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Comparison of Effect on Tobacco Consumption and Carbon Monoxide Absorption of Changing to High and Low Nicotine Cigarettes

M. A. H. RUSSELL, C. WILSON, U. A. PATEL. P. V. COLE, C. FEYERABEND

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Summary

In 10 sedentary workers, smoking as they felt inclined over a five-hour period in the middle of a typical working day, changing to low nicotine cigarettes (<0·3 mg) caused an increase in the number and weight of cigarettes smoked, while changing to high nicotine cigarettes (3·2 mg) caused a decrease ($P < 0·01$). The average number and weight smoked in five hours for usual, low, and high nicotine brands were respectively 10·6 (6·00 g), 12·5 (6·52 g), and 6·7 (4·19 g). When smoking the usual brand the average blood carboxyhaemoglobin (COHb) increased 1·78% (from 6·38% to 8·16%). But on changing to either high or low nicotine cigarettes the COHb levels instead of increasing, tended to fall ($P < 0·01$). The average fall of 0·34% while smoking low nicotine cigarettes was due to the low carbon monoxide (CO) yield of these cigarettes, while the fall of 1·04% when smoking high nicotine cigarettes was attributable to reduced consumption. The findings support the view that smoking behaviour is modified to regulate nicotine intake. Besides having low tar and CO yields, the least harmful cigarettes for heavy smokers may be those with a high, rather than low, nicotine yield.

Introduction

On 11 April 1973 the Government published for the first time the tar and nicotine yields of 101 brands of cigarette sold in the United Kingdom (D.H.S.S., 1973; "Public Health," 1973). Behind the publication of this "league table" lies the assumption that it is less hazardous to smoke cigarettes with a low yield of tar and nicotine (Royal College of Physicians, 1971; Wynder, 1972). Recently we have shown that cigarettes also vary in their carbon monoxide (CO) yield (Russell *et al.*, 1973 a). This suggests that any consideration of a cigarette's degree of hazard is incomplete without information about its CO yield, and that CO yield should be added to official publications of tar and nicotine yield.

Safer though it may be to take in less nicotine, tar, and CO, to what extent is this achieved by changing to a low nicotine cigarette? The information available is scanty and conflicting. It has, for instance, been clearly shown in two independent studies (Ashton *et al.*, 1970; Frith, 1971) that smokers unconsciously modified their puff rate to regulate their nicotine intake. When smoking a high nicotine cigarette they puffed less often and when smoking a low nicotine cigarette they increased their puff rate and thus compensated for the low nicotine yield. A change to cigarettes of lower nicotine yield, however, does not seem to lead to increased consumption in terms of the number smoked per day (Waingrow and Horn, 1968), nor does reducing the nicotine yield by cutting cigarettes to half length cause a compensatory increase in the number smoked (Goldfarb and Jarvik, 1972). There is, however, some evidence that as the nicotine content of the cigarette is increased the number smoked declines (Goldfarb *et al.*, 1970).

The main aim of this study was to attempt to resolve the question of the role of nicotine yield as a determinant of the amount of cigarettes smoked. If lowering the nicotine yield does indeed give rise to a compensatory increase in inhalation with consequent increased absorption of tar and CO, or if raising the nicotine yield lowers the amount smoked, the assumption that low nicotine cigarettes are less hazardous would need to be re-examined (Russell, 1972). It would then become necessary to focus on the ratio of the nicotine yield to the tar and CO yield and to consider the possibility that the safer cigarette might be the one with a high nicotine yield but low tar and CO yield.

We have also attempted to verify predictions arising out of the findings of previous work (Russell *et al.*, 1973 a) which indicated that the smoking frequency would have to be extremely high for the COHb level to increase appreciably wh smoking cigarettes with a low CO yield. For example, smoke

Addiction Research Unit, Institute of Psychiatry, Maudsley Hospital, London SE5 8AF

M. A. H. RUSSELL, M.R.C.P., M.R.C.PSYCH., Senior Lecturer and Honorary Consultant

C. WILSON, B.SC., Research Worker

U. A. PATEL, M.SC., Statistician

St. Bartholomew's Hospital, London EC1A 7BE

P. V. COLE, M.B., F.F.A. R.C.S., Consultant Anaesthetist

Poisons Unit, New Cross Hospital, London SE14 5ER

C. FEYERABEND, B.SC., Research Worker

with blood COHb levels in the region of 6–7% would have to smoke at least one of these cigarettes every 20 minutes just to maintain the same level.

