Metabolic Catch-22 of Exercise Regimens

Some researchers argue that if you are obese enough to need to exercise in order to lose weight, you probably won't be able to exercise enough to boost your body's metabolism

IT sounded too good to be true. Exercise, it was said, increases the metabolic rate for as long as 12 to 24 hours to come, helping dieters burn off fat even after their exercise session is finished. Health clubs and fitness advocates have promoted this benefit of exercise unquestioningly, but investigators are now asking whether it really occurs.

As researchers start to do careful studies to verify the effect of exercise on the metabolic rate, they are finding that the exercise effect is not so clear-cut. It now appears that the sort of moderate exercise program that obese people are able to do may have no sustained effects on metabolism. To increase the metabolic rate for hours afterwards, a person may have to exercise at a much higher intensity or for a much longer time than was previously assumed.

In particular, F. Xavier Pi-Sunyer of St. Luke's-Roosevelt Hospital Center and Columbia University College of Physicians and Surgeons in New York said that "the type of exercise that most people do" has no sustained effect on the metabolism. Pi-Sunyer said he is talking about jogging for half an hour three times a week, for example, or taking several aerobics classes that each involve 20 minutes or so of vigorous exercise.

On the other hand, Claude Bouchard and Angelo Tremblay of Laval University in Quebec do find that very vigorous and sustained exercise can alter the metabolism. But, the effect "is probably dependent on quantity and intensity of exercise," cautioned Bouchard. "You have to exercise either very intensively or for very long times." But the effect can last for as long as 2 to 3 days after a person stops exercising.

Exercise proponents, including health clubs and fitness magazines, have made the sustained effects of exercise on metabolism a tenet, according to Pi-Sunyer. "All the cardio-fitness people latched onto it because they could use it to sell their programs," he said. Yet it originally was based on old literature that was "not very good." For example, one frequently cited study was completed in the 1930s. A physical education professor at Harvard University measured the metabolic rates of the Harvard football team before and after its game with Yale University. The Harvard players, he reported, had increased metabolic rates for 48 hours after the Yale game.

A well-designed study of exercise and metabolism is tedious and labor-intensive. Volunteers must not only exercise but also must live in a metabolic ward where they consume controlled diets. Because food itself can raise the metabolic rate, food intake must be carefully measured. "You have to have one research assistant for every three or four subjects and the research assistant has to live in the ward with them," said Bouchard. "You also have to have biochemists and nutritionists" working on the project.

Burning up calories. *These runners, who have reached mile 9 of Washington's 10-mile Cherry Blossom Festival race, will probably have an increased metabolic rate for the next 2 to 3 days.*

After looking at the old literature on exercise and metabolism, Pi-Sunyer and his associates decided to do their own studies to see if there is an effect. In one study, they recruited 23 volunteers, aged 25 to 45, who were between 85 and 115% of their ideal body weights. The subjects were divided into high, medium, and low fitness groups according to their customary level of physical activity. Members of the high fitness group ran more than 25 miles a week. Those in the medium fitness group exercised aerobically for at most 30 minutes three times a week. The low fitness group did not exercise formally.

Pi-Sunyer tested the effects of exercise by having each volunteer exercise on a treadmill for 30 minutes a day at a speed of 3.5 miles per hour. He found no increase in metabolic rate when he measured metabolism 40 minutes to 3 hours after exercise. The study participants had the same metabolic rate after exercising as they had on days when they did not exercise at all.

In another study, Pi-Sunyer and his colleagues studied obese and lean women for 19 days in a metabolic ward. The researchers required the lean subjects to exercise at moderate intensity on a treadmill for 5 hours a day and the obese women for 1½ hours a day. The exercise was the equivalent of a brisk walk. Yet, said Pi-Sunyer, "their resting metabolic rate was unchanged the next morning."

Bouchard and his associate Tremblay approached the exercise question from a different direction. They wanted to know why individuals have different metabolic rates. Their first hypothesis was that these rates were largely inherited. But, said Bouchard, after they looked at "twins, parents and children, and the usual network of relatives," they concluded that "the overwhelming individual differences in resting metabolic rates are not caused by inherited differences." Genes play only a minor role in determining metabolism, Bouchard and Tremblay found.

The principal determinant of metabolism is fat-free mass—the proportion of a person's mass that is muscle rather than fat. The more muscle tissue, the greater the metabolic rate, according to Bouchard. This is because muscle tissue uses much more energy than fat. "In muscle, protein synthesis is going on all the time," Bouchard said.

So Bouchard and Tremblay decided to use vigorous or sustained exercise to try to alter the resting metabolic rate of volunteers. They conducted several studies, all with essentially the same results. When exercise is truly strenuous or prolonged, it does appear to alter the resting metabolic rate for 24 to 48 hours afterwards.

For example, in one study Bouchard and Tremblay recruited ten moderately obese young women. The women had about 32% body fat, whereas nonobese women have about 20% fat. The women trained for 11 weeks, spending six sessions and a total of 5 hours each week on aerobic exercise, including aerobic dancing, swimming, and running. Their resting metabolic rate, expressed per kilogram of fat-free mass, increased by 8%.

