알레르기를 치료하는데 약 말고 다른 치료는 없나요? - “알레르기에 좋은 음식이나 영양제가 있을까요? 면역 치료는 효과가 있나요?"

경희대학교 의과대학 소아과학교실
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최선희

Syndemics, synergistically interaction epidemics that occur in a particular context with shared drivers

- **Asthma**
- **Allergic rhinitis**

➢ **Airway allergic diseases**

- **Food allergy**
- **Atopic dermatitis**
- **Chronic urticaria**

Others rather than pharmagologic drugs

- *Foods*: Vitamins
  - Vit D, A
  - Antioxidants: Vit E, C
  - Probiotics

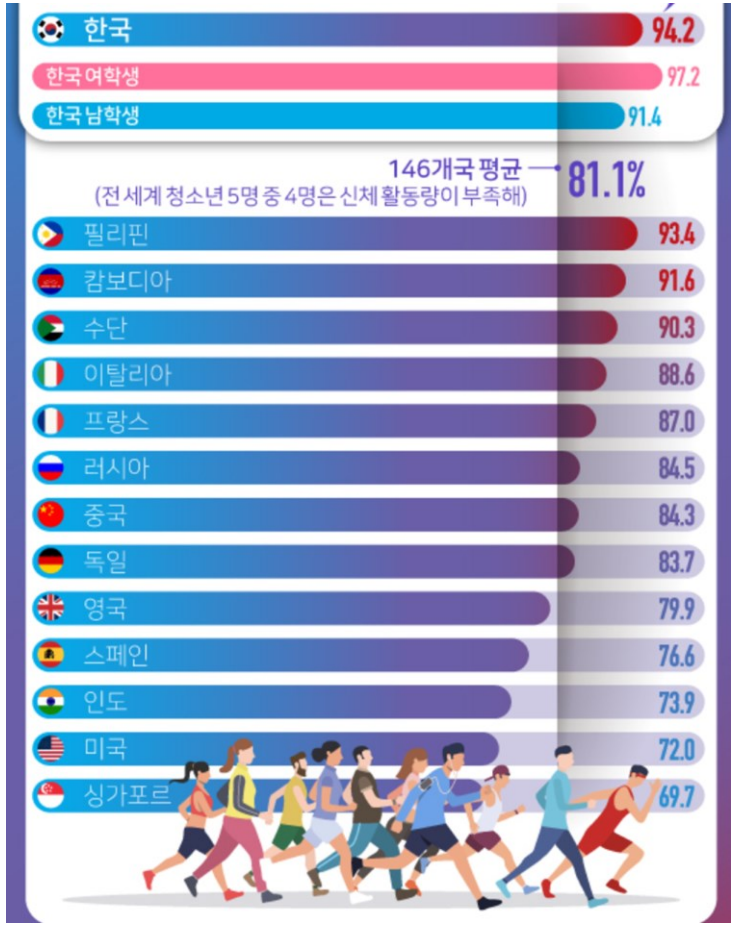
- *Allergen immunotherapy*

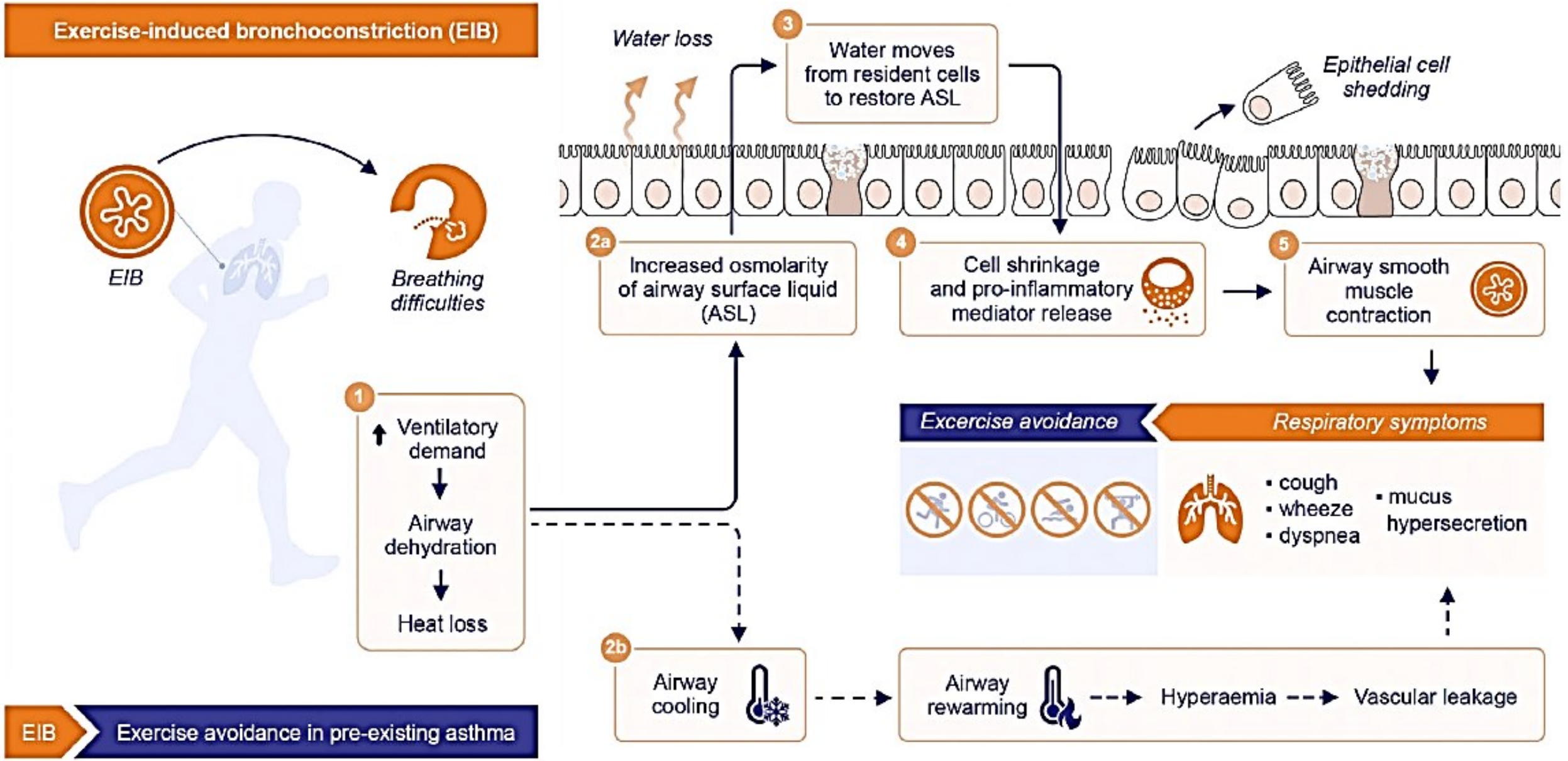
- Aerobic exercises
- Yoga, earthing

➢ *Trigger or Treatment*

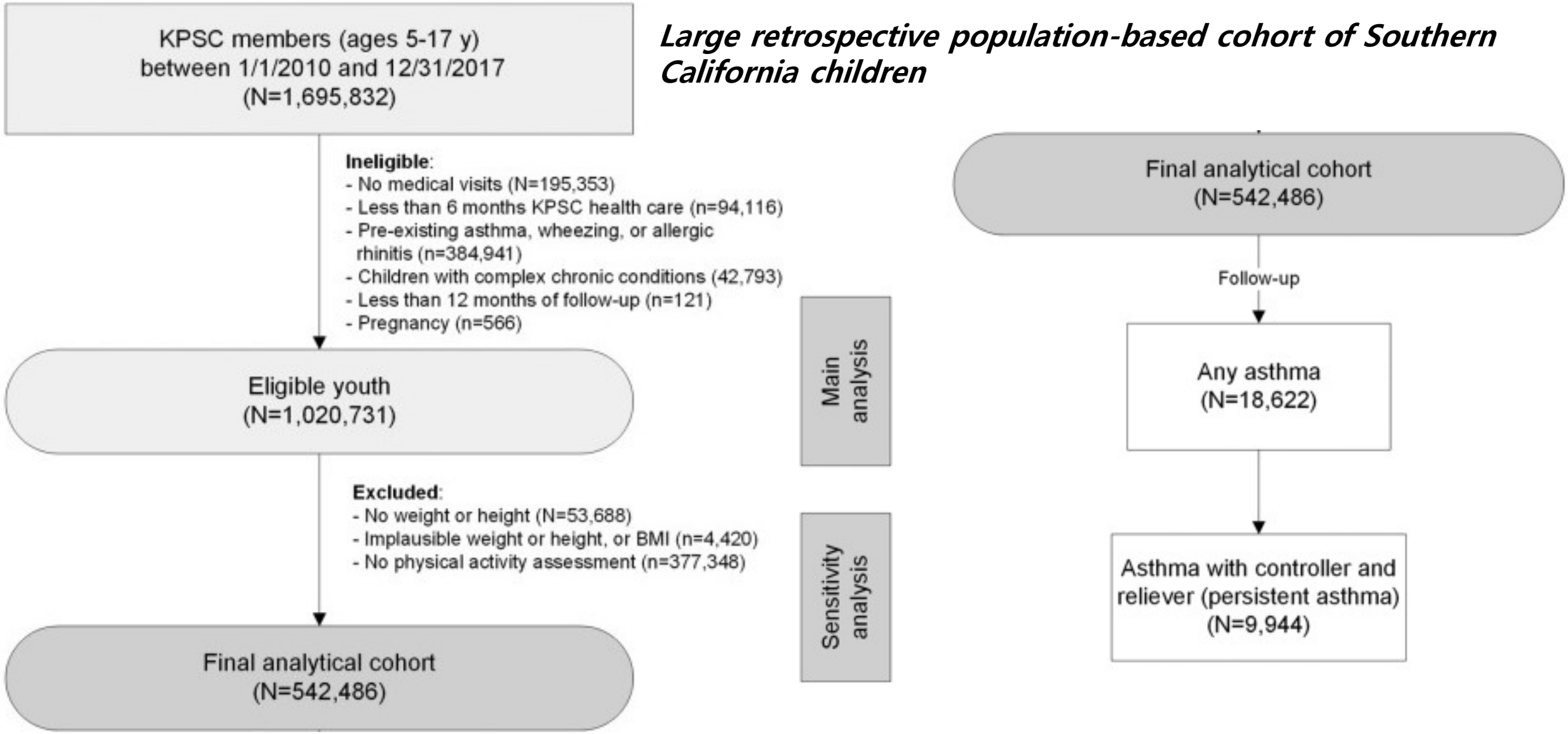
Exercises, Yoga, earthing

Trigger or Treatment ?!




Exercise-induced bronchoconstriction (EIB)
EIB
Breathing difficulties
Water loss
3
Water moves from resident cells to restore ASL
Epithelial cell shedding
2a
Increased osmolarity of airway surface liquid (ASL)
4
Cell shrinkage and pro-inflammatory mediator release
5
Airway smooth muscle contraction
1
Ventilatory demand
Airway dehydration
Heat loss
Excercise avoidance
Respiratory symptoms
cough
wheeze
dyspnea
mucus hypersecretion
2b
Airway cooling
Airway rewarming
Hyperaemia
Vascular leakage
EIB
Exercise avoidance in pre-existing asthma

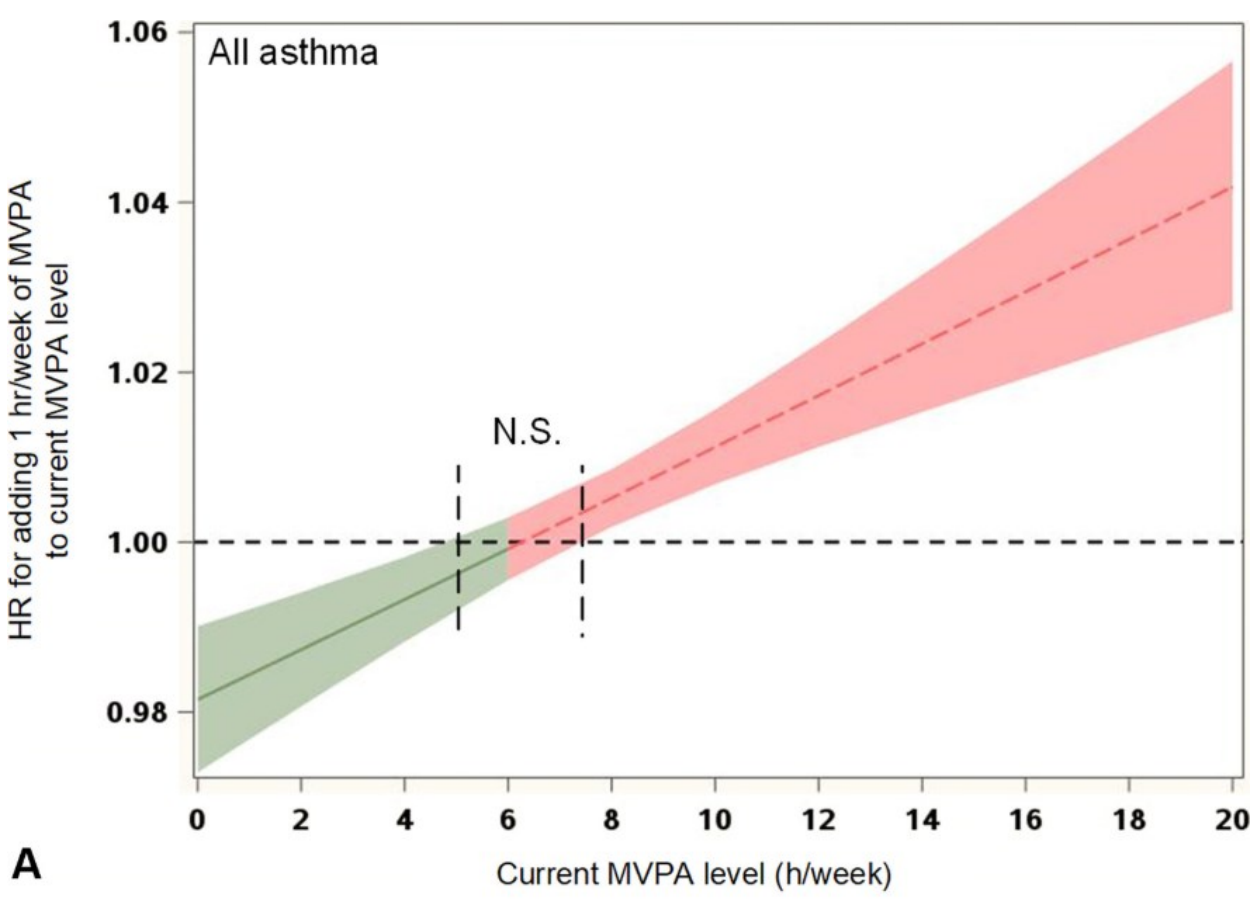
Large retrospective population-based cohort of Southern California children

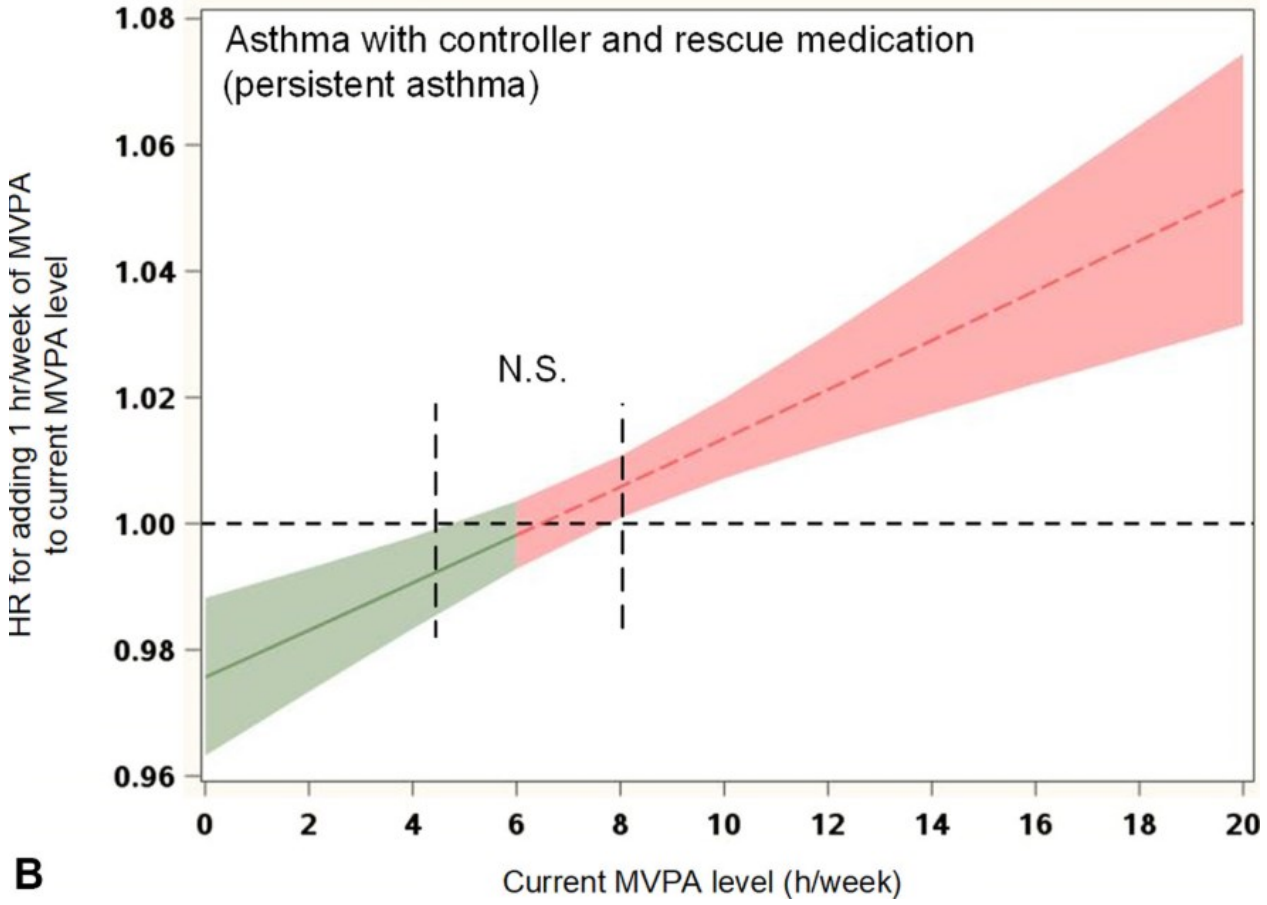


Self-Reported Physical Activity and Asthma Risk in Children. J Allergy Clin Immunol Pract. 2022;10:231-9.

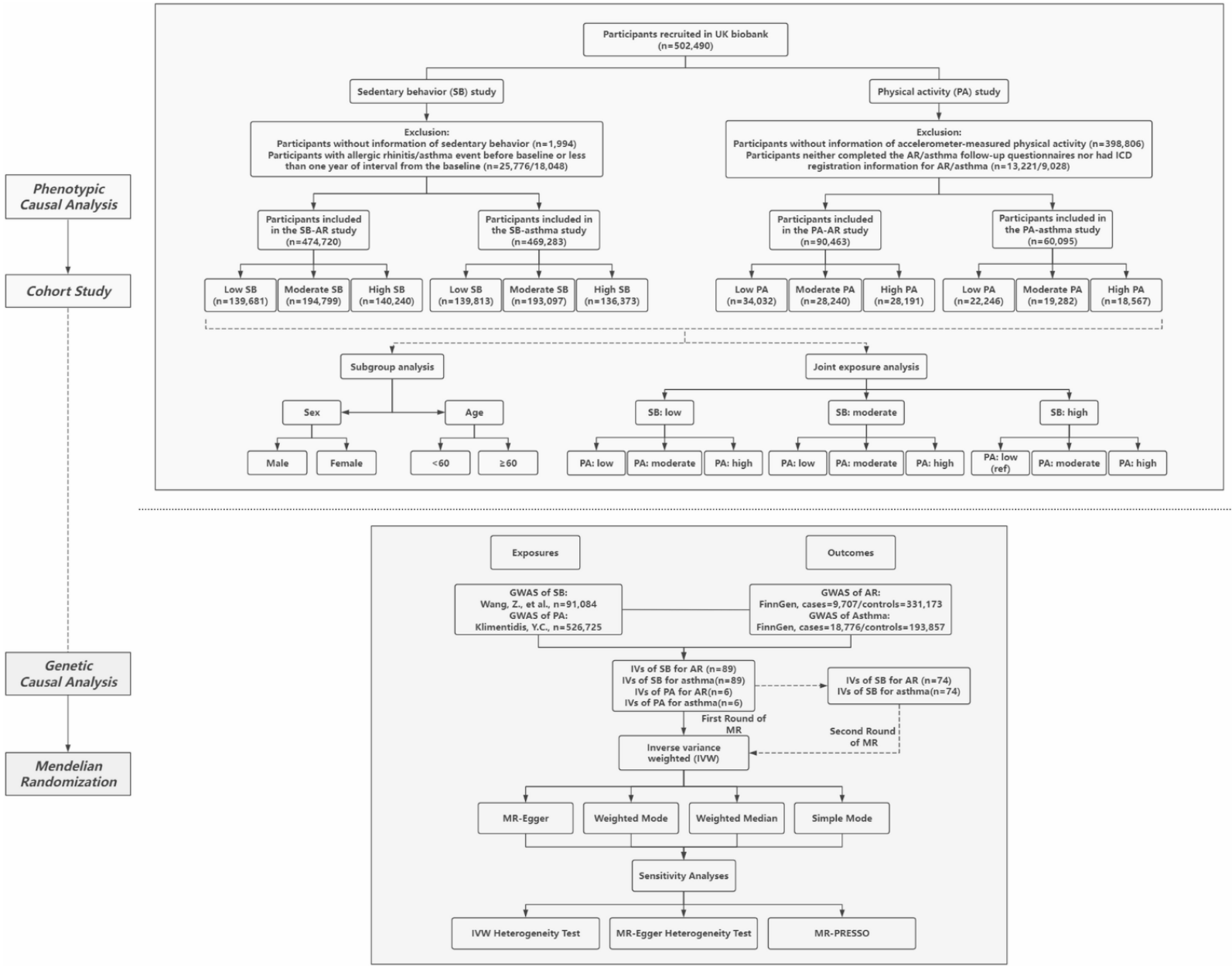
Characteristic	Total	Cases	Person-years	Incident rate (95% CI) per 1000 person-years
Overall	542,486	18,622	2,401,653	7.754 (7.643, 7.866)
Age (y)				
2-5	**163,711**	**9,449**	**639,570**	**14.774 (14.479, 15.075)**
6-11	165,814	5,257	763,971	6.881 (6.698, 7.070)
12-14	99,501	2,296	474,846	4.835 (4.641, 5.037)
15-17	113,460	1,620	523,266	2.943 (2.949, 3.250)
Sex				
Male	261,372	9,080	1,150,803	7.890 (7.730, 8.054
Female	281,114	9,542	1,250,851	7.628 (7.477, 7.783)
Race and ethnicity				
Non-Hispanic/White	138,703	4,610	596,783	7.725 (7.505, 7.951)
Hispanic	290,582	10,159	1,324,531	7.670 (7.522, 7.820)
Black	**38,971**	**1,782**	**183,171**	**9.729 (9.287, 10.191)**
Asian/Pacific Islander	39,626	1,284	175,591	7.312 (6.923, 7.724)
Other/unknown	34,604	787	121,577	6.473 (6.036, 6.942)
Government health care assistance				
No	422,767	13,689	1,898,499	7.210 (7.091, 7.332)
Yes	**119,719**	**4,933**	**503,155**	**9.804 (9.534, 10.082)**
Body weight class				
Underweight/normal	368,597	12,356	1,615,118	7.650 (7.517, 7.786)
Overweight	86,832	2,948	391,585	7.528 (7.261, 7.805)
Moderate obese	27,347	941	125,143	7.519 (7.054, 8.016)
Severe obese	**59,710**	**2,377**	**269,808**	**8.810 (8.463, 9.171)**
Moderate-to-vigorous physical activity (h/wk)				
0-1	**96,057**	**3,980**	**438,820**	**9.070 (8.792, 9.356)**
1-4	116,318	3,893	563,108	6.913 (6.700, 7.134)
4.1-7.9	117,395	3,396	518,532	6.549 (6.333, 6.773)
≥8	**212,716**	**7,353**	**881,194**	**8.344 (8.156, 8.537)**

BMI was positively associated with asthma risk (HR: 1.042 for each kg/m2, 95% CI: 1.039, 1.046). However, there was no significant interaction between BMI and MVPA.





Adjusted for sex, race and ethnicity, government health care assistance, and air pollution (ozone levels); stratified by baseline year. Missing values for body mass index or MVPA were imputed



Study design of cohort and Mendelian randomization analyses: UK biobank

1. Sedentary time into three groups among participants:

low-level sedentary group **(0-2 h/day**), moderate-level sedentary group **(>2-4 h/day**) and high-level sedentary group **(>4 h/day**)

2. PA based on tertiles of accelerometer data: **low-level PA group (< 24.32 mg)**, **moderate-level PA group (24.32–30.70 mg),** and **high-level PA group (≥ 30.70 mg)**

Sedentary behaviors, physical activity, and risk of allergic rhinitis and asthma: evidence from cohort and Mendelian randomization studies. BMC Pulm Med. 2025;25:320.

