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Exercise and lifestyle change

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Summary

While the evidence for a clustering of health habits is not particularly strong, there are both pedagogic and economic arguments in favour of a multifaceted approach to health education. The present review thus examines the impact of regular physical exercise upon other forms of health behaviour, testing the extent to which an activity programme can be a catalyst of improved lifestyle in both primary and secondary preventive therapy.

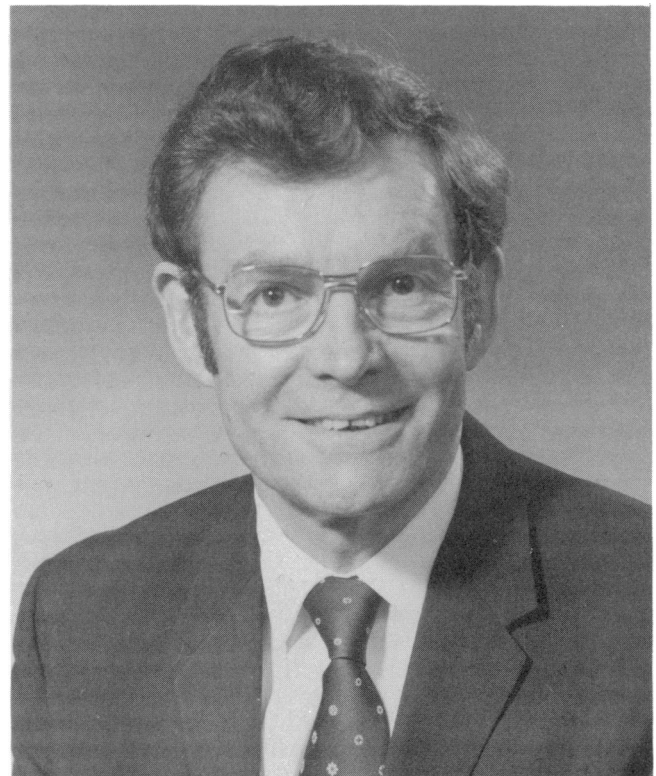
The conceptual framework of health promotion is examined with particular reference to the models of Skinner, Becker, Fishbein, Triandis and Rokeach. Certain differences are noted between the decision to exercise and the marketing decisions for which Fishbein's model was originally designed. Nevertheless, in its later modifications, it provides a basic framework for understanding how human lifestyle is shaped.

Theoretical mechanisms are suggested whereby exercise could influence such behaviours as cigarette smoking, alcohol consumption and drug usage, seat-belt usage, hypertension, body mass, lipid profile, promiscuous sexual behaviour, the carrying of lethal weapons, and acceptance of regular preventive medical examinations.

The empirical evidence from both cross-sectional and longitudinal experiments shows a relatively weak association between exercise habits and other desirable forms of health behaviour. Moreover, it is arguable that other forms of health intervention such as smoking withdrawal or dieting might be equally effective as a primary change agent, and much of the observed association between exercise and other health habits could be attributable to a common dependence on demographic and socio-economic factors.

On the other hand, the apparent weakness of associations may arise in part from difficulties in measuring both habitual physical activity and other forms of health behaviour, with a resultant attenuation of correlations. Possibly, a stronger association between exercise participation and other favourable health habits would be uncovered if attention were focused upon those forms of endurance exercise currently thought to enhance cardiac health. Given that moderate endurance exercise is also positive and pleasant advice, further examination of the potential of multifaceted but exercise-centered health promotion programmes appears warranted.

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Theoretical basis of health behaviours

Introduction

There is now abundant epidemiological evidence that from the viewpoint of the cardiovascular system, it is better to be active than to be sedentary (Shephard, 1985c, 1988; Powell, 1987; Oldridge, 1982). However,

the theoretical basis of this association is less clear. Does exercise exert its main effect directly, by strengthening cardiac and skeletal muscle (Powell, 1987)? Does it also act indirectly, by helping the development of a healthy lifestyle? Does exercise modify the severity of certain risk factors? Or are we merely sorting out a healthy group of people by focusing our attention upon those who begin and continue an exercise programme?

The present review will explore the second of these possibilities. This is an important issue for those concerned with health promotion, since attempts to make a more direct attack upon such behaviours as smoking, an excessive consumption of alcohol or obesity are seen as authoritarian and an attack upon personal enjoyment. On the other hand, an exercise-centred campaign such as the Canadian ParticipACTION or 'Be all you can be' is positive advice, which is well received.

In discussing the exercise, it is first useful to distinguish physical activity (which may have an occupational or a leisure basis), exercise (which is voluntarily undertaken physical activity), and physical fitness (which provides only a limited marker of physical activity, because it is also strongly influenced by constitutional factors (Casperse, *et al.*, 1985). It may be helpful to go even further, as do Eadie and Leather (1988), breaking down exercise into sport (which often involves inter-personal competition, and may not enhance fitness), exercise (deliberately undertaken to improve fitness, strength and endurance, but sometimes regarded by a sedentary population as demanding an excess of effort), active recreation (which is often socially and generally enjoyed), and active pastimes such as gardening. Such distinctions are probably important in terms of the direct influence of exercise upon cardiac health, and they may have even greater relevance in terms of an indirect impact upon cardiac risk factors.

