백의효과에 영향을 주는 요인
(Factors Influencing White Coat Effect)

한양의대 심장내과
신 진 호

혈압평가에 영향을 주는 요소

- 고혈압을 이상적으로 치료의 첫 걸음
  - 혈압에 대한 정확한 평가

- 측정 오차
- 무작위 변동성(Random variability)

- **백의효과(White coat effect)**
- 가면(Masked) 고혈압

백의효과

의료환경 및 혈압 측정자에 의해서
유발되는 혈압상승 현상

White-Coat Effect

- Actual measurement of the BP may invoke an alerting reaction, a reaction that is only transient in most patients but persistent in some.

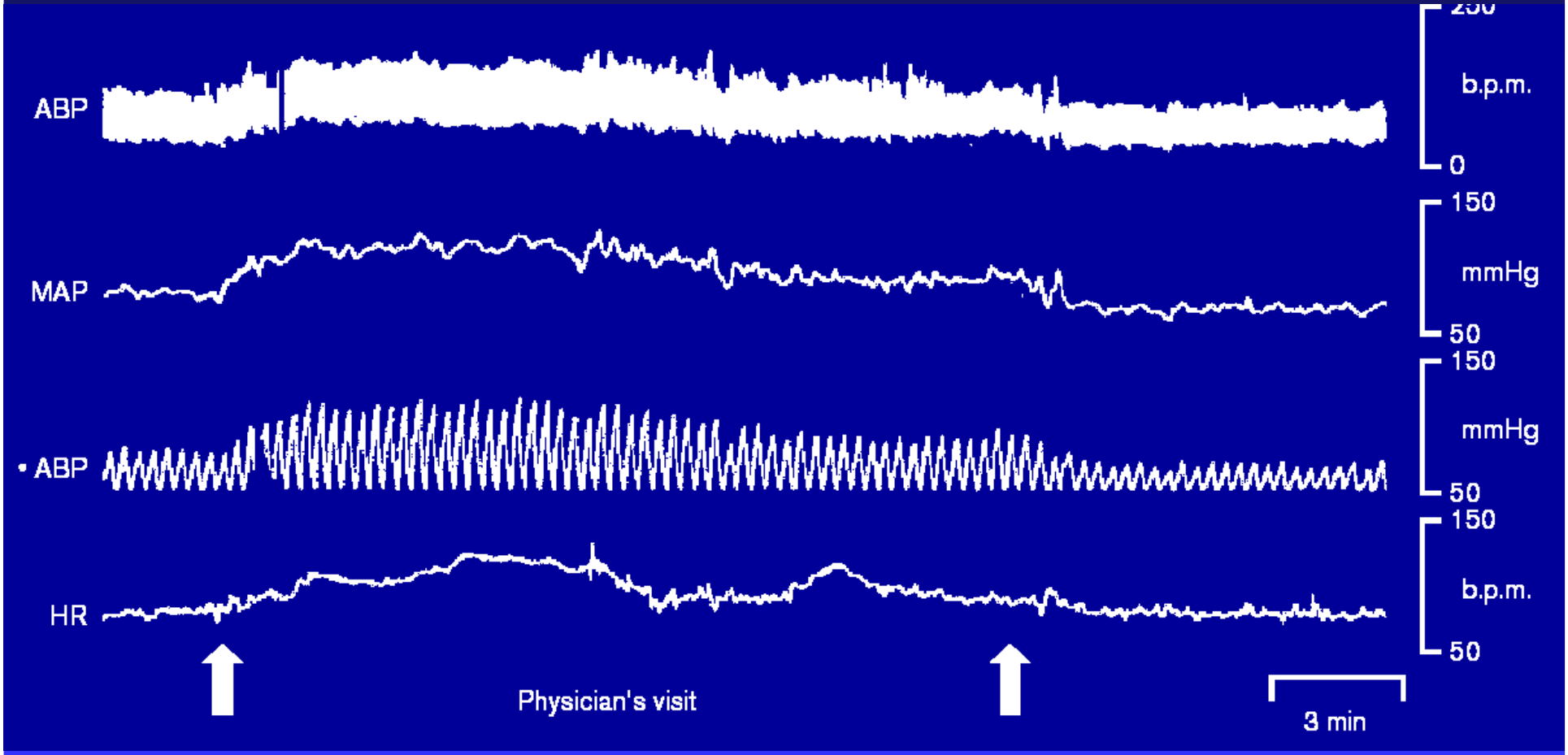
- This reaction may be partially related to the environment but is mostly related to the measurer

Kaplan's Clinical Hypertension 8th Ed.

백의효과의 정의

- 20/10mmHg이상의 혈압 차이
  - 수은주 혈압계 혈압 측정 시 2SD
  - 임상적인 차이를 인정할 수 있는 수준
  - 73% of treated HTN(AJH1991;4:844)
- 진료실 혈압–주간혈압 > 0
- > 집단 내 백의현상의 정중값

백의효과 – 직접 측정법

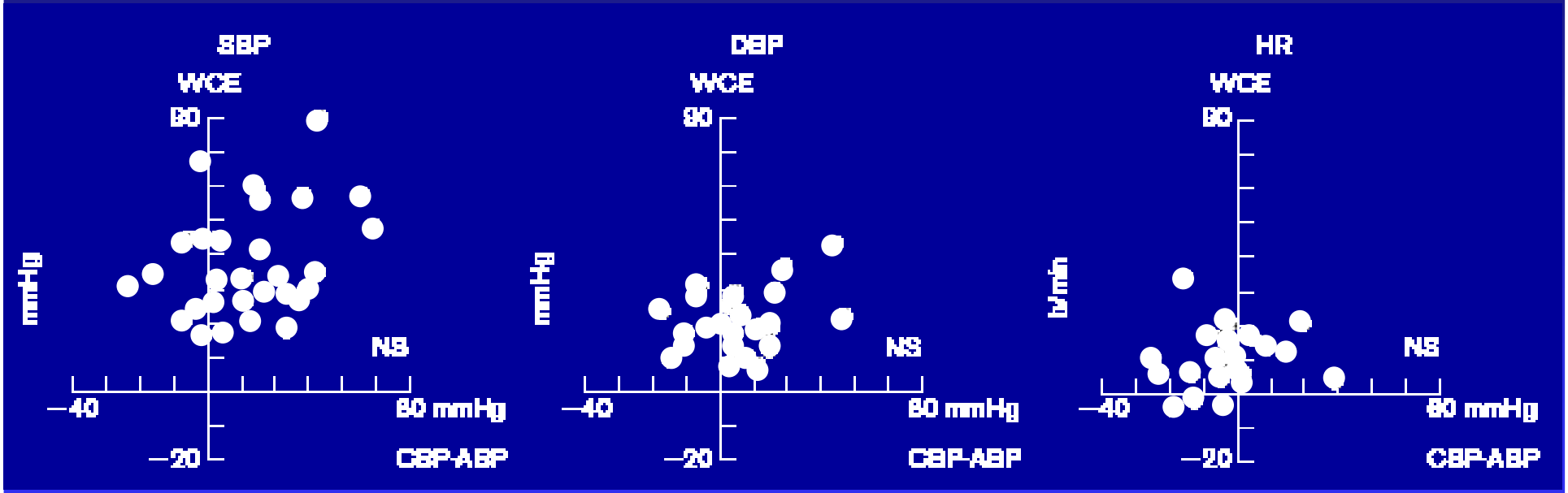


Journal of Hypertension 2003, 21:481–486

백의효과 측정법 -간접법

- 주간(평균)혈압을 기저혈압으로 간주
- 백의효과 = 진료실혈압-주간혈압

직접측정법과 간접측정법 간의 상관관계

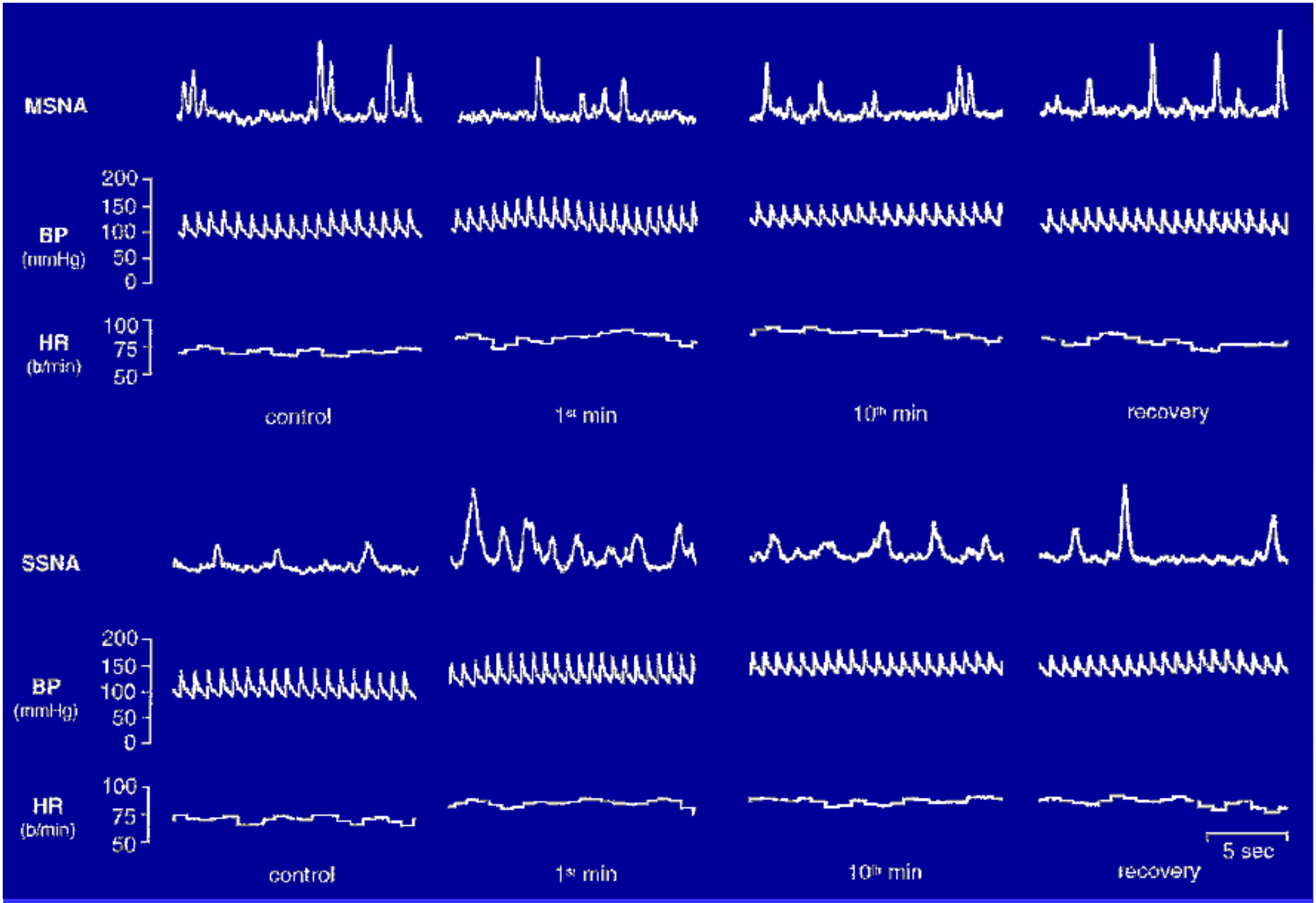


Journal of Hypertension 2003, 21:481–486

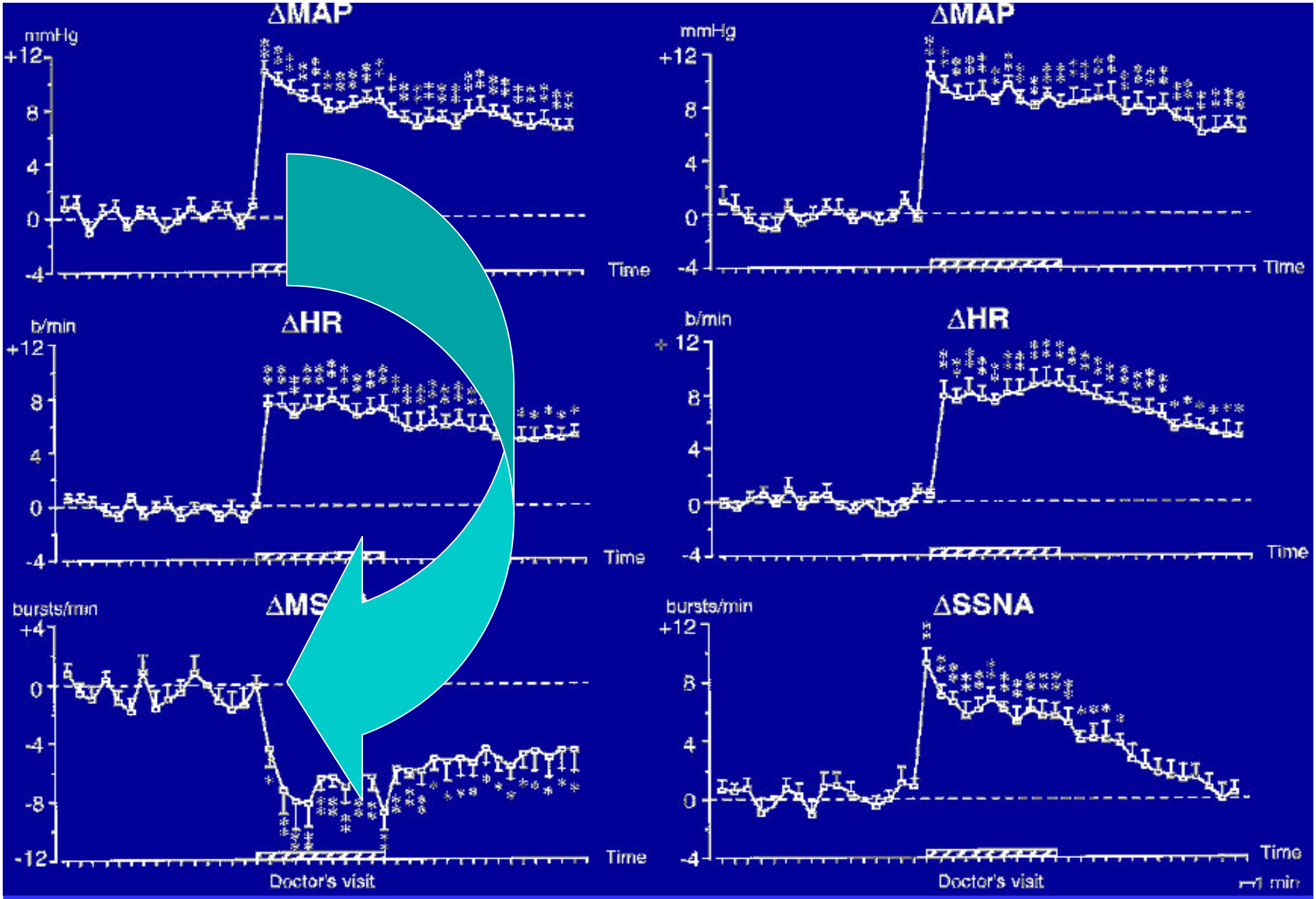
수축기 혈압의 백의효과

Study	N	Difference (SD) from clinic		
		Daytime	Nighttime	24hr
Ironson, 1989	119	5		
Jula, 1999	233	**−3.8**	19	**2.8**
Khoury, 1992	131			17
Modesti, 1994	139	**9**	22	**12**
Myers, 1995b	147	14		
Narkiewicz, 1995	411	11.2		
Staessen, 1999	808	21.9		
Stergiou, 1998b	189	**6.9**	23.9	**13.1**
Thijs, 1996	477	21		
Zachariah, 1991	126			−7
Zachariah, 1988	168	**4**		**8**
Zawadzka, 1998	410	11.5		

