EPA-650/1-74-001

July 1973

Environmental Health Effects Research Series

THE USE OF PANELISTS AS SUBSTITUTES FOR TAXICAB DRIVERS IN CARBON MONOXIDE EXPOSURE

Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC 20460

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THE USE OF PANELISTS AS SUBSTITUTES FOR TAXICAB DRIVERS IN CARBON MONOXIDE EXPOSURE

by

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Contract No. CPA 22-69-97
Program Element No. 1AA005

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Prepared for

COORDINATING RESEARCH COUNCIL, INC.
30 ROCKEFELLER PLAZA
NEW YORK, N.Y. 10020
Project No. CAMP-8-68(1-68)

and

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

July 1973

Acknowledgments

The authors express their appreciation for the dedicated interest and efforts of the Division of Environmental Health Sciences' staff, who obtained the samples, performed the laboratory analyses, and provided constructive suggestions at every stage. These persons included Mr. Richard Hanauer, Mrs. Elaine Nelson, and Mrs. Maria Graham.

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REPORT

on

The Use of Panelists as Substitutes for Taxicab Drivers in Carbon Monoxide Exposure Studies

CRC-APRAC Project No. CAPM-8-68 (1-68)

Summary

Analyses of breath and limited blood samples from 30 pairs of taxi drivers and panelists who drove in New York City traffic for 8 hours on two consecutive days indicated that both panelists and drivers attained similar COHb (blood carboxyhemoglobin) levels. This was true for both smokers and non-smokers though smokers had significantly higher concentrations of COHb than non-smokers. There was no consistent difference between the first and second day of driving in the levels of alveolar carbon monoxide.

Methodology

Background

Data for this study were collected between June 27, 1969 and November 15, 1970. There were four objectives:

a) To determine whether panelists attain concentrations of COHb (blood carboxyhemoglobin) similar to those attained by taxicab drivers with equal exposure.

b) To determine if the levels of COHb for smokers differed from those of non-smokers.

c) To determine the relationship between concentrations of carbon monoxide (CO) inside an automobile and the levels of COHb.

d) To compare the levels of COHb in blood obtained by finger prick with the level of carbon monoxide in the expired alveolar air after 20 seconds of breath holding.

The Subjects

Sixty individuals were divided into 30 pairs, each pair consisting of a taxicab driver and a panelist. Half of the pairs were current cigarette smokers while the other half had never smoked tobacco in any form or had not smoked within the previous year. The smoking history is described in table I. All were males, and pairs were matched by age within 6 years with the exception of 2 pairs. (See table II).

Before the study, subjects received a complete physical examination that included a chest x-ray, electrocardiogram, test of 1-second forced expiratory volume, hemoglobin test, and other indicators of physical condition. Prospective subjects with evidence of pulmonary disease, cardiac disease, blood dyscrasias, or any other disease that might affect normal cardiopulmonary physiology were excluded from the study. In addition, subjects who were considered incapable of properly providing samples of expired alveolar air were excluded to facilitate the study.

Materials and Methods

With his panelist seated beside him, each driver drove through heavily travelled streets in Manhattan and Brooklyn for two successive days. All drivers used the same automobile, a rented 1969 Dodge Dart Sedan. It was not air conditioned, and subjects were permitted to open and close the car windows freely.

A member of the study team accompanied the test vehicle, and he collected ambient air and alveolar air specimens while seated in the back seat. The driving schedule extended from 8:00 a.m. to 5:00 p.m. with a coffee break around 10:00 a.m. and lunch from noon to 1:00 p.m. After their dinner, subjects were requested to return for a final alveolar air specimen at 8:00 p.m. Tests were scheduled as follows:

Hours	Alveolar Air	Ambient Air
0800	X	X
0900		X
1000	X	X
1100		X
1200	X	
1300		X
1400		X
1500	X	X
1600		X
1700	X	
2000	X	X*

*Ambient levels in the laboratory where the specimens were obtained. Range was constant between 5-10 parts per million CO.

Breath and air samples were collected in bags of aluminum foil covered by polyester film and equipped with valved closures. When filled, the bags were shown to lose less than 10% of their volume after three days, and they withstood shipping.

To provide a breath sample, a subject exhaled completely and then inhaled rapidly. After holding his breath for 20 seconds while being timed by a stopwatch, he discarded the first 1400 cc. of breath and the remaining portion was collected and analyzed. Ambient air was pumped into a 7-liter bag over a 15-minute period. Alveolar and ambient air specimens were analyzed on the same day using a Hilger and Watts Infra-Red Gas Analyzer, type S. C. /L. C. This is a single-range instrument with a linear response and a range -- for the purpose of this study -- of 0-200 ppm of carbon monoxide. Carbon dioxide and water vapor are removed prior to analysis by a drying tube containing soda lime and magnesium perchlorate.

While driving, smokers were allowed to smoke at will except when specimens were taken. Since the opening of windows would affect panelists and drivers equally, it was not considered to affect the comparability of carbon monoxide levels between panelists and drivers. The number and time of cigarettes smoked would affect COHb but the study was designed to measure the comparability of carbon monoxide in smoking panelists and drivers rather than the possible reasons for differences in carbon monoxide levels.