The practical value and the cost-effectiveness of health promotion programmes in general and fitness/rehabilitation programmes in particular would certainly be much enhanced if the form of regular exercise or deliberate physical activity that was adopted not only had direct benefits, but also encouraged the development of a more healthy overall lifestyle, with a reduction of other known cardiac risk factors. Thus, the US Public Health Service (DHSS, 1980) and other health professionals (DHSS, 1985) have suggested focusing promotional efforts upon the health-related component of physical fitness, both in exercise prescription (Blair, 1985; LaPorte *et al.*, 1985) and in fitness testing (AAHPERD, 1980; Pate, 1983; Pate and Shephard, 1989).

The pedagogic potential for a linkage between required physical activity and other forms of health education is quite strong in children and adolescents, since physical education and health are often taught by the same professional (Montoye, 1986). Moreover, during the years of schooling there is quite a strong relationship between the individual's level of physical fitness and the presence of other cardiac risk factors (Tell and Vellar, 1988). With some forms of risk-factor reduction (for example, the correction of obesity), a team approach to health promotion can be envisaged, involving not only the physical educator, but also

other teachers, the school nurse, the guidance counsellor and even the lunchroom supervisor (Ward and Bar Or, 1986). However, it is less certain that a reduction of risk-factors in childhood or adolescence will be sustained through to adult life.

In adults, any potential impact of occupationally-required physical activity upon the prevalence of cardiac risk factors is heavily overlaid by the effects of associated socio-economic differences, and evidence for a linkage between physical activity and other forms of health behaviour has thus been sought mainly in terms of voluntary exercise, whether organized at the work-site or in the community. Again, schemes to promote fitness in adults, whether through a company newsletter, television programmes, magazine articles or general advertising suggest a potential for the simultaneous promotion of several forms of positive health behaviour.

Behavioural theorists tend to argue against any carryover of learning from one form of behaviour to another. Nevertheless, empirical factor analyses suggest some clustering of health behaviours (Criqui *et al.*, 1980; Kannas, 1981; Tapp and Goldenthal, 1982; but not Kok *et al.*, 1982). Habitual exercise-related variables tend to load on a single factor. Prudent dietary practices apparently load on this same factor (Langlie, 1979; Williams and Wechsler, 1972), although it is unclear from such studies which of the two variables is cause and which effect; indeed, both may share a common external determinant. It is also arguable that other forms of health promotion (for instance, the correction of obesity, the cessation of smoking, or even regular medical examination) might offer alternative methods of inducing a general improvement of lifestyle, including an increase of physical activity.

The first part of this review will examine our current knowledge concerning the structure of health attitudes and behaviour, and will consider reasons why physical activity might serve as a possible primary agent of risk-factor reduction; the second part of the review will consider empirical evidence, both cross-sectional and longitudinal-linking exercise and overall lifestyle in secondary and tertiary preventive programmes.

Health attitudes and behaviour

General considerations

The modification of health attitudes is a complex and costly process. Mass media campaigns can transmit information and produce some alteration of attitudes, but they have relatively little influence upon the adoption of complex behaviours such as seat-belt use (Robertson *et al.*, 1974) or the regular practice of physical activity (Jackson, 1976).

The conceptual framework of behavioural change encompasses social learning theory (Bandura, 1982; Ray *et al.*, 1973), the communication and diffusion of ideas (McGuire, 1969; Rogers, 1982), Skinnerian theory, the Health Belief model and the Fishbein model of reasoned behaviour (Table 1).

Skinnerian theory

The conditioned response of B.F. Skinner (1953) provides the simplest explanation of our various health behaviours. A reward (such as a sense of sophistica-

Table 1. Possible models of health behaviour

Author	Basis	Limitations
Skinner (1953)	Reward encourages behaviour. Punishment reduces behaviour.	Rewards complex. Affected by life experiences.
Becker <i>et al.</i> (1977)	Susceptibility to illness. Behaviour reduces illness.	Must perceive susceptibility and efficacy. Experience?
Fishbein and Ajzen (1974)	Intention depends on attitude and subjective norm.	Intention is not behaviour. Experience?
Triandis (1977)	Role playing modifies behaviour.	Fishbein model is basis.
Rokeach (1968)	Situation modifies behaviour.	Fishbein model is basis.
Bandura (1982)	Self-efficacy modifies behaviour.	Examines overt behaviour, not underlying basis.

tion or maturity which some people feel when smoking) provides a positive feedback that encourages repetition of a particular positive or negative behaviour when a further stimulus is applied. On the other hand, absence of a reward, or an unpleasant consequence (such as repeated bouts of coughing or a negative comment from a friend) lead to a progressive extinction of the behaviour. In the rat, at least, the response to such feedback is maximal when the reward or punishment follows closely upon the behaviour, and the size and frequency of the reinforcing stimulus are unpredictable.

