

1 **Full title: Oscillometric central blood pressure and central systolic loading in stroke patients: Short-**
2 **term reproducibility and effects of posture and fasting state**

3 **List title: Reproducibility in central blood pressure evaluation in stroke patients**

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27 **Abstract**

28 **BACKGROUND:** This study examined the short-term reproducibility of non-invasive estimates of
29 central and peripheral blood pressure and markers of central systolic loading (augmentation index
30 [Alx; a measure of central systolic loading] and Alx75 [Alx standardised to 75 b·min⁻¹ heart rate]) and
31 the effect of posture and fasting state on these variables in patients with acute stroke. **METHODS:**
32 Twenty-two acute stroke patients (72 ± 10y) had blood pressure measured using the SphygmoCor
33 XCEL in supine and seated postures and whilst fasted and non-fasted. **RESULTS:** Acceptable short-term
34 reproducibility (ICC >0.75) was reported for all peripheral and central variables in all conditions (ICC =
35 0.77–0.90) and for Alx and Alx75 in both fasted postures (ICC = 0.78–0.81). Food consumption
36 significantly lowered all blood pressures ($p < 0.05$; $\eta^2_p = 0.20$ –0.55). The seated posture resulted in a
37 significantly greater Alx than supine ($p < 0.05$; $\eta^2_p = 0.22$). Fasting state had significant main effects on
38 Alx and Alx75 ($p < 0.05$; $\eta^2_p = 0.14$ –0.22). **CONCLUSIONS:** Oscillometric estimates of central blood
39 pressure have high short-term reproducibility in different postures and fasting states but markers of
40 systolic load should be assessed whilst fasted. Fasting state has a large effect on central and peripheral
41 blood pressures and on measures of systolic loading. It is important for clinicians to be aware of
42 optimal assessment conditions without this impacting on patient wellbeing.

43 **Clinical trial registry name:** NCT02537652

44 <https://clinicaltrials.gov/ct2/show/NCT02537652>

45 **KEY WORDS**

46 Augmentation index, Pulse wave analysis, Central haemodynamics, SphygmoCor XCEL

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49

50 Introduction

51 Hypertension is the most common disease seen in primary care [1]. This condition is positively and
52 continuously related to first-time stroke [2-3] due to added haemodynamic stresses on the brain [4].
53 Controlling hypertension is a cornerstone of recurrent stroke risk reduction [5]. Increased stresses on
54 the brain cause poor neurological recovery after stroke [6] and lead to elevated risk of stroke
55 recurrence [7]. Treating hypertension may be the most important tool in preventing recurrent strokes
56 [8] and maximising quality of life post-stroke.

57 The assessment of blood pressure is traditionally completed through occlusion of the brachial artery
58 (peripheral blood pressure), but central blood pressure (cBP) measures (either measured directly or
59 derived from peripheral pulse waves) may be more closely related to cardiovascular risk [9]. The
60 invasive measurement of central pressures is usually contraindicated [10], but novel techniques are
61 able to non-invasively estimate central pressures using oscillometric pulse wave analysis (PWA). There
62 is good agreement with PWA and tonometer-based methods of measuring central pressures in
63 patients with atrial fibrillation [11], a frequent indicator of elevated stroke risk. Although oscillometric
64 devices have been demonstrated to be valid [12-15], research is required to report the reproducibility
65 of these devices when assessing central haemodynamic variables before they can be used
66 diagnostically and prognostically in clinical research and treatment settings.

67 Identifying the optimal operating conditions of devices able to non-invasively calculate central
68 haemodynamic variables in terms of both posture and fasting state is an important step in their
69 introduction to research and clinical use. Posture [16-17] and fasting state [18] have been found to

70 alter peripheral blood pressure measures in non-clinical populations (aged 18-62y). Whilst the acute
71 effects of postural change and fasting state on central blood pressures and central systolic loading
72 (e.g., Augmentation index; AIx) have been investigated in both young and older non-clinical
73 populations [19-21], the short-term reproducibility of these variables has not been investigated in a
74 stroke population. This is important as blood pressures are measured in differing postures and fasting
75 states within clinical settings according to a variety of environmental and situational factors.

