LARS, Environmental Research Laboratory
SIMG-Societa' Italiana di Medicina Generale / ISDE-International Society of Doctors for the Environment

BLACK CARBON CONTENT IN PM AS A METRIC TO EVALUATE THE IMPACT OF THE CAR-FREE SUNDAYS OF WINTER 2011 ON AIR QUALITY IN MILAN.

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INTRODUCTION: On the end of January 2011 the PM10 concentrations in Milan exceeded the limit of 50 µg/m3 for several days and the Municipality decided to stop the traffic on two consecutive Sundays. Traffic restrictions are an unpopular tool to mitigate urban air pollution, and a measurable improvement in air quality is needed to demonstrate the effectiveness of this measure. Previous attempts failed to detect measurable reductions of PM mass pollution within the areas subject to traffic restriction. However, black carbon, which is emitted primarily by traffic sources, could be a PM metric more suitable than PM mass to demonstrate pollutant reductions. In this study we report the results of a black carbon monitoring campaign carried out in Milan, Italy, with the aim to detect - and demonstrate more suitably than PM mass- differences in local urban air quality.

OBJECTIVE: To compare PM and black carbon concentrations in Milan (Italy) during two no-traffic Sundays in winter 2011 as compared to preceding and following days with normal traffic intensity, in order to evaluate possible improvement of the air quality as a consequence of temporary traffic restrictions.

METHOD: Instrumentation & Equipment. PM10, PM2.5 and PM1 were measured in real time with a mass pre-calibrated Optical Particle Counter (OPC) Aerocet 531 (Metone Instruments Inc., USA), and black carbon with a MicroAethalometer AE 51 (Magee Scientific, USA).
Procedures Air quality was assessed placed at a walkside monitoring site in one of the main roads of Milan city center on Friday, Saturday, Sunday and Monday on three week-ends, two with no-traffic Sundays, and one with no restriction at all. On Sundays the stop to private traffic was implemented from 08:00 a.m. to 06:00 p.m. The measurements were carried out in the afternoon, 04:00 p.m. to 07:00 p.m. on each of the campaign day. During the Sunday they also measured the concentration before and after the cessation of the traffic restrictions. Traffic density was also measured.

RESULTS: **Table 1 and figg. 1 through 6** report the absolute values (SD) of PM_{10} and BC during the three weekends of measurements, the first and second with no traffic Sunday and the third with traffic. Absolute values of BC on both no traffic Sunday (from 8.00 am to 6.00 pm) result lower than all other days while PM_{10} on both no traffic Sunday results higher. **Table 2 and figg. 7 through 9** report the mean content of BC in PM_{10} which result the lowest during the no traffic Sunday and higher on traffic Sunday. **Table 3 rand fig. 10** report the total mean % BC in PM_{10} of the no traffic Sundays compared with the traffic Sunday. **Table 4 and fig. 11** report the total reduction of BC content in PM_{10} with a reduction of 53.3 and 41.6 during the no traffic Sundays and of 2.7 only during the normal traffic Sunday.

Table 1: PM & BC in µg/m³ (SD)

	PM10 (SD)	BC (SD)
Sun. Jan. 30th. I° weekend (no traffic Sunday)		
Friday	79.9(14.6)	8.3(4.5)
Saturday	37.5(10.1)	2.7(2.9)
Sunday before 6,00 pm	56.7 (8.2)	2.1(0.6)
Sunday after 6,00 pm	60.1(11.5)	4.1(2.1)
Monday	117.2(13.9)	8.1(3.9)
Sun. Feb. 6th. II° weekend (no traffic Sunday)		
Friday	89.8(10.6)	9.5(3.1)
Saturday	78.3(15.9)	11.5(4.2)
Sunday before 6.00 pm	120.6(42.2)	8.1(1.8)
Sunday after 6.00 pm	141.3 (6.2)	17.6(3.9)
Monday	117.5(17.5)	9.9(2.4)
Sun. Feb 13th. III° weekend (traffic Sunday)		
Friday	78.1(23.7)	6.1(2.5)
Saturday	45.7(29.4)	7.8(4.3)
Sunday before 6.00 pm	92.4(12.9)	10.6(6.1)
Sunday after 6.00 pm	106.9(12.4)	11.0(3.4)
Monday	105.7(20.7)	12.5(5.5)

Table 2: Mean % BC in PM_{10}

	I° weekend	II° weekend	III° weekend
Friday	10.4	10.6	7.8
Saturday	7.2	14.7	17.1
Sun. before 6,00 pm	3.7	6.7	11.4
Sun. after 6,00 pm	6.8	12.4	10.3
Monday	6.9	8.4	11.8
p =	0.050	0.498	