The human response is generally much more complex than that of the pigeon or rat. A long chain of events separates action from reward. Responses become unpredictable, being modified by a lifetime of accumulated experiences, as well as immediate social and environmental factors (Shephard, 1974; Rode and Ross, 1972). Many of the forms of behaviour desired by the health educator may be perceived by the client as medically-imposed restrictions. Compliance with these requirements is then shaped substantially by the rewards found in the practitioner/client relationship (McCord, 1986; Yoos, 1981), as encountered, for example, in an exercise or rehabilitation class.

Health Belief model

The Health Belief model (Becker *et al.*, 1977) is an outgrowth of the Skinnerian model. It assumes that a health behaviour such as exercise is determined by perceptions of susceptibility to a particular illness (such as heart disease); the perceived severity of this threat; the perceived likelihood that the recommended behaviour will reduce either susceptibility to the illness or the severity of an attack; and any cues and barriers to action, together with demographic factors.

Recent publicity about the value of exercise in the prevention of a variety of medical disorders may well be leading to a positive interaction between exercise participation and health beliefs.

Fishbein model

Fishbein's model is a further development of Skinnerian theory. Fishbein and Ajzen (1974) examined the various steps that intervene between stimulus and response in their model of rational behaviour. De-

veloped initially for the marketing of various commercial products, the model has since been applied with some success to the interpretation of such health-related behaviours as cigarette smoking (Chassin *et al.*, 1981; Jaccard, 1975) and habitual exercise (Godin and Shephard, 1985; Riddle, 1980).

In the Fishbein model, actual behaviour is seen as depending upon intention. The behavioural intent in turn is shaped by the attitude of the individual towards a given action (for example, smoking 20 cigarettes per day) and the subjective norms contributed by significant others (such as a spouse, a friend, or, in the case of children, a parent or teacher).

The overall attitude of the individual—whether positive or negative—reflects the summed product of individual beliefs about the behaviour (b_n) and the corresponding personal evaluation of those beliefs (e_n), each measured on a seven point scale (+3 to -3):

$$\text{Attitude} = \sum_{i=1}^n b_i \cdot e_i$$

For instance, b_i might be 'smoking 20 cigarettes per day can cause emphysema', and the corresponding e_i might be 'emphysema will make me exceedingly short of breath'.

The subjective norm reflects the summed product of the perceived beliefs of significant other (NB_i) and the individual's motivation to comply with these beliefs (MC_i):

$$\text{Subjective norm} = \sum_{i=1}^n NB_i \cdot MC_i$$

For example, NB_7 might be 'my wife does not like me to smoke', but MC_7 might be 'I don't need to accept what my wife tells me about smoking'.

Note that habitual exercise could have an impact at several points in this model. The congruence between behavioural intention and actual behaviour (Jaccard, 1975) depends on the time interval between the assessment of intention and the observation of behaviour; possible arrival of new information; the number of steps needed to translate intention into action; the perceived ability to undertake the action; memory; previous habits; and the usual level of congruence between intention and behaviour in a given individual. Congruence is particularly likely in a person with an internal 'locus of control' (Saltzer, 1981) and a strong belief in their self-efficacy (Bandura, 1982).

Triandis model

Triandis (1977) supplemented the Fishbein model by adding concepts of role-playing. For example, a doctor might enjoy smoking, but would refrain from doing so at a sports medicine meeting because of a perceived role as a member of a group that advocated abstinence from tobacco.

Rokeach situational model

Rokeach (1968) and Bandura (1978) argued that behaviour was a function of the immediate environment in which the person was situated. For example, the doctor discussed above might resume smoking if a number of colleagues were seen to be smoking on the golf course while attending the same sports medicine meeting.

Recent models

Fishbein's model ignored habit, assuming that the behaviours he wished to test (initially voting patterns and purchasing choices) were largely volitional rather than habitual. It was further assumed that behavioural intention usually translated into an overt expression of behaviour.

Some authors, such as Bagozzi (1981) and Bentler and Speckart (1979) have questioned the unidirectionality of the relationship between attitude and behaviour. In their view, attitudes can also be influenced by the previous behaviour of an individual, particularly if the behaviour in question is addictive (as are smoking, drinking and to a lesser extent exercising).

However, the supporting empirical evidence is not particularly strong. We found (Godin *et al.*, 1983) that a fitness test and health counselling had no immediate impact upon attitudes, while Reid and Morgan (1979) found no change of health beliefs over a six month programme of exercise and health education. Likewise, in post-coronary patients, Muensch (1987) found no relationship between the pattern of health beliefs and the duration of participation in a rehabilitation programme.

One problem may be that many people perceive exercise as a high level of personal fitness or as participation in athletic competition, rather than as a habit of regular moderate physical activity. Nevertheless, Godin *et al.* (1987) were able to demonstrate directionality in the exercise attitude/behaviour relationship by the statistical technique of path analysis. Exercise intention was directly influenced by both attitude and habit, with attitude being the dominant component in most samples of subjects. Usually, there was a substantial gap between intentions and actual behaviour.

In a prospective study, exercise behaviour measured three weeks after a statement of intention was shown to be the result of habit only, but behaviour measured two months later reflected both the individual's intention and her or his proximal behaviour. It should be emphasized that the study was observational in nature, and stronger relationships might have been observed in a situation where patients were vigorously encouraged to exercise.