76 This study examined the effect of posture and fasting state on the short-term reproducibility of
77 peripheral and central blood pressures and central systolic loading in an acute stroke population using
78 a non-invasive, oscillometric device (SphygmoCor XCEL). It was hypothesised that posture and fasting
79 state would have a significant effect on peripheral and central blood pressures and markers of central
80 systolic loading and that oscillometric PWA would report high between-day reproducibility in an acute
81 stroke population. These findings will be of importance to those considering the use of the non-
82 invasive oscillometric devices to estimate central blood pressures in research and clinical settings.

83 **Materials and methods**

84 The methods of this study are reported in accordance with the Helsinki Declaration of 1975 and
85 STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines [22].

86 **Participants**

87 Twenty-two stroke patients (M=16; age: 72.3 ± 10.4 y; National Institutes of Health Stroke Scale
88 [NIHSS]: 8.1 ± 5.1 ; time after stroke: 13.2 ± 12.2 days) provided written consent whilst they were in-
89 patients at a hospital in Hampshire, UK. Recruitment is outlined in Fig. 1. Patients were excluded if
90 they were end-of-life stroke patients, had an unstable cardiac condition, were oxygen-dependent, had
91 significant dementia, were unable to swallow normally, lacked capacity to consent, were diagnosed
92 more than eight weeks prior to assessment, had either type I or II diabetes mellitus or were

93 hypoglycaemic at hospital admission. All participants completed a health history questionnaire [23;
 94 Table 1]. Ethical approval was granted by the Health Research Authority (REC reference: 15/SC/0559)
 95 South Central – Hampshire A Research Ethics Committee. The study was registered as a clinical trial
 96 (NCT02537652; <https://clinicaltrials.gov/ct2/show/NCT02537652>).

97 **Fig 1: Consort statement**

98 **Table 1: Participant demographic data**

		<i>n</i>	%
Participants		22	
Age (y)		72.3 ±10.4	
Sex	Male	16	73
	Female	6	27
Descent	European	22	100
Stroke subtype	Small vessel lacunar	2	9
	Partial anterior circulation stroke	8	36
	Total anterior circulation stroke	3	14
	Posterior circulation stroke	1	5
	Intracerebral haemorrhage	6	27
	Undetermined	2	9
Family history of CVD	Myocardial infarction	9	41
	Heart surgery	1	5
	Stent	0	0
	Catheter	1	5
	Heart defect	1	5
	Stroke	7	32
Personal history of CVD	Hypertension	10	45
	High cholesterol	6	27
	Diabetes	0	0
	Coronary artery disease/heart failure	5	23
	Atrial Fibrillation	8	36
	Comorbidities	Thyroid disease	2
	Lung disease	0	0
	Asthma	0	0
	Cancer	2	9
	Kidney disease	1	5
	Hepatitis	2	9
Lifestyle factors	Current smoker	2	9
	Previous smoker	6	27
	Current alcohol drinkers	17	77
	Current weight loss plan	1	5
Everyday activity	Sedentary	3	14
	Lightly active	3	14
	Moderately active	15	68
	Vigorously active	1	5
Medication	Statins	2	9
	Anti-thrombotic	14	64
	Diuretics	1	5

Calcium blockers	5	23
Alpha blockers	1	5
Beta blockers	5	23
Anticoagulants	1	5
Other anti-hypertensive medication	5	23
ACE-I	4	18
ARB	2	9

99 a. Abbreviations: ACE-I – Angiotensin-converting-enzyme inhibitor, ARB – Angiotensin II
100 receptor blockers, CVD – Cardiovascular disease