Table 3: Mean % BC in PM_{10}

	I° weekend	II° weekend	III° weekend
Mean Fri, Sat, Sun after 6 pm, Mon with traffic	7.8	11.5	11.8
Mean Sunday without traffic	3.7	6.7	11.4
p =	0.203	0.470	

Table 4: Reduction of BC content in PM_{10}

	I° weekend	II° weekend	III° weekend
% reduction	53.3	41.6	2.7

No traffic Sunday

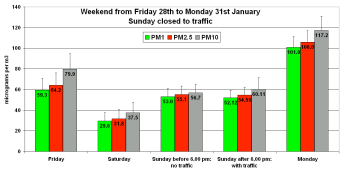

Fig.1 PM10, PM2.5 and PM1 were significantly higher despite the stop of the traffic probably due to changes in atmospheric conditions

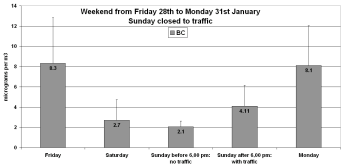

Fig.4 Despite the increase in PM, the BC concentrations showed a slight but significant decrease in absolute values

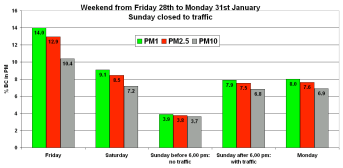

Fig. 7 Also the % BC in all PMs showed a significant decrease

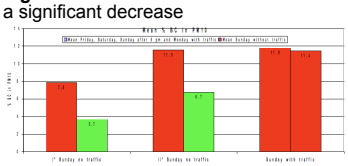

Fig. 10 Total mean % BC in PM_{10} of the no traffic Sundays compared with the traffic Sunday.

No traffic Sunday

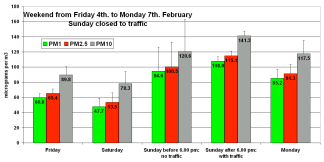

Fig.2 PM10, PM2.5 and PM1 were significantly higher despite the stop of the traffic probably due to changes in atmospheric conditions

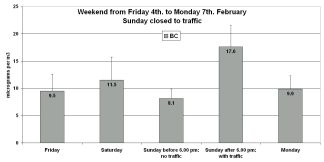

Fig. 5 Despite the increase in PM, the BC concentrations showed a slight but significant decrease in absolute values

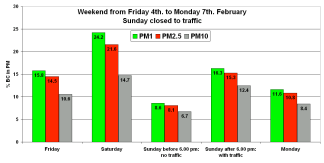

Fig. 8 Also the % BC in all PMs showed a significant decrease

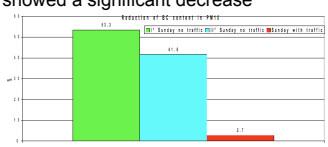

Fig. 11 Mean % reduction of 53.3 and 41.6 on no traffic Sundays and of 2.7 during the normal traffic Sunday.

Traffic Sunday

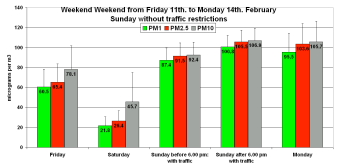

Fig.3 PM10, PM2.5 and PM1 significantly increase on Sunday as compared with Saturday but not after 6.00 pm and the next Monday

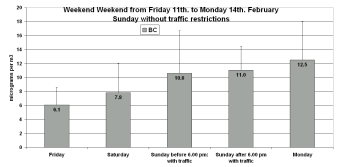

Fig. 6 The BC concentration showed a significant increase in absolute values

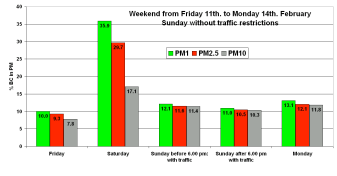

Fig. 9 The % BC in PMs decreased as compared with Saturday but remain constant after 6.00 pm and the next Monday

CONCLUSION: Although PM concentrations increased during the no traffic Sundays, probably due to change in atmospheric conditions, a relevant reduction in BC concentrations was found during the traffic restriction time, with an overall 50% decrease of the BC/PM ratio, indicating a net benefit on exposure to traffic proximity pollution. Temporary traffic restriction gise rise to an immediate reduction in exposure to traffic proximity carbonaceous polltants. This effect can represent a partial health benefit for those children and adults who decide to spend an open air day in metropolitan cities.