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Roy J. Shephard, M.D., Ph.D.

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Guest Editor

Edward R. Eichner, M.D.

Chief, Section of Hematology, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma



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1988
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American Heart Journal
American Journal of Cardiology
American Journal of Clinical Nutrition
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Fitness Programs and Industrial Stress*

ROY J. SHEPHARD, M.D., PH.D.

Director, School of Physical and Health Education; and Professor of Applied Physiology, Dept. of Preventive Medicine & Biostatistics, Faculty of Medicine, University of Toronto.

Introduction

"It is a laughable sight, to see those guilds of cobblers and tailors . . . when they march in procession . . . stooping, round-shouldered, limping men, swaying from side to side. They look as though they had all been carefully selected for an exhibition of their infirmities."

Bernadino Ramazzini, 1700

From the time of Bernadino Ramazzini, physicians have recommended increased physical activity as a means of improving the health of sedentary workers. Experts in sports medicine and ergonomics have more recently added to these general concerns about well-being the specific perspective of matching the physical and mental capacities of employees with the demands imposed by the machines that they operate, not only through the redesign of equipment, but also through the development of appropriate workplace fitness programs.

Despite some early initiatives from such places as the Harvard Fatigue Laboratory, most exercise physiologists and ergonomists first became interested in the energy demands of physical work immediately after World War II. The prime emphasis of their research was on a reduction of physical demands through improvement of industrial design. This sparked a quest for the optimization of such items as wheelbarrows, truck seats, and office chairs.^{1,2} More recently, industrial mechanization has progressed to the point that the health problem at most work sites has become a lack, rather than an excess, of physical activity. At the same time, the control processes of certain major industrial plants have become so complex that it has become necessary to exploit the very limits of human mental performance,³⁻⁶ with a resultant increase in stress levels. At the other extreme, tasks such as car manufacture, letter sorting, and even grocery checkout have become so mechanized that little mental demand is made upon the worker of average intelligence.

This article will examine the physical and the mental stresses that arise from both an excessive and an inadequate occupational demand, examining critically the potential contribution that work site fitness programs make to optimization of physical and mental health and to increased profitability of industrial operations. A final section will consider the continuing justification for work site fitness programs in what may soon become a postindustrial society.

*Based in part on an invited keynote lecture to the Ergonomics Research Society International Conference on Sports, Leisure and Ergonomics, Liverpool, England, November 1987.

Optimization of Stress in the Workplace

If the occupational demand—physical or mental—is too high or too low, there is a cost to both personnel health and company profitability. We may think of the perceived health of the typical worker as lying on a continuum linking well-being with sickness (Fig 1). Although not listed in the International Classification of Diseases, personnel perceptions of health are important to the individual employee, the employer, and the health insurance agency. If perceived health becomes poor, production falters, absenteeism occurs, and medical services are demanded.⁷⁻⁹ Indeed, most of consultations with primary care physicians reflect poor perceived health rather than any clear-cut organic illness.

Note that most employees do not seek a stress-free workplace. Selye¹⁰ commended a situation of eu-stress, an optimum level of physical and mental stress to which the body could make a positive adaptation (Fig 2). Excessive physical stress leads to a buildup of intramuscular lactate, fatigue, and an increased risk of musculoskeletal injury. Whether the pace of work is self-determined or is regulated by union contract, it is thus wise to limit the steady loading over an 8-hour working day to no more than 40% of peak aerobic performance.¹¹⁻¹³ There is an analogous inverted U-shaped relationship between system demands and psychomotor performance.¹⁴⁻¹⁷ The optimum location of either a worker or an athlete on this curve depends on other stressors, such as a high noise level or a hot environment, together with the personality, and intelligence of the individual relative to task difficulty.

When a physician is advising management about the need for an industrial fitness program, it is important to emphasize not only the likely increase of personal well-being, but also the fiscal justification for such an initiative through gains of productivity. It becomes important to define task-specific curves and, where possible, to introduce measures that will move the worker to the crest of his or her performance curve by combining appropriate job selection with physical and mental training.