Methods

Ten clerical and social workers volunteered to take part in the experiment. All were regular cigarette smokers who said that they inhaled deeply. Cigarette consumption was studied over four five-hour periods, from mid-morning to mid-afternoon, on four separate working days; two consecutive days of one week and the same two days of the following week. On the first day of each week's dyad the subjects smoked their usual brand of cigarette and on the second day they smoked either a high or a low nicotine cigarette. Half the subjects were randomly assigned to smoke the low nicotine cigarette on the first week and the high nicotine cigarette on the second week; with the other half this order was reversed (see tables I and II). The high nicotine cigarette used was Capstan Full Strength (tar 38 mg, nicotine 3·2 mg), and the low nicotine cigarette was Silk Cut Extra Mild (tar 4 mg, nicotine <0·3 mg). These two cigarettes occupy the top and bottom positions of the current tar and nicotine "league table" (D.H.S.S., 1973; "Public Health," 1973). The low nicotine cigarette was filter tipped but the high nicotine one was plain.

For each of the five-hour periods studied subjects were given an adequate supply of the appropriate brand of cigarette with instructions not to offer them to others and to smoke as much or as little as they felt inclined, but only from the cigarettes supplied. We estimated the number of cigarettes smoked by subtracting the remaining cigarettes from the number in the full packets which were supplied. Subjects also stored their cigarette ends and this provided an additional check on the number smoked and enabled consumption to be calculated in terms of the weight of cigarettes burned up in the five-hour study period.

Venous blood was taken before and after each five-hour period. No restrictions were placed on smoking on the morning before the experiment, but to avoid error due to variation in time-span between the last cigarette and collection of the blood sample subjects were required to smoke a cigarette im-

TABLE I—*Changes in Cigarette Consumption of Sedentary Workers over Five-hour Period of Smoking Usual, Low Nicotine, and High Nicotine Cigarettes*

Subjects			Usual Cigarettes Smoked			Cigarette Consumption over Five-hour Period							
						First Week				Second Week			
						Usual Brand (Day 1)		Experimental Brand (Day 2)		Usual Brand (Day 1)		Experimental Brand (Day 2)	
No.	Sex	Age	Brand	Nicotine Yield (mg)	No./day	No.	Weight (gg)	No.	Weight (gg)	No.	Weight (gg)	No.	Weight (gg)
1	M.	25	Player's No. 6 Filter	1·2	25	9	3·97	9*	4·97	13	5·55	8†	5·73
2	M.	19	Embassy Filter	1·3	30	9	6·28	15*	8·87	8	5·46	7†	6·07
3	F.	20	Embassy Filter	1·3	17	6	3·60	8*	4·02	4	2·64	4†	2·35
4	F.	23	Gitanes Caporal Filter	1·4	35	12	7·99	13*	6·50	16	9·84	9†	5·14
5	F.	22	Embassy Filter	1·3	30	19	10·32	17*	8·18	16	8·35	5†	1·78
6	M.	25	Rothman's King Size	1·4	35	12	9·14	6†	3·66	12	8·80	15*	8·22
7	M.	63	Player's Weights Plain	1·6	18	10	5·31	7†	5·29	11	6·14	14*	7·18
8	F.	26	Player's Gold Leaf	1·5	35	10	6·26	8†	4·59	7	3·74	15*	7·66
9	F.	48	Player's No. 6 Filter	1·2	25	6	2·83	5†	3·02	9	3·96	10*	5·36
10	F.	29	Player's No. 6 Filter	1·2	22	12	5·08	8†	4·22	12	4·78	9*	4·25
Mean ± S.D.		30 ± 14·2		1·34 ± 0·13	27·2 ± 6·86	10·5 ± 3·7	6·08 ± 2·44			10·8 ± 3·9	5·93 ± 2·37		

*Low nicotine cigarette.
†High nicotine cigarette.