Multivariable Cox regression analyses of movement behaviors with allergic rhinitis and asthma

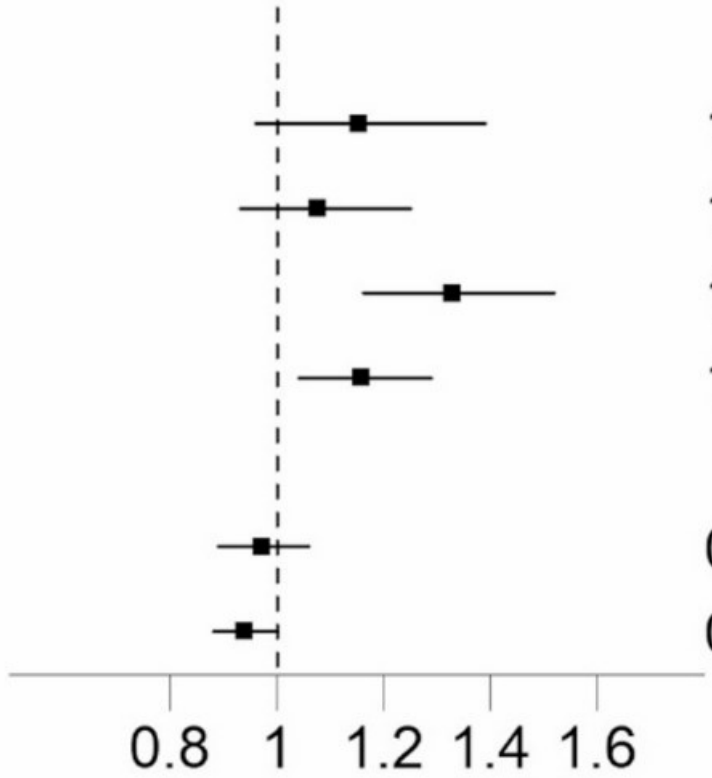
Exposure		Allergic rhinitis					Asthma				
		Total Number	Event	HR (95%CI)	P-value	Glob-al P	Total Number	Event	HR (95%CI)	P-value	Global P
Sedentary behavior	**Low**	135,873	1,464	Reference		0.2	5,533	5,533	Reference		**< 0.001**
	Moderate	190,818	1,968	1.03 (0.96–1.10)	0.4		8,576	8,576	1.04 (1.01–1.08)	**0.019**	
	High	137,358	1,395	1.07 (0.99–1.15)	0.091		7,113	7,113	1.14 (1.10–1.18)	**< 0.001**	
Physical activity	**Low**	33,405	627	Reference		0.058	1,349	1,349	Reference		**0.012**
	Moderate	27,862	575	1.08 (0.96–1.21)	0.2		948	948	0.89 (0.81–0.97)	**0.006**	
	High	27,842	497	0.93 (0.82–1.05)	0.2		905	905	0.9 (0.83–0.99)	**0.026**	

Model****: Adjusted for age, sex, BMI, ethnic background, education, TDI, smoking and alcohol drinking status

AR, allergic rhinitis; HR, Hazard Ratio; CI, Confidence Interval

Causality between movement behaviors and AR/asthma by inverse variance weighted from Mendelian randomization

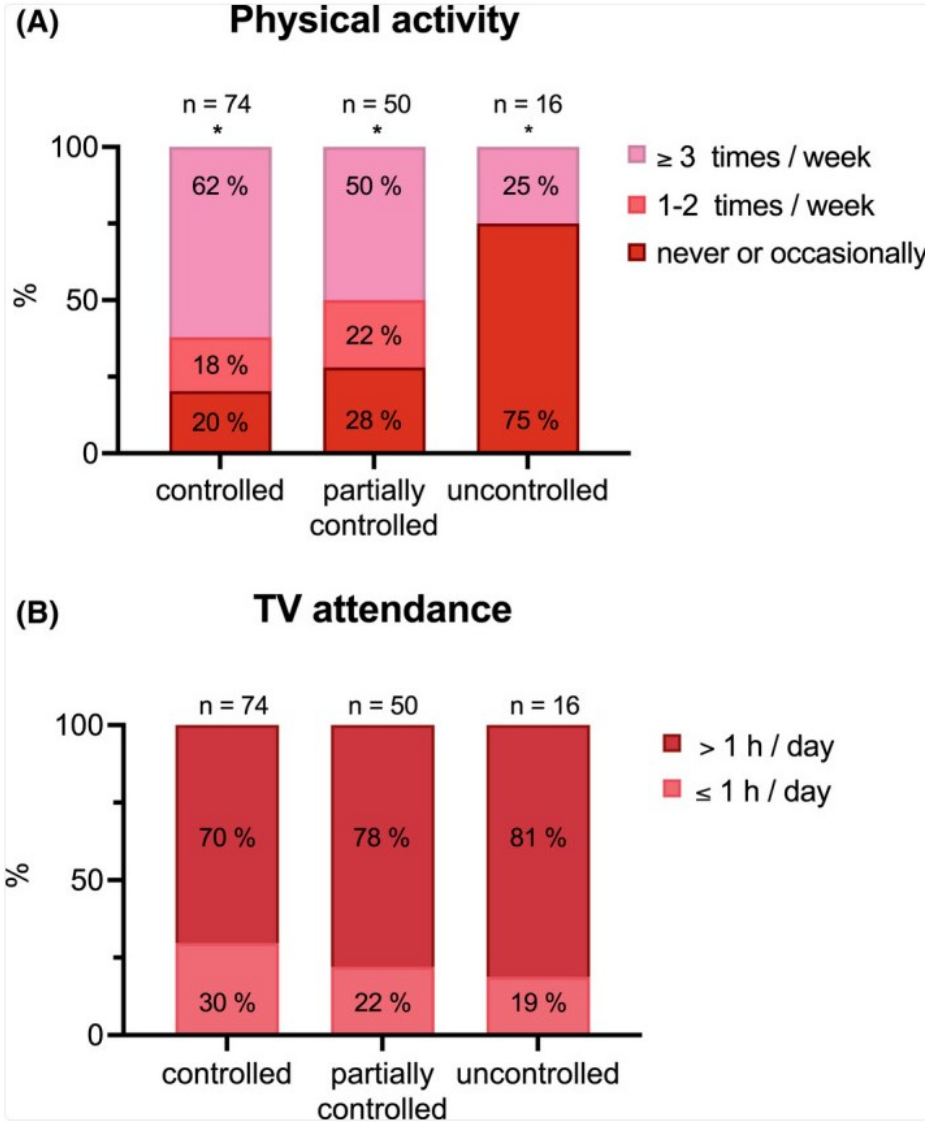
Exposure	Outcome	N	OR (95% CI)	P-value
Sedentary behavior				
	AR	89	1.15 (0.96-1.39)	0.13
	AR*	74	1.08 (0.93-1.25)	0.324
	Asthma	89	1.33 (1.16-1.52)	<0.001
	Asthma*	74	1.16 (1.04-1.29)	0.009
Physical activity				
	AR	6	0.97 (0.89-1.06)	0.506
	Asthma	6	0.94 (0.88-1.00)	0.046



Method : IVW

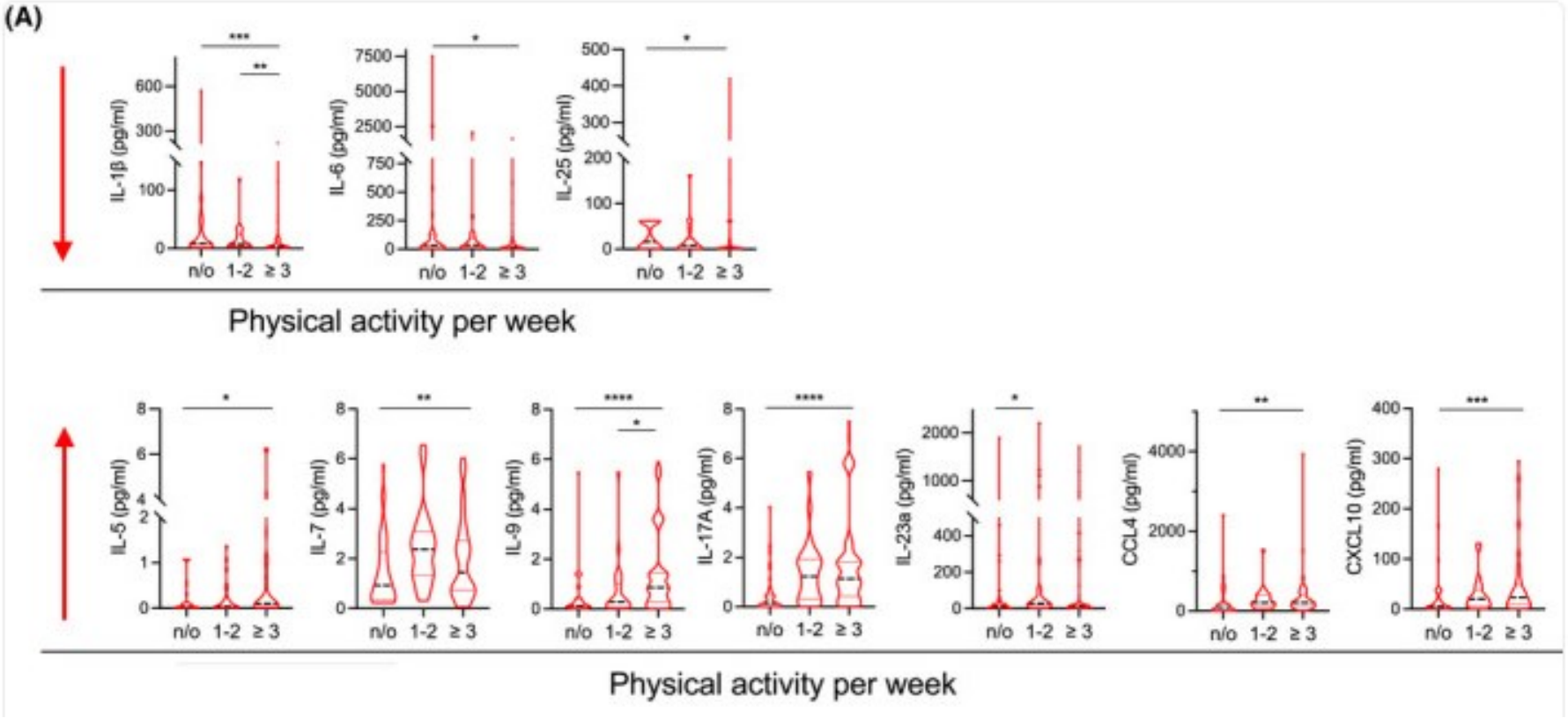
PreDicta study, a 2-year multi-center prospective cohort study that has been conducted across five major European cultural and climatic regions (Greece, Germany, Belgium, Poland, and Finland: mild to moderate asthma by GINA

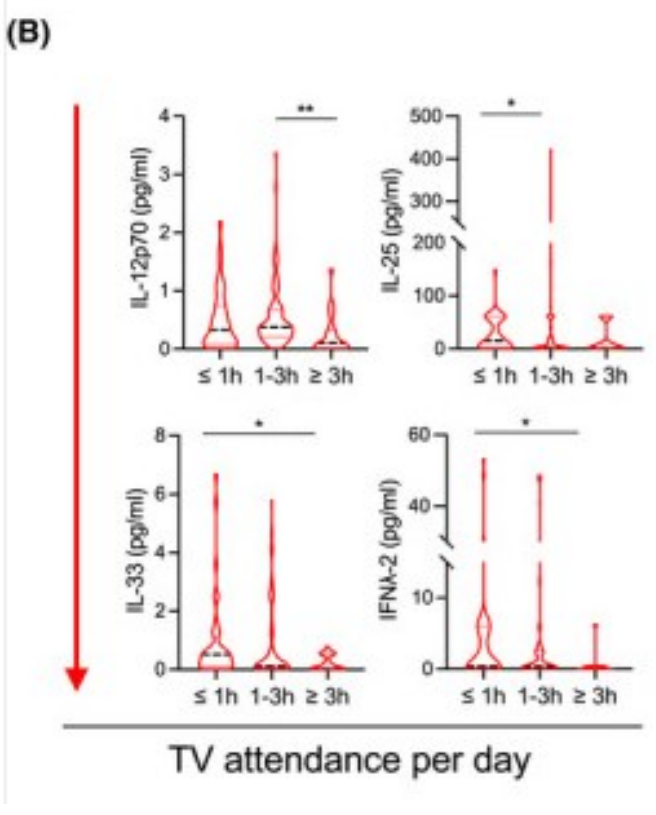
Patient characteristics	Healthy control (*n* = 53)	Asthmatic patients (*n* = 140)	*p* value
Gender (F/M)	31/22	58/82	**0.04**
Age (y) mean ± SD	5.0 ± 0.8	5.3 ± 0.7	ns
Wheezer (yes), *n* (%)	0 (0%)	140 (100%)	**<.0001**
Atopic diseases (yes), *n* (%)			
Allergic rhinitis, *n* (%)	0 (0%)	89 (64%)	**<.0001**
Atopic dermatitis, *n* (%)	0 (0%)	73 (52%)	**<.0001**
Adverse food reaction, *n* (%)	0 (0%)	44 (31%)	**<.0001**
Asthma control, *n* (%)			
Controlled	–	74 (53%)	–
Partly controlled	–	50 (36%)	–
Uncontrolled	–	16 (11%)	–
Vigorous physical activity (times per week), *n* (%)			
Never or occasionally	13 (25%)	42 (30%)	ns
Once/twice	10 (19%)	24 (17%)	ns
Three times or more	30 (57%)	75 (53%)	ns
TV attendance (hours per day), *n* (%)			
≤1 h	25 (47%)	36 (26%)	**<.05**
1–3 h	22 (42%)	82 (59%)	**<.05**
≥3 h	6 (11%)	22 (16%)	ns



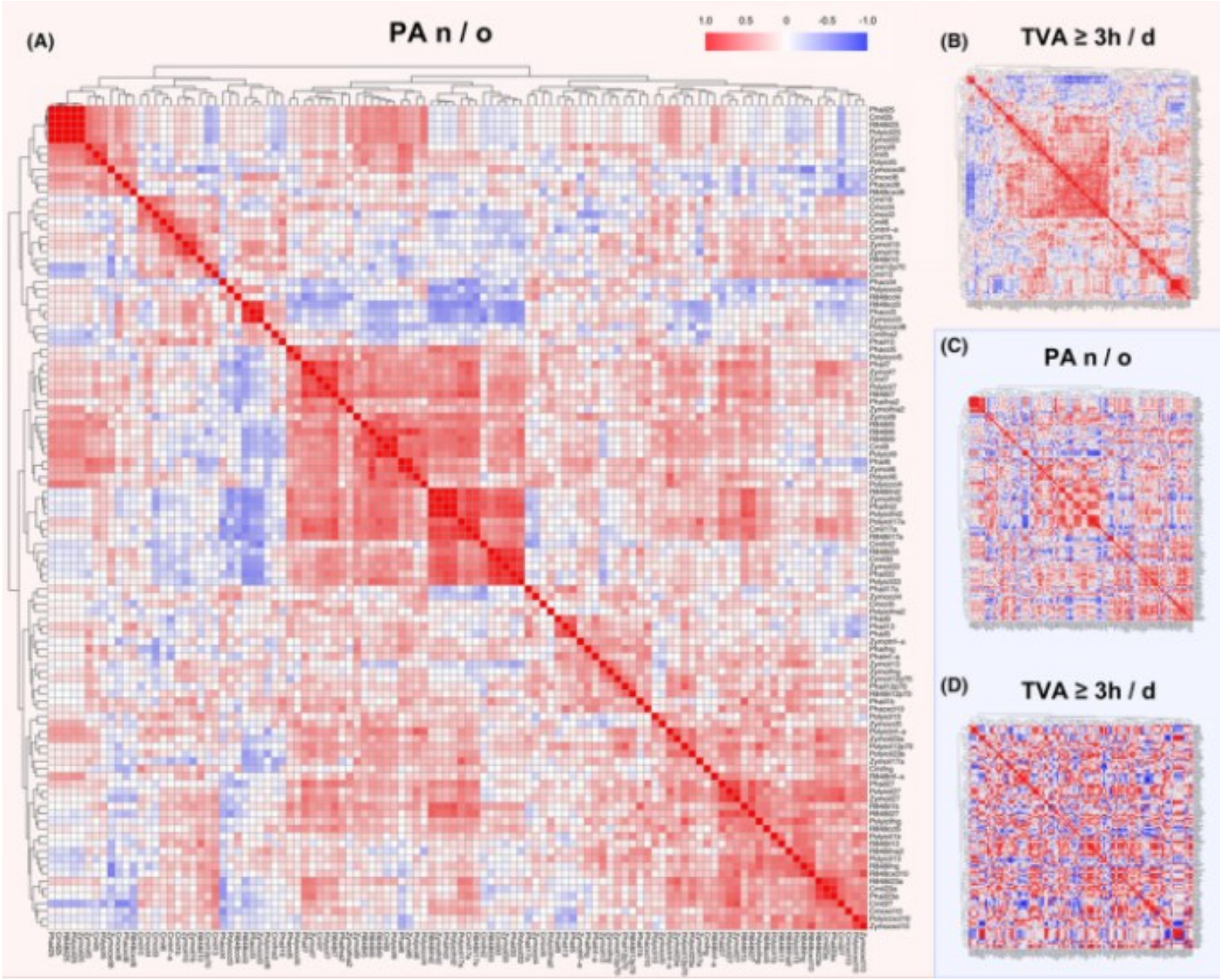
Physical activity in asthma control and its immune modulatory effect in asthmatic preschoolers. Allergy. 2022;77:1216-30.

Impact of physical activity and TV attendance on unstimulated cytokines in asthmatic (A, B) and healthy (C, D) preschoolers.

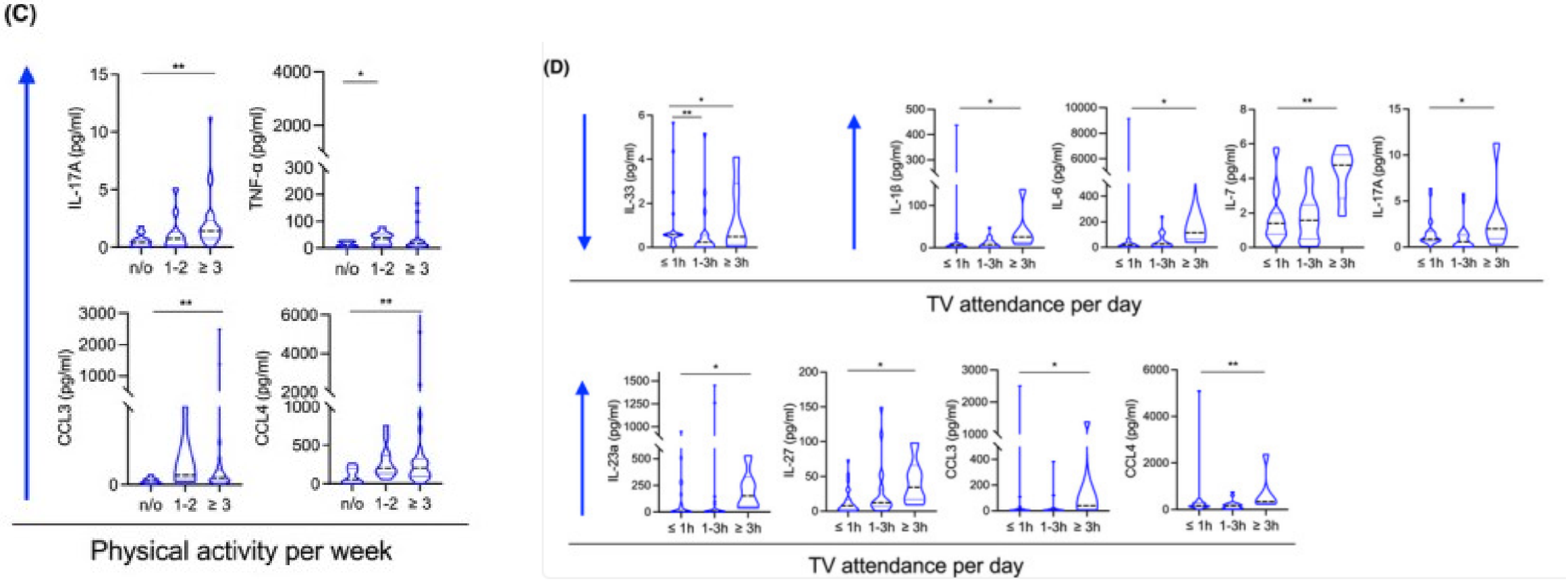




Asthmatic children with **no or only occasional PA** and / or **TVA ≥ 3 h per day** showed **high correlations of proinflammatory cytokines**



Barely any clusters of correlation could be identified in **healthy children of the same PA and TVA groups**

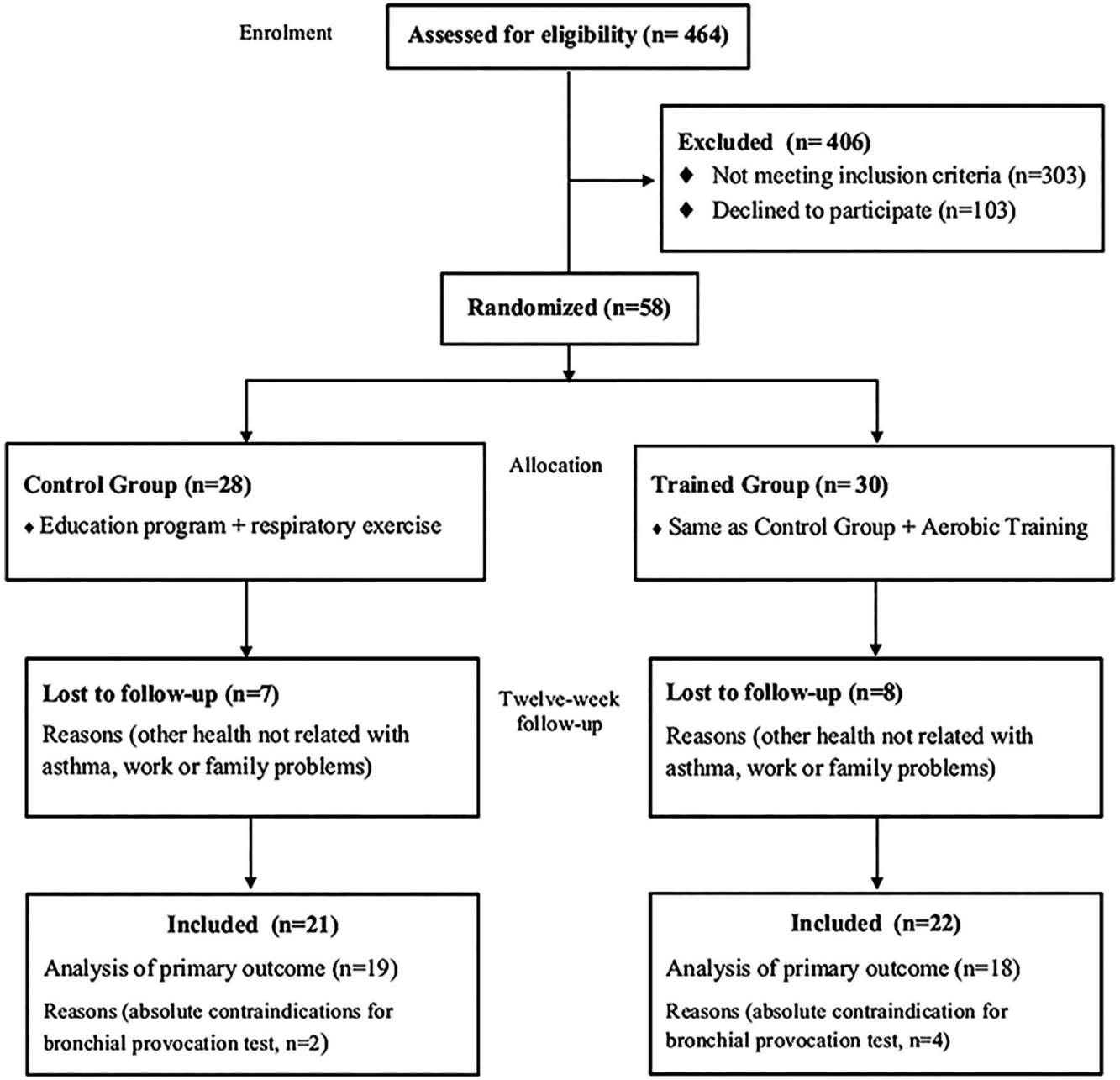

(C)
IL-17A (pg/ml)
TNF-α (pg/ml)
CCL3 (pg/ml)
CCL4 (pg/ml)
n/o 1-2 ≥ 3
Physical activity per week
(D)
IL-33 (pg/ml)
IL-1β (pg/ml)
IL-6 (pg/ml)
IL-7 (pg/ml)
IL-17A (pg/ml)
≤ 1h 1-3h ≥ 3h
TV attendance per day
IL-23a (pg/ml)
IL-27 (pg/ml)
CCL3 (pg/ml)
CCL4 (pg/ml)
TV attendance per day

- Patients diagnosed with mild-moderate asthma and presenting exercise-induced symptoms: (a) children and adolescents aged 7 to 17 years old; (b) asthma diagnosis with at least 6 months of evolution; (c) exercise-associated symptoms (a score 0-1 in the question 2 of the asthma control test [ACT] childhood questionnaire.
- for 12 weeks, with a frequency of 3 days/week (36 sessions in total), from Monday to Friday.
- combined (resistance and aerobic) and the duration of each session was 60 minutes.

