



Longitudinal Changes in Left Ventricular Mass Index and Blood Pressure Control in Children With Chronic Kidney Disease

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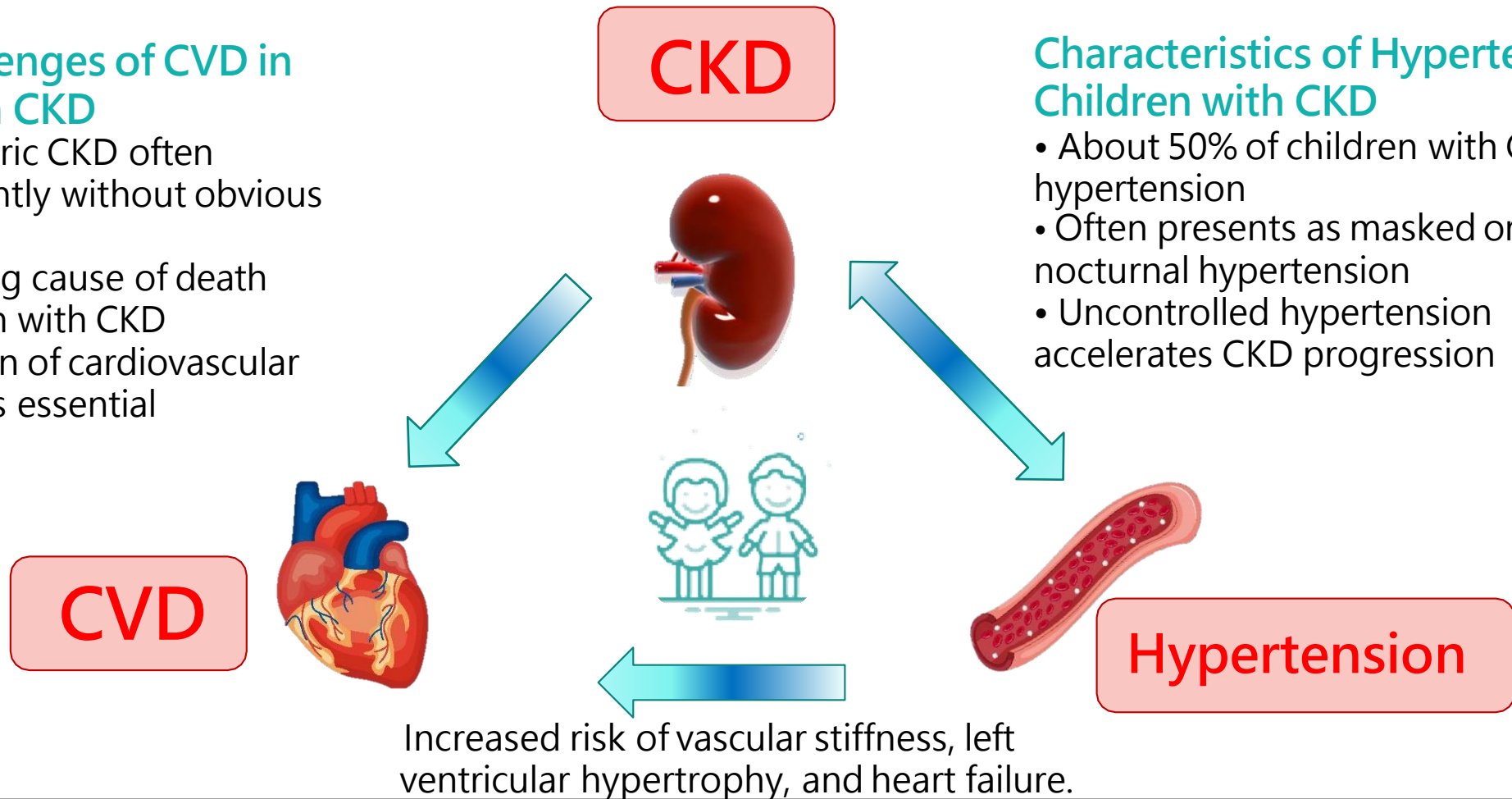
Controlling BP and Detecting CVD Early Are Key to improving the Long-term Outcomes of Children with CKD

Unique Challenges of CVD in Children with CKD

- CVD in pediatric CKD often progresses silently without obvious symptoms
- It is the leading cause of death among children with CKD
- Early detection of cardiovascular abnormalities is essential

