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Fallacies of lifestyle cancer theories

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Self-interest of the chemical industry apart, the lifestyle theory of cancer causation is held to reflect misinformation and 'inactive conservatism'.

PETO'S article[1], purporting to be a review of the book *The Politics of Cancer*[2], is largely a restatement of the lifestyle theory of cancer causation. This theory postulates that if you get cancer it is essentially your own fault, and that the causal role of past involuntary exposure to environmental and occupational carcinogens is trivial. Not surprisingly, the lifestyle theory has emerged as the major professed basis of the chemical industry's objections to the regulation of its carcinogenic products and processes[3]. As an enthusiastic proponent of this theory, Peto asserts that smoking-derived and fat-associated cancers "collectively account for more than half of all cancer deaths." As a corollary, of Peto's emphasis on lifestyle factors, he denigrates the role of occupational and environmental carcinogens and the need for their effective regulation, claiming that there has been no recent increase in cancer mortality rates other than that due to smoking. We shall demonstrate that there is scant scientific basis for the lifestyle theory, and that it is in fact contradicted by a substantial body of published evidence.

Cancer rate trends

Peto justifies his emphasis on lifestyle factors by dismissing evidence for recently increasing cancer rates, apart from "that due to the massive effects of smoking on lung cancer". However, there is substantial evidence to the contrary. Standardized cancer death rates, adjusted to the 1940 age structure of the total United States population, show a progressive overall increase of about 7% from 1935 to 1970 (ref. 4) despite marked reductions of stomach cancer rates for unexplained reasons and of cervix cancer rates for reasons including the frequency of elective hysterectomy for non-malignant disease and the success of screening programmes. These trends are consistent with standardized mortality data for the United States (Table 1)[5], where they are even more marked in black males, and with crude mortality data for the United Kingdom (Table 2)[6]. The overall rate of increase in US cancer mortality in the 7-year period from 1969 to 1976 (5.5%), adjusted to the 1970 age structure, is substantial and comparable with that for the preceding 35 years, 1935 to 1970 (7%). The overall increase in incidence rates is even more marked than mortality rates in the past decade, involving a wide range of organs besides the lung (Table 3)[5]. Moreover, the increase in incidence for all sites is comparable with that when lung cancer is excluded (Table 4)[7,8].

Reliance on overall age-adjusted incidence or mortality rates alone is simplistic, as such rates can mask steep increases in organ-specific cancers in high risk population subgroups, such as asbestos insulation workers or menopausal women treated with oestrogen replacement therapy. The overall probability, at today's death rates, of a person born now getting cancer by the age of 85 is 27% for both men and women; this is increased from the 19% for men and 22% for women born in 1950 (ref. 9). Furthermore, recent cancer rate trends reflect exposures and events beginning some 20 or 30 years ago, when the production of synthetic organic chemicals was relatively trivial compared with the present levels. The production of synthetic organic compounds in the United States in 1935, 1950 and 1975 was about 1, 30 and 300 billion pounds per annum, respectively[10]; sharp increases have also been observed for a wide range of derived industrial products such as chlorinated hydrocarbon solvents, plastics and resin materials, and of industrial carcinogens, such as vinyl chloride and acrylonitrile. It is reasonable to anticipate that greater production has been paralleled by increased exposure of increasing numbers of both the workforce and the general public, which is likely further to accentuate increasing trends in cancer rates. It must also be recognized that before the 1976 Toxic Substances Act, which the chemical industry so effectively stalled for so long[11], there were no requirements for testing chemicals before their introduction into commerce (with the exception of special-purpose legislation for drugs, pesticides and food additives). Thus, the overwhelming majority of industrial chemicals now in use have never been tested for chronic toxic and carcinogenic effects, let alone for ecological effects.