Determination of Carboxyhemoglobin

Determination of carboxyhemoglobin levels were made by analyzing finger-prick blood and using a procedure that was a slight modification of one described by B. T. Commins and P. J. Lawther (1). About 0. 025 ml. of blood from a finger prick was dissolved in 25 ml. of 0. 04% ammonia solution. This solution was divided in half, and oxygen was bubbled through one half to convert any carboxyhemoglobin into oxyhemoglobin. The spectra of the two halves was then compared in a spectrophotometer. The difference between the spectra was used to estimate the carboxyhemoglobin content of the blood and was compared with the difference between the spectra of pure oxyhemoglobin and pure carboxyhemoglobin samples of the same blood. The formula for the percent of carboxyhemoglobin was:

$$\% \text{ COHb} = \frac{h}{h_o}$$

Where h = optical height above the mean of the absorbances at 414 mu (b) and 426 mu (c) with a peak at 420 mu (a). A value was obtained by h = 2 - (b+x)/2. h_o was obtained by the same procedure from the two pure samples.

Results

Ambient Air Concentrations of Carbon Monoxide

As described in Table 3, the carbon monoxide levels varied from 2 ppm to 48 ppm. The average reading for each hour, however, varied from a minimum of 16.1 ppm of carbon monoxide at 1000 to 23.7 ppm. at 1500. Comparing the carbon monoxide levels in the cars of non-smokers to smokers, the averages were the same at 1100 and the maximum difference between averages occurred at 1500 when levels in non-smokers' air reached an average of 3.7 ppm higher.

These concentrations are generally similar to those recorded by Jaffe (2) for the commuter exposure in New York City. Using an automatic infra-red analyzer and 20-30 minute integrated samples, he found the following concentrations in the "Center City" in 1966 and 1967:

Maximum:	52 and 48 ppm
Average:	32 and 27 ppm
Minimum:	14 and 9 ppm

Values in 14 other American cities: 8 to 70 ppm

Johnson, Dworetzky and Heller (3) recorded carbon monoxide levels continuously within a trailer parked in midtown Manhattan during 1967. The median hourly concentration on week days was 12-13 ppm. Colucci and Begeman (4) found median hourly averages of 7.5 and 10.5 ppm on week days at two sites in midtown Manhattan during 1962-64.

Comparison of Drivers and Panelists

As shown by Figure 1, the average hourly alveolar air measurements for drivers and panelists showed that carbon monoxide concentrations for the two groups varied almost identically for non-smokers. For smokers, slight differences can be discerned. This lack of conformity for smokers can be attributed to the broad range that carbon monoxide measurements spanned, varying from below 25 ppm to over 45 ppm. By contrast, the average carbon monoxide readings for non-smokers had a minimum of about 12 ppm and a maximum of less than 20. When each day was investigated separately, as shown in Figure 2, the same general observations could be made.

Comparison of Smokers and Non-Smokers

The striking contrast in the study occurred when smokers, both drivers and panelists, were compared with non-smokers. As shown in Figure 3, smokers consistently exhibited a considerably higher concentration of carbon monoxide than non-smokers. The difference was greater at 5:00 p.m. in the case of drivers and at either 3:00 p.m. among panelists, depending upon whether the first or second day is being considered. However, the gap already existed at 8:00 a.m. and remained through 8:00 p.m. three hours after driving had ceased.

Interestingly, the level of carbon monoxide in non-smokers at 8:00 a.m. was slightly lower among panelists than for taxicab drivers. This raised the question whether the groups differed in exposure at home or on the way to work. An occupational effect could have existed, but this does not seem likely since the effects of occupational exposure presumably would have worn off by the next morning.

Analysis of Variance

All carbon monoxide readings were averaged by four categories: (1) smoking drivers, (2) non-smoking drivers, (3) smoking panelists, and (4) non-smoking panelists. When these categories were averaged, the difference between drivers and panelists was -2.9 ppm for smokers and +1.5 ppm for non-smokers. Statistical tests were then performed to see whether a significant difference existed between any of the four comparable groups. Tests were performed on the log CO concentration, and the model was a three-way incomplete analysis of variance. But the difference between drivers and panelists on both the smoker and non-smoker categories was not statistically significant.

Trend Over Time

As illustrated by Figure 1, the change in carbon monoxide levels among non-smoking drivers during each day was minor. Among panelists, the levels rose slightly to peak around 3:00 p.m. or 5:00 p.m. For smokers, on the other hand, the increase was considerable, and the peak occurred at 5:00 p.m. A consistent difference in alveolar carbon monoxide between the first and second days of driving did not appear to exist.