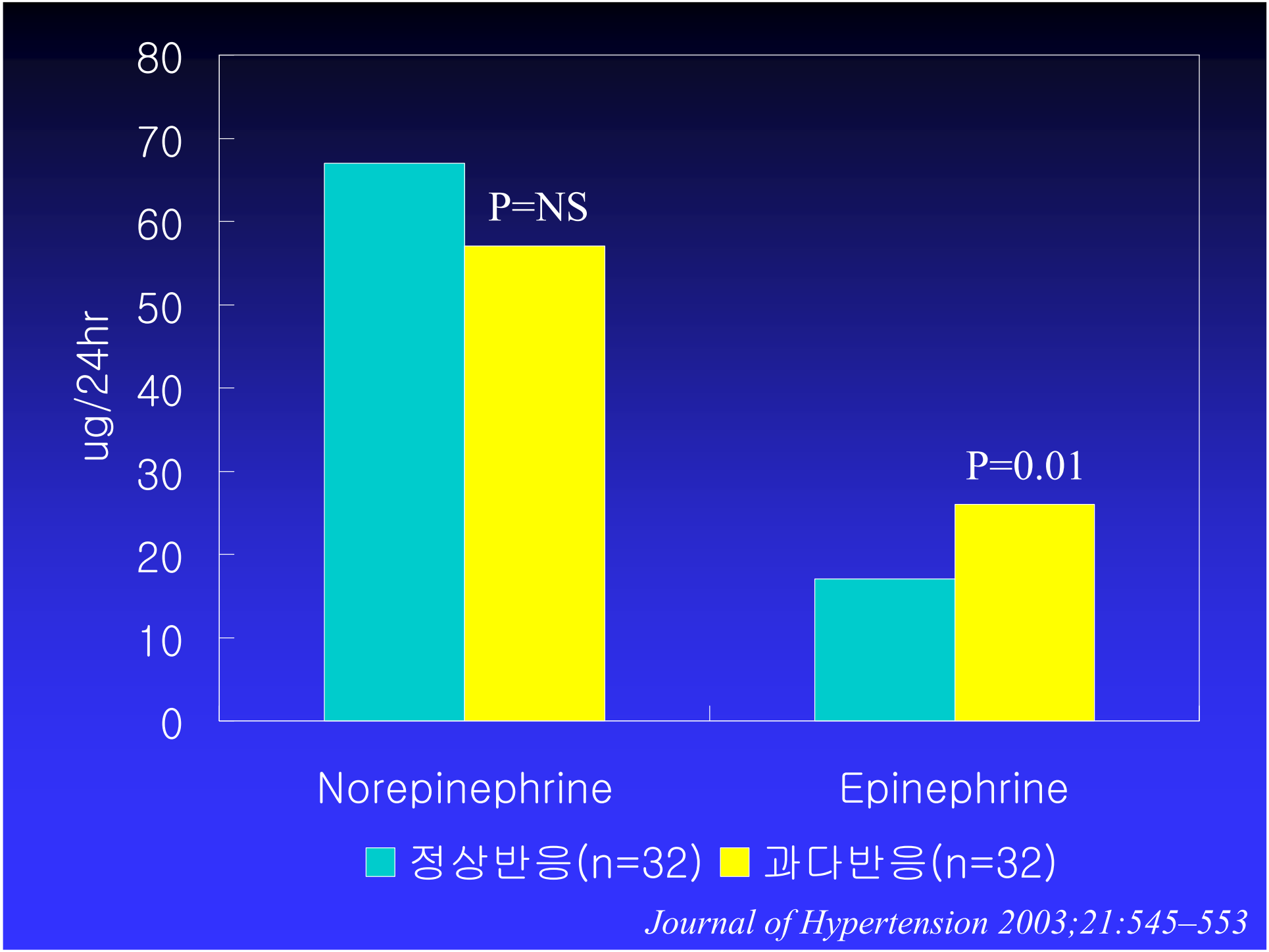
13.5mmHg ?



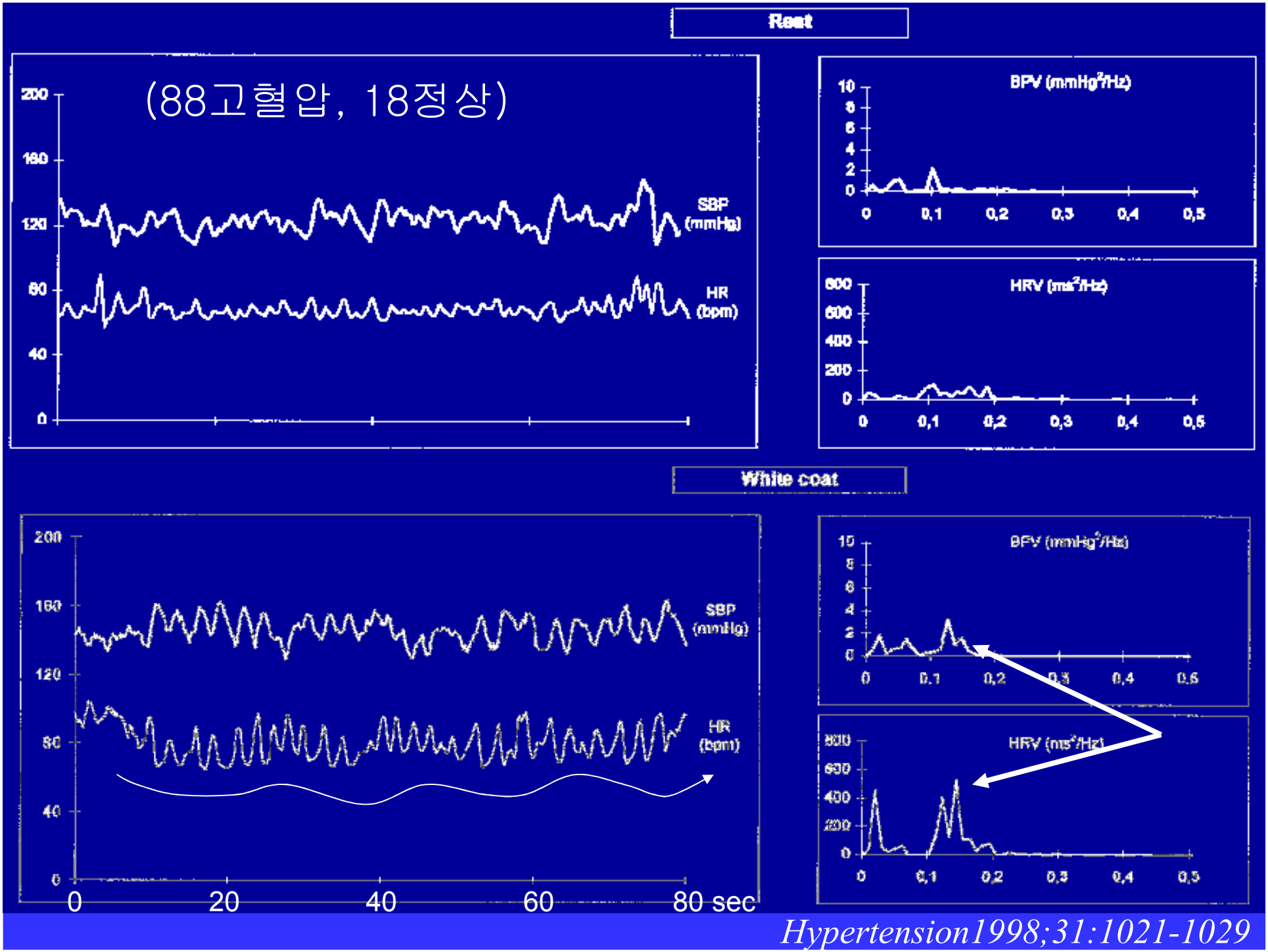
근육과 피부의 교감신경 활성도*(Circulation*1999;100:222)



근육과 피부의 교감신경 활성도 *(Circulation* 1999;100:222)