Role of smoking

As emphasized in *The Politics of Cancer*[1] (p. 178), "Smoking is the single most important cause of lung cancer, as well as of cancer at other sites, chronic bronchitis and emphysema, and cardiovascular diseases". Less well appreciated by lifestyle advocates is that overemphasis on smoking is widely used to divert attention from occupational causes of lung and other cancers. Of the approximately 100,000 annual lung cancer deaths in the United States, at least 20% occur in nonsmokers. It is relevant that lung cancer death rates in nonsmokers approximately doubled[12] from 1958 to 1969, an increase maintained since. Furthermore, the role of occupational exposure to carcinogens was not recognized in most of the classic epidemiological studies which linked lung cancer with smoking. This led to overestimation of the contribution of smoking compared with occupational risks or to their possible interactions.

Table 1 Age-adjusted cancer mortality rates per 100,000 US population for selected sites by sex and year 1969–76, and average per cent change*

Site	Sex†	Mortality rate per 100,000		Average % change 1969–76	
		1969	1976	Annual	7-Year
All sites	WM	195.0	210.2	0.9	7.8
	WF	129.0	133.8	0.5	3.7
Stomach	WM	10.6	8.7	−2.9	−17.4
	WF	5.3	4.1	−3.6	−22.6
Colon	WM	18.7	20.7	1.3	10.7
	WF	16.2	16.5	0.0	1.9
Rectum	WM	6.9	5.6	−3.0	−18.8
	WF	3.9	3.2	−3.1	−17.9
Pancreas	WM	11.0	11.0	0.0	0.0
	WF	6.6	6.8	0.3	3.0
Lung	WM	55.0	66.7	2.6	21.3
	WF	10.2	17.8	7.6	74.5
Melanoma	WM	2.0	2.6	4.0	30.0
	WF	1.4	1.6	0.8	14.3
Breast	WF	26.2	27.2	0.3	3.8
Cervix	WF	5.5	3.9	−4.9	−29.1
Uterus	WF	4.6	4.2	−1.7	−10.5
Prostate	WM	19.0	21.0	1.2	8.7
Bladder	WM	7.1	7.5	0.6	5.6
	WF	2.1	2.0	−1.4	−4.8
Kidney	WM	4.3	4.5	0.6	4.7
	WF	2.0	2.1	0.7	5.0
Leukaemia	WM	9.4	9.2	−0.4	−2.1
	WF	5.7	5.2	−1.7	−8.8

* For age adjustment the 1970 United States population was used as standard.
† WM, white male; WF, white female.

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Table 2 Crude cancer mortality rates per 100,000 population for selected sites by sex and year, England and Wales, 1971–77, and average per cent change[6]

Site	Sex	Mortality rate per 100,000		Average % change 1971–77	
		1971	1977	Annual	6-Year
All sites	M	265	283	1.1	6.8
	F	215	233	1.3	8.4
Stomach	M	30	28	−1.2	−6.7
	F	21	19	−1.7	−9.5
Large intestine and rectum	M	30	32	1.1	6.7
	F	34	35	0.4	2.9
Respiratory	M	106	112	0.9	5.7
	F	22	29	5.3	31.8
Breast	F	45	47	0.7	4.4
Uterus	F	15	16	1.1	6.7
Prostate	M	17	19	1.9	11.8
Bladder	M	12	12	0.0	0.0
	F	4.1	5.1	3.7	24.4
Leukaemia	M	7.0	7.2	0.4	2.9
	F	5.5	6.0	1.5	9.1

Table 3 Age-adjusted cancer incidence rates per 100,000 US population (whites) for selected sites by sex and year, 1969–76, and average per cent change[5]

