Activité physique en cas de fuite ou de dilatation aortique

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Conflits d’intérêt

Au cours des 3 années précédentes, j’ai été rémunéré pour des actions de communication ou d’expertise médicale par les sociétés suivantes :

- Novo Nordisk
- Astra Zeneca
- Les Laboratoires Servier

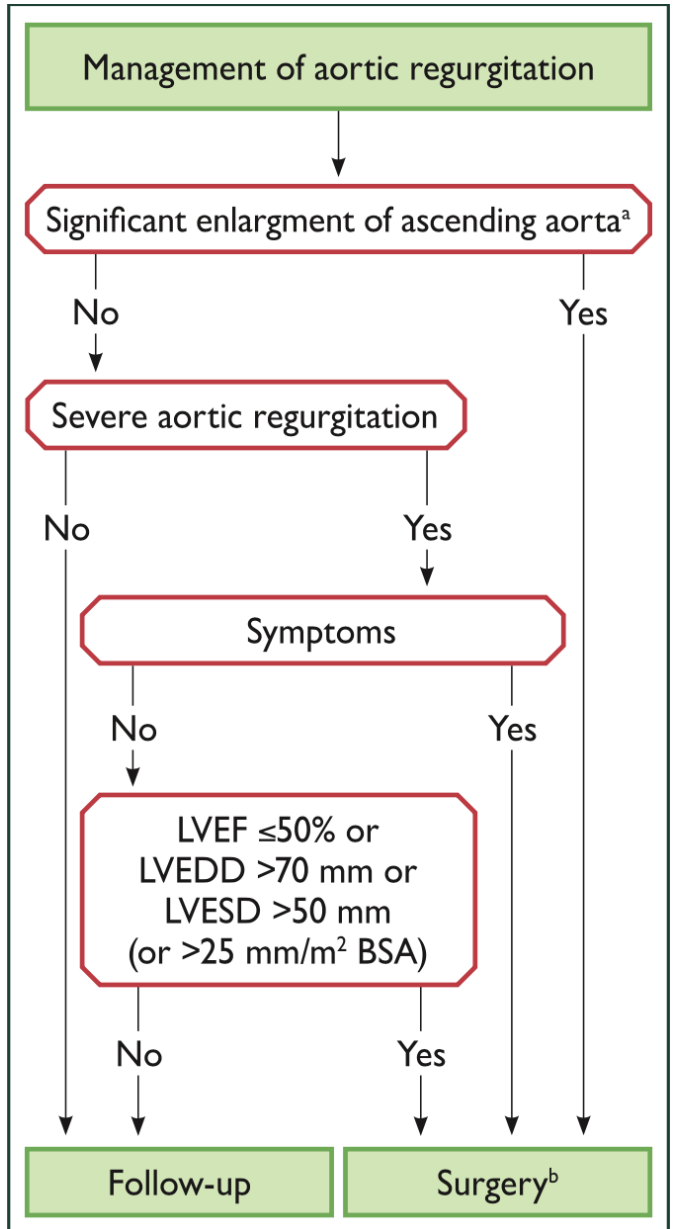
L'insuffisance aortique, un problème ?

- La réalité est une excellente tolérance dans le cadre de l'activité physique, même en cas de fuite sévère car la tachycardie diminue l'importance de la fuite…
- Pas de réelle spécificité chez le sportif, ce qui compte c'est la taille de l'aorte… et la FEVG

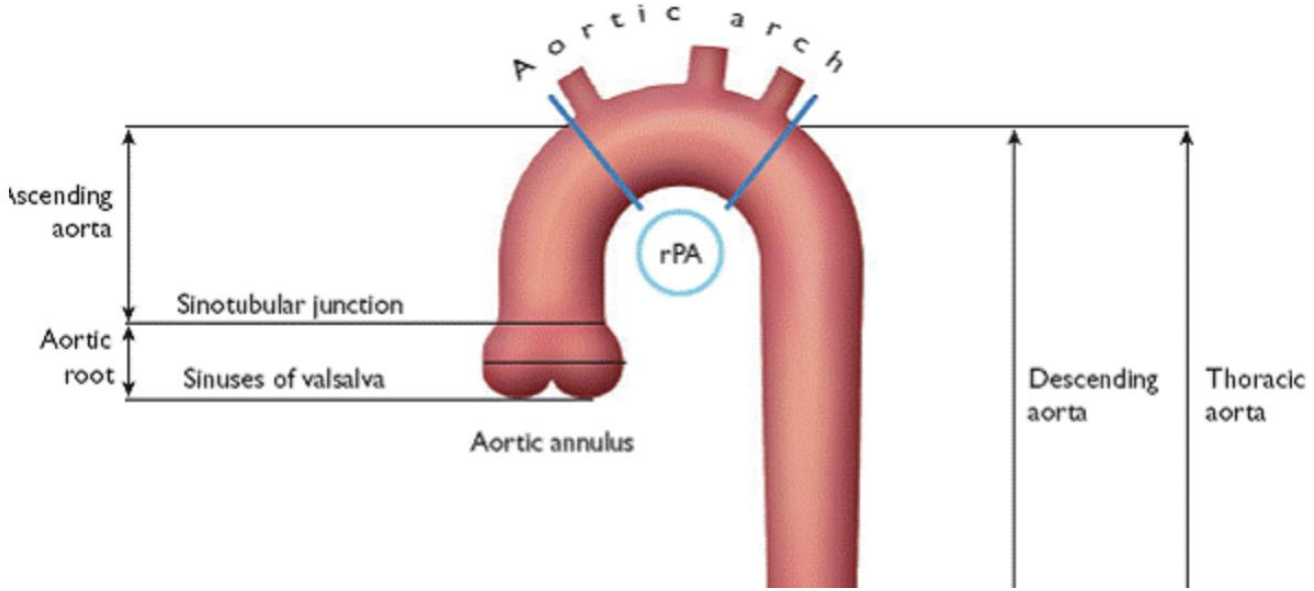
Recommendations for participation in competitive sports in asymptomatic individuals with aortic regurgitation

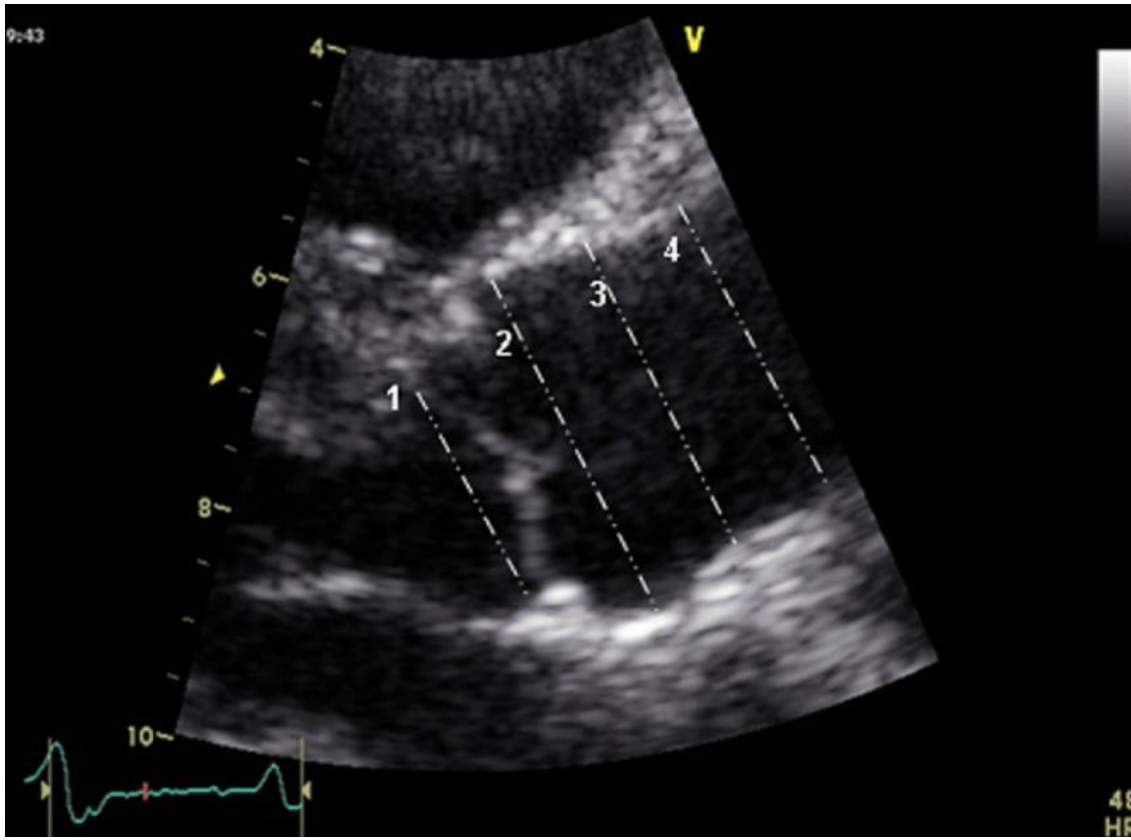
	Aortic regurgitation[c]		
	Recommendation	**Class[a]**	**Level[b]**
Mild	Participation in all competitive sports, if desired, is recommended.	I	C
Moderate	Participation in all competitive sports, if desired, should be considered in individuals with LVEF>50% and normal exercise test.	IIa	C
Severe	Participation in most competitive sports involving low to moderate intensity may be considered in individuals with a mild or moderately dilated LV with LVEF>50% and normal exercise stress test.	IIb	C
	Participation in any moderate- or high-intensity competitive sports is not recommended in individuals with severe AR and/or LVEF≤50% and/or exercise-induced arrhythmias	III	C

Pelliccia A et al. Eur Heart J 2020



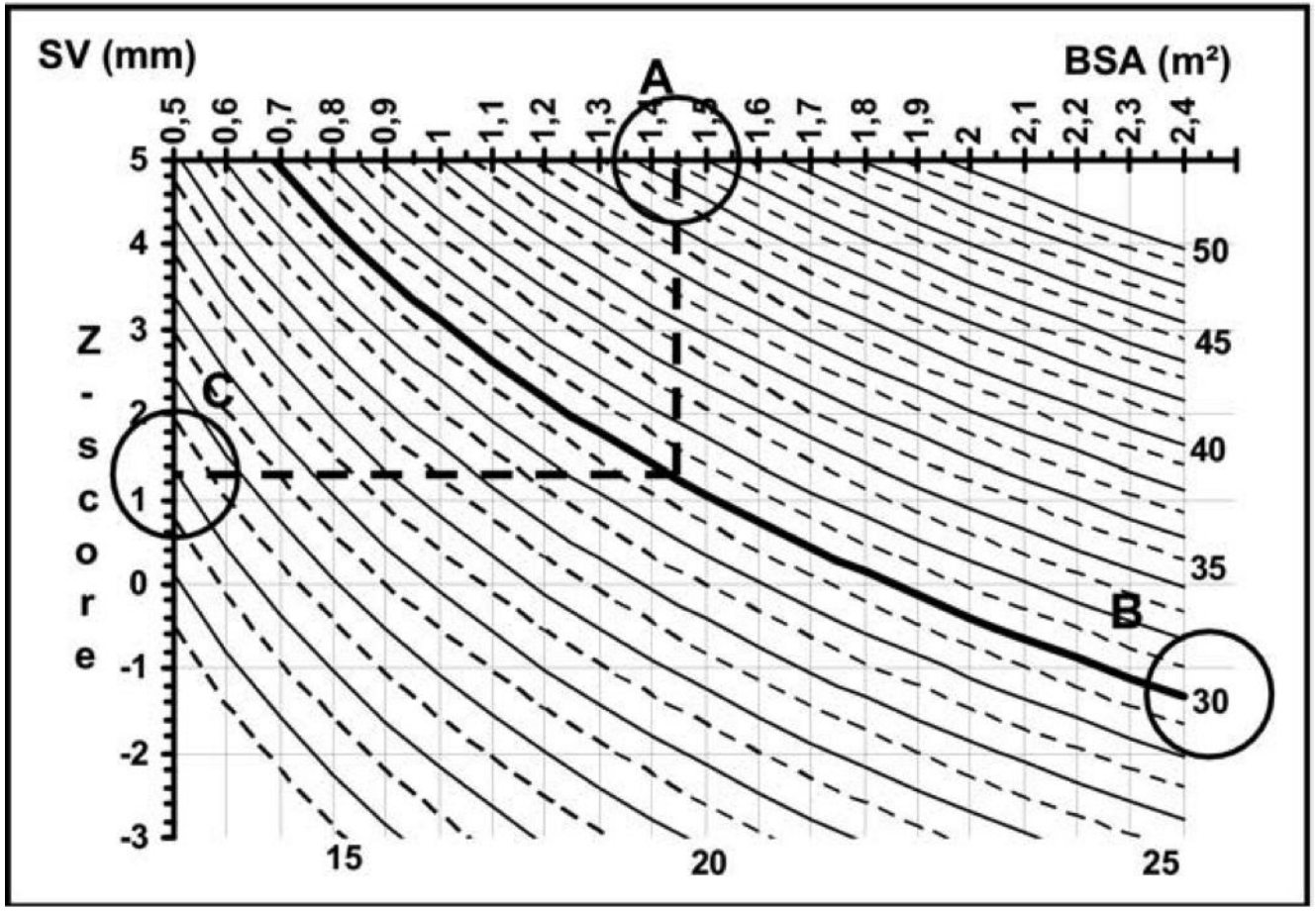
Aorte normale et dilatation/anévrisme aortique

