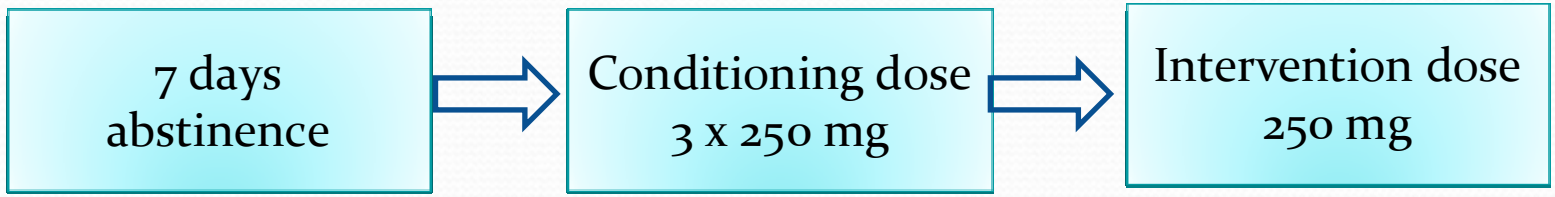
HABITUAL COFFEE AND TEA DRINKERS EXPERIENCED INCREASES IN BLOOD PRESSURE AFTER CONSUMING LOW TO MODERATE DOSES OF CAFFEINE

Michael K. McMullen, Julie M. Whitehouse, Gillian Shine, Anthony Towell

University of Westminster, London, UK.

Caffeine tolerance

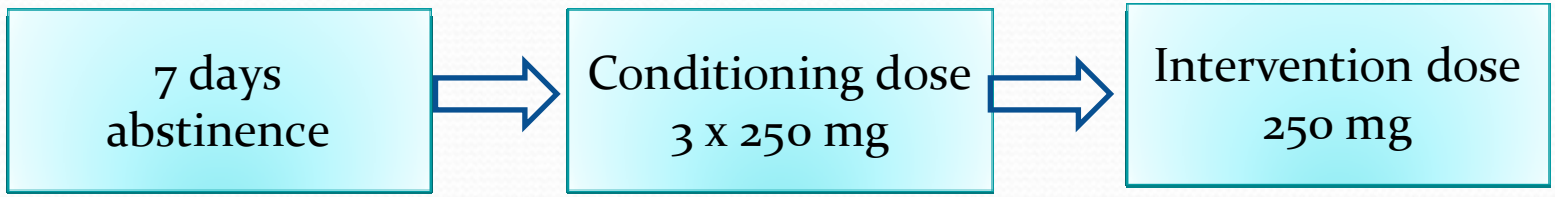
- Caffeine has a vasopressor effect (constricts blood vessels).
- Caffeine increases blood pressure in the period 30 to 90 minutes after intake when plasma levels are elevated.
- Robertson and co-workers (1978, 1981, 1984, 1990) demonstrated the development of caffeine tolerance (i.e. no pressor effect) after several days of caffeine intake in abstaining individuals.
- Their research model involved:



Caffeine tolerance

- Can this research model be applied to coffee and tea drinkers outside of the laboratory?
- Two questions:

1. Does the conditioning dose represent normal daily consumption patterns?
2. Does the intervention dose represent a normal serving of coffee or tea?



Caffeine usage worldwide

- Average adult caffeine intake is approximately 250 mg/d which is only **33% of the conditioning dose of 750 mg/d**.