Site	Sex	Incidence rate per 100,000		Average % change 1969–76	
		1969	1976	Annual	7-Year
All sites	M	346.6	374.0	1.3	7.9
	F	271.5	301.2	2.0	10.9
Stomach	M	15.4	12.6	−2.3	−18.2
	F	7.1	5.6	−3.7	−21.1
Colon	M	34.5	36.9	1.5	7.0
	F	30.6	31.4	0.7	2.6
Rectum	M	17.5	19.4	1.3	10.9
	F	11.1	11.4	1.2	2.7
Pancreas	M	12.1	11.5	−0.5	−5.0
	F	7.5	8.0	0.9	6.7
Lung	M	70.6	77.8	1.4	10.2
	F	13.3	23.7	8.6	78.2
Melanoma	M	4.4	6.8	6.8	54.5
	F	4.1	6.1	6.2	48.8
Breast	F	73.9	83.5	1.8	13.0
Cervix	F	16.0	10.6	−5.9	−33.8
Uterus	F	22.6	31.2	5.9	38.1
Ovary	F	14.9	13.6	−0.4	8.7
Prostate	M	59.0	68.6	2.3	16.3
Bladder	M	23.8	26.4	2.3	10.9
	F	6.3	7.3	2.5	15.9
Kidney	M	9.0	9.6	1.2	6.7
	F	4.3	4.8	1.3	11.6
Leukaemia	M	13.2	13.1	−0.2	−0.8
	F	8.0	7.1	−1.0	−11.3

The 1970 population was used as standard for age-adjustment.

Thus, "we are unable to say how much of the risks attributed to cigarettes is a 'pure' cigarette risk and how much is cigarette times another, possibly on the job hazard"[8]. Moreover, smoking and occupation are confounded variables, smoking among men being more prevalent in 'blue-collar' workers than in professional and managerial classes[13]. Occupational causes of lung cancer include asbestos, radon daughters, nickel ores, chromium, arsenic, beryllium, mustard gas, vinyl chloride and bischloromethyl ether, apart from incompletely identified carcinogens in a wide range of industries such as rubber curing, tanning, steel (coke ovens), foundries, automobile, and petrochemicals. Thus, lung cancer rates in asbestos insulation and topside coke oven workers are as much as 10 times greater than general population rates.

Underestimation of the role of such occupational carcinogens has been assisted by the fact that lung cancer mortality rates, based on the International Classification of Diseases, fail to distinguish pleural mesotheliomas from lung cancers; there is evidence of substantial under-reporting of mesotheliomas (by about 75%) in high risk groups[14], and even more so in occupations, such as automobile mechanics, where asbestos exposure has not been well recognized. There is a further lack of distinction between lung cancers of different histological types, some of which, such as adenocarcinomas, are less likely to be due to smoking than to occupational carcinogens[15,16]. "In several instances where the risk of bronchogenic carcinoma has been shown to be increased among occupationally exposed groups, there has been an accompanying shift in the distribution of histologic types of tumours", away from the small-cell undifferentiated and squamous cell carcinoma of the lung, the principal types whose frequency is increased by smoking, in the direction of other types, particularly adenocarcinoma[16]. "This (shift) has been noted among metal miners, uranium miners, copper smelter workers, vinyl chloride polymerization workers, chloromethyl methyl ether production workers, and mustard gas manufacturers" (ref. 16).

Possible variations of smoking patterns fail to account for the marked excess in US lung cancer rates identified in specific occupational exposures, particularly among ethnic minorities and migrants from southern states[17]. A further challenge to the dominant role ascribed to smoking seems to be provided by observations that the risk of lung cancer in certain occupational groups, such as American Indian uranium miners[18], Swedish zinc–lead miners[19], mustard gas workers[20], copper smelters exposed to arsenic[21], and chloromethyl methyl ether workers[22], is about as high among nonsmokers as smokers, although the latency period is reduced in smokers, suggesting a possible promotional effect of smoking. It appears that the relative risks of lung cancer for smokers as against risks for nonsmokers may have been overestimated, particularly in less than lifetime studies[13]. Variations in smoking do not account for geographic excesses in lung cancer rates in US males and females, which overall reflect proximity of residence to petrochemical and certain other industries[23,24]; there are also data showing associations between levels of atmospheric carcinogens and lung cancer mortality rates[25]. It may be noted that a report[26] from Peto's own institution demonstrates that the correlation coefficient between lung cancer and smoking internationally explains only one-third as much of the variation as does the correlation between lung cancer and solid fuel consumption (0.4 versus 0.7; $r^2 = 0.16$ versus 0.49).