Comparison of Ambient Air and Alveolar Air

To determine the effect of carbon monoxide levels in ambient air upon corresponding levels in alveolar air, correlation coefficients were calculated using the logarithms of carbon monoxide measurements in ppm for each type of air. Since 60 persons -- either drivers or panelists -- were involved for two days, each correlation was based on 60 pairs of numbers. Both the morning and daily averages of carbon monoxide levels in ambient air were used since it seemed possible that morning values might reveal a time-lag relationship. As shown in Table 5, however, the data did not confirm this hypothesis, and the morning figures did not appear to have any advantage over the figures of the entire day. In general, the correlation was stronger with the 5:00 p.m. alveolar air carbon monoxide than with the 8:00 p.m. concentrations. In general, the correlation was higher among non-smokers than smokers, a predictable observation since non-smokers had ambient air as their only source. The maximum correlation coefficients were relatively weak: 0.60 and 0.55 for non-smoking panelists and drivers respectively at 5:00 p.m.

The only other recorded study comparing ambient air within a car and concentrations of carbon monoxide by the car's occupants was by Clayton et al (5). Two individuals drove for 8 hours continuously in a police scout car, presumably entirely within Detroit. One smoked cigars, and the other did not smoke. The carbon monoxide was monitored continuously, and readings were recorded every five minutes. Using 50 readings, the average value was

17 ppm and a peak of 120 ppm occurred when the engine was idling. The COHb rose from 0.8 to 1.2% in the non-smoker and 3.1 to 3.9% in the smoker. The correlation coefficient for ambient carbon monoxide and COHb was not provided.

Comparison of Finger Prick Blood and Alveolar Air

Blood was obtained by finger prick six times a day for the two-day test from four drivers and their panelists. Half of the pairs smoked. Table 6 illustrates the correlation between COHb and the alveolar air carbon monoxide; but, because of the small number of subjects, additional statistical evaluation was indicated because a plot of all values for alveolar air carbon monoxide and the simultaneous COHb on a scatter diagram indicated that the comparison did not approximate a normal distribution. The Spearman Rank Correlation Test was then performed. When smoking habits were disregarded, an r of 0.5531 was found between the carbon monoxide alveolar air and the COHb readings. A test of significance gave the T_n-2 as 6.26, which indicates statistical significance at the 1% level. The second test using non-smokers resulted in values of r = 0.4002 (N=48) and T_n-2 = 2.96 significant at the 1% level. The final procedure testing only the values of smokers resulted in values of r = 0.0795 (N=43) and T_n-2 = 0.51 with no statistical significance indicated.

According to the article, "Post Exposure Relationship of Carbon Monoxide in Blood and Expired Air" by J. E. Peterson (6), "Alveolar breath analysis can be used to accurately estimate the percent COHb saturation in adult white males provided the ambient carbon monixide concentration is near zero." In our study, a definite difference appeared to exist between correlations among smokers and non-smokers, perhaps suggesting that part of the ambient air exposure in smokers is the carbon monoxide present in the respiratory exchange necessary for smoking cigarettes.

Further study has been conducted at the request of the authors by another laboratory to correlate measurements between single samples of expired alveolar air concentrations of carbon monoxide and single finger prick blood specimens as well as venous blood specimens for determination of COHb. Carbon monoxide concentrations of below 2 parts per million were maintained in the ambient atmosphere. The only major variable was the smoking habit of the individual. Under no circumstances were non-smokers tested in the same laboratory where a smoker had previously been tested. Subjects consisted of five adult males aged 22, 25, 30 and 34 years with smoking histories of at least two packs daily during recent years. Examinations and medical records indicated no demonstrable physical disease. Using the Spearman Rank Correlation, the relationship between expired alveolar air carbon monoxide and finger prick COHb determinations was found to be $r = 0.568$, which indicates no statistical significance.

Then six 1-pack-per-day male smokers of ages 22, 22, 35, 44, 38, and 21 were tested for carbon monoxide concentrations in alveolar air and COHb in blood. Correlations by the Spearman Rank Test were found to be almost identical with the smoking group of the cab drivers in this study. The r was 0.0821 and the $T_n-2 = 6.84$, which gave statistical significance at the 1% level. Correlations between the finger prick and the venous blood methods indicated a correlation coefficient of 0.87, which was considered to be highly significant.

Discussion

Use of Panelists as Substitutes for Taxicab Drivers

In general, this study found that panelists attained concentrations of COHb similar to those attained by taxicab drivers with equal exposure. Some questions remain though, on some points, such as the generally higher average carbon monoxide readings in alveolar air for panelists in the smoking category. But to investigate this subject further, more information would have to be obtained. Contributing factors could be the air-pollution concentrations at the residence of subjects, the method of transportation from home to the study site, and the length of time for travel from home to the site of the study. Seasoning (i. e., long or heavy experience in driving) and age may possibly affect levels of carbon monoxide in subjects.

Nelson and Hasselblad (7) examined four taxi drivers and four passengers at 9:00 a.m., 11:00 a.m., 1:00 p.m. and 3:00 p.m. on two successive days. The design paired one non-smoking driver with one non-smoking passenger and one smoking driver with one smoking passenger. While no gross differences between drivers and passengers were observed, the sample was obviously minimal in size. This seems to be the only published study comparing drivers and passengers.