TABLE II—*Changes in COHb Levels in Sedentary Workers before and after Five-hour Period of Smoking Usual, Low Nicotine, and High Nicotine Cigarettes*

Subjects			Blood Carboxyhaemoglobin Levels (%)											
			First Week						Second Week					
			Usual Brand (Day 1)			Experimental Brand (Day 2)			Usual Brand (Day 1)			Experimental Brand (Day 2)		
No.	Sex	Age	Before	After	Difference	Before	After	Difference	Before	After	Difference	Before	After	Difference
1	M.	25	6·2	9·0	+2·8	7·0	7·3*	+0·3	8·2	10·8	+2·6	8·0	‡†	
2	M.	19	6·1	8·7	+2·6	7·4	7·3*	−0·1	8·0	9·7	+1·7	8·3	6·9†	−1·4
3	F.	20	3·7	4·3	+0·6	4·0	3·9*	−0·1	5·6	4·9	−0·7	4·8	3·7†	−1·1
4	F.	23	5·0	9·5	+4·5	7·8	6·5*	−1·3	6·9	13·0	+6·1	6·7	7·2†	+0·5
5	F.	22	5·2	9·1	+3·9	6·3	8·0*	+1·7	3·9	8·8	+4·9	4·3	2·8†	−1·5
6	M.	25	5·5	7·9	+2·4	4·7	3·9†	−0·8	6·4	8·4	+2·0	6·2	7·4*	+1·2
7	M.	63	7·3	9·2	+1·9	7·1	6·5†	−0·6	7·6	9·1	+1·5	7·7	7·6*	−0·1
8	F.	26	4·6	6·3	+1·7	3·4	4·0†	+0·6	5·1	5·0	−0·1	4·8	5·1*	+0·3
9	F.	48	10·2	9·3	−0·9	10·3	6·7†	−3·6	11·4	8·6	−2·8	11·2	6·2*	−5·0
10	F.	29	5·0	6·6	+1·6	5·6	4·1†	−1·5	5·6	5·0	−0·6	2·6	‡*	
Mean ± S.D.		30 ± 14·2	5·88 ± 1·81	7·99 ± 1·72	2·11 ± 1·55				6·87 ± 2·09	8·33 ± 2·68	1·46 ± 2·67			

*Low nicotine cigarette.
†High nicotine cigarette.
‡Blood specimen clotted.

mediately before each blood sample, which was then taken about three minutes after completion of that cigarette. The blood samples were collected in heparinized syringes which were capped and stored in a refrigerator. The analysis for COHb was done on the same day with an IL 182 CO-Oximeter. This is an accurate method with reproducibility having 95% confidence limits within 0·1% COHb (Russell *et al.*, 1973 b).

Visual analogue scales (Aitken, 1969) were used for comparing the different brands of cigarette on subjective ratings of "satisfaction," "strength," and "taste evaluation." Subjects indicated their ratings by making a mark at the appropriate point on a series of 100-mm horizontal lines between two extremes. Average test-retest reliability for all scales between morning and afternoon ratings of the usual brand of cigarette was satisfactory ($r = 0.91$). Statistical analysis was by Student's t test.

Results

CHANGES IN NUMBER OF CIGARETTES SMOKED

When subjects were smoking their usual brand of cigarette the number smoked over the five-hour experimental period was fairly consistent from one week to the next ($r = 0.75$; $P < 0.02$), the means for the first and second week being 10·5 and 10·8 respectively (table I). On changing to low nicotine cigarettes the numbers smoked increased from a mean of 10·6 (for the usual brand) to 12·5 (table III) but this increase is not statistically significant ($t = 1.8$; D.F. = 9). On changing to high nicotine cigarettes, however, there was a 38% decrease from a mean of 10·7 to 6·7 ($t = 3.8$; D.F. = 9; $P < 0.01$). The difference is even more striking when the average number smoked of the low and high nicotine cigarettes is compared (12·5 *v.* 6·7; $t = 5.3$; D.F. = 9; $P < 0.001$).

