TABLE 4. — *Effects of carbon monoxide on psychomotor functions — Continued*

Reference	Test or Measurement	CO level ppm	COHb level (Percent)	Effect
Fodor, G.G., Winneke, G. (*19*)	Attentiveness to auditory stimuli	50 x 5 hrs.	2-5	Decreased
	Flicker fusion	50 x 5 hrs.	2-5	No change
	Speed of motor performance	50 x 5 hrs.	2-5	No change
	Perception of complex visual patterns	50 x 5 hrs.	2-5	Improved
Schulte, J.H. (*43*)	Cognitive function	100	5	Decreased
	Reaction time		20	No change
Bender, W., et al. (*6*)	Threshold for temporal resolution of visual stimuli	100	7.25	Raised
	Manual dexterity	100	7.25	Decreased
	Learning meaningless syllables	100	7.25	Decreased
	Retention of 10 syllables for 1 hr	100	7.25	No change
Groll-Knapp, E., et al. (*22*)	Attentiveness to auditory stimuli	50 100 150		Deterioration at 50 ppm, worse at 100 ppm, worst at 150 ppm
Wright, G., et al. (*50*)	Reaction time		6.3	Prolonged
	Glare recovery		6.3	Prolonged
	Careful driving habits		6.3	Failure to improve with practice

Two government sponsored studies have attempted to evaluate the degree of minor irritation due to cigarette smoke experienced by bus and plane passengers. The U.S. Department of Transportation (*44*) studied the environment on two ventilated buses – one with simulated unrestricted smoking and another with simulated smoking limited to the rear 20 percent of the seats. In one bus, lighted cigarettes were placed at every other seat (23 cigarettes) to simulate a bus filled with smokers. In the other bus, cigarettes were placed only in the rear 20 percent of the bus (five cigarettes) to simulate a bus where smoking was limited to the rear 20 percent of the seats. When smoking was limited, the CO level at the driver's seat was only 18 ppm (ambient air 13 ppm) compared to the level of 33 ppm (ambient air 7 ppm) measured in the unrestricted smoking situation. Four of the six subjects seated in the bus reported eye irritation during the unrestricted smoking simulation. None of the six subjects reported any eye irritation in the restricted smoking situation (not even those seated in the rear 20 percent of the bus).

Several Federal agencies (*48*) cooperated to survey the symptoms experienced by travelers on both military and commercial aircraft. They distributed a questionnaire to passengers on 20 military and 8 commercial flights; 57 percent of the passengers on the military flights and 45 percent of the passengers on the commercial flights were smokers. The planes were well ventilated and CO levels were always below 5 ppm with low levels of other pollutants as well. In spite of the low level of measurable pollution, over 60 percent of the nonsmoking passengers and 15 to 22 percent of the smokers reported being annoyed by the other passengers' smoking. Seventy-three percent of the nonsmoking passengers on the commercial flights and 62 percent of the nonsmoking passengers on the military flights suggested that some remedial action be taken; 84 percent of those suggesting remedial action felt that segregating the smokers from nonsmokers would be a satisfactory solution. These feelings were even more prevalent among those nonsmokers who had a history of respiratory disease.

Children have been found to have a higher incidence of respiratory infections than adults and are thought to be more sensitive to the effects of air pollution due to their greater minute ventilation per body weight than adults. Several researchers have investigated the effects of parental smoking on the health of children. Cameron, et al. conducted two telephone surveys of Detroit families to determine the relationship between children's respiratory illness and parental smoking habits. In the first survey (*9*) they found a statistically significant relationship between the prevalence of

children's respiratory infection and parental smoking habits only when all children under 16 were considered (not when only those under 9 or under 5 were considered). In a larger survey of the same city (*10*) they found a relationship between parental smoking and prevalence of respiratory illness in the 10- to 16-year age group and in the birth to 5-year age group. Neither study controlled for smoking by the children which might be a factor in the 10- to 16-year age group or for socioeconomic status which has an effect on both smoking habits and illness. However, the data were consistent with a higher prevalence of respiratory disease in families where there are smokers than in nonsmoking families.