Smokers vs. Non-Smokers

There is abundant evidence that cigarette smoking has a more potent effect on carbon monoxide concentrations than ambient city air, and the ambient air concentrations in this study were not extraordinary. But is there interaction between smoking and ambient air? Our data suggest that there may be. The ambient air carbon monoxide has only a small effect alone. But the large rise for smokers, as shown in Figure 1, could be due to cigarette smoking alone, except that the sharp fall between 5:00 p.m. when driving stopped and 8:00 p.m. implies a significant effect of ambient air. Of course, alternative explanations for this drop could also be found.

Bartlett (8) stressed the point that carbon monoxide from smoking and carbon monoxide from ambient air are not additive. If one has a high level of COHb from smoking, and exposure to a low level of carbon monoxide in ambient air will not increase the COHb. But Bartlett adds, "this conclusion is modified by the fact that smokers' carbon monoxide excretion between cigarettes is slower in a carbon monoxide polluted environment than in pure air. Thus, their long-term average COHb concentrations are slightly higher in the presence of environmental carbon monoxide than in its absence."

Ambient Air and COHb

The relationship between ambient carbon monoxide concentration within the automobile and COHb is positive but weak. But this correlation is inherently different to ascertain for subjects driving an automobile and is more suitably investigated in the rigidly controlled conditions obtainable in a laboratory chamber. We were not able to operate the infra-red analyzer in the car because the shocks and jolts could not be softened sufficiently. We then used bag samples integrated over 15 minutes, taking 8 samples over the 9-hour day. In view of the potentially radically different concentrations encountered in driving, even from one block to another, and the fact that subjects escaped exposure to high levels of ambient carbon monoxide during the one hour lunch period, it is not surprising that the correlation was not great.

Alveolar Air, Finger Prick and Venipuncture Blood

The correlation between carbon monoxide in alveolar air and the COBh in finger prick blood was weak. But a significant correlation can only be expected where the ambient air concentrations of carbon monoxide are relatively low; and, in this study, the ambient carbon monoxide concentrations were elevated in all collections of expired air with the exception of the evening specimen at 8:00 p.m.

Another explanation for the insignificant correlation is technical. In any micro method using finger puncture techniques, the possibility of dilution by tissue juices is always regarded as a valid technical disclaimer. Additional venous blood and finger tip comparisons were conducted by one of the authors (A.W.H.), and the significant correlation (0.82) between COHb as determined by finger prick and by venous blood methods was obtained for 15 subjects, seven smokers and eight non-smokers. Because the test subjects for the panelist study were in a vehicle, venipuncture was not feasible and the micro finger prick method had to be used.

Conclusions

The data of this study indicate that panelists are a satisfactory substitute for taxi drivers in field studies of carbon monoxide concentrations. Use of alveolar air to indicate the probable levels of COHb, however, did not prove to be a viable assumption since CO concentrations in alveolar air did not correlate acceptably with COHb under the conditions of this study. More satisfactory for future studies, the authors believe, will be expanded application of the finger-prick method.

This study suggested several promising areas for future investigation. The influence of high levels of ambient carbon monoxide on the validity of alveolar air measurements must be further explored. Correlation of COHb and expired air from heavy smokers should be studied. And there should be a more intensive effort to establish a standardized method for field determinations of COHb.

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Robert M. Albrecht, M. D.

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APPENDIX A

TABLES AND FIGURES

TABLE 1

Smoking History

Smoking	Drivers	Panelists
Never	5	7
Ex-smokers	10	8
Currently under 1 pack of cigarettes per day	4	4
Currently 1 to 2 packs of cigarettes per day	7	9
Currently over 2 packs of cigarettes per day	4	2
Total	30	30

TABLE 2

Age Difference Between Driver and Panelist

Number of Years	Number of Pairs
0 - 3	21
4	3
5	2
6	2
7	--
8	1
9	1

TABLE 3

Ambient Air Concentrations of CO in ppm by

Time of Day

Hour	MINIMUM	AVERAGE		MAXIMUM
		Non-smokers	Smokers	
0800	8	22. 5	19. 3	41
0900	3	20. 6	18. 8	42
1000	6	18. 1	16. 1	36
1100	4	21. 7	21. 7	48
1300	4	18. 9	16. 4	42
1400	2	19. 2	19. 3	43
1500	6	23. 7	20. 0	44
1600	5	19. 4	20. 2	43

TABLE 4

Average CO Concentrations in ppm by

Time of Day

NON-SMOKERS

	8:00 A.M.	10:00 A.M.	12 NOON	3:00 P.M.	5:00 P.M.	8:00 P.M.
Drivers, Day 1	18.	18.	15.	18.	17.	15.
Drivers, Day 2	15.	18.	16.	20.	21.	16.
Avg. Drivers	16.5	18.0	15.5	19.0	19.0	15.5
Panelists, Day 1	13.	15.	14.	16.	18.	14.
Panelists, Day 2	12.	14.	16.	21.	21.	15.
Avg. Panelists	12.5	14.5	15.0	18.5	19.5	14.5