101

102 **Experimental design**

103 Participants were tested on three consecutive mornings, having consumed only water in the 12 hours
104 prior to data collection. After random allocation to a supine-first or seated-first condition using a
105 computerised random number generator, participants assumed this posture in a fasted state for
106 twenty minutes. A minimum of two PWA measurements were completed using the SphygmoCor XCEL
107 (AtCor Medical, Sydney, Australia) with a three minute interval. Measures of PWA consisted of a
108 peripheral blood pressure measure followed by a 10-second sub-systolic recording. The merging
109 points of the forward and reflected waves were identified on the aortic pressure waveform [20].
110 Augmentation index (AIx) is defined as the augmentation pressure expressed as a percentage of
111 central pulse pressure. If a difference of > 5 mmHg in peripheral blood pressure and a difference of >
112 4% AIx was recorded (as per manufacturer guidelines), a third measure was completed and an average
113 taken of the closest two. Measurements were taken at heart level in both postures to ensure no
114 changes in AIx were found due to alterations in arm angle. Participants rested for twenty further
115 minutes in the alternative posture before these measures were repeated to complete the fasted
116 condition on each morning. A standard hospital breakfast was consumed (either cereal with milk, a
117 bread roll with marmalade or porridge – all with the option of a small juice) before the protocol was
118 repeated in the same order but in a non-fasted state. Order of fasted state was not randomised due
119 to measurements occurring in a narrow timing window to avoid blood pressure differences caused by
120 circadian rhythms and timing constraints in terms of days of data collection per participant before
121 discharge. This protocol led to the final measures being approximately 45 minutes after food intake.

122 There were approximately eight data points per session, leading to a total of ~528 data points per
123 variable.

124 **Sample size**

125 A priori sample size calculations were based on central systolic blood pressure measures as the
126 primary outcome and assumed a typical error of 6.4 mmHg adopted from a previous reliability study
127 with healthy participants [24]. The maximum chances of a type 1 or 2 error were set at 5% (very
128 unlikely) and an approximate total of eight participants were required to detect a 6 mmHg change
129 (based on the smallest change reported in previous blood pressure studies [19]).

130 **Statistics**

131 Analyses were run using Statistical Package for Social Sciences v.22 (SPSS, Inc., Chicago, Illinois, USA).
132 All presented data are means (standard deviation, SD). Statistical significance was set at $p < 0.05$ (two
133 tailed). Analysis of variance for repeated measures with two within-participant factors (posture and
134 fasting state) examined differences in central and peripheral pressures (peripheral systolic blood
135 pressure [SBP], peripheral diastolic blood pressure [DBP], central systolic blood pressure [cSBP],
136 central diastolic blood pressure [cDBP] and central pulse pressure [cPP]) and central systolic loading;
137 Aix standardised to HR of 75 $\text{b}\cdot\text{min}^{-1}$ [Aix75]). An independent samples t-test was run to ensure that
138 gender had no significant effect on measures of blood pressure, Aix or Aix75 ($p > .05$). Effect sizes
139 were reported using partial eta squared (η_p^2) with 0.01, 0.06 and 0.14 representing small, medium
140 and large effects [25].

141 The short-term reproducibility of the device was measured by calculating the intra-class correlation
142 coefficient (ICC), standard error of measurement (SEM) and smallest detectable change (SDC; the
143 critical difference in a variable which must be exceeded between two sequential results for a

144 statistically significant change to occur [26]. Excellent reproducibility was reported as an ICC > 0.75
145 [27].

146 Results

147 Data was successfully collected from all participants in each condition. There were no gender
148 differences in measures of blood pressure, Alx or Alx75 ($p > .05$).

149 **Central and peripheral blood pressures**

150 When measuring peripheral blood pressure and CBP, the SphygmoCor XCEL reported excellent short-
151 term reproducibility in all variables with ICCs exceeding the 0.75 criterion for excellent reproducibility
152 (ICC = 0.77–0.90; Table 2). No interaction effects were observed. Posture was reported to have a
153 significant main effect on DBP and cDBP ($p = 0.001$; $\eta^2_p = 0.43$), with DBP and cDBP both significantly
154 increasing in a seated posture relative to supine. Fasted state had a significant main effect on central
155 and peripheral haemodynamics, with significant decreases in SBP, DBP, pPP, cSBP, cDBP and cPP
156 observed ($p < 0.05$; $\eta^2_p = 0.20 - 0.55$; Table 3 & Supplementary Table).

