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OCCUPATIONAL HYPOKINESIA AS A HYGIENIC PROBLEM

K. M. Smirnov

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16. Abstract This article discusses insufficient motor activity at the work place as a widely prevalent problem reducing worker efficiency and adversely affecting worker health. Some guidelines are provided for evaluating and promulgating measures to prevent and correct hypokinesia at the work place and compensate for it during off-hours. The article suggests developing standards for optimal work-related motor activity and setting limits for its reduction.			
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exercises, (A. M. Krestovnikov; N. V. Zimkin; L. A. Ioffe; Vaughan). The state of a person living in hypokinetic conditions may be characterized as that of physical deconditioning, (A. V. Korobkov; K. M. Smirnov, 1972). Hypokinesia at work and in everyday life is manifested not as acutely as during strict bed rest in patients' hospitals or in laboratory experiments. On the other hand, insufficient exercise usually affects a person over the course of his entire life or most of it. A reduction of physical efficiency to a level lower than that in persons involved in heavy physical labor, or in athletes, is the most distinct symptom, (Figure 1). Less

noticeable alterations are found in many physiological processes involving the activity of the entire body.

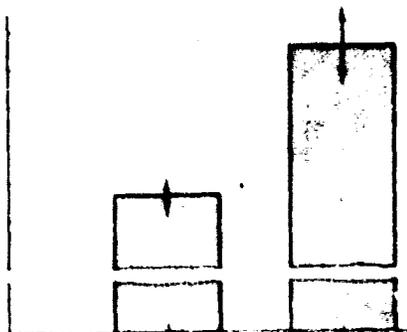


Figure 1. Results of the PWC<sup>170</sup> test in males from various professions (from S. P. Faustov). Along the ordinate -- value of PWC<sup>170</sup> (in kilogram meters per 1 kilogram of body weight); numbers under the columns: 1-- operators at electric power station control panel; 2--laborers at brick works, occupied with heavy physical labor. Columns correspond to the arithmetic mean, and the arrows on them -- doubled average errors.

When hypokinesia acts over the course of an entire lifetime, it promotes health disorders -- the genesis and exacerbation of a number of illnesses. It is viewed as a risk factor significant in hypertensive disease, ischemic heart disease, and some other pathological states, (G. I. Kositskiy *et al.*; V. I. Metelitsa; Morris and Crawford). Occupational hypokinesia should correspondingly be viewed as a factor facilitating the onset of occupationally related disease rates.

Hypokinesia is a factor of human ecology created by the technological evolution of industry. It is reflected in the physical condition of working people and on the effectiveness of their work.

Under the influence of inadequate motor activity, the body's exertion may decrease over a working shift relative to the initial condition of the body before and after work. Sedentary, localized, and monotonous work may slow down the cardiac contractions and reduce adrenocortical activity during a working shift, (X. M. Smirnov et al., 1977) (Figure 2). These alterations may be viewed as a

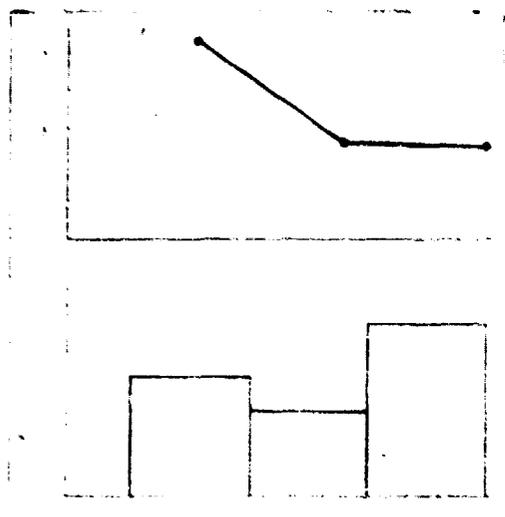


Figure 2. Reduction of physical effort during work hours for persons doing sedentary, local, and monotonous work on an assembly line for radio parts. A--along the ordinate -- frequency of cardiac contractions; numbers under the graphics: 1--beginning; 2--middle; 3--end of work shift (from K. M. Smirnov et al., 1977); B--along the ordinate -- secretion of 17 -- oxycorticosteroids from the kidneys (in micrograms per gram); along the abscissa -- hours of the days, work time in hatched area, (from K. M. Smirnov et al., 1978).

reduction in "vigilance level", similar to its reduction in neurophysiological laboratory experiments, (M. A. Gritsevskiy and Zh. I. Zaytseva) and in clinical observations.