Country	Average daily adult intake	Coffee	Black tea	Green & Oolong tea	Maté tea	Carbonated beverages
Argentina (Olmos et. al. 2009)	288 mg	36%	7%	na	51%	7%
Japan (Yamada et. al. 2010)	247 mg	47%	4%	47%	na	1%
United Kingdom (Heatherley et. al. 2006)	245 mg	44%	49%	na	na	na
United States (Frary et. al. 2005)	238 mg	71%	12%	na	na	16%

na = not available

Caffeine content per serving

- Coffee: 50 to 100 mg & teas 20 to 50 mg
- **20 – 40% and 10 – 20% intervention dose of 250**

Country	coffee	black tea	green & oolong tea	mate
Argentina: 200 mL (Olmos et. al. 2009)	**70[1] / 72[2]** (36-120)	**19[3] / 41[4]** (16-68)	na	**22[3] / 56[4]** (24-79)
Japan: 100 mL (Yamada et. al. 2010)	**70[2]** (45-92)	**28[4]** (15-49)	**50[4]** (7-99)	na
United Kingdom: serving (Food Standards Agency 2004)	**54[1] / 105[2]** (15-254)	**30** (1-90)	na	na
United States 150 ml (Barone & Roberts 1995)	**60[1] / 85[2]** (29-176)	**30** (8-91)	na	na

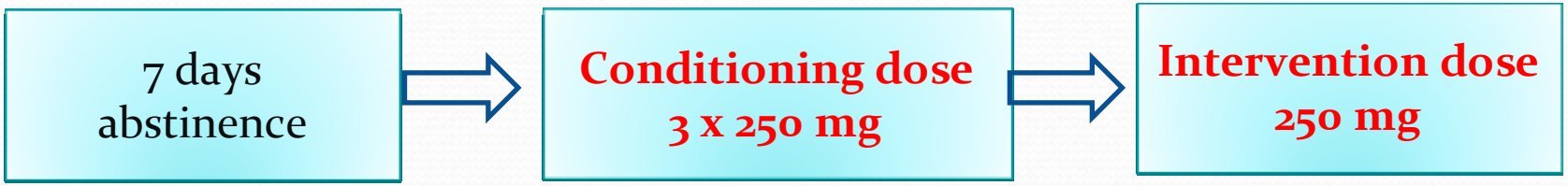
[1] instant, [2] brewed, [3] bag, [4] loose

Caffeine tolerance

- Two questions:

1. Does the conditioning dose represent normal daily consumption patterns? **NO**
2. Does the intervention dose represent a normal serving of coffee or tea? **NO**

- Can this research model be applied to coffee and tea drinkers outside of the laboratory? **NO**