CHANGES IN WEIGHT OF CIGARETTES SMOKED

The differences between brands in the weight of cigarettes smoked in the five-hour period are of a similar pattern to the differences in numbers smoked (tables I and III). There was great consistency between the first and second weeks in the weight smoked of the usual brand, the respective means being 6·08 g and 5·93 g ($r = 0.81$; $P < 0.01$). The tendency to smoke slightly more of the low nicotine cigarettes was not statistically significant, but the tendency to smoke less of the high nicotine cigarettes compared with the usual brand was significant (4·19 g *v.* 6·04 g; $t = 2.2$; D.F. = 9; $P < 0.05$). The difference in the weight smoked of low and high nicotine cigarettes was also significant (6·52 g; *v.* 4·19 g; $t = 3.6$; D.F. = 9; $P < 0.01$).

COHb CHANGES

The average initial COHb level over all four days was 6·48% (± 2·05 S.D.). It was fairly consistent between the four days (see tables II and III: $r = 0.78$ to 0.93; $P < 0.01$). When the subjects were smoking their usual cigarettes the percentage of COHb showed a mean increase of 1·78, from 6·38% to 8·16%, over the five-hour smoking period. This increase is statistically significant ($t = 3.7$; D.F. = 19; $P < 0.005$; first and second week combined). The COHb increase was also fairly consistent from the first to the second week (mean 2·11% *v.* 1·46%; $r = 0.97$; $P < 0.001$). In contrast to the usual brand, when smoking either high or low nicotine cigarettes the COHb levels decreased rather than increased over the five-hour smoking period (table III). On the low nicotine cigarette there was a fall of 0·34%, which differed significantly from the increase on the usual brand ($t = 3.5$; D.F. = 8; $P < 0.01$), while on the high nicotine cigarette the fall of 1·04% also differed significantly from the increase on the usual brand ($t = 4.9$; D.F. = 8; $P < 0.01$). The difference in the COHb decreases on the high and low nicotine cigarettes is not statistically significant.

In the case of the usual brand of cigarette there was a positive relation between COHb increase over five-hours and the amount smoked during this period both in terms of the number of cigarettes smoked ($r = 0.71$; $P < 0.01$) and the weight of cigarettes smoked ($r = 0.78$; $P < 0.01$). However, there was no such association when smoking either the high or the low nicotine cigarettes.

SUBJECTIVE RATINGS OF CIGARETTE BRANDS

The usual brand of cigarette was rated before and after the five-hour smoking period on the first day, and after the smoking period on each of the subsequent days (fig. 1) The values shown are therefore the means of five ratings. The high and low nicotine cigarettes were rated only once, immediately after the five-hour period in which they were smoked. On average the usual cigarettes tasted "very good," were "very satisfying," and were neither "too strong" nor "too weak."

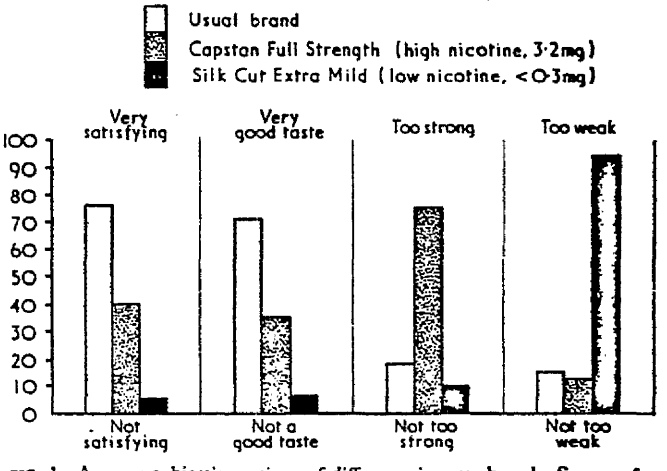

FIG. 1—Average subjective ratings of different cigarette brands. See text for significance of differences.