Current Levels of Workplace Stress

Tasks with inadequate mental demand

Measures to maximize worker performance are important in an increasingly competitive world economy but are difficult to introduce for both technical and political reasons. Classical Marxist theory has postulated an inevitable polarization of society into the “workers” who would

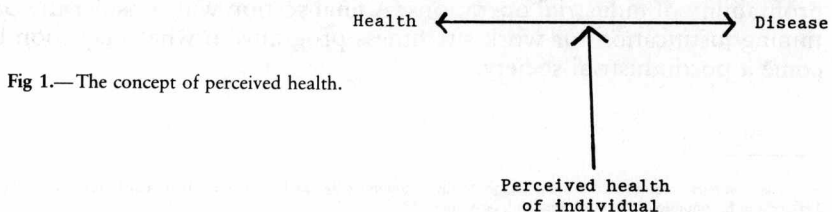


Fig 1.—The concept of perceived health.

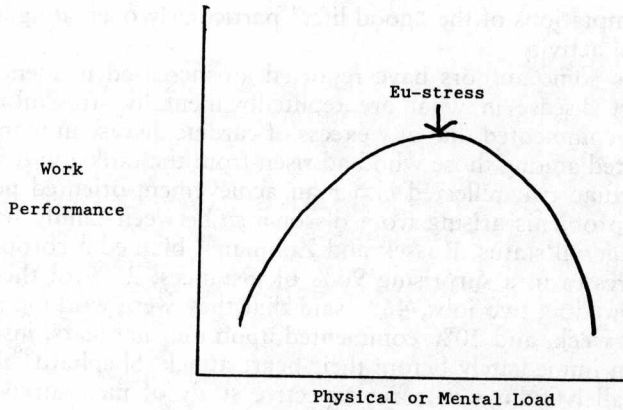


Fig 2.—Concept of eu-stress.

be forced to carry out increasingly repetitive machine-oriented tasks and “capitalists” who would live on the resultant economic surplus.¹⁸ Inevitably, the workers would show increasing signs of stress and alienation until their well-being was assured by victory in a final class struggle. The monograph “Work in America”¹⁹ apparently subscribed to this view, painting a bleak picture of omnipresent worker dissatisfaction. From Canada, Coburn²⁰ also has written eloquently on the “impoverishment” of job skills caused by modern technology. Others^{21–23} have applied objective measures of job satisfaction, finding results that suggested a relatively content labor force in both Canada and the United States. However, it must be admitted that the corporations accepting such surveys have tended to be nonunion, white-collar operations, with progressive policies and good industrial relations. Moreover, there remain frequent reports of boredom, anxiety, depression, and fatigue among blue-collar workers from both sides of the Iron Curtain,^{24–30} with such tangible evidence of worker dissatisfaction as frequent strikes and a high employee turnover rate.

Although the primary problem of the modern production line is usually inadequate physical and mental stress, with resultant boredom, there can sometimes be a secondary increase of stress because the worker is afraid of missing some vital but rarely occurring fault in the machine that is being minded.^{31–33} Simple tasks may also become excessively stressful because the machine sets too rapid a pace, there are frequent interruptions of work, conflicting demands are placed on the employee, or there is an inability to vary the working pace.^{34,35} Environmental factors further augmenting job stress include a lack of opportunity for vigorous physical activity, sensory isolation,³⁶ compulsory overtime,³⁷ shift work,^{38–40} and serious consequences of operator error.^{41–43}

Tasks with excessive mental demand

At the executive level, one hears much about the stress of employment, although cynics have argued that the main stressors faced by managers

are the temptations of the "good life," particularly overeating and a lack of physical activity.

Whereas some authors have reported an increased incidence of ischemic heart disease in what are reputedly mentally stressful jobs,⁴⁴⁻⁴⁶ Hinckle⁴⁷ commented that any excess of cardiac disease in managers was concentrated among those who had risen from the ranks; in his view, the added cardiac risk reflected either an achievement-oriented personality, or social problems arising from dissonance between family background and managerial status. Russek and Zohman⁴⁸ blamed a coronary attack on job stresses in a surprising 90% of instances; 25% of their patients reported holding two jobs, 46% said that they were working at least 60 hours per week, and 20% commented upon unusual fears, insecurity, or frustration immediately before their heart attack. Shephard⁴⁹ had somewhat parallel findings in a retrospective study of men surviving a first coronary attack. Over the preceding year, 70% claimed to have had unusual business worries, a finding not duplicated in immediate colleagues who had remained free of clinical heart disease. However, it remains possible that the acute cardiac episode had served to heighten the patient's perception of unrelated and omnipresent occupational problems.