157 **Table 2: Short-term reproducibility of SphygmoCor XCEL in measuring peripheral and central haemodynamic variables**

	Supine-F			Supine-NF			Seated-F			Seated-NF		
	ICC	SEM	SDC	ICC	SEM	SDC	ICC	SEM	SDC	ICC	SEM	SDC
MAP (mmHg)	0.88	4.6	12.7	0.81	5.6	15.4	0.83	5.1	14.3	0.84	5.8	16.0
SBP (mmHg)	0.84	7.3	20.4	0.84	7.8	21.7	0.83	7.3	20.3	0.85	7.6	21.1
DBP (mmHg)	0.89	3.6	9.9	0.80	4.5	12.5	0.82	4.5	12.5	0.81	5.3	14.6
PP (mmHg)	0.80	5.4	15.1	0.89	4.9	13.5	0.77	5.8	16.2	0.82	5.7	15.9
cSBP (mmHg)	0.85	6.3	17.4	0.83	7.0	19.4	0.81	6.3	17.5	0.83	7.0	19.4
cDBP (mmHg)	0.90	3.5	9.7	0.82	4.4	12.2	0.83	4.4	12.2	0.83	5.1	14.2
cPP (mmHg)	0.84	4.1	11.4	0.88	3.8	10.4	0.79	4.5	12.6	0.83	4.3	11.9
Heart rate (b·min ⁻¹)	0.89	3.3	9.2	0.83	4.4	12.3	0.88	3.8	10.6	0.85	4.0	11.0
AP (mmHg)	0.76	2.8	7.8	0.66	3.0	8.4	0.72	3.5	9.7	0.71	2.9	8.1
Alx (%)	0.81	3.7	10.3	0.66	5.1	14.0	0.78	5.1	14.2	0.73	5.1	14.1
Alx75 (%)	0.81	4.7	12.9	0.70	5.6	15.4	0.78	6.2	17.1	0.74	5.8	16.1

165 a. Abbreviations: Abbreviations: Alx - Augmentation Index, Alx75 - Augmentation Index @ 75bpm, AP = Augmented Pressure, cDBP - Central Diastolic
 166 Blood Pressure, cPP - Central Pulse Pressure, cSBP - Central Systolic Blood Pressure, DBP - Diastolic Blood Pressure, F – Fasted, ICC – Intraclass
 167 Correlation Coefficient, MAP - Mean Arterial Pressure, NF - Non-Fasted, SDC – Smallest Detectable Change, SEM – Standard Error of Measurement,
 168 SBP - Systolic Blood Pressure

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170

171

172 **Table 3: Mean and SD for peripheral and central haemodynamic variables**

173

	Total	Supine		Seated		Interaction		Posture		Fasted		
		Fast	Non	Fast	Non	<i>P</i>	η^2_p	<i>P</i>	η^2_p	<i>P</i>	η^2_p	
MAP (mmHg)	\bar{X}	100	104	94	106	97	.86	.00	.003	.34	<.001	.52
	<i>SD</i>	12	13	13	12	15						
SBP (mmHg)	\bar{X}	142	147	137	148	138	.82	.00	.09	.14	<.001	.48
	<i>SD</i>	18	18	20	18	20						
DBP (mmHg)	\bar{X}	79	82	74	85	76	.90	.00	.001	.43	<.001	.53
	<i>SD</i>	10	11	10	10	12						
PP (mmHg)	\bar{X}	64	65	63	64	62	.57	.02	.33	.05	.04	.20
	<i>SD</i>	13	12	14	12	13						
cSBP (mmHg)	\bar{X}	130	135	123	137	124	.82	.03	.06	.16	<.001	.59
	<i>SD</i>	15	16	17	15	17						
cDBP (mmHg)	\bar{X}	80	83	75	86	78	.95	.00	.001	.43	<.001	.50
	<i>SD</i>	10	11	10	11	12						
cPP (mmHg)	\bar{X}	49	52	48	51	47	.71	.01	.06	.16	<.001	.55
	<i>SD</i>	10	10	11	10	10						
Heart rate (b·min ⁻¹)	\bar{X}	68	65	68	66	71	.30	.05	.04	.19	<.001	.60
	<i>SD</i>	10	10	11	11	10						
AP (mmHg)	\bar{X}	16.2	18.8	14.9	17.5	13.7	.65	.01	.02	.22	<.001	.61
	<i>SD</i>	5.4	5.8	5.2	6.6	5.5						
Alx (%)	\bar{X}	31.9	35.5	30.3	33.5	28.4	.97	.00	.02	.22	.001	.43
	<i>SD</i>	8.7	8.6	8.6	10.9	9.7						
Alx75 (%)	\bar{X}	28.2	30.7	27.2	28.7	26.4	.54	.02	.08	.14	.03	.20
	<i>SD</i>	10.8	10.8	10.1	13.0	11.4						