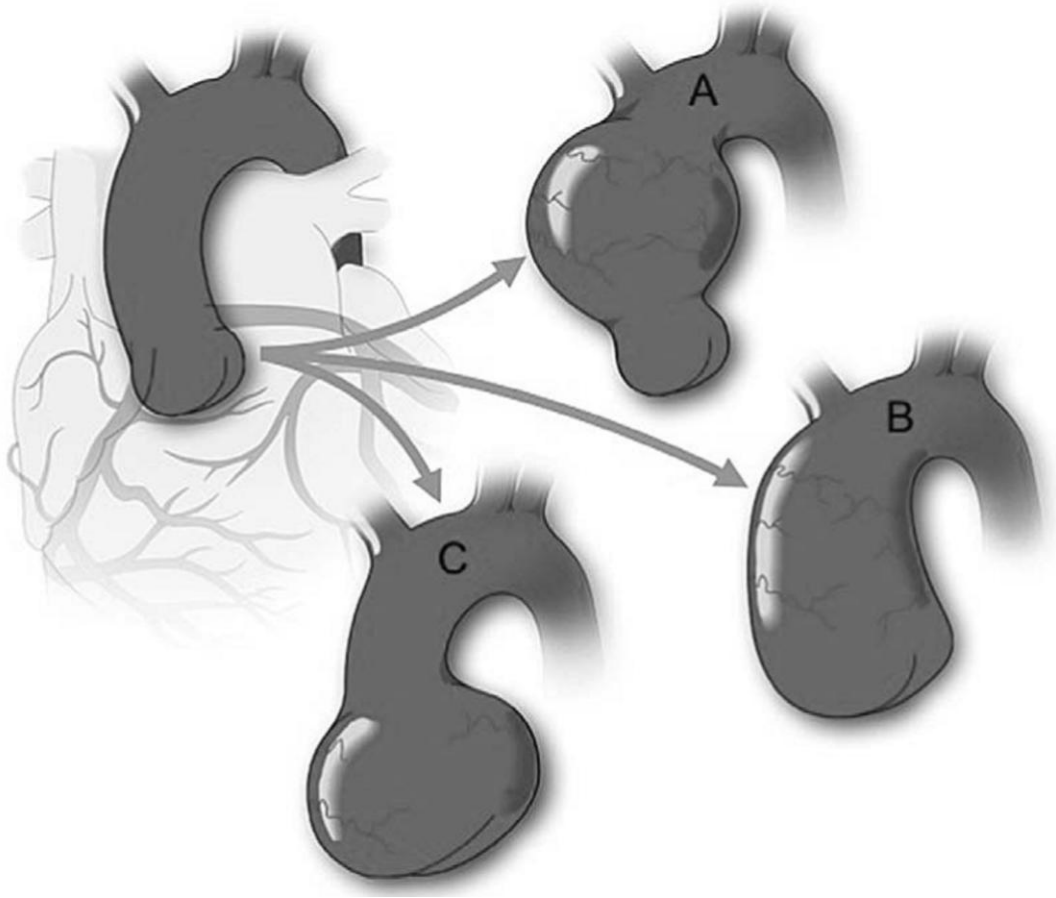




Aorte normale et dilatation/anévrisme aortique

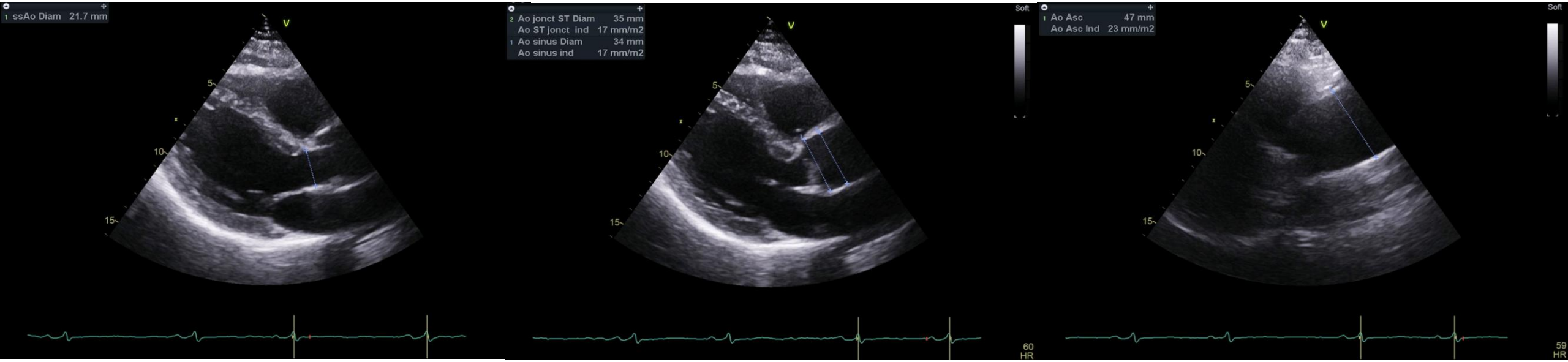
- https://www.marfan.fr/accueil/zscore/





Monsieur G, 67 ans

- Consulte à distance d'un épisode de diplopie transitoire sans argument pour un accident neurovasculaire (IRM cérébrale normale, EDTSA normal, Holter ECG montrant une extrasystolie supra-ventriculaire sans FA, ECG normal, ETT…)
- PA 141/89, FC 52/min, clinique RAS
- GAJ 1,12 g/L, HDL 0,78 g/L, LDL 1,21 g/L



Etat des lieux des dimensions de l'aorte ascendante chez les sportifs

- 3781 athlètes (UK) de 19 +/- 5,3 ans, 63,3% H, suivis en moyenne 5 +/-1,5 ans.
- 0,17% H et 0,4% F > 99ème percentile (40 mm H, 38 mm F)
- Pas de progression…

Table 3 Mean aortic root diameter at the level of the sinuses of Valsalva in male and female athletes according to static, endurance and mixed sport

Sports category	Male athletes (n=2393)	Female athletes (n=1388)	P valve
Static sport	(n=200) 27.7±3.5 Ao>40 mm=1	(n=459) 26.7±3.8 Ao>38 mm=3	0.002
Endurance sport	(n=584) 29.7±4.0 Ao>40 mm=8	(n=337) 26.7±3.7 Ao>38 mm=3	<0.001
Mixed sport	(n=1609) 28.7±3.9 Ao>40 mm=4	(n=592) 26.8±4.0 Ao>38 mm=6	<0.001
P value	0.462	0.600	

Ao, aortic sinus of Valsalva diameter.

Table 2 Echocardiographic comparison between athletes and controls* This table is redundant and needs to come out. We do not make reference to it and the most important information (lines 3 and 4) is already in the text.

	Athletes (n=3781)	Controls (n=806)	P value
HR (bpm)	60.6±11.9	71.7±14.4	<0.001
Ao (mm)	28.3±4.1	27.8±4.1	0.010
Ao (mm/m^2)	15.5±2.1	15.4±2.0	0.019
Max-LVWT (mm)	9.2±1.3	8.8±1.2	<0.001
LVED (mm)	51.0±5.2	48.2±4.8	<0.001
LVM/BSA (g/m^2)	113±32	106±38.1	<0.001
LAD (mm)	34.0±6.0	31.7±8.7	<0.001
FS %	34.9±5.7	36.0±5.9	0.004
AV Vmax (cm/s)	1.36±2.4	1.49±4.1	0.101
E/A ratio	2.2±0.8	2.1±0.6	0.223

*Data are expressed as mean±SD.
Ao, aortic sinus of Valsalva diameter; AV Vmax, continuous wave aortic flow velocity; E/A, ratio of early diastolic mitral valve peak inflow velocity to late diastolic mitral valve inflow velocity; HR, heart rate; LA, left atrial diameter; LV FS, left ventricular fractional shortening; LVED, LV end-diastolic diameter; Max-LVWT, maximal left ventricular wall thickness in end diastole.

Gati S et al. Heart 2019

Etat des lieux des dimensions de l'aorte ascendante chez les sportifs

- 3821 athlètes élite espagnols (caucasiens), tous sports représentés

Table 1. Demographic Characteristics of White Elit

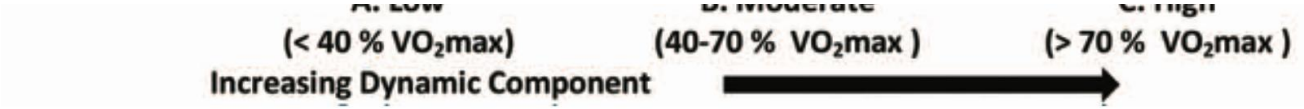
	Male (n=2039)	Female (n=124	
Age, y	24.1±5.8	21.5±5	
Height, cm	179.9±9.2	167±8	
Weight, kg	76.3±13.4	60.7±10.4	
BSA, m^2	1.9±0.2	1.7±0.2	
Training regimen, h/wk	19.2±8.7	19.2±9.9	
Duration of training, y	9.6±5.1	8±4.5	
Resting heart rate, bpm	58.3±10.3	62.7±11.1	
Systolic blood pressure, mm Hg	121.5±9.9	112.5±9.7	
Diastolic blood pressure, mm Hg	66.9±7.4	63±7.1	0.0001
VO_2max, mL/kg · min	57.3±9.1	48.4±7.7	0.0001

IIIA (n=591; F:285/M:306) | IIIB (n=147; F:64/M:83) | IIIC (n=578; F:163/M:415)

Table 3. Raw and Corrected Values of Aortic Root Size in White Elite Athletes

	Male (n=2039)		Female (n=1242)		
	Mean	P95	Mean	P95	*P* Value
Aortic M mode, mm	30.3±3.3	36.1	25.8±2.6	30.3	0.0001
Aortic annulus, mm	25.4±3.2	30.9	21.6±2.7	26.3	0.0001
Sinuses of Valsalva, mm	31.6±3.5	37.7	27.2±2.8	32.1	0.0001
Sinotubular junction, mm	26.4±3.3	32	23±2.7	27.4	0.0001
Proximal ascending aorta, mm	26.8±3.6	33	23.5±3.1	28.8	0.0001
Aortic M mode/BSA, mm/m^2	15.6±1.7	18.6	15.5±1.6	18.2	0.017
Aortic annulus/BSA, mm/m^2	13.1±1.7	16	12.9±1.7	15.8	0.007
Sinuses of Valsalva/BSA, mm/m^2	16.3±1.9	19.7	16.3±1.9	19.4	0.79
Sinotubular junction/BSA, mm/m^2	13.6±1.8	16.6	13.8±1.8	16.8	0.008
Proximal ascending aorta/BSA, mm/m^2	13.8±1.9	17.1	14.1±1.9	17.5	0.001

Inner–inner measures are presented as mean±standard deviation and 95th percentile. BSA indicates body surface area.



Boraita A. et al. Cir Cardiovasc Imag 2016

Etat des lieux des dimensions de l'aorte ascendante chez les sportifs chez l'athlète plus âgé

- Anciens cyclistes professionnels espagnols 40-60 ans (TDF, Vuelta, Giro)

TABLE 1. Descriptive characteristics by group.

Aortic Region	Cases (Former Professional Cyclists, *n* = 23) Mean	SD	Healthy Controls (*n* = 59) Mean	SD	*P*
Age (yr)	46	6	47	7	0.464
Body mass (kg)	76.5	9.9	81.4	12.3	0.092
Height (cm)	178	6	176	6	0.303
BSA (m^2)	1.94	0.15	1.99	0.17	0.248
BMI ($kg \cdot m^{-2}$)	27.2	3.2	25.7	2.7	**0.036**
Normal range, *n* (%)	16 (72)		23 (39)		**0.002**
Overweight, *n* (%)	5 (23)		36 (61)		
Obese, *n* (%)	1 (5)		—		
SBP (mm Hg)	125	9	125	8	0.334
DBP (mm Hg)	78	10	77	9	0.921

BSA was calculated as $0.007184 \times \text{height (cm)}^{0.725} \times \text{weight (kg)}^{0.425}$ (19). Significant *P* values are in boldface.

