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## **Evidence of a Blood Pressure Reduction during the COVID-19 Pandemic and Associated Lockdown Period**

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Running title: Blood pressure and COVID-19 lockdown

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## **Abstract**

*Background:* Despite widespread investigation into the incidence of acute myocardial infarction during the COVID-19 pandemic and associated lockdown, no study has examined the situation's impact on blood pressure (BP) levels.

*Methods:* Measurements of BP and heart rate (HR) were obtained from persons living in the Paris urban area using connected home BP monitors (accessible to patients and health providers through a secured server). Three time periods of e-Health recordings were compared: during the pandemic prior to the lockdown, during the lockdown and the same time period in 2019.

*Results:* A total of 297,089 BP recordings from 2,273 participants (age  $56.3 \pm 12.8$  years, 81.1% male) were made. During confinement, systolic BP gradually decreased by 3 mmHg (-2.4 to -3.9), and diastolic BP, by 1.5 mmHg (-1.4 to -2.2) (all  $p < 0.001$ ); this decrease was greater for participants with higher BP ( $p < 0.0001$  each). No significant variation in HR was noted.

*Conclusion:* Among a very large cohort, we observed a significant decrease in home BP measured with e-Health devices during the first lockdown period. This study emphasizes the research potential of e-Health during the Covid crisis.

## **Introduction**

The COVID-19 pandemic that emerged in China in late 2019 rapidly spread around the world, affecting >70,000,000 patients globally<sup>1</sup>. In order to reduce the risk of person-to-person transmission and to combat the disease's wide dissemination, many countries have imposed one or more lockdown periods. Several reports highlighted a 20–30% decrease in the incidence of acute cardiovascular diseases, mainly non-ST segment elevation acute myocardial infarction (AMI) during – and a possible rebound after – the lockdown period<sup>2-4</sup>. In contrast of this large body of evidence, very little is known about blood pressure (BP) and other chronic cardiovascular diseases and/or risk factors.

The application of big data analysis in medicine has opened up new frontiers, such as the development of predictive models and personalised medicine, and population-level health analyses<sup>5</sup>. Given the promotion of home BP monitoring over the last several years, many people are now equipped with wireless monitors, enabling the generation of very large databases.

To address the issue of BP trends during the pandemic and associated lockdown period, we analysed big data registries from users of connected home blood pressure monitors, and compared BP and heart rate (HR) measurements obtained during the lockdown period with data obtained immediately prior to the lockdown, as well as with data obtained from the same period in 2019.

## **Methods**

All adults living in the Paris region with an ambulatory 'Withings' BP monitor, having at least one available BP measurement recorded in the three studied time periods – namely,

during the COVID-19 lockdown period (from 17 March to 11 May 2020), prior to the lockdown and in 2019 – were included in the analysis. Measurements were obtained and automatically transmitted after a complete de-anonymisation process and with participants' consent on a secured server.

In order to assess changes over time in systolic blood pressure (SBP), diastolic blood pressure (DBP) and HR, repeated measures linear mixed effect models were constructed, with time as fixed effect and patient as random effect. Models were also assessed by adjusting for age and gender as fixed effects. The adjusted means were calculated for each period, and the pairwise differences of adjusted means were compared using Tukey's post hoc t-test from the model.

According to French law, as we only had access to anonymized data, no formal IRB approval was needed.

## **Results**

From 1 January 2019 to 5 May 2020, 297,089 BP recordings were available from 2,273 participants. Most participants were <60 years old (58.5%, mean age was  $56.3 \pm 12.8$ , range 19 to 95), with the majority being male (81.1%). The number of BP measurements performed before and after the lockdown were 1.5/week (0.7–3.9) and 1.6/week (0.7–4.3), respectively. SBP and DBP both significantly declined during the lockdown period. SBP gradually decreased during the first 4 weeks of confinement, reaching a 3-mmHg decrease plateau (range = -2.4 to -3.9 mmHg decrease from week 4 to week 7, all  $p < 0.001$ ; Figure 1 and Table 1). A similar pattern was also observed for DBP, with a gradual decrease up to week 4 of lockdown, and a plateau of decrease of approximately 1.5 mmHg (range -1.35 to -2.22 mmHg decrease from week 4 to week 7, all  $p < 0.001$ ; Figure 1). Similar results were observed when taking into account age and sex. In contrast, changes in HR were limited to a less than 1 bpm, non-significant decrease (Figure 1).