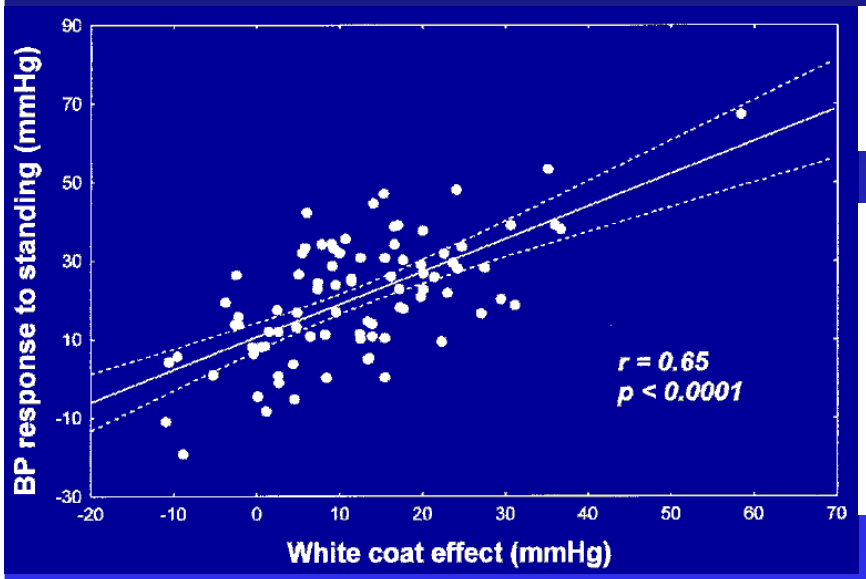


Journal of Hypertension 2003;21:545–553

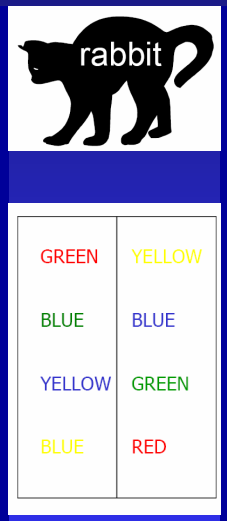


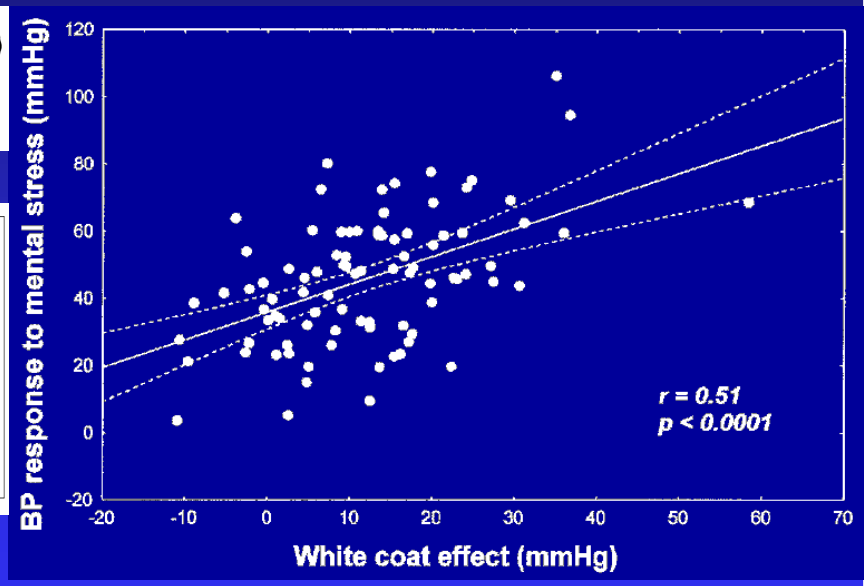
Hypertension1998;31:1021-1029

기립 및 정신적 스트레스에 대한 혈압 상승과 백의효과의 상관관계



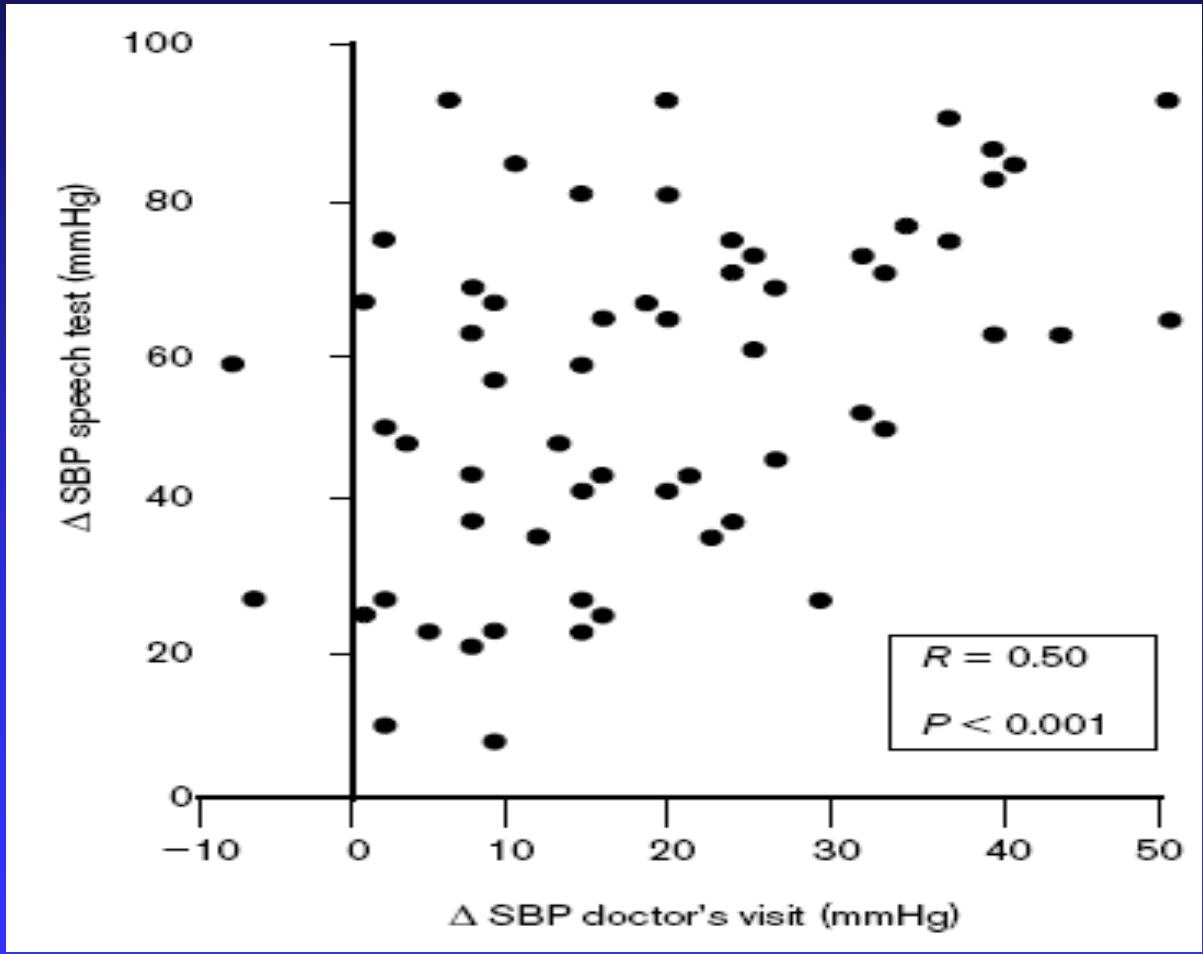
기립 시 혈압상승과 백의 효과





정신적 스트레스 시
혈압상승과 백의 효과

Hypertension 1998;31:1021-1029



J Hypertens2003;21:545–553

백의효과와 압수용체 반사의 민감도

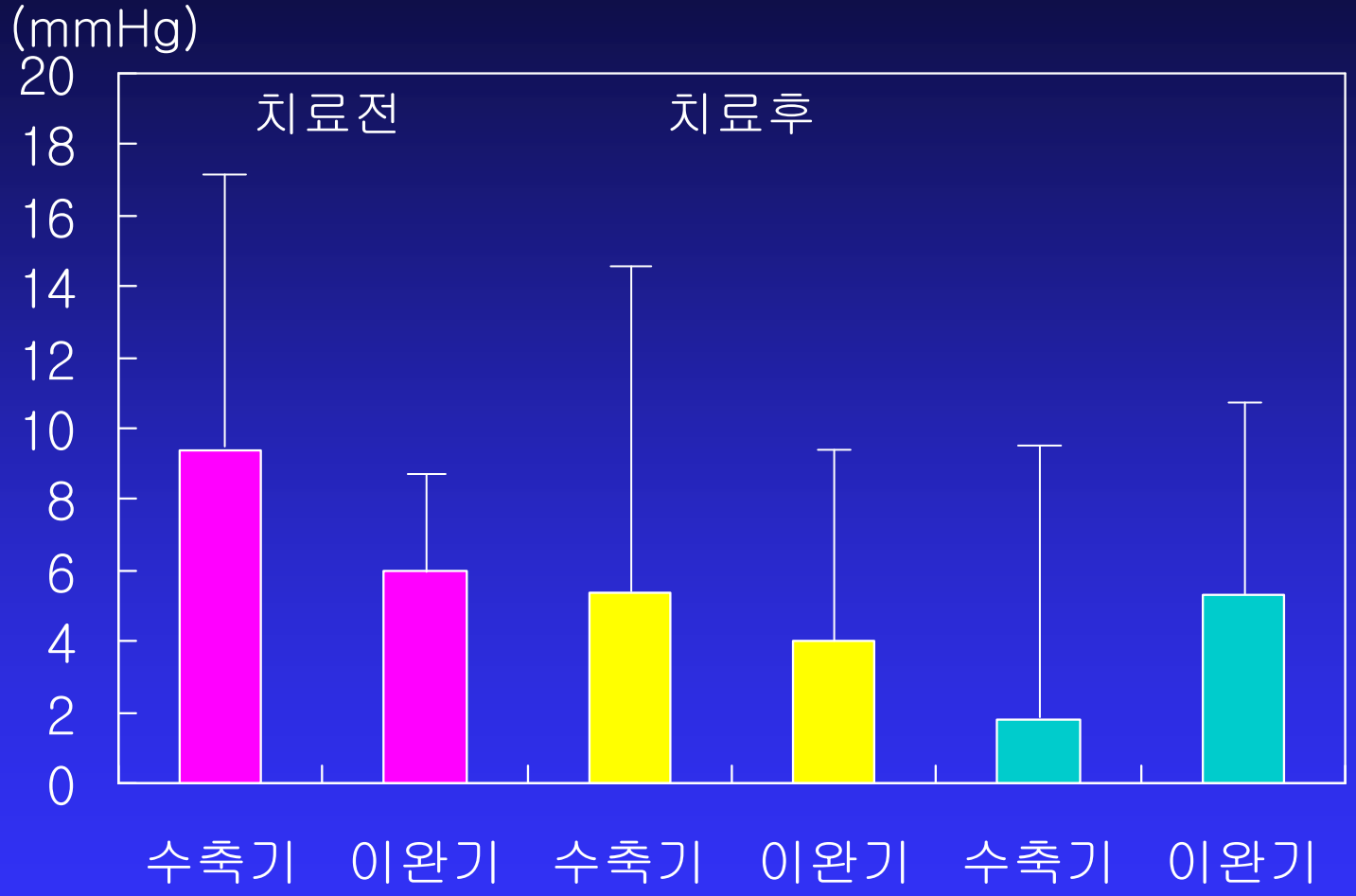
	NT N=49	WCNT N=18	HT N=76	WCHT vs. NT	WCNT vs. HT	NT vs. HT
Lying Position						
PS+/RR+	9.32±3.13	8.20±2.17	7.39±2.25	0.21	0.22	**<.001**
PS-/RR-	10.96±3.6	9.69±3.15	8.50±2.7	0.19	0.17	**<.001**
MF Gain	9.4±5.6	8.9±5.3	6.4±2.9	0.66	0.06	**0.002**
Standing Position						
PS+/RR+	5.53±1.47	4.72±1.32	4.61±1.6	**<.04**	0.64	**0.005**
PS-/RR-	5.34±1.58	4.63±1.37	4.78±1.76	0.08	0.76	**0.05**
MF Gain	4.49±2.33	4.10±2.94	3.89±2.78	0.26	0.76	**0.03**

NT normotensives, WCNT high BP with normal ABP, HT hypertensives, PS+/RR+ and PS-/RR- (ms/mmHg), sequential methods*, MF gain (ms/mmHg), cross-spectral analysis in mid-frequency band

* at least three cardiac cycles, Variation threshold: 1mmHg for PS/4ms for RR, only for the values of $r \geq 0.95$

Clin Auton Res 2004; 14 : 160–166

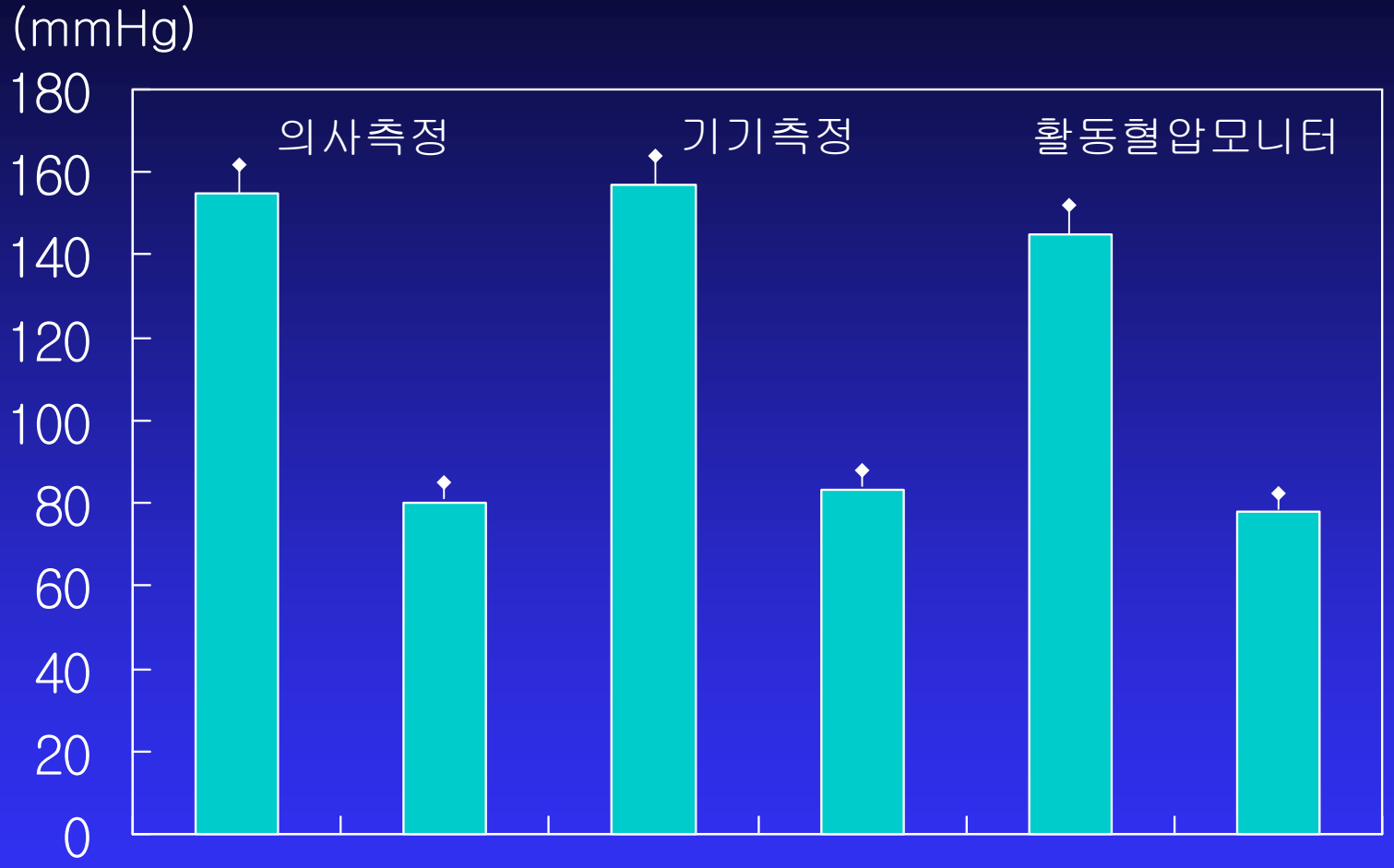
직장사무실과 병원검사실과의 혈압차이



본태성 고혈압 환자(n=25) 정상성인(n=25)

J Hum Hypertens 2000;14:355

진료실에서 기기를 이용한 혈압측정



약물 치료 중인 본태성 고혈압 환자(n=25)

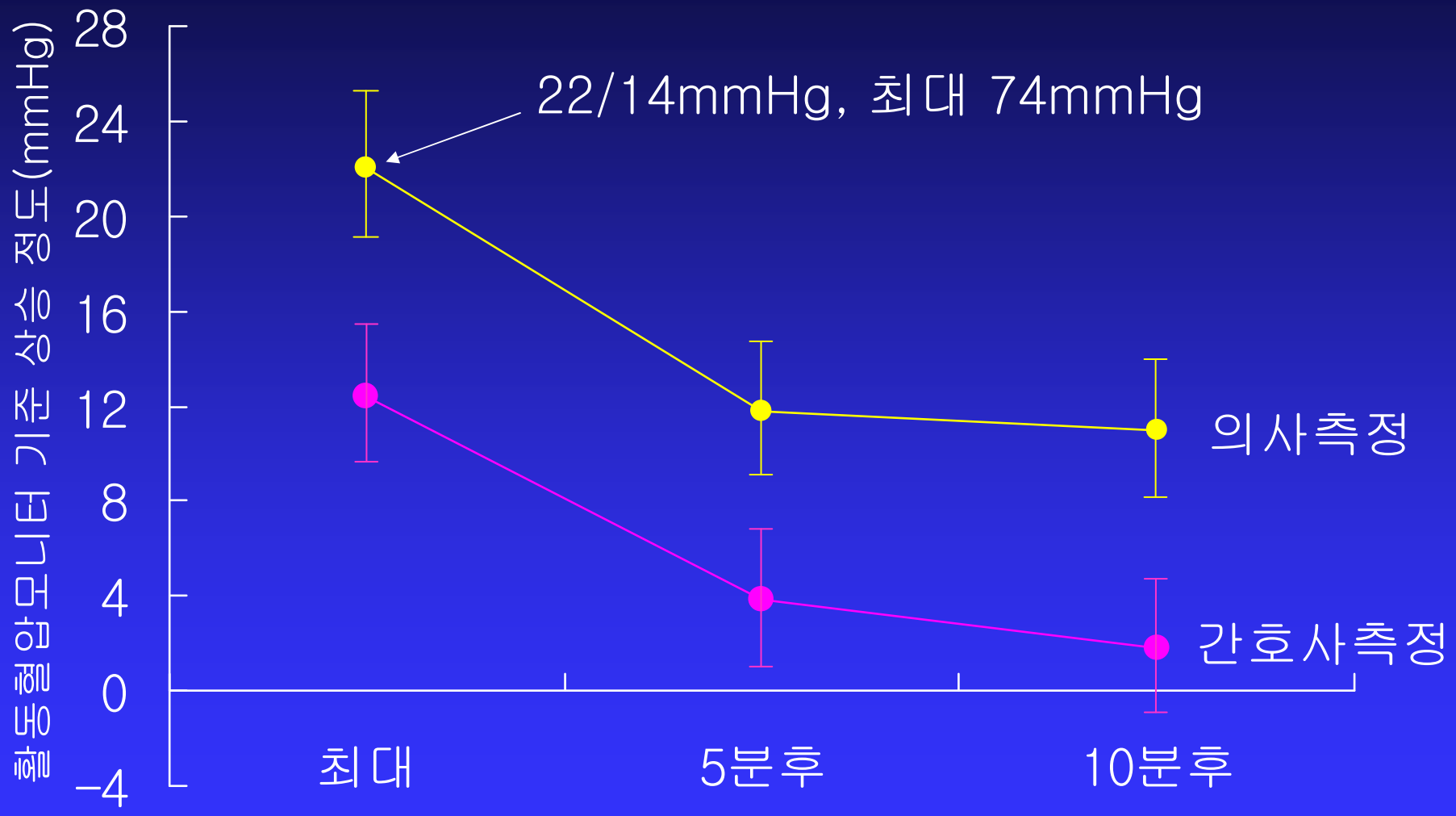
J Hum Hypertens 1997;11:491

병원환경에서 백의효과 측정

	Normotensive Patients	Hypertensive patients
Day 1 resting level	72.5 (11.1)	72.8 (13.2)
Day 2 waiting room resting level	76.7 (12.1)	76.8 (13.0)
Day 2 examination room resting level	74.7 (12.2)	75.8 (13.7)
Day 2 examination room post-physician	73.4 (11.96)	73.3 (12.6)