Colley (*12*) also found a relationship between parental smoking habits and the prevalence of respiratory illness in the children. He found an even stronger relationship between parental cough and phlegm production and respiratory infections in children. He postulates this latter relationship to result from the greater infectivity of these parents due to their cough and phlegm production. The relationship between parental cigarette smoking and respiratory infection in their children would then occur because cigarette smoking caused the parents to cough and produce phlegm and would not be indicative of a direct effect of cigarette smoke-filled air on the children.

Harlap and Davies (*29*) studied infant admissions to Hadassah Hospital in West Jerusalem and found a relationship between admissions for bronchitis and pneumonia in the first year of life and maternal smoking habits during pregnancy. Data on maternal smoking habits after the birth of the child were not obtained, but it can be assumed that most of the mothers who smoked during pregnancy continued to smoke during the first year of the infant's life. A relationship between infant admission and maternal smoking habits was demonstrable only between the sixth and ninth months of infant life and was more pronounced during the winter months (when the effect of cigarette smoke on the indoor environment would be greatest). Mothers who smoke during pregnancy are known to have infants with a lower average birth weight than the infants of nonsmoking mothers. The relationship between maternal smoking and their infants' admission to the hospital found in this study was greater for low birth weight infants, but was also found for normal birth weight infants (Table 5) (*29*). Harlap and Davies (*29*) demonstrated a dose-response relationship for maternal smoking and infant admission for bronchitis and pneumonia; however, they also found a relationship between maternal smoking and infant admissions for poisoning and injuries. This may indicate a bias in the study

TABLE 5.– *Admission rates (per 100 infants) by diagnosis, birth weight, and maternal smoking*

Diagnosis	Birth weight (g)						Total (including unknown)	
	≤2,999		3,000 - 3,499		3,500+			
	S (297)	NS (2,326)	S (415)	NS (4,098)	S (264)	NS (3,195)	S (986)	NS (9,686)
Bronchitis and pneumonia	19.2	12.3	9.6	8.2	12.1	9.0	13.1	9.5
All other	22.6	19.9	14.5	14.6	15.2	13.3	16.9	15.5
Total	41.8	32.2	24.1	22.8	27.3	22.3	30.0	24.9

NOTE. – S=Smokers; NS=Nonsmokers.
Source: Harlap, S., Davies, A.M. (*29*).

due to relationships which may exist between smoking and factors such as parental neglect or socioeconomic class. In addition, hospital admission rates may not be an accurate index of infant morbidity.

Colley, et al. (*13*) studied the incidence of pneumonia and bronchitis in 2,205 children over the first 5 years of life in relation to the smoking habits of both parents. They found that a relationship between parental smoking habits and respiratory infection in children occurred only during the first years of life (Table 6). They also showed a relationship between parental cough and phlegm production and infant infection (Table 6) which was found to be independent of the effect of parental smoking habits. The relationship between parental smoking and infant infection was greater when both parents smoked and increased with increasing number of cigarettes smoked per day. The relationship persisted after social class and birth weight had been controlled for.

Thus, respiratory infections during the first year of life are closely related to smoking habits independent of parental symptoms, social class, and birth weight. Because of the dose-response relationship between parental smoking and infant respiratory infection established by Colley, et al. (*13*), it is reasonable to suspect that cigarette smoke in the atmosphere of the home may be the cause of these infections; however, other factors such as parental neglect may also play a role.

The above studies examined the effects of involuntary smoking on relatively healthy people. A substantial proportion of the U.S. population suffers from chronic cardiovascular and pulmonary diseases, however, and they represent the segment of the population most seriously jeopardized by conditions found in involuntary smoking situations. In Chapter 1 of this report (Cardiovascular Diseases) evidence was presented which showed that levels of CO sometimes experienced in smoke-filled environments (50 ppm) are capable of significantly decreasing the exercise tolerance of persons with angina pectoris and intermittent claudication. In addition, these levels of CO have been shown to decrease cardiac contractility and to raise left ventricular end-diastolic pressure (an indication of heart failure) in persons with cardiovascular disease.