TABLE III—*Average Consumption and COHb Changes over Five-hour Period of Smoking Usual, Low Nicotine, and High Nicotine Cigarettes*

Brand of Cigarette	Amount Smoked in Five Hours (Mean ± S.D.)		Blood Carboxyhaemoglobin Levels (%) (Mean ± S.D.)		
	No. of Cigarettes	Weight (g)	Before	After	Difference
Usual	10·6 ± 3·6	5·96 ± 2·38	6·23 ± 2·09	7·67 ± 2·04	+1·44 ± 2·21
Silk Cut Extra Mild (nicotine < 0·3 mg)	12·5 ± 3·2	6·52 ± 1·76	6·93* ± 2·06	6·59* ± 1·34	−0·34* ± 1·94
Usual	10·7 ± 3·9	6·04 ± 2·44	6·52 ± 1·95	8·65 ± 2·35	+2·13 ± 2·15
Capstan Full Strength (nicotine 3·2 mg)	6·7 ± 1·6	4·19 ± 1·45	6·13* ± 2·19	5·09* ± 1·70	−1·04* ± 1·25

*Mean of nine subjects. Other means ± 1 S.D. are derived from 10 subjects.
Mean values for usual brand of cigarette differ slightly from those in tables I and II. Values shown here are split across first and second weeks to make a more valid comparis with cross-over "experimental" cigarettes. Thus "experimental" cigarettes are compared with "usual" cigarette vaues of preceding day.

When compared with the usual brand the low nicotine cigarette was much "too weak" ($P<0.001$) and not at all "satisfying" ($P<0.001$) or "good tasting" ($P<0.001$); the high nicotine cigarette, on the other hand, was moderately "satisfying" ($P<0.02$) and "good tasting" (not significant) despite being far "too strong" ($P<0.01$).

PREDICTION OF COHb CHANGES WITH PERIODIC SMOKING

Data from a previous study (Russell *et al.*, 1973 a) were subjected to further analysis to predict and explain the COHb changes of the present study. The regression of COHb level on COHb fall in 20 minutes provides estimates of the expected COHb fall over 20 minutes at rest for the range of COHb levels often found in smokers (see table IV). The estimated half life for COHb based on the regression equation is two to two and a half hours. The average initial COHb level for all subjects on all four days of the present study was 6·48% (see above). The estimated decline over 20 minutes for this initial level is 0·61%. Since the smoking of a single Silk Cut Extra Mild cigarette produces an average COHb increase of only 0·64% (Russell *et al.*, 1973 b), it follows that on average the subjects would have to smoke about one such cigarette every 20 minutes—that is, 15 cigarettes in the five-hour smoking period—to maintain the same COHb level (see fig. 2). In those smoking more than 15 an increase would be expected, while in those smoking fewer than 15 there should be a decrease. This is more or less what happened (see tables I and II). Those subjects (Nos. 2, 5, 6, and 8) who smoked 15 or more of the low nicotine cigarettes (Silk Cut Extra Mild) in five hours tended to maintain or increase their COHb while the only substantial falls occurred in those who smoked fewer cigarettes.

TABLE IV—*Pattern of Decline in Blood COHb Level while Sitting and Not Smoking for 20 minutes*

Blood COHb level (%)	3	4	5	6	7	8	9	10	11
Expected fall in 20 min (%)	0·31	0·40	0·48	0·57	0·66	0·75	0·83	0·92	1·00

Based on data from 22 subjects of a previous study (Russell *et al.*, 1973 b). Regression equation for COHb level on fall in 20 min: $y^1 = 0{\cdot}09 \times + 0{\cdot}05$; $r = 0{\cdot}65$; $P<0{\cdot}01$. Estimated half life for COHb based on this equation is two to two and a half hours.