Caffeine research on blood pressure

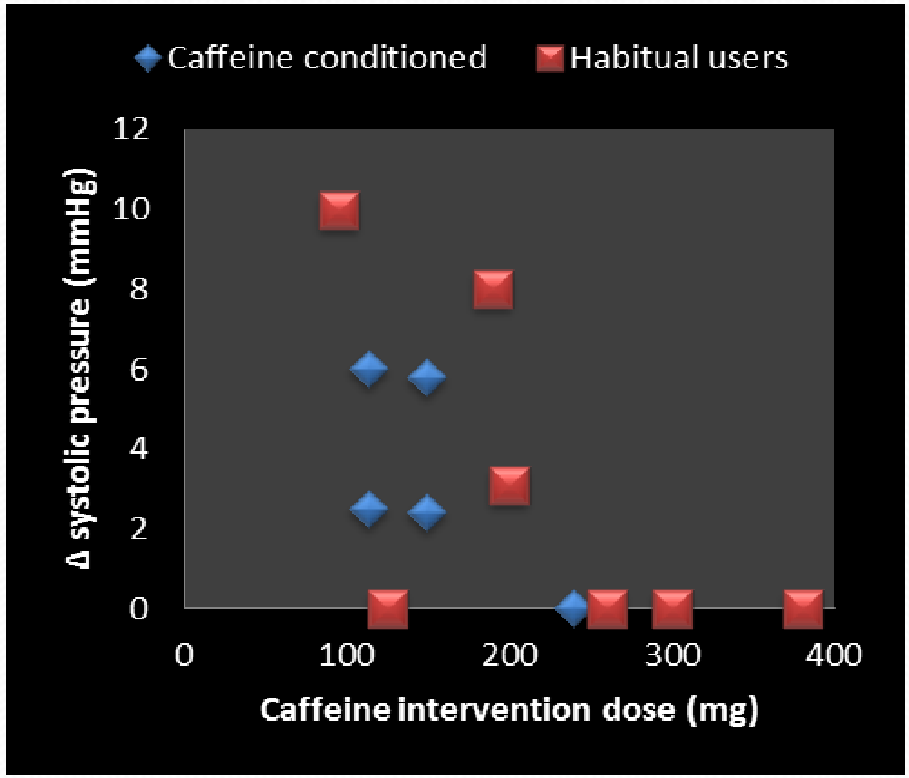
- Intervention ≤ 200 mg

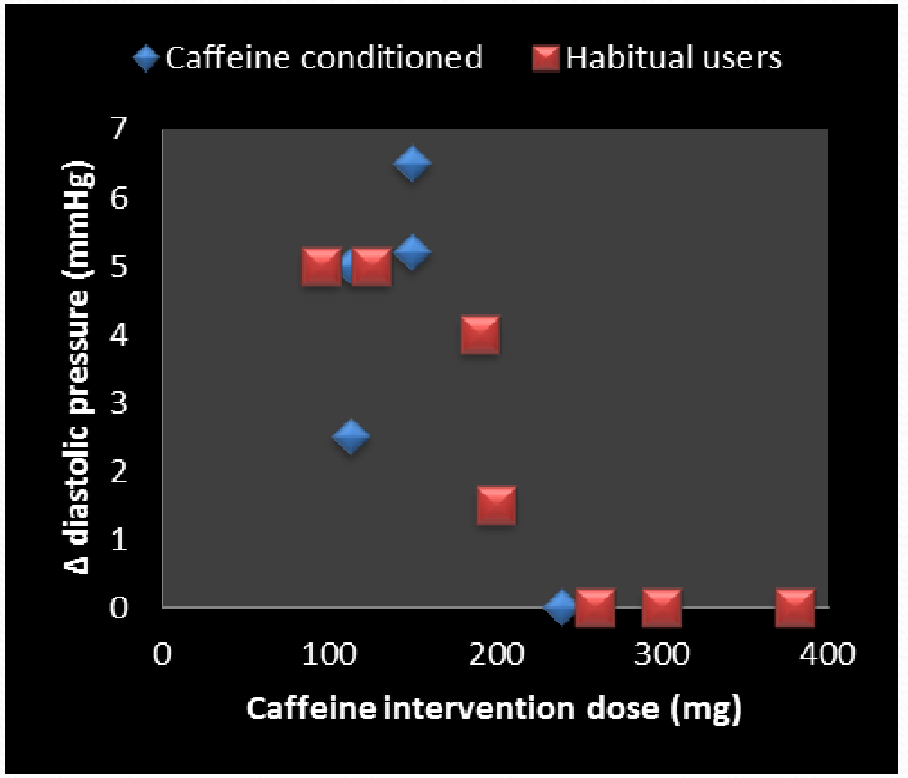
95 mg Hasenfrantz 1994
114 mg James 1994a
114 mg James 1994b
125x2 mg Lane 1989
150 mg Goldstein 1990
190 mg Hasenfrantz 1994
200 mg Schutte 2003
200 mg Watson 2002

