted HR (95% CI)			
	Marginal analysis	Interaction analysis		
	Overall	Asian	Non-Asian	Interaction P
Stroke				0.19
No PPM	Reference	Reference	Reference	
Moderate PPM	0.73(0.33-1.64)	0.43(0.13-1.49)	1.29(0.39-4.21)	
Severe PPM	0.96(0.35-2.61)	1.70(0.50-5.82)	0.62(0.12-3.06)	
Rehospitalization				0.73
No PPM	Reference	Reference	Reference	
Moderate PPM	1.00(0.74-1.34)	1.06(0.69-1.62)	0.94(0.63-1.41)	
Severe PPM	0.84(0.57-1.24)	1.08(0.52-2.24)	0.77(0.49-1.21)	

No significant difference between severe PPM and no PPM group regardless of racial group.

Study limitations

- Selection bias: a non-randomized, observational study
- Inter-site variability: multicenter registry
- Weak generality: mainly balloon expandable valves (>80%) and high volume centers
- No core laboratory evaluation for echocardiographic or computed tomographic data
- Relatively small sample size and short-term follow-up period

Take home message

- **Asian population** had a significantly **lower incidence of PPM** than non-Asian population.

- In our observational cohort, the MACE was similar between the PPM and no PPM groups regardless of race (Asian vs. non-Asian population). However **the clinical impact of PPM after TAVR is still controversial.**

- Further long-term follow-up studies are required to define universal and clinically relevant PPM and address its long-term clinical outcomes and related racial disparity.