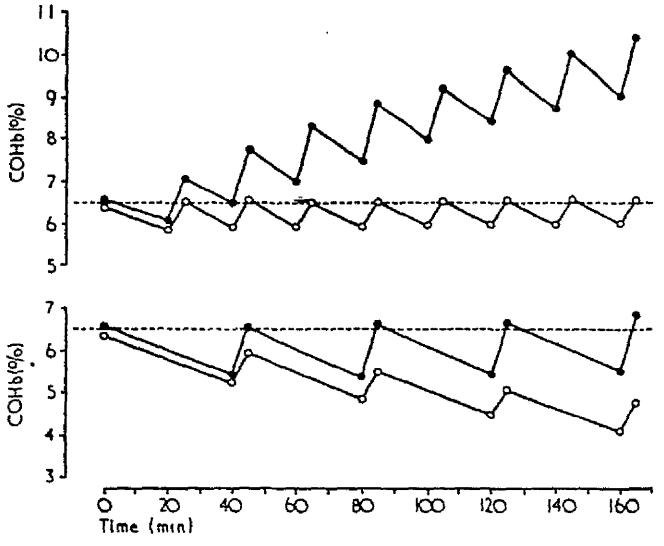

FIG. 2—Predicted pattern of COHb changes on smoking extra-mild (o—o) and non-mild (●—●) cigarettes at 20-min and 40-min intervals in subjects with a mean initial COHb level of 6·5%, (broken rule). Based on data from 22 subjects of a previous study (Russell *et al.*, 1973 b). Regression equation for COHb level on fall in 20 min: $y^1 = 0{\cdot}09 \times + 0{\cdot}05$; $r = 0{\cdot}65$; $P<0{\cdot}01$. See text for mean increases in COHb per cigarette.

There was even more concordance between predictions and findings in the case of "non-mild" cigarettes—that is, usual and high nicotine taken together. Average COHb increase after smoking a single non-mild cigarette was 1·27% (mean of Embassy Filter = 1·45, and Player's No. 6 Filter = 1·09) (Russell *et al.*, 1973 b). Thus, very approximately it would need a smoking rate of about one cigarette every 40 minutes—seven to eight cigarettes in the five-hour smoking period—to offset the expected mean rate of COHb decrease for these subjects (1·17% in 40 minutes; see fig. 2). The findings (tables I and II) show this prediction to be well substantiated. Taking the values for both days on usual cigarettes together with the values for the high nicotine cigarette, of the 19 five-hour periods when eight or more cigarettes were smoked 16 were associated with an increase in COHb whereas there was a fall in COHb in nine out of 10 five-hour periods when less than eight cigarettes were smoked ($P<0.005$, Fisher's exact test).

Discussion

The number of cigarettes smoked by this sample of sedentary workers smoking their usual brand of cigarettes during a five-hour period in the middle of a typical working day averaged 10·6 cigarettes of which 6·00 g was actually burned. The quantity smoked was fairly consistent between a given day of one week and the same day of the next week. When the subjects changed to smoking a low nicotine brand (Silk Cut Extra Mild) the amount smoked increased to a mean of 12·5 cigarettes (6·52 g burned) and when they changed to a high nicotine brand (Capstan Full Strength) the amount smoked decreased to a mean of 6·7 cigarettes (4·19 g burned). The tendency to increase consumption on changing to low nicotine cigarettes did not reach statistical significance but the tendency to reduce consumption of high nicotine cigarettes was statistically significant ($P<0.01$). It is just possible that some of the difference in the number of cigarettes smoked between the usual and "experimental" brands was due to the fact that they were smoked on different weekdays, but this would not have affected the highly significant difference ($P<0.001$) in the amount smoked between the two "experimental" brands (low nicotine and high nicotine) which were smoked on the same weekday.

The subjects were carefully instructed to smoke "as they felt inclined." The consistency from one week to the next when smoking the usual brand of cigarettes and the balanced cross-over design used for the smoking of the two "experimental" brands make it extremely unlikely that the differences in the quantities smoked were due to anything other than differences in inclination to smoke different quantities of the different brands. Such differences in inclination could, however, have been due to differences in either palatability or nicotine yield. The fact that the subjects smoked more of the low nicotine cigarette which was rated very unfavourably and less of the high nicotine cigarette which was rated only moderately unfavourably suggests that the nicotine yield was the most important determinant of the changes in the quantity smoked. These findings therefore support those studies cited above (Ashton *et al.*, 1970; Goldfarb *et al.*, 1970; Frith, 1971) which indicate that regular smokers who inhale modify their smoking behaviour to regulate their nicotine intake.