Characteristics of Hypertension in Children with CKD

- About 50% of children with CKD have hypertension
- Often presents as masked or nocturnal hypertension
- Uncontrolled hypertension accelerates CKD progression



Background

- Elevated blood pressure (BP) is common in pediatric CKD and contributes substantially to cardiovascular disease (CVD) and CKD progression.
- Left ventricular hypertrophy (LVH), quantified by left ventricular mass index (LVMI), is the most prevalent form of target organ damage in this population.
- LVMI closely correlates with BP and serves as both a surrogate marker of treatment efficacy and a predictor of long-term cardiovascular risk.
- Time in target range (TTR) provides a dynamic measure of sustained BP control and is associated with slower CKD progression, lower LVMI, and reduced cardiovascular risk.
- This study investigated how sustained BP control relates to changes in LVMI and the risk of LVH in children with CKD.

Methods

Study Population

- Ages 3-18
- Stages 1-4 CKD
- N = 141
- Precision Medicine Project for Pediatric CKD (PMP-PCKD) cohort



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Exposure

- Clinical SBP/DBP: TTR of normotension
- Echocardiography: LVMI

Outcome

- LVH: (1) $\text{LVMI} \geq 38 \text{ g/m}^2.7$; (2) \geq age- and height-specific 95th reference interval
- Association between $\text{TTR} \geq 50\%$ and LVH