The main driver of BP changes during the lockdown was the BP level prior to the lockdown. Participants with higher systolic BP had higher decrease in systolic BP during the lockdown (Beta for each 10 mmHg increase in systolic BP prior to the lockdown =  $-1.91 \pm 0.12$ ,  $p < 0.0001$ ), whereas age and sex had no significant effect ( $p = 0.9$  and  $0.054$ , respectively). Similarly, participants with higher diastolic BP had higher decreases in diastolic BP during the lockdown (Beta for each 10 mmHg increase in diastolic BP prior to lock down =  $-1.43 \pm 0.12$ ,  $p < 0.0001$ ), whereas sex had no significant effect ( $p = 0.15$ ).

## **Discussion**

Our study shows that participants experienced a 3-mmHg SBP decrease and a 1.5-mmHg decrease DBP decrease (which was not accompanied by an HR reduction) during the lockdown related to the COVID-19 crisis.

Several behavioural changes have been observed during the COVID-19 pandemic and associated lockdown. Most of these were expected to adversely impact BP – e.g. sedentary lifestyles leading to increased food and alcohol intake, and in turn increased weight, and greater psychological tensions<sup>6</sup>. Some patients may have also stopped taking their medicine in the early phase of the pandemic due to preliminary warnings about a possible interaction between angiotensin converting enzyme inhibitors and the COVID-19 outcome<sup>7</sup>. A recent survey presented during the Argentine Congress of Cardiology indicated there were fewer emergency department (ED) admissions during the lockdown period compared to the period just prior to the isolation, but there was a greater proportion of patients having hypertension as defined by a SBP  $\geq 160$ mmHg and/or a DBP  $\geq 100$ mmHg ([www.sciencedaily.com/releases/2020/11/201119083923.htm](http://www.sciencedaily.com/releases/2020/11/201119083923.htm)). Although our results appear in contradiction with the survey's findings, there might be selection bias, as the authors only report on patients admitted in the ED, and both their acute disease and transportation to the

ED during the pandemic may be particularly stressful and thus responsible for increased BP measurements.

In contrast, we studied a very large population, and all measurements were homemade. In addition, the BP reduction we observed occurred less than one month following the onset of the lockdown and was of a higher magnitude when compared to the minimal BP changes observed during the beginning of the pandemic, suggesting a direct link between the lockdown and BP reduction. The exact link cannot be derived from our study. Nonetheless, it is very unlikely that many therapeutic changes were performed during that period. In addition, we report a greater BP reduction among people having the most elevated BP prior to this time. We therefore hypothesise a decreased occupational stress level and increased treatment compliance during the lockdown, thereby resulting in greater BP control<sup>8</sup>.

France was one of the countries most affected by COVID-19 in Europe. The French government decreed a period of confinement from 17 March to 11 May 2020. During this period, a decrease in hospitalizations for AMI was reported<sup>3</sup>. The present study particularly focused on participants living in the Paris urban region, which was massively impacted by the COVID-19 epidemic and in which the lockdown was strictly enforced, resulting in a sudden and prolonged cessation of non-essential activities. Whether our results of decreased BP may account for part of the observed trends in AMI during the lockdown remains to be established.

### **Limitations**

Some limitations deserve consideration. First, our analysis is limited by our inability to collect clinical data about medical diseases and treatments. As we studied all persons equipped with a wireless BP monitor, and because its use has been endorsed by national guidelines and advocated by physicians, our population should mostly correspond to hypertensive patients. The observed greater reduction in patients with higher BP prior to the lockdown may confirm



our hypothesis. Second, we cannot comment on the possible clinical relevance and the possible link to the observed AMI reduction – a 3/1.5 mmHg BP reduction in our population – although a similar BP reduction was associated with reduced stroke and AMI in the VALUE trial<sup>9</sup>.

### **Conclusion**

The present study demonstrates a progressive decrease in SBP and DBP during the lockdown.

Whether this could partly explain the concomitant reduction in the incidence of acute cardiovascular diseases remains to be studied.

### **Authorship confirmation statement**

Nicolas Girerd: data analysis, writing and revision of the manuscript

Christophe Meune: data analysis, writing and revision of the manuscript

Kevin Duarte: statistics

Vincent Vercamer: data transfer

Marilucy Lopez-Sublet: writing and revision of the manuscript

Jean-Jacques Mourad: conception, data analysis, writing and revision of the manuscript

### **Disclosure**

Vincent Vercamer is employed by Withings; however, he was neither involved in the data analysis nor in the decision to publish the results.