Reduction in vigilance level during low motor activity makes it possible the more distinctly to show up a reduced level of work exertion, studied in detail by many researchers, (Z. M. Zolina; Yu. V. Moykin and V. I. Tkhorevskiy; V. S. Aver'yanov et al.) in various forms of monotonous work, i. e. hypokinesia is one of the basic preconditions for monotonous

Reduction of exertion below limits optimal for a given type of work reduces work efficiency. In these cases hypokinesia is adversely reflected in the effectiveness of the work. In a number of such cases work efficiency

has been successfully increased and the results of work have been improved through the use of some increase in exertion -- a return of

it to an optimal level due to some other factors. Hence, some increase in the work pace reduced the percentage of waste during "sedentary", local and monotonous work. A further increase in the pace of work again increased the amount of waste. /7

By reducing the reactivity of the human body, hypokinesia makes it possible for various emotional factors to have a more substantial effect on all physiological functions and concomitantly magnifies the possible harmful effects of negative emotions on human health, (A. L. Myasnikov and I. A. Ryvkin; Strauzenberg). It has become accepted to explain these distinctions through the role of "muscle discharge" in the elimination of the consequences of emotional reactions, (P. K. Anokhin; G. I. Kositskiy). In particular, the restoration of the consequences of emotional stimulation in the heart muscle occurs more quickly and fully in physically conditioned persons than in nonconditioned persons, (Raab). The mechanisms of physiological processes put together in the phylogeny and history of mankind are calculated in accordance to the mobilization of reactions and muscle and emotional loads. Frequent misalignment of such reactions in modern work cause a supplementary aggravation of the harmful effects of hypokinesia.

Hypokinesia alters the distribution of the human energy expenditure throughout the day. Of course, in the case of heavy physical labor the majority of energy expenditure occurs during working hours, while in "sedentary" and localized work not only is the general daily energy expenditure level decreased, but maximum expenditure occurs during free time, (Figure 3). If sedentary work is complicated or done at a fast pace, the work effort caused by these factors is at temporal variance with maximum muscle load, i. e., the circadian rhythm of these and other changes in the body is uncoordinated.

The discrepancy between low general work effort during sedentary and local work and the high level of localized effort caused, for example, by fast-paced localized work, (L. V. Donskaya; N. Yu. Tarasenko et al.), also has a harmful effect. In such situations

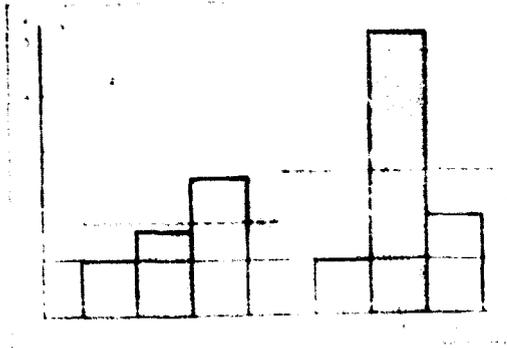


Figure 3. Energy expenditure throughout the day, (computed data diagram from material by S. A. Faustov). Along the ordinate -- energy expenditure (in kilocalories per minute); numbers under the columns 1--night; 2--working hours, (hatched column); 3 --non-working hours during the day; solid line -- base line level; dashed line -- midday expenditure; A--operators at control panel of electric power station; B--laborers at brick works -- heavy physical labor.

a special pathology arises -- overstressing the motor apparatus of the upper extremities, (L. N. Gratsianskaya et al.).

The amount of hypokinesia is assessed according to two basic criteria -- level of energy expenditure on muscular work and level of the person's physical condition or decondition (K. M. Smirnov, 1970; Weiner and Lorie; Schephard). Additional criteria, such as the site of muscular exertion, fixedness of work stance, monotony of work activities and presence and degree of work effort reduction during working hours have been proposed for use in evaluating occupational hypokinesia. (K. M. Smirnov, (1973).