Exercise is not a novel behaviour, even for those who are usually sedentary, and for this reason it may be less volitional and more under the control of habit than the decision, for example, to purchase a particular brand of toothpaste. It may also differ from the decision to make a commercial purchase in that the subject has experienced not only the advantages of exercise, but also some of the disadvantages, such as a previous injury or an unhappy experience of required physical education as a child. Finally, associations between exercise and other health habits may be difficult to demonstrate because of difficulties in measuring either physical activity or the other health behaviours accurately (Shephard, 1986b).

Potential impact of exercise upon overall health

Prudent lifestyle

An individual's lifestyle is conveniently assessed by the Canadian Health Hazard Appraisal instrument (Health and Welfare Canada, 1976; Spasoff *et al.*, 1980). A self-administered questionnaire examines

Table 2. Example of health hazard appraisal for women aged 45 years

Variable	Appraised risk		Achievable risk	
	Value	Risk	Value	Risk
Breast exam	Nil	1.00*	monthly	0.50
Body mass	68 kg	0.96	62 kg	0.88
Smoking	10/day	1.85	stop	1.10
Blood pressure: syst.	140	1.00	140	1.00
	diast.	95	1.38	recheck
Cholesterol	280	1.50	280	1.50
Physical activity	little	1.40	3/wk	0.85
Family history of heart disease	parent	1.20	parent	1.20

*Normal risk.

Taking account of these risk-factors, the cumulative risk of dying from each of 12 major disorders over the next ten years is calculated; the appraised age gives an equivalent prognosis.

those aspects of personal lifestyle which are most likely to cause death over the next ten years. An 'appraised age' is then calculated for each individual, based upon a population that has a similar prospect of dying over the next decade from the 12 major sex and age specific causes of death. A 'compliance age' is also computed, based on the effect of correcting all potentially modifiable faults of lifestyle. Elements of risk that have been identified, in addition to physical inactivity, include the consumption of cigarettes, alcohol and drugs, failure to use a car seat-belt, uncorrected hypertension, excess body mass, an adverse lipid profile, promiscuous sexual behaviour, the carrying of lethal weapons, and (in women) failure to undertake preventive medical examinations such as pap smears and breast examinations (Table 2).

What influence is habitual exercise likely to have upon each of these facets of personal lifestyle?

Cigarette smoking

First, let us consider how regular exercise might affect smoking habits. Physical activity could bring to light 'punishing' symptoms of dyspnoea, anginal pain, or ECG abnormalities (Shephard, Rode and Ross, 1972). Association with a group of healthy, exercising non-smokers might also strengthen beliefs in the adverse effects of smoking, while providing a strong subjective norm favouring abstinence from cigarettes. The 'role' of a fitness enthusiast is not congruent with a cigarette habit. Furthermore, the regular practice of exercise sets significant barriers between the latent, addiction-related desire to smoke and its realization. For example, friends no longer offer cigarettes to smoke, and discretionary income is spent on fitness equipment and clothing rather than cigarettes; the diversion of income is particularly likely to influence the behaviour of the lower socio-economic groups, often the hardest to dissuade from smoking.

A final factor adversely affecting health behaviour is a sense of personal alienation. If one of the native population in Canada, a negro in a US ghetto, or an unemployed labourer in Glasgow feels an unappreciated and largely irrelevant cog in a machine over which he or she has no control, then there may be little motivation to conserve health (Coburn, 1979). Adverse socio-economic circumstances have perverted

the individual's evaluation of the consequences of a dangerous behaviour such as smoking. This raises issues of societal versus personal responsibility for risk-taking (Godin and Shephard, 1984).

Unemployment can cause a loss of interest in sport and exercise. On the other hand, personal successes in a personal fitness or athletic programme may counter the individual's feeling of alienation and improve his or her self-image (Sidney and Shephard, 1977). The person concerned then has a greater incentive to conserve health and less necessity to seek the sophistication, thrills, masculinity (males) or liberation (females) that is so temptingly promised by cigarette advertisements.

Alcohol consumption and drug usage

Habit and depression of mood are significant factors in alcohol and drug dependence.

Health-conscious, exercising friends have a positive influence upon both of these factors, encouraging moderation in the use of alcohol and the avoidance of other drugs. If the lunch-time rush is to the gym rather than to the bar, then the weekly consumption of alcohol should drop. Again, cost is a significant factor influencing consumption of alcohol (Lint and Schmidt, 1971), and to the extent that the habit of regular exercise diverts discretionary income to alternative expenditures, alcohol consumption may be reduced (Shephard, 1986). Finally, exercise is well-recognized as a corrective for anxiety, and as a source of arousal and elevation of mood (Morgan and Goldstein, 1987), so that the physically active individual may be less vulnerable to the depression for which alcohol is sought.