### **Funding statement**

None to declare

### **Figure legend**

Fig 1: Changes in systolic, diastolic blood pressure and heart rate prior to and during the COVID-19 lockdown in France

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**Table 1: Changes in systolic and diastolic BP prior and during the country lock-down**

	Unadjusted random effect model			Random effect model adjusted for age and sex		
	Adjusted Mean $\pm$ SE	Changes in BP		Adjusted Mean $\pm$ SE	Changes in BP	
		Adjusted delta (95%CI)	p-value		Adjusted delta (95%CI)	p-value
<b>Systolic BP</b>						
<b>January-March 2019</b>	130.25 $\pm$ 0.25	1.33 (1.17 to 1.50)	<0.0001	129.13 $\pm$ 0.31	1.33 (1.16 to 1.49)	<0.0001

<b>April-June 2019</b>	129.27±0.25	0.35 (0.19 to 0.51)	0.002	128.14±0.31	0.34 (0.18 to 0.50)	0.002
<b>July-September 2019</b>	128.11±0.25	-0.81 (-0.96 to -0.66)	<0.0001	126.99±0.31	-0.81 (-0.96 to -0.66)	<0.0001
<b>October-December 2019</b>	129.73±0.24	0.81 (0.69 to 0.94)	<0.0001	128.61±0.31	0.81 (0.68 to 0.94)	<0.0001
<b>2020 prior to lockdown (April 5 2020)</b>	128.92±0.24	Reference	-	127.80±0.30	-	-
<b>Lockdown week 1</b>	127.91±0.27	-1.01 (-1.26 to -0.75)	<0.0001	126.79±0.33	-1.01 (-1.26 to -0.76)	<0.0001
<b>Lockdown week 2</b>	127.25±0.27	-1.67 (-1.92 to -1.41)	<0.0001	126.14±0.33	-1.67 (-1.92 to -1.41)	<0.0001
<b>Lockdown week 3</b>	127.12±0.27	-1.80 (-2.06 to -1.54)	<0.0001	126.00±0.33	-1.80 (-2.06 to -1.54)	<0.0001
<b>Lockdown week 4</b>	124.97±0.27	-3.94 (-4.20 to -3.69)	<0.0001	123.86±0.33	-3.95 (-4.20 to -3.69)	<0.0001
<b>Lockdown week 5</b>	125.81±0.27	-3.11 (-3.37 to -2.85)	<0.0001	124.69±0.33	-3.11 (-3.37 to -2.85)	<0.0001
<b>Lockdown week 6</b>	125.65±0.27	-3.27 (-3.54 to -3.01)	<0.0001	124.53±0.33	-3.27 (-3.54 to -3.01)	<0.0001
<b>Lockdown week 7</b>	126.52±0.27	-2.40 (-2.67 to -2.13)	<0.0001	125.40±0.33	-2.40 (-2.67 to -2.13)	<0.0001
<b>Diastolic BP</b>						
<b>January-March 2019</b>	80.90±0.19	0.35 (0.25 to 0.46)	<0.0001	79.57±0.23	0.35 (0.25 to 0.46)	<0.0001
<b>April-June 2019</b>	80.46±0.19	-0.09 (-0.19 to 0.02)	0.91	79.13±0.23	-0.09 (-0.19 to 0.02)	0.91
<b>July-September 2019</b>	79.96±0.19	-0.58 (-0.68 to -0.49)	<0.0001	78.63±0.23	-0.58 (-0.68 to -0.49)	<0.0001
<b>October-December 2019</b>	81.04±0.18	0.50 (0.41 to 0.58)	<0.0001	79.71±0.23	0.50 (0.41 to 0.58)	<0.0001
<b>2020 prior to lockdown (April 5 2020)</b>	80.55±0.18	Reference	-	79.21±0.23	-	-
<b>Lockdown week 1</b>	79.96±0.20	-0.58 (-0.75 to -0.42)	<0.0001	78.63±0.24	-0.58 (-0.75 to -0.42)	<0.0001
<b>Lockdown week 2</b>	79.50±0.20	-1.05 (-1.22 to -0.88)	<0.0001	78.16±0.24	-1.05 (-1.22 to -0.88)	<0.0001
<b>Lockdown week 3</b>	79.52±0.20	-1.03 (-1.20 to -0.86)	<0.0001	78.19±0.24	-1.03 (-1.20 to -0.86)	<0.0001
<b>Lockdown week 4</b>	78.33±0.20	-2.22 (-2.39 to -2.05)	<0.0001	76.99±0.24	-2.22 (-2.39 to -2.05)	<0.0001
<b>Lockdown week 5</b>	78.83±0.20	-1.72 (-1.89 to -1.55)	<0.0001	77.50±0.24	-1.72 (-1.89 to -1.55)	<0.0001
<b>Lockdown week 6</b>	78.82±0.20	-1.73 (-1.90 to -1.56)	<0.0001	77.49±0.24	-1.73 (-1.90 to -1.56)	<0.0001
<b>Lockdown week 7</b>	79.20±0.20	-1.35 (-1.52 to -1.17)	<0.0001	77.87±0.24	-1.35 (-1.52 to -1.17)	<0.0001

**Figure 1:**