SMOKERS

	8:00 A.M.	10:00 A.M.	12 NOON	3:00 P.M.	5:00 P.M.	8:00 P.M.
Drivers, Day 1	22.	29.	30.	38.	41.	30.
Drivers, Day 2	23.	26.	23.	37.	39	30
Avg. Drivers	22.5	27.5	26.5	37.5	40.0	30.0
Panelists, Day 1	29.	29.	22.	45.	44.	33.
Panelists, Day 2	23.	31.	25.	40.	44.	36.
Avg. Panelists	26.0	30.0	23.5	42.5	44.0	34.5

TABLE 5

Correlation Coefficients

	Correlation with:	
Smokers	Avg. all day Ambient air CO	Avg. morning Ambient air CO
Drivers 5PM, CO	0.38	0.40
Drivers 8PM, CO	0.26	0.34
Panelists 5PM, CO	0.36	0.29
Panelists 8PM, CO	0.45	0.40
Non-Smokers		
Drivers 5PM, CO	0.55	0.51
Drivers 8PM, CO	0.53	0.49
Panelists 5PM, CO	0.60	0.56
Panelists 8PM, CO	0.17	0.23

TABLE 6

Correlation of COHb obtained by

finger-prick and alvcolar air CO

Pair number	Smoker	Driver	Panelist
1	Yes	.15	0
2	Yes	.65	.08
3	No	.50	.54
4	No	.71	.23

FIGURE. 1

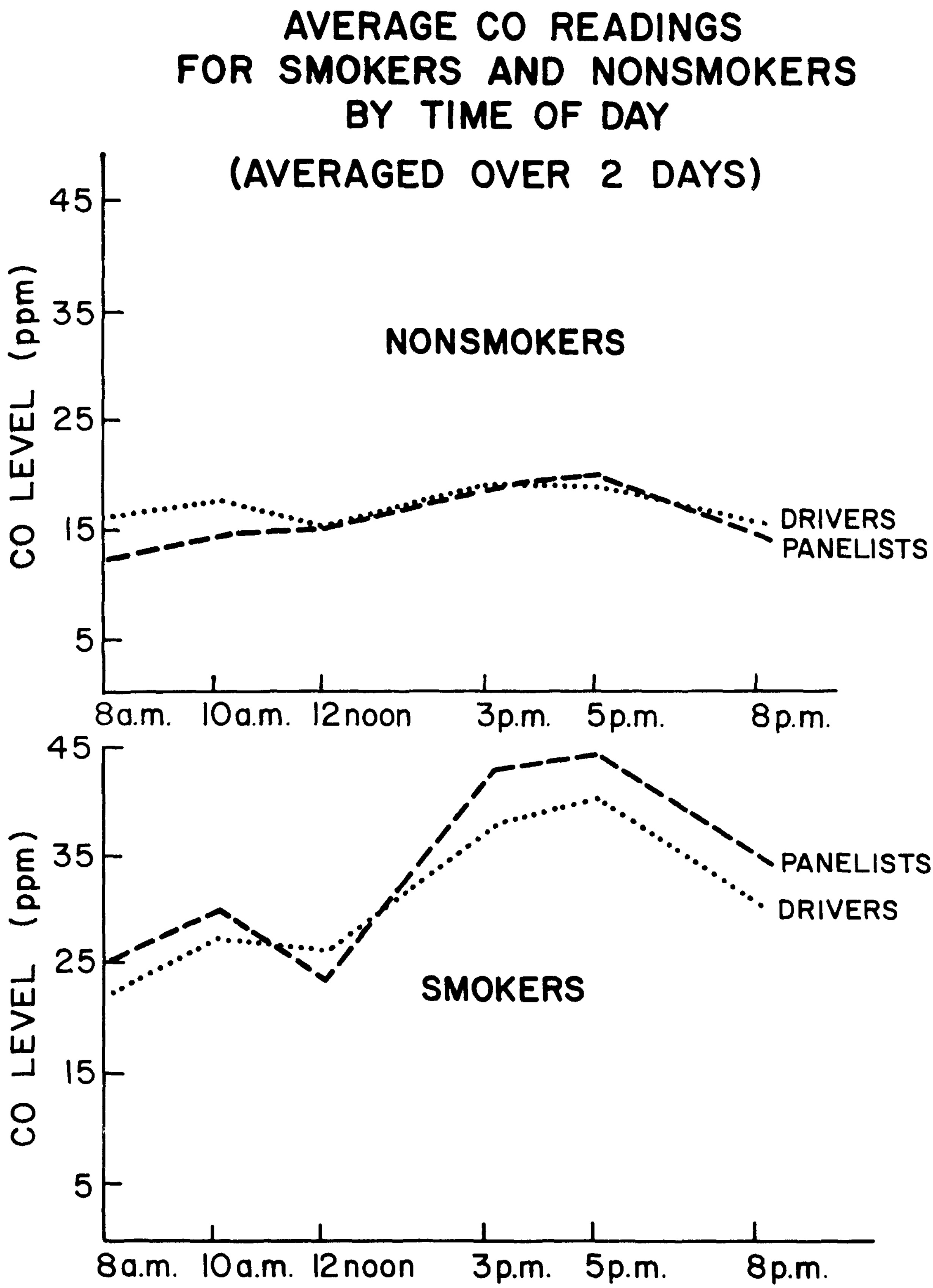

AVERAGE CO READINGS
FOR SMOKERS AND NONSMOKERS
BY TIME OF DAY
(AVERAGED OVER 2 DAYS)
NONSMOKERS
CO LEVEL (ppm)
45
35
25
15
5
DRIVERS
PANELISTS
8a.m.
10a.m.
12noon
3p.m.
5p.m.
8p.m.
SMOKERS
PANELISTS
DRIVERS