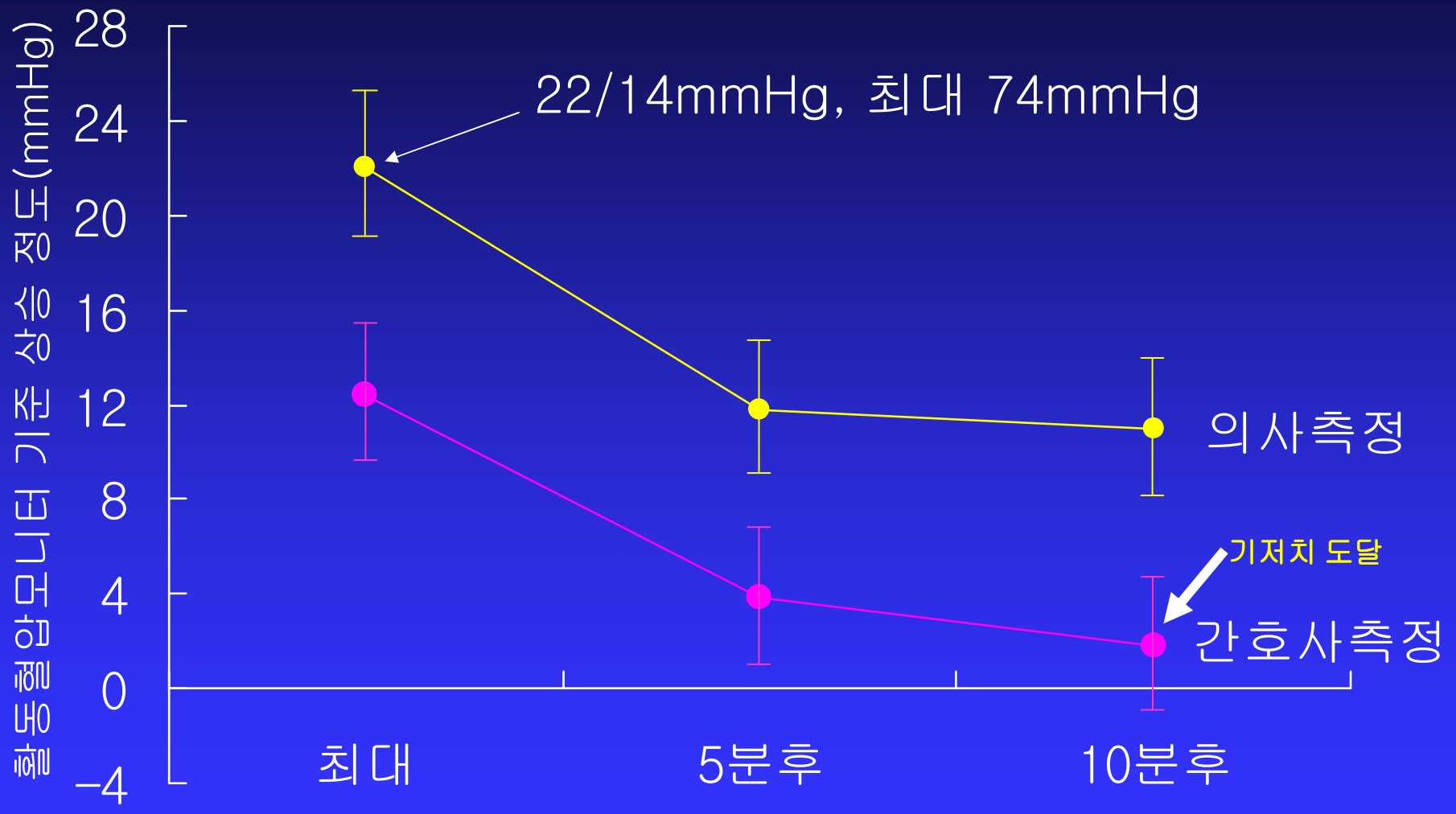
Journal of Hypertension 2006, 24:67–74

측정자 요인 – 의사와 간호사



Hypertension 1987;9:209

측정자 요인 – 반복측정 효과



Hypertension 1987;9:209

실제 진료 시 백의효과

의사	**19/11 mmHg**
간호사 1	5/8 mmHg
간호사 2	5/6 mmHg
병원 내 자기혈압측정	10/13 mmHg
가정에서 자기혈압측정	5/6 mmHg

N = 173, 본태성 고혈압 환자, 개인의원 3곳

Little et al, BMJ 2002; 325: 254

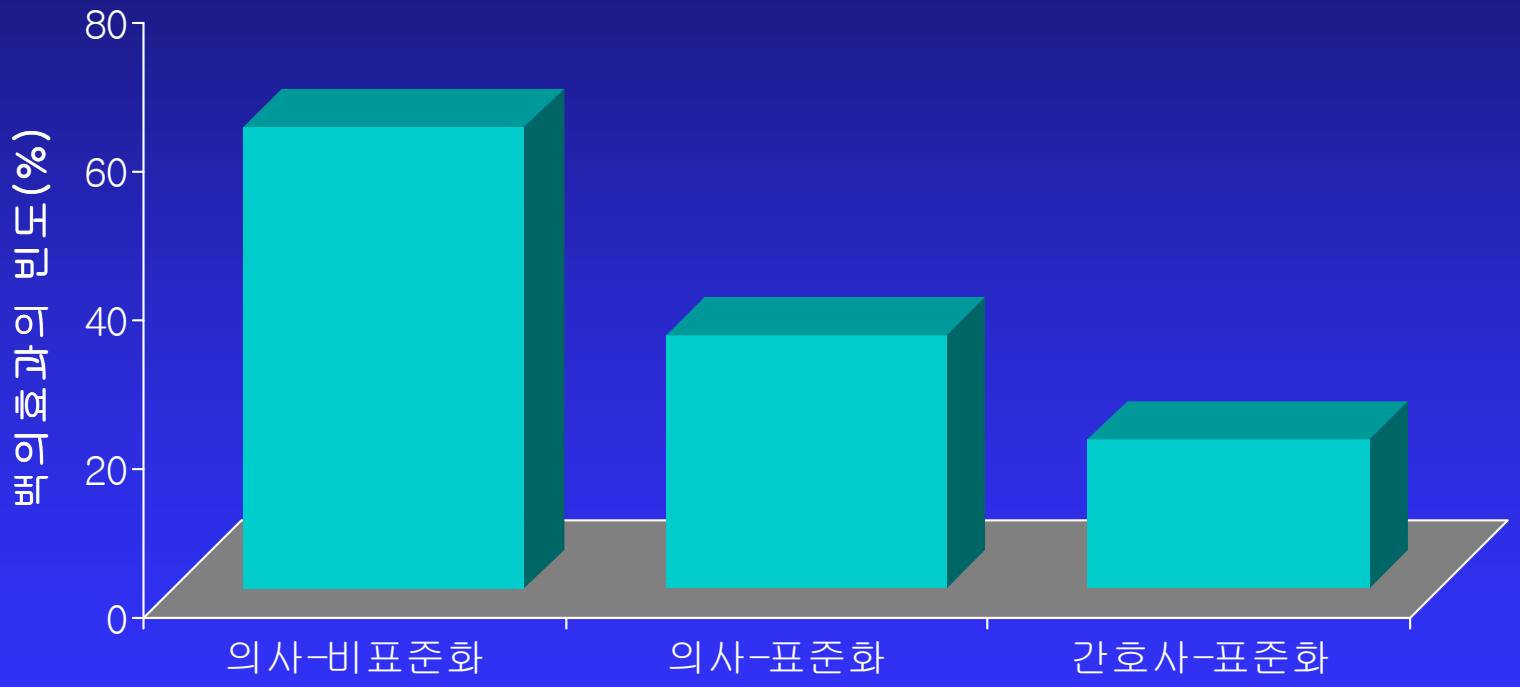
수축기혈압을 기준으로 본 고혈압 진단의 정확성

측정자	예민도(%)	특이도(%)	LR +	LR −
의사	91.2	25.8	1.2	0.33
간호사	83.3	41.2	1.4	0.41
자가-병원	92.7	50.0	1.9	0.15
자가-가정	87.0	59.7	2.2	0.22

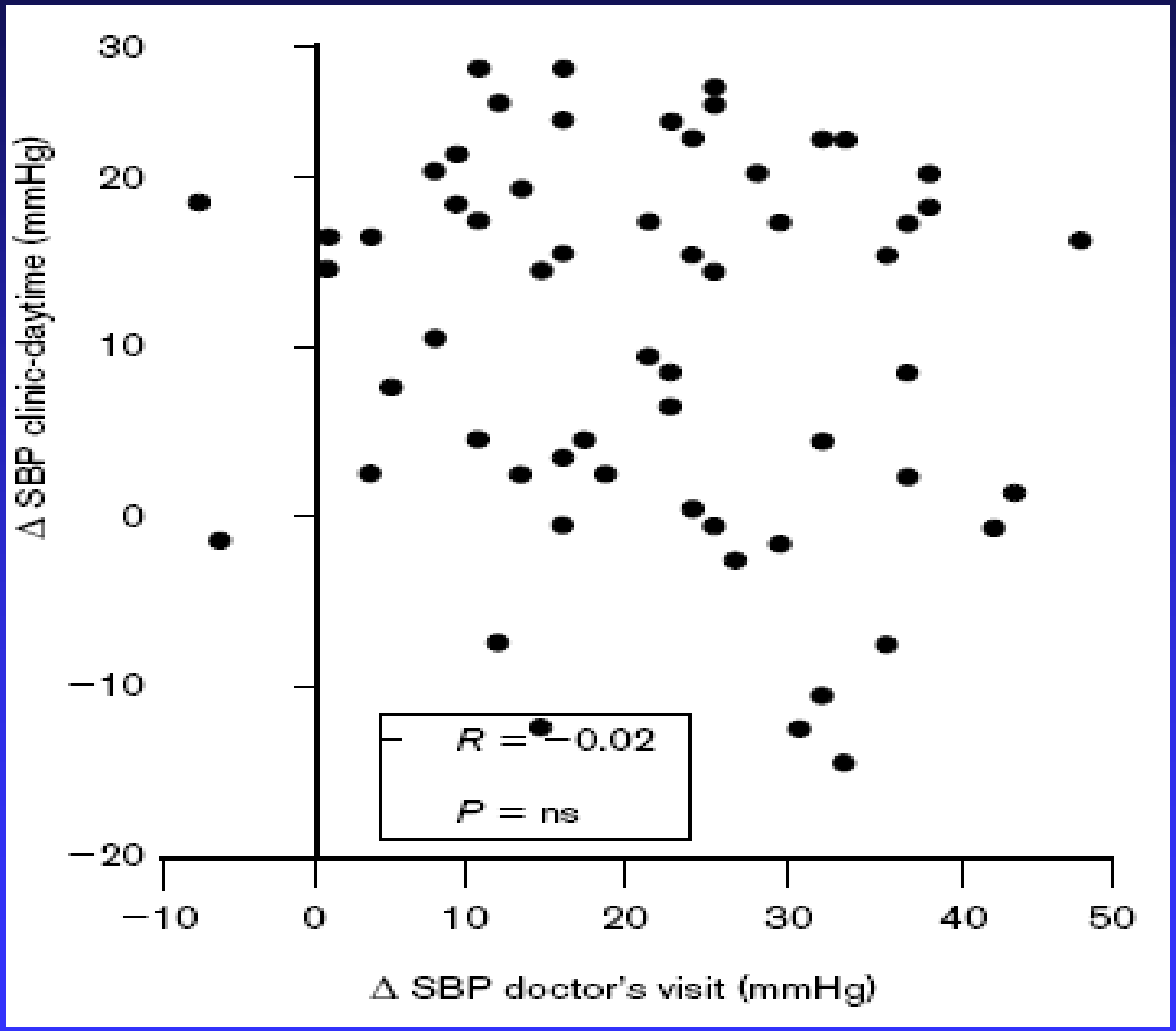
Little et al, BMJ, 2002;325:254

혈압측정자와 측정방법에 따른 백의효과

백의효과의 정의: ≥20/10mmHg of CBP-ABP

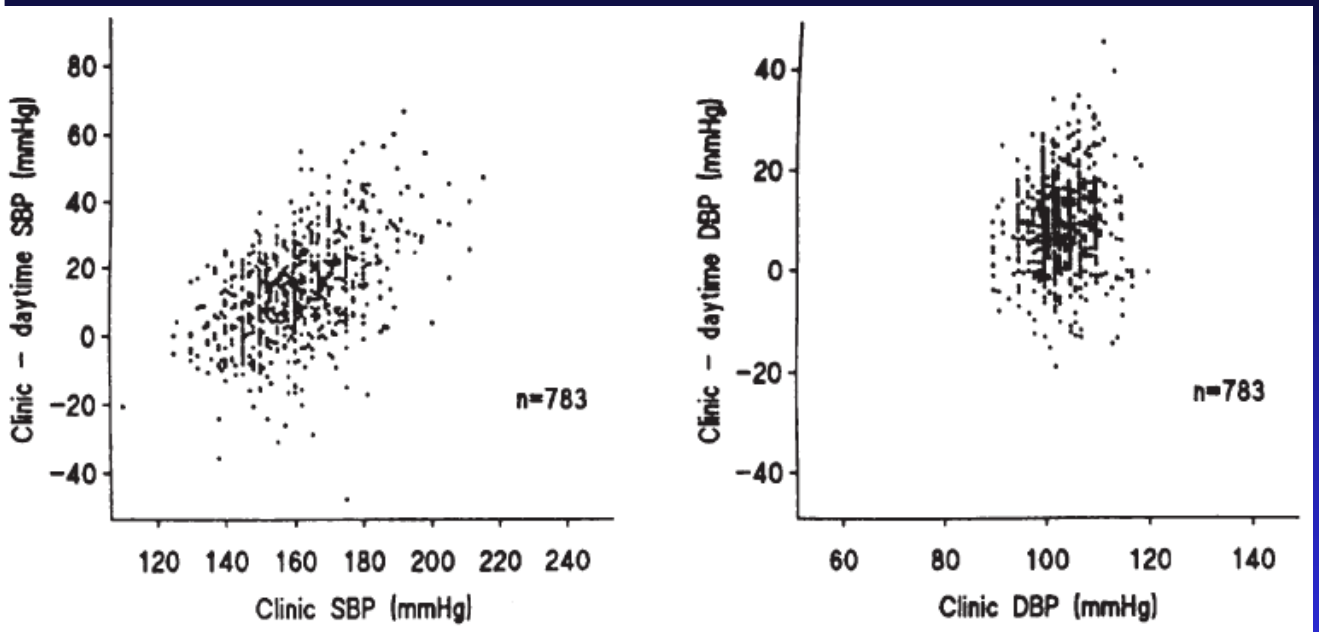


Myers, et al. Am J Hypertens 1995;8:591-7. Campbell et al. Blood Press Monit 1999;4:71-6.