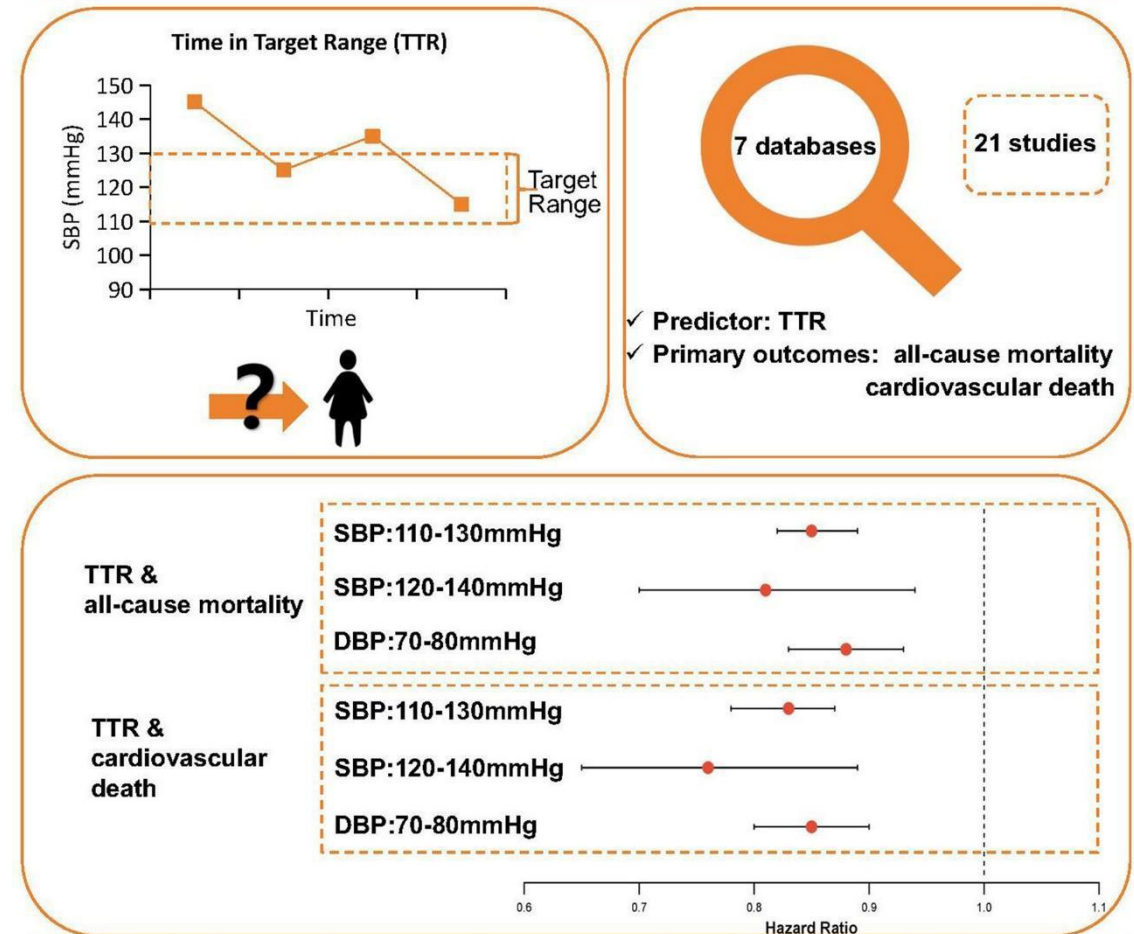
Statistical Analysis

- Mean \pm SD or median (IQR).
- Baseline characteristics stratified by $\text{TTR} \geq 50\%$.
- GEE models with logit link and robust errors used for repeated LVMI/LVH measures.
 - Model 1: adjusted for sex, age, eGFR
 - Model 2: added BMI Z score and comorbidities.
- Sensitivity analyses used alternate LVH definition and $\text{TTR} \geq 40\%$ cutoff.

TTR: Time in Target Range

- TTR reflects the percentage of time a patient's BP stays within the target range. It provides a dynamic picture of BP control rather than relying on single readings.
- Meta-analysis of 21 adult studies examined the relationship between BP TTR and major health outcomes.
- Higher TTR correlated with decreased all-cause mortality and major adverse cardiovascular events.

