Socioeconomic status modifies the seasonal effect on blood pressure: findings from a national panel study

Supplementary Data 1: Statistical analyses and further results

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1. Additional descriptive statistics

Additional Table 1 shows the characteristics of the sample at wave 2 and wave 3. Additional Table 2 shows the distribution of subjects by month of data measurement, separately for each wave.

Additional Table 1: Sample descriptive statistics at wave 2 and wave 3

	Wave 2			Wave 3		
Variable	**N**	**Median / percent.**	**Frequency / IQR**	**N**	**Median / percent.**	**Frequency / IQR**
Age [years]	11439	37	[24 ; 52]	11439	39	[26 ; 54]
Completed education	11438			11428		
None		13.42%	1535		13.37%	1528
Primary		23.12%	2644		22.71%	2595
Secondary		53.94%	6170		50.91%	5818
Tertiary		9.52%	1089		13.01%	1487
Place of residence	11379			11415		
Urban formal		39.08%	4447		40.40%	4612
Urban informal		6.47%	736		6.96%	794
Rural formal		10.31%	1173		10.26%	1171
Tribal area		44.14%	5023		42.38%	4838
Household monthly income per capita [ZAR]	11426	575	[308 ; 1200]		785	[437 ; 1600]
Current smoking	10400	15.81%	1644	10133	18.23%	1847
Body Mass Index	9324			9879		
Underweight		4.86%	453		2.75%	272
Normal weight		40.80%	3804		40.95%	4045
Overweight		24.96%	2327		26.97%	2664
Obese		29.39%	2740		29.33%	2898
Systolic BP [mm Hg]	9268	122.5	[111.5 ; 137.0]	9940	123.0	[111.0 ; 137.5]
Diastolic BP [mm Hg]	9946	81.5	[73.5 ; 90.5]	9946	81.5	[73.5 ; 90.5]
BP classification*	8114			8154		
Normal		36.33%	2948		38.05%	3103
Pre-hypertension		37.45%	3039		37.55%	2917
Stage I hypertension		16.77%	1361		16.15%	1317
Stage I hypertension		9.44%	766		10.02%	817
Antihypertensive treatment	11224	11.56%	1297	11230	16.43%	1845

N = number of non-missing values; IQR= interquartile range; Hg = mercury; ZAR = South African Rands.

* According to the Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (Chobanian, AV et al. Hypertension, 2003;42(6): 1206–1252.), excluding subjects in treatment.

Additional Table 2: Distribution of subjects by month of data collection

	Wave 1 (2008)	Wave 1 (2010)	Wave 1 (2012)
Month	**N**	**N**	**N**
January	10	548	-
February	1333	321	-
March	3051	193	-
April	2795	89	477
May	1022	125	1629
June	2443	667	1685
July	34	1352	1660
August	16	2522	1986
September	263	2603	1802
October	317	2214	1835
November	134	673	342
December	22	133	24
Total	**11440**	**11440**	**11440**

N = Number of subjects

2. Notes on statistical analyses

Model Estimation: A full-information maximum likelihood estimator (MLR) was used to estimate models coefficients. The complex sampling scheme of the NIDS survey was taken into account through weighting of the likelihood function and using of a sandwich estimator.[2] Standard errors and confidence intervals of the combination of model coefficients representing age-specific and population averaged seasonal effects were calculated using the delta method.

Model Fit: Model fit was assessed using multiple indices, as per common practice in the literature.[3] Additional Table 3 shows the values of these indices for the various models estimated in the whole sample and within each subpopulation defined by different levels of education, tertile of household monthly income per capita and (limited to the urban dwellers) residence in informal vs. formal settlements. Column 2 in the table shows the actual sample size (i.e. the total number of measurements, varying from 1 to 3 for each subject) used for the estimation in each subsample.

Additional Table 3: Fit indices for the structural equation models

	Sub population	Sample Size	χ2	χ2/df	RMSEA	CFI	TLI	SRMR
Women	**Whole sample**	19046	56.48 df=43, p=0.08	1.31	0.004	1.000	1.000	0.001
	No education	2765	39.47 df=43, p=0.63	0.92	<0.001	1.000	1.000	0.002
	Primary education	5816	29.69 df=43, p=0.06	0.69	<0.001	1.000	1.000	0.002
	Secondary/Tertiary education	10453	58.11 df=43, p=0.63	1.35	0.006	1.000	0.999	0.001
	Income tertile I	6076	40.05 df=43, p=0.60	0.93	<0.001	1.000	1.000	0.001
	Income tertile II	6488	33.19 df=43, p=0.86	0.77	<0.001	1.000	1.000	0.001
	Income tertile IIII	6482	35.32 df=43, p=0.79	0.82	0.000	1.000	1.000	0.001
	Informal settlement	9881	46.74 df=43, p=0.32	1.08	0.003	1.000	1.000	0.001
	Formal settlement	8174	49.69 df=43, p=0.22	1.15	0.004	1.000	1.000	0.001
Men	**Whole sample**	11969	71.05 df=43, p=0.005	1.65	0.007	1.000	1.000	0.001
	No education	1104	48.609 df=43, p=0.26	1.13	0.011	0.999	0.997	0.003
	Primary education	4054	56.51 df=43, p=0.08	1.31	0.009	0.999	0.998	0.002
	Secondary/Tertiary education	6080	48.97 df=43, p=0.25	1.14	0.005	1.000	0.999	0.002
	Income tertile I	3261	48.58 df=43, p=0.26	1.13	0.006	0.999	0.999	0.002
	Income tertile II	3558	44.61 df=43, p=0.40	1.04	0.003	1.000	1.000	0.002
	Income tertile IIII	5150	68.05 df=43, p=0.01	1.58	0.011	0.999	0.998	0.002
	Informal settlement	6329	50.21 df=43, p=0.21	1.17	0.005	1.000	0.999	0.002
	Formal settlement	6403	73.21 df=43, p<0.01	1.70	0.010	0.998	0.997	0.002