Seat-belt use

Regular use of a seat-belt while driving is one simple expression of personal interest in health and safety. Whether the adoption of a regular exercise habit encourages other safety-conscious behaviours such as seat-belt use is more problematical (Nader and Baranowski, 1985). Certainly, many regular exercisers read books on preventive health, thus modifying the 'belief' component of seat-belt use. Improved self-image may also encourage a positive evaluation of safety information, increasing motivation to comply with safety measures (Langlie, 1979; Mechanic and Cleary, 1980; Williams and Wechsler, 1972). However, some of the association may be indirect, since safe driving habits and regular exercise have a mutual dependence on socio-economic status.

Uncorrected hypertension

One laboratory marker of physical fitness, maximal oxygen intake, is negatively correlated with resting blood pressure after co-varying for such other facets of lifestyle as body mass, cigarette consumption, and alcohol intake (Rauramaa *et al.*, 1988).

Likewise, regular exercise induces a small but statistically significant 5–10 mm Hg reduction of systemic blood pressure (Tipton, 1984). This change apparently reflects the influence of habitual exercise upon obesity, catecholamine secretion and anxiety, rather than any specific behavioural change such as the more regular taking of anti-hypertensive medication.

Body mass

Participants in regular endurance exercise commonly have a trim figure, and in some pursuits such as gymnastics, this may be carried to the point of anorexia (Taylor *et al.*, 1985). More commonly, healthy dietary practices are linked to regular exercise (Williams and Wechsler, 1972), but it is difficult to disentangle cause from effect.

Certainly, some early cinematograph studies (for example, Bullen *et al.*, 1964) found that obese children were likely to minimize their opportunities for physical exertion. There are plainly important negative consequences for the obese person who attempts to exercise. Such 'punishments' could lead to either a dislike of obesity or a dislike of exercise! However, a part of the association between weight loss and exercise is physiological rather than behavioural. Exercise increases blood sugar and suppresses appetite (Brownell, 1982; Stevenson, 1967), and may cause a prolonged, post-exercise stimulation of metabolism. Improved self-image (Sidney and Shephard, 1977) may also encourage a greater concern about body profile, while the fact that friends are trim-figured may modify social norms, reinforcing the motivation to lose excess weight.

Lipid profile

Because of increases in certain tissue enzymes, particularly lecithin-cholesterol-acyl transferase (LCAT), regular endurance exercise (for instance a jogging distance of more than 18–20 km/week) is usually associated with a favourable change of lipid profile (particularly an increase in the blood concentration of the scavenging HDL₂-cholesterol and its apo-proteins (Kavanagh *et al.*, Krauss *et al.*, 1977; Williams *et al.*, 1982; Wood *et al.*, 1983). This response is seen in both healthy subjects and in patients following myocardial infarction.

Williams *et al.* (1982) and Wood *et al.* (1983) have suggested that there may be some association between regular running distance, HDL cholesterol, body fat stores and dietary food intake, but it is unclear whether the observed correlations reflect a common antecedent concern for health, or whether exercise has had a more direct effect on eating patterns.

Promiscuous sexual behaviour

Promiscuous sexual behaviour is associated with an increased risk of carcinoma of the cervix in women, and in both sexes there is an increased risk of contracting AIDS. Popular Victorian literature extolled regular exercise as a means of reducing sexual urges, and recent research has shown that very prolonged training can reduce levels of sex hormones, with loss of libido (Wheeler *et al.*, 1984).

Carrying of lethal weapons

With regard to dangers associated with the carrying of lethal weapons, an active person should have other methods of self-actualization than a weapon-based sense of power. Moreover, a physically fit individual is likely to have a greater confidence in his or her ability for self-defence.

Preventive medical examinations

Involvement in exercise groups may increase know-

ledge of the value of regular health examinations, thus changing basic health beliefs. An improved self-image may also enhance the evaluation of such beliefs, while association with health-conscious friends may establish a social norm of preventive care. While early analyses gave only limited support to this concept (Langlie, 1979; Williams and Wechsler, 1972), the recent experience of multi-faceted, but exercise-centred corporate lifestyle programmes has been more encouraging (Blair *et al.*, 1986).

Empirical evidence

General considerations

Empirical evidence links regular exercise and/or personal fitness with various favourable health behaviours (for example, Allen *et al.*, 1978; Blair *et al.*, 1986; Cooper *et al.*, 1976) and health (Breslow and Enstrom, 1980). Exercise is also tied to many perceived health benefits. However, it is difficult to discern cause and effect, to distinguish physiological from psychological linkages, or to exclude a mutual dependence upon extrinsic factors such as good initial health or a high socio-economic status (Berkman and Syme, 1979; Hinkle *et al.*, 1968; Hossack and Berger, 1987; Leren *et al.*, 1983; Liu *et al.*, 1982; Marti *et al.*, 1987; Rose and Marmont, 1981). For example, a study conducted at the head office of the General Foods Corporation near New York City (Shephard *et al.*, 1980) noted that not only participants in an employee fitness programme, but also their spouses and their friends had more strongly developed health beliefs than non-participants in the programme.