- Intervention ≥ 250 mg

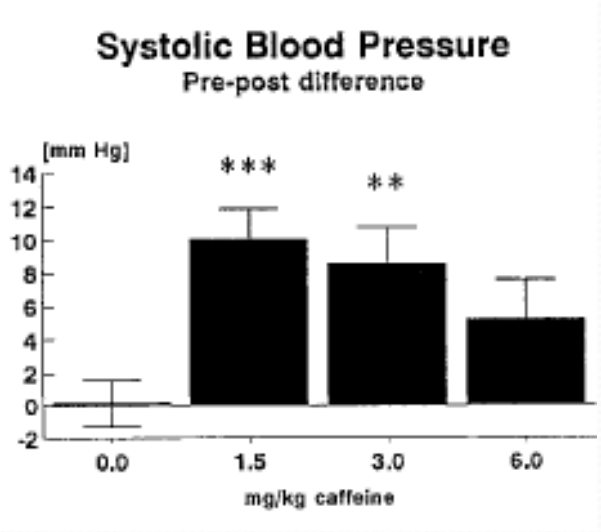
250 mg Robertson 1978
250 mg Robertson 1981
250 mg Mosqueda-Garcia 1990
250 mg Haugh 1993
250 mg Debrah 1995
250x2 mg Lovallo 2004
250 mg Barry 2005
250 mg Barry 2008
300 mg Waring 2003
380 mg Hasenfrantz 1994

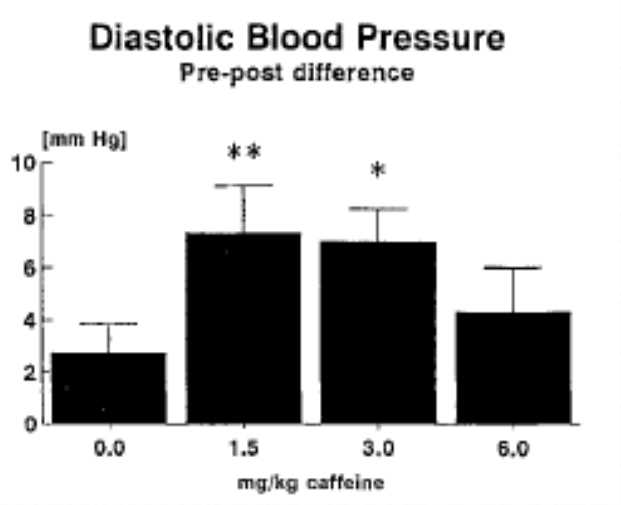
Δ BP following caffeine intake V's caffeine intervention dosage





Hasenfrantz et.al.1994: caffeine interventions of 95, 190 and 380 mg





* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

- This study has been cited 41 times while Robertson et. al. (1978) has been cited 545 times and Robertson et. al. (1981) 352 times.

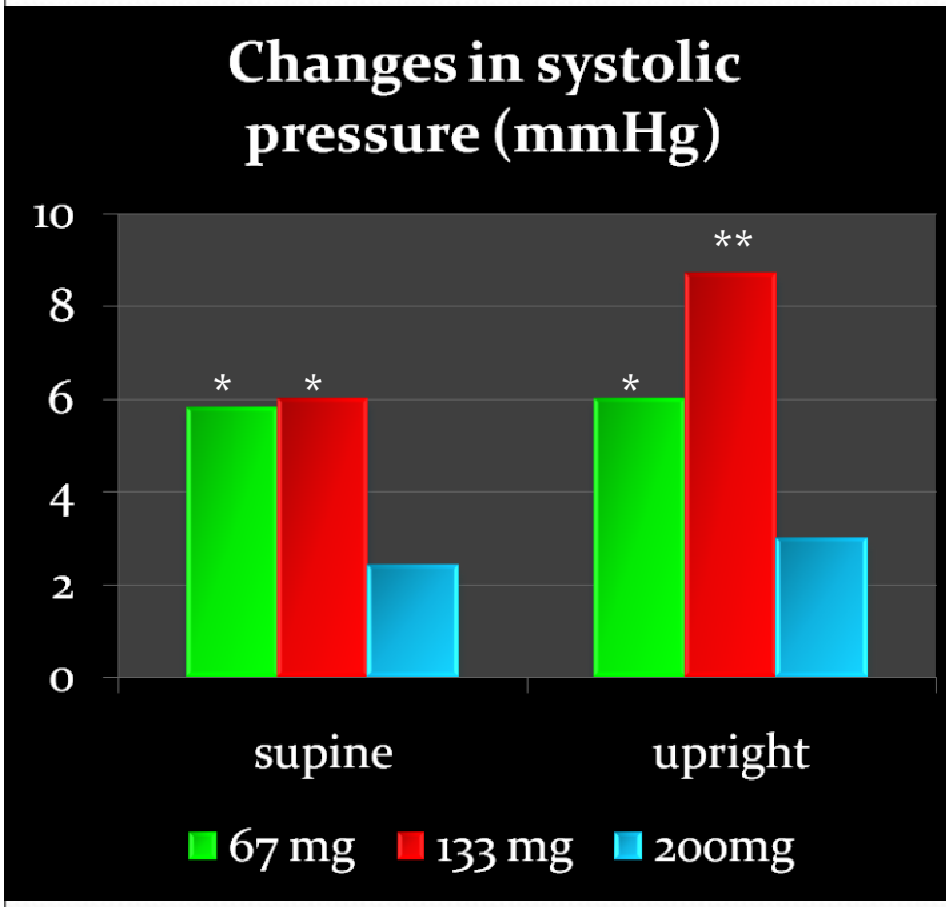
Our caffeine interventions: 67, 133 and 200 mg (1, 2, 3 mg/kg)