Persons with chronic bronchitis and emphysema have considerable excess mortality under conditions of severe air pollution. In smoke-filled environments levels of CO and several other pollutants may be as high or higher than occur during air pollution emergencies. The effects of short-term exposure of persons with chronic obstruc-

TABLE 6. – *Pneumonia and bronchitis in the first 5 years of life by parents' smoking habit and morning phlegm*

Year of Followup	Annual incidence of pneumonia and bronchitis per 100 children (Absolute numbers in parentheses)									
	Both nonsmokers		One smoker		Both smokers		Both ex-smokers or one ex-smoker or smoking habit changed		All	
	N	O/B	N	O/B	N	O/B	N	O/B	N	O/B
1	7.6 (343)	10.3 (29)	10.4 (424)	14.8 (128)	15.3 (339)	23.0 (139)	8.2 (546)	13.2 (129)	10.1 (1,652)	16.7 (425)
2	8.1 (322)	8.3 (36)	7.1 (365)	15.5 (129)	8.7 (286)	9.2 (152)	6.5 (599)	10.7 (159)	7.4 (1,572)	11.3 (476)
3	6.9 (305)	8.1 (37)	10.5 (353)	9.4 (107)	7.9 (242)	11.0 (154)	8.2 (661)	11.6 (173)	8.4 (1,561)	10.6 (471)
4	8.0 (287)	11.1 (36)	7.5 (306)	10.8 (102)	7.6 (236)	11.6 (121)	8.2 (695)	9.1 (187)	7.9 (1,524)	10.3 (446)
5	6.7 (285)	14.7 (34)	5.6 (267)	9.4 (107)	3.9 (208)	10.6 (132)	6.4 (737)	7.3 (219)	5.9 (1,497)	9.1 (492)

NOTE. – N=neither with winter morning phlegm. O/B=one or both with winter morning phlegm.
Source: Colley, J.R.T., et al. (*13*).

tive bronchopulmonary disease (COPD) to these conditions have not been evaluated. Persons with COPD are also possibly at increased risk to CO exposure because of their low alveolar Po_2. Due to the reduced amount of oxygen available to compete with the CO for hemoglobin binding sites, these persons might experience a carboxyhemoglobin to oxyhemoglobin ratio higher than those in healthy subjects under the same conditions of CO exposure. The retention of CO may also be prolonged due to both this increased binding of CO to hemoglobin under low alveolar Po_2 and decreased ventilatory capacity to excrete CO.

In summary, the effects of cigarette smoke on healthy nonsmokers consists mainly of minor eye and throat irritation. However, people with certain heart and lung diseases (angina pectoris, COPD, allergic asthma) may suffer exacerbations of their symptoms as a result of exposure to tobacco smoke-filled environments. These effects are dependent on the degree of individual exposure to cigarette smoke which is determined by proximity to the source of the tobacco smoke, the type and amount of tobacco product smoked, conditions of room size and ventilation as well as the amount of time the individual spends in the smoke-filled environment, and his physiologic condition at the time of exposure.

SUMMARY

1. Tobacco smoke can be a significant source of atmospheric pollution in enclosed areas. Occasionally under conditions of heavy smoking and poor ventilation, the maximum limit for an 8-hour work exposure to carbon monoxide (50 ppm) may be exceeded. The upper limit for CO in ambient air (9 ppm) may be exceeded even in cases where ventilation is adequate. For an individual located close to a cigarette that is being smoked by someone else, the pollution exposure may be greater than would be expected from atmospheric measurements.

2. Carbon monoxide, at levels occasionally found in cigarette smoke-filled environments, has been shown to produce slight deterioration in some tests of psychomotor performance, especially attentiveness and cognitive function. It is unclear whether these levels impair complex psychomotor activities such as driving a car. The effects produced by CO may become important when added to factors such as fatigue and alcohol which are known to have an effect on the ability to operate a motor vehicle.

3. Unrestricted smoking on buses and planes is reported to be annoying to the majority of nonsmoking passengers, even under conditions of adequate ventilation.

4. Children of parents who smoke are more likely to have bronchitis and pneumonia during the first year of life, and this is probably at least partly due to their being exposed to cigarette smoke in the atmosphere.

5. Levels of carbon monoxide commonly found in cigarette smoke-filled environments have been shown to decrease the exercise tolerance of patients with angina pectoris.

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