Time in Target Range for Blood Pressure and Adverse Health Outcomes

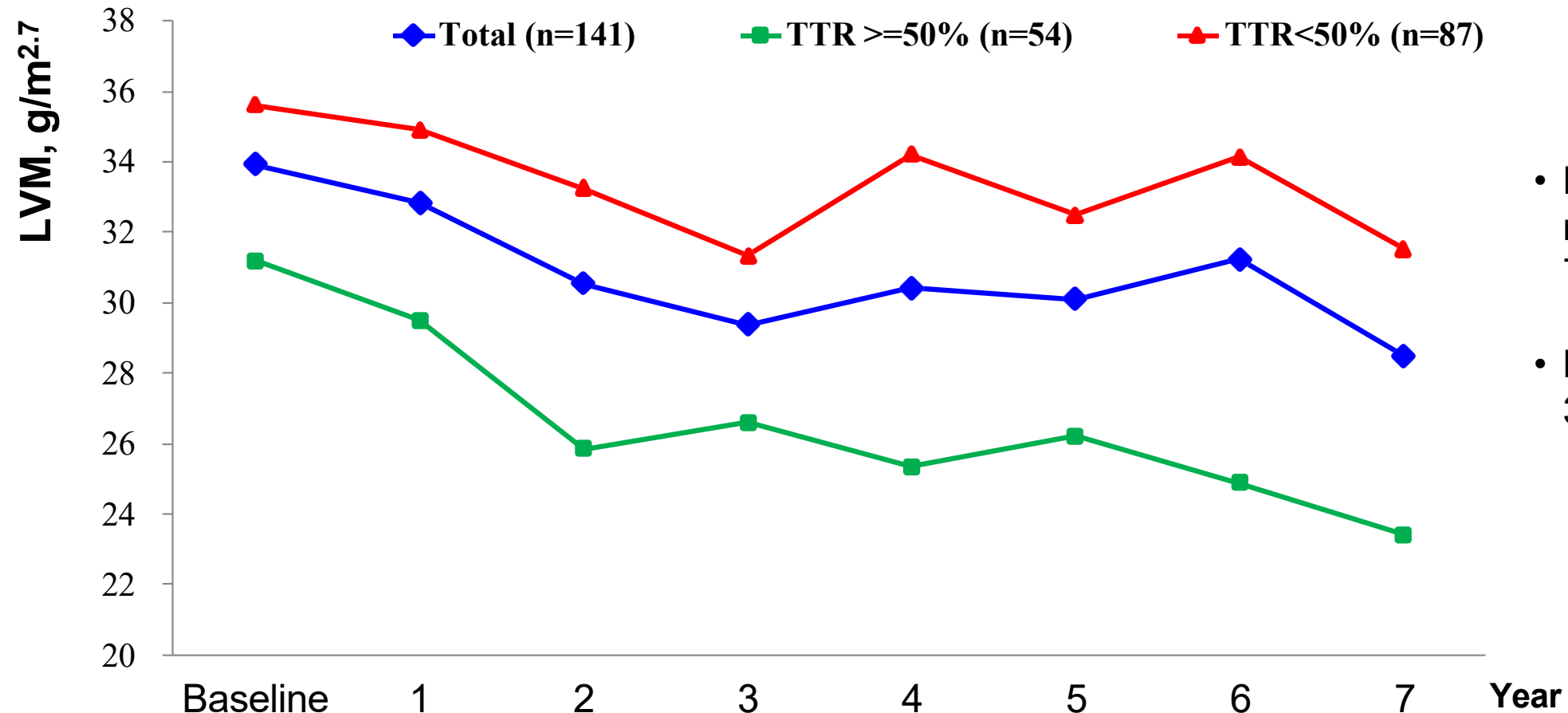


High TTR for blood pressure is associated with low risks of adverse health outcomes

Baseline Characteristics by TTR

Characteristics at enrollment	Total (n=141)		TTR ≥50% (n=54)		TTR <50% (n=87)		P value
Age, year, n (%)							
3-6	57	(40.43)	17	(31.48)	40	(45.98)	0.0266
7-12	51	(36.17)	27	(50.00)	24	(27.59)	
13-18	33	(23.40)	10	(18.52)	23	(26.44)	
Sex, n (%)							0.0061
Boys	83	(58.87)	24	(44.44)	59	(67.82)	
Girls	58	(41.13)	30	(55.56)	28	(32.18)	
Hypertension (office), n (%)	65	(46.10)	9	(16.67)	56	(64.37)	<.0001
Ever hypertension (office), n (%)	113	(80.14)	31	(57.41)	82	(94.25)	<.0001
LVMI, g/m ^{2.7}							
Median (IQR)	32.8	(27.6, 39.9)	30.3	(25.9, 34.3)	34.5	(29.2, 42.1)	0.0010
LVH (LVMI≥38)	42	(29.79)	9	(16.67)	33	(37.93)	0.0073
LVH (LVMI≥95 th)	21	(14.89)	6	(11.11)	15	(17.24)	0.3203
eGFR U25 by age, mean (SD)	96.19	(36.43)	97.45	(22.67)	95.41	(42.92)	0.6286
eGFR group, n (%)							
≥90	81	(57.45)	35	(64.81)	46	(52.87)	
60-89.9	49	(34.75)	17	(31.48)	32	(36.78)	
45-59.9	6	(4.26)	1	(1.85)	5	(5.75)	
30-44.9	4	(2.84)	1	(1.85)	3	(3.45)	
15-29.9	1	(0.71)	0	(0.00)	1	(1.15)	