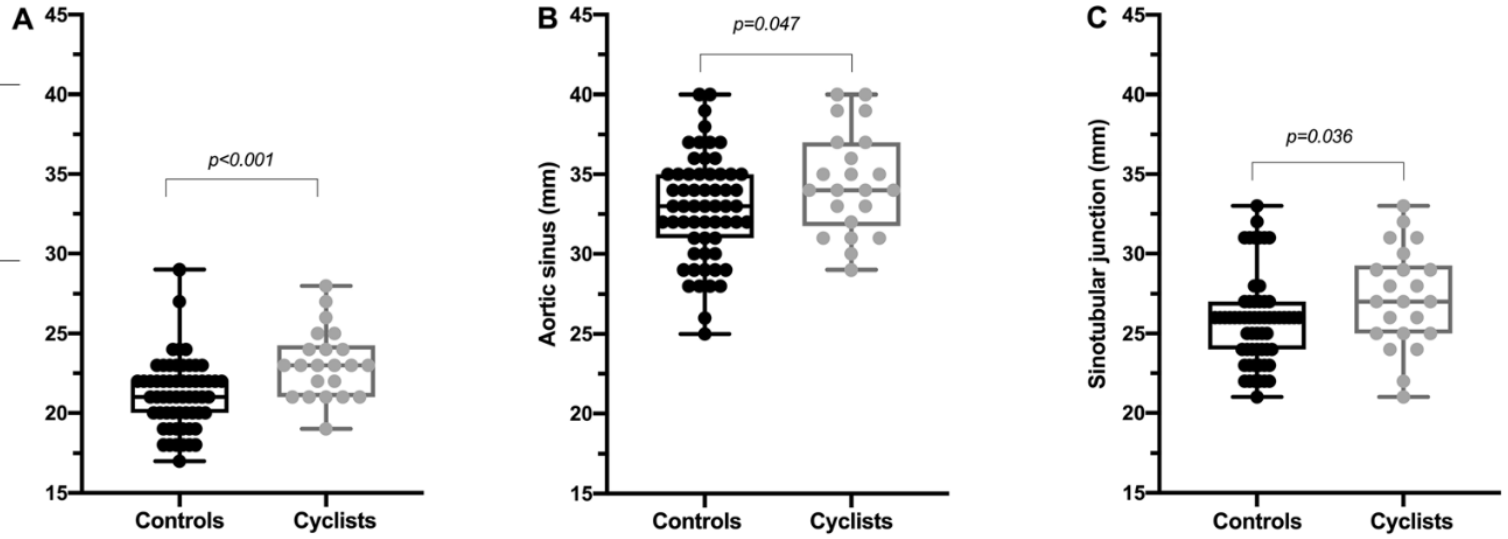


TABLE 4. Prevalence of aortic calcifications by group.

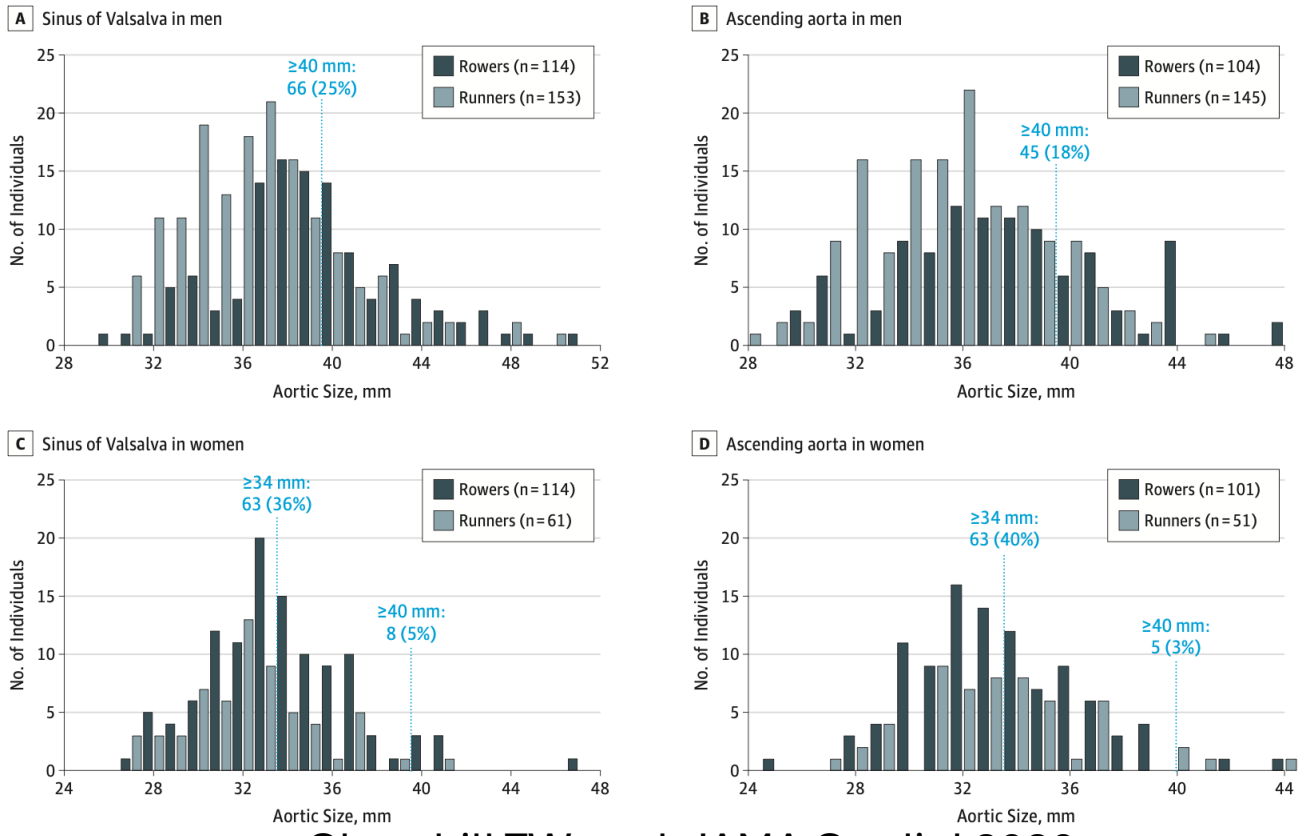
Aortic Region	Cases (Former Professional Cyclists, *n* = 23)	Controls (*n* = 59)	*P*
Agatston score, mean (SD)	3.9 (12.2)	12.2 (67.7)	0.560
Ascending aorta, *n* (%)	3 (13)	0 (0)	**0.020**
Descending aorta, *n* (%)	3 (13)	3 (5)	0.342
Aortic valve, *n* (%)	0 (0)	1 (2)	1.000
Thoracic aorta, *n* (%)	0 (0)	0 (0)	1.000

Valenzuela PL et al. Med Sci Sports Exerc 2023

Etat des lieux des dimensions de l'aorte ascendante chez les sportifs chez l'athlète plus âgé

- 442 athlètes (US), aviron ou course à pied
- Exclusion des bicuspidies

Figure 1. Distribution of Aortic Sizes by Sport and by Sex



Churchill TW et al. JAMA Cardiol 2020

Table 1. Participant Data and Select Echocardiographic Parameters

Characteristic	Mean (SD)			
	Male		Female	
	Rowers (n = 114)	Runners (n = 153)	Rowers (n = 114)	Runners (n = 61)
Age, y	63 (6)	59 (6)	62 (7)	59 (6)
Height, in	72 (3)	70 (2)	66 (2)	65 (3)
Weight, kg	87 (13)	74 (8)	67 (10)	57 (8)
BMI	25 (3)	24 (2)	23 (3)	21 (2)
Blood pressure, mm Hg				
Systolic	125 (15)	132 (15)	119 (13)	122 (14)
Diastolic	75 (9)	78 (9)	71 (9)	75 (10)
Medical history, No. (%)				
Coronary artery disease	6 (5)	6 (4)	1 (1)	1 (2)
Hypertension	24 (21)	19 (12)	7 (6)	5 (8)
Hyperlipidemia	26 (23)	31 (20)	19 (17)	8 (13)
Diabetes mellitus	3 (3)	2 (1)	1 (1)	2 (3)
Smoking (current or former)	18 (16)	19 (12)	26 (23)	16 (26)
Atrial fibrillation	10 (9)	2 (1)	4 (4)	0
Medications				
No medications	50 (44)	104 (68)	41 (37)	31 (51)
Antihypertensive medication	19 (17)	9 (6)	4 (4)	2 (3)
Statin	25 (22)	11 (7)	3 (3)	1 (2)
Antiplatelet/anticoagulant	8 (7)	7 (5)	6 (5)	0
Athletic history				
Cumulative years training	26 (11)	24 (11)	20 (8)	22 (9)
Annual training volume, h	244 (96)	243 (98)	239 (96)	237 (77)
No. of marathons[a]	6 (9)	32 (31)	7 (13)	33 (54)
Marathon time (personal best), min	NA	196 (23)	NA	222 (21)

Figure 2. Actual vs Predicted Aortic Sizes by Sex and Sport

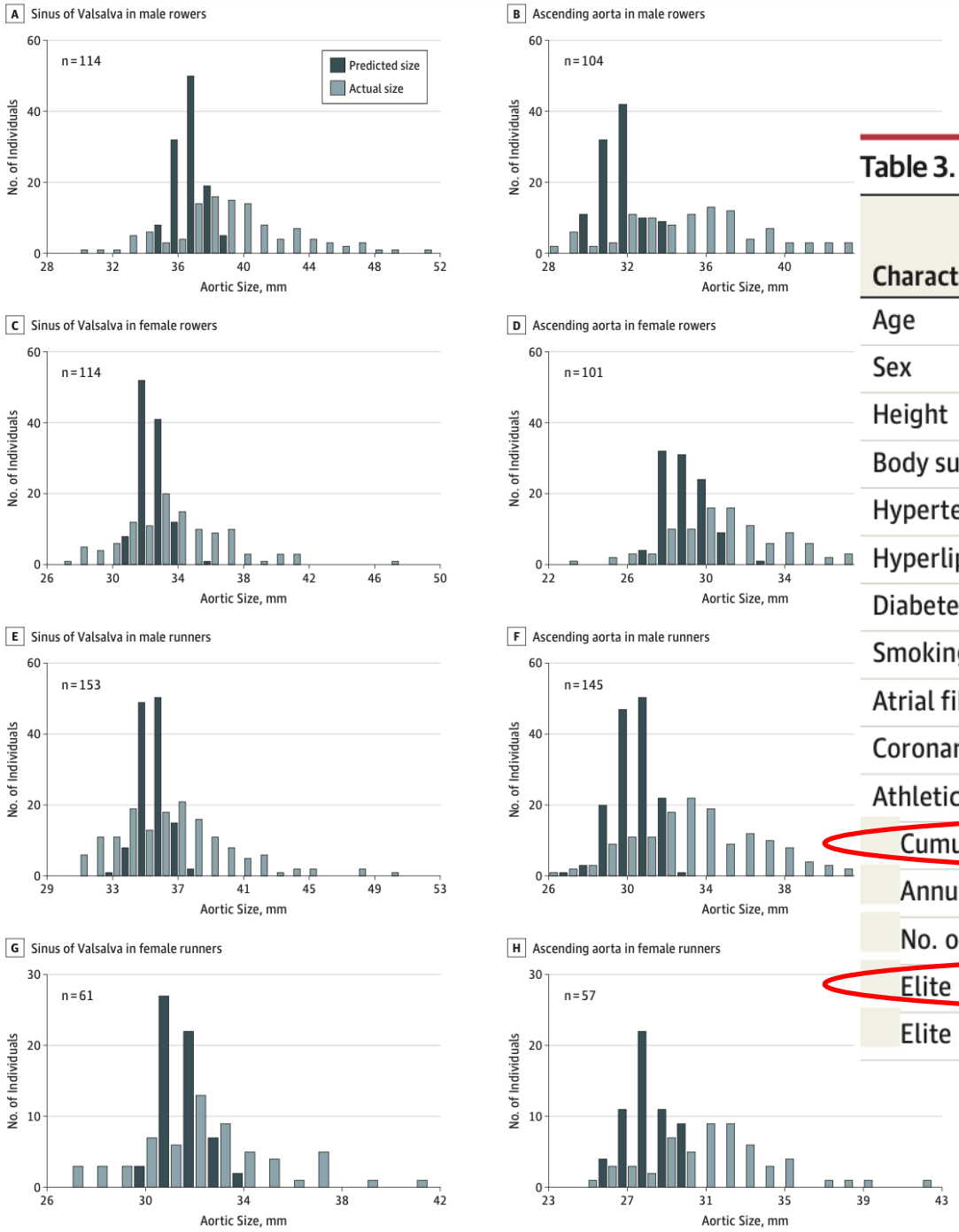
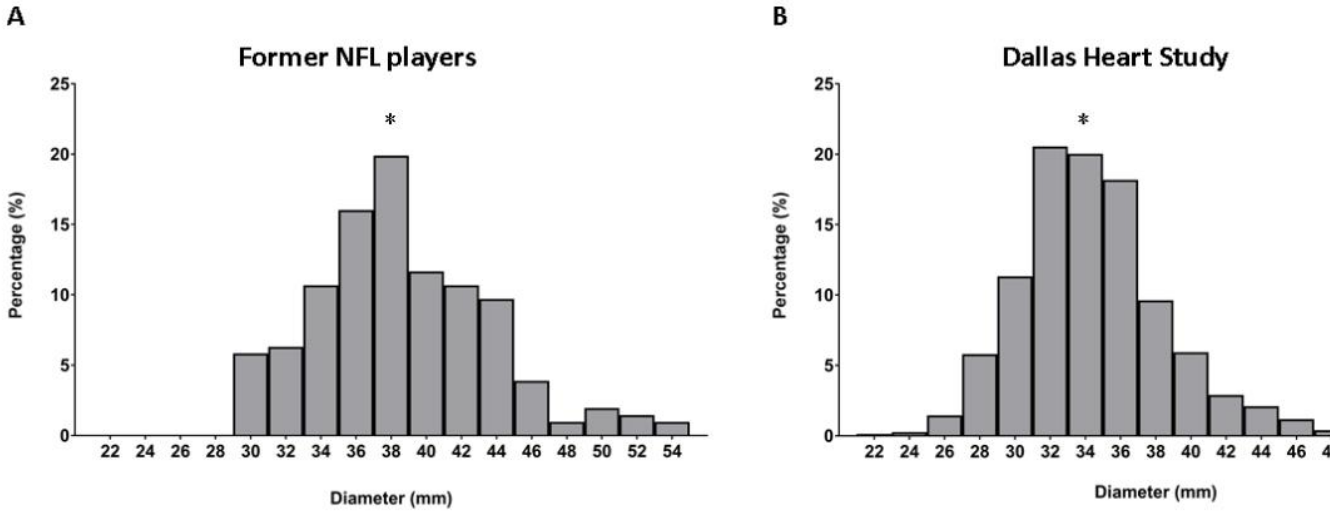