FIGURE 2

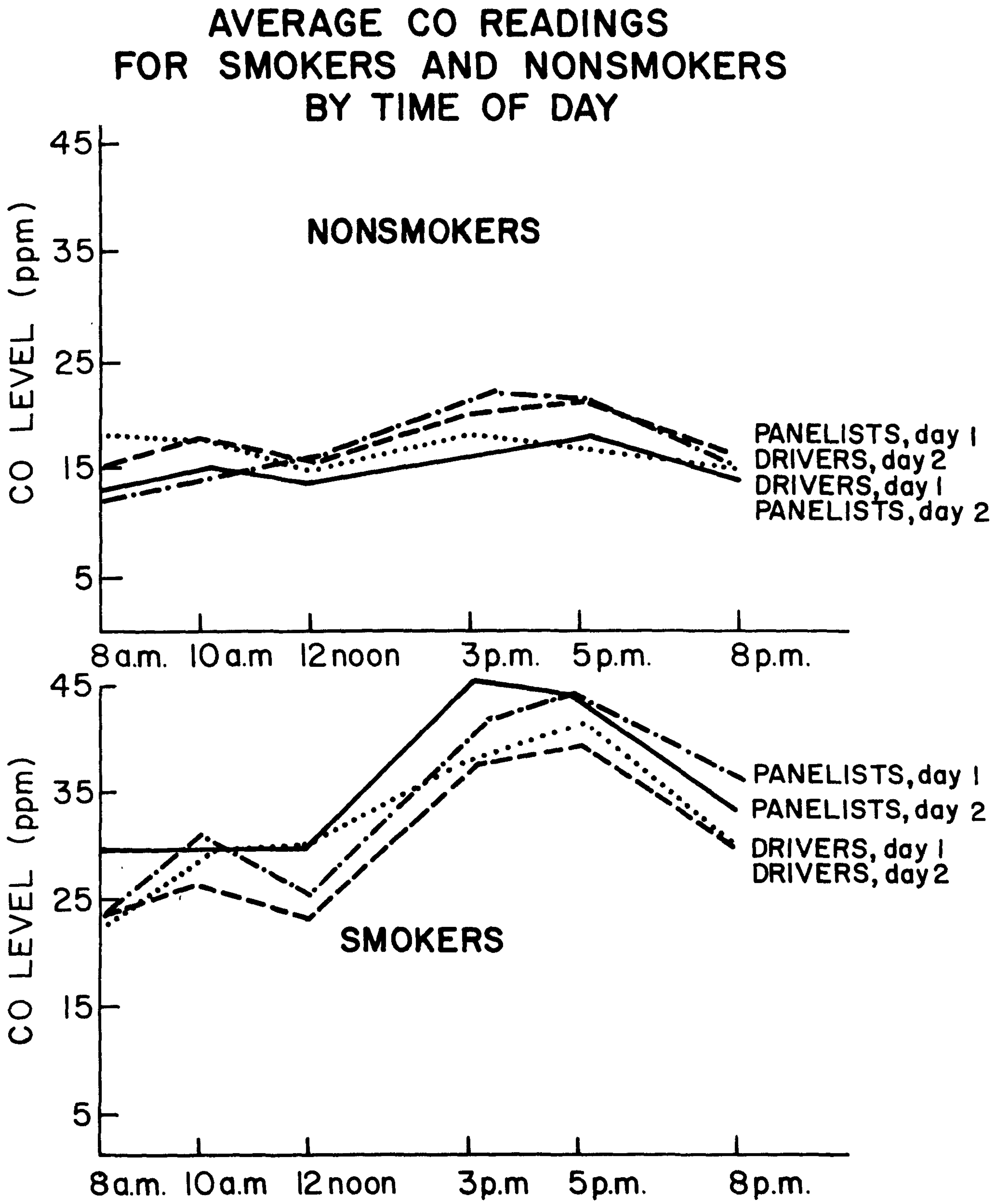
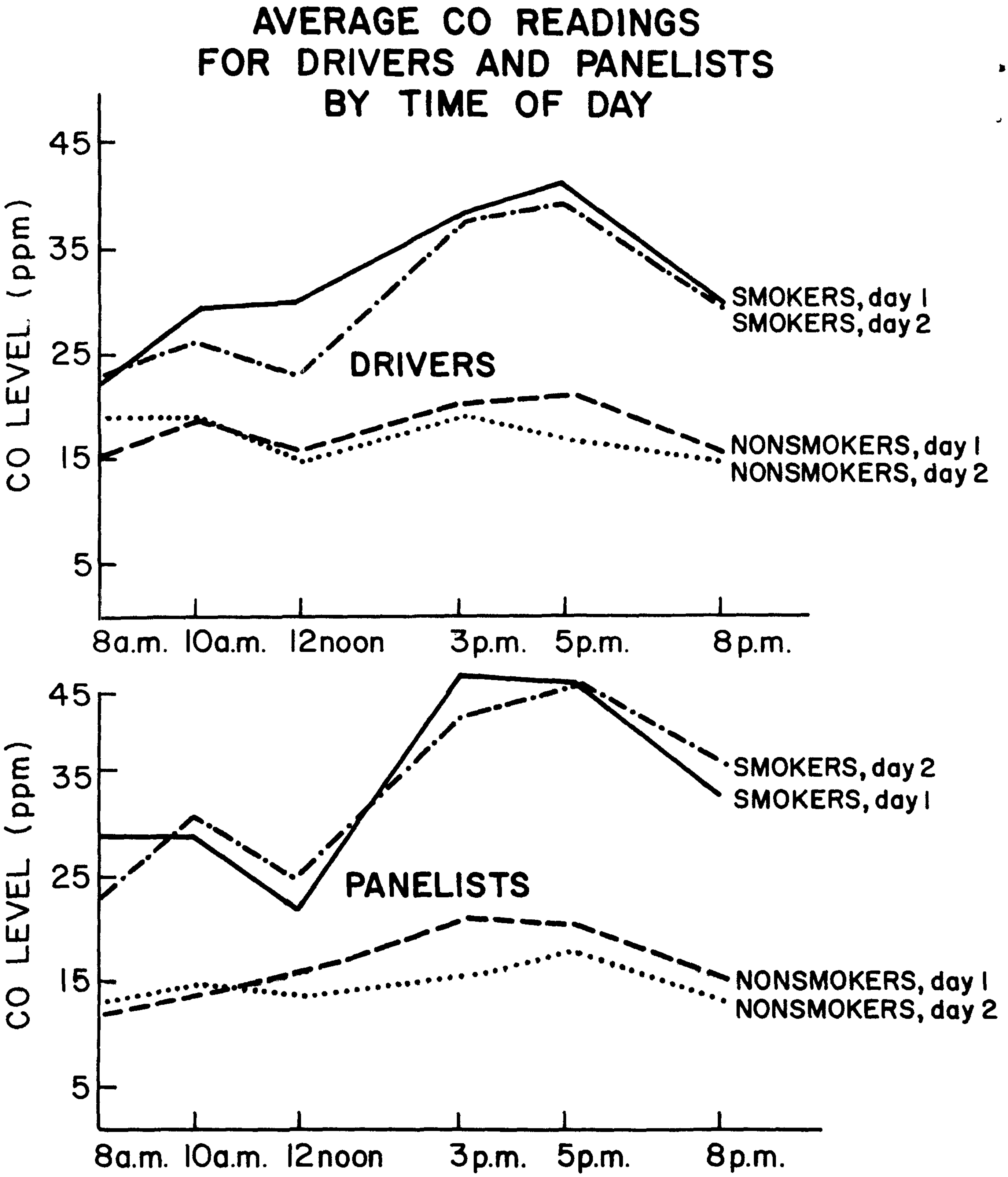