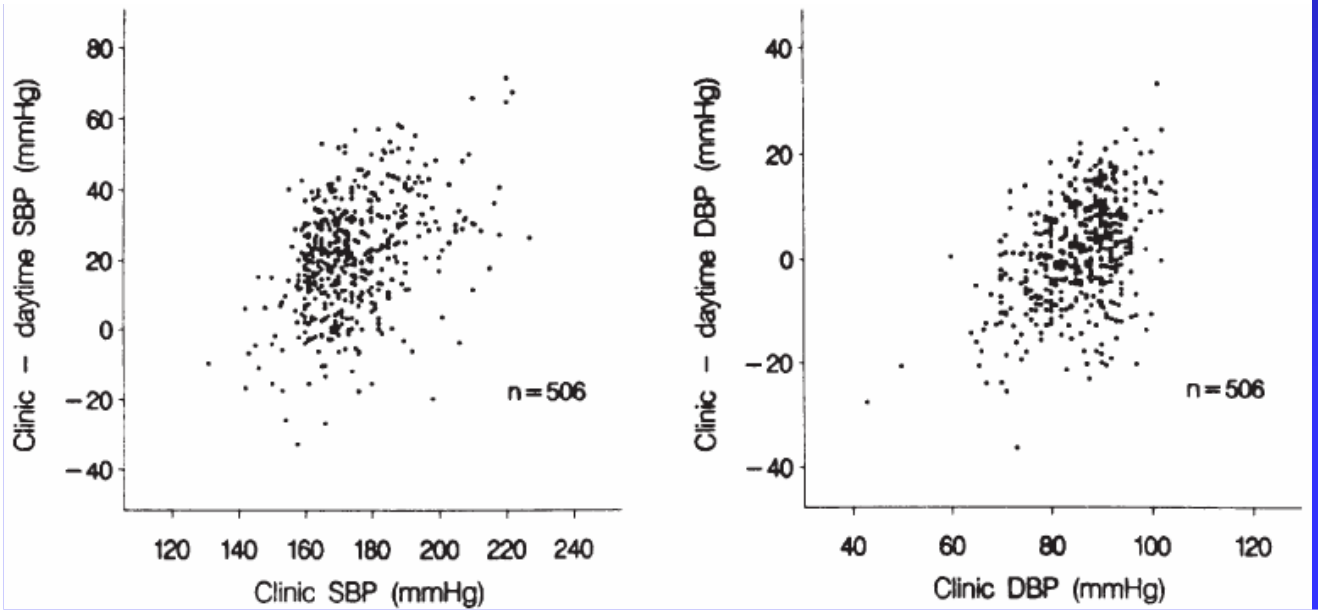


Journal of Hypertension 2003;21:545–553

진료실 혈압과 백의효과

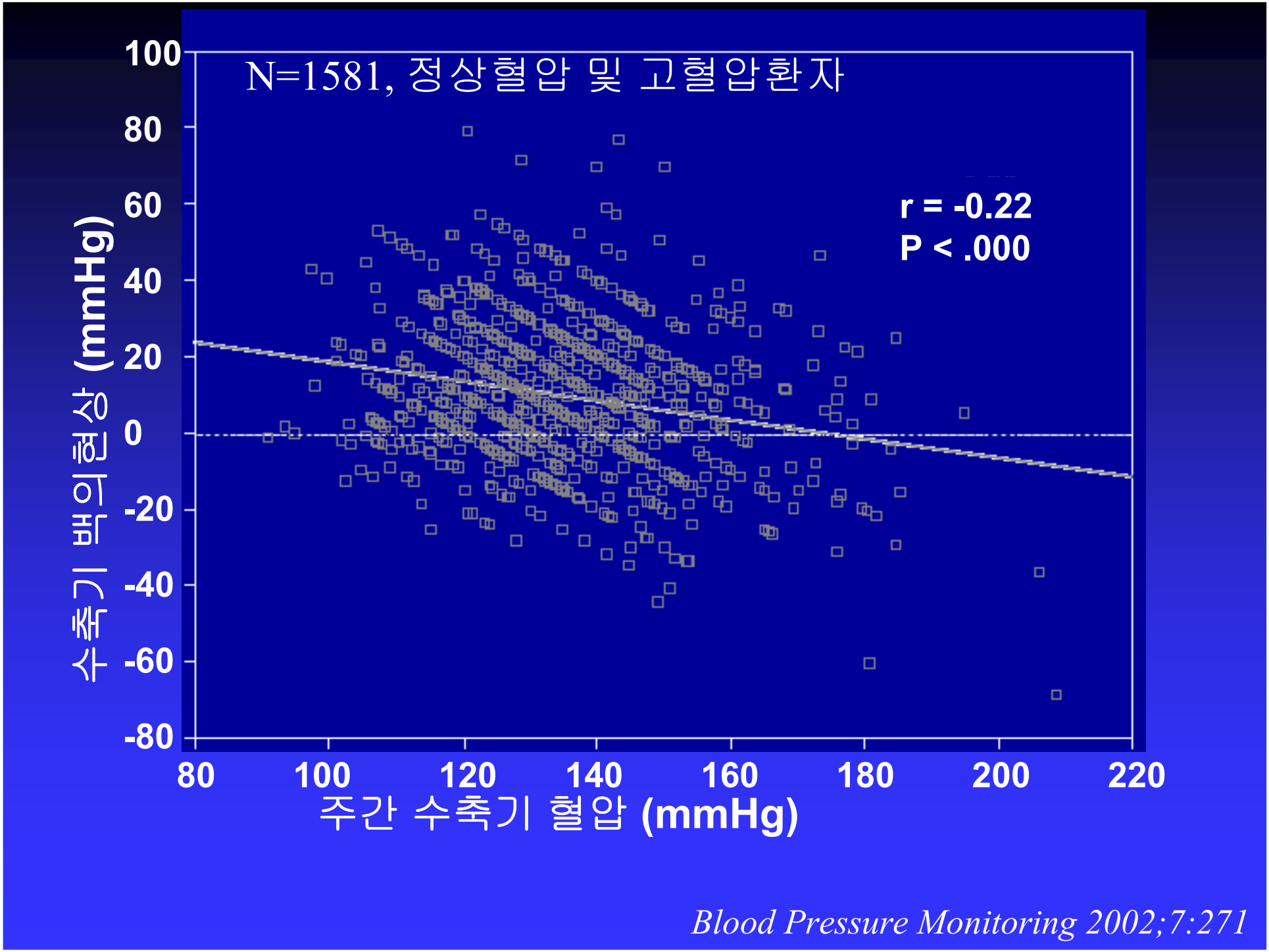


본태성 고혈압



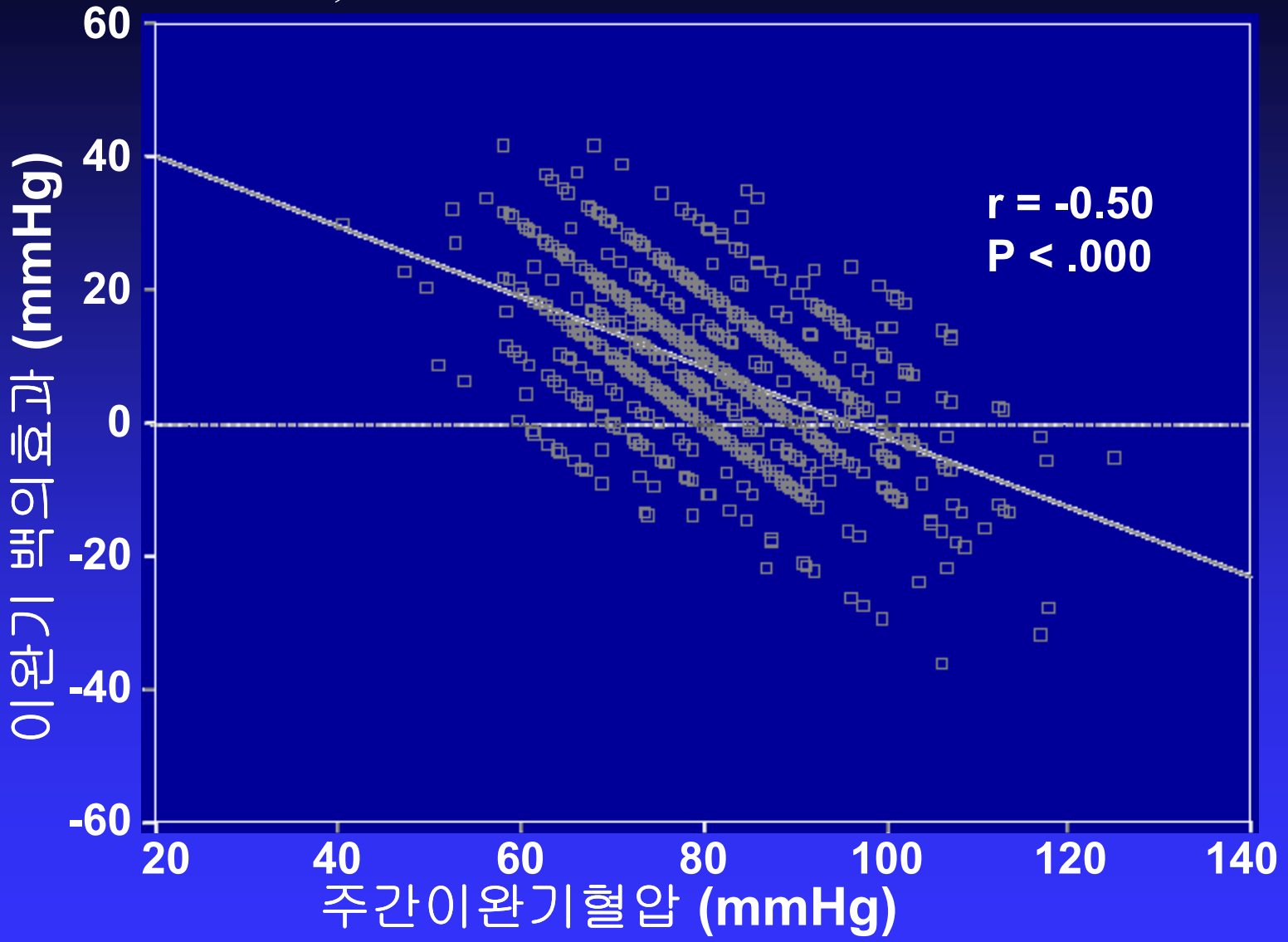
수축기 고혈압

J Hypertens1998;16:23



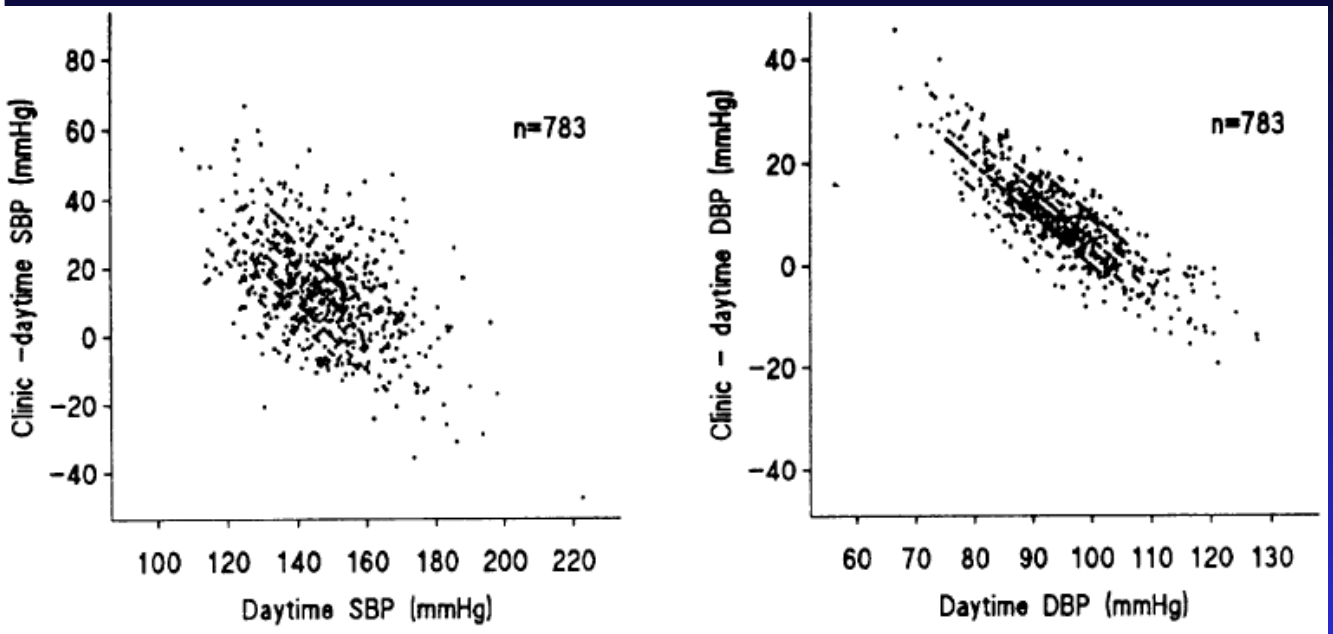
Blood Pressure Monitoring 2002;7:271

N=1581, 정상혈압 및 고혈압 환자

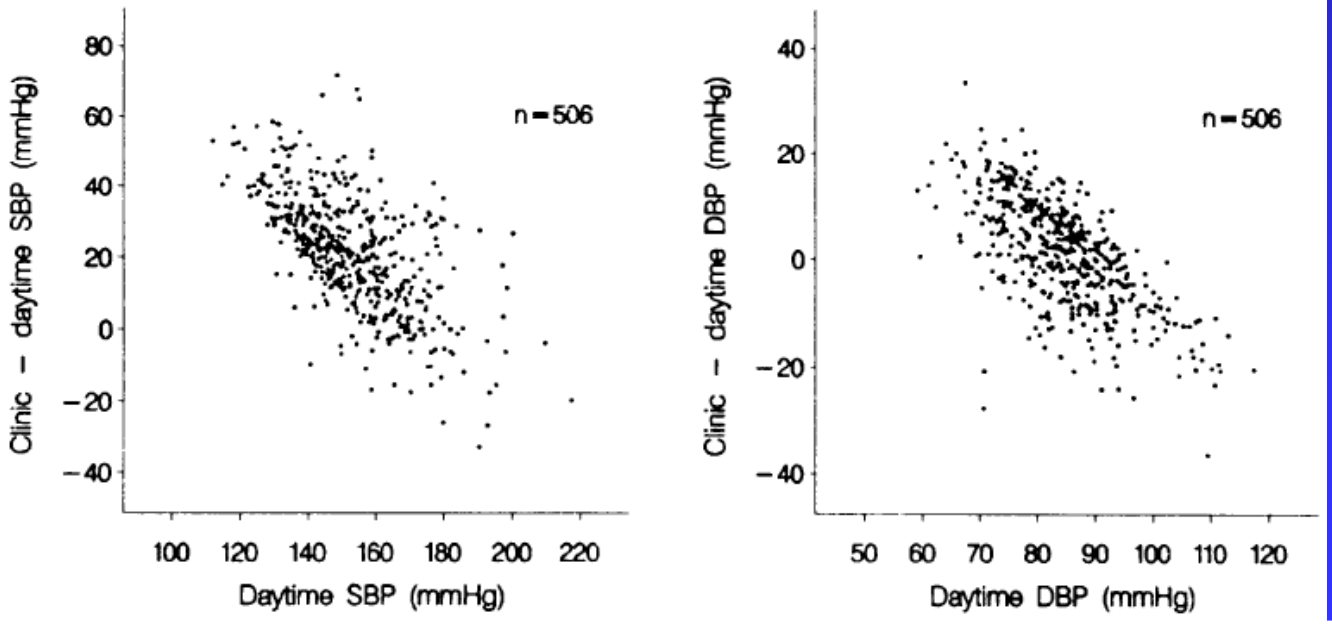


Blood Pressure Monitoring 2002;7:271

주간평균혈압과 백의효과

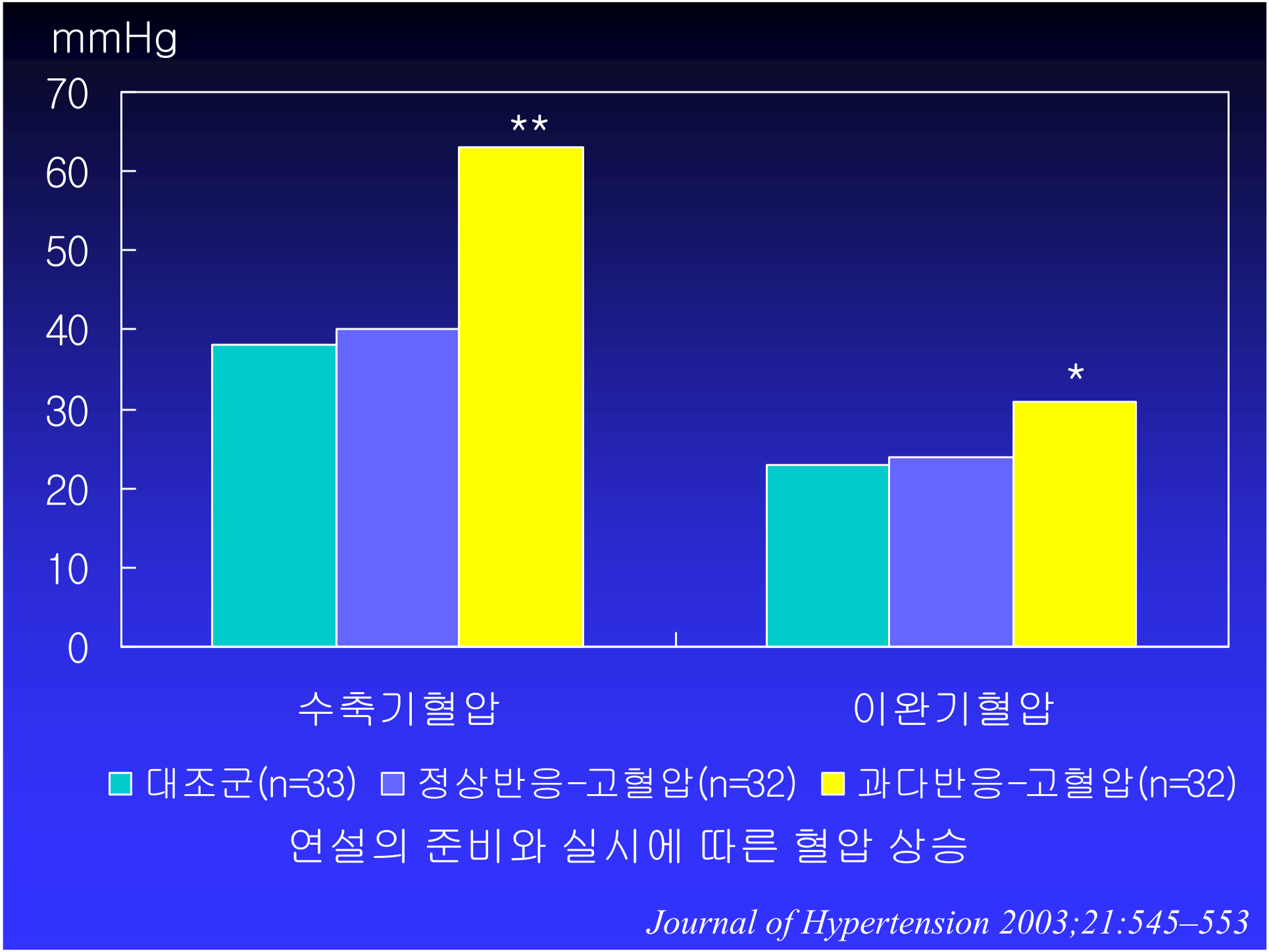


본태성 고혈압