Variables evaluated	Total	IG	CG	*P*
Sex (% girls)	58.3	60	57.1	.825
Age (y)	11.5 ± 2.6	12.1 ± 2.1	11.1 ± 2.9	.119
Weight (z-score)	0.57 ± 1.1	.79 ± 0.90	.41 ± 1.21	.185
Height (z-score)	0.26 ± 1.02	.34 ± 1.02	.20 ± 1.03	.595
Body Mass Index (z-score)	0.64 ± 1.3	.95 ± 1.08	.42 ± 1.4	.119
Waist height ratio	0.48 ± 0.06	.49 ± 0.05	.47 ± 0.07	.418
EIB (%)	**48.3**	**56.0**	**42.9**	.315
Atopic dermatitis (%)	61.7	64	60	.753
Allergic reaction (%)	63.3	68	60	.526
Food allergy (%)	25	24	25.7	.880
Passive smoker (%)	45	52	40	.357
Hemoglobin (g/dL)	13.75 ± 0.92	13.83 ± 0.93	13.69 ± 0.93	.593
FeNO first visit (ppB)	31 (46.5)	21 (29.5)	17 (24)	.453
Total eosinophils (mcl)	335 (349)	280 (241)	420 (375)	.309
Tanner				.066
Lung function				
FEV_1 (L)	2.29 (0.94)	2.44 (0.55)	1.91 (0.95)	.072
FVC (L)	2.76 (0.91)	2.81 (0.55)	2.3 (0.86)	.019
FVC (z-score)	−0.47 (1.42)	-0.45 (1.37)	−0.5 (1.8)	.922
FEV_1/FVC (absolute)	.82 (0.1)	.82 (0.1)	.84 (0.12)	.534
$FEF_{25\%-75\%}$ (L/min)	2.16 (1.51)	2.22 (1.35)	2.13 (1.76)	.414

Effect of a combined exercise program on physical fitness, lung function, and quality of life in patients with controlled asthma and exercise symptoms: A randomized controlled trial. Pediatr Pulmonol 2020;55:1608-16

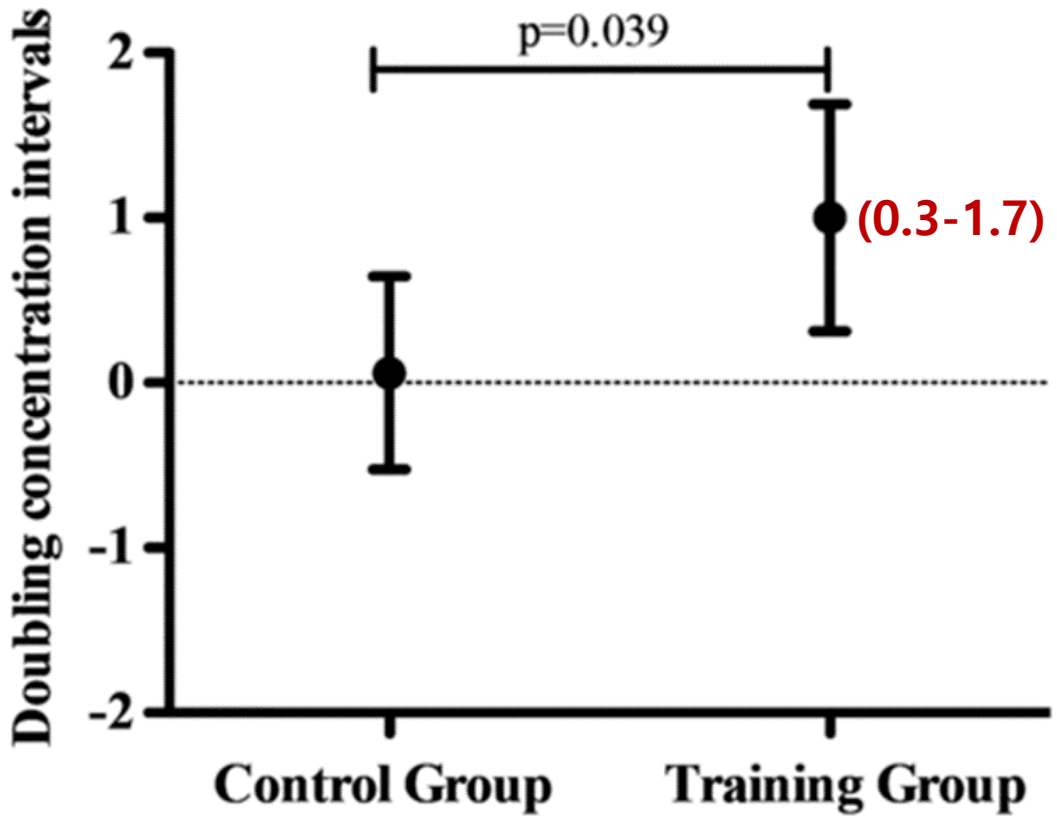
Variables evaluated	IG	CG	*P*	η2p
CPET				
Δ Ventilatory threshold				
HR, bpm	4.32 ± 15.47	−1.54 ± 10.06	.080	.052
VO_2, $mL \cdot kg^{-1} \cdot min^{-1}$	1.58 ± 3.39	−0.21 ± 4.48	.100	.046
VO_2, %VO_2peak	−0.88 ± 10.18	−1.09 ± 9.94	.936	<.001
V_E, $L \cdot min^{-1}$	1.61 ± 5.33	.99 ± 5.7	.672	.003
V_E/VO_2	−1.2 ± 3.73	.8 ± 3.04	.025	.083
V_E/VCO_2	−1.16 ± 3.17	.14 ± 4	.182	.031
Δ Peak exercise				
HR, bpm	2.6 ± 17.14	−3.46 ± 9.67	.087	.050
VO_2, $mL \cdot kg^{-1} \cdot min^{-1}$	3.61 ± 4.03	.59 ± 4.29	.008	.116
V_E, $L \cdot min^{-1}$	5.89 ± 11.18	3.44 ± 7.14	.304	.018
V_E/VO_2	−0.92 ± 6.11	1.14 ± 3.37	.099	.046
V_E/VCO_2	−0.24 ± 4.03	.23 ± 4.09	.661	.003
RER	0 ± 0.17	0 ± 0.14	.942	.001
Test time, min	.96 ± 2.09	−0.11 ± 1.17	.014	.100
Δ Lung function (z-score)				
FEV_1	**-0.05 (0.93)**	**-0.15 (1.88)**	**.412**	.013
FVC	**-0.19 (0.85)**	**-0.10 (1.31)**	**.722**	.002
FEV_1/FVC	**.32 (0.73)**	**-0.03 (1.05)**	**.066**	.064
$FEF_{25\%-75\%}$	**.31 (1.06)**	**-0.01 (1.38)**	**.245**	.016
Δ Asthma control				
ACT	1 (4)	.5 (5.75)	**.430**	.012
Δ Quality of life-PAQLQ				
Global	.61 (1.2)	.22 (1.05)	**.327**	.02
Emotional sphere	.25 (1.16)	0 (0.69)	**.888**	.047
Physical activity limitation	.1 (1.55)	.2 (1)	**.127**	<.001
Symptom	.45 (1.6)	.3 (1.25)	**.327**	.02



1. Moderate or severe persistent asthma (based on GINA), aged between 20 and 59 years, were recruited from a University Hospital.
2. Cardiovascular, musculoskeletal or other chronic lung diseases; current participation in a moderate or vigorous exercise programme; and current smokers or ex-smokers.
3. Aerobic training, twice per week - indoor treadmill, 5-25-5 min **for 12 weeks**

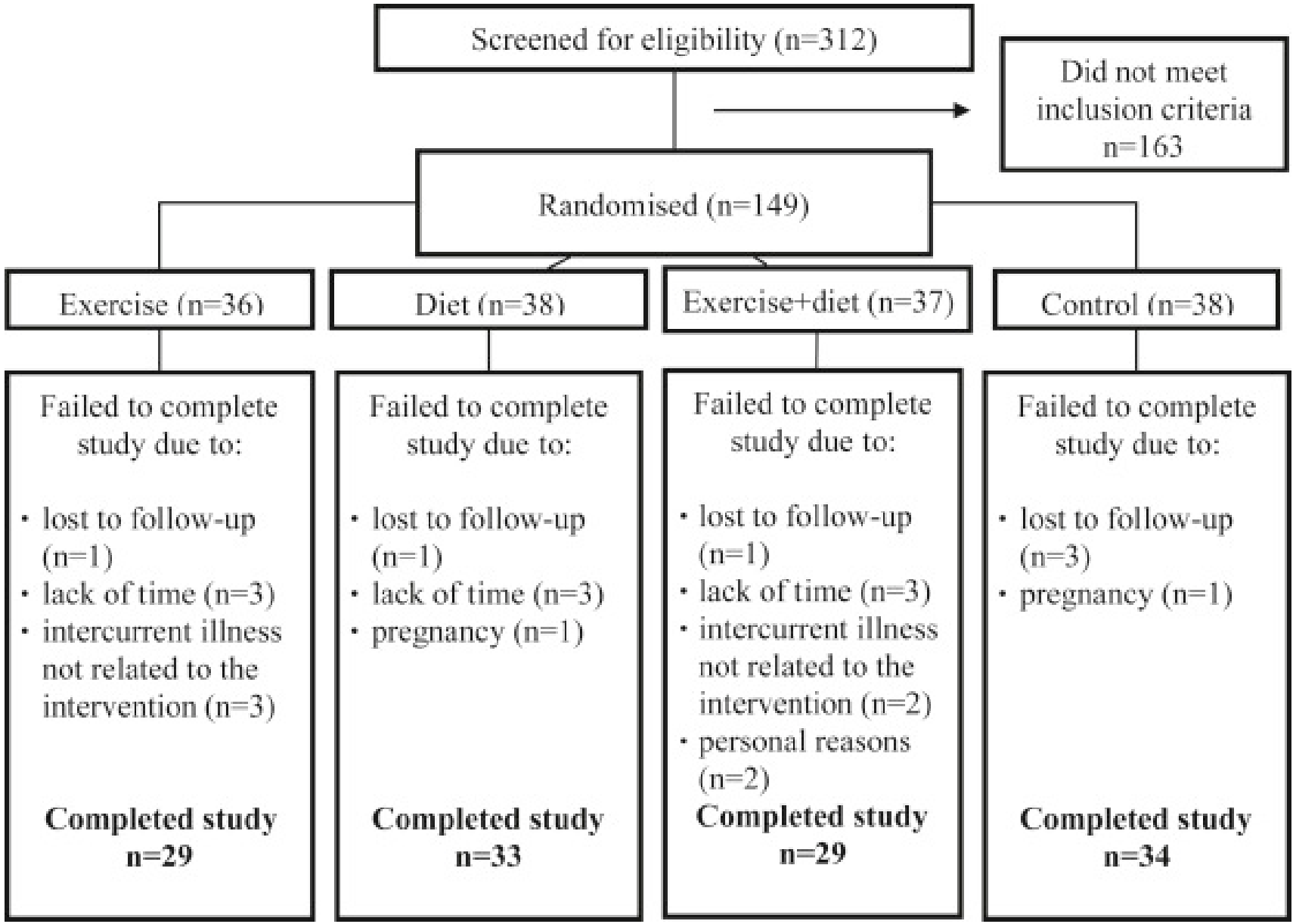
Aerobic training decreases bronchial hyperresponsiveness and systemic inflammation in patients with moderate or severe asthma: a randomised controlled trial. Thorax. 2015;70:732-9.

Patient characteristics	Control group (n=21)	Training group (n=22)
Anthropometric data		
Sex (F/M)	17/4	17/5
Age, years old; mean (SD)	44 (9)	40 (11)
BMI, kg/m^2; mean (SD)	26.4 (4.3)	26.5 (4.2)
Medication		
Budesonide dosage, μg/day; mean (SD)	804 (370)	909 (594)
Long-acting β_2 agonists, μg/day; mean (SD)	34.5 (32.1)	26.7 (17.7)
Onset of asthma in childhood, n (%)	12 (57)	17 (77)
IgE, IU/mL; median (25th–75th)	289.0 (57–877)	451.5 (151–1183)
Atopy, n (%)	15 (71.4)	20 (91.0)
BHR, PC_{20}, mg/mL; median (25th–75th)	0.5 (0.3–1.7)	0.3 (0.2–0.5)
Eosinophils, %; median (25th–75th)	6.1 (9)	10.1 (12)
FeNO, ppb; median (25th–75th)	26.7 (22.5–38.9)	32.0 (21.1–44.8)
ACQ-7, score; mean (SD)	1.6 (0.9)	1.4 (1.2)
Exacerbations in the last 12 months; no. events/patients	1.9	1.2
AQLQ, total score; mean (SD)	4.2 (1.1)	4.6 (1.4)
Aerobic capacity, VO_{2max}, mL/kg/min; mean (SD)	25.5 (5.9)	27.0 (4.3)
Pulmonary function		
FEV_1, %; mean (SD)	66.3 (19.0)	69.0 (21.0)
FEV_1/FVC, %; mean (SD)	72.2 (10.0)	73.0 (10.5)



	Control group (n=21)			Training group (n=22)			Treatment effect	
Outcomes	**Before**	**Mean (95% CI) within-group difference**	**p**	**Before**	**Mean (95% CI) within-group difference**	**P**	**Mean (95% CI) between -group difference**	**p**
IL-5 (fg/mL)	129.2 (80.1 to 205.3)	46.8 (-3.3 to 95.6)	0.066	155.5 (87.4 to 170.3)	2.0 (-21.2 to 25.1)	0.862	-19.4 (-53.3 to 14.4)	0.252
IL-6 (fg/mL)	298.2 (162.8 to 633.9)	67.6 (-186.7 to 322.0)	0.585	258.7 (214.5 to 467.6)	212.6 (83.0 to 341.7)	0.003	207.1 (7.7 to 406.1)	0.042
IL-8 (fg/mL)	1713.9 (1392 to 1858)	51.7 (-185.9 to 289.6)	0.655	1564.0 (1115 to 1941)	318.8 (76.0 to 561.6)	0.013	127.3 (-5.4 to 508.6)	0.055
IL-10 (fg/mL)	100.7 (1.0 to 166.7)	21.3 (-16.4 to 58.9)	0.253	95.4 (1.0 to 123.9)	17.6 (-16.3 to 51.5)	0.291	10.7 (-39.1 to 60.5)	0.667
MCP-1 (pg/mL)	14.1 (4.5 to 19.3)	0.5 (-2.8 to 3.9)	0.743	20.6 (17.1 to 26.7)	4.5 (-0.4 to 9.0)	0.052	-5.3 (-10.5 to −0.1)	0.045
IgE (IU/mL)	289.0 (60.5 to 878.5)	65.4 (-133.3 to 264.1)	0.500	**360.5** (78.5 to 993.2)	-238.5 (-1066.3 to 589.4)	0.555	-280.4 (-1144 to 583.7)	0.516

Outcomes	Control group (n=21)			Training group (n=22)			Treatment effect	
	Before	Mean (95% CI) within-group difference	p Value time	Before	Mean (95% CI) within-group difference	p Value time	Mean (95% CI) between-group difference	p Value treatment
Clinical Control								
Asthma symptom-free days	15.3 (11.0)	−2.5 (6.2 to 1.2)	0.180	12.0 (11.2)	−4.3 (−8.4 to −0.2)	0.042	0.1 (−7.2 to 7.3)	0.987
ACQ-7	1.6 (0.9)	0.1 (−2.1 to 0.5)	0.395	1.4 (1.2)	0.2 (−0.2 to 0.5)	0.267	0.2 (−0.3 to 0.7)	0.457
ACQ-6	1.5 (1.0)	0.1 (−2.8 to 0.6)	0.502	1.2 (1.2)	0.2 (−0.2 to −0.6)	0.236	0.3 (0.3 to 0.8)	0.327
AQLQ								
Overall	4.2 (1.1)	−0.3 (−0.8 to 0.2)	0.259	4.6 (1.4)	−0.7 (−1.9 to 0.2)	0.005	−0.9 (−1.7 to −0.1)	0.034
Activity limitation domain	3.8 (0.9)	−0.2 (−0.8 to 0.4)	0.433	4.3 (1.3)	−0.8 (−1.2 to −0.3)	0.002	−1.1 (−1.8 to −0.3)	0.009
Symptoms domain	4.8 (1.5)	−0.2 (−0.9 to 0.4)	0.469	5.1 (1.5)	−0.6 (−1.1 to 0.0)	0.053	−0.7 (−1.5 to 0.1)	0.091
Emotional function domain	4.1 (1.9)	−0.6 (−1.6 to 0.4)	0.250	4.6 (1.8)	−1.0 (−1.6 to −0.3)	0.005	−0.9 (−2.0 to 0.1)	0.084
Environmental stimuli domain	3.7 (1.8)	−0.5 (−1.5 to 0.6)	0.359	4.5 (2.0)	−0.6 (−1.3 to 0.2)	0.118	−0.9 (−2.0 to 0.3)	0.140
Induced sputum								
Total cell (10^6/mL) median (25th–75th)	0.9 (0.1–1.4)	−0.8 (−1.5 to 0.2)	0.055	0.8 (0.4 to 1.6)	0.2 (−0.44 to 0.77)	0.583	0.6 (−0.6 to 1.7)	0.333
Eosinophils (%) median (25th–75th)	6.1 (0.25–14.9)	−7.9 (−17.7 to 1.8)	0.106	10.1 (1.6 to 21.9)	−0.6 (−8.8 to 7.6)	0.881	−8.8 (−2.0 to 0.3)	0.648
Neutrophils (%) median (25th–75th)	33.8 (22.1–66.2)	3.4 (−6.9 to 13.7)	0.500	37.4 (16.7 to 57.5)	1.6 (−12.6 to 15.7)	0.821	1.7 (−13.1 to 16.6)	0.816
Lymphocytes (%) median (25th–75th)	0.0 (0.0–0.1)	0.9 (−2.7 to 4.4)	0.620	0.0 (0.0 to 0.8)	−1.2 (−2.9 to 0.4)	0.137	−1.0 (−2.8 to 0.7)	0.251
Macrophages (%) median (25th–75th)	40.5 (11.1–73.1)	1.4 (−9.8 to 12.5)	0.799	43.4 (25.7 to 65.2)	−0.9 (−16.1 to 14.4)	0.907	−6.7 (−22.7 to 9.2)	0.248
FeNO (ppb) median (25th–75th)	26.7 (22.5–38.9)	−5.9 (−5,8 to 4.6)	0.815	32.0 (21.1 to 44.8)	4.5 (−0.7 to 9.7)	0.087	4.4 (−5.9 to 14.7)	0.397
Exercise capacity								
Aerobic capacity (VO_{2max} mL/kg/min)	25.5 (5.9)	2.4 (−0.2 to 4.5)	0.053	27.0 (4.2)	−1.0 (−2.4 to 0.5)	0.182	−4.8 (−8.9 to −0.8)	0.019
Maximal workload (watts)	202.8 (67.3)	−3.3 (−25.4 to 18.9)	0.762	190.3 (32.3)	−57.1 (−73.1 to −41.1)	<0.001	−44.1 (−83.4 to −4.8)	0.029
Pulmonary function								
FEV_1, (L)	2.00 (0.7)	−0.1 (−0.2 to 0.1)	0.471	2.1 (0.76)	0.00 (−0.1 to 0.1)	0.952	−0.0 (−0.5 to 0.4)	0.930
FEV_1 % predicted	66.3 (19.0)	−2.3 (−8.6 to 3.9)	0.447	69.0 (21.0)	−1.1 (−4.8 to 2.6)	0.546	2.5 (−11.5 to 16.5)	0.721



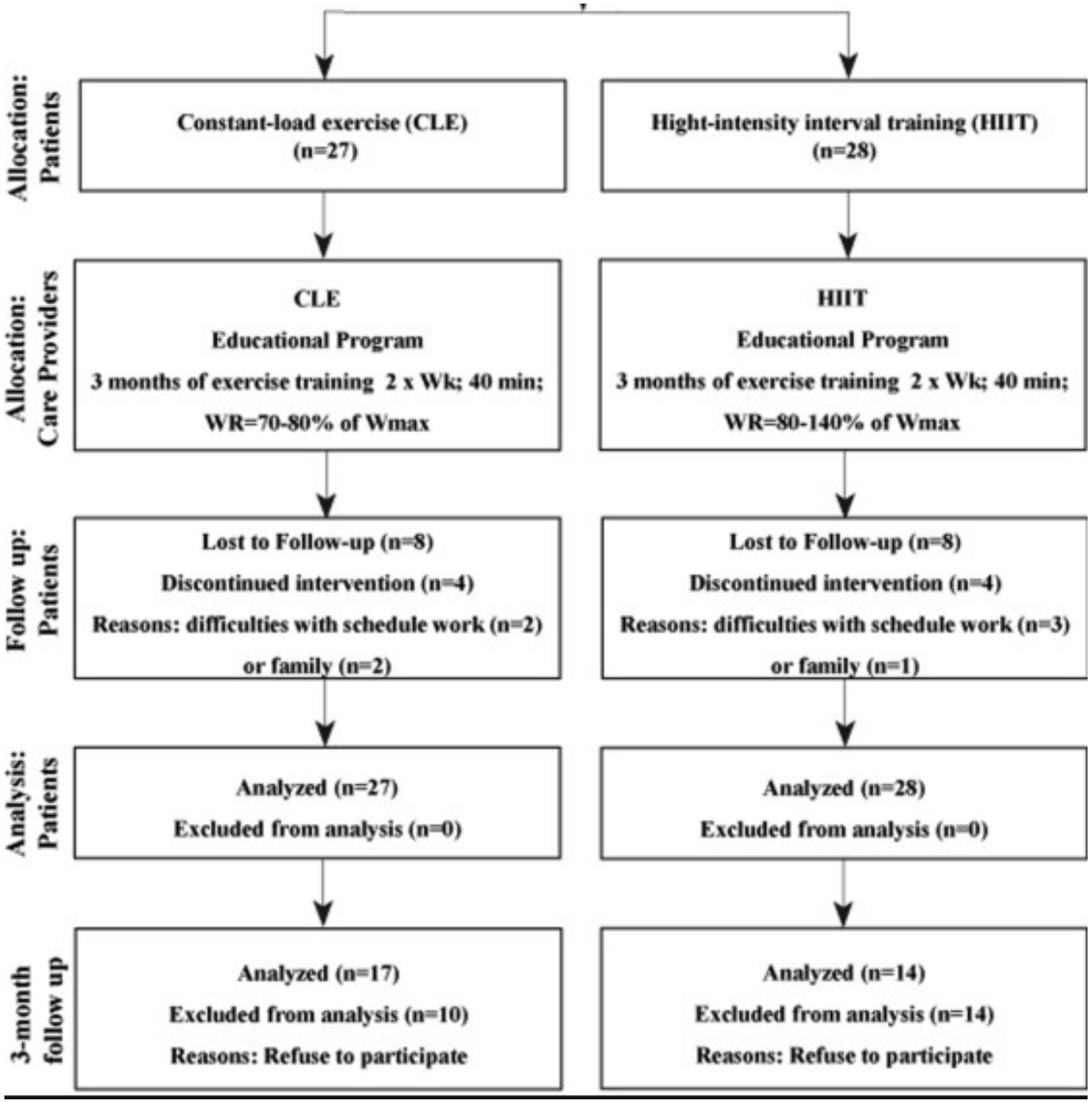
Effects of Exercise and Diet in Nonobese Asthma Patients-A Randomized Controlled Trial. J Allergy Clin Immunol Pract. 2018;6:803-11.

Characteristic	Exercise	Diet	Exercise + diet	Control	*P* value
N (completed study)	29	33	29	34	
Men	16 (55)	8 (24)	7 (24)	8 (24)	.02
Age (y)	39.4 ± 12.5	40.7 ± 14.7	43.7 ± 13.9	38.2 ± 12.7	.8
Body mass index (kg/m^2)	24.9 ± 2.5	25.0 ± 2.8	26.1 ± 2.5	25.5 ± 2.4	.8
Years with asthma	17.2 ± 13.7	14.4 ± 10.8	19.4 ± 14.7	18.9 ± 10.5	.2
Use of ICS	22 (76)	24 (73)	17 (59)	23 (68)	.5
ICS dose (budesonide equivalents at entry, µg)	645 (440)	692 (521)	663 (370)	739 (469)	.6
Smoking					.6
No	21 (72)	25 (76)	18 (62)	19 (56)	
Yes	0 (0)	1 (3)	1 (3)	2 (6)	
Former	8 (29)	7 (21)	10 (34)	13 (38)	
ACQ score	1.7 ± 0.6	2.0 ± 0.6	1.9 ± 0.7	1.8 ± 0.7	.7
FEV_1 %pred	84.9 ± 12.6	87.6 ± 14.5	82.6 ± 15.2	81.9 ± 12.3	.6
FVC %pred	93.1 ± 10.4	95.8 ± 11.5	94.3 ± 15.3	96.0 ± 12.5	.2
FEV_1/FVC	0.91 ± 0.08	0.92 ± 0.12	0.88 ± 0.10	0.85 ± 0.08	.05
Atopy[†]	21 (72)	23 (85)	26 (84)	26 (84)	.5

Outcomes	Exercise (n = 29)		Diet (n = 33)		Exercise + diet (n = 29)		Control (n = 34)		*P* *
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	
ACQ score	**1.7 ± 0.6**	**1.0 ± 0.8†**	**2.0 ± 0.6**	**1.3 ± 0.8†**	**1.9 ± 0.7**	**1.0 ± 0.7†,‡**	**1.8 ± 0.8**	**1.5 ± 0.8§**	**.05**
AQLQ score	**5.7 ± 0.6**	**6.2 ± 0.5†**	**5.3 ± 0.8**	**5.9 ± 0.9†**	**5.2 ± 0.8**	**6.2 ± 0.7†,‖**	**5.2 ± 0.8**	**5.7 ± 0.7†**	**.04**
FEV1 %pred	84.9 ± 12.6	84.5 ± 13.1	87.6 ± 14.5	89.4 ± 13.4	82.6 ± 15.2	84.5 ± 16.2	81.9 ± 12.3	81.6 ± 12.8	.50
FVC %pred	93.1 ± 10.4	94.0 ± 10.3	95.8 ± 11.5	99.2 ± 11.6	94.3 ± 15.3	96.8 ± 14.0‡,¶	96.0 ± 12.5	95.0 ± 13.5	.08
Sputum eosinophils (%)	4.5 (15.1)	2.5 (13.5)	0.5 (5.8)	0.5 (2.5)	7.8 (14.9)	4.8 (13.1)	1.5 (6.7)	0.8 (5.2)	.19
Sputum neutrophils (%)	61.3 (12.0)	57.3 (18.1)	54.3 (26.0)	61.0 (45.5)	43.0 (52.4)	46.3 (33.6)	60.3 (41.0)	55.4 (33.5)	.21
FENO (ppb)	28.5 (23.8)	23.5 (36.3)	20.5 (13.0)	18 (19.5)	32.5 (29.0)	27 (32.3)	20.8 (35.6)	20.3 (22.3)	.12
AHR	-1.19 (-1.37~-1.01)	-1.19 (-1.40~-0.99)	-1.14 (-1.35~ -0.93)	-1.26 (-1.51~-1.01)	-1.00 (-1.25~ -0.75)	-1.09 (-1.43~ -0.76)	-0.98 (-1.18~ -0.78)	-1.09 (-1.36~-0.81)	.87
Blood eosinophils ($\times 10^{-9}$/l)	0.19 (0.22)	0.19 (0.16)	0.16 (0.23)	0.13 (0.18)	0.21 (0.14)	0.21 (0.14)	0.18 (0.19)	0.18 (0.26)	.06
Serum hs-CRP(mg/L)	0.86 (1.32)	0.65 (0.81)	1.12 (1.63)	0.92 (1.76)	0.89 (2.12)	1.15 (1.38)	1.14 (1.99)	1.08 (1.34)	.90
Serum IL-6(pg/mL)	1.27 (0.72)	1.27 (0.81)	1.46 (0.95)	1.34 (0.72)	1.53 (0.83)	1.63 (0.92)	1.68 (1.58)	1.45 (0.84)	.40

Outcomes	Exercise			Diet			Exercise+ diet			Control
	B	95% CI	*P* value	*B*	95% CI	*P* value	*B*	95% CI	*P* value	
ACQ score (PP)*	−0.3	−0.76 to 0.09	.12	0.4	−0.77 to 0.05	.09	0.6	−1.02 to−0.18	<.05	Ref.
ACQ score (MI)†	−0.4	−0.78 to 0.01	.06	0.4	−0.80 to 0.02	.06	0.6	−1.02 to−0.14	.01	Ref.
AQLQ score (PP)*	0.05	−0.34 to 0.44	.80	0.12	−0.25 to 0.49	.52	0.5	0.13 to 0.91	<.01	Ref.
AQLQ score (MI)†	−0.01	−0.38 to 0.37	.98	0.08	−0.29 to 0.45	.67	0.5	0.10 to 0.88	.01	Ref.