Overemphasis on the carcinogenic effects of smoking, and ignoring or discounting the role of occupational and other exposures, is extended by Peto and others to cancers of the

Table 4 Changes in US cancer incidence rates from 1970 to 1975[7,8]

Groups	Average % increase in incidence rates, 1970–75			
	Cancers of all sites		Cancers of all sites except lung	
	Annual	5-Year	Annual	5-Year
White male	0.9	4.7	0.9	4.6
Non-white male	2.3	11.9	2.7	14.3
White female	2.2	11.6	1.8	10.2
Non-white female	6.1	34.6	5.7	32.2

Table 5 International correlations between breast, colon and liver cancers and possible aetiological variables[26]

	Correlation coefficients			
	Consumption of fat	Consumption of animal protein	Gross National Product	Total energy production
Breast cancer				
Incidence	0.79	0.77	0.83	0.70
Mortality	0.89	0.83	0.72	0.60
Colon cancer (M)				
Incidence	0.74	0.74	0.81	0.68
Mortality	0.85	0.86	0.77	0.69
Colon cancer (F)				
Incidence	0.78	0.80	0.82	0.67
Mortality	0.81	0.84	0.69	0.62
Liver cancer (M)				
Incidence	−0.49	−0.59	−0.42	−0.25*
Liver cancer (F)				
Incidence	−0.59	−0.67	−0.53	−0.31*

* Liquid energy.

bladder and pancreas which are variously characterized as related to or caused by smoking[27,28]. However, the relative risks for these cancers are several times less in smokers compared with nonsmokers than is the case for lung cancer. Excess bladder cancer rates have been identified in several occupational categories, including rubber, paint manufacturing and textile dyeing workers[29], and among residents in highly industrialized counties[30], particularly those with large chemical industry complexes[31]. Excess pancreatic cancer rates have also been reported in various occupations including steel and metal workers[32] and organic chemists.

Recognition of the important role of occupational exposures in lung cancers previously ascribed, exclusively or largely, to smoking in no way detracts from the recognition, emphasized in *The Politics of Cancer*, that the impact of smoking constitutes a "national disaster". There is no basis for regarding the smoking/lifestyle and occupational theories as mutually exclusive, particularly as these exposures may operate interactively. Furthermore, lifestyle is a somewhat misleading rubric for smoking as it restrictively implies voluntary personal choice. Placing responsibility for personal choice of an addictive lethal habit on young teenagers, the fastest growing group of new smokers, seems inappropriate. Failure to control smoking reflects a wide range of political and economic constraints, including massive press advertising by the industry which omits the word 'death' from the guarded small print warning of danger, massive revenues to federal, state and local government from tobacco taxes, federal subsidies to the industry and unwillingness of governments to increase tobacco taxation or to develop incentives to tobacco farmers to diversify. It is also important that the industry has moved to open up massive new markets with high-tar cigarettes in less developed countries, where the population is poorly informed on the hazards of smoking.

Role of diet

Lifestyle proponents are on less sure ground when they bracket diet, excess fat and overnutrition with smoking as the causes of the majority of cancer deaths. This claim is based largely on international correlations between consumption of total fat and rates for cancer of the breast and colon[26]; however, such correlations by themselves are not proof of causality. Similar correlations were found, in the same study from Peto's institution, between breast and colon cancers and other variables, such as Gross National Product and consumption of animal protein, which also appear to reflect industrialization[26] (Table 5). Furthermore, "epidemiologically, the case against fat is weak because there are populations that have a high fat intake and little bowel cancer..."[33]. Of two case control studies on the association between diet and breast cancer, one found no effect[34] and the other found trivial effects of fat and caloric intake, concluding that "... recommendations of major dietary modification as a possible preventive measure for breast cancer are clearly premature"[35].