AVERAGE CO READINGS
FOR SMOKERS AND NONSMOKERS
BY TIME OF DAY
NONSMOKERS
CO LEVEL (ppm)
45
35
25
15
5
PANELISTS, day 1
DRIVERS, day 2
DRIVERS, day 1
PANELISTS, day 2
8 a.m.
10 a.m
12 noon
3 p.m.
5 p.m.
8 p.m.
SMOKERS
PANELISTS, day 1
PANELISTS, day 2
DRIVERS, day 1
DRIVERS, day 2

FIGURE 3


AVERAGE CO READINGS
FOR DRIVERS AND PANELISTS
BY TIME OF DAY
CO LEVEL (ppm)
45
35
25
15
5
DRIVERS
SMOKERS, day 1
SMOKERS, day 2
NONSMOKERS, day 1
NONSMOKERS, day 2
8a.m.
10a.m.
12noon
3p.m.
5p.m.
8p.m.
PANELISTS
SMOKERS, day 2
SMOKERS, day 1
NONSMOKERS, day 1
NONSMOKERS, day 2

APPENDIX B

STATISTICAL CORRELATION OF ALVEOLAR AIR CARBON MONOXIDE CONCENTRATIONS AND CARBOXYHEMOGLOBIN USING SPEARMAN RANK CORRELATION TEST

Statistical Correlation of Alveolar Air Carbon Monoxide Concentration and Carboxyhemoglobin Using Spearman Rank Correlation Test

All values of the simultaneous readings of CO* and COHb* were roughly plotted on a scatter diagram. It was found through observation that the comparison between the two values did not approximate a normal distribution. It was, therefore, decided not to accept the correlation coefficient test since the assumption of normality of distribution must be made for the test to be valid. Conversion of the CO and COHb values to logarithms still left doubt as to the normalcy of distribution, although normalcy was being approached.