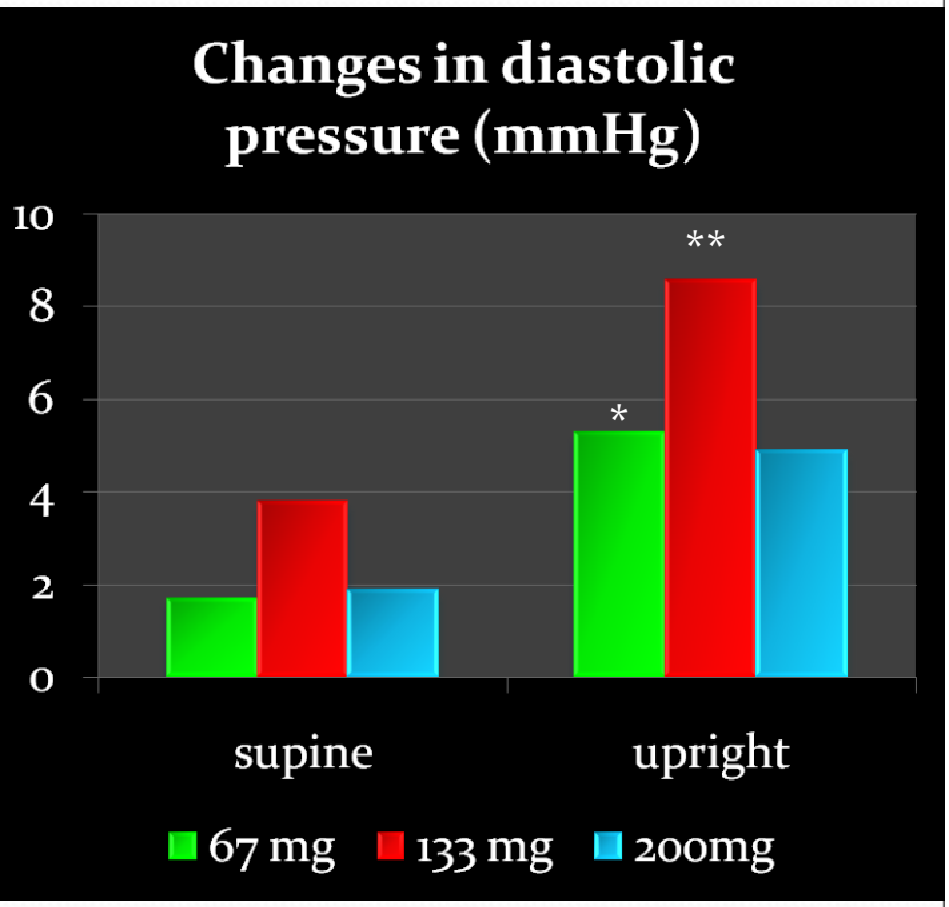
- In a group of habitual caffeine users following their preferred consumption regimen and without caffeine abstinence.
- Post-ingestion measures at 30 and 60 minutes were averaged.