χ^2 =Chi-squared test of model fit; df= degrees of freedom; RMSEA=Root Mean Square Error of Approximation; CFI=Comparative Fit Index; TLI= Tucker Lewis Index; SRMR=Standardized Root Mean Square Residual.

Test for monotonic trends: The existence of a statistically significant monotonic trend in the seasonal effect across increasing levels of education and income was tested by simulation, adapting the procedure proposed by Soderberg and Hennet.[4]

To this end, we ran a number of iterative calculations of the Kendall's tau correlation coefficient between the estimated magnitude of seasonal effects in each sub-population and the ordinal variable representing increasing levels of socioeconomic status (either education class or income tertile). To take into account the uncertainty of the estimated seasonal effects, at each iteration the value of the seasonal effects was randomly selected from a normal distribution with mean and standard deviation given by the point estimate and standard deviation of the estimated seasonal effect, per group. The procedure was repeated 50000 times, and the empirical distribution of Kendall's tau across the repetitions was used to calculate the point estimate (the distribution

median) and lower and upper bound of the 95% confidence interval (the 0.025th and 0.975th quantiles).

Impact on cardiovascular risk: To estimate the differences in cardiovascular risk due to the winter-summer variation in blood pressure, we used the following procedure, separately for each subpopulation of interest:

A. We estimated the weighted annual average of systolic blood pressure and BMI in the subpopulation.
B. We calculated the minimum and maximum seasonal value of systolic blood pressure respectively by subtracting and adding half of the seasonal effect (age specific) to the annual average.
C. We used the Framingham equations to calculate the 10-year absolute cardiovascular risk, once with the maximum values of blood pressure, and again with the minimum values. In both cases the values of the other risk factors were kept constant at the specific values shown in Figure 5. BMI was set at the average annual value, and history of diabetes and antihypertensive treatment assumed absent.
D. The difference between the values calculated above was reported in Figure 5.

3. Additional results

Seasonal effects in formal vs. informal dwellers: The differences in seasonal effect between urban dwellers living in formal and informal settlements are shown in Additional Table 4. All differences were in the expected direction, i.e. higher effects in those dwelling informal settlements, but none reached statistical significance.

Additional Table 4: Magnitude of seasonal effect on blood pressure among urban dwellers, by place of residence and gender (estimates and 95% confidence intervals)

		Formal settlement	Informal settlement	Difference
Women	**Systolic**	**3.39** (1.59 ; 5.20)	**5.35** (1.94 ; 8.76)	-1.96 (-5.82 ; 1.9)
	Diastolic	**3.09** (1.88 ; 4.30)	**3.23** (1.45 ; 5.01)	-0.14 (-2.29 ; 2.01)
Men	**Systolic**	**3.60** (1.76 ; 5.55)	**4.81** (0.49 ; 9.13)	-1.21 (-5.93 ; 3.51)
	Diastolic	**4.35** (2.91 ; 5.79)	**4.53** (2.15 ; 6.92)	-0.18 (-2.97 ; 2.61)