Equally unconvincing are the studies, cited by Peto as corroborative evidence on the experimental effects of diet, which were largely concerned with the influence of fat on the incidence of tumours induced by chemical carcinogens and ionizing radiation, and the influence of caloric intake on the incidence of spontaneous and induced tumours. Not only were different variables defined in the animal and human studies—per cent fat in the diet and total dietary fat, respectively—but increasing fat levels in the animal experiments were associated with increased incidence of skin, liver and breast cancers, whereas the reported correlations between fat consumption and liver cancer mortality are negative for both men and women (Table 5). Moreover, these experiments often failed to differentiate between variations of total dietary fat and caloric intake in test animals and to adjust caloric intake in controls to reflect dietary fat variations in test animals; the magnitude of the variations in fat and caloric intake required substantially to influence the incidence of induced and spontaneous tumours in experimental animals is generally far in excess of the dietary differences observed among the various human populations studied[35]. These experiments invariably failed to adjust the intake in controls of fat soluble carcinogens, present in fat as accidental environmental contaminants, to reflect variations of fat intake of test animals.

Peto's claim for the causal role of dietary fat in human cancer overstates the conclusions of those cited as the basis for his claims. Armstrong and Doll[26], for instance, merely suggest that dietary fat levels may influence the incidence of colon and breast cancers, without asserting causality. Doll considers that diet may act by modifying the incidence of tumours induced by carcinogens or by acting as a vehicle for exogenous carcinogens[36]—a suggestion also made in *The Politics of Cancer* which Peto dismisses as "implausible". Carrol concludes that "although caloric intake may be a factor in human carcinogenesis, it does not appear to offer a practical approach to the problem"[37]. As recognized by current concepts on the multifactorial aetiology of cancer, there is a substantial probability that a wide range of influences, diet and other lifestyle factors included, modify individual responses to carcinogenic agents. To ascribe causality to any particular modifying factor requires a degree of scientific evidence that has not yet been presented for dietary fat.

Role of occupation

Peto associates himself with the insistence by the chemical industry[2] and other lifestyle proponents that occupational exposures account for about 5% (refs 38–40) or "a very small proportion"[41] of all cancers. This view is based on ascribing given percentages to known or alleged lifestyle factors, including smoking, fatty diet and sunlight, leaving a small unaccounted for residue to which occupational factors are arbitrarily assigned by exclusion. The authors of this simplistic hypothesis compensate for its tenuous basis by reliance on 'educated estimates' and by making circular references to each other, often by 'personal communication', as the responsible authority.

However, there are problems with such 'guesstimates'. First, they fail to consider the multifactorial aetiology of cancer and the role of multiple causal agents, such as asbestos and smoking[42]; thus, the summation of known causes of cancer should properly exceed 100%. As one of the lifestyle authors recently stressed[36], "there is now strong evidence to suggest that the risk of cancer is commonly increased by interaction of two or more factors". Second, current cancer rates reflect exposures 20 to 30 years ago, when production levels of occupational carcinogens were a small fraction of the present; such estimates should thus now be adjusted to reflect increasing numbers of workers exposed. Third, the authors of these guesstimates failed to consider the very limited nature of the data base on exposure to occupational carcinogens. Nor have they at any stage protested or even commented on the persistent refusal of the chemical industry to make such critical data available. In the absence of exposure data, it is even less clear how the 'lifestylers' confidently arrive at their estimate of less than 5%.

Rather than addressing himself to such problems, Peto dismisses recent estimates of the importance of occupational carcinogens in a report by the US Public Health Service[43] as exaggerated, unsound and unreasonable. This report, prepared by nine named and internationally recognized experts in cancer epidemiology, statistics and carcinogenesis from three federal research agencies, is based on a National Occupational Hazard Survey which between 1972 and 1974 surveyed nearly 5,000 workplaces chosen to provide a cross-section of industry in the United States. The report estimated the total number of workers exposed to asbestos, nickel ores, chromium, arsenic, benzene and petroleum fractions, including aromatics. The excess cancers attributable to each of these carcinogens were derived by multiplying the number of exposed workers by known risk ratios and subtracting the "normal incidence" of the cancer.

The report concluded that "as much as 20% or more" of cancers in the near term and future may reflect past exposure to the six carcinogens considered. The uncertainties and

limitations in these conclusions, including the possibility that exposures and risk ratios may have been overestimated in some instances, were clearly stated in the report, as were other considerations including the multifactorial aetiology of cancer, and the role of lifestyle factors and their possible interactions with occupational exposures.