Thus, the Spearman Rank Correlation Test was applied since normal distribution of values would not be a limiting factor. Three tests were performed. The first was to correlate all CO and COHb readings taken as a single group, without regard to smoking. The formula for the test was:

$$r = 1 - \frac{6\Sigma (d)^2}{n^3 - n}$$

where r = correlation, d = difference of the ranks, and n = 91. This gave a value of r= 0.5531. A test of significance gave $t_{n-2} = 6.26$, which indicates a statistical significance at the 1% level.

The second test, using non-smokers only, resulted in values of r = 0.4002 (n = 48) and $t_{n-2} = 2.96$ significant at the 1% level. The final test using only smokers resulted in values of r = 0.0795 (n = 43) and $t_{n-2} = 0.51$, showing no statistical significance.

*CO concentration is measured in ppm (parts per million) and COHb in % (per cent)

APPENDIX C

DATA ON COHb BY FINGER PRICK AND ALVEOLAR AIR CO

Levels of COHb (%) and Alveolar Air CO (ppm) for 4 Panelists and 4 Drivers

Non-Smokers

		Driver A		Panelist A	
Time		% COHb	CO (ppm)	%COHb	CO
Day 1	8 a.m.	2.7	16	1.5	10
	10 a.m.	2.2	18	7.5	10
	12	2.6	21	2.6	10
	3 p.m.	4.3	22	1.8	20
	5	2.6	21	2.8	21
	8	1.5	18	2.9	11
Day 2	8 a.m.	1.5	20	1.3	11
	10	2.3	21	3.6	14
	12	5.3	19	2.4	13
	3 p.m.	3.5	22	2.2	18
	5	1.5	17	4.7	17
	8	.1	12	.1	7

		Driver B		Panelist B	
Day 1	8 a.m.	2.2	15	2.6	16
	10.30	0	15	2.8	20
	12.30	2.1	12	2.8	11
	3.15	3.5	22	2.4	16
	5.30	2.9	18	2.8	22
	8	3.6	35	2.8	23
Day 2	8 a.m.	3.8	22	1.1	14
	10	3.0	23	2.5	18
	12	3.4	23	3.7	18
	3	3.2	25	3.1	19
	5	3.0	22	2.3	20
	8	1.3	21	2.5	17

Levels of COHb (%) and Alveolar Air CO (ppm) for 4 Panelists and 4 Drivers

Smokers

Time		Driver C % COHb	Driver C CO (ppm)	Panelist C %COHb	Panelist C CO
Day 1	8 a.m.	6.2	29	6.9	28
	9.35	8.1	41	6.5	45
	11.45	11.0	40	8.6	15
	2.30 p.m.	17.8	35	7.4	45
	5	12.5		10.4	-
	8	12.8	36	8.9	31
Day 2	8 a.m.	7.9	30	10.2	8
	10	13.1	35	7.9	24
	11.45	11.5	23	16.2	32
	2.30	13.4	31	14.0	34
	4.30	22.0	38	8.5	37
	8	12.2	23	17.3	44

Time		Driver D % COHb	Driver D CO (ppm)	Panelist D %COHb	Panelist D CO
Day 1	8 a.m.	2.0	12	1.1	-
	10.45	5.7	50	3.0	33
	12.30	7.7	50	3.1	50
	3.15	5.5	13	6.5	39
	5	6.5	50	4.3	50
	8	6.6	45	7.8	45
Day 2	8 a.m.	3.3	38	6.4	30
	12	3.2	22	3.1	10
	2.45	6.3	32	1.7	39
	5	4.6	37	1.7	39
	8	-	19	4.9	19

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-650/1-74-001	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE The Use of Panelists as Substitutes for Taxicab Drivers in Carbon Monoxide Exposure.		5. REPORT DATE July 1973 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) A. Walter Hoover, M.D. & Robert M. Albrecht, M.D.		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Division of Environmental Health Sciences School of Public Health, Columbia University 600 West 168th Street New York, N.Y. 10032		10. PROGRAM ELEMENT NO. 1A1007 21AFU 11. CONTRACT/GRANT NO. CAMP-8-68(1-68) and CPA 22-69-97
12. SPONSORING AGENCY NAME AND ADDRESS Coordinating Research Council, Inc, 30 Rockefeller Plaza, New York, N.Y. 10020 and The Environmental Protection Agency, Research Triangle Park, North Carolina 27711		13. TYPE OF REPORT AND PERIOD COVERED Final Report 14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

Analyses of breath and limited blood samples from 30 pairs of taxi drivers and panelists who drove in New York City traffic for 8 hours on two consecutive days indicated that both panelists and drivers attained similar COHb (blood carboxyhemoglobin) levels. This was true for both smokers and non-smokers though smokers had significantly higher concentrations of COHb than non-smokers. There was no consistent difference between the first and second day of driving in the levels of alveolar carbon monoxide.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
carbon monoxide exposure smoking driving blood carboxyhemoglobin level (COHb)	CRC-APRAC Project No. CAPM-8-68 (1-68)	Plumonary Physiology Environmental Toxicology
18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS (This Report) N/A 20. SECURITY CLASS (This page)	21. NO. OF PAGES 35 22. PRICE

EPA Form 2220-1 (9-73)