	ACQ		AQLQ	
	Pearson *r*	*P*	Pearson *r*	*P*
Sputum eosinophils (%)	0.20	0.06	<0.01	1.0
Blood eosinophils	0.25	<0.01	0.15	0.13
FENO (parts per billion)	0.05	0.61	0.08	0.39
AHR	0.02	0.84	0.03	0.76



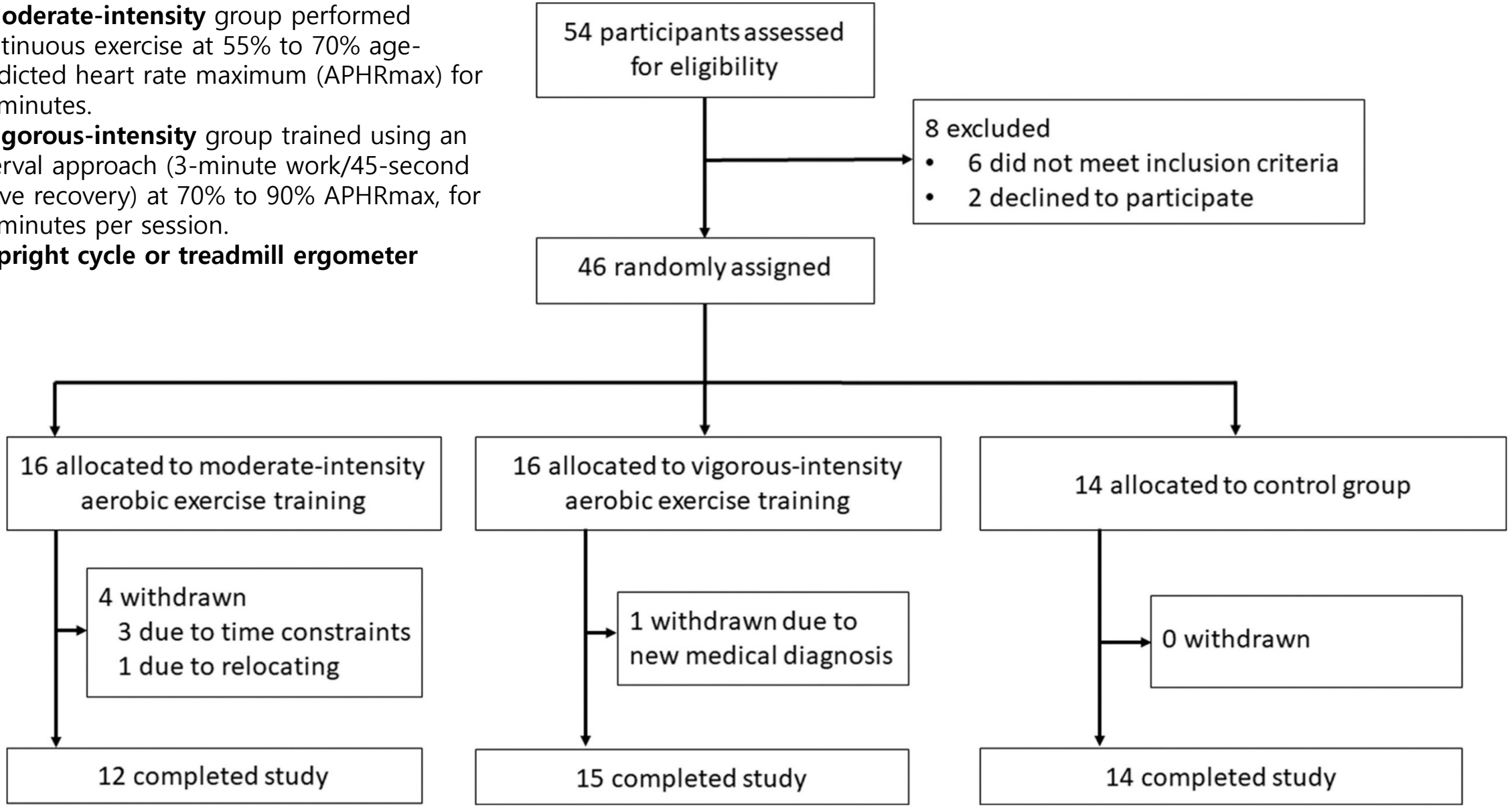
Twice a week for 12 weeks for a total of 24 sessions.

1. HIIT : 40 minutes (5 minutes of warm-up, 30 minutes of exercise, and 5 minutes of cool down) on a cycle ergometer In the first 2 weeks, the participants performed HIIT at 80% of Wmax; in weeks 3 to 4, 90% to 100% Wmax; in weeks 5 to 6, 110% to 120% Wmax; in weeks 7 to 8, 120% Wmax; in weeks 9 to 10, 130% Wmax; and in weeks 11 to 12, 140% Wmax.

2. CLE : 40 minutes (5 minutes of warm-up, 30 minutes of exercise, and 5 minutes of cool down) on a cycle ergometer. Initiation at 70% of the Wmax on the CPET. The workload up, by 5% every 2 week

Constant-Load Exercise Versus High-Intensity Interval Training on Aerobic Fitness in Moderate-to-Severe Asthma: A Randomized Controlled Trial. J Allergy Clin Immunol Pract. 2022;10:2596-604

- **Moderate-intensity** group performed continuous exercise at 55% to 70% age-predicted heart rate maximum (APHRmax) for 45 minutes.
- **Vigorous-intensity** group trained using an interval approach (3-minute work/45-second active recovery) at 70% to 90% APHRmax, for 30 minutes per session.
- **Upright cycle or treadmill ergometer**



Effects of Moderate- Versus Vigorous-Intensity Exercise Training on Asthma Outcomes in Adults. J Allergy Clin Immunol Pract. 2024;12:2744-53.

Characteristic	Control (n = 14)	Moderate (n = 16)	Vigorous (n = 16)
Sex: female, n (%)	11 (78.6)	11 (68.8)	11 (68.8)
Age (y)	39.7 (11.7)	38.6 (10.0)	39.7 (9.4)
BMI (kg/m^2)	29.2 (4.3)	29.5 (6.1)	29.1 (4.6)
Weight (kg)	83.5 (16.4)	88.9 (25.8)	82.6 (14.1)
Total fat mass (kg)	32.2 (8.9)	33.8 (11.6)	32.7 (9.7)
Android fat mass (kg)	2.5 (1.1)	2.9 (1.6)	2.9 (1.3)
Gynoid fat mass (kg)	5.3 (4.2, 6.4)	5.5 (4.3, 7.0)	5.1 (4.3, 6.4)
Total lean mass (kg)	46.6 (39.8, 57.7)	44.3 (41.8, 66.1)	47.8 (41.0, 49.2)
Lung function			
FEV_1 %pred	86.1 (17.4)	86.4 (10.0)	79.7 (17.8)
FEV_1 (L)	2.95 (2.33, 3.25)	2.98 (2.52, 3.54)	2.85 (2.39, 3.14)
FVC %pred	94.9 (10.6)	94.7 (7.8)	89.3 (15.2)
FVC (L)	3.85 (3.46, 4.80)	3.98 (3.52, 5.02)	3.76 (3.56, 3.98)
%FEV_1/FVC	73.7 (12.3)	73.7 (6.7)	72.3 (11.3)
ICS dose (μg/d), Fluticasone	250 (0, 500)	250 (0, 438)	438 (0, 500)
Former smokers, n (%)	5 (35.7)	5 (31.3)	3 (18.8)
Pack-years of former smokers (n = 13)	2.0 (0.9, 2.5)	12.5 (2.0, 15.0)	0.9 (0.1, 7.0)
Age at asthma diagnosis (y)	5 (4, 14)	5 (1, 12)	8 (3, 21)
ACQ score	0.85 (0.57, 1.04)	0.93 (0.57, 1.54)	0.86 (0.43, 1.90)
AQLQ score	5.9 (5.5, 6.4)	6.3 (5.8, 6.5)	6.3 (5.5, 6.7)

Outcome	Moderate vs control		Vigorous vs control		Moderate vs vigorous	
	Mean difference (95% CI)	*P* value	Mean difference (95% CI)	*P* value	Mean difference (95% CI)	*P* value
Primary outcome						
AQLQ score	0.63 (0.33 to 0.93)	**<.001**	0.46 (0.14 to 0.80)	**.007**	0.16 (−0.03 to 0.35)	.097
Secondary outcomes						
Clinical asthma outcomes						
ACQ score	−0.51 (−0.83 to −0.19)	**.003**	−0.36 (−0.69 to −0.02)	**.040**	−0.15 (−0.36 to 0.05)	.135
AQLQ subdomains						
Symptoms	0.71 (0.35 to 1.07)	**<.001**	0.58 (0.16 to 0.99)	**.007**	0.13 (−0.09 to 0.36)	.242
Activity limitation	0.43 (0.05 to 0.80)	**.027**	0.35 (−0.00 to 0.70)	.050	0.08 (−0.13 to 0.29)	.456
Emotional function	0.68 (0.21 to 1.15)	**.005**	0.31 (−0.25 to 0.86)	.268	0.37 (0.02 to 0.73)	**.037**
Environmental stimuli	0.83 (0.34 to 1.33)	**.001**	0.66 (0.11 to 1.20)	**.020**	0.18 (−0.16 to 0.52)	.296
FEV_1 (L)	−0.03 (−0.22 to 0.16)	.716	0.01 (−0.18 to 0.19)	.934	−0.04 (−0.17 to 0.09)	.516
FVC (L)	−0.02 (−0.15 to 0.10)	.697	0.05 (−0.06 to 0.15)	.364	−0.07 (−0.19 to 0.05)	.364
FEV_1/FVC (%)	−0.63 (−3.90 to 2.64)	.697	−0.79 (−4.47 to 2.88)	.664	0.16 (−1.97 to 2.29)	.878
Cardiorespiratory fitness						
Relative VO_{2peak} (mL/kg/min)	1.9 (−0.2 to 4.1)	.077	4.0 (1.5 to 6.5)	**.002**	−2.1 (−4.2 to 0.1)	.055
Absolute VO_{2peak} (L/min)	0.15 (−0.13 to 0.42)	.282	0.28 (0.03 to 0.53)	**.028**	−0.14 (−0.38 to 0.11)	.270
Body composition (kg)						
Body weight	−1.6 (−3.6 to 0.4)	.107	−1.5 (−3.9 to 0.8)	.199	−0.1 (−2.7 to 2.6)	.951
Total body fat mass	−1.1 (−2.7 to 0.5)	.184	−1.6 (−3.7 to 0.4)	.111	0.6 (−1.7 to 2.8)	.615
Android fat mass	−0.0 (−0.2 to 0.2)	.719	−0.2 (−0.5 to 0.0)	.073	0.2 (−0.1 to 0.5)	.155
Gynoid fat mass	−0.3 (−0.6 to −0.0)	**.035**	−0.3 (−0.6 to 0.0)	.076	−0.0 (−0.4 to 0.3)	.832
Total lean mass	0.1 (−1.1 to 1.2)	.931	0.4 (−0.5 to 1.3)	.373	−.03 (−1.7 to 1.0)	.604

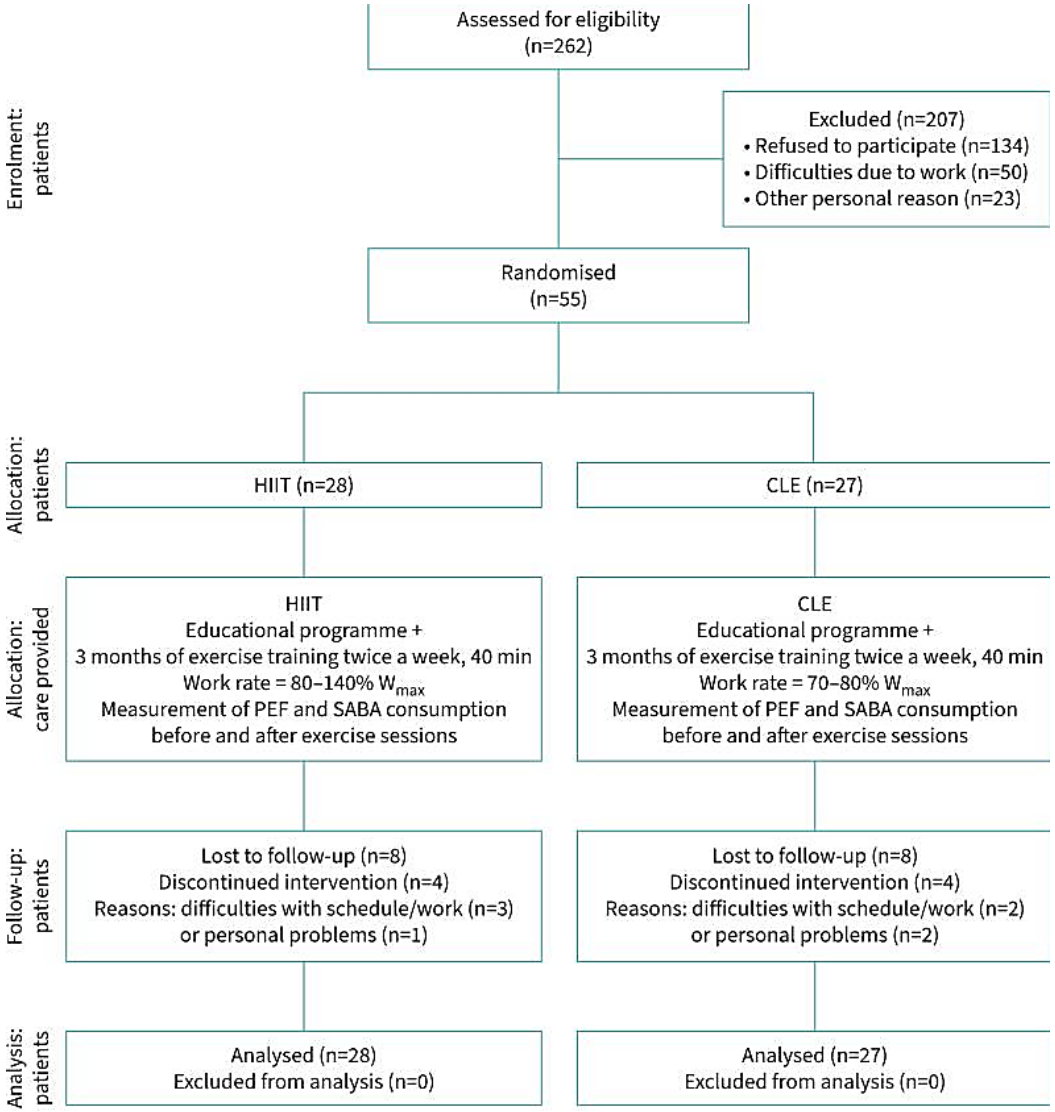
Outcome	Moderate vs control		Vigorous vs control		Moderate vs vigorous	
	Mean difference (95% CI)	*P* value	Mean difference (95% CI)	*P* value	Mean difference (95% CI)	*P* value
Airway inflammation						
Total cell count ($\times 10^6$/mL)	−1.19 (−4.08 to 1.69)	.405	0.29 (−2.21 to 2.80)	.812	−1.49 (−4.54 to 1.57)	.328
Eosinophils (%)	−1.6 (−11.3 to 8.2)	.744	−4.3 (−12.4 to 3.9)	.296	2.7 (−4.7 to 10.1)	.466
Eosinophils ($\times 10^4$/mL)	−161 (−449 to 128)	.265	−130 (−458 to 197)	.423	−30 (−312 to 251)	.828
Neutrophils (%)	1.0 (−21.0 to 23.0)	.930	−10.0 (−25.6 to 5.6)	.202	10.9 (−10.8 to 32.7)	.315
Neutrophils ($\times 10^4$/mL)	627 (−2057 to 3311)	.637	87 (−1722 to 1895)	.923	540 (−2191 to 3271)	.689
Macrophages (%)	−3.7 (−23.5 to 16.0)	.703	7.2 (−6.2 to 20.7)	.281	−11.0 (−32.5 to 10.6)	.309
Macrophages ($\times 10^4$/mL)	−1341 (−2491 to −191)	**.024**	450 (−570 to 1471)	.375	−1791 (−2855 to −727)	**.002**
Lymphocytes (%)	−1.7 (−4.0 to 0.5)	.127	−1.1 (−3.6 to 1.4)	.388	−0.7 (−2.1 to 0.8)	.352
Lymphocytes ($\times 10^4$/mL)	−114 (−220 to −8)	**.036**	−59 (−181 to 63)	.331	−55 (−128 to 18)	.132
IL-6 (pg/mL)	544 (−400 to 1488)	.249	674 (−411 to 1760)	.214	−130 (−782 to 522)	.686
Systemic inflammation (pg/mL)						
IL-6	0.6 (−0.8 to 2.1)	.371	−0.2 (−0.5 to 0.2)	.290	0.8 (−0.6 to 2.3)	.255
IL-1ra	8.0 (−252.9 to 268.9)	.951	−88.0 (−268.0 to 92.0)	.328	96.0 (−125.4 to 317.4)	.385

Group comparisons adjusted for the baseline value. Statistically significant results highlighted in bold ($P < .05$).

CI, Confidence interval; *IL-1ra*, IL-1 receptor antagonist.

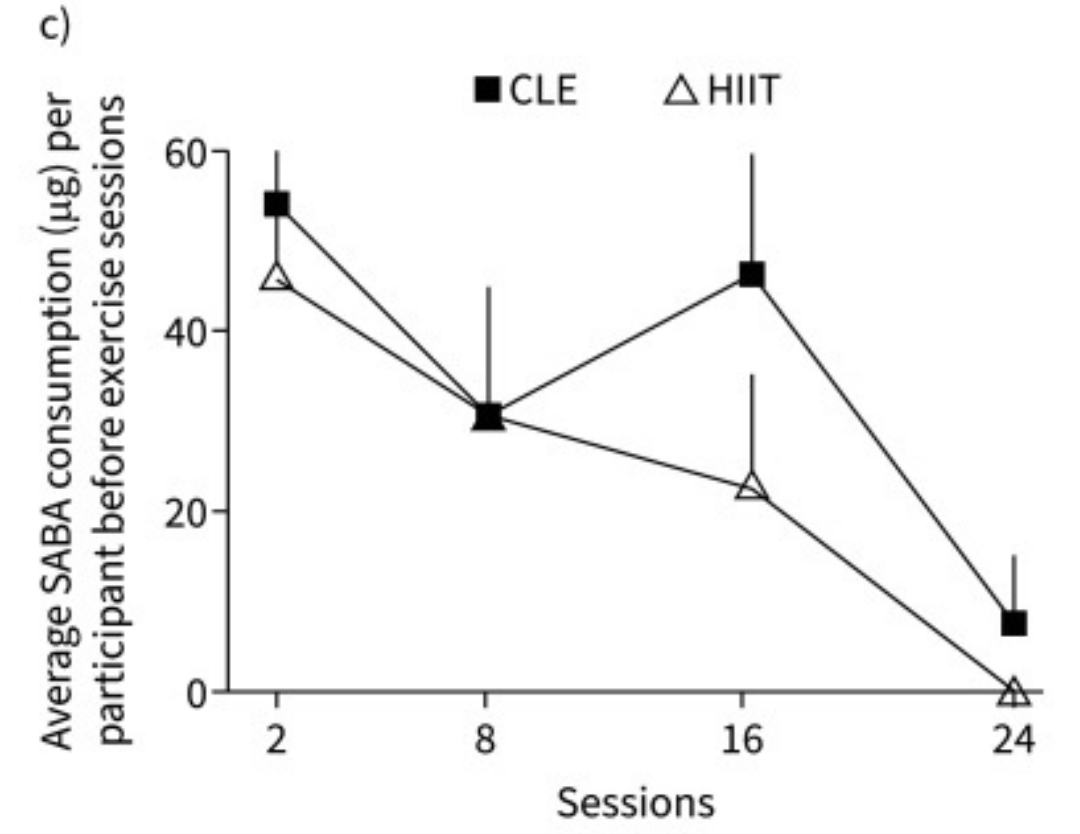
Clinical asthma outcome	Relative VO_{2peak}	Absolute VO_{2peak}	Body weight	Total fat mass	Android fat mass	Gynoid fat mass
AQLQ score	0.125	0.022	–0.232	**–0.346**	**–0.341**	**–0.353**
Symptoms	0.208	0.082	**–0.334**	**–0.415**	**–0.325**	**–0.452**
Activity limitation	0.130	0.052	–0.159	–0.276	**–0.380**	–0.224
Emotional function	0.114	–0.027	–0.074	–0.234	–0.229	–0.274
Environmental stimuli	0.130	0.035	–0.039	–0.154	–0.221	–0.201
ACQ score	–0.168	–0.079	0.113	0.169	0.207	0.207
FEV_1 (L)	0.114	0.226	0.223	0.210	0.135	0.186
FVC (L)	0.012	–0.024	–0.028	0.051	–0.017	0.073
FEV_1/FVC	0.018	0.158	0.261	0.221	0.212	0.197
Airway inflammation						
Eosinophil count	–0.072	0.041	0.012	0.026	0.049	0.144
Neutrophil count	0.112	0.183	0.140	0.025	0.054	0.079
Macrophage count	–0.059	–0.014	0.012	–0.005	0.241	–0.100
Lymphocyte count	–0.018	–0.174	**–0.384**	**–0.487**	**–0.348**	–0.336
IL-6	0.031	0.209	**0.458**	**0.391**	**0.422**	0.305
Systemic inflammation						
IL-6	0.120	0.200	0.084	0.121	0.223	0.103
IL-1ra	0.212	**0.322**	0.136	0.165	0.063	0.066

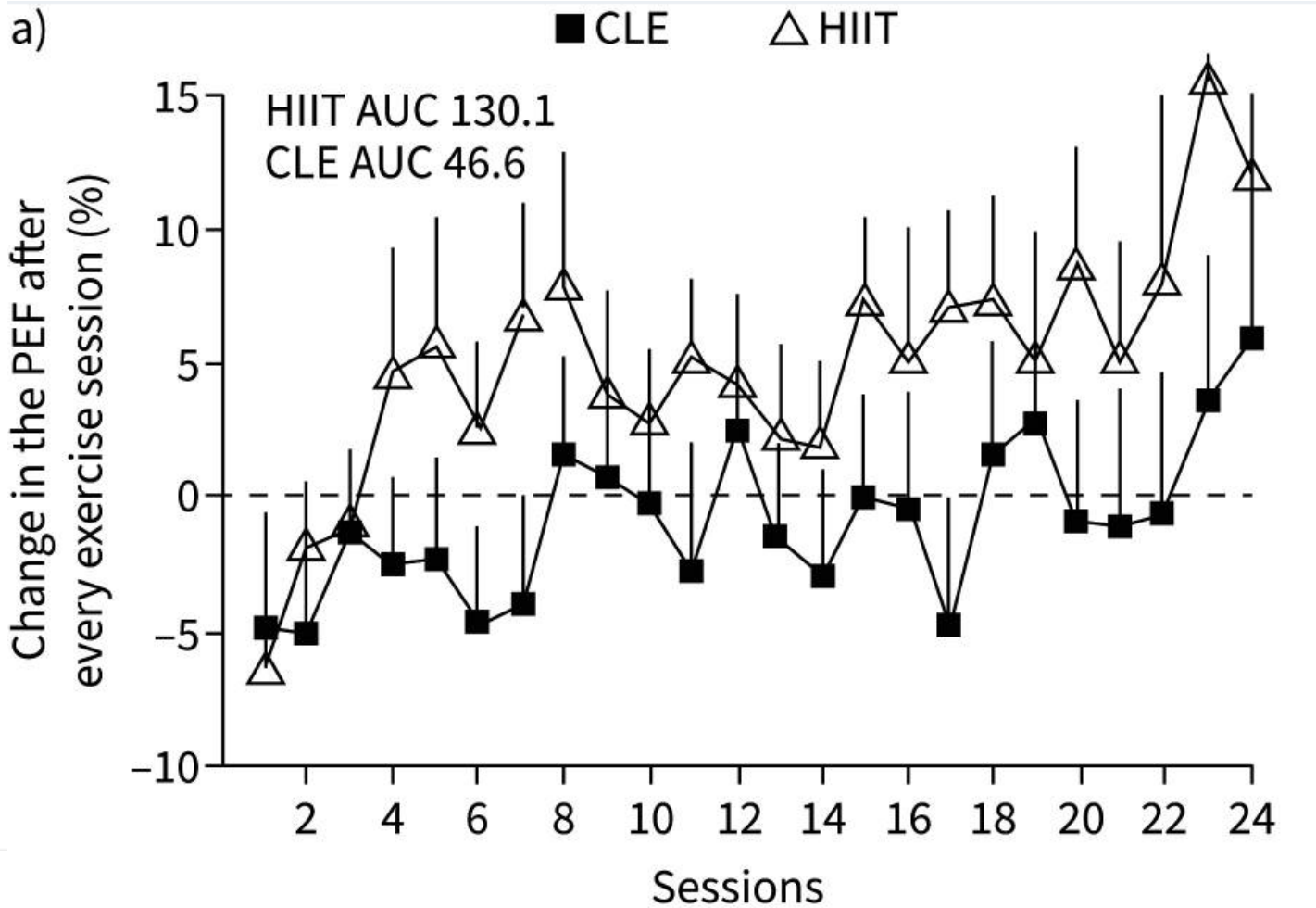
Studies	Lung function	Asthma control	Health-related quality of life
Abd El-Kader et al[82] (2016)			
Arandelović et al[83] (2007)	+*		
Bacon et al[84] (2015)	N	+*	
Boyd et al[85,86] (2012)	N	N	
Evaristo et al[87-90] (2020)	N	+*	+*
Franca-Pinto et al[91-94] (2015)	N	+*	+*
Freitas et al[77,95-98] (2017)	N	+*	+
Haas et al[99] (1987)	N		
Ma et al[100] (2015)	N	N	+
Mendes et al[78,101,102] (2010)	N	+*	+*
Meyer et al[103] (2015)	N	N	N
Paul and Mithun[104] (2013)	+		+*
Razavi et al[105] (2011)	+*		
Refaat and Gaawish[106] (2015)	+*		+*
Scichilone et al[107] (2012)	N		
Scott et al[108] (2013)	+*	N	N
Shaw and Shaw[79,109] and Shaw et al[110] (2010)	+*		
Toennesen et al[111] (2018)	N	+*	+*
Turk et al[112] (2017)		+*	
Turner et al[113] (2011)	N	N	+*