The possibility that this government report underestimates rather than overestimates the role of occupational exposures, for several reasons some of which are recognized in the report, has not been considered by its denigrators, including Peto. First, the calculations in the report ignore the role of radiation and of some ten epidemiologically recognized occupational carcinogens, other than the six considered. Second, the risk ratios considered may be artificially low as they were largely derived from less-than-lifetime epidemiological studies, which may thus underestimate the true risk in view of the long latencies commonly involved. Third, the report does not consider the many statistical and methodological constraints common to most occupational epidemiological studies[44] such as relatively small numbers of workers in many locations, changes in exposure patterns over time due to employee turnover, plant shutdown, process and production changes and changes in management, all of which lead to fragmentation of health and exposure records, access to which is often restricted by industry. Fourth, the estimates fail to take account of the many chemicals recognized as carcinogenic in animals for which there are no exposure or epidemiological data. Thus, of 442 chemicals and industrial processes recently evaluated by the International Agency for Research on Cancer (IARC), epidemiological data are available for only 60 (14%), although evidence of experimental carcinogenicity was considered to be sufficient for 143 (32%)[45]. Fifth, the estimates exclude high risk occupations with incompletely defined carcinogens, such as the steel, rubber and tanning industries. Sixth, the estimates do not adequately reflect conditions in small business where exposure levels are likely to be higher than in major chemical companies. Seventh, the report does not reflect major increases in the production of the occupational carcinogens it considered such as benzene, with the likelihood of recently increasing exposures. Eighth, the study examined only a limited number of sites, excluding cancers such as skin and bladder which are known to be occupationally related. Finally, the estimates neglect the possible role of fugitive point-source emissions of industrial carcinogens as causes for the excess of overall and organ-specific cancers, including lung, bladder, colon, pancreas and breast, in residents of certain highly industrialized counties.

This government report has received extensive support from various expert bodies, such as the Toxic Substances Strategy Committee, whose position has been endorsed by 17 federal agencies, and international groups, such as the International Labor Organization, and the US and British trades union. The report has also received additional support in the critique of two consultants to the chemical industry's American Industrial Health Council which concluded that "... the full range (of total cancer attributable to occupational exposure) using multiple classifications may be from 10 to 33% or perhaps higher if we had better information on some other potentially carcinogenic substances .... The annual number of cancer deaths attributable to asbestos is in the range from 29,700 to 54,000, which corresponds to a percentage range of the total cancer of 7 to 14% .... Any argument over these numbers cannot detract from the fact that asbestos exposure was, as the authors (of the Government report) state, a major public health disaster .... We also believe that reduction of exposure to carcinogens in the course of employment can certainly be expected to affect major reductions in the frequencies of occurrence of cancer and is one of the most promising applications of preventive medicine"[47]. The American Industrial Health Council failed to release this critique until the record of the recent Occupational Safety and Health Administration hearings on regulation of occupational carcinogens closed.

Finally, there is no basis whatsoever for recent unsubstantiated allegations by Peto and others that all or most authors of the government report have disowned or rejected it or its conclusions (K. Bridbord, M. Schneiderman and A. Upton, personal communication). It should be further emphasized that this 50-page report was prepared as a government document specifically for inclusion in public hearing records, and not for submission to a scientific journal.

Conclusions

Cancer is a disease of multifactorial aetiology to which occupational exposure and smoking can contribute importantly, sometimes interactively. There have been substantial recent increases in cancer rates which cannot be accounted for by smoking alone. Smoking is the major lifestyle factor of importance in cancer, and evidence for the causal role of other lifestyle factors, particularly diet, is slender. The role of lifestyle factors has been exaggerated, by those with an economic or intellectual investment in this theory, by largely excluding involuntary exposures to carcinogens and minimizing the role of occupational carcinogens. These considerations further illustrate the primary thesis of *The Politics of Cancer*: cancer is essentially a preventable disease which requires intervention and regulation at several levels, particularly the occupational and smoking. Failure to prevent cancer reflects major political and economic constraints which have hitherto been largely unrecognized or discounted.

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