The first task in preventing the harmful effects of hypokinesia is to determine the boundaries of the physiological norms for human motor activity. Any generalizations and recommendations are empirical and approximate in the interim. For humans and other animals as well, there is a characteristic need for movement and a concomitant striving to even out any divergence from the usual level of activity, (K. M. Smirnov et al., 1972; Smirnov). However, the need for movement is formed over a lifetime and does not absolutely correspond to the optimal level of activity for a given person. When ascertaining optimal motor activity, which differs with sex, age and health, it is essential to consider the effects of movement on human health and

efficiency. Some data of this sort are available from sources in sports medicine and physical therapy, (A. B. Gandel'sman and K. M. Smirnov; M. M. Mokeyeva and I. B. Temkin). Information about the motor activity required by Cosmonauts for overcoming the harmful consequences of weightlessness or conditions simulating weightlessness is pertinent, (B. S. Katkovskiy; M. Ye. Panferova).

The harmful effects of hypokinesia should be guarded against in all occupations involving sedentary and non-physical or localized physical labor if it is necessary to stay in one place for all or most of the working day, or if the physical activity is performed using only the hands and forearms. Reduction of work effort during work hours accompanied by a reduction in personnel efficiency may also be taken as a preliminary physiological symptom of possible subsequent harmful effects. A mid-shift muscular work expenditure of 0.5 kilocalories per meter may serve as a rough guide below which the harmful effects of hypokinesia must be averted. In developing these norms which determine the optimal boundaries of motor activity and limits of its permissible reduction, we should consider the possibility of establishing different limits for muscle loads depending upon the accompanying emotional reactions and informational load.

Three groups of health-promoting measures reducing the effects of hypokinesia can be mentioned: Prevention, correction and compensation. Prevention, or more accurately, reduction of hypokinesia may be realized in a number of cases through improvements of the work place and worker's duties so that fixed postures, extreme monotony, and simple motions are decreased; short pauses and even just standing up at the work position are measures that may be introduced to ensure that changes in body posture occur. Correcting hypokinesia is achieved to a certain extent by activation of respiration during regimented breaks. Activation includes calisthenics, (L. N. Nifontova; A. A. Minkh and I. V. Muravov) and simply walking to another place -- a snack-bar, recreation room, etc. -- plus open-air walks in the summer. Attempts are now being made to use physical

exercise systematically during the short pauses as well, (G. A. Kuznetsova). Such breaks for calisthenics may be employed collectively and in organized fashion, or by each worker individually. A number of corrective measures have been directed at countering the monotony of work activities and areas, such as the use of functional music, (I. A. Gol'varg) and considering aesthetics in the design of industrial equipment and work place interiors.

In most cases it is necessary to compensate for inadequate motor activity at work by increasing activity during off-hours. Calisthenics may fully counter the harmful effects of hypokinesia. Becoming active in sports is one radical solution to the problem for young and healthy people. In the second half of life, health-promoting physical exercises must hypothetically include muscular energy amounting to roughly 200--500 kcs per day, (depending upon age) expended on additional muscular work. The establishment of standards is now on the agenda.

## OCCUPATIONAL HYPOKINESIA AS A HYGIENIC PROBLEM

K. M. Smirnov

Institute of Industrial Safety Measures of the All-Union  
Central Trade-Union Council

Industrial mechanization and automation have reduced both the 5\* number of persons involved in physical labor and the volume and intensity of muscular activity for working people. As a result, prospects are becoming favorable for eliminating extremely heavy physical labor. At the same time, a potentially harmful factor is appearing -- occupational motor activity that is insufficient for human health and efficiency.

The term "hypokinesia" has been accepted to designate an insufficient level of motor activity, (K. M. Smirnov, 1972; Krause; and Raab). It is appropriate to speak of occupational hypokinesia where there is too little motor activity in the work-place, (K. M. Smirnov, 1976). The term "hypodynamia" has become widely used in space biology and medicine to designate inadequate use of muscle strength during weightlessness or where this state is simulated in the laboratory, (A. V. Korobkov; M. E. Panferova). Under terrestrial conditions, however, it is important to consider not only the amount of muscular effort, but also all other aspects and peculiarities of inadequate muscular activity -- low energy expenditure on muscular work, the local character of muscle actions, fixed work poses, and also the monotony, simplification and unification of motor coordination. The totality of these peculiarities is best termed "hypokinesia".

The effects of hypokinesia on humans in everyday life and work 6 are contrary to those of physical conditioning. The basic facts about the effects of this kind of hypokinesia have been obtained in research on the physiology of physical education and sport when studying the physical condition of persons not involved with physical

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\*Numbers in the margin indicate pagination in the foreign text.

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