Bouchard and Tremblay also looked at the effects of de-training. They asked highly trained long-distance runners to refrain from exercising and determined that their resting metabolic rates declined by 6.6% after 3 days of rest.

But there were large individual differences in responses to exercise which Bouchard and Tremblay attribute to inheritance. They studied six pairs of monozygotic twins, for example, who exercised vigorously for 2 hours each day. On average, the twins' metabolic rates increased but, said Tremblay, "there was much individual variation" within the group. Yet each pair of twins had identical responses. "Whenever one twin had an increase in resting metabolic rate, so did the other," Bouchard said.

Although the results of Bouchard and Tremblay seem to disagree with those of Pi-Sunyer, both groups of investigators think the contradiction is more apparent than real. Whether exercise has an effect on metabolism, said Bouchard, "depends on the quantity and intensity of the exercise." In order to make a difference, exercise has to "either be very intensive or go on for a very long time."

Pi-Sunyer points out, however, that the average person who exercises will not experience sustained increases in the metabolism. "The mild activity that is considered realistic for the average fat lady or fat man you ask to exercise is not likely to have an effect," he said.

Pi-Sunyer does not intend to discourage people from exercising to lose weight. "You are getting a caloric effect just from the exercise," he said. His results on the effects of moderate exercise, he explained, "are not to say exercise is not good or helpful." But he added that the widespread promotion of exercise as a way to effect a sustained increase in the metabolic rate "fools people into thinking they are getting more out of exercise than they really are." ■

GINA KOLATA

Tracking the Wandering Poles of Ancient Earth

New analyses support the contention that Earth's poles have wandered across the globe, at times as fast as continental drift

SINCE the turn of the century, the North Pole has crept about 10 meters toward eastern Canada. By the standards of continental drift that is a near gallop, but the drift of North America had nothing to do with it. Instead, the North Pole appears to be wandering.

Such true polar wandering, if sustained long enough, could considerably confuse efforts to backtrack from the present positions of drifting continents to their positions in the distant geologic past. At the present rate of polar wander, for example, Philadelphia with its reasonably temperate climate would find itself 10° closer to the North Pole, at the latitude of southern Labrador, in just 10 million years.

But has polar wandering been rapid enough and has it persisted long enough to affect maps of past continental positions? Recent estimates of the magnitude of past polar wander have been dropping toward insignificance as better data have become available. But new analyses that extend the most thorough published study, which found only 5° of wander during the past 90 million years, show that a relatively sudden polar shift of 10° to 15° occurred between 70 million and 100 million years ago. That shift would have been at least half as fast as the present observed rate and comparable with continental drift rates. What could have caused such polar wander is unknown, but it must have involved the redistribution of mass on or within the planet.

When Roy Livermore of the British Geological Survey in Keyworth and his colleagues started their search for polar wander, they knew that it would be a tricky business. If the very ground is moving—as part of tectonic plate motion—as well as the pole, where is the benchmark against which polar wander can be measured? Today it is the stars and quasars. Conveniently enough, given the lack of dinosaurian astronomical observations, Earth's spin axis is fixed with respect to the stars, with the exception of some periodic, predictable wobble. It is actually Earth that slowly tumbles like a rolling ball beneath the pole—where the spin axis meets the surface—to create "polar wander." Geoscientists merely assume for their own convenience the perspective in which Earth is fixed and the pole wanders.

Given the stability of the spin axis, Livermore and his colleagues followed the line of reasoning that has become popular in the field. They retraced to a given time the erratic wanderings of the plates on the basis of the record of sea-floor spreading preserved in ocean crust. They then located the magnetic pole at that time from the magnetic signature frozen in rocks and sediments formed then. Presumably, the magnetic pole and the spin axis coincide, at least when averaged over some tens of thousands of years. That provides one reference frame, one of fixed orientation.

Livermore and his colleagues took exceptional care in locating paleomagnetic poles in that they included data from both the major continents and the huge Pacific plate, an area omitted from other studies. The Livermore group was also the first to allow for irregularities in the magnetic field that might produce spurious pole motion.

Having located the spin axis at a certain time in the past, they then compared this fixed point with a second reference frame, the set of hot spots that form volcanic centers such as Hawaii and Iceland. There is some uncertainty here. Presumably hot spots mark the top of plumes of magma that rise nearly 3000 kilometers through the mantle from near the core. There is no general agreement yet about how securely these plumes are fixed within the mantle. Livermore and others who have taken similar approaches assume that hot spots do not move significantly with respect to the mantle. If the pole "wanders" over time with respect to hot spots, then it is the mantle, if not the entire Earth, that has reoriented with respect to the pole.

Not everyone is that sanguine about the fixity of hot spots. Clement Chase of the University of Arizona has attempted to measure any motion of individual hot spots with respect to the hot spot frame of reference. Hot spots do move, he says, up to 2.5 centimeters per year versus typical plate speeds of 5 centimeters per year. "The reason they appear to be fixed," he says, "is that the motion is semi-coherent." North Pacific hot spots as a group are moving to the north, those in the South Pacific to the