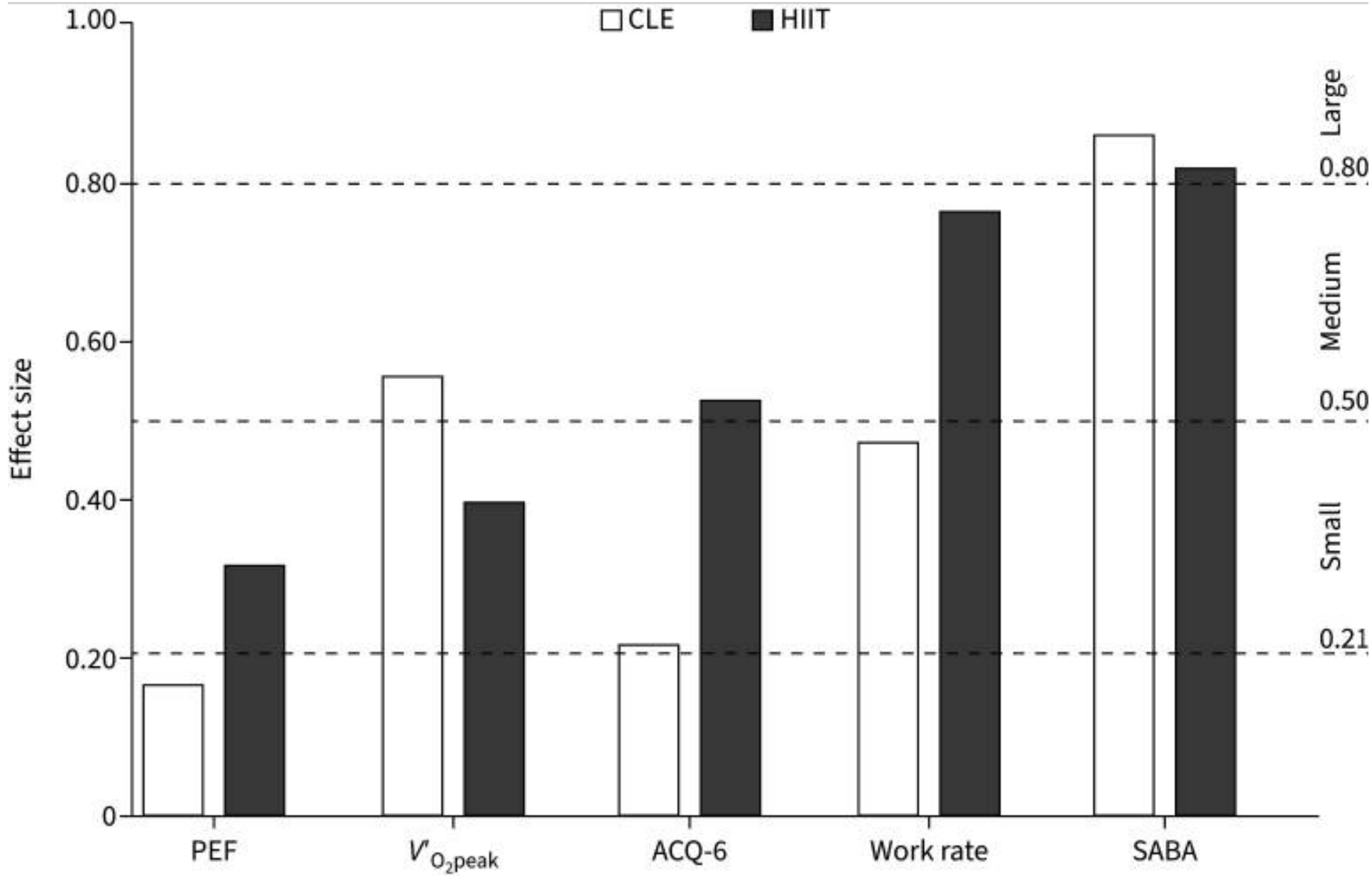


	CLE	HIIT
Participants	27	28
Anthropometric data		
Female	23 (86)	23 (83)
Age years	48.0 (34.2–52.7)	42.5 (33.5–49.0)
BMI $kg{\cdot}m^{-2}$	30.4 (25.5–31.6)	27.2 (24.8–31.8)
Lung function after broncho dilation		
FEV_1 %	72.0 (62.5–85.7)	79.0 (67.0–84.6)
FVC %	92.0 (82.2–100.0)	99.5 (83.0–95.5)
FEV_1/FVC %	86.3 (81.0–93.0)	85.0 (78.5–92.5)
PEF L	303.3 (250.2–368.3)	300.8 (287.1–358.8)
Aerobic fitness		
$\dot{V}O_{2peak}$ $mL{\cdot}min^{-1}$	1341.3 (1218.2–1627.8)	1698.3 (1419.4–1958.1)
$\dot{V}O_{2peak}$ % predicted	87.5 (78.8–100)	87.9 (76.8–109)
Work rate W	100 (100–125)	125 (100–137)
Work rate % predicted	107.5 (86.1–133.0)	107.0 (86.1–131.8)
Clinical control		
ACQ-6 score	1.83 (0.70–2.33)	1.85 (1.33–2.41)
Medication		
Budesonide $\mu g{\cdot}day^{-1}$	800 (500–1200)	800 (800–1500)

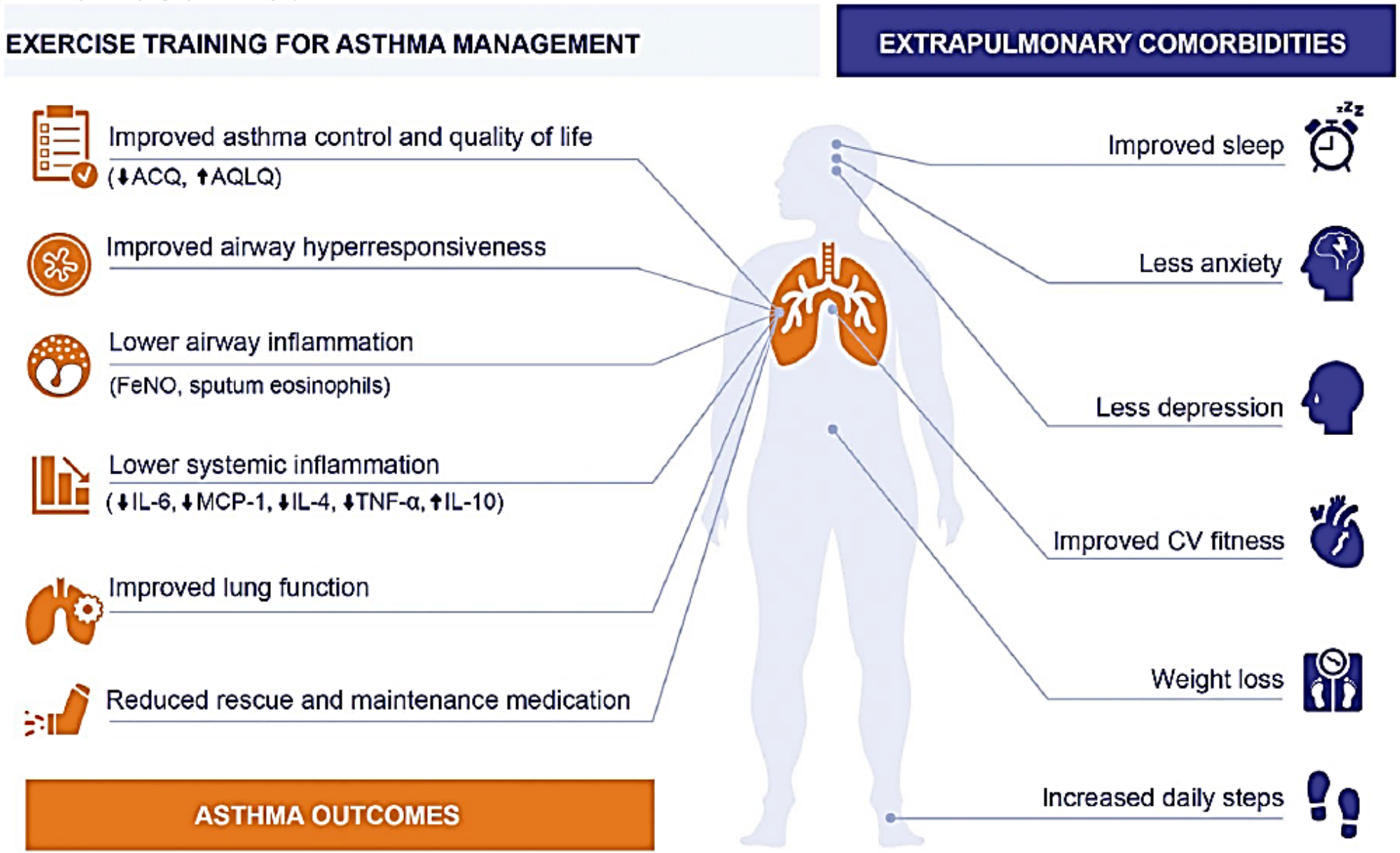
*Effects of **constant-load exercise** and **high-intensity interval training on reliever medication consumption and peak expiratory flow** in individuals with asthma: a randomised controlled trial. ERJ Open Res. 2024;10:00899-2023.*


c)
CLE
HIIT
Average SABA consumption (µg) per participant before exercise sessions
60
40
20
0
2
8
16
24
Sessions


a)
CLE
HIIT
HIIT AUC 130.1
CLE AUC 46.6
Change in the PEF after every exercise session (%)
15
10
5
0
−5
−10
2
4
6
8
10
12
14
16
18
20
22
24
Sessions


CLE
HIIT
Effect size
1.00
0.80
0.60
0.40
0.20
0
Large
Medium
Small
0.80
0.50
0.21
PEF
$\dot{V}'_{O_2peak}$
ACQ-6
Work rate
SABA

Exercise should be included as a part of a comprehensive care plan for the patient with asthma.



Practical approach to exercise prescription

- **Initial asthma review**

① Detailed asthma medical history-spirometry, BDR, MCT(AHR), allergy test, FeNO/TEC, response to ICS

② If Exercise related symptoms-check-out the test for EIB

③ Assessment of current activity status (IPAQ-SF, smart phone app)

④ Open-ended questions, reassurance for dyspnea etc, delayed onset muscle soreness

- **Assessing exercise tolerance and functional capacity**

① Exercise testing in clinical practice -> submaximal aerobic metabolism

② Cardiopulmonary exercise testing(CPET=heart+lung+muscle)

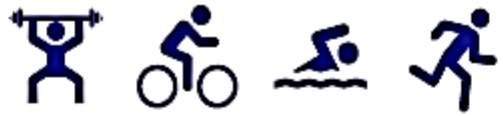
③ If Exercise related symptoms-check-out the test for EIB

④ CPET with incremental protocol>> 6 min walking test with heart rate/SpO2

Practical approach to exercise prescription

- Exercise training principles for healthy adults
- FITT / FITT-VP : heart rate reserve, VO2 reserve, Borg rating(6-20)
- Inactive / sedentary / those suggestive of cormobid cardiovascular, metabolic and renal diseases.
- Rescue medication and structured warm-up

- Hyperventilation -> mouth breathing
- Environmental factors including meteorological condition and air pollution/airborne allergens



ASTHMA EXERCISE PRESCRIPTION

Step 1

Determine current activity status using validated tools (IPAQ-SF) or smartphone pedometer for objective data

***Physically inactive and/or signs or symptoms** suggestive of comorbid cardiovascular, metabolic and renal disease

Medical evaluation and progress to exercise training following clearance

***Physically active with no signs or symptoms** suggestive of comorbid cardiovascular, metabolic and renal disease

Step 2

Exercise training programme developed according to established FITT principles

Frequency	Intensity	Time	Type
3-5 days per week (aerobic); 2-3 days per week (resistance); ≥ 2-3 days per week (flexibility)	HRR or VO_2R based on CPET derived data or Borg rating of perceived exertion scale (6-20)	30-40 mins per day (aerobic); 2-4 sets of 8- 12 reps or <2 sets of 15-20 reps (resistance strength and endurance)	Factor personal preferences to optimize enjoyment and promote long-term adherence

Step 3

Review exercise programme during routine review and maintain / adjust according to specific goals / asthma control

Exercise on allergic rhinitis

- **Key words: allergic rhinitis, aerobic exercise//clinical trial, RCT**.

1. Yu T, Yue W, Zhang S. **Resistance exercise and its impact on allergic rhinitis**. Am J Otolaryngol. 2025;46:104613.

2. **Tongtako W**, Klaewsongkram J, Mickleborough TD, Suksom D. Effects of aerobic exercise and vitamin C supplementation on rhinitis symptoms in allergic rhinitis patients. Asian Pac J Allergy Immunol. 2018;36:222-31.

3. Chanta A, Klaewsongkram J, Mickleborough TD, **Tongtako W**. Effect of Hatha yoga training on rhinitis symptoms and cytokines in allergic rhinitis patients. Asian Pac J Allergy Immunol. 2022;40:126-33.

4. Impact of Hatha Yoga on the Airway Resistances in Healthy Individuals and Allergic Rhinitis Patients. Indian J Otolaryngol Head Neck Surg. 2019;711748-56.

5. Kerdkaew K, **Tongtako W**. Acute Effects of Exercise at Different Temperatures on Clinical Symptoms and Nasal Blood Flow in Patient with Allergic Rhinitis: A Randomized Crossover Trial. Int J Exerc Sci. 2024;17:779-93.

2022-2044, residing locally
No AIT

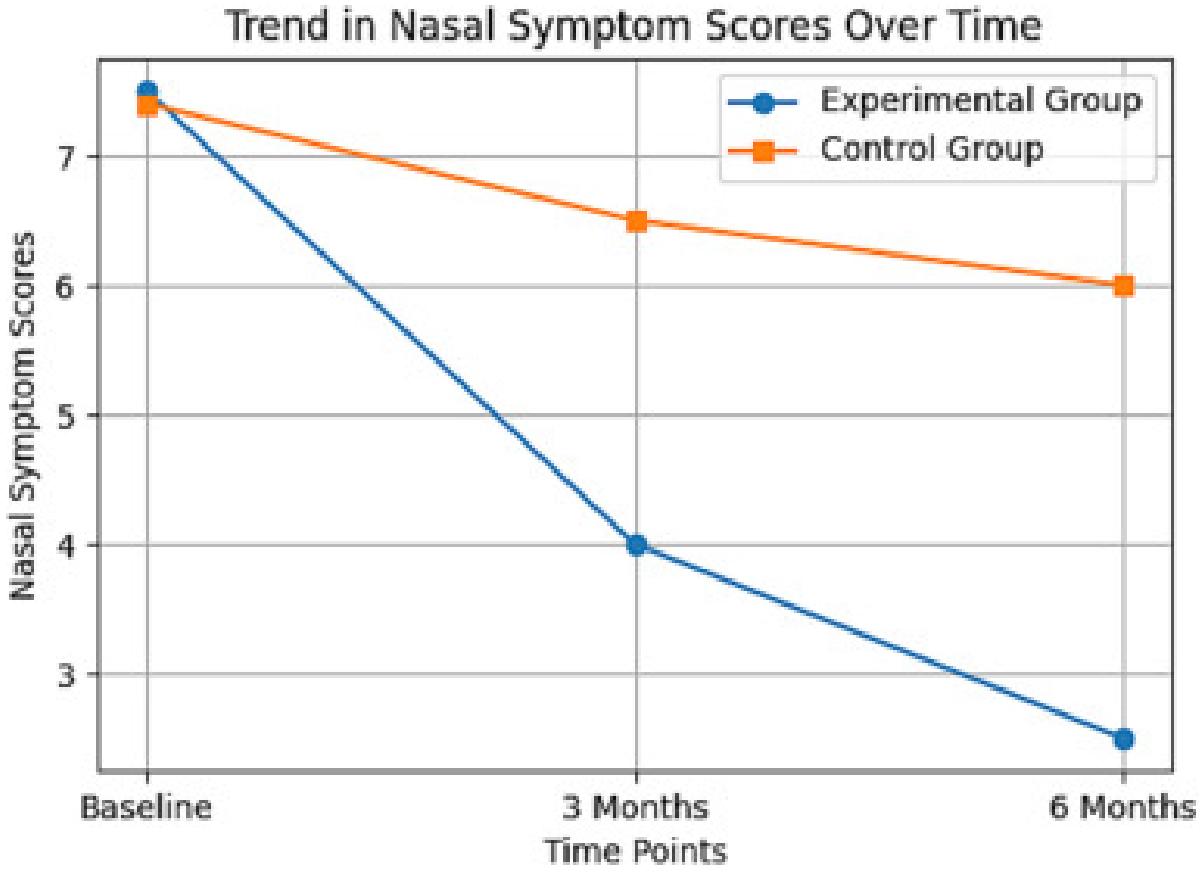
Training Plan:
3 sessions per week.
45–60 min per session.
6 months.

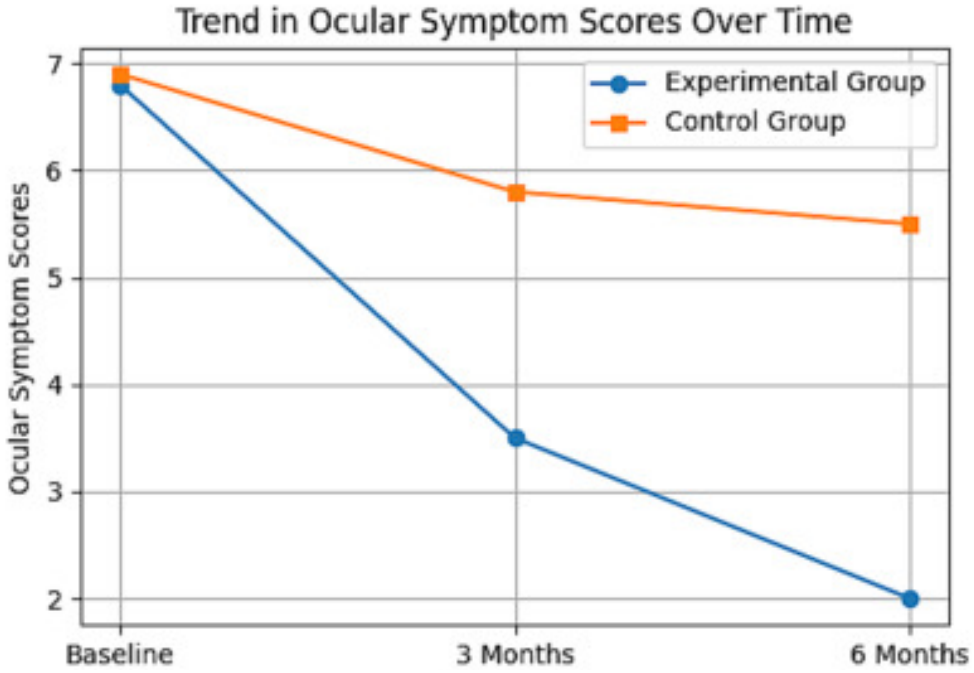
Intensity: adjusted to 50 %–70 % of the one-repetition maximum (1RM) strength test.
Each session included three sets per exercise, with 8–12 repetitions per set.

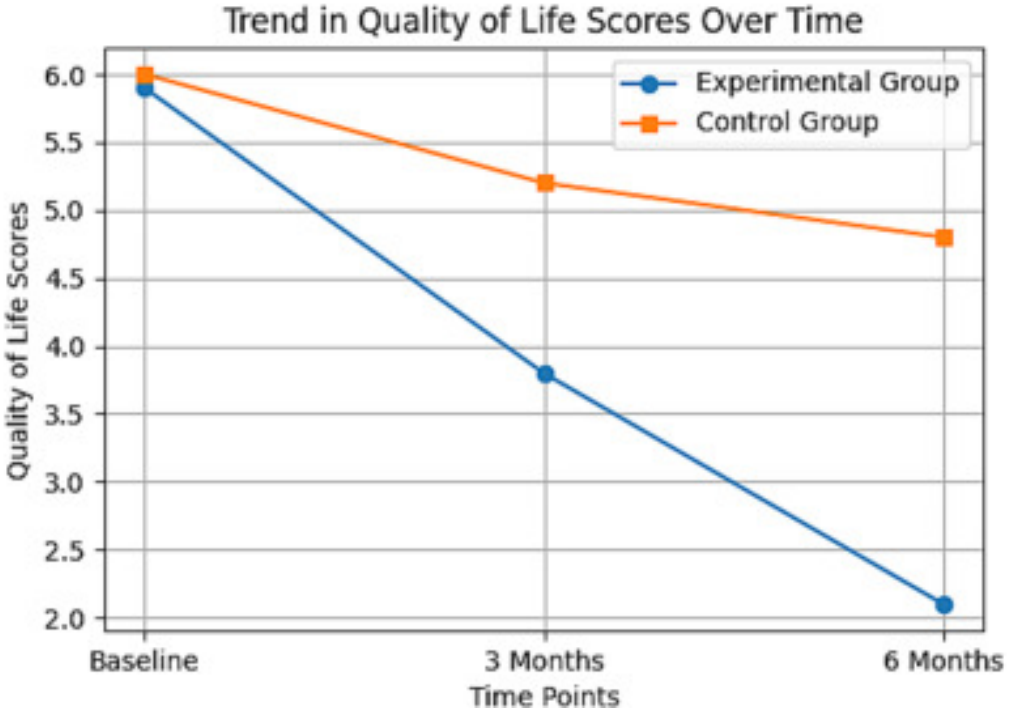
Lower: Squats, Lunges.
Upper: Dumbbell Press, Lateral Raises.
Core: Plank, Crunches.

Characteristic	Experimental Group (n=78)	Control Group (n=78)	P-value
Age (years)	35.6 ± 8.2	36.1 ± 7.9	0.752
Gender (Male/Female)	42/36	40/38	0.658
Nasal Symptom Score	7.5 ± 1.2	7.4 ± 1.3	0.843
Ocular Symptom Score	6.8 ± 1.1	6.9 ± 1.2	0.792
Quality of Life Score	5.9 ± 0.8	6.0 ± 0.9	0.714
IL-4 (pg/mL)	92.3 ± 5.6	91.8 ± 5.9	0.682
IL-6 (pg/mL)	88.5 ± 6.3	87.9 ± 6.2	0.761
IgE (IU/mL)	132.8 ± 15.2	131.9 ± 15.6	0.805
Allergic Rhinitis Type (SAR/PAR)	50/28	48/30	0.689
Positive Specific IgE Test (%)	87.2	85.9	0.745
Positive Skin Prick Test (%)	89.7	88.5	0.813

Yu T, Yue W, Zhang S. ***Resistance exercise and its impact on allergic rhinitis****. Am J Otolaryngol. 2025;46:104613.*

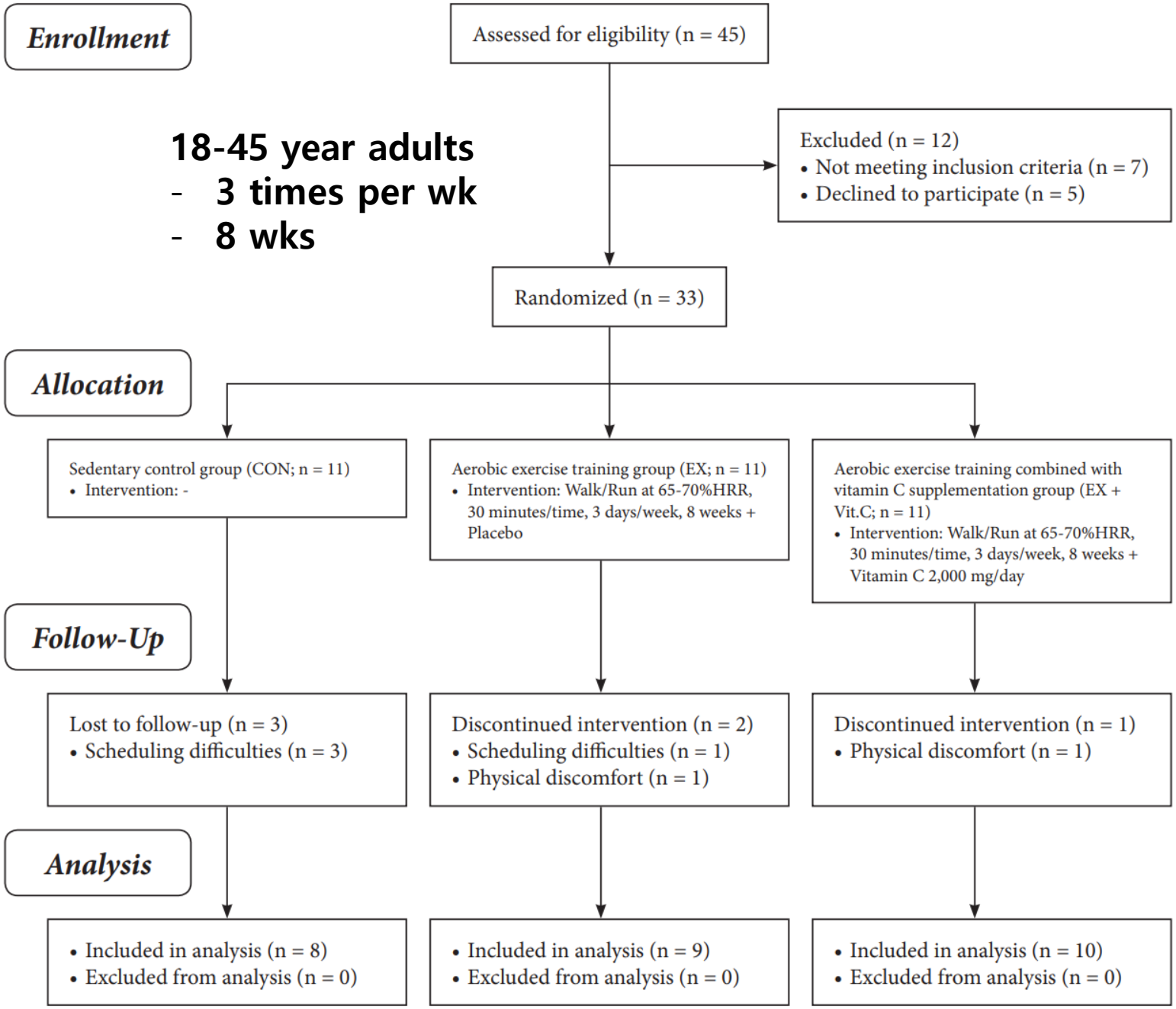

Trend in Nasal Symptom Scores Over Time
Experimental Group
Control Group
Nasal Symptom Scores
7
6
5
4
3
Baseline
3 Months
6 Months
Time Points


Trend in Ocular Symptom Scores Over Time
Experimental Group
Control Group
Ocular Symptom Scores
7
6
5
4
3
2
Baseline
3 Months
6 Months


Trend in Quality of Life Scores Over Time
Experimental Group
Control Group
Quality of Life Scores
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
Baseline
3 Months
6 Months
Time Points