Table 3. Univariate Associations of Aortic Size With Medical, Athletic, and Echocardiographic Covariates

	Sinus of Valsalva		Ascending Aorta	
Characteristic	β (SE)	*P* Value	β (SE)	*P* Value
Age	0.09 (0.03)	.004	0.13 (0.03)	<.001
Sex	4.6 (0.4)	<.001	3.2 (0.4)	<.001
Height	0.2 (0.02)	<.001	0.17 (0.02)	<.001
Body surface area	10.9 (0.8)	<.001	8.6 (0.8)	<.001
Hypertension[a]	1.7 (0.6)	.005	2.2 (056)	<.001
Hyperlipidemia	0.3 (0.5)	.56	0.9 (0.5)	.06
Diabetes mellitus	−0.5 (1.5)	.75	1.0 (1.4)	.46
Smoking (current or former)	−0.80 (0.5)	.13	−0.5 (0.5)	.30
Atrial fibrillation	1.9 (1.1)	.09	1.4 (1.0)	.17
Coronary artery disease	0.6 (1.2)	.63	0.6 (1.1)	.62
Athletic experience				
Cumulative years training	0.05 (0.02)	.02	0.05 (0.02)	.01
Annual training volume	−0.007 (0.002)	.72	−0.003 (0.002)	.22
No. of marathons completed	−0.004 (0.007)	.60	−0.002 (0.006)	.68
Elite rower[b]	3.0 (1.0)	.002	2.3 (0.9)	.02
Elite runner[c]	4.4 (1.1)	<.001	1.2 (1.0)	.24

Etat des lieux des dimensions de l'aorte ascendante chez les sportifs chez l'athlète plus âgé

- 206 anciens footballeurs américains (NFL) vs 759 patients de la DHS



Gentry JL et al. Circ Cardiovasc Imag 2017

Relation taille de l'aorte/SC ou âge,
Ajustée sur âge, ethnie, SC, IMC, PAS, autres FRCV

Predictors of an Enlarged Ascending Aorta > 40 mm

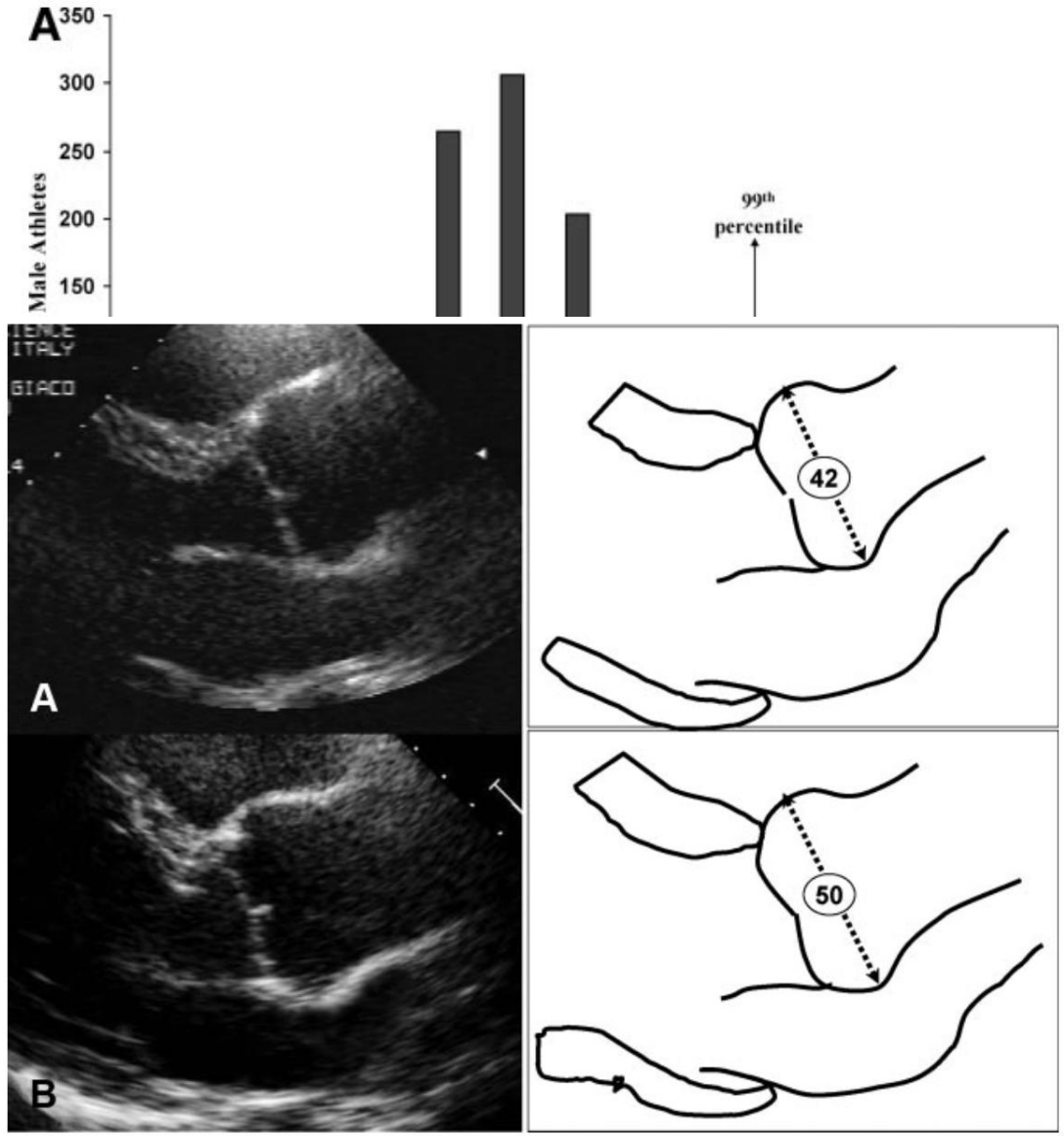
Risk Factor	Odds Ratio (95% CI)	p value
Unadjusted		
N = 965; N = 126 with aorta > 40 mm		
NFL vs. DHS	4.49 (3.03, 6.65)	< 0.0001
Adjusted		
N = 932; n = 124 with aorta > 40 mm		
NFL vs. DHS	1.99 (1.14, 3.44)	0.014
Age (per 1 SD)	2.08 (1.65, 2.62)	< 0.0001
Black	0.78 (0.5, 1.21)	0.267
Systolic blood pressure	1.001 (0.99, 1.01)	0.923
Hypertension	1.41 (0.86, 2.3)	0.175
Diabetes	0.73 (0.41, 1.32)	0.297
Current Smoking	0.66 (0.35, 1.25)	0.197
BSA (per 1 SD)	1.67 (1.29, 2.15)	< 0.0001
Non-HDL-C (per 1 SD)	1.05 (0.84, 1.32)	0.654
HDL-C (per 1 SD)	1.36 (1.10, 1.68)	0.005

Age

Quid de la progression de la dilatation de l'aorte chez les sportifs ?

- 2317 athlètes italiens de haut niveau, âge moyen 24,8 ans, 56% H

- 17 H avec Ao > 40 mm, 10 F avec Ao > 34 mm
- Jusqu'à 16 ans de suivi
- Progression de la dilatation de 40.9 +/- 1.3 à 42.9 +/- 3.6 mm, surtout après la fin de la carrière
- 2 patients ont atteint 50 mm (FBN1 -)



Pelliccia A et al. Circulation 2010

Quid de la progression de la dilatation de l'aorte chez les sportifs ?

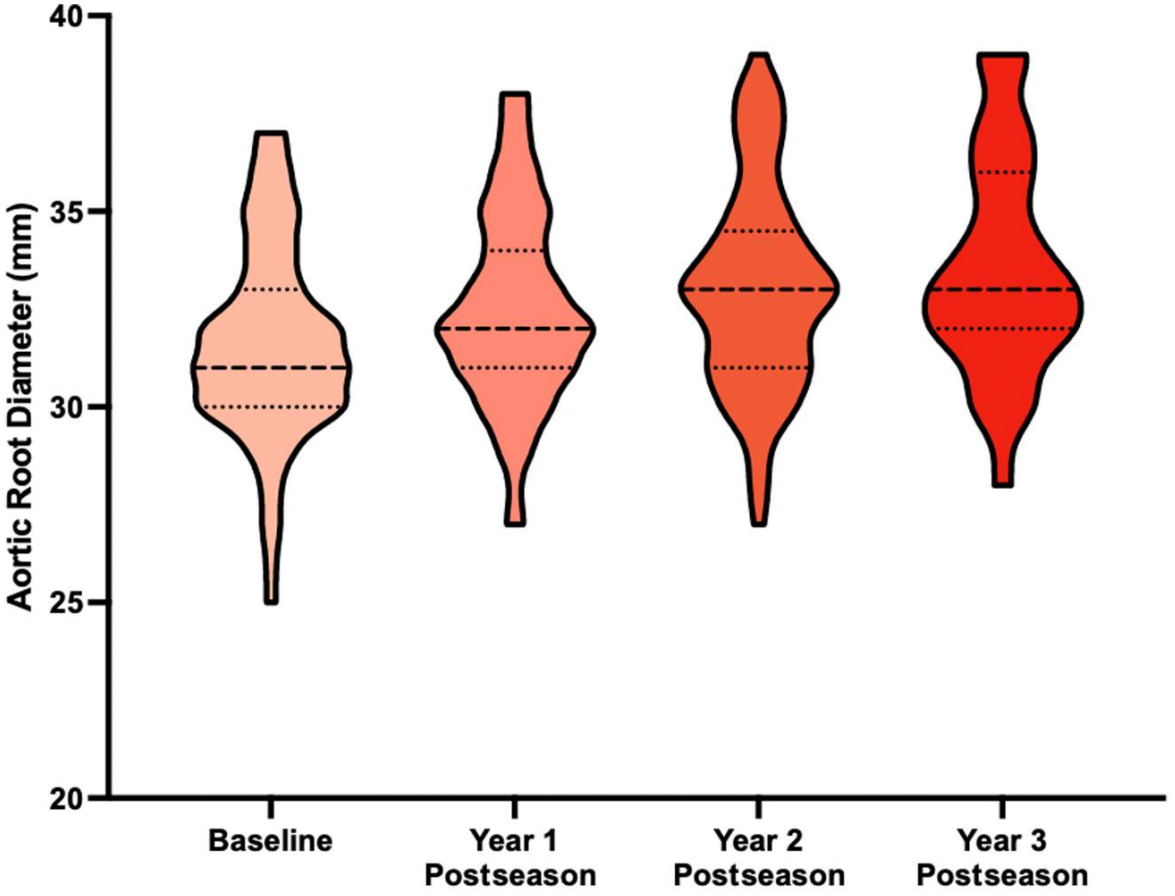
- Etude prospective sur des footballeurs américains universitaires, suivi de 3 ans

Table 1. Baseline Characteristics

Characteristic	N=247 Athletes
Age, y	18±0.4
Race and ethnicity	119 (48%) Black
	126 (51%) White
	2 (1%) Latino
Player position	91 (37%) Linemen
	156 (63%) Non-linemen
Height, cm	185±6
Weight, kg	100.2±19.1
Systolic blood pressure, mm Hg	128±12
Diastolic blood pressure, mm Hg	76±10

Table 2. Longitu

Characteristic	alue
Weight, kg	001
Systolic BP, mm Hg	001
Diastolic BP, mm H	2
LV mass, g	001
LV mass/body surf area, g/m^2	001
LV internal diamete at end-diastole, mr	001
Mean wall thicknes	001
Relative wall thickn	001
LV ejection fraction	1
E', cm/s	001
Pulse wave velocity	001
Aortic root diamete	001



Dilatation progressive avec le temps, signe de maladaptation vasculaire?