The demonstrated coefficients of correlation between regular exercise and other health behaviours are relatively weak, and often the health benefit of exercise cannot be demonstrated after due allowance for other favourable habits of lifestyle (Kannel and Sorlie, 1979). However, a part of the difficulty in showing strong associations between regular exercise and other good health habits (particularly where these make good intuitive sense) is that population estimates of physical activity patterns are extremely crude (Blair *et al.*, 1985; Blair, 1987; Verschuur, 1987); a substantial variability of data is often compounded by an upward response bias. Recent US estimates have estimated the prevalence of regular habitual exercise at figures ranging in various surveys from 9 to 78 per cent of adults. Coefficients of correlation and the magnitude of the apparent health benefit are greatly reduced by the resultant process of attenuation.

Cross-sectional studies

Cigarette smoking

Perhaps because of the difficulty of identifying active subjects accurately, several large-scale surveys in Britain and the US have found no significant differences in the proportions of smokers between active and inactive categories of individual (Epstein *et al.*, 1976; Langlie, 1979; Perrier, 1979; President's Council on Physical Fitness and Sport, 1974) (Table 3).

Perrier (1979) further commented on the need to distinguish participation in health-related activities

Table 3. Relationships between cigarette smoking and exercise

Authors	Relationship	Comments
<i>Cross-sectional</i>		
Bjartveit <i>et al.</i> (1983)	positive	occupational
	negative	leisure activity
Blair <i>et al.</i> (1985)	negative	literature review
Bradstock <i>et al.</i> (1984)	negative	leisure activity
Can. Fit. Survey (1983)	37% v 42%	active v inactive
Epstein <i>et al.</i> (1976)	nil	not prime focus of study
Erikssen <i>et al.</i> (1981)	negative	relative to cycle ergometer score
Folsom <i>et al.</i> (1985)	negative	leisure activity
Hickey <i>et al.</i> (1975)	negative	leisure activity
Holme <i>et al.</i> (1981)	positive	occupational
		leisure activity
Kannas (1981)	negative	leisure activity
Langlie (1979)	nil	simple score, mostly walking and stairs
Leon <i>et al.</i> (1981)	negative	relative to treadmill score
Marti <i>et al.</i> (1987)	negative	females, leisure
Norwegian Confed. of Sport (1984)	44% v 56%	active v inactive
Perrier (1979)	nil	all types active
		leisure
President's Council Phys. Fitness & Sport (1974)	nil	limited evidence of activity patterns
<i>Longitudinal studies</i>		
Biener (1976)	less smokers	active adolescents
Blair <i>et al.</i> (1983)	no change	increased treadmill tolerance over 1.6 y
Blair and Kohl (1985)	decreased smokers	cited by Blair <i>et al.</i> (1987)
Blair <i>et al.</i> (1986)	decreased smokers	controlled experiment
Kavanagh <i>et al.</i> (1983)	decreased smokers	One year after infarct; no subsequent changes
Kavanagh <i>et al.</i> (1989)	ex-smokers	Masters athletes stopped before sporting involvement
Laasko <i>et al.</i> (1976)	less smokers	active adolescents
Morgan <i>et al.</i> (1976)	many ex-smokers in sample	Masters athletes
Verschuur (1987)	less smokers	active adolescents
Wood <i>et al.</i> (1982)	no change	2 years, running 12 miles/week

from the enjoyment of social or thrill-seeking sports in future surveys. Another factor confounding some studies of occupational activity is that heavy workers tend to be drawn from the lower socio-economic categories (Keys *et al.*, 1966); such groups not only undertake hard physical work, but also have a high cigarette consumption (Bjartveit *et al.*, 1983; Hickey *et al.*, 1975; Holme *et al.*, 1981; Kannas, 1981). Despite these technical problems, several authors have found a weak negative relationship between regular exercise and cigarette addiction (Bjartveit *et al.*, 1983; Blair *et al.*, 1985; Bradstock *et al.*, 1984; Erikssen *et al.*, 1981; Folsom *et al.*, 1985; Marti *et al.*, 1987).

The Canada Fitness Survey (1983) made a rather crude binary classification of subjects into active and inactive categories, finding that that relative to their sedentary peers, the active individuals were less likely to smoke (37 v 42 per cent). Among Norwegians (Norwegian Confederation of Sport, 1984), also, a substantial gradient of smokers was demonstrated from active (44 per cent) to inactive (56 per cent) individuals.

Diet

Community surveys (Montoye, 1975) have demonstrated an inverse relationship between physical activity and body fatness. Likewise, regular exercise is associated with a lower body mass index (Blair *et al.*, 1985; Bradstock *et al.*, 1984; Cooper *et al.*, 1976; Folsom *et al.*, 1985; Gibbons *et al.*, 1983). It could nevertheless be argued that obesity has discouraged physical activity, rather than the converse.

Active individuals generally consume more food than their sedentary peers in order to maintain an energy balance (Blair *et al.*, 1982; Durrant *et al.*, 1982; Gorsky *et al.*, 1982; Pomrehn *et al.*, 1982; Short and Short, 1983; Wood *et al.*, 1982 but not Moore *et al.*, 1983; Wood *et al.*, 1983; or Woo *et al.*, 1982). Thus active subjects increase their intake of vitamins and trace elements. Food intake may also be related to within-group differences in energy expenditure (Wood *et al.*, 1983).