		Supine Posture		Upright Posture	
Parameter	**Caffeine**	**Pre-ingestion**	**Post-ingestion**	**Pre-ingestion**	**Post-ingestion**
SP	placebo	116.2 ± 11.7	119.3 ± 6.8	133.5 ± 14.1	131.5 ± 11.8
(mmHg)	67 mg	115.2 ± 10.4	**124.1 ± 9.4***	127.6 ± 9.1	**135.6 ± 10.1***
	133 mg	115.3 ± 10.3	**124.4 ± 8.5***	126.9 ± 11.1	**137.6 ± 14.1****
	200 mg	120.6 ± 12.1	126.1 ± 9.8	127.5 ± 10.2	132.7 ± 10.7
DP	placebo	68.1 ± 6.6	67.5 ± 6.8	86.4 ± 8.7	82.9 ± 8.4
(mmHg)	67 mg	67.0 ± 5.3	68.1 ± 6.6	81.9 ± 6.7	**84.7 ± 6.0***
	133 mg	66.7 ± 5.8	69.9 ± 4.5	81.4 ± 7.7	**86.5 ± 8.2****
	200mg	69.8 ± 6.4	71.1 ± 3.7	81.1 ± 5.5	83.5 ± 8.2

* $p < 0.05$, ** $p < 0.01$

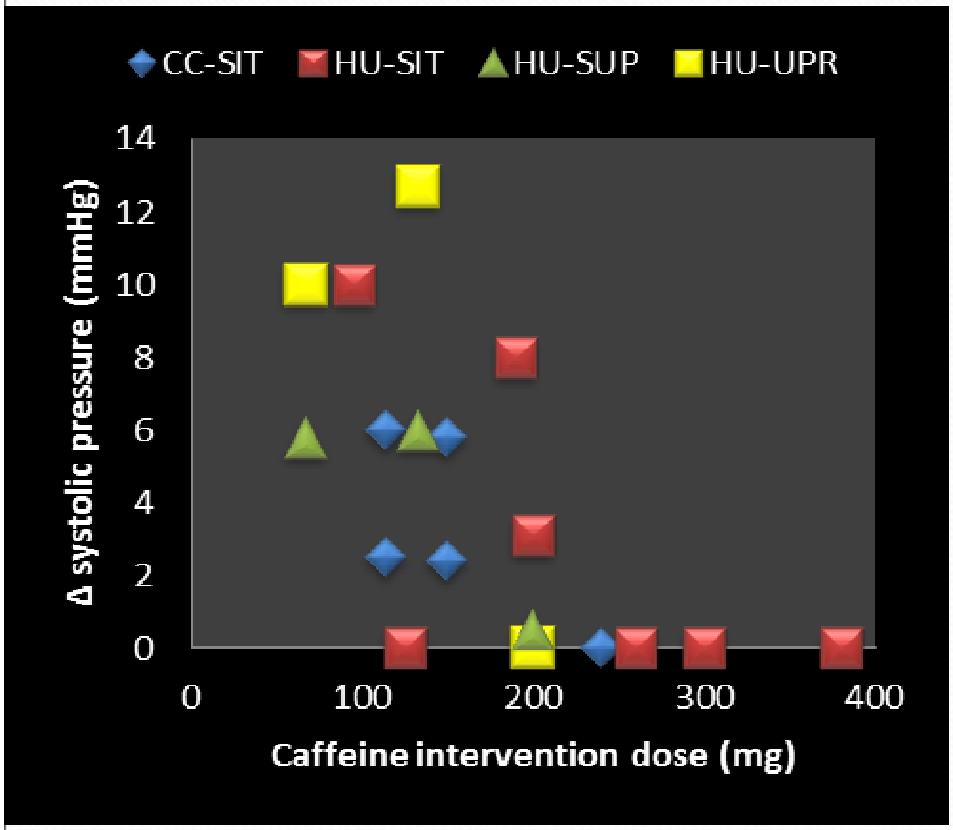
Caffeine interventions of 67 and 133 mg increased blood pressure but not the 200 mg intervention