수축기 고혈압

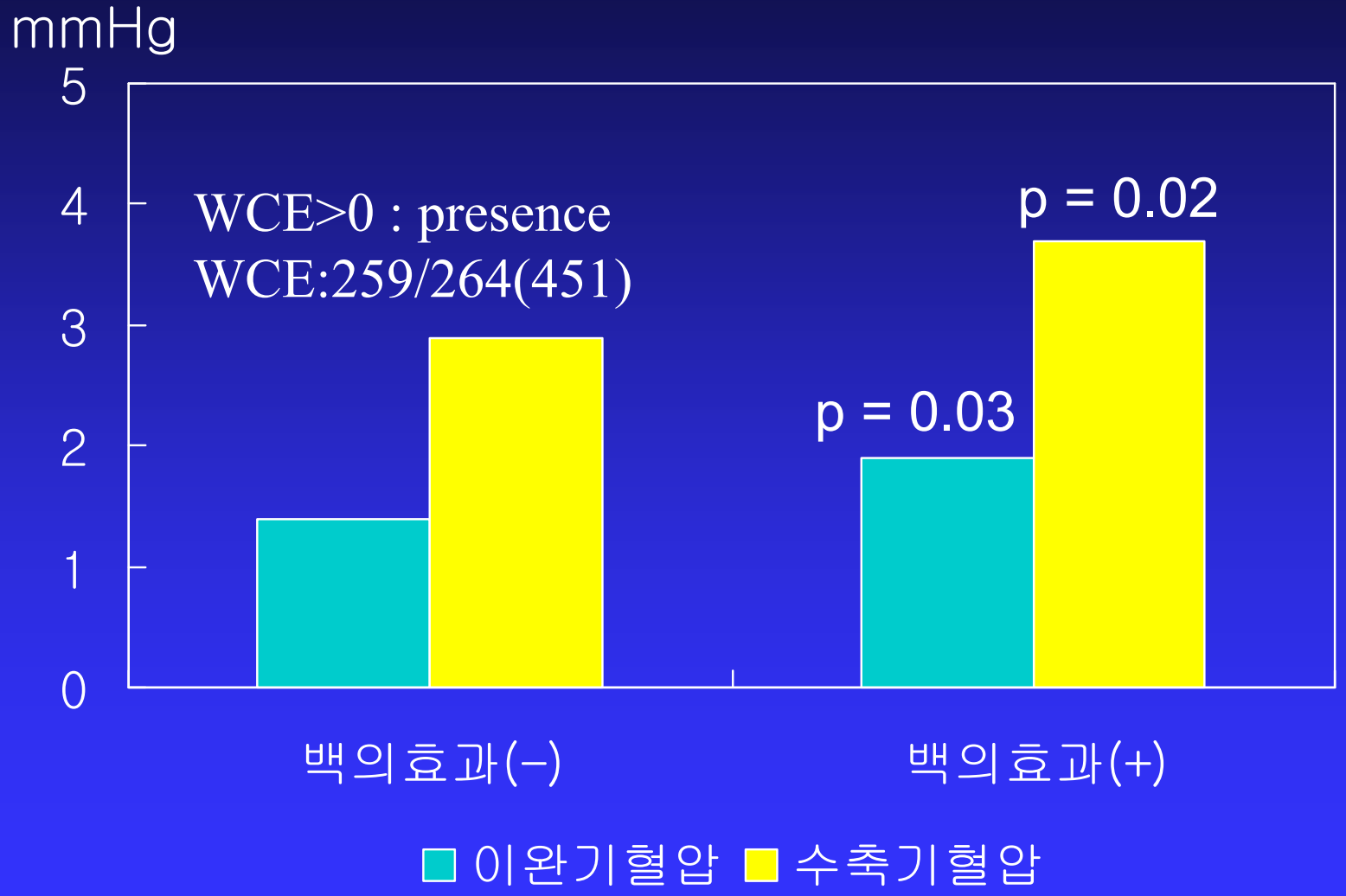
J Hypertens1998;16:23



연설의 준비와 실시에 따른 혈압 상승

Journal of Hypertension 2003;21:545–553

신체활동에 대한 반응과 백의효과



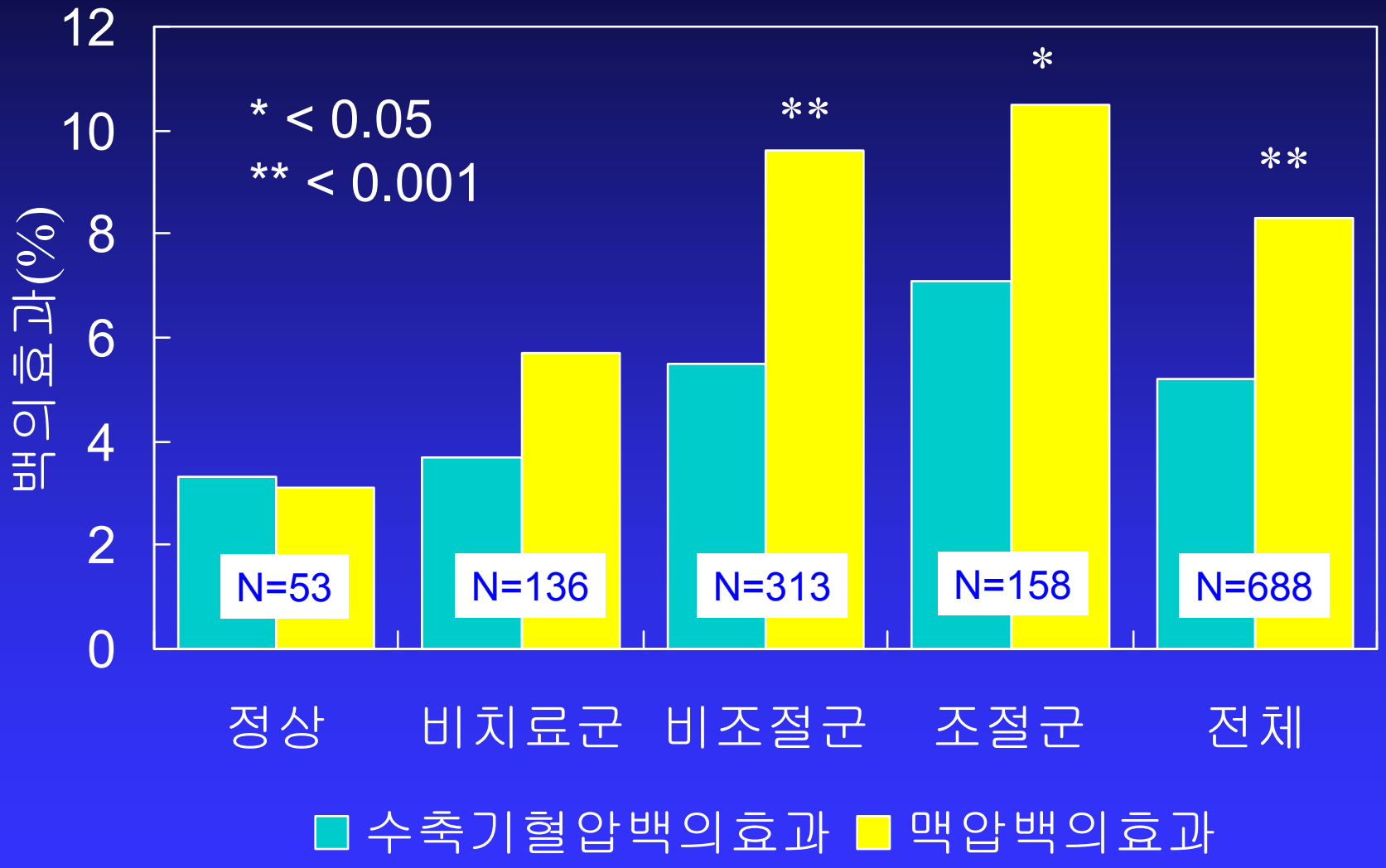
Blood Press Monit2002;7: 209

혈압의 변동성과 일상생활

활동	수축기혈압(mmHg)	이완기혈압(mmHg)
회의	+20.2	+15.0
작업	+16.0	+13.0
운반	+14.0	+9.2
도보	+12.0	+5.5
옷입기	+11.5	+9.5
합창	+10.7	+6.7
통화	+9.5	+7.2
식사	+8.8	+9.6
대화	+6.7	+6.7
사무	+5.9	+5.3
독서	+1.9	+2.2
제택근무	+1.6	+3.2
티비시청	+0.3	+1.1
이완휴식	0.0	0.0
수면	-10.0	-7.6