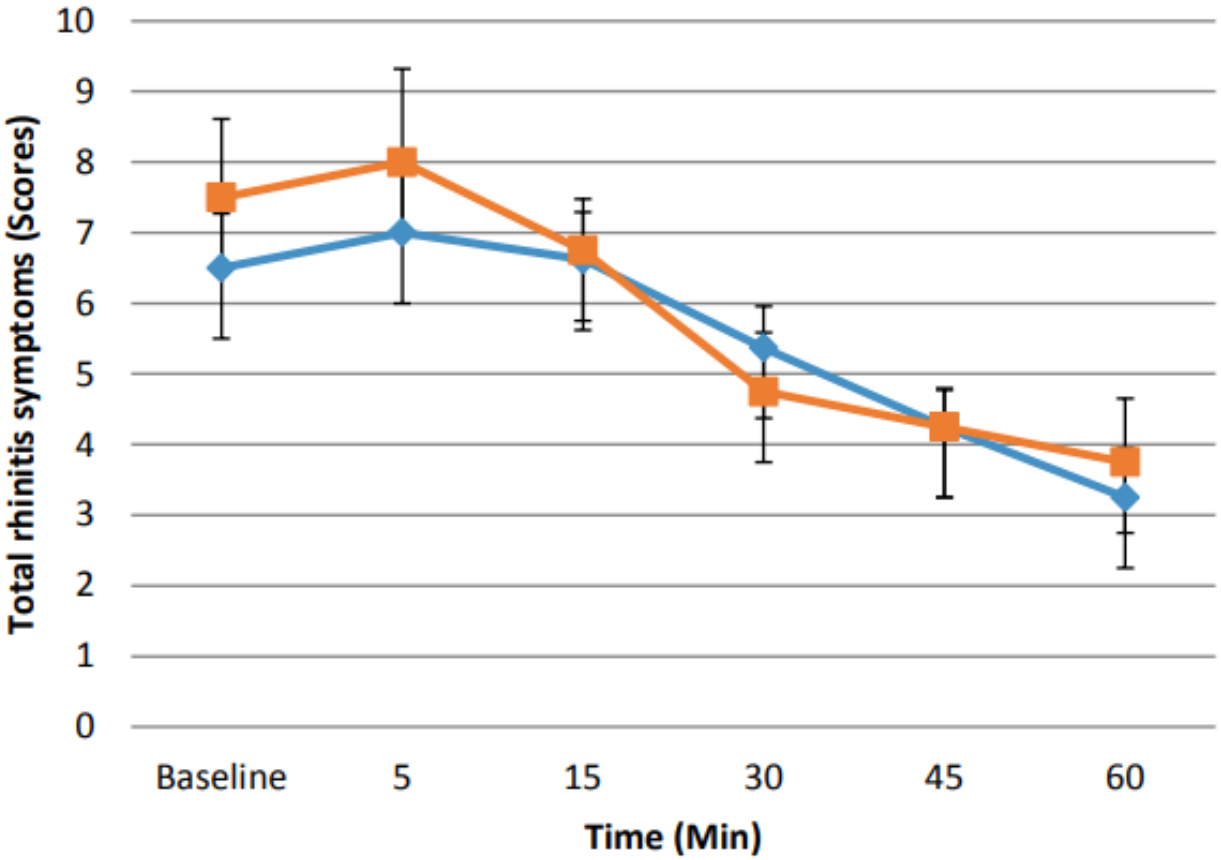
Changes in serum inflammatory cytokines and IgE levels

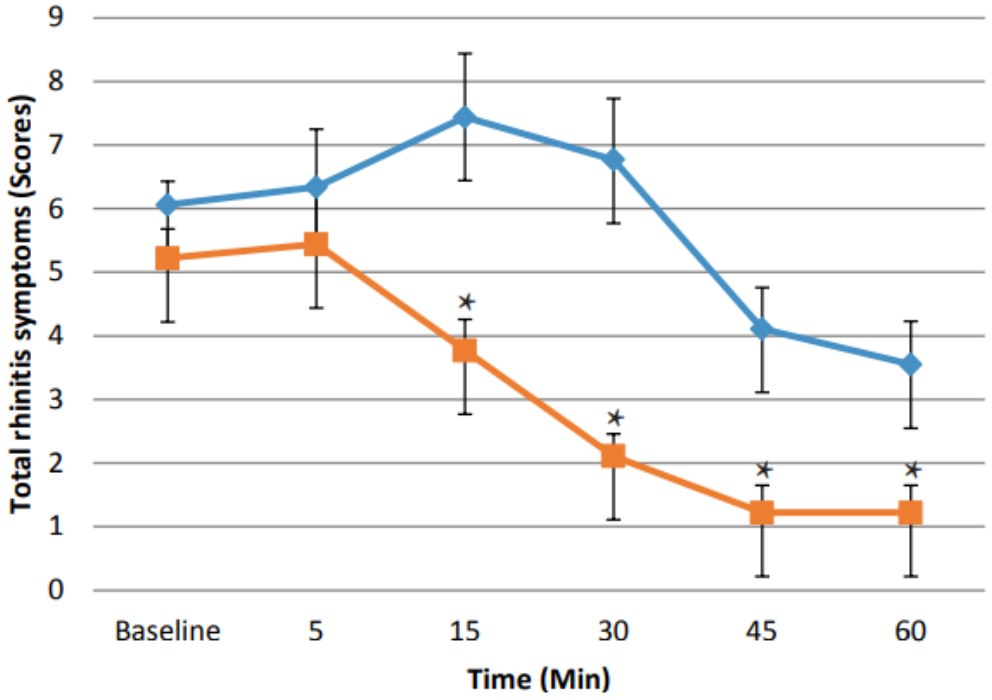
Time Point	IL-4 (pg/mL)	IL-6 (pg/mL)	IgE (IU/mL)
Experimental Group (n=78)			
Baseline	92.3 ± 5.6	88.5 ± 6.3	132.8 ± 15.2
6 Months	60.2 ± 4.5*	52.4 ± 5.0*	72.6 ± 10.2*
Control Group (n=78)			
Baseline	91.8 ± 5.9	87.9 ± 6.2	131.9 ± 15.6
6 Months	80.1 ± 5.2	75.8 ± 5.5	120.5 ± 12.3
P-value	<0.001	<0.001	<0.05

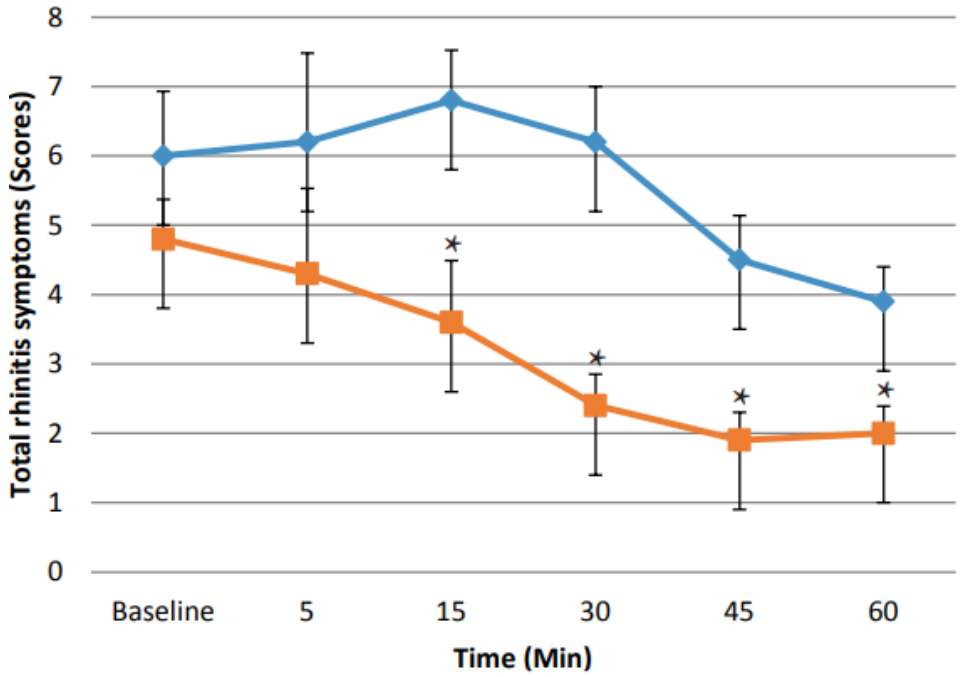


Effects of aerobic exercise and vitamin C supplementation on rhinitis symptoms in allergic rhinitis patients. Asian Pac J Allergy Immunol. 2018;36:222-31.

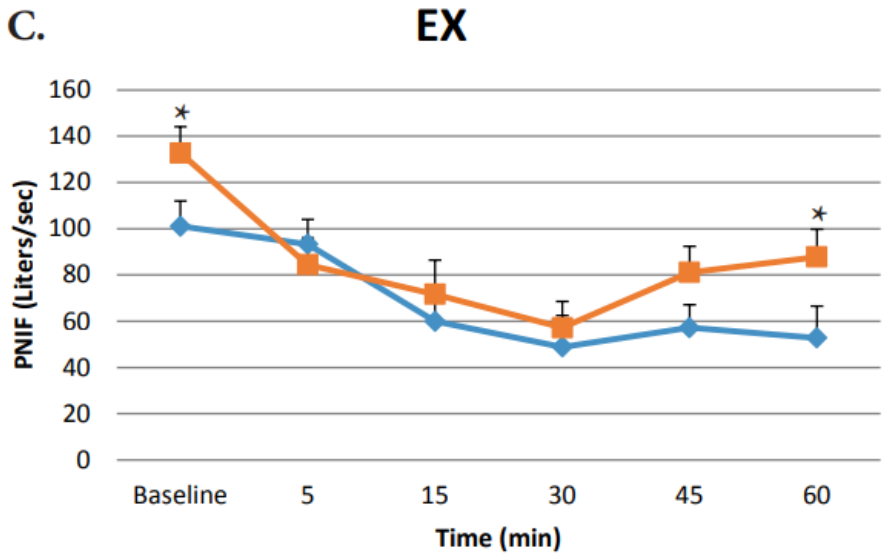
The comparison of total rhinitis symptoms after **nasal challenge by house dust mite** between pre and post-training in ***control***, ***exercise*** and ***exercise combined vitamin C supplementation***

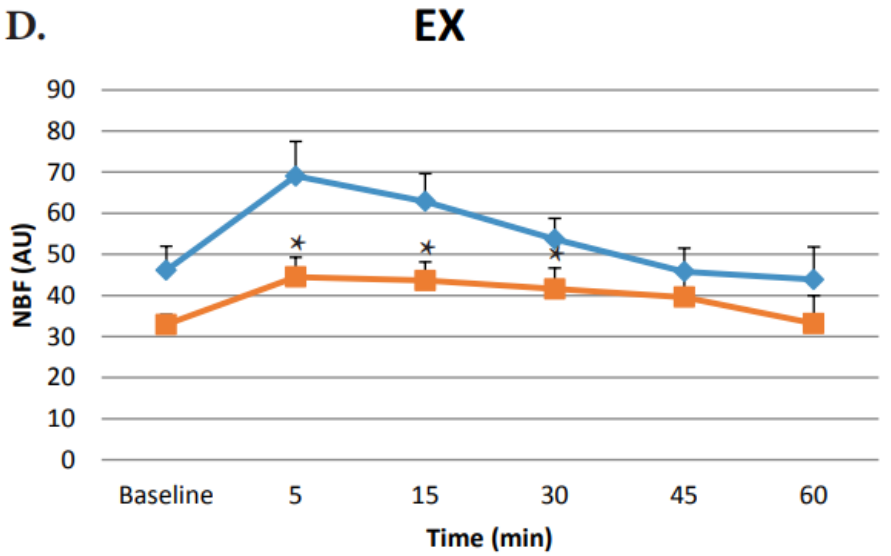


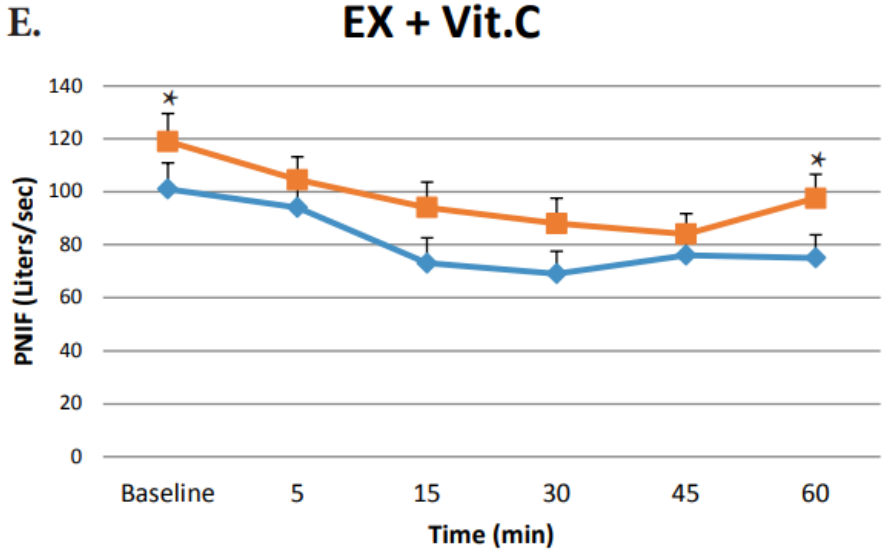


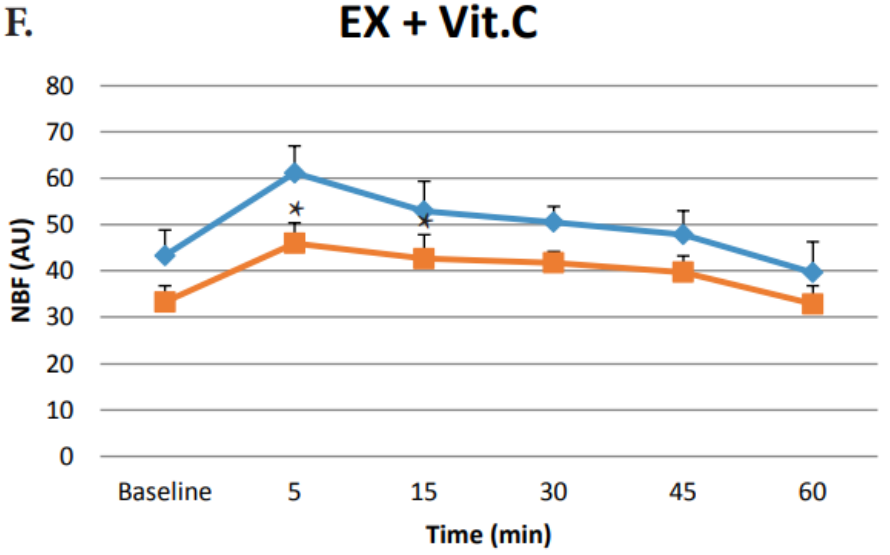


The comparison of **peak nasal inspiratory flow (PNIF)** and **nasal blood flow (NBF) after nasal challenge** by house dust mite

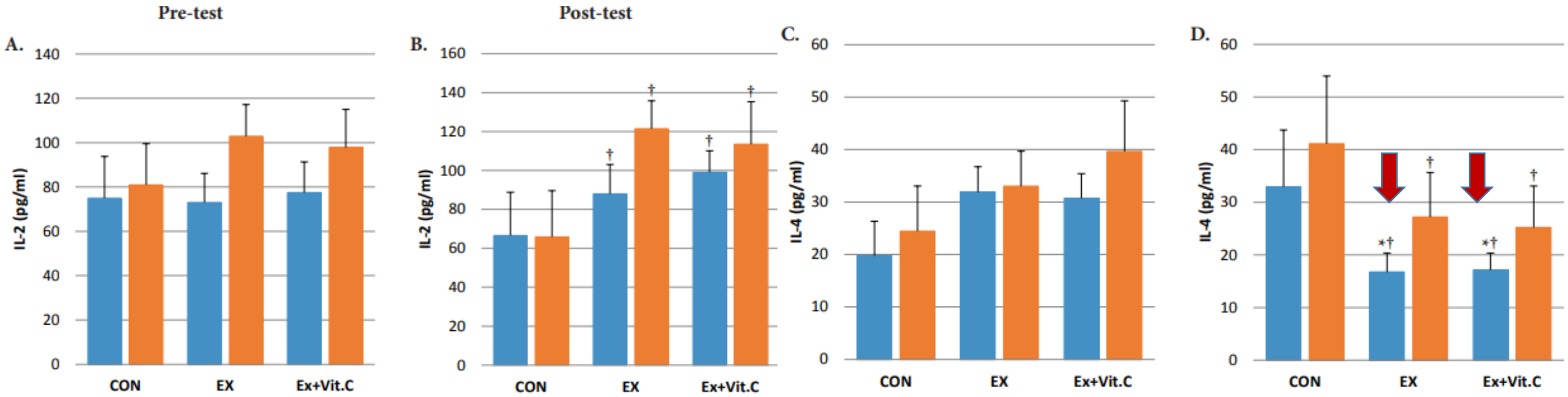


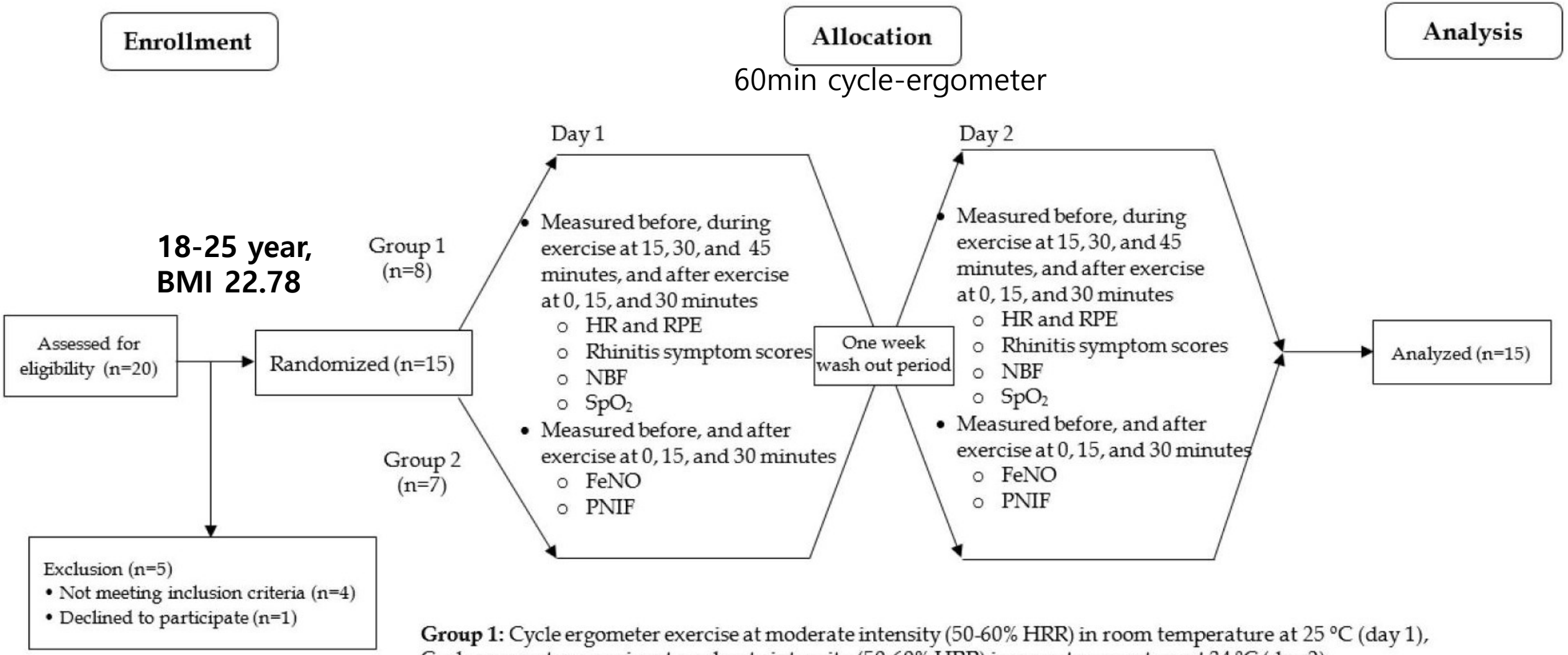






The comparison of cytokine levels in **nasal secretion** at baseline and after 5 minutes nasal challenge between pre-test and post-test and among three groups of subjects**: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).**

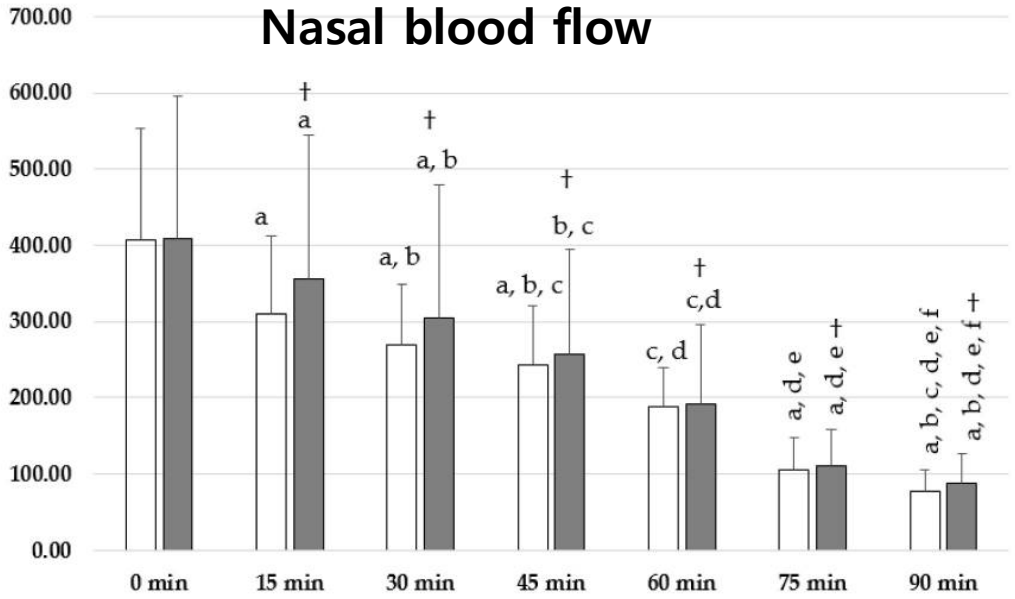




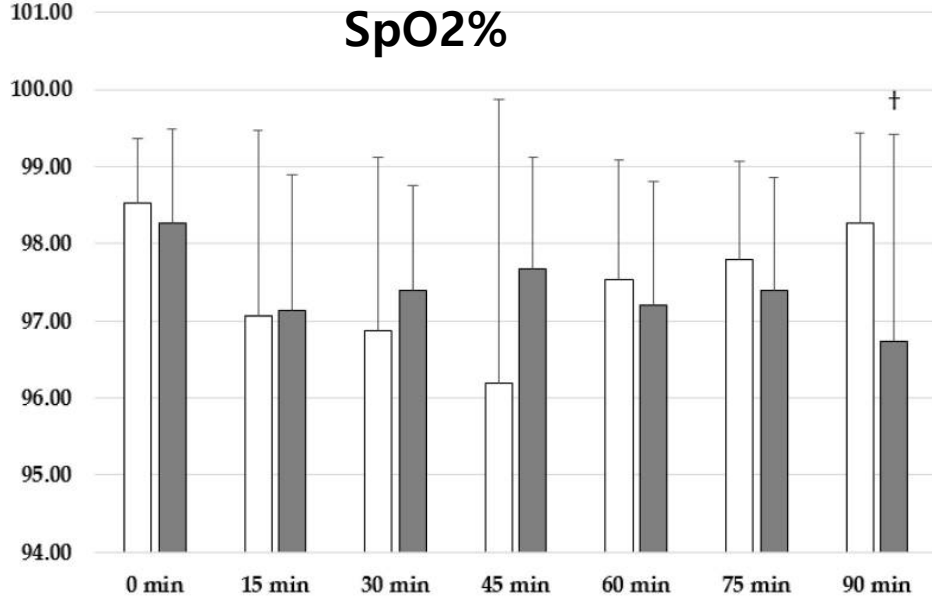
Group 1: Cycle ergometer exercise at moderate intensity (50-60% HRR) in room temperature at 25 °C (day 1), Cycle ergometer exercise at moderate intensity (50-60% HRR) in room temperature at 34 °C (day 2)
Group 2: Cycle ergometer exercise at moderate intensity (50-60% HRR) in room temperature at 34 °C (day 1), Cycle ergometer exercise at moderate intensity (50-60% HRR) in room temperature at 25 °C (day 2)

Temperature	Time (n = 15)							P-Value (vs times)
	0 min	15 min	30 min	**45 min**	60 min	75 min	90 min	
Nasal congestion scores								
Exercise at 25°C	2.00 ± 0.75	1.53 ± 0.99	0.93 ± 0.70	0.66 ± 0.72	0.20 ± 0.41	0.33 ± 0.48	0.20 ± 0.41	<0.001
Exercise at 34°C	2.20 ± 0.67	1.40 ± 0.73	0.93 ±0.79	0.86 ± 0.74	0.46 ± 0.63	0.40 ± 0.63	0.40 ± 0.50	<0.001
P-value (vs temps)	0.31	0.67	1.00	0.36	0.15	0.73	**<0.001**	
Itching scores								
Exercise at 25°C	1.80 ± 1.10	0.66 ± 0.90	0.60 ± 0.98	0.46 ± 0.74	0.60 ± 0.98	0.33 ± 0.81	0.33 ± 0.61	<0.001
Exercise at 34°C	0.80 ± 0.86	0.46 ± 0.83	0.53 ± 0.99	0.53 ± 0.99	0.40 ± 0.73	0.46 ± 0.91	0.46 ± 0.91	<0.001
P-value (vs temps)	0.76	1.00	0.58	0.73	0.65	0.15	0.56	
Sneezing scores								
Exercise at 25°C	1.73 ± 0.59	0.66 ± 0.61	0.20 ± 0.56	0.20 ± 0.41	0.06 ± 0.25	0.06 ± 0.25	0.20 ± 0.41	<0.001
Exercise at 34°C	1.74 ± 0.60	0.66 ± 0.81	0.66 ±0.81	0.33 ± 0.61	0.13 0.35	0.20 0.41	0.26 ± 0.45	<0.001
P-value (vs temps)	1.00	0.95	**0.01**	**0.02**	0.31	0.15	0.56	
Rhinorrhea scores								
Exercise at 25°C	2.00 ± 0.84	1.20 ± 1.08	0.73 ± 0.96	0.46 ± 0.63	0.46 ± 0.51	0.46 ± 0.51	0.20 ± 0.41	<0.001
Exercise at 34°C	2.00 ± 0.75	0.86 ± 0.63	0.60 ±0.63	0.60 ± 0.50	0.33 0.48	0.26 0.45	0.40 ± 0.73	<0.001
P-value (vs temps)	1.00	0.37	0.72	0.41	0.31	0.18	0.38	
Total rhinitis symptoms scores								
Exercise at 25°C	7.53 ± 1.06	4.53 ± 1.88	2.53 ± 1.41	1.80 ± 1.57	1.07 ± 1.03	0.93 ± 0.96	0.80 ± 1.01	<0.001
Exercise at 34°C	7.54 ± 1.10	4.06 ± 1.43	3.00 ± 2.27	2.40 ± 1.99	1.20 ± 1.15	1.07 ± 1.16	1.20 ± 1.32	<0.001
P-value (vs temps)	1.00	0.68	0.31	0.25	0.41	0.72	0.22	

