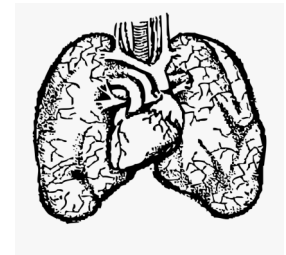# Explore: How does exposure to particulate air pollution affect the cardiovascular system?

Name_____ Class_____ Date_____

Background: Drs. Rudy Sinharay and Jicheng Gong and their colleagues from Imperial College in London did a pioneering air quality research study that was published in the British medical journal The Lancet in 2017. Briefly, the study involved exposing a group of volunteers to varying levels of particulate air pollution and then measuring their respiratory and cardiovascular response for up to 26 hours after the exposure. The volunteers were men and women over 60 and they were divided into three nearly equal size groups: healthy individuals; individuals with respiratory problems in the form of COPD (chronic obstructive pulmonary disorder); and individuals with cardiovascular disease in the form of ischaemic heart disease. The volunteers were randomly assigned to two groups. One group took a two hour walk along London's busy Oxford Street and the other group took a two hour walk through Hyde Park. The particulate pollution levels along Oxford Street were found to be significantly higher than those measured in Hyde Park. Lung and cardiovascular function were measured two hours before the walk; immediately after the walk (2 hours after starting the walk); and at 4, 6, and 26 hour intervals after starting the walk.

1. Use web resources to look up COPD and ischaemic heart disease. Describe the two conditions.

Human heart & lungs

2. This activity focuses on the effects of exposure to particulate air pollution on the cardiovascular system. The Sinharay study mentioned above measured pulse wave velocity as an indicator of cardiovascular function. What is pulse wave velocity?

3. Hypothesis: make a prediction about how you think pulse wave velocity will change over time in individuals exposed to the higher levels of particulate air pollution measured on Oxford Street compared to those exposed to the lower levels of particulate air pollution at Hyde Park. Be sure to explain your prediction.
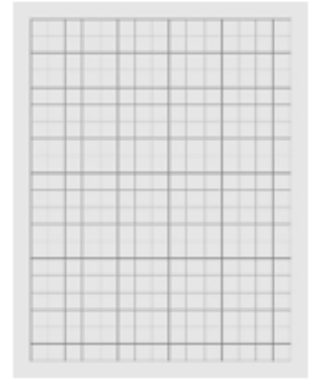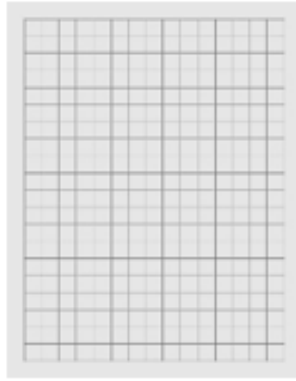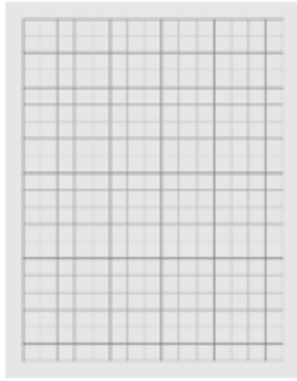
Data

Table 1: Average percentage change in pulse wave velocity on Oxford Street vs. Hyde Park*

Research Group	Location	2 hrs. Prior	End of walk, 2 hrs. after start	4 hrs. after start	6 hrs. after start	26 hrs. after start
Healthy	Oxford St.	0	-1	+2	+3	+7
	Hyde Park	0	-5	-3	-2	-4
COPD	Oxford St.	0	+2	+3	+4	+4
	Hyde Park	0	-6	-5	-2	-4
Ischaemic Heart Disease	Oxford St.	0	+1	+5	+4	+3
	Hyde Park	0	-7	-5	-2	-5

 *Data was adapted from the Sinharay study (Sinharay et al., 2017).

Use the coordinate systems on the next page to graph the data from Table 1 above: time is the independent variable on the x-axis and percentage change of pulse wave velocity, pwv, is the dependent variable on the y-axis. Designate one graph for the healthy group, one for the COPD group, and one for the ischaemic heart disease group. Draw a dashed horizontal line at 0% pwv change on each graph to represent the baseline—the initial resting pwv measure. Since these are trend line graphs, use a straight edge to connect the plotted points. Be sure your graphs exhibit all of the properties of properly constructed graphs.

Graphs that are to be submitted digitally on this pdf must be constructed on another platform—Microsoft Word or Excel or Google docs or sheets. It is easiest to insert these constructed objects into a pdf when the pdf is opened in **Adobe Acrobat Reader**. To insert a graph in this pdf, copy the constructed object from the original platform using the Copy function or the snipping tool. In Adobe Acrobat Reader, open the *Stamp* tool from the right side tool bar. The *Stamp* commands will now appear on the upper tool bar. Click on *Stamp,* then click on *Paste Clipboard Image as Stamp Tool* from the bottom of the opened menu. The cursor will now appear as a stamper. Move the stamper to the center of the coordinate system below and left click. The pasted object can be moved or re-sized by left clicking on the object.

Explain

4. Describe the overall trend in pulse wave velocity among the three study groups on Oxford Street and in Hyde Park.

5. According to the data, is it better to undertake moderate exercise such as walking when particulate air pollution levels are elevated or is it better to limit exertion to cleaner air environments? Defend your response using examples from the data.

6. The $PM_{2.5}$ (air particulates with a diameter of 2.5 μm or smaller – small enough to be respirable) levels Sinharay measured on Oxford Street varied from 5 – 39 µg/m^3 with a median or middle value of 17 µg/m^3. In contrast, $PM_{2.5}$ concentrations measured during the Rice Ridge Fire near Seeley Lake, Montana in 2017 varied from 19.1 – ***636.8*** µg/m^3 and the median value was 187.5 µg/m^3. How do you think exercising in the form of a sport practice during a forest fire smoke event would affect the cardiovascular system?

Conclusion: revisit your hypothesis and write a conclusion for this activity. Begin by re-stating your hypothesis, discuss its validity, and use examples from the data to support your conclusion.

<u>Teacher Comments:</u>