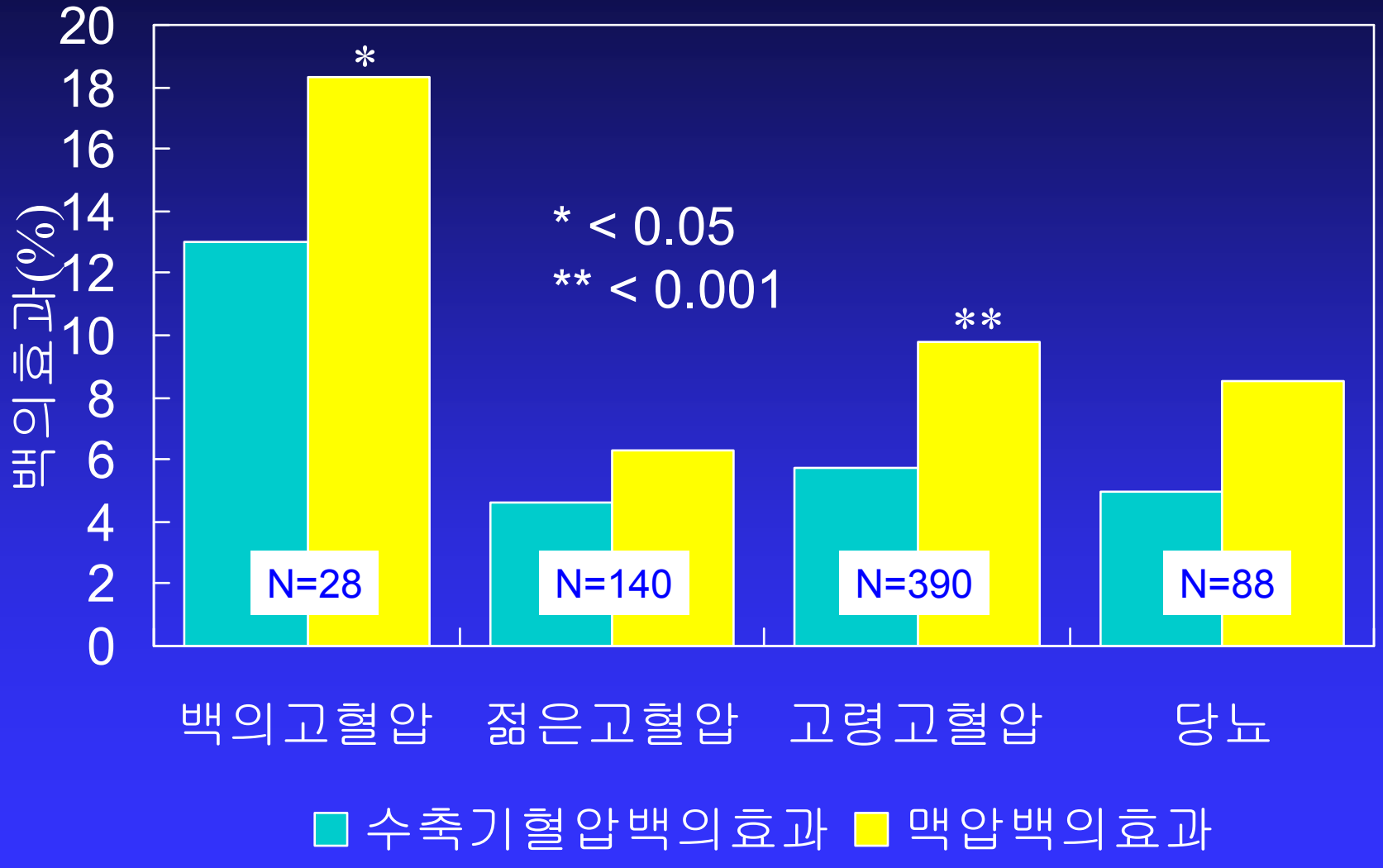
J Chronic Dis1987;40:671

맥압 백의효과

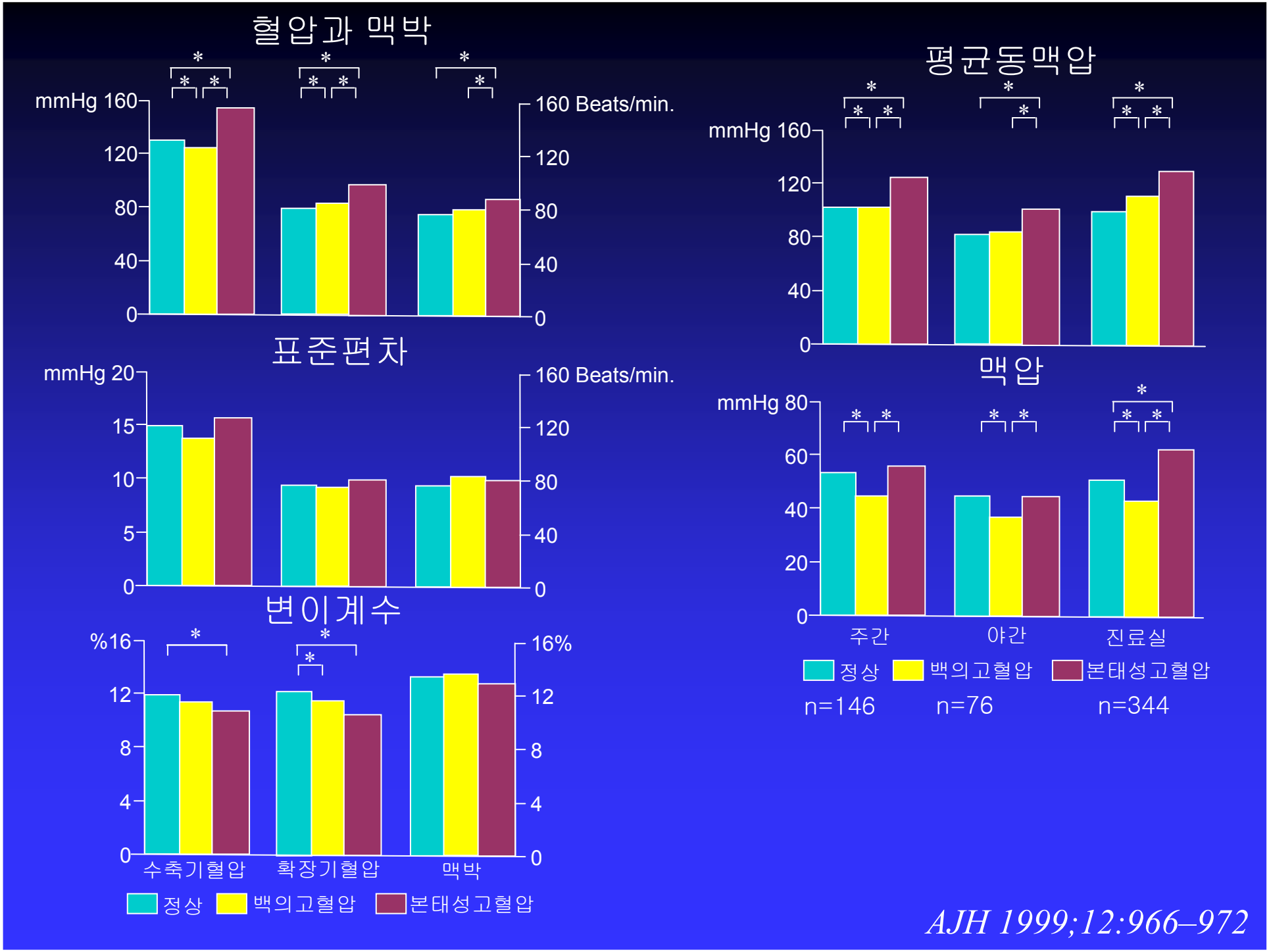


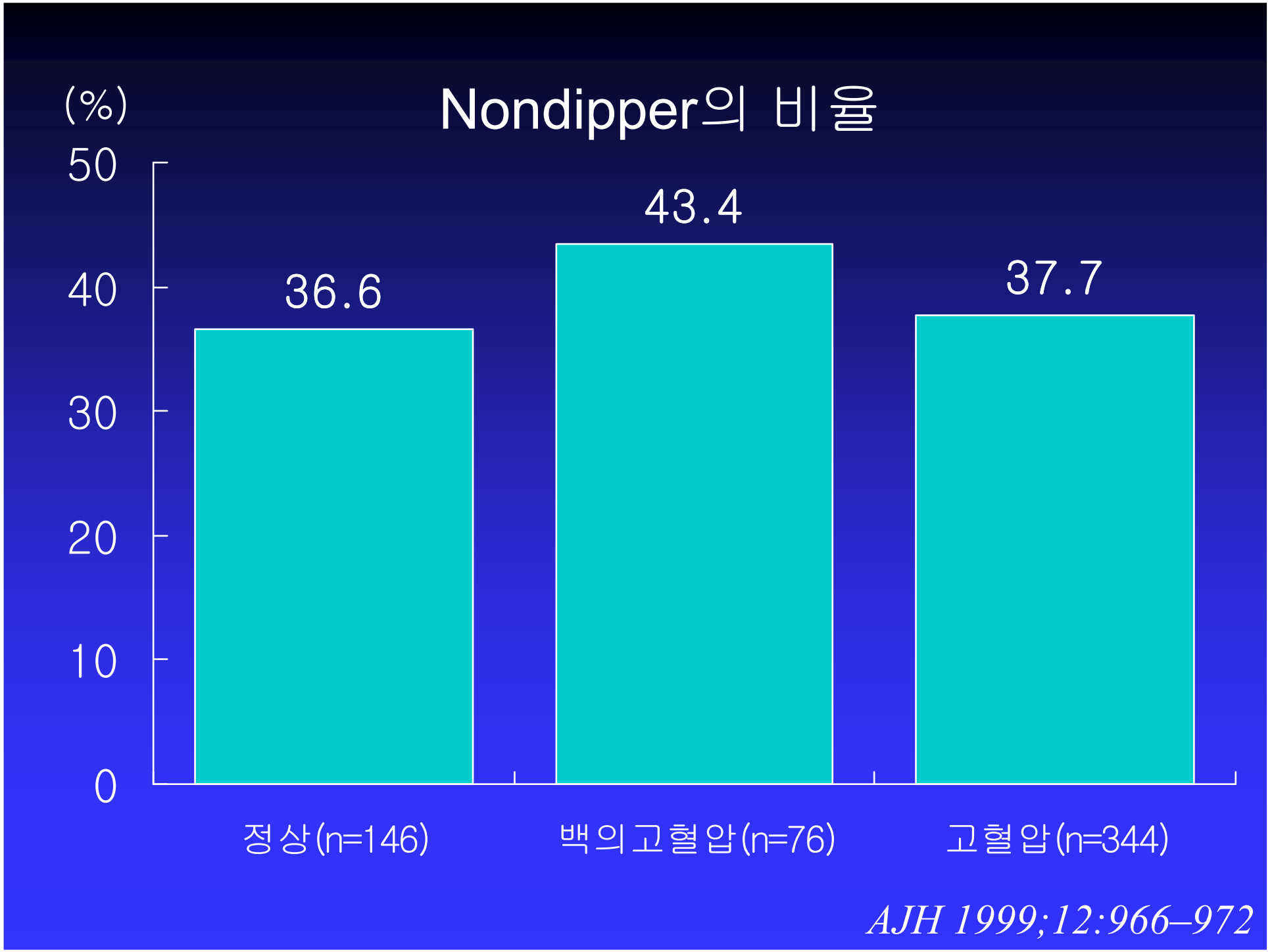
AJH 2004; 17:535–539

백의고혈압에서 맥압 백의효과



AJH 2004; 17:535–539


혈압과 맥박
mmHg 160
120
80
40
0
160 Beats/min.
120
80
40
0
표준편차
mmHg 20
15
10
5
0
160 Beats/min.
120
80
40
0
변이계수
%16
12
8
4
0
16%
12
8
4
0
수축기혈압
확장기혈압
맥박
정상
백의고혈압
본태성고혈압
평균동맥압
mmHg 160
120
80
40
0
맥압
mmHg 80
60
40
20
0
주간
야간
진료실
정상
백의고혈압
본태성고혈압
n=146
n=76
n=344
AJH 1999;12:966–972


Nondipper의 비율
(%)
50
40
30
20
10
0
36.6
43.4
37.7
정상(n=146)
백의고혈압(n=76)
고혈압(n=344)
AJH 1999;12:966–972

Means and correlations among anxiety, expectancy and white coat effect(n=226)

	Anxiety	Expectancy	Systolic WCE	Diastolic WCE
Anxiety	-	0.58**	0.29**	0.27**
Expectancy	0.58**	-	0.40**	0.26**
Systolic WCE	0.27**	0.39*	-	0.71**
Diastolic WCE	0.26**	0.26**	0.73**	-
Mean(SD)	20.0(22.6)	1.3(1.5)	1.1(14.6)	0.74(9.0)

Bivariate correlations are presented above the diagonal;
partial correlations adjusted for age and sex are presented below diagonal.**P<0.001

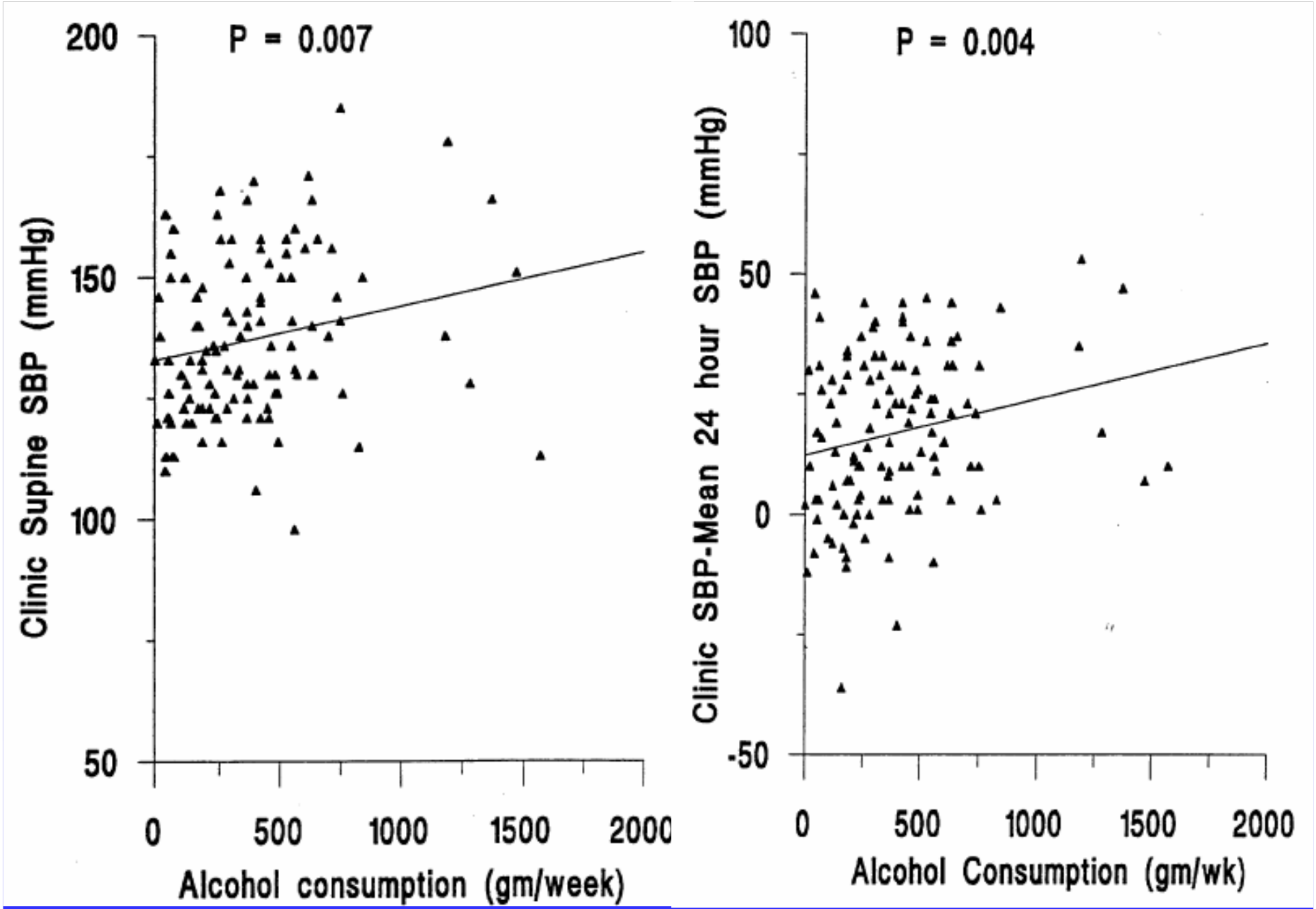
Pickering et al. Blood Pressure Monitoring2005;10:317

Regression models examining the effects of anxiety and expectancy on the systolic and diastolic white coat effect, controlling for age and sex(n=226)

	Systolic WCE		Diastolic WCE	
	B	P	B	P
Mean awake ABP	-0.184	0.005	-0.311	0.000
Age	0.334	0.000	0.031	0.625
Sex	-0.012	0.843	-0.064	0.326
Anxiety	0.085	0.236	0.196	0.010
Expectancy	0.352	0.000	0.188	0.014