- 186 a. Abbreviations: Abbreviations: Alx - Augmentation Index, Alx75 - Augmentation Index @ 75bpm, AP = Augmented Pressure, cDBP - Central Diastolic
187 Blood Pressure, cPP - Central Pulse Pressure, cSBP - Central Systolic Blood Pressure, DBP - Diastolic Blood Pressure, F - Fasted, N - Non-Fasted, MAP
188 - Mean Arterial Pressure, PP – Pulse Pressure, SBP - Systolic Blood Pressure
189 b. **Bolded** *P*<.05

190 **Central systolic loading**

191 When assessing Alx and Alx75, the SphygmoCor XCEL device reported excellent short-term
192 reproducibility in both fasted postures (ICC = 0.78–0.81) and moderate reproducibility in both non-
193 fasted postures (ICC = 0.66–0.74 [Table 2]). Posture had a significant main effect on Alx, with a
194 significant decrease observed in the seated posture ($p = 0.024$; $\eta^2_p = 0.22$) but not in Alx75; suggesting
195 that these differences were mainly due to the significant changes in heart rate observed in this study.
196 Fasting state had a significant main effect on both Alx and Alx75 with significant decreases reported
197 after food consumption ($p < 0.05$; $\eta^2_p = 0.14$ – 0.22 [Table 3 & Supplementary Table]).

198 **Discussion**

199 The SphygmoCor XCEL exhibits high short-term reproducibility in different fasting states and postures
200 when assessing peripheral and central blood pressure measures, but central systolic loads were more
201 reproducible in a fasted than non-fasted state. Fasting state was demonstrated to have a large
202 influence on both peripheral and central blood pressure and central systolic load measures, whereas
203 posture significantly influenced peripheral and central diastolic measures and Alx, but no other
204 variables recorded. The lack of statistical differences in Alx75 between postures suggests that
205 differences in Alx are caused by fluctuations in heart rate caused by postural change. This is in line
206 with previous research showing that Alx is confounded by the timing of the reflected wave [28]. When
207 measuring peripheral and central blood pressures in a stroke population, patients should be in a fasted
208 state to optimise the accuracy and reproducibility of collected data. If patients are non-fasted, it is
209 important that researchers and clinicians are aware of the immediate effects of food intake on these
210 measures and analyse these blood pressure measures accordingly. Due to the high reproducibility and
211 the demonstrated effect of posture and fasting state on central haemodynamic variables, the
212 experimental hypotheses of this study were accepted.

213 **Central and peripheral blood pressure**

214 High short-term reproducibility was reported when assessing central and peripheral blood pressure
215 measures, with ICCs exceeding the 0.75 criterion of excellence in all conditions. These ICCs (0.77–0.90)
216 are consistent with, but slightly better than, previous work examining the short-term reproducibility
217 of the SphygmoCor XCEL in a younger, healthy population which reported ICCs of 0.68–0.90 for
218 peripheral and central measures [20]. To our knowledge, no other work has been completed
219 determining the short-term reproducibility of this device in an acute stroke population. Based upon
220 the ICC analysis, this study suggests that non-invasive measures may be suitable for the assessment
221 of central haemodynamics. However, it is interesting to note that the SDCs were wider than those
222 reported using the same device in a young, healthy population [20].