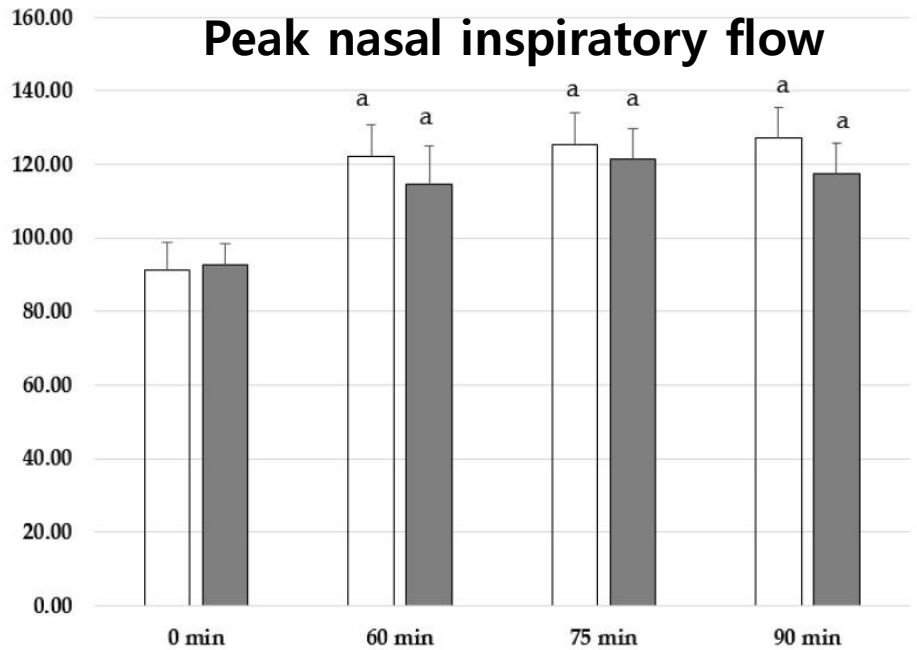
Nasal blood flow



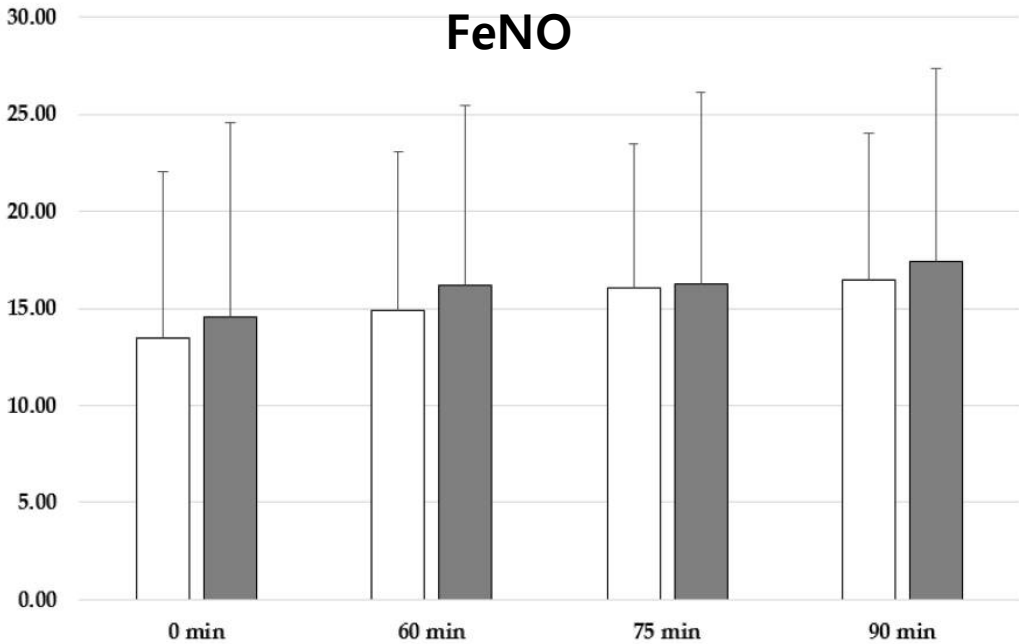
SpO2%



Peak nasal inspiratory flow



FeNO

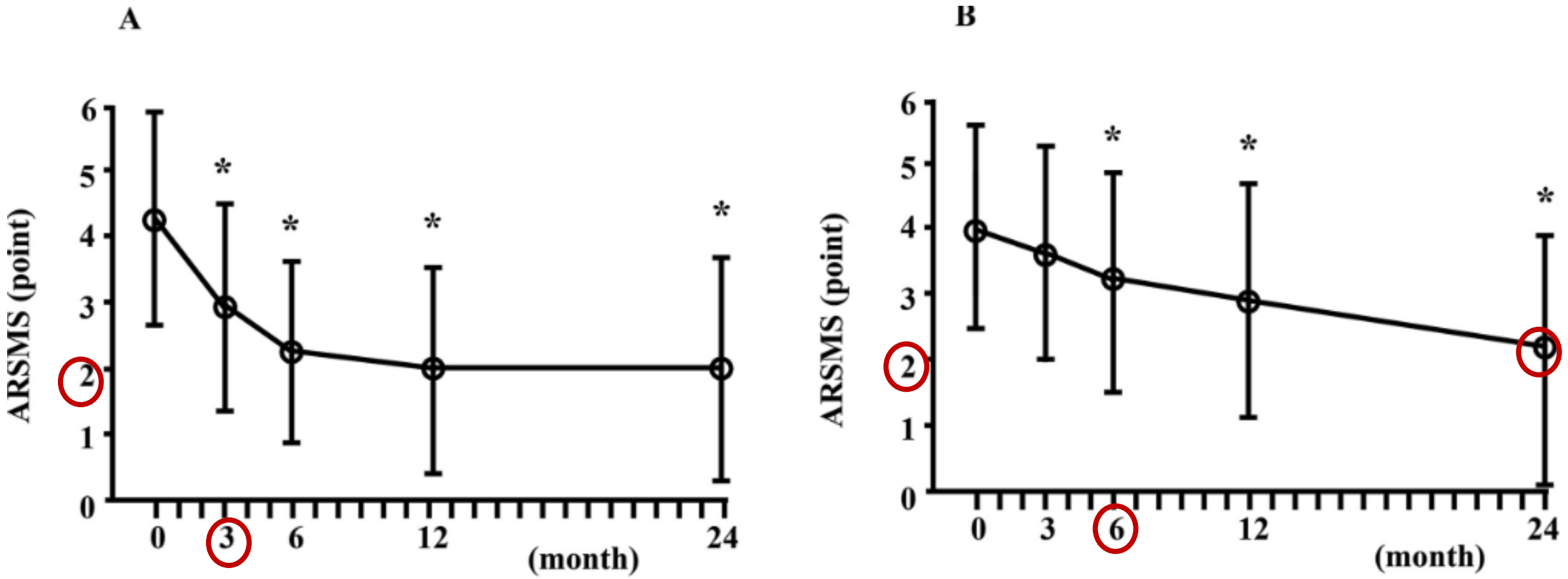


Allergen ImmunoTherapy (AIT)는?

Background factors of HDM SCIT and HDM SLIT groups before and after propensity score matching

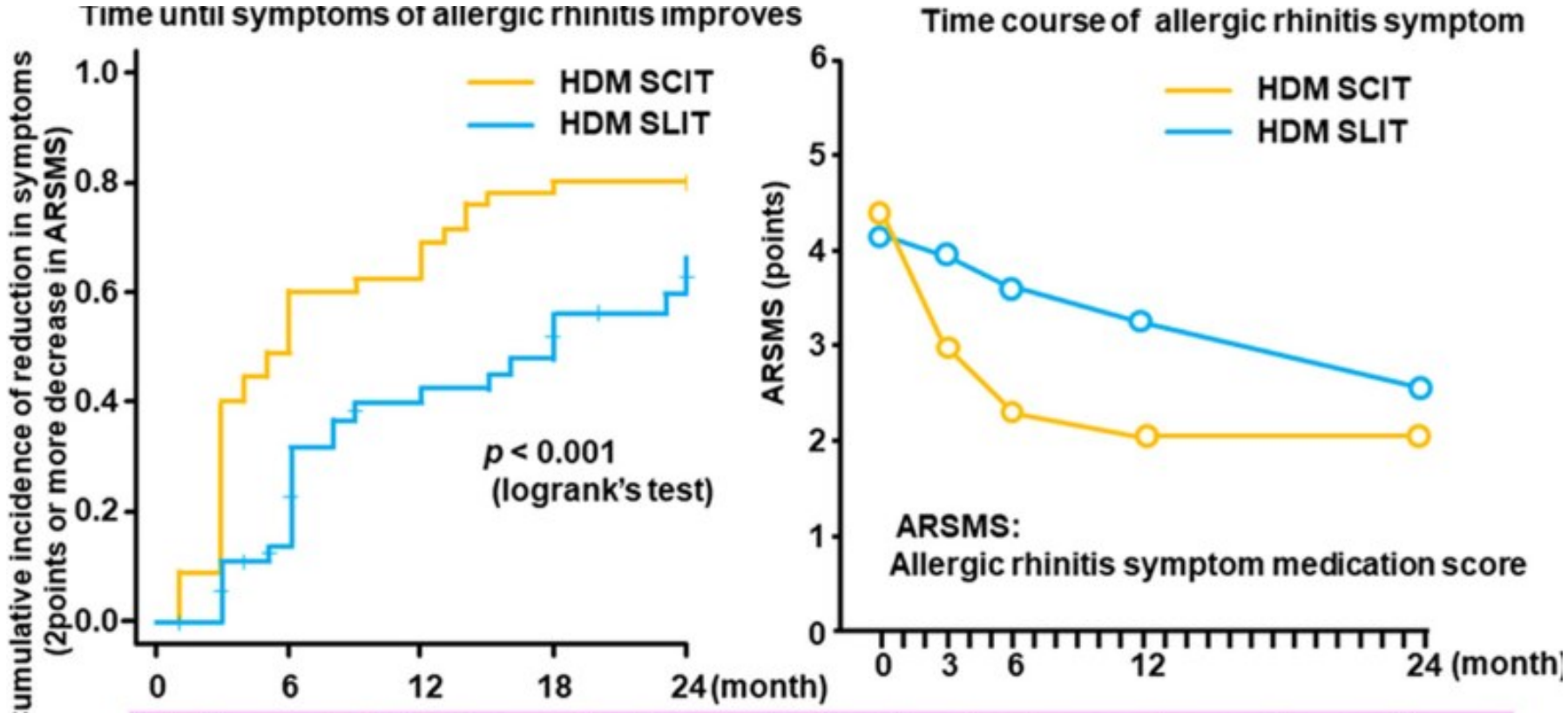
Background factors	Whole patients			Propensity score-matched patients		
	HDM SCIT group (n = 70)	HDM SLIT group (n = 72)	p-value	HDM SCIT group (n = 44)	HDM SLIT group (n = 44)	SMD
Male, n (%)	51 (72.9)	42 (58.3)	0.079	32 (72.7)	32 (72.7)	<0.01
Age of study participants (years), mean ± SD	6.9 ± 2.8	7.3 ± 2.9	0.483	6.7 ± 2.8	6.6 ± 2.7	0.033
Allergic rhinitis severity†						
Mild, n (%)	13 (18.6)	19 (26.4)	0.019	6 (13.6)	12 (27.3)	
Moderate, n (%)	18 (25.7)	30 (41.7)		12 (27.3)	13 (29.5)	
Severe, n (%)	24 (34.3)	18 (25.0)		18 (40.9)	13 (29.5)	
Most Severe, n (%)	15 (21.4)	5 (6.9)		8 (18.2)	6 (13.7)	
ARSMS (points), mean ± SD	4.3 ± 1.6	3.7 ± 1.5	0.027	4.1 ± 1.7	4.3 ± 1.6	0.083
Comorbid allergic disease						
Bronchial asthma, n (%)	68 (97.1)	59 (81.9)	0.005			
Bronchial asthma severity†						
Mild persistent, n (%)	33 (48.5)	29 (59.2)	0.052			
Moderate persistent, n (%)	10 (14.7)	12 (24.5)				
Severe persistent, n (%)	20 (29.4)	8 (16.3)				
Most severe persistent, n (%)	5 (7.4)	0 (0.0)				
PBATS, median (IQR)	225 (120–630)	120 (0–300)	<0.01	150 (120–330)	150 (120–400)	0.022
Atopic dermatitis, n (%)	58 (82.9)	44 (61.1)	0.005			
Type 1 food allergy, n (%)	41 (58.6)	33 (45.8)	0.135			
Total IgE level (IU/mL), median (IQR)	615.0 (277.0–1489.0)	675.5 (282.5–1574.3)	0.504			
Specific IgE level (IUA/mL), median (IQR)						
Dermatophagoides pteronyssinus	66.7 (32.7–121.8)	74.5 (27.7–157.3)	0.419			
Dermatophagoides farinae	101.0 (60.7–205.0)	120.0 (55.2–214.5)	0.396			
Specific IgE level (IUA/mL) (log-transformed)						
Dermatophagoides pteronyssinus, mean ± SD				1.8 ± 0.7	1.7 ± 0.7	0.137

Hamada M et al. Comparison of rush-subcutaneous and sublingual immunotherapy with house dust mite extract for pediatric allergic rhinitis: A prospective cohort study. Allergol Int. 2023;72:573-579.



Changes in Allergic Rhinitis Symptoms/Medication Score before and after Treatment **A:SCIT, B:SLIT**

Schedule	Dose of HDM
HDM SCIT	
Schedule 1 (July 2015 to October 2017)	
in the inpatient setting	
Day1 start dose	0.01–10
Day1 target dose	0.5–100
Day2 start dose	1–200
Day2 target dose	30–300
Day3 start dose	50–400
Day3 target dose	200–400
Day4 start dose	300–500
Day4 target dose	500
Day5	500
Schedule 2 (From January 2018)	
in the inpatient setting	
Day1 start dose	10
Day1 target dose	30
Day2 start dose	100
Day2 target dose	200
Day3	300
in the outpatient setting	
Day 9–10	500
HDM SLIT	
in the outpatient setting	
Day 1	3300
at home	
Day 2–7	3300
Day 8-	10,000

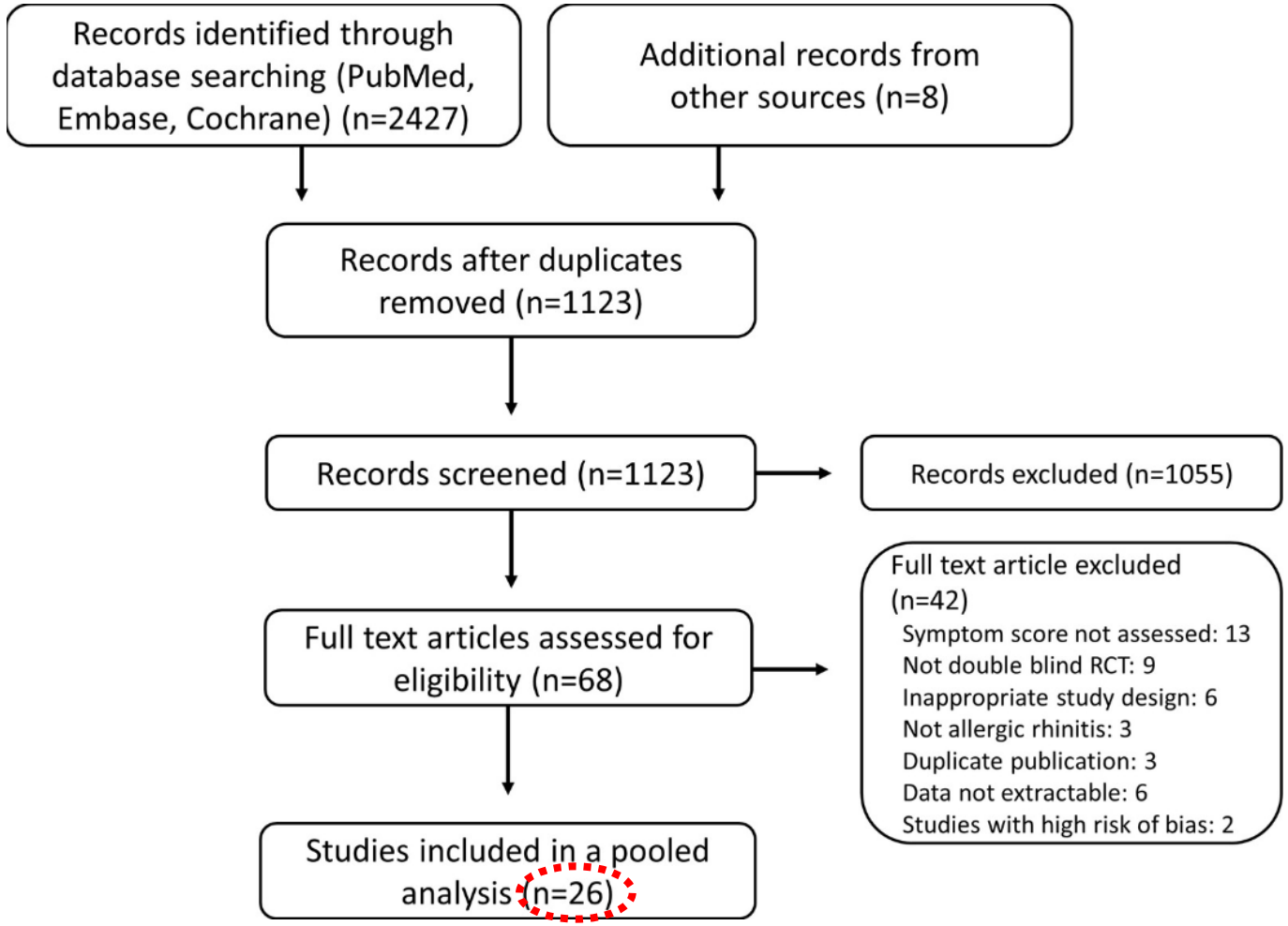


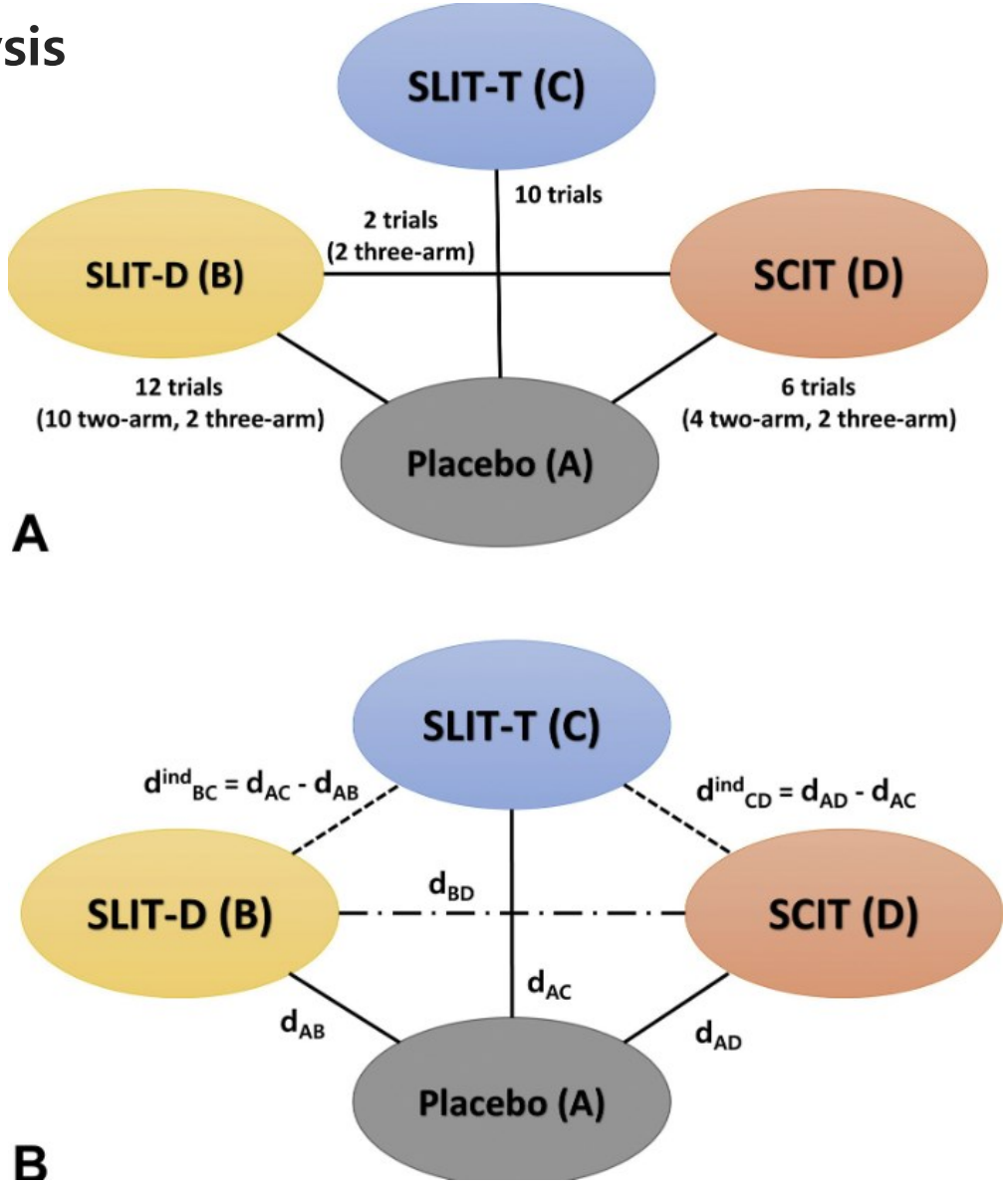
Earlier onset of effectiveness for allergic rhinitis with subcutaneous immunotherapy than sublingual immunotherapy using standardized house dust mite extracts

	HDM SCIT	HDM SLIT
Time to treatment effect	6 months	24 months
Treatment effect after 2 years	54.6%	47.6%
Discontinuation rate	0.0%	20.5%
Systemic reactions in maintenance phase	18.2%	0.0%

Effect Speed	SCIT > SLIT
Long-term effect	SCIT = SLIT
Compliance	SCIT > SLIT
Safety	SCIT < SLIT

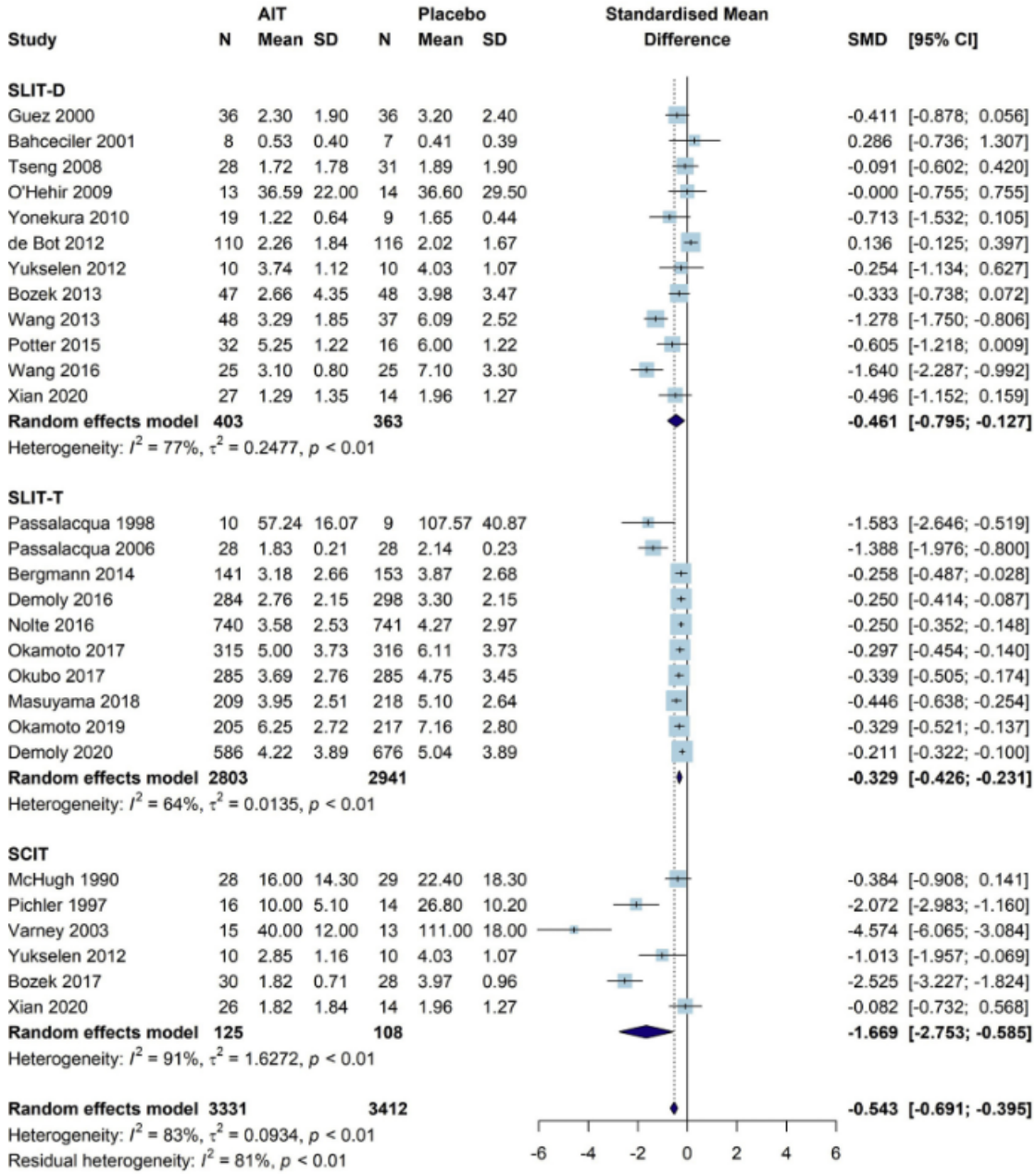
Direct pair-wise meta-analysis, Net-work meta-analysis