Trajectory of LVMI by BP Control



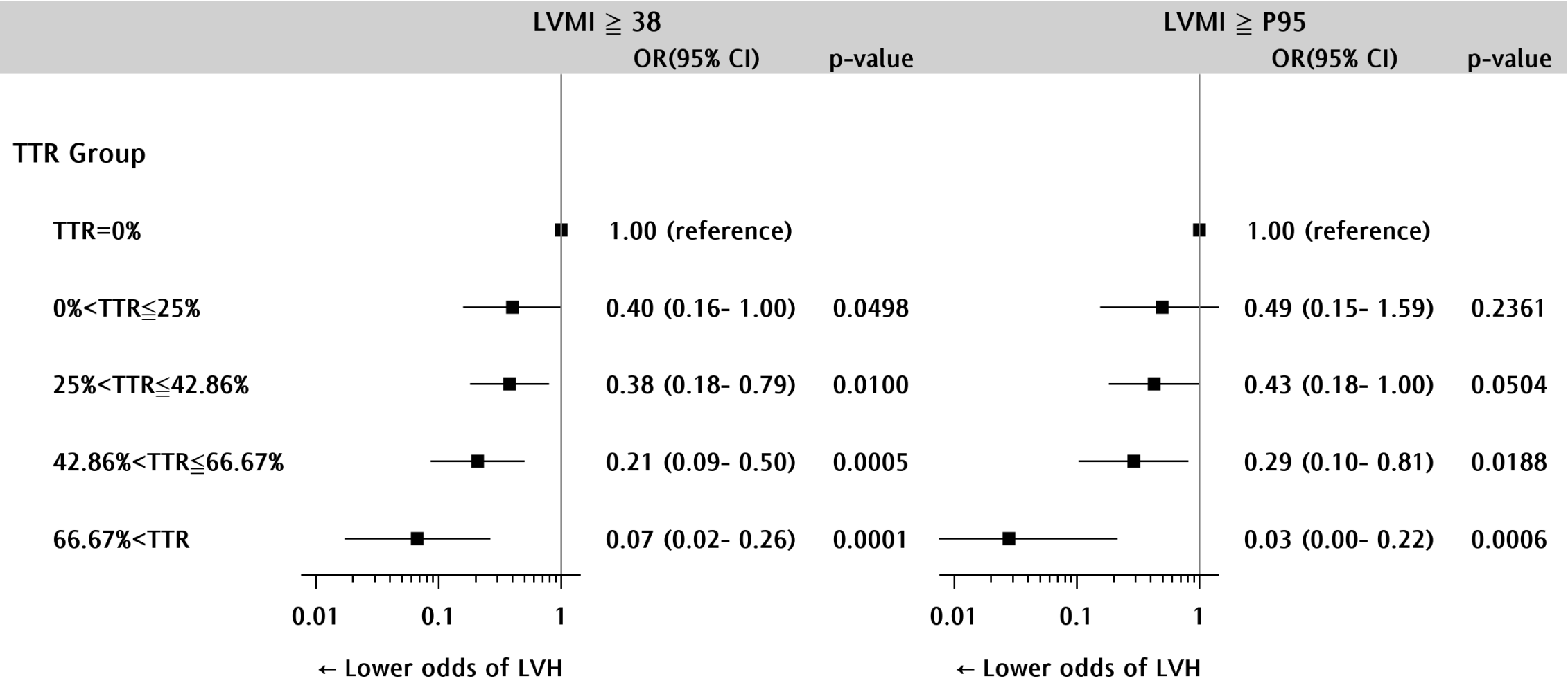
- N= 556 LVMI measures for up to 7 years follow-up
- Mean BP TTR was 35% (± 33.5)

TTR<50%, n	87	87	66	41	27	18	11	5
TTR≥50%, n	54	54	38	29	20	11	5	3
All children, n	141	141	104	70	47	29	16	8

Association between sustained BP control (TTR≥ 40%) and LVH by Definition

	LVMI ≥38 g/m ^{2.7}					LVMI ≥95th percentile			
	aOR	95% CI		p-value		aOR	95% CI		p-value
TTR ≥40%	0.40	0.20	0.80	0.0101		0.41	0.17	0.98	0.0445
Male sex	2.03	1.04	3.96	0.0379		1.84	0.84	4.06	0.1301
Age (ref 3-6 yrs)									
7-12	0.33	0.17	0.63	0.0009		2.31	0.96	5.53	0.0613
13-18	0.31	0.15	0.65	0.0020		2.31	0.89	5.95	0.0839
eGFR (ref ≥90 ml/min/1.73m ²)									
60-89.9	1.20	0.72	1.99	0.4805		0.98	0.50	1.90	0.9514
<60	3.56	1.20	10.54	0.0219		2.83	0.75	10.71	0.1265
BMI Z score	1.67	1.29	2.16	0.0001		1.58	1.16	2.16	0.0041
Number of comorbid conditions									
1	0.92	0.39	2.15	0.8389		2.10	0.63	6.99	0.2281
2	1.59	0.68	3.72	0.2831		2.90	0.72	11.60	0.1328
≥3	1.38	0.45	4.24	0.5788		3.03	0.59	15.60	0.1859

Proportion of Increased LVMI Event among Five Quantiles of TTR Groups



Conclusions

What is New?

- This study is the first to apply TTR to evaluate the consistency of office BP control in children with CKD. Higher TTR, reflecting sustained BP control, was associated with lower LVMI and reduced risk of LVH.
- These findings highlight the potential of TTR as a dynamic and clinically meaningful metric for monitoring BP management in pediatric CKD.

What Is Relevant?

- Subclinical cardiac remodeling begins early in pediatric CKD, and elevated LVMI is the most common manifestation of target organ damage.
- Conventional single-point BP measurements may underestimate the true burden of hypertension. Maintaining BP within the target range over time—rather than achieving isolated normal readings—may be essential to prevent LVH and cardiovascular progression in children with CKD.

Acknowledgements

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Thank You for Your Attention