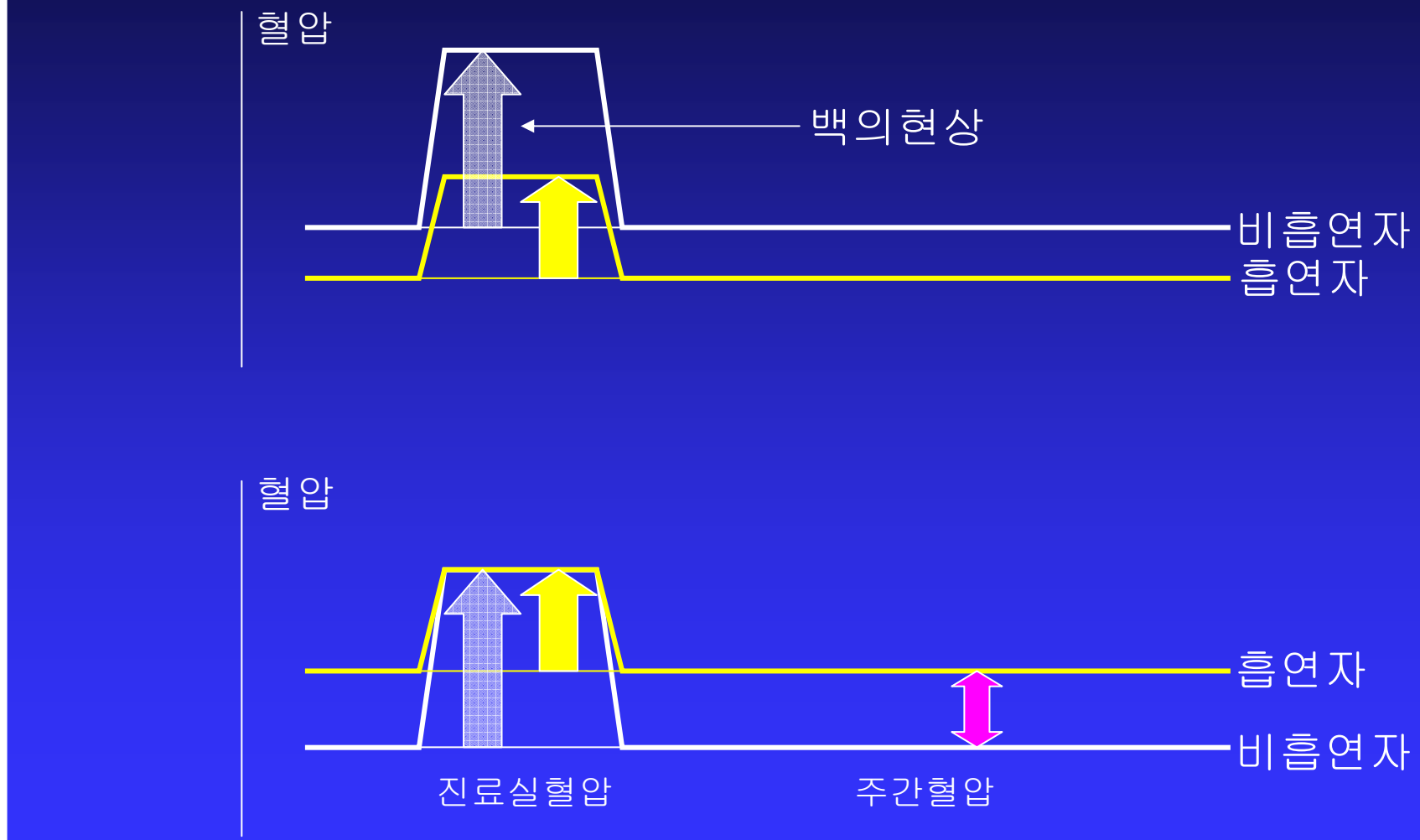
ABP, ambulatory blood pressuure

Pickering et al. Blood Pressure Monitoring2005;10:317



Am J Hypertens 2000;13:1135

흡연자에서 백의효과



AJH 1997;10:483

백의효과와 백의고혈압

- WCH is a measure of blood pressure level, whereas white coat effect is a measure of change (*Pickering TG 1996*)
- WCE by BP difference and WCH; no significant correlation

백의고혈압

정의(HTN1999;34:267)

1. Blood pressure ≥140/90 mmHg when measured in office at least three occasions
2. Normal daytime ambulatory pressure <135/85 mmHg(Normal daytime BP except first 1 hr recording)
3. Providing that a minimum difference of 20/10mmHg in manual BP(technically?)

백의고혈압의 유병율

- 10% of general population, 10-15% in referral clinic for ABPM(JAMA1988;259:225, Circ2001;104:1385)
- 20% in untreated HTN(JAMA1988;259:225, AJH1992;5:64, HTN1999;34:267, JH1993;11;1289, Lancet1996;348:1443)

Lancet1996;348:1444

백의고혈압

- 인위적인 구분에 불과
  - 정상주간혈압을 얼마로 정의하느냐에 따라서 유병율이 차이가 난다.
- 재현성?
  - 140/90mmHg 전후로 변동하는 경우
- 여성환자를 남성이 혈압 측정할 때
- 고령, 여성, 비흡연자(n=5716, BPM2004;9:307)

백의고혈압이 될 가능성

- Y = 3.4343 + 0.4603 x 성별(남=0, 여=1) + 0.5989 x 현재흡연(0=예, 1=아니오) - 0.0482 x 진료실 이완기혈압 - 0.0312 x 좌심실질량지수[g/ht($m^{2.7}$)]
- Y = 2.6438 + 0.5128 x 성별 + 0.4543 x 진료실 이완기혈압
- 백의고혈압확률 = Exp(Y)/[1+Exp(Y)]
  - N=1564
  - WCH = 10.4%

Verdecchia P et al. J Hypertens 2001;19:1015

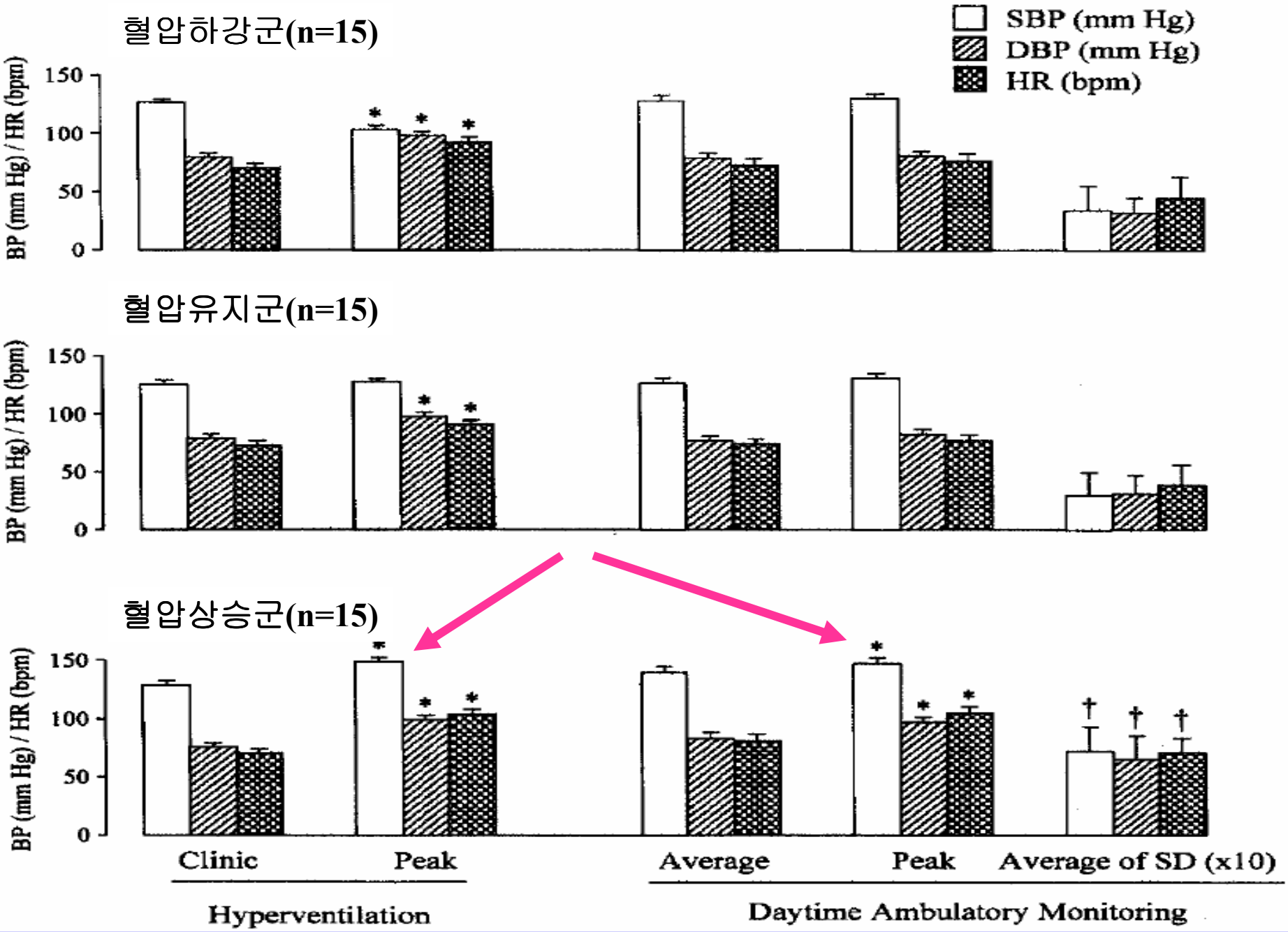
Deep-Breath Test Responses in Patients with and without White-Coat Effect

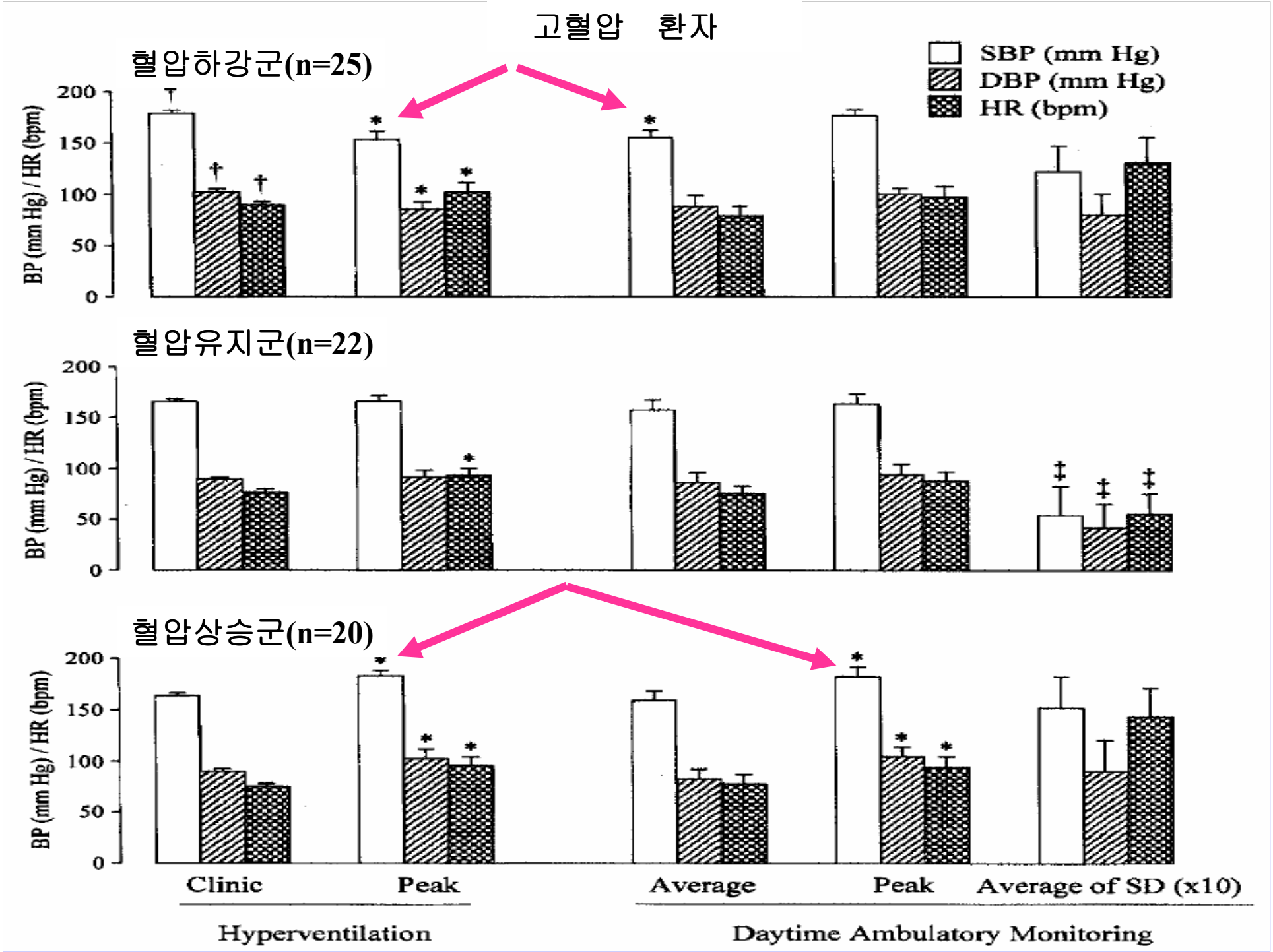
	White Coat Effect		
	Present (n=45)	Absent (n=28)	P
Systolic BP(mmHg)↓	17.8±10.6	10.9±8.1	.005
Diastolic BP(mmHg)↓	6.6±6.9	5.4±5.2	NS

WCE > 10% difference of CBP

J Am Board Fam Pract 2004;17:184

정상 성인


혈압하강군(n=15)
혈압유지군(n=15)
혈압상승군(n=15)
SBP (mm Hg)
DBP (mm Hg)
HR (bpm)
BP (mm Hg) / HR (bpm)
150
100
50
0
Clinic
Peak
Average
Peak
Average of SD (x10)
Hyperventilation
Daytime Ambulatory Monitoring


고혈압 환자
혈압하강군(n=25)
혈압유지군(n=22)
혈압상승군(n=20)
SBP (mm Hg)
DBP (mm Hg)
HR (bpm)
BP (mm Hg) / HR (bpm)
200
150
100
50
0
Clinic
Peak
Average
Peak
Average of SD (x10)
Hyperventilation
Daytime Ambulatory Monitoring

Deep-Breath Test Operating Characteristics for SBP Drop

Cutoff value	Sensitivity	Specificity	Likelihood Ratio	
			Positive	Negative
>5mmHg	86.7	17.9	1.05	0.7
>10mmHg	80.8	35.7	1.2	0.6
>15mmHg	60.0	71.4	2.3	0.6
>20mmHg	51.1	85.7	3.6	0.6
>25mmHg	28.9	96.4	8.1	0.7

J Am Board Fam Pract 2004;17:184

백의효과에 영향을 미치는 인자

- 대부분 생리학적 동반 현상, 단순관련요인
- 백의효과 증가
  - 기대심리, 불안감
  - 음주
- 백의효과 감소
  - 흡연, 심호흡
- 백의고혈압: 여성, 고령
- 진료실혈압 상승 인자 : 과대평가
- 주간혈압 상승 인자: 과소평가

Does Evidence-Based Medicine Suggest That Physicians Should Not Be Measuring Blood Pressure in the Hypertensive Patient?

John W. Graves and Sheldon G. Sheps

- It is clear from evidence trails that current practice of BP measurement is inadequate.
- Thus, the question is
  - not whether physicians should or should not measure BP in the hypertensive patients;
  - rather, it is how are we to replace the physician measurement with a higher quality BP determination.

Am J Hypertens 2004;17:354–360

감사합니다