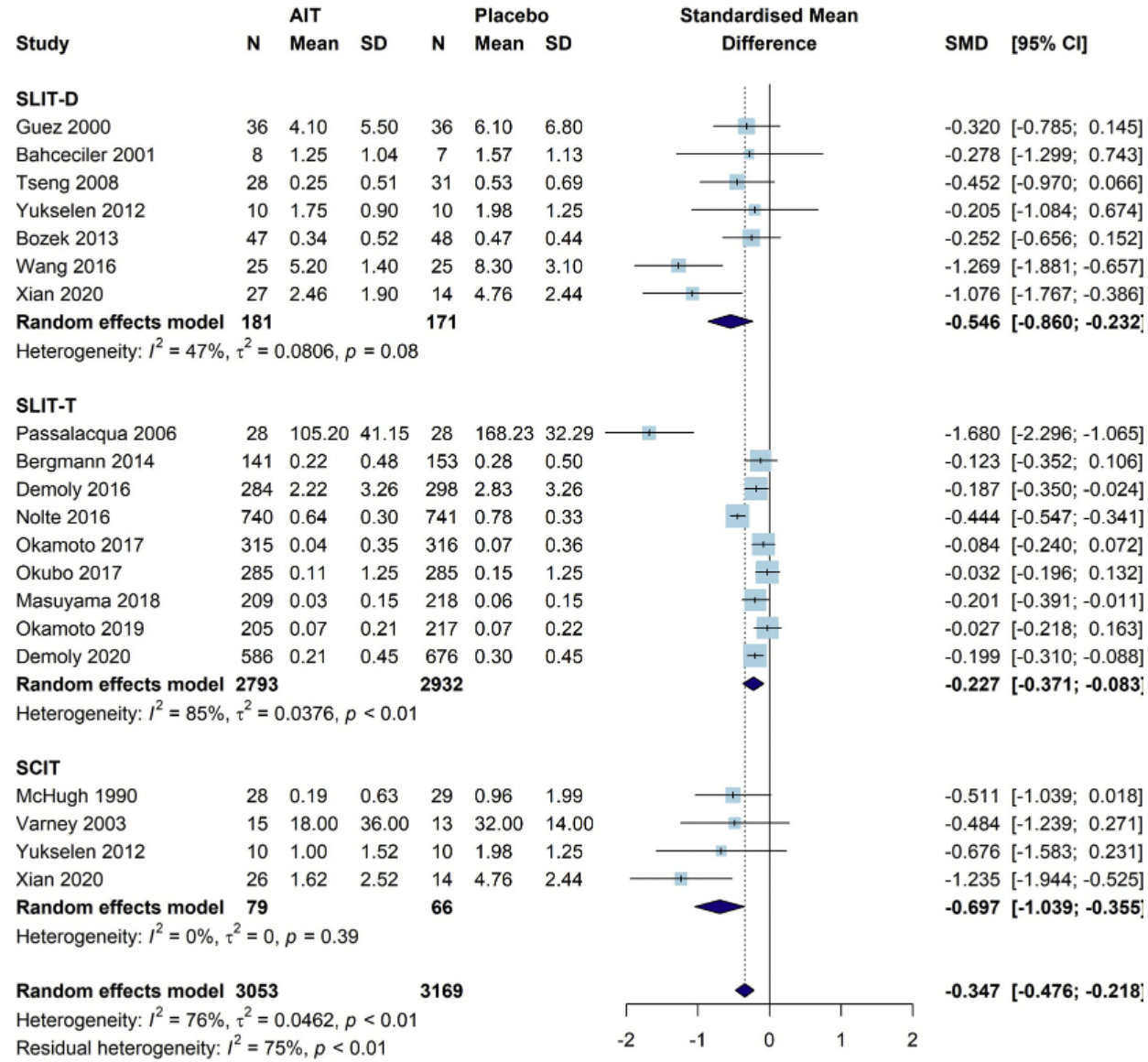


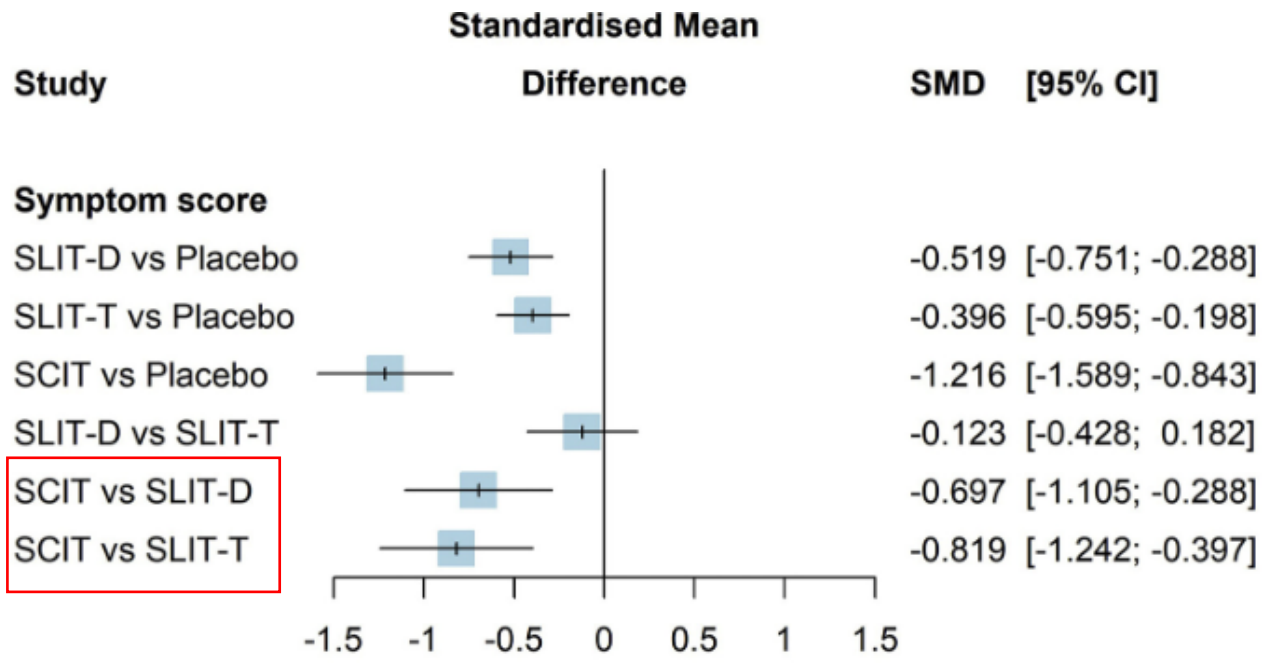
Efficacy of Subcutaneous and Sublingual Immunotherapy for House Dust Mite Allergy: A Network Meta-Analysis-Based Comparison. J Allergy Clin Immunol Pract. 2021;9:4450-4458.e6.

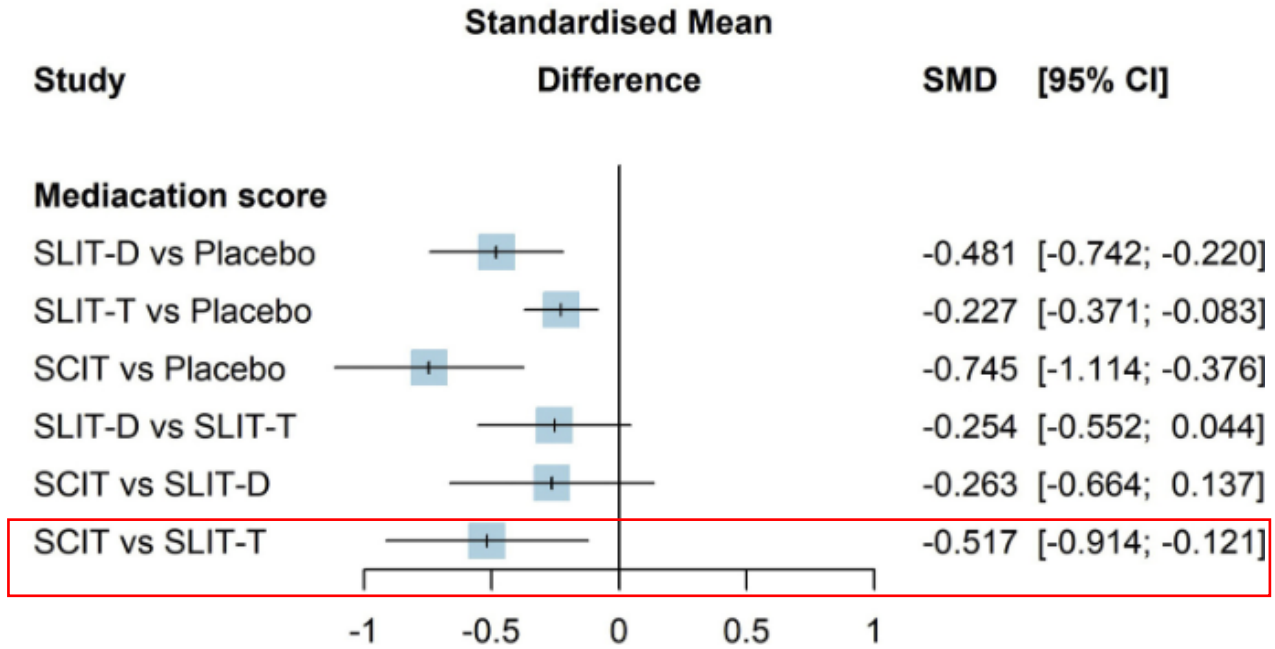
Symptom score



Medication score

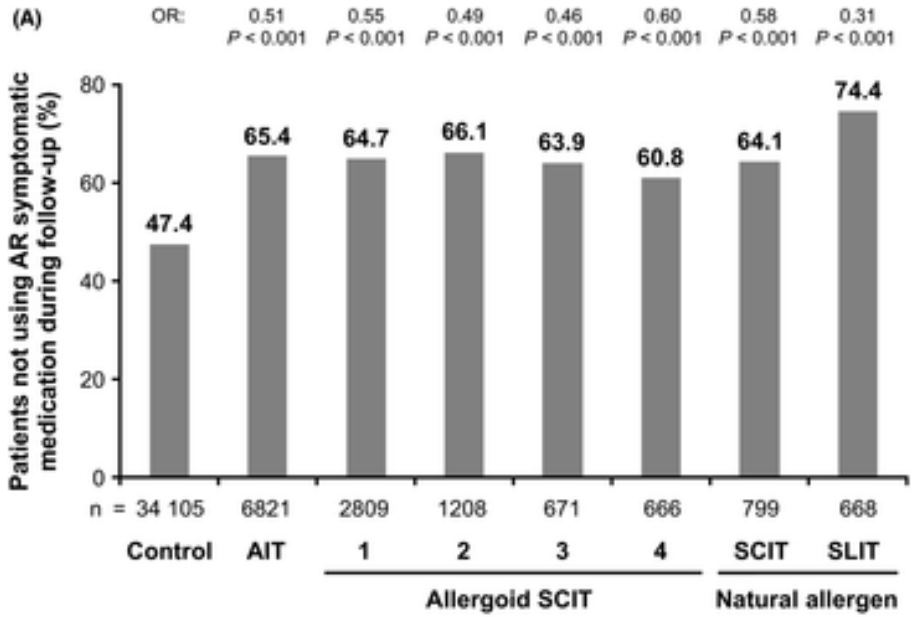


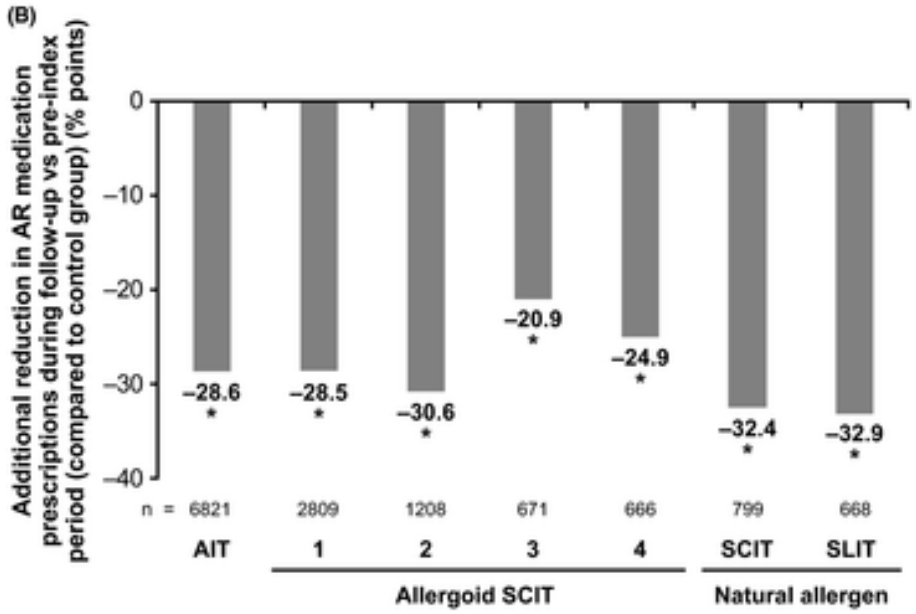


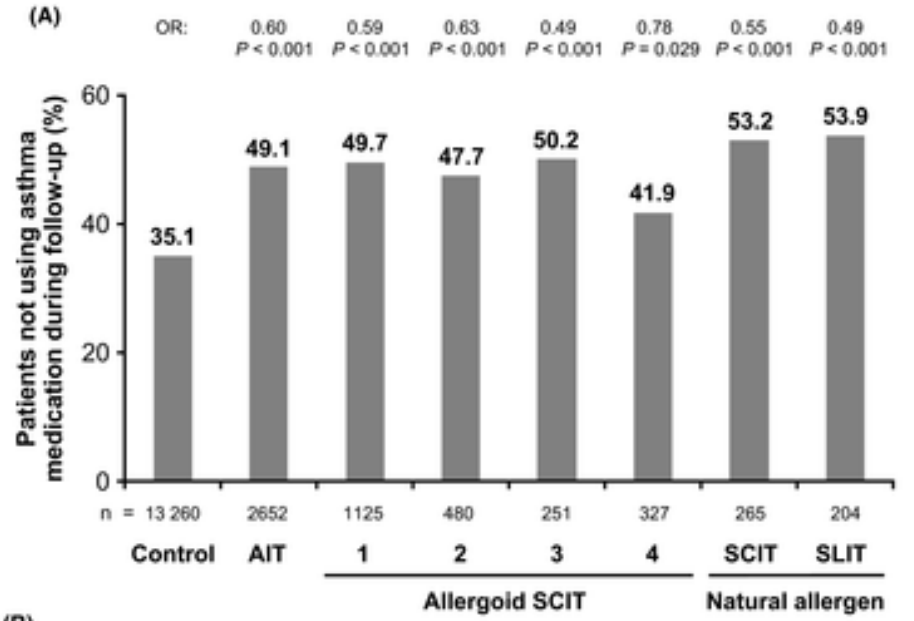


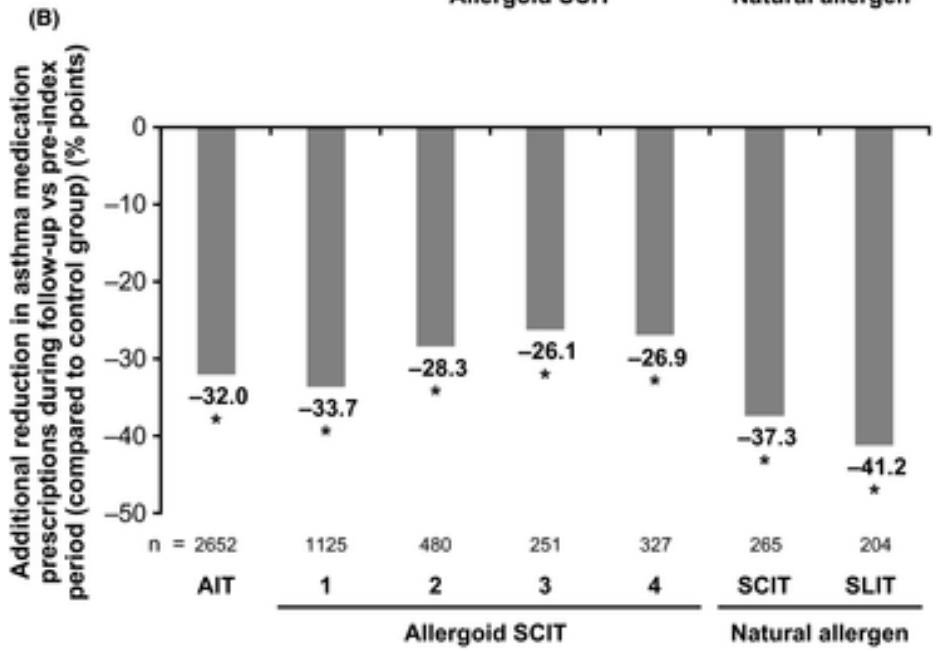
Results of network meta-analysis. Direct and indirect comparison of (A) the symptom score and (B) the medication score.

Retrospective of German longitudinal prescription database

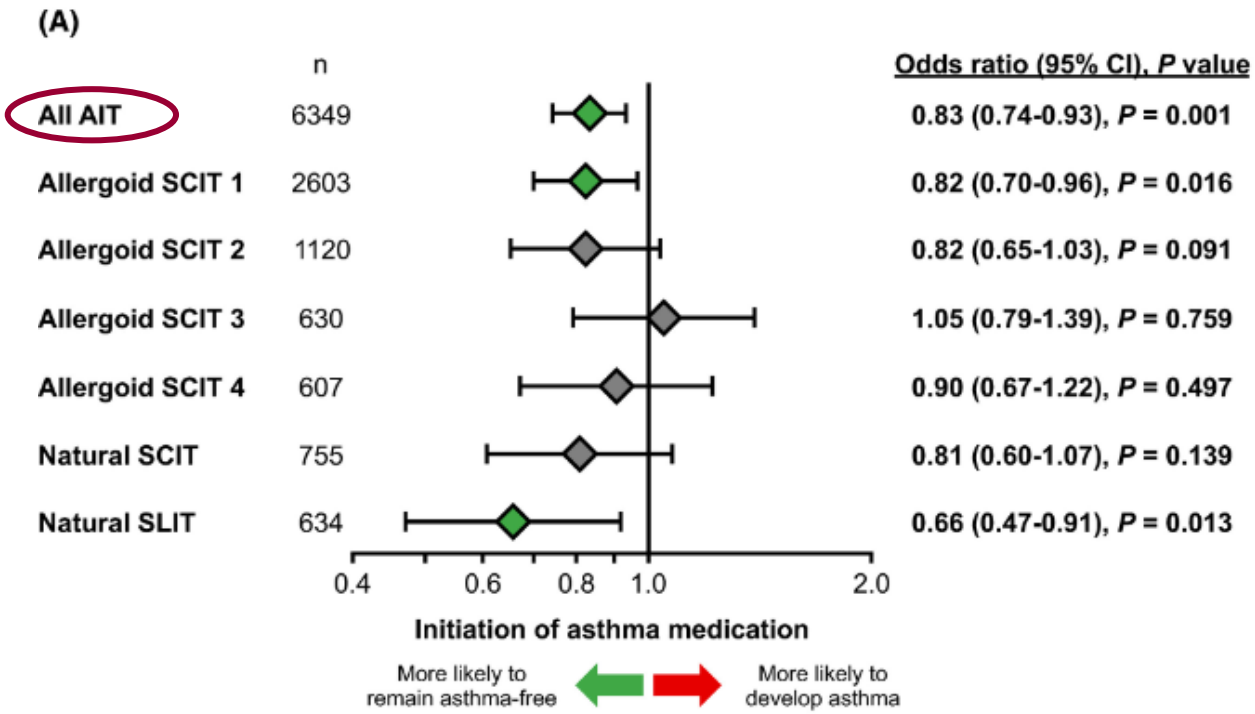


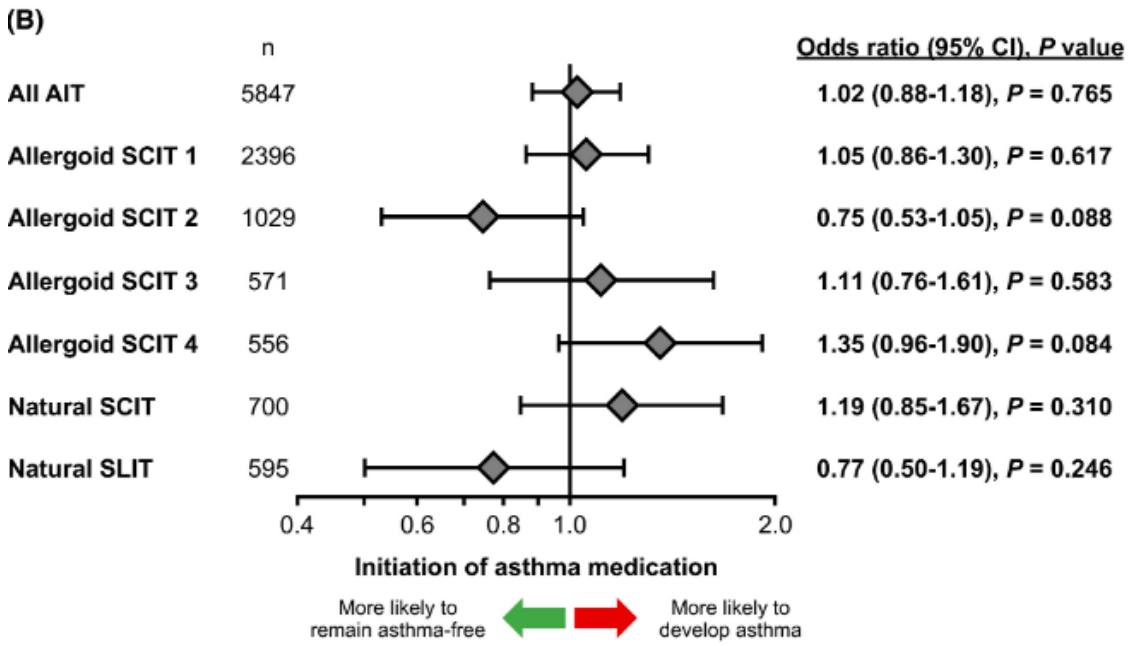


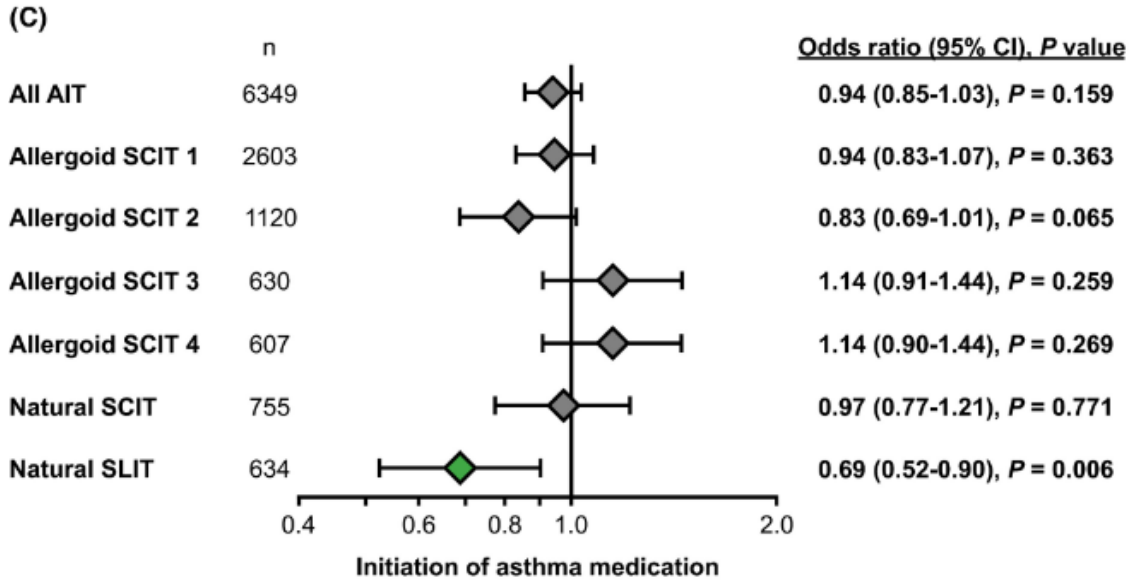




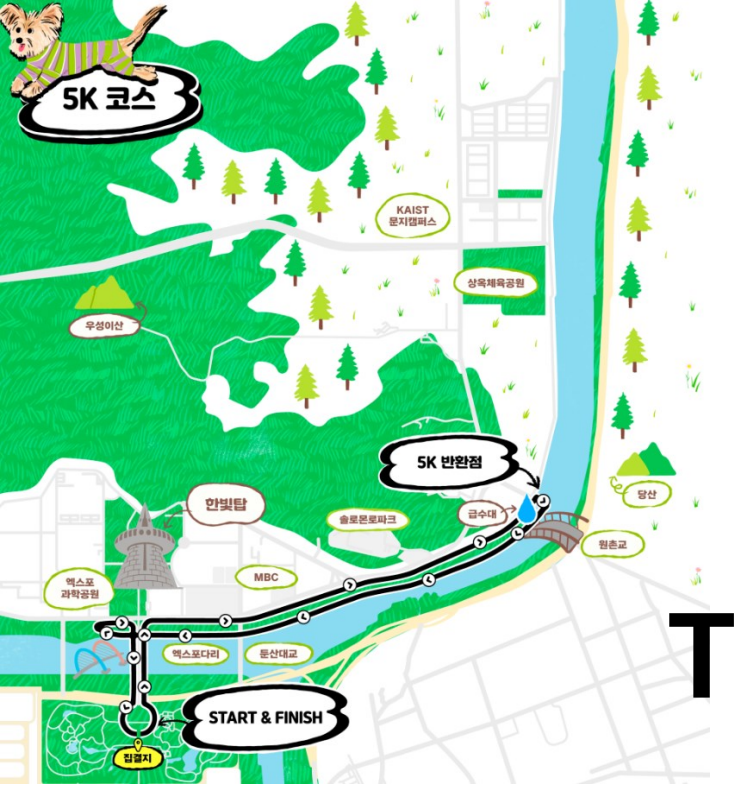
*Real-world benefits of allergen immunotherapy for **birch pollen-associated allergic rhinitis and asthma**. Allergy. 2019;74: 594-604*







Odds of starting asthma medication use **during** the treatment **(A)**, **post-treatment (B)** or full-analysis **(C)** periods in patients with birch family pollen-associated AR but **no concomitant asthma at baseline**



Thank you for attention.