There probably are some executives who face an unhealthy level of stress at work, and such individuals would profit from exercise programs designed to counter stress. However, many persons who seek and win "high-pressure" jobs function well under conditions of very heavy mental demand. For them, it seems that high-pressure activity is a "eu-stress" situation that needs no specific correction.

Physical stress at work

How far has automation eliminated excessive physical stress at work? As early as 1966, Allen et al.⁵⁰ noted that in Australia, the average maximum oxygen intake of supposedly "heavy" workers was no greater than that of the general population, suggesting that "heavy" work no longer provided enough exercise to sustain physical condition. One weakness in their argument, common to many subsequent surveys, was that leisure patterns differed markedly with socioeconomic status. Thus the heavy workers did show a small advantage of aerobic fitness if sportsmen were eliminated from the sedentary sample. Edholm⁵¹ suggested that mechanization increased the speed of working without diminishing the physical stress imposed upon the worker. Edholm's view may well have been correct during an era of low-level technology; operation of a rotary cultivator, for instance, can require as much energy as horse ploughing. However, Edholm's thesis can hardly be sustained with respect to either modern farming or a robot-operated factory. Physical work is disappearing even from traditional "heavy" industries, and the maintenance of an adequate aerobic condition has become dependent on involvement in a deliberate fitness program, either at the work site or in the community.

Nevertheless, one can still identify a few tasks that impose significant physical stress, i.e., tasks that involve prolonged walking, frequent stair

climbing, and the lifting or carrying of heavy weights, for example, the work of a mail carrier or marine surveyor.⁵²⁻⁵⁴ Epidemiologic comparisons suggest that the energy demands in such employment may be sufficient to have had a favorable impact on the incidence of ischemic heart disease,^{52,55,56} although sceptics point out that the aerobic fitness of such groups has yet to be measured, and there also has been some self-selection of active, healthy individuals to fill physically demanding jobs.

The physical demands of continuing "heavy work" have recently attracted renewed attention in the context of Equal Opportunity Legislation. At issue have been the employment of women and mandatory retirement.⁵⁷⁻⁵⁹ Specific points of discussion have included the extent of sex-related and age-related differences in exercise tolerance, and the possibility that job demands could be met if companies provided appropriate work site fitness and training programs.

Benefits of Work Site Sport and Recreational Activity

Mechanisms of benefit

How might an exercise program improve the health and job satisfaction of a worker? The arousing effects of vigorous leisure are well documented.⁶⁰⁻⁶² Plainly, a deliberate exercise-induced increase of arousal will help to counter boredom and job dissatisfaction, particularly if the worker is mentally understressed. Social involvement in an exercise class and a perception of management interest in life-style and health also may counter worker dissatisfaction. Participation in a multifaceted fitness/life-style program could also encourage adoption of other healthy forms of behavior, such as cessation of smoking or weight reduction, although in practice there is surprisingly little clustering of the various health habits. Further, there may be some reduction in the incidence of chronic disease, particularly ischemic heart disease,⁶³ although this is a long-term dividend and probably requires a higher level of energy expenditure than that reached in the typical work site program.

In jobs with a high level of mental stress, recreation offers a potential for detente. Unfortunately, many managers have "type A," achievement-oriented behavior patterns that they carry to fitness programs. They try to win every game of squash and set unrealistic personal training goals, so that detente is not realized. If the objective is a release of tension, the quality of the recreation is also much more important than its intensity or duration. A brisk walk in the open countryside may prove better therapy than 30 minutes of aerobic exercise in a hot office basement.

If a job is physically stressful, it might seem obvious that the ability of the average worker to carry it out would be improved by the introduction of an employee fitness class. Some gains in aerobic power and flexibility with loss of body fat can certainly be demonstrated during the first few months of program participation (Table 1), although the average benefit is less than would be anticipated in a controlled laboratory

TABLE 1.—CHANGES IN PHYSICAL FITNESS IN RESPONSE TO 6 MONTHS' PARTICIPATION IN AN EMPLOYEE FITNESS PROGRAM*

Variable	High Adherent	Low Adherent	Control
Maximum oxygen intake (ml/kg/min)	+3.9†	+2.8†	+1.9
Flexibility (sit and reach, cm)	+3.0†	+3.1†	+1.6
Body fat (%)	-1.7†	-1.7†	-0.2

*Based on data from Cox, M., Shephard, R.J., and Corey, P.: Influence of an employee fitness programme upon fitness, productivity and absenteeism. *Ergonomics* 24:795-806, 1981.