There is some evidence of more selective eating behaviour, even after adjustment of data for differences of total food intake between active and sedentary subjects. Active individuals watch their diets carefully, consuming a somewhat more healthy diet than sedentary people (General Mills, 1979; Perrier, 1979). For example, they eat less candies, cookies, cake and fried food. The US Department of Health and Human Services (1981) noted that more active subjects had a body mass that was less than 120 per cent of the recommended value (78 v 74 per cent); relative to the sedentary group, the active individuals also ate less red meat. The Canada Fitness Survey (1983) and Kannas (1981) both found that active subjects were more likely to take a nutritious protein-containing breakfast (51 v 43 per cent), while a Gallup poll in the US (Blair *et al.*, 1987) found active individuals eating more fruit and vegetables, less sugar and less meat than those who were sedentary. However, all of these differences are quite small, and tend to disappear after control for age, sex and socio-economic status (Blair *et al.*, 1985).

Emotional stress

A number of authors have suggested an association between habitual exercise, adequate sleep and emotional well-being (Belloc and Breslow, 1972; Canada Health Survey, 1982; Canada Fitness Survey, 1983; Perrier, 1979; Stephens, 1988; Taylor *et al.*, 1985; Williams and Wechsler, 1972). It is unclear whether this association has a physiological or a behavioural basis.

There have been suggestions that exercise modifies reactivity to stress (Blumenthal *et al.*, 1983) or serves as a stress-buffer (Kobasa *et al.*, 1972). However, there is no association between physical fitness and sleep patterns (Paxton *et al.*, 1984).

Other health habits

Several other favourable health practices have been seen in active groups (Blair *et al.*, 1985; Langlie, 1979; Mechanic and Cleary, 1980; US Dept. of Health and Human Services, 1981; Williams and Wechsler, 1972), including the regular use of seat-belts when driving (25 v 19 per cent), moderation in the use of alcohol (87 v 82 per cent), regular preventive visits to a doctor (73 v 63 per cent) and dentist (62 v 57 per cent), regular checking of blood pressure (95 v 91 per cent) and regular breast examination (93 v 82 per cent).

A cross-sectional study of women attending the Cooper Clinic in Dallas likewise noted that subjects in the higher fitness categories consumed less alcoholic beverages, coffee and tea (Blair *et al.*, 1984b). On the other hand, data from the US National Survey of Personal Health Practices and Consequences and the Behavioral Risk Factor Survey (Blair *et al.*, 1985) have found little relationship between activity patterns and alcohol consumption. A relationship has been found between regular activity and alcohol consumption in men, while Folsom *et al.* (1985) even found a positive association between physical activity and alcohol consumption. Plainly, exercise can create thirst, and some sports groups have a tradition of celebrating victory in a local hostelry!

There is currently a strong social-class gradient favouring exercise among the wealthy (Canada Fitness Survey, 1983; Stamler, 1981). Favourable health characteristics such as the greater use of medical and dental services by exercisers could thus reflect a mutual dependence of health practices upon socio-economic status, although Blair *et al.* (1985), Bradstock *et al.* (1984) and Wiley and Camacho (1980) have all argued against establishing such a relationship.

Even if subjects are allocated randomly to exercise and control groups, defections from the exercised group are correlated with a low social class and thus with poor health habits (Massie and Shephard, 1971; Oldridge, 1982; Sidney and Shephard, 1977). Second, economic pressures now favour the introduction of a multi-faceted lifestyle process rather than a pure exercise regimen (Blair *et al.*, 1986), so it is becoming increasingly difficult to test the exercise hypothesis in isolation from the encouragement of other good health practices. Even where a multifaceted approach is not implicit in a programme, exercised subjects usually have greater exposure to health professionals, who inevitably stress a good personal lifestyle by both word and example.

Blair *et al.* (1986) compared 2600 experimental with 1700 control employees over a two year exercise-centred lifestyle intervention at the Johnson & Johnson Corporation. The maximum oxygen intake of the active population increased by an average of 10.5 per cent. At the same time, their health attitudes and health knowledge were improved, cigarette and alcohol consumption were reduced, and the exercised subjects reported an improvement of general well-being (Blair *et al.*, 1986; Shipley *et al.*, 1988).

Verschuur (1987) followed active and inactive students through adolescence. Those individuals electing an active lifestyle had less body fat and were less likely to start to smoke than their sedentary peers, but there was no obvious influence of exercise upon blood pressure. Biener (1976) and Laasko *et al.* (1979) also noted a favourable influence of self-selected sports participation upon smoking habits.

Morgan *et al.* (1976) found that a very high proportion of Masters athletes who had been smokers as young adults had been successful in quitting their habit. At first inspection, this appeared to be a beneficial effect of long-distance running, but a subsequent study of Masters competitors (Kavanagh *et al.*, 1989) showed that in most cases the athletes had ceased smoking before they began serious training. Success in stopping smoking was thus one expression of un-

derlying interest in a healthy lifestyle. Some other prospective studies have found no decrease in the proportion of smokers as a result of involvement in an exercise programme (Blair *et al.*, 1983; Wood *et al.*, 1982), although data from the Cooper Clinic (Blair *et al.*, 1987) has suggested a decrease in smoking rates coincident with an increase in exercise participation.