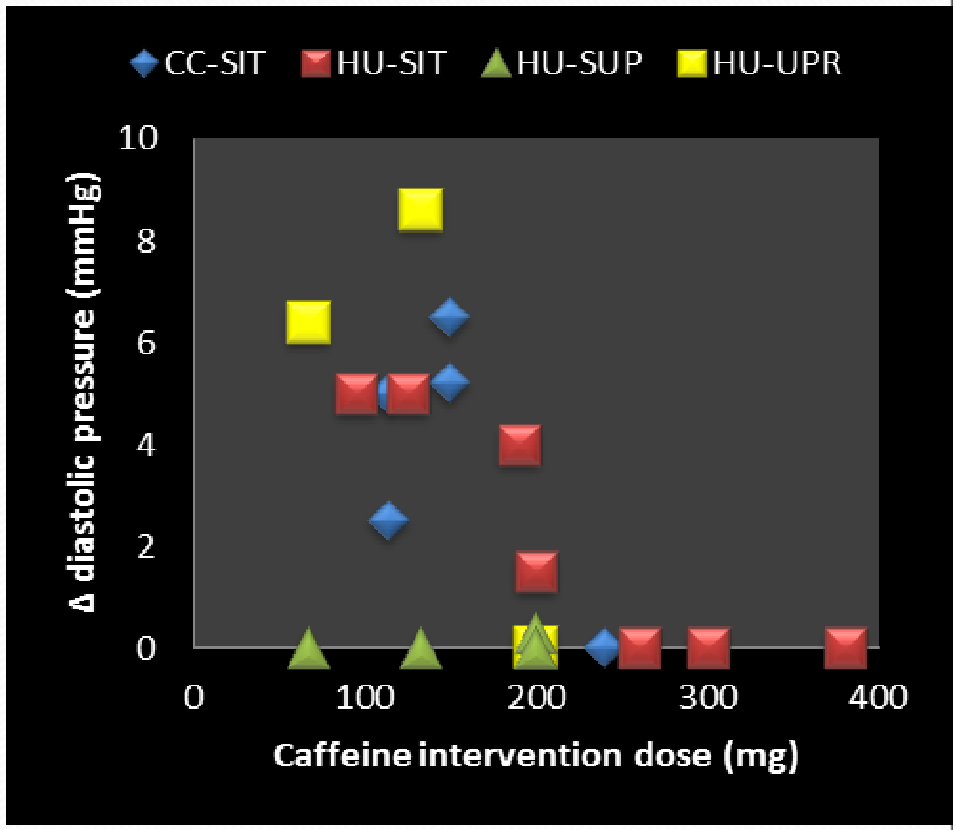




* $p < 0.05$ ** $p < 0.01$

The present study supports the finding of previous studies





Implications

1. Are caffeinated beverages are health risk?

   This study does not address this question because we tested caffeine.

2. Is long-term caffeine consumption a health risk?

   This study does not address this question because we tested short-term and not long-term caffeine use.

3. <u>Does this study tell us anything?</u>

   Yes, everyday drinkers of coffee and tea can be expected to experience blood pressure increases following the intake of preparations containing caffeine. **Caffeine tolerance is not evident outside of the laboratory.**

Implications

4. Do the current results have clinical significance?

   Yes. **Blood pressure readings** can be expected to be increased following ingestion of caffeine. These increases are likely to be larger amongst hypertensives than normotensives. The ingestion of caffeine in medications, such as painkillers prior to a medical consultation, is likely to lead to misdiagnosis and incorrect medication.