Previous workers have always shown that the COHb level of smokers is at its lowest in the morning before smoking and that it tends to rise as subjects smoke throughout the day (Bowden and Woodhall, 1964; Goldsmith, 1970; Surgeon General, 1972). This pattern was repeated in the present study when subjects were smoking their usual brand of cigarettes. Over the five-hour period from mid-morning to mid-afternoon the average COHb% increased from 6·38% to 8·16% (tables II and III). But when the subjects changed to smoking either high nicotine or low nicotine cigarettes, instead of increasing,

the COHb level tended to fall slightly. Compared with the average increase of 1·78% when smoking their usual cigarettes, there was an average decrease of 1·04% when smoking high nicotine cigarettes ($P<0·01$) and a decrease of 0·34% when smoking the low nicotine cigarettes ($P<0·01$). The fact that the COHb decreased on switching to high nicotine cigarettes can be accounted for by the reduction in the amount smoked. In the case of the low nicotine cigarettes, however, the decrease in COHb occurred despite an increase in the amount smoked and this is probably explained by the low CO yield of this brand of low nicotine cigarette (Russell *et al.*, 1973 a).

With knowledge gained from our previous study (Russell *et al.*, 1973 b) about the rate of decline of COHb in resting subjects and its dependence on the actual level of COHb, together with data on the very different increase in COHb produced by smoking "non-mild" (Embassy Filter and Player's No. 6 Filter) as opposed to "extra-mild" (Silk Cut Extra Mild) cigarettes, we were able to predict and explain the changes observed in the present study. Due to their low CO yield, the smoking of extra-mild cigarettes does not increase COHb appreciably even when smoked as heavily as one every 20 minutes—that is, about 50 a day (fig. 2). On the other hand, with non-mild cigarettes this high smoking rate would produce a steady increase in COHb to the high levels (10-15%) which occur in heavy smokers. It should be emphasized that these estimates, illustrating COHb fluctuations with smoking, apply only to subjects at rest. The overall tendency for COHb to rise with smoking would be very much less in more physically active subjects. The relation of COHb dynamics to exercise could partly account for the belief that the adverse effects on health of smoking and lack of exercise are synergistic or mutually enhancing. It also suggests that those who spend their evenings smoking heavily while slumped in an armchair for several hours before retiring are especially prone to prolonged exposure to raised COHb levels.

The COHb half life estimated from the regression equation in table IV was only two to two and a half hours. This is appreciably less than the generally accepted figure of three to four hours. (U.S. Public Health Department, 1970). This difference may be explained by the fact that previous determinations of COHb half life have been made after more prolonged exposures to inspired air CO. This allows more time for equilibration between COHb and extravascular sites such as myoglobin than is the case with the brief intermittent exposures to the far higher CO levels (2-5%) (Wynder and Hoffman, 1967) inhaled by tobacco smokers. Though each type of CO exposure may produce equivalent COHb levels, in the former case the COHb decline is due mainly to loss through the lungs while after the acute rise produced by a bout of smoking there may be an additional loss of CO from Hb to myoglobin.

It seems paradoxically to be the case that the two least hazardous cigarettes, at least in terms of CO exposure, are those at the top and bottom of the current tar and nicotine "league table." The low nicotine brand (Silk Cut Extra Mild) produces little rise in COHb levels because of its low CO yield, while the high nicotine yield of the other (Capstan Full Strength) so reduces consumption that again little rise in COHb is produced.

But what about overall safety? Apart from other factors such as the pH of the smoke, the sugar content, and method of curing the tobacco which are not the concern of this study, our findings suggest that for heavy smokers a cigarette would be less harmful if it combined the qualities of the low nicotine and the high nicotine brands by having a low tar and CO yield but a high, rather than low, nicotine yield.

The ideal of a cigarette with a low nicotine, low tar, and low CO yield is unfortunately not feasible for most smokers whose main reason for smoking is to obtain nicotine (Russell, 1971). Besides the tendency for consumption to be increased, low CO yield is unfortunately not feasible for most smokers. None of the 32 smokers in this study and our previous study (Russell *et al.*, 1973 b) were prepared to change permanently to the low nicotine brand (Silk Cut Extra Mild). On the other hand, a cigarette with a high nicotine yield would enable heavy smokers to curb their tobacco consumption, and harmfulness would be further reduced if, at the same time, the tar and CO yields were low.

At present a cigarette combining a high nicotine yield with a low tar and CO yield does not, so far as we know, exist. The correlation between the tar and nicotine yields of the cigarettes on the current "league table" is high (0·96). To reduce tar yield without lowering the nicotine yield presents a challenge to cigarette technology but it is one which the skill and resources available are no doubt capable of meeting; especially if prompted by appropriate selective taxation.

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