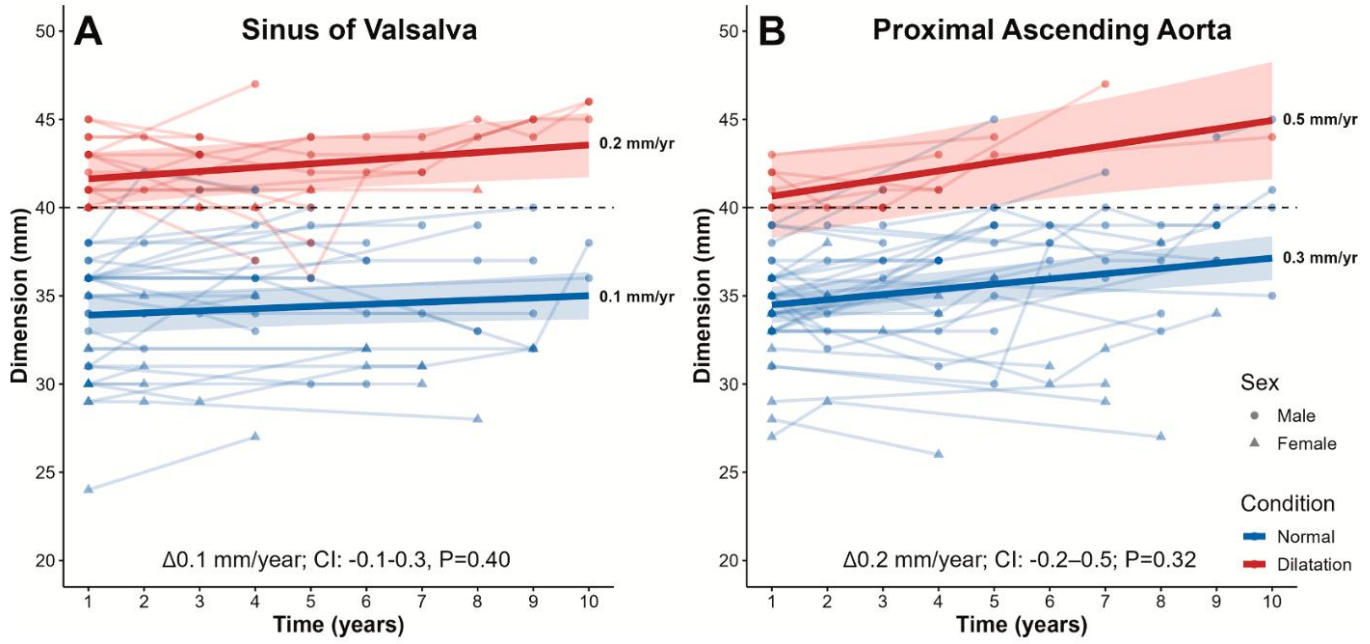
Tso JV et al. JAHA 2023

Quid de la progression de la dilatation de l'aorte chez les sportifs plus âgés ?

- Analyse rétrospective de la Master Athlete Screening Study
- 50 athlètes dont 30 amateurs, 60 +/- 8 ans, 26% F
- Volume AP: 81 +/- 39 MET-h/sem
- Evaluation de la progression à 5 ans

- Dans tous les cas < au rythme de 3 mm/an considéré comme un critère de croissance rapide…

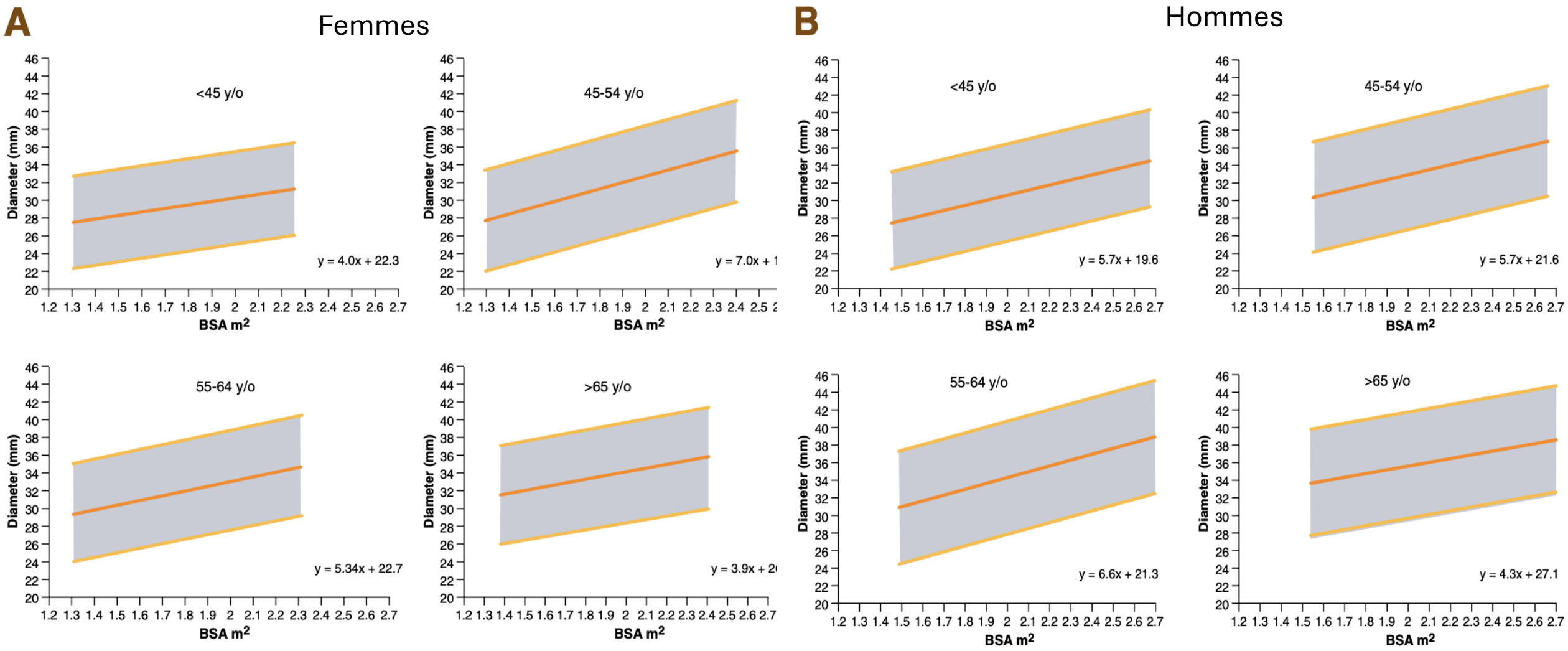
FIGURE 1 Rate of Change in Aortic Dimensions of Aortic Dilation vs Nondilated Masters Athletes



Linear mixed-effects (LME) models (thick lines with CI shading) of the change in (A) sinus of Valsalva and (B) proximal ascending aorta dimensions over time between aortic dilatation (red) and nondilated (blue) groups. Thin lines represent individual male (circle) and female (triangle) measurements from transthoracic echocardiogram reports. Thick lines represent the estimates of the LME models. Colored shading represents 95% CIs of the LME model estimates. The dashed black line indicates the threshold for aortic dilatation (≥40 mm).

Moulson N et al. JACC: Advances 2025

Quels sont les facteurs associés à une taille d'aorte augmentée ? Paramètres morphométriques…



Wolak A et al. JACC Cardiovasc Imag 2008

Quels sont les facteurs associés à une taille d'aorte augmentée ? La réponse vasculaire…

- 652 athlètes élite allemands,
- 25,8 +/- 5 ans
- Sports mixtes

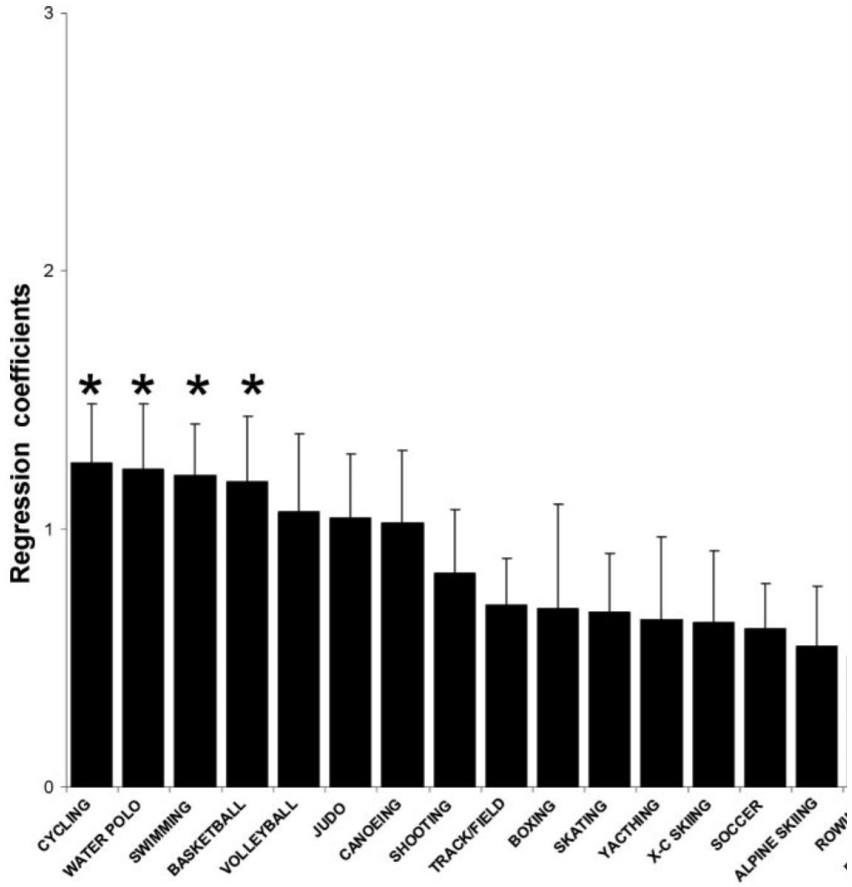
- Mesure non invasive de la PA centrale et de la fonction vasculaire

	Male elite athletes		
	SBP/MET slope ≤ 6.2 mmHg/MET	SBP/MET slope > 6.2 mmHg/MET	*p* value
Number (%)	461 (71)	191 (29)	
Age (years)	25.9 ± 5.1	25.4 ± 5	0.232
Height (cm)	188.4 ± 8.7	190.4 ± 7.5	**0.003**
Body weight (kg)	90.6 ± 12.2	94.5 ± 11.5	**< 0.001**
Body mass index (kg/m^2)	25.5 ± 1.8	26 ± 2.1	**0.003**
Body surface area (m^2)	2.14 ± 0.33	2.23 ± 0.17	**< 0.001**
Training history (years)	8.9 ± 5.2	8.6 ± 5.1	0.414
Training per week (h)	18.4 ± 4	19.4 ± 2.6	**< 0.001**
Systolic blood pressure (mmHg)	124.6 ± 11.5	124.7 ± 9.8	0.896
Diastolic blood pressure (mmHg)	63.8 ± 10.5	64.4 ± 10.5	0.103
Mean arterial blood pressure (mmHg)	80.2 ± 9.6	80.7 ± 9.5	0.508
Resting heart rate (beats/min)	58.7 ± 10.7	56.6 ± 9.6	**0.011**
Aortic root size (mm)	31.9 ± 3.2	32.8 ± 3.3	**< 0.001**
Aortic root size/BSA (mm/m^2)	14.73 ± 1.41	14.76 ± 1.36	0.772
Aortic root size/height (mm/m)	0.17 ± 0.015	0.18 ± 0.015	**0.015**
Aortic root size/height$^{1.025}$ (mm/m$^{1.025}$)	0.17 ± 0.016	0.18 ± 0.015	**0.015**
Aortic root size/LVEDD Index	0.59 ± 0.056	0.62 ± 0.061	**< 0.001**
LVEDD/aortic root size Index	1.69 ± 0.16	1.64 ± 0.16	**< 0.001**
SBP/MET slope (mmHg/MET)	4.53 ± 1.46	7.85 ± 1.33	**< 0.001**

Une pente PAS/MET > 6,2 mmHg/MET (mauvaise réponse vasculaire) semble prédicteur d'une dilatation de l'aorte ascendante

Most A et al. Clin Res Cardiol 2024

Quels sont les facteurs associés à une taille d'aorte augmentée ?
Le type de sport prat