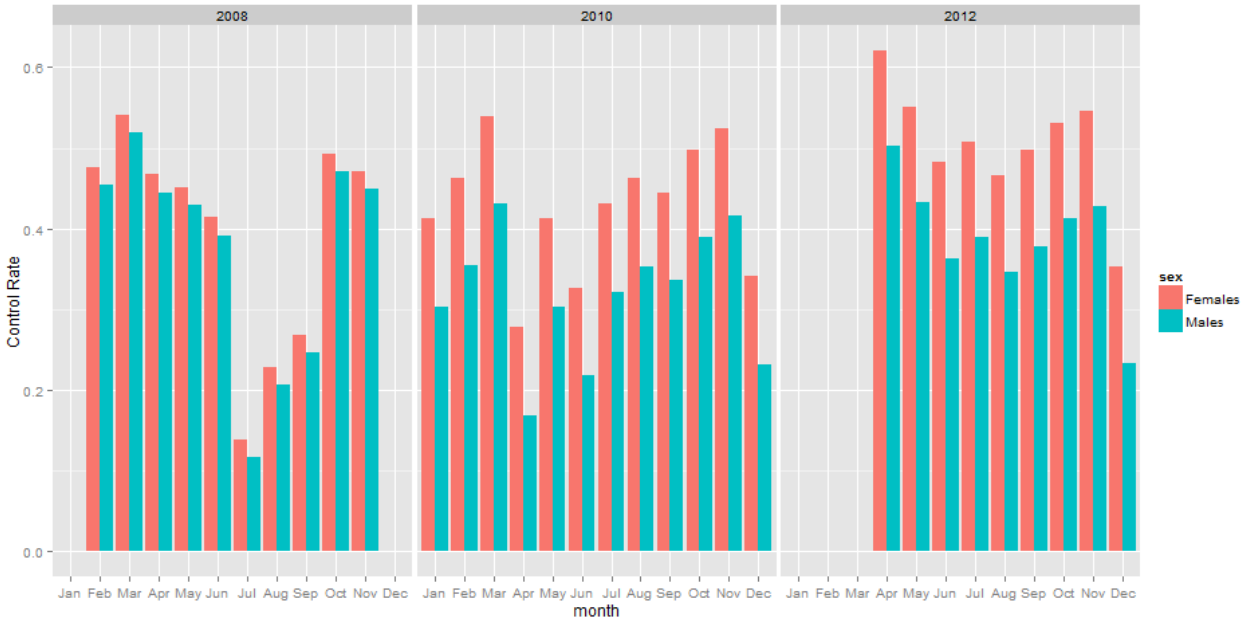
Hypertension control: Additional Figure 1 shows the estimated proportion of subjects with controlled hypertension in the NIDS sample, by month, sex and year of measurement.

Values for the month on December in two of the three years seem to be in contrast with the general pattern in which colder months record lower control rates than warmer months. However, the

interpretation of this finding must take into account the low reliability of the December estimates owing to the small number of subjects interviewed in that month, as well as a possible confounding effect of the holiday season such as changes in routine behaviour, and lesser availability of medical services.

The average proportion of subjects with hypertension shows a clear increase moving from one wave to the next. The effect of the survey protocol in which participants with elevated blood pressures were referred to health services may have influenced this result.

Additional Figure 1: Control of hypertension in the NIDS study, by month, sex and year of measurement



Control prevalence is calculated as the proportion of subjects with lifetime diagnosis of hypertension who have systolic blood pressure lower than 140 mm Hg and diastolic blood pressure lower than 90 mm Hg at the time of measurement.
Estimates are adjusted for age, education and urban/rural environment, and take into account the NIDS sampling scheme.
Shown values refer to the average individual in the 35-45 years age category with secondary education, as the largest strata for those variables.

Sensitivity Analyses: Additional table 5 shows the seasonal effect for the whole population and within each of the subpopulation defined by education and income level, estimated excluding subjects on antihypertensive treatment.

Additional Table 5: Seasonal effect estimates excluding subjects on antihypertensive treatment

		Seasonal effect (95% CI), [mmHg]	
	Subpopulation	**Systolic Blood Pressure**	**Diastolic Blood Pressure**
Women	Whole sample	4.2 (3.2 ; 5.2)	3.8 (2.9 ; 4.6)
	No education	12.7 (7.3 ; 18.1)	9.7 (6.4 ; 12.9)
	Primary Education	6.0 (3.9 ; 8.1)	5.1 (3.5 ; 6.7)
	Secondary/tertiary education	3.8 (2.2 ; 5.4)	3.5 (2.4 ; 4.6)
	Income tertile I (lowest)	5.2 (3.3 ; 7.0)	4.9 (3.4 ; 6.4)
	Income tertile II	4.9 (3.3 ; 6.5)	3.9 (2.8 ; 5.1)
	Income tertile III	3.5 (1.9 ; 5.1)	3.1 (1.9 ; 4.2)
Men	Whole sample	4.1 (2.9 ; 5.2)	3.9 (3.0 ; 4.8)
	No education	10.2 (4.9 ; 15.6)	6.8 (2.9 ; 10.8)
	Primary Education	4.5 (2.1 ; 6.8)	4.0 (2.5 ; 5.5)
	Secondary/tertiary education	4.5 (2.7 ; 6.3)	3.9 (2.5 ; 5.2)
	Income tertile I (lowest)	5.2 (2.7 ; 7.7)	5.0 (3.4 ; 6.7)
	Income tertile II	5.0 (2.8 ; 7.1)	3.7 (2.3 ; 5.2)
	Income tertile III	3.9 (2.3 ; 5.4)	3.9 (2.7 ; 5.2)

4. References

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2. Hooper D, Coughlan J, Mullen MR. Structural equation modelling: guidelines for determining model fit. EJBRM. 2008;6(1):53–60.
3. Soderberg K, Hennet RJ-C. Uncertainty and Trend Analysis—Radium in Ground Water and Drinking Water. Ground Water Monit Remediat. 2007;27(4):122–129.