

The general effects of exercise are analogous to the local effects, viz., fluxionary movement towards the outer periphery, acceleration of the pulse and respiratory movements, perspiration, &c.

In passing on to describe the effects of exercise on certain organs of the body, I avail myself again, in a condensed form, of Dr. Parkes' excellent Manual of Hygiene.

*The lungs.*—The most important effect of muscular exercise is produced on the lungs. The pulmonary circulation, the quantity of air inspired and of carbonic acid expired, is greatly increased. Thus, a man inhales, under ordinary circumstances, 480 cubic inches of air per minute: if he walks four miles an hour, he inhales 2,400 cubic inches; at six miles an hour, 3,360 cubic inches; the amount of carbonic acid in the expired air increases in proportion. With fair exertion for 10 hours a day the amount of carbon given off in 24 hours would be increased about one-third over that given off in the same time during rest.

Thus muscular exercise is necessary for a due elimination of carbon from the body; and it is plain that, in a state of prolonged rest, either the quantity of carboniferous food must be reduced, or carbon will accumulate in the system.

Excessive and ill-directed exertion may lead to congestion of the lungs, and even hæmoptysis. Deficient exercise, on the other hand, is one of the causes which produce those nutritional deteriorations in the lungs that are classed as tuberculous.

*The heart and blood vessels.*—The action of the heart increases rapidly in force and frequency, and the flow of blood through all parts of the body, including the heart itself, is augmented. The amount of increase is usually from 10 to 30 beats, but occasionally much more. After exercise, the heart's action must be carefully watched, and the exercise should be discontinued if the pulsations become extremely quick (from 120 to 140 per minute) and irregular. Excessive exercise leads to affection of the heart, rupture, palpitation, hypertrophy in many cases, and more rarely valvular disease. Injuries to vessels may also result from sudden or prolonged exercise. Deficient exercise leads to weakening of the heart's action and to fatty degeneration.

*The skin.*—The skin becomes red from turgescence of the vessels, perspiration is increased; water, chloride of sodium, and acids being given off abundantly. Evaporation reduces and regulates the heat of the body, which would otherwise soon become excessive; so that the bodily temperature rises little above the average. If anything check the evaporation, the bodily heat increases, and soon languor comes on and exertion becomes irksome.

During exercise there is little danger of chill under almost any circumstances; but when the exertion is over, there is then great danger of chill, because the heat of the body rapidly declines below the normal amount, while the evaporation from the skin, still further abstracting the heat, continues.

*The nervous system.*—There is no doubt that great bodily exertion is quite consistent with extreme mental activity. Considering that perfect nutrition is not possible without bodily activity, it may be inferred that a fair amount of exercise is necessary for the perfect performance of mental work.

*The digestive system.*—The appetite largely increases with exercise, especially for meat and fat. Digestion is more perfect, and probably a larger development of force is obtained from an equal quantity of food, than in a state of rest. The circulation through the liver increases, and the abdominal circulation is carried on with more vigour.

*The metamorphosis of tissue.*—The weight of the body is lessened by exertion, owing to the increased excretion of carbon, nitrogen, water and salts. The renewal of the muscles appears to take place only during rest; and they require apparently much rest, especially weak muscles.

The muscles, after exercise, easily absorb and retain water. Water taken after exertion does not pass off as usual by the kidneys or the skin; and instead of causing an augmented metamorphosis, as it does in a state of rest, it produces no effect whatever. It is probable that it enters into the composition of the muscles from which water has been passing so rapidly during their exercise.

Thus, as has been seen from the above statements from Dr. Parkes, exercise stimulates the nutritive functions, accelerates secretion, increases animal heat, and is an efficacious means of counteracting extremes of temperature. At the same time it sharpens the external senses, promotes gaiety and vivacity, and induces refreshing sleep.

Is the strengthening of the constitution the definitive result of exercise? It is true the athletes were frequently subject to maladies, and were only moderately efficient soldiers. They had, as a rule, indifferent constitutions. But this was rather due to exaggerated and one-sided exercise, to the violation of all hygienic rules, as well as to a life of idleness and excess. Agesilaus, feeble and sickly at his birth, was on the point of being exposed to die, and only owed his life to a movement of maternal pity. By the practice of gymnastics, he became capable of resisting the greatest fatigues of war. But we must distinguish between force proper and force of resistance. There is a difference between being strong and being robust. Gymnastics bestow less easily the second quality than the first. The robust man owes in some part his vigour to the vigour of his native constitution; special aptitude to meet the rigour of the elements, and fatigues joined to privations, is not imparted by gymnastics, but only fostered by them. But to restrict the effects of gymnastics within exact limits, is not to contest their importance and usefulness.

In fortifying the constitution, gymnastics exercise a very beneficial influence, as prophylactics of many diseases, upon their cure and on convalescence. They are salutary in epidemics, when bodily activity is often the most efficacious means to stir up mental energy. They are efficacious against scrofula, rachitis, against arthritic affections followed by ankyloses, against chlorosis, chorea, and against most nervous affections. On delicate chests gymnastics have a very beneficial effect. In fact, a well regulated course of exercises is acknowledged to be an important remedial measure in threatened phthisis.

There are, however, several maladies which preclude the use of gymnastics, such as all cases of inflammation, where rest is the first condition of treatment, organic affections of the heart and of the large vessels, advanced phthisis, &c. But in the first stages of the latter disease gentle and cautious exercise has been prescribed with success.

It may be imagined that gymnastics, which render all the functions of the body more energetic, might themselves become a source of disease, unless carried out with certain precautions and according to hygienic rules. I will point out certain rules, the observance of which I consider highly necessary.

During exercise the action of the lungs should be perfectly free; not the least impediment should be offered to the free play of the chest and the action of the respiratory muscles. The action of the lungs should be watched when men are being trained for exertion; as soon as the respiration becomes laborious, and especially if there be sighing, the lungs are becoming congested, and rest is