Boraita A. et al. Cir Cardiovasc Imag 2016

Table 4. Aortic Root Size According to Mitchell's Sport Classification in Males

	IA (n=117)		IB (n=102)		IC (n=386)		IIA (n=39)		IIB (n=222)		IIC (n=369)		IIIA (n=306)		IIIB (n=83)		IIIC (n=415)	
Male	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95
Aortic M mode, mm	30±3.1	36.8	29.8±3.3	35.2	29.9±2.8	34.6	29.9±3.7	36.4	29.8±3.1	36	31.6±3.7	38.9	29.5±3	35	30.1±3.3	36.1	30.6±3.1	35.9
Aortic annulus, mm	25.2±3	30.5	23.7±2.9	29.1	25.4±3	30.3	25.2±3.2	31.4	24.9±3.3	31.1	26.6±3.5	32.7	24.6±2.8	28.9	24.7±2.8	28.8	26±3.1	31.4
Sinuses of Valsalva, mm	31.3±3.4	38.9	30.6±3.6	37	31.3±3.1	36.4	31.4±3.9	37.9	31.4±3.8	38.2	32.9±3.8	39.9	30.7±3.3	36.6	31±3.1	36.5	32±3.4	37.9
Sinotubular junction, mm	26.4±3.3	32.1	25.3±3.3	30.3	26.2±2.9	31.3	26.1±3.4	31.7	26±3.5	32	27.5±3.6	33.5	25.5±3	30.7	26±3	30.7	27±3.3	32.8
Proximal ascending aorta, mm	26.5±3.5	33.5	25.6±3.4	31.1	26.5±3	31.3	26.8±3.7	33.3	26.2±3.8	32.8	28±4	35.1	25.9±3.2	31.5	26.6±3.2	32	27.6±3.6	33.5
Aortic M mode/BSA, mm/m²	15.6±1.9	19.5	14.9±1.6	17.3	16±1.6	18.9	15.5±1.7	18.8	14.9±1.4	17.4	15.3±1.7	18.2	15.3±1.6	18.4	15.8±2	20	16.2±1.7	19.1
Aortic annulus/BSA, mm/m²	13.1±1.8	16.4	11.9±1.6	14.6	13.6±1.6	16.7	13.1±1.7	15.5	12.5±1.5	14.8	12.9±1.7	15.8	12.8±1.5	15.2	13±1.6	15.7	13.8±1.7	17
Sinuses of Valsalva/ BSA, mm/m²	16.3±2	20.2	15.3±1.8	18.6	16.7±1.8	20	16.4±2.2	20.2	15.7±1.6	18.4	16±2	19.2	15.9±1.8	19.2	16.3±2	19.7	17±2	20.3
Sinotubular junction/BSA, mm/m²	13.8±1.9	17.1	12.7±1.7	15.6	14±1.6	17	13.6±1.9	16.7	13±1.5	15.6	13.4±1.8	16.3	13.3±1.6	16	13.7±1.9	17	14.3±1.8	17.3
Proximal ascending aorta/BSA, mm/m²	13.8±1.9	17.4	12.8±1.7	15.6	14.2±1.7	17	14±2	17.3	13.1±1.6	15.9	13.7±2	16.6	13.5±1.8	16.3	14±2	17.7	14.6±2	18

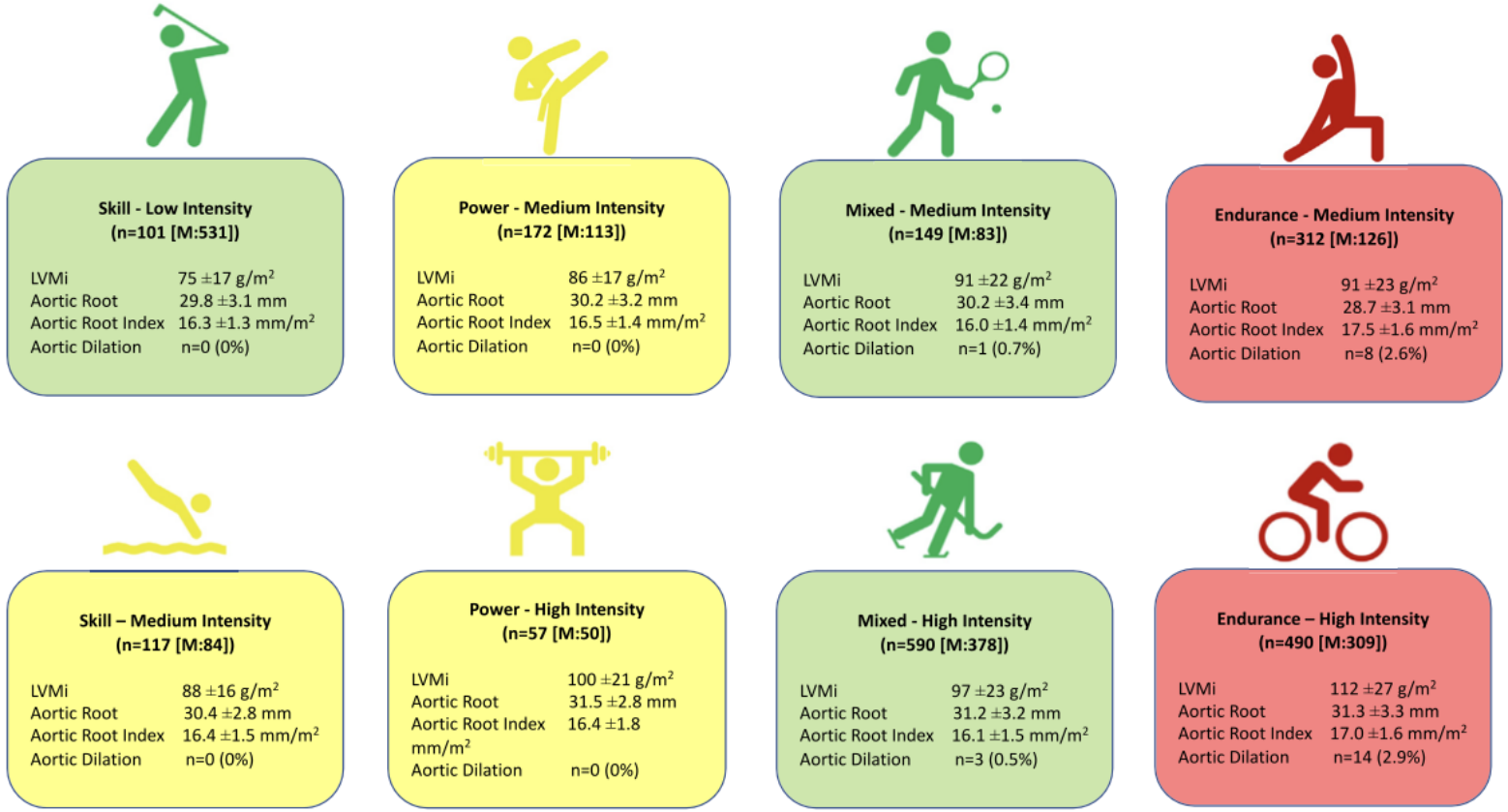
Inner–inner measures are presented as mean±standard deviation and 95th percentile. BSA indicates body surface area.

3281 sportifs de haut niveau espagnols, 23,5 +/_ 5,7 ans

Table 5. Aortic Root Size According to Mitchell's Sport Classification in Females

	IA (n=75)		IB (n=81)		IC (n=225)		IIA (n=20)		IIB (n=121)		IIC (n=208)		IIIA (n=285)		IIIB (n=64)		IIIC (n=163)	
Female	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95	Mean	P95
Aortic M mode, mm	25.5±2.5	30.2	26.5±2.6	30.2	25.5±2.4	29.8	25.2±2.7	30.9	25.8±2.5	30.2	26.9±2.8	31.8	25.1±2.5	29.8	25.4±2.2	29.6	26.2±2.2	29.8
Aortic annulus, mm	21±2.7	25.4	21.6±2.7	26	21.4±2.5	26.1	22±3.2	27.7	21.4±2.5	26.1	22.7±2.7	27.4	21±2.4	25.2	21.2±2.5	26.2	21.9±2.9	27.3
Sinuses of Valsalva, mm	26.2±2.4	30.3	27.7±3.2	33.2	26.9±2.7	31.4	26.4±2.5	30.9	27±2.8	32	28.4±2.9	33.1	26.5±2.6	30.9	26.8±2.8	32.8	27.6±2.9	32.1
Sinotubular junction, mm	22.7±2.6	26.9	23.5±3	28.6	22.8±2.8	27	22.2±2.6	26.7	22.9±2.6	27.5	24.1±2.5	28.4	22.4±2.6	26.7	23±2.7	27.4	23.2±2.8	28.5
Proximal ascending aorta, mm	22.9±3.1	28.4	22.8±3.1	29.2	23.2±3.1	28.2	22.2±2.9	28	23.4±2.9	28	24.8±3	29.7	22.9±2.9	27.4	23.3±3.1	28.1	23.8±3.2	28.8
Aortic M mode/BSA, mm/m²	15.5±1.5	18.1	15±1.6	18.4	15.8±1.7	18.7	14.9±1.4	17.9	15.2±1.5	17.7	15.2±1.6	17.8	15.4±1.6	18.3	15.6±1.4	17.8	15.8±1.5	18.6
Aortic annulus/BSA, mm/m²	12.9±2.1	16.7	12.3±1.4	15.3	13.3±1.8	16.4	13±1.7	15.4	12.7±1.6	15.6	12.9±1.6	15.4	12.9±1.6	15.7	13.1±1.6	15.8	13.2±1.9	16.7
Sinuses of Valsalva/BSA, mm/m²	16±1.8	19.2	15.7±1.9	19.4	16.7±2	20.1	15.6±1.5	18.9	16±1.7	18.9	16.1±1.7	19	16.2±1.9	19	16.5±1.7	19.2	16.6±2.1	20.6
Sinotubular junction/BSA, mm/m²	13.9±1.9	16.9	13.4±1.7	16.3	14.1±2	17.5	13.2±1.3	14.9	13.5±1.6	16.2	13.7±1.5	16.2	13.7±1.7	16.6	14.2±1.7	16.8	14±1.9	18
Proximal ascending aorta/BSA, mm/m²	14±2.1	18.3	13.5±1.8	17.1	14.4±2.1	17.8	13.1±1.6	17.1	13.8±1.7	16.4	14.1±1.8	17	14±1.9	16.9	14.4±2	18.4	14.3±2.2	18.2

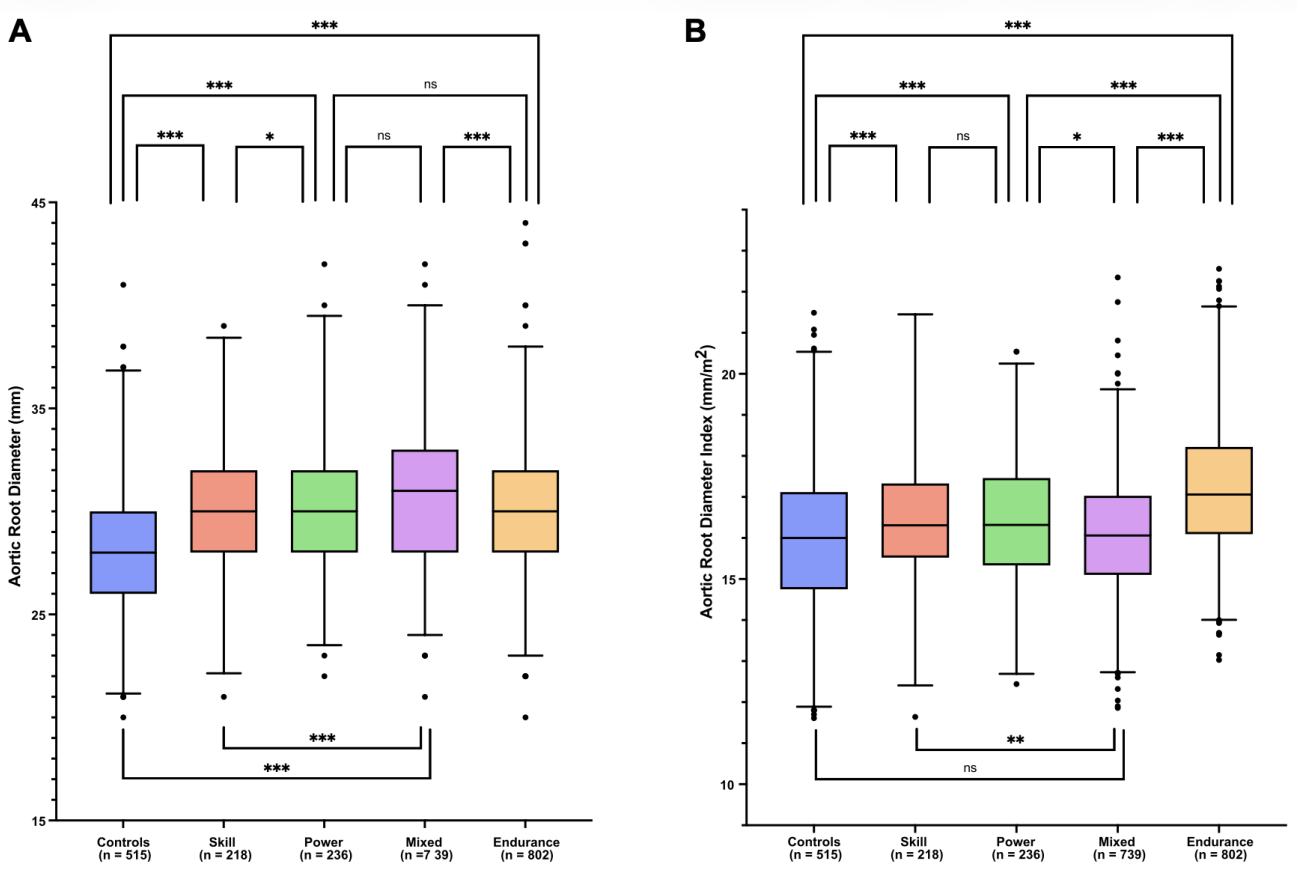
Inner–inner measures are presented as mean±standard deviation and 95th percentile. BSA indicates body surface area.