223 No significant interaction effects were reported. Significant main effects were observed for both
224 posture and fasting state on peripheral and central blood pressures. Due to technological advances,
225 the measurement of these variables non-invasively may become widespread. As a result, research into
226 factors influencing central measures is of great importance. It is possible that medications may induce
227 different responses between peripheral and central blood pressure measures [29]. The significant
228 increase in DBP and cDBP in a seated position compared to supine mirrors the findings of previous
229 work [16, 30]. This, alongside a non-significant change in systolic measures, caused a non-significant
230 decrease in pulse pressure. As cPP is recognised as being extremely relevant to vascular ageing [31],
231 the significant influence of posture on cDBP is particularly relevant.

232 Fasting state was demonstrated to cause statistical decreases in SBP, DBP, pPP, cSBP, cDBP and cPP.
233 A post-prandial decrease of ~10 mmHg was reported in SBP and ~12 mmHg in cSBP. A smaller decrease
234 in DBP (8-9 mmHg) and cDBP (8 mmHg) caused a large change in pPP and cPP to occur. Significant
235 decreases in central blood pressure after food consumption have been observed in a non-clinical
236 population over the age of 50 [21] but not in a young, healthy sample [20]. This suggests that healthy

237 populations may be able to make necessary autonomic adjustments to redirect blood flow without a
238 drop in central blood pressure, but older and clinical populations may be less able to do so effectively.
239 A post-prandial drop in cBP variables was observed by Ahuja *et al* [19] who reported a decrease of 6.1
240 mmHg after food and water consumption compared to water alone but recruited a wide-ranging
241 sample aged 21-80 years old. After food consumption, this drop in blood pressure may be due to a
242 post-prandial reduction in arterial stiffness in the splanchnic bed, allowing cardiac output to be
243 maintained alongside a decrease in blood pressure. Ahuja and colleagues [19] suggest a peak time-
244 frame of 45 minutes for a blood pressure drop after food intake; indicating that the data reported in
245 this study may reflect the greatest changes in a post-prandial state. It is worth noting that as well as
246 physiological adaptations, these changes in blood pressure may be contributed to by the presence of
247 regression to the mean effect due to the repeated measures taken; a potential bias which is inevitably
248 present for as long as there is less-than-perfect repeatability in the measurement of BP [32]. It should
249 be at the discretion of consultants as to how these optimal operating conditions are balanced against
250 practical patient care, with nutritional strategies adopted to avoid poor outcomes and prolonged stays
251 in hospital [33].

252 **Central systolic loading**

253 This study reports that the SphygmoCor XCEL has high short-term reproducibility when reporting Alx
254 and Alx75, particularly in fasted participants. ICCs of 0.78–0.81 were observed when recording Alx and
255 Alx75 in a fasted state, whereas this lowered to 0.66–0.73 and 0.70–0.74 for Alx and Alx75,
256 respectively, when participants were non-fasted. The digestive process causes alterations in
257 vasodilation which may vary on a day-to-day or meal-to-meal basis depending on extraneous factors
258 (e.g., meal composition, temperature, hydration status). This may cause the assessment of Alx and
259 Alx75 to become less stable when the body is not truly at rest as it would be more likely to be in a
260 fasted state. The significant main effect observed for posture in Alx but not in Alx75 may add credence
261 to the concept that Alx and HR may not be entirely linearly related; a suggestion which reduces the

262 propriety of Alx75 being reported without Alx alongside [34]. Significant changes to Alx and Alx75 in
263 different postures have not been observed in previous work in a healthy, young population [20].
264 However, a significant change in Alx but not Alx75 has also been reported in hypertensive participants
265 over the age of 50 [21] but not in the normotensive sample in the same study, who demonstrated
266 significant differences in both Alx and Alx75 in supine and seated postures. A reduction in Alx75 has
267 been reported in a supine state compared to a seated position in a female-only population [35]. Such
268 a finding was not mirrored in this study, with measurements of Alx and Alx75 being -1-2% lower in
269 the seated posture compared to supine. This finding was not statistically significant ($p = 0.08$), whilst
270 wide ranges in the reported 95% confidence intervals were reported (see Supplementary Table). This
271 may be due to a potential lack of statistical power to detect an association of this magnitude in this
272 sample of 22 stroke patients. The finding that fasting state had a significant main effect on Alx and
273 Alx75 with post-prandial reductions observed in both measures aligns with previous research and may
274 be a result of increased arterial compliance due to tone alterations in the small vessel beds, large
275 artery function and large artery geometry [20].