†P < .001 relative to control.

experiment.⁶⁴⁻⁶⁷ Moreover, the overall impact on the health and performance of the company's labor force is limited. No more than 20% of employees are initially likely to be recruited to a program, and only about 10% will attend exercise classes regularly.^{68,69} Even the regular attender obtains less than an optimal dose of aerobic conditioning. There may be attendance at two 30-minute sessions per week, but a fair part of the available time is occupied with warm-up, cool-down, and the mechanics of instruction. If there is finally a 20% gain of maximum oxygen intake with parallel gains of strength and flexibility among the more enthusiastic participants, this group should be less tired at the end of the day. Unfortunately, those recruited are often the fittest members of the labor force, having the least need of such therapy. It is also problematic whether there will be any matching gains in industrial performance. Productivity is all too commonly limited not by the physical performance of the workers but, rather, by poor organization of the work site, a shortage of tools and materials, a lack of team work, and union or management restrictions.

Nature of Work Site Fitness Programs

It is axiomatic that the impact of work site fitness programs in optimizing physical and mental stress depends on the type of program that is offered, its availability, and the participation rate. In older, blue-collar industries the main demand has been for team sports, whereas in offices the emphasis has been on the development of aerobic conditioning classes, sometimes directed to senior management and sometimes with an attempt to maximize the number of employees involved.⁵⁷

Some companies have sought merely to create an awareness of physical fitness through exercise breaks of 5-7 minutes. Others have installed showers and offered simple exercise prescriptions (Table 2). Larger companies have established a variety of on-site exercise facilities; these have varied from the carpeting of a disused basement to the construction of lavish, purpose-built pools, gymnasias, and indoor tracks. Some programs have aerobic exercise as their primary focus, whereas others feature social activities or promote a wide variety of healthy life-styles.

TABLE 2.—POTENTIAL SCALE OF FACILITIES NEEDED FOR
AN EMPLOYEE FITNESS PROGRAM*

Size of Company	Type of Facility
Small	Shower facilities Periodic exercise testing and prescription Shared facility on industrial campus Membership of private fitness club
Medium	Small facility and part-time instructor
Large	Large facility and full-time instructor (Floor space: 150-m ² gym; 30-m ² office; 50-m ² individual exercise space; minimum, 1.25 m ² per participant) (Cost \$100 - \$350 per worker)

*Based on the recommendations of M. Collis.

Plainly, such diverse initiatives have had differing effectiveness, both in countering industrial stress and in improving industrial output.

Corporate Benefits From Work Site Fitness Programs

A company may decide to introduce an employee fitness program because of management interest or a desire to be a good corporate citizen. However, if such commitment is lacking, the sports physician who wishes to encourage the introduction of a work site fitness program can suggest several benefits to management. These benefits potentially include improvement of the corporate image and facilitation of recruitment, gains in productivity, a better quality of work, less absenteeism and fewer strikes, less employee turnover, reduced health care costs, and fewer industrial injuries.

Corporate image

The corporate image may be enhanced by the introduction of an employee fitness program, particularly if a health-related product such as food is being marketed. A trim figure also helps the image of groups such as the military and the police.

If corporate policy is fitness oriented, there may further be a selective recruitment of employees with a positive self-image. Fit individuals tend to be high achievers and are therefore premium recruits for executive positions.⁷⁰

Productivity

Industrial productivity is often determined by factors other than personal well-being, as discussed above. Nevertheless, the health status of the worker is sometimes a factor. In a low-stress job, poor productivity often reflects boredom. Either a short "fitness break" or a longer vigorous exercise class can then optimize arousal, with the likelihood that production will be increased. Nevertheless, before such a tactic is commended to a company, we must compare the cost effectiveness of a

fitness break with alternative methods of manipulating the individual's arousal and job satisfaction (e.g., the employment of less intelligent personnel, the use of bright colors or an increased level of illumination on the shop floor, and the playing of vigorous music at the work site).