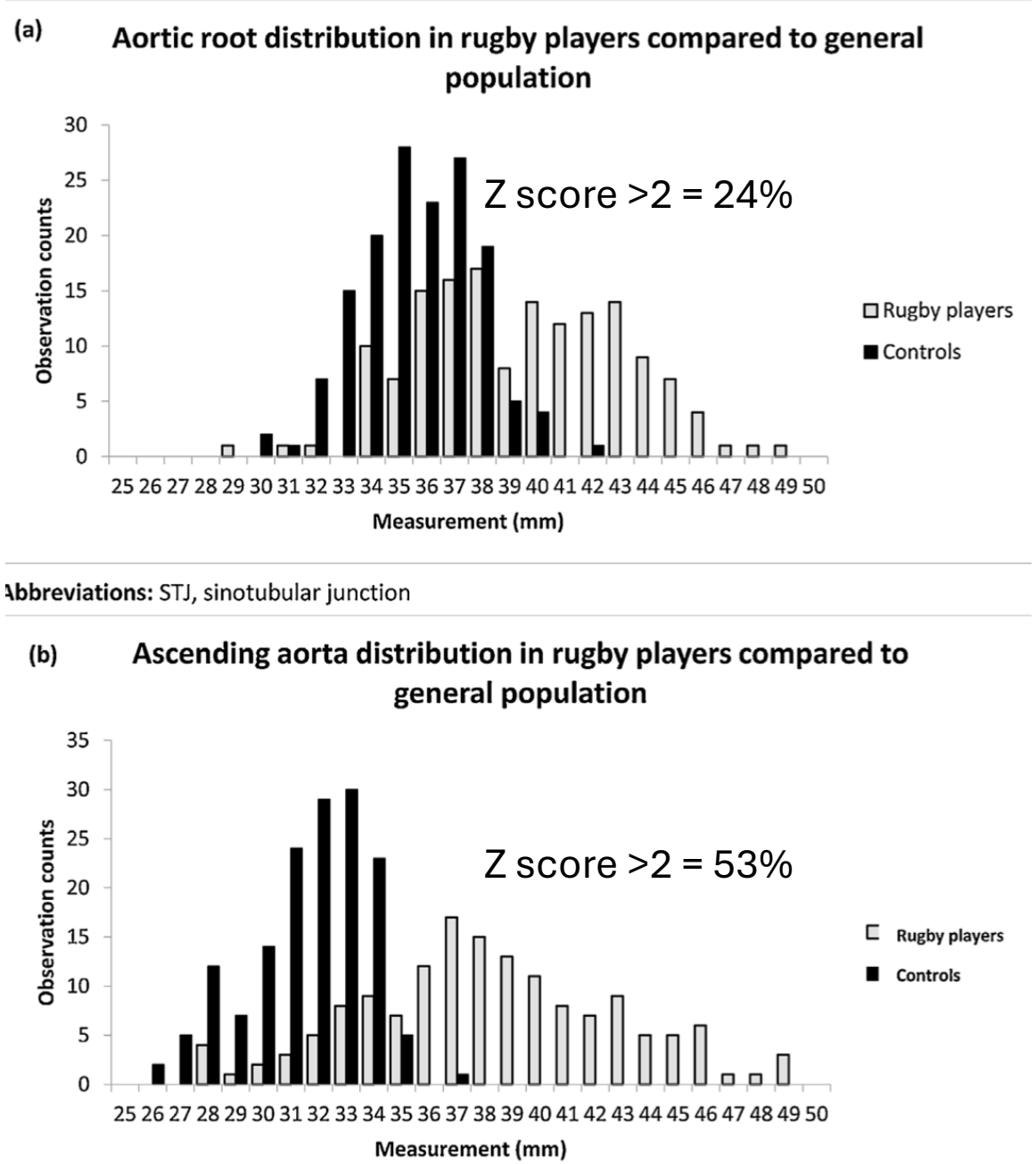
Clinical features	Skill (n = 218)		Power (n = 236)		Mixed (n = 739)		Endurance (n = 802)	
	Low (n = 53)	Medium (n = 84)	Medium (n = 113)	High (n = 50)	Medium (n = 83)	High (n = 378)	Medium (n = 126)	High (n = 309)
Male								
Aortic root, mm								
Mean ± SD	31.6 ± 2.7	31.4 ± 2.1	31.7 ± 2.5	31.8 ± 2.8	32.2 ± 2.9	32.6 ± 2.6	31.2 ± 2.3	33.1 ± 2.5
2-SD range	27.3-37.4	28.0-35.9	27.0-38.0	28.0-36.8	27.0-39.9	28.0-38.6	28.0-36.0	30.0-38.0
Aortic root index, mm/m^2								
Mean ± SD	16.1 ± 1.1	16.1 ± 1.3	16.4 ± 1.3	16.5 ± 1.8	16.0 ± 1.5	16.0 ± 1.4	17.2 ± 1.5	16.9 ± 1.6
2-SD range	14.4-18.7	14.0-18.7	14.0-19.0	12.7-19.4	13.8-18.7	13.5-19.0	14.8-20.7	14.1-20.6
Female								
	Low (n = 48)	Medium (n = 33)	Medium (n = 59)	High (n = 7)	Medium (n = 66)	High (n = 212)	Medium (n = 186)	High (n = 181)
Aortic root, mm								
Mean ± SD	27.9 ± 2.2	27.8 ± 2.2	27.6 ± 2.3	29.7 ± 2.4	27.6 ± 2.2	28.6 ± 2.5	27.0 ± 2.4	28.4 ± 2.5
2-SD range	24.0-30.8	23.0-31.2	23.6-31.4	26.3-32.8	24.0-32.0	24.0-34.0	22.6-31.0	24.0-32.5
Aortic root index, mm/m^2								
Mean ± SD	16.4 ± 1.5	17.1 ±1.8	16.7 ± 1.6	15.3 ± 1.5	15.9 ± 1.3	16.3 ± 1.6	17.6 ± 1.6	17.2 ± 1.6
2-SD range	13.2-18.7	14.2-21.4	13.5-19.9	13.2-17.4	13.5-18.3	13.4-19.1	14.8-21.0	14.6-20.8

SD, standard deviation.

Limongelli G et al. Can J Cardiol 2023



Limongelli G et al. Can J Cardiol 2023



152 rugbymen élite australiens, âge moyen 45 +/- 13 ans

Kay S et al. Heart, Lung and Circ 2020

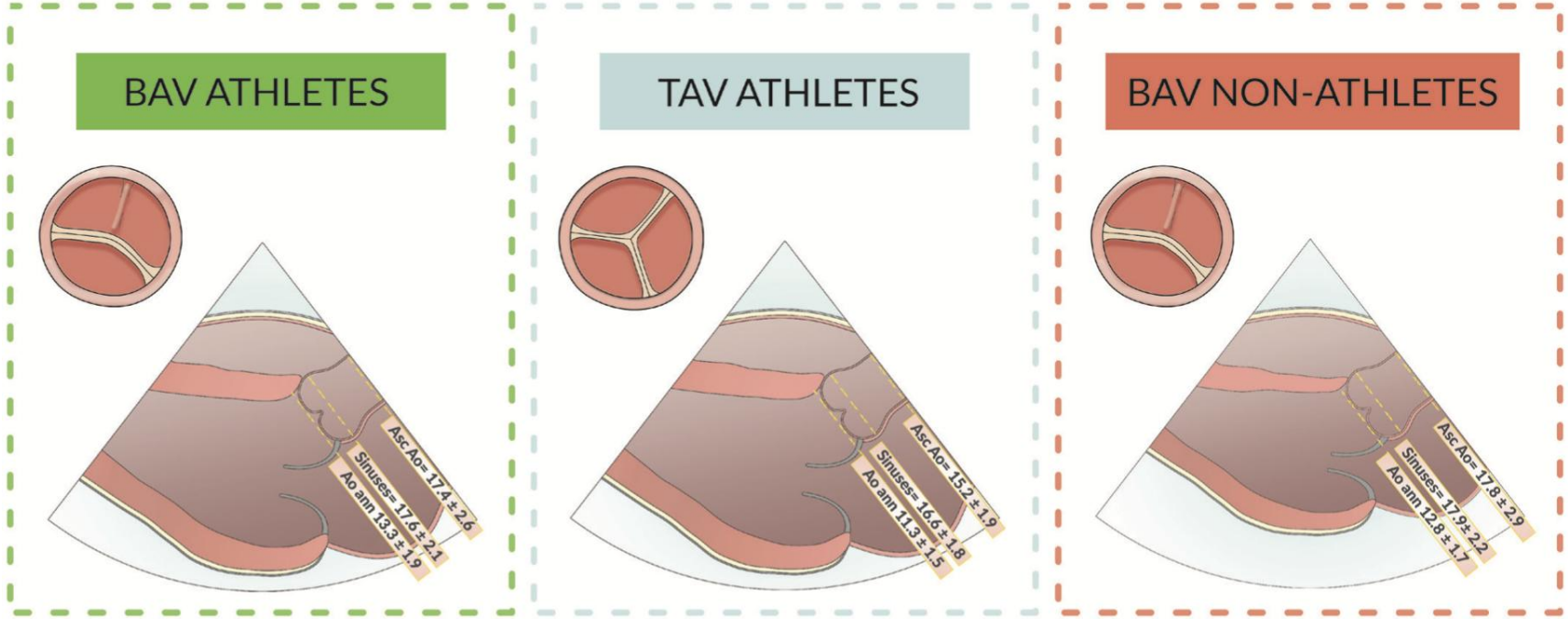
Cas particulier de l'athlète avec bicuspidie, y a-t-il un sur-risque par rapport au non athlète ?

- Données issues de la SPREAD study (Sport PRactice and its Effects on aortic size and valve function in bicuspid Aortic valve Disease)

Table 1 Demographic characteristics of the study population

Variables	BAV athletes (n=186)	TAV athletes (n=193)	BAV non-athletes (n=125)	P value overall
Age, years	30±11	30±11	34±10*	0.01
Males, n (%)	157 (84)	158 (82)	102 (82)	0.72
Height, cm	177±9	179±10†	176±10	0.01
Weight, kg	73±12	75±13	75±15	0.11
BSA, m^2	1.89±0.19	1.94±0.21	1.88±0.22	0.06
BMI	23.1±2.5	23.3±2.7	23.4±3.9	0.58
Smoker, n (%)	17 (9)	14 (7)	15 (12)	0.31
Dyslipidaemia, n (%)	8 (4)	5 (3)	6 (5)	0.53
Family history CAD, n (%)	28 (15)	20 (10)	10 (8)	0.14
Sport discipline			NA	
Skill	10 (5.4)	6 (3.1)		
Power	30 (16.1)	23 (11.9)		
Mixed	114 (61.3)	121 (62.7)		
Endurance	32 (17.2)	43 (22.3)		
Hours of training per week	8±5	11±6†	2±1*	<0.001
Years of training	12±7	14±7	NA	0.16

*P<0.005 between other groups.
†P<0.005 versus BAV non-athletes.
‡P<0.005 versus TAV athletes.
§P<0.005 versus BAV athletes.



D'Ascenzi F et al. Br J Sports Med 2024

En pratique, que disent les recommandations européennes de 2020?

	Low risk	Low-intermediate risk	Intermediate risk	High risk
Diagnosis	• Aorta <40 mm in BAV or tricuspid valve • Turner syndrome without aortic dilatation	• MFS or other HTAD syndrome without aortic dilatation • Aorta 40–45 mm in BAV or tricuspid valve • After successful thoracic aorta surgery for BAV or other low risk situation	• Moderate aortic dilatation (40–45 mm in MFS or other HTAD; 45–50 mm in BAV or tricuspid valve, Turner syndrome ASI 20–25 mm/m^2, tetralogy of Fallot <50 mm) • After successful thoracic aorta surgery for MFS or HTAD	• Severe aortic dilatation (>45 mm in MFS or other HTAD, >50 mm in BAV or tricuspid valve, Turner syndrome ASI >25 mm/m^2, tetralogy of Fallot >50 mm) • After surgery with sequelae
Advice	• All sports permitted with preference for endurance over power sports	• Avoid high and very high intensity exercise, contact, and power-sports. • Preference for endurance over power sports	• Only skill sports or mixed or endurance sports at low intensity	• Sports are (temporarily) contra-indicated
Follow-up	Every 2–3 years	Every 1–2 years	Every 6 months to 1 year	Re-evaluation after treatment

Pelliccia A et al. Eur Heart J 2020

Et en cas d'aortopathie héréditaire type Marfan?

Recommendations for Sports and Surgery in Marfan Syndrome				
	<40 mm	**40–45 mm**	**45–49 mm**	**≥50**
Advice	Avoid high- and very high intensity exercise, contact, and power sports. Preference for endurance over power sports	Only skill sports or mixed or endurance at low intensity	No sport recommended	
Follow-up	1–2 years	6 months–1 year	6 months	Re-evaluate after surgery
Surgery		≥45 surgery recommended if ≥1 high-risk factor. High-risk factors for Marfan syndrome patients are: (a) Aortic diameter at the sinuses of Valsalva ≥5 cm; (b) Rapid increase in aortic dilatation (≥3 mm per year); (c) Family history of aortic dissection at a low aortic size; (d) Progressive aortic regurgitation; (e) Personal history of spontaneous vascular dissection and (f) Desire for pregnancy.		Surgery is indicated

Monda E et al. Diagnostics 2022

Et les recommandations ACC/AHA de 2025?