Implications

4. Do the current results have clinical significance?

   Yes. **Blood pressure readings** can be expected to be increased following ingestion of caffeine. These increases are likely to be larger amongst hypertensives than normotensives. The ingestion of caffeine in medications, such as painkillers prior to a medical consultation, is likely to lead to misdiagnosis and incorrect medication.

5. **How can misdiagnosis be avoided?**

   Testing blood pressure in a fasting state i.e. in a similar manner to cholesterol and blood sugar testing.

Thankyou

- To the participants in my study
- To my co-workers
- To the librarians

at the University of Westminster

London UK

- and you, for your attention.

Intervention dose[1]	Conditioning dose per day	Blood pressure	Degree of olerance[2]	Study
95 mg / 1.5 mg/kg	Habitual use 3 to 16 cups coffee	≈10/5 mmHg	No tolerance*	(Hasenfratz and Battig 1994)
114 mg / 1.75 mg/kg	3 x 1.75 mg/kg	6/5 mmHg	No tolerance	(James 1994a)
114 mg / 1.75 mg/kg	3 x 1.75 mg/kg	2.5/2.5 mmHg	Partial tolerance	(James 1994b)
125mg / 1.9 mg/mg 2nd125mg / 1.9 mg/mg	Habitual use: 200 to 600 mg	Not measured 0/5 mmHg	- Partial tolerance	(Lane and Manus 1989)
150 mg / 2.3 mg/kg 2nd 150 mg / 2.3 mg/kg	3 x 150 mg	5.8/6.5 mmHg 2.4/5.2 mmHg	No tolerance Partial tolerance	(Goldstein, Shapiro et al. 1990)
190 mg / 3 mg/kg	Habitual use- 3 to 16 cups coffee	≈ 8/4 mmHg	Partial tolerance*	(Hasenfratz and Battig 1994)
200 mg / 2.4 mg/kg	Habitual use: <300 mg	3.1/1.5 mmHg	Partial tolerance*	(Schutte 2003)
200 mg / 3.1 mg/kg	2 x 200 mg	SP AUC p < 0.04, DP 0	Partial tolerance	(Watson, Deary et al. 2002)
250 mg / 3.8 mg/kg	Habitual use: 116 ± 81 mg	15.2/15.2 mmHg	No tolerance	(Chamnan, et al. 2010)
2x250 mg / 7.6 mg/kg Average change after two interventions	LT: 300 mg LT: 2 x 300 mg HT: 300 mg HT: 2 x 300 mg	2.5/2.5 mmHg 3.5/4.0 mmHg 0/0.8 mmHg -1/-1 mmHg	Partial tolerance Partial tolerance Partial tolerance Complete tolerance	(Lovallo, Wilson et al. 2004)
250 mg / 3.8 mg/kg	3 x 250 mg	No change	Complete tolerance	(Robertson, Wade et al. 1981)
250 mg / 3.8 mg/kg	Habitual use 258 to 923 mg	No change	Complete tolerance	(Haigh, Harper et al. 1993)
250 mg / 3.8 mg/kg	250 mg	No change	Complete tolerance	(Debrah, Haigh et al. 1995)
250 mg / 3.8 mg/kg	Habitual use 2 to 4 cups of tea/coffee	No change	Complete tolerance*	(Barry, Rushby et al. 2005)
250 mg / 3.8 mg/kg	Habitual use 2 to 4 cups of tea/coffee	No change	Complete tolerance*	(Barry, Clarke et al. 2008)
300mg / 4.2 mg/kg	Habitual use: 180 to 360 mg in tea/coffee	No change	Complete tolerance	(Waring, Goudsmit et al. 2003)
380 mg / 6 mg/kg	Habitual use 3 to 16 cups coffee	No change	Complete tolerance*	(Hasenfratz and Battig 1994)