Our experience with post-coronary patients who enrolled in a progressive exercise training regimen (Kavanagh *et al.*, 1979) demonstrated some early reduction of cigarette smoking and alcohol consumption (Table 2), but these changes could have been related to awareness of the recent heart problem rather than the activity component of their rehabilitation programme (Burt *et al.*, 1974). In any event, the change of smoking behaviour was small relative to the decrease in consumption of animal fat. Moreover, we saw no further dramatic reduction in the percentage of smokers over the next three years of exercise-centred rehabilitation, although in what had previously been a hard-smoking, coronary-prone sample, lack of recidivism may in itself have been a beneficial by-product of the exercise regimen. Labuhn and Baird (1988) further noted that those who were successful in quitting smoking showed a greater increase of physical working capacity in response to a cardiac rehabilitation programme.

Prospective studies, including a meta-analysis (Epstein and Wing, 1980) have confirmed the value of exercise in weight control (Blair *et al.*, 1987; Brownell, 1982; Epstein and Wing, 1980; Thompson *et al.*, 1982; Wilmore, 1983) and amelioration of the lipid profile (Wood *et al.*, 1983 Fig. 1); in general, the obese seem under-exercised rather than over-fed. On the other hand, exercise programmes have generally had little impact upon alcohol consumption (Blair *et al.*, 1984; Wood *et al.*, 1983), although Sinyor *et al.* (1982) suggested that exercise was of some value in the treatment of alcoholism.

There have been suggestions that regular exercise can alleviate mild depression (Blumenthal *et al.*, 1982), anxiety (Kobasa *et al.*, 1982; Sinyor *et al.*, 1983) and type A behaviour (Blumenthal *et al.*, 1980).

Some of the most encouraging longitudinal data to date comes from an employee fitness study conducted at the Canada Life Assurance Company (Shephard *et al.*, 1982). The Canadian Health Hazard Appraisal instrument was administered on recruitment to the exercise programme and six months later. When first seen, the Canada Life group were somewhat health conscious, with an initial appraised age that was below their calendar age (an advantage of 1.8 years in male subjects and 3.1 years in females).

Nevertheless, there was still some scope for improvement of lifestyle, particularly in the men, the gap between the appraised age and the compliance age amounting to 3.8 years in males and 1.7 years in females. After six months operation of the fitness/lifestyle programme, the gap between the appraised age and the compliance age had narrowed to 3.0 years in the men and 1.4 years in the women. Moreover, this development was particularly noticeable among the strongest programme adherents. It reflected a decrease of cigarette consumption, a decrease of alcohol consumption and a decrease of systemic blood pressure, the decrease in composite risk being significantly associated with such measures of programme partici-

pation as exercise heart rate and predicted maximal oxygen intake.

Conclusions

There seem to be a number of mechanisms whereby regular participation in vigorous exercise might have a beneficial influence upon personal lifestyle. However, part of the observed association between an active lifestyle and positive health habits could reflect a mutual dependence upon socio-economic status. Moreover, with the exception of dietary practices, the associations between regular exercise and other positive health behaviours are quite weak. Nevertheless, the observed correlations are probably attenuated by difficulties in measuring both physical activity and other health behaviour patterns accurately. A second important reason for the weakness of correlations is the lack of a single consistent reason for undertaking physical exercise. While some people exercise mainly for reasons of health, others are attracted to activity programmes by such motives as increased social contacts and excitement (Sidney and Shephard, 1977). Possibly, a stronger association between exercise and health habits will be uncovered if attention is focused upon those forms of exercise that enhance health, particularly regular participation in moderate endurance activity.

In general, there is some encouragement for those who would use exercise as an instrument of lifestyle change. Recent statistics suggest a substantial reduction of health costs from the introduction of an exercise-centred health promotional programme. From a cost-effectiveness standpoint (Shephard, 1986), it remains arguable that a primary focus upon smoking cessation or dieting might offer an equally effective single intervention, and from the viewpoints of both subjective acceptance and costs, there is little doubt that a multifaceted approach is more effective than any unitarian approach. Indeed, successful primary preventive studies such as the *Live for Life* programme (Blair *et al.*, 1986; Wilbur, 1983) and the Canada Life programme (Shephard *et al.*, 1982) have consistently adopted a total approach to health, albeit centred around an exercise programme. Moreover, a holistic approach has apparently contributed to a reduction of the recidivism that has plagued simple exercise programmes (Martin and Dubbert, 1985; Shephard, 1985c).

One particularly fascinating area for future enquiry is the impact of exercise recidivism upon other lifestyle changes initiated during the phase of increased activity; if a person stops exercising, is the adverse impact upon self-image and feelings of self-efficacy (Bandura, 1982) such that other bad health habits also return?

We may conclude that exercise will remain an appropriate focal point for the health promotional programmes of the future, but it is likely that they will adopt a multi-faceted approach, also targetting other known health risks.

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