Aortic Enlargement or Thoracic Aortic Root and Ascending Aorta Aneurysms

Unexplained thoracic aortic dilation <45 mm is common among masters endurance athletes.[35,36] For unexplained thoracic aortic aneurysms ≥45 to 49 mm,[186] despite a paucity of data, competitive sports participation can be considered with SDM. With strength sports, concerns of static afterload stress on the aorta may lead to consideration of reductions to moderate-intensity strength training. With aneurysms ≥50 mm, risk of aortic dissection with competitive sports participation is likely high, thus competitive sports participation should be avoided. Competitive sports participation can be considered (see section VII) after surgical repair on the basis of limited data from athletes with BAV aortopathy.[251]

- Dilatation < 45 mm fréquente chez l'athlète master
- Entre 45 et 49 mm, on pourrait autoriser la compétition (décision partagée +++)

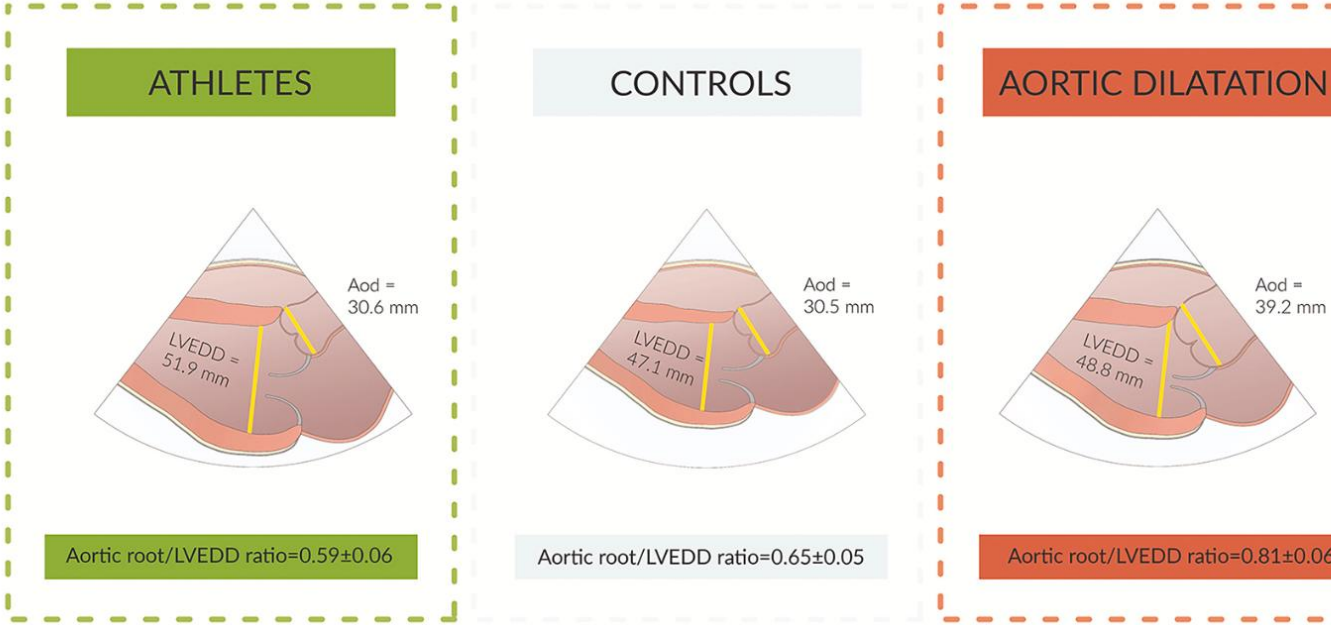
Among different imaging metrics,[186] the most robust outcomes data are based on absolute aortic dimensions. Adhering to existing guidelines that recommend using absolute values to define an aneurysm and surgical thresholds, this framework is used for these clinical considerations (Table 10). Sex-specific criteria for aortic size are not included, although differences in aortic dimensions between men and women exist,[187,188] primarily because of variations in body size. *Z* score–based criteria are not included given the lack of robust outcomes data associated with this metric. However, body size cannot be ignored, given its correlation with aortic size, and should be considered in the evaluation of competitive athletes with concern for aortopathy.

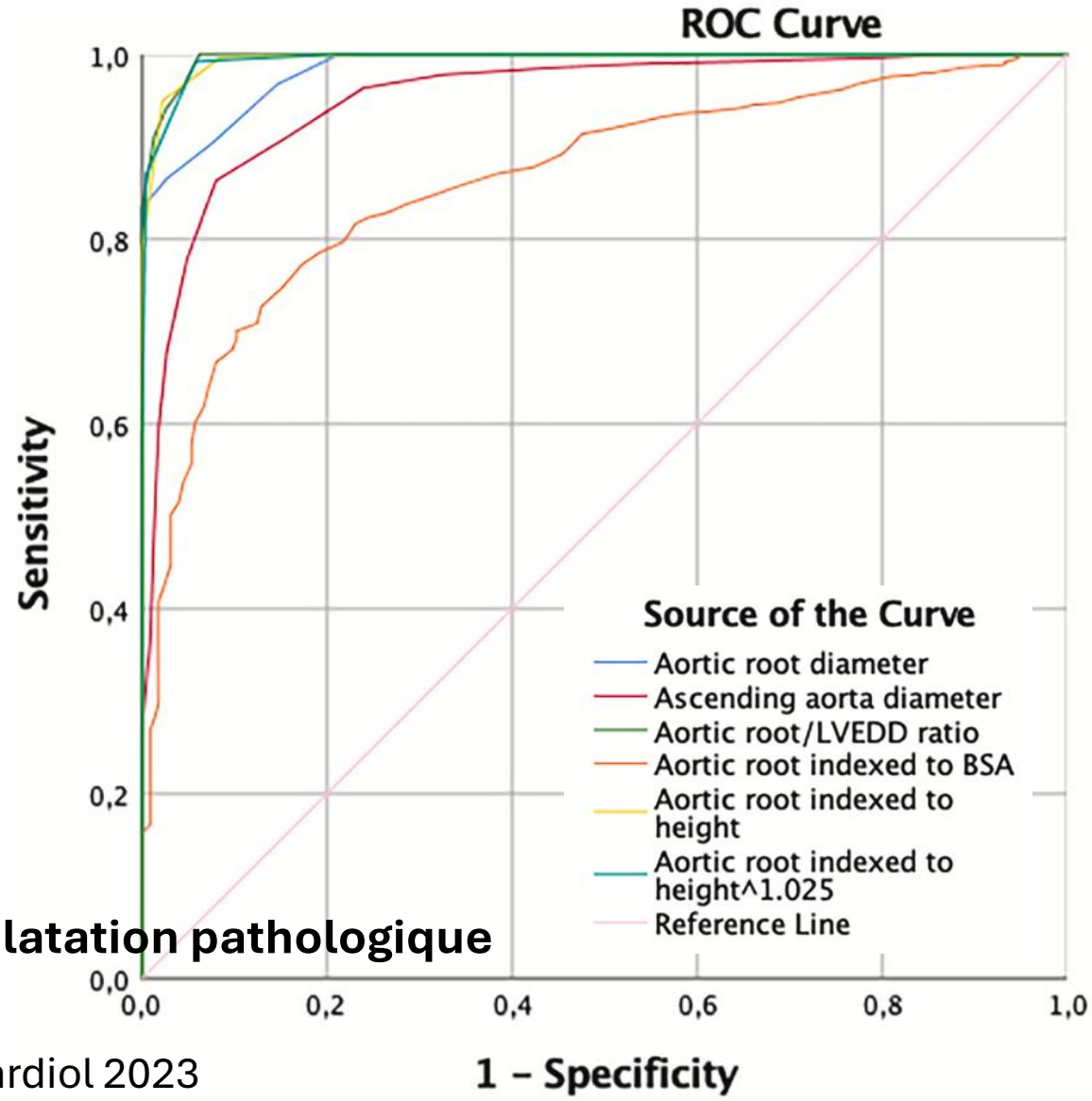
- Il faut utiliser les dimensions absolues…
- Sans critère de genre…
- Mais on ne peut faire abstraction des données biométriques…

Kim JH et al. JACC 2025

Au final, comment évaluer correctement une aorte de sportif?

- Quel outil pour différencier du remodelage physiologique d'une maladaptation?
- <u>Intérêt du ratio Ao/DTDVG</u>



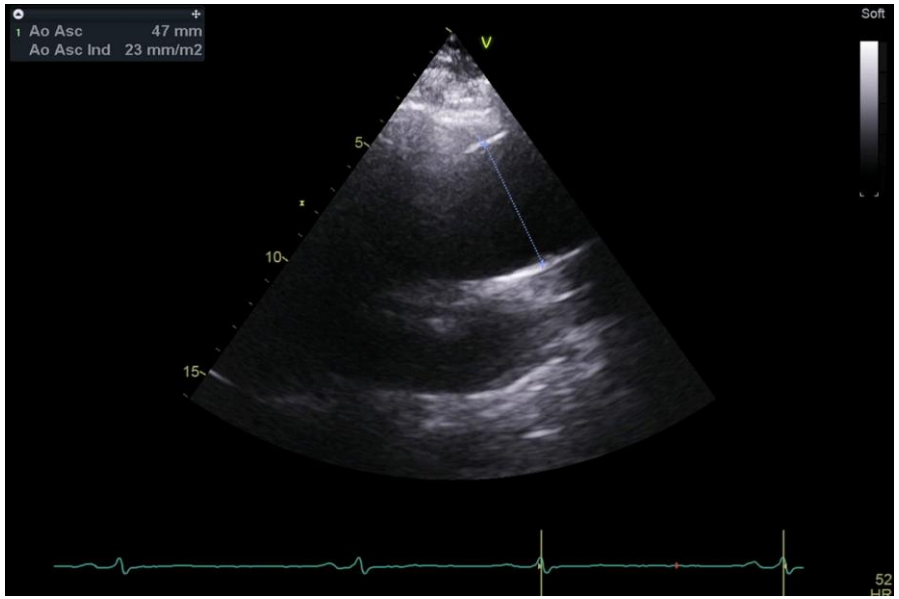


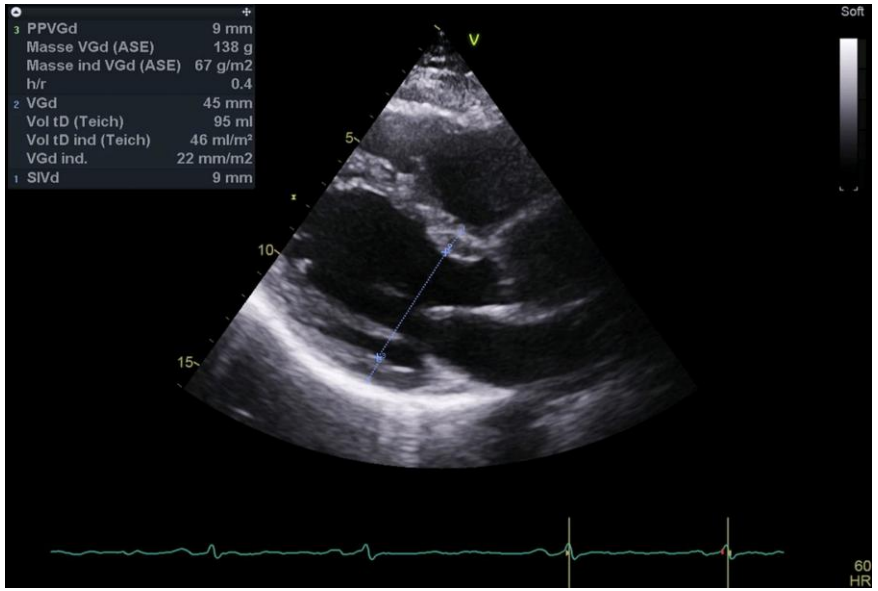
Ao/DTDVG >0.71 → Se 96% Sp 99% en faveur d'une dilatation pathologique

Cavigli L et al. Int J Cardiol 2023

Retour sur M. G, on fait quoi ?

- Recommandations européennes : non
- Recommandations américaines : pourquoi pas… mais décision bilatérale argumentée +++





Attention, à réfléchir… ratio Ao/DTDVG à 1,04 en faveur d'une maladaptation pathologique mais en doutiez-vous ?

Take home message

- Les athlètes ont des aortes de taille plus grande que la population générale mais peu dépassent les limites habituellement reconnues (adaptation vasculaire dans le cadre du cœur d'athlète).
- Ce phénomène est encore plus fréquent chez les masters.
- Dilatation de l'aorte aggravée par l'activité physique elle-même reste encore débattue.
- Rechercher une bicuspidie aortique ou une aortopathie héréditaire +++
- Les recommandations ACC/AHA de 2025 ouvrent la porte à plus de souplesse en termes d'autorisations sous couvert de décision partagée+++

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Merci pour votre attention