276 **Clinical significance**

277 This study suggests that non-invasive central blood pressure assessments provide reproducible
278 measurements of peripheral and central haemodynamics. Significant decreases in peripheral and
279 central blood pressures were observed after food consumption. During hospitalisation after stroke,
280 assessments of central and peripheral blood pressures should therefore be assessed in a fasted state
281 to reduce the variability caused by food intake. This is particularly true when medication prescription
282 is at least partially based on these routine blood pressure measures. The combined effect of post-
283 stroke medication and fasting state should also be considered when monitoring patient health, as
284 both variables cause a decrease in peripheral and central blood pressure measures.

285 With regards to central systolic loading, increased arterial stiffness is reported to be significantly
286 associated with reduced cognitive function in stroke patients [36]. Reporting this decrease in central
287 systolic loading in terms of prandial state may have some importance with regards to perfusion
288 pressures and the timing and assessment of cognitive state examinations in a clinical setting around
289 meal times. Further work should investigate any potential links between arterial stiffness, perfusion
290 pressures and cognitive performance both before and after food intake in clinical populations.

291 **Limitations and strengths**

292 It is important to contextualise the study through the recognition of strengths and weaknesses. Firstly,
293 we did not recruit a unisex sample, a fact which may influence results due to potential differences in
294 responses to postural changes in peripheral blood pressure between sexes [37]. Secondly, due to
295 stringent exclusion criteria and subsequent slow levels of recruitment, we recruited a sample with a
296 range of stroke subtypes and severity according to NIHSS (range: 1 – 18). Further work should examine
297 whether there are differences in the reproducibility of the SphygmoCor XCEL in more severe strokes,
298 and between stroke subtypes. The study was also not able to take into account the effect of body
299 mass or body composition variables on changes of peripheral and central haemodynamics as patients
300 were not routinely weighed on admission. Finally, the sample contained participants with and without
301 atrial fibrillation; a condition which may lead to some inconsistencies in measured data due to
302 inconsistent stroke volumes. However, biases in oscillometric assessment of central blood pressure
303 have been shown to not significantly differ in the presence or absence of AF when three repeated
304 measures are taken [38], as happened in at least some conditions for every participant in this study.
305 Focusing on central blood pressure assessments in those specifically with atrial fibrillation has the
306 potential to be an interesting area of future study. However, the time-frames involved in the data
307 collection process ensured that post-prandial measures after food consumption were in accordance
308 with recommendations set out by Ahuja and colleagues [19] in terms of capturing the peak effects of
309 food intake on haemodynamic variables. Additionally, the in-patient nature of the study ensured a

310 controlled environment for data collection to occur. Furthermore, the randomisation of condition
311 order and standardised overnight fast also contributed to a strong protocol. Finally, assessments
312 occurred at the same time each day, reducing the likelihood of circadian rhythms altering the blood
313 pressures recorded in the morning.

314 In conclusion, this study demonstrates that the SphygmoCor XCEL, a non-invasive oscillometric PWA
315 device, possesses high short-term reproducibility in assessing both central and peripheral blood
316 pressure measures in both fasted and non-fasted states, and good short-term reproducibility when
317 assessing markers of central systolic loading, particularly in a fasted state. The current study
318 demonstrates that posture has a significant effect on DBP, cDBP and AIx, whereas, fasting state
319 significantly influences all peripheral and central variables, as well as both AIx and AIx75, in acute
320 stroke patients. The findings of this study are pertinent to researchers and clinicians, although
321 consideration around the practicalities of implementing these measures within practice (e.g.
322 optimising conditions for BP assessment whilst minimising adverse events associated with fasting
323 state) is necessary.

324 Conflicts of interest

325 No conflicts of interest exist with relation to this manuscript.

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440 Supporting information

441 S1_Raw_Data_File

442 S2_Supplementary_Table.1