Few investigators have used any form of control group when looking at relationships between fitness and productivity. Cox et al.⁶⁴ were able to do this; they measured the productivity of assurance workers relative to the standard time that they were allowed for various jobs (Table 3). In the first year after introduction of an employee fitness program, there was a 7% gain in productivity at the test company, but a matched control company also showed a 4.3% gain. The apparent net payroll advantage from the program was thus 2.7%. Even in such a controlled experimental design, however, the gains in performance at the experimental company could reflect a Hawthorne effect rather than a true response to work site exercise. Unfortunately, there seems to be no way to introduce an exercise program in a truly double-blind fashion.

Self-reports and supervisor commentaries have generally suggested that fitness programs can increase productivity in mentally stressful jobs.^{61,71-76} However, such studies have generally been uncontrolled, often with the reports provided by those operating the fitness center. There have also been a few negative reports.⁷⁷⁻⁷⁹ One source of difficulty is uncertainty regarding the best type of exercise to reduce mental stress. A lack of correlation between exercise habits and employee performance could reflect an inadequate amount of activity in the supposedly active group, or an inappropriate type of exercise (e.g., the competitiveness of the workplace might be carried to the gymnasium or the sports field).

If a task is physically stressful, it might be anticipated that a 20% advantage of maximum oxygen transport would allow a corresponding 20% gain in productivity. In cross-sectional comparisons between worker-athletes and sedentary Russians, Pravosudov⁸⁰ suggested that there was indeed a benefit of this order. In Canada, Danielson and Danielson⁸¹ compared physically trained and untrained forest firefighters. The former were able to sustain a higher speed of cutting a firebreak under hot and arduous conditions. However, the more general translation

TABLE 3.—INFLUENCE OF WORK SITE FITNESS
PROGRAM ON PRODUCTIVITY*

Group	Change of Productivity Relative to Previous Year
Experimental company	7.0%
Control company	4.3%
Net payroll saving	2.7%

*Based on data from Cox, M., Shephard, R.J., and Corey, P.: Influence of an employee fitness programme upon fitness, productivity and absenteeism. *Ergonomics* 24:795-806, 1981.

of increased aerobic power into improved performance of a physically limited task depends on union acceptance of a faster pace of working and elimination of other constraints on productivity.

Quality of output

In general, there is an inverse relationship between the quality and quantity of industrial output. However, both may deteriorate if there is a loss of personal well-being and job satisfaction. Conversely, arousal from a brief period of work site activity can apparently decrease production errors during a constant pace of working, as has been seen in studies of textile workers and teletype operators.^{82,83}

In more senior jobs, some association between recreational detente and creativity might be anticipated. Studies to date have been cross-sectional, with all of the problems of self-selection of exercise. Russian scientists claimed a close linkage between physical and creative activity,⁸⁰ but Stallings et al.⁷⁹ found no correlation between sports participation and the research output of a United States university faculty.

Absenteeism

Strikes, lockouts, and other manifestations of workplace dissatisfaction receive much publicity, but their effect on productivity is small relative to that of lateness, absenteeism, and excessive staff turnover. Absenteeism alone can cause a loss in production of about 6 days per worker per year in nonunion operations and 10 to 11 days per worker per year in union operations. Moreover, less than 50% of this absenteeism has any clear pathologic basis.

It is difficult to measure how much work is lost at the upper end of the occupational scale (because reliable statistics are rarely kept on executives). However, the most common form of absenteeism at all levels of employment seems to be an uncertified absence of 1 to 3 days; this reflects job dissatisfaction, associated alcohol and drug abuse, and poor perceived health. Typically, 65% of the labor force have near-perfect attendance, 15% are absent occasionally, and 20% are frequently absent. Problems are concentrated (1) among blue-collar workers, (2) female employees (particularly those with small children), and (3) those about to leave a company.

The skewed distribution of absenteeism immediately limits any potential benefits from a company-wide fitness program. For success, the absentee must be targeted. However, those recruited to a work site fitness class tend to be the most faithful of the white-collar employees.⁸⁴ An alternative approach to absenteeism (e.g., an employee assistance program) may thus achieve greater success.⁸⁵

Most studies have found a small decrease in absenteeism either in the company as a whole or in program participants after the introduction of sports and fitness programs.^{67,73,80,86-89} One negative report⁹⁰ found no correlation between self-reported physical activity in the community and sick leave. However, no measurements of physical fitness were included