Body changes near the snow line

Photos: IBP High Altitude Research Program

High altitudes are hard on the lungs, generally good for the heart, and can take weight off a person who stays up there

by Joan Lynn Arehart

Ernest Hemingway once wrote about the highest mountain in Africa: "And there, ahead, all he could see, as wide as all the world, great, high, and unbelievably white in the sun, was the square top of Kilimanjaro. . . ."

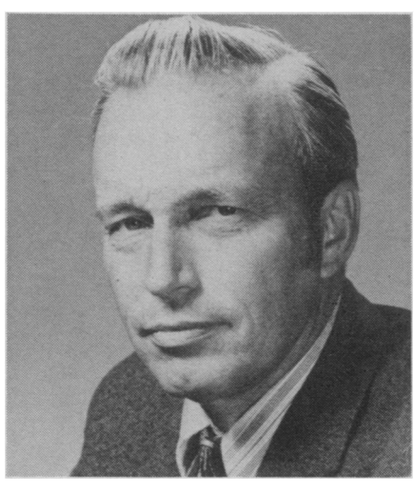
A poet's vision, yes, but also a common apparition among newcomers to altitudes of 8,000 to 10,000 feet. As their lungs rack for oxygen, they may experience an illusive exhilaration. At 15,000 to 17,000 feet they may find things incongruously hilarious. At 20,000 to 25,000 feet, on the slopes of Mount Everest, oxygen hunger can trigger hallucinations and lure climbers to their death.

Exactly what happens to the human body when it is subjected to high altitudes—one of the most severe stresses man has been exposed to for hundreds of years? Are natives of high altitudes different from lowlanders in their anatomy and physiological responses? Is there anything to high-altitude myths, such as that mountains harbor some of the most virile and long-lived peoples of the world? It has been precisely to separate facts from fictions about high altitude and the human body that Paul T. Baker, a biological anthropologist at Pennsylvania State University, has been conducting field studies in the Andes of Peru and Bolivia, and the Himalayas of Nepal and Tibet. These ranges boast some of the highest peaks in the world, and some of the world's most elevated inhabitants. They live from 13,000 to 16,000 feet above sea level. Some, such as the Andean Indians, commute daily up to 17,000 feet to work lead and silver mines.

Baker's team has included both United States scientists and local scientists, primarily from the Institute of Andean Biology in Lima, Peru. They have done their work under the auspices of the U.S. National Committee for the International Biological Program (IBP). Their high-altitude studies have been in progress for seven years. Field work was completed in December. Baker and his colleagues are now integrating and interpreting the mass of data they have collected in their studies.

The team has found that newcomers to high altitudes are handicapped by the scarce oxygen supply available, but that some people adapt far better than others. They have also found that natives of high altitudes have certain anatomical and physiological characteristics that set them apart from people living at lower levels. Persons from high-altitude parentage born near sea level, then moving into the mountains later in life, respond still differently to high altitudes. High-altitude peoples migrating to lower altitudes likewise experience singular physiological responses.

Baker says that although it is too early to extrapolate the study results to low-altitude health problems, such as heart disease and lung disease, some insights will probably be forthcoming as soon as the results are weighed and scrutinized. But practically speaking, the study results will probably hold more immediate and forceful clinical applicability for those tens of thousands of high-altitude migrants now spilling into coastal towns and cities. This past summer, for example, 10 of Baker's researchers were busy studying the health and physiological adaptability of Andean migrants to Cocachacra, a town on the southern coast of Peru. The town includes both lowland natives and scores of high-altitude migrants.

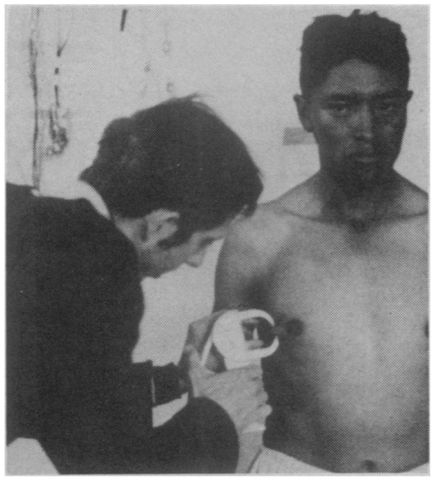


Baker: Heads IBP high-altitude study.

One of the particulars to emerge from the studies about high-altitude newcomers is that oxygen absorption into the bloodstream, by the lungs, is reduced about 20 percent. Oxygen levels are a good index to work, sport or other physical performance capabilities. Baker and his colleagues, athletes and some other high-altitude newcomers volunteered to raise their metabolism by vigorous exercise so that their maximum oxygen absorption capabilities could be measured. Some of them experienced severe muscle cramps, or fainted. "If you want a miserable test, this is it," Baker laments.

Yet the apparently universal 20 percent slash in oxygen absorption does not seem to affect all newcomers to the same extent. Some new arrivals to high altitudes say they feel fine. Others experience nausea, fainting or loss of peripheral vision because of a reduced oxygen intake, but then adapt. Fluid fills the lungs of still another small percentage of newcomers. If they are not rushed to lower levels within 24 hours, they may die. Such variations in response are not yet understood. Physical fitness may have something to do with it.

Athletes who come up to high altitudes, for example, seem to lose more physical performance, comparatively speaking, than do more sedentary newcomers. Scientists are not sure why. "It may be that if one trains up to his peak performance level, oxygen loss is more crucial," Baker speculates. But even with a greater loss of performance over what they can do below, some of



Examining a Peruvian highlander.

these athletes have retained enough resilience to compete with high-altitude natives in a foot race.

The IBP researchers have also found that newcomers to high altitudes lose weight. "But it is temporary," says Baker. "You put it back on when you go down."

Not surprisingly, the IBP studies have shown that the highlander has better developed lungs than the lowlander. For example, highlanders' lungs have more small blood vessels to absorb oxygen. There may also be cellular differences that allow greater oxygen pickup in the presence of reduced oxygen pressure. These and other factors may explain why high-altitude natives can absorb as much oxygen into their bloodstream at high levels as lowlanders do at lower levels. Charles Weitz of Pennsylvania State College, one of the Baker team members, has just returned from a year and a half with the Sherpa, the high-altitude Nepalese who are famous for their ability to climb extremely treacherous peaks. Weitz reports that the Sherpa have oxygen absorption capabilities comparable to the Andean natives.

Cardiovascular disease, the number one killer in the United States, is virtually nonexistent among highlanders, Baker affirms. Low-blood pressure among high-altitude peoples, as well as the very recent findings of low cholesterol and fatty acids in their blood, may help explain the relative lack of heart disease. What is more, highlanders appear to be every bit as fertile as lowlanders, contrary to some reports. This finding reinforces their own self image as extremely virile people. (The Andean Indians, for example, thought the sperm the IBP team was collecting was to be taken back to the United States and used to make American men more potent.) Lowlanders cannot claim the same sexual prowess when they migrate to the mountains. They usually experience a drop in sperm count and in sex hormone levels.

However there are some drawbacks to being born up in the mountain tops. High-altitude newborns are often of small birth weight, which makes them particularly susceptible to medical complications and death during the first critical days of life. Many highland neonates—18 times more, in fact, than lowland newborns—are born "blue babies." This means that the opening between the two ventricles of their heart fails to close at birth, so that oxygen is pumped indiscriminately into both ventricles simultaneously. As a result, they suffer a high mortality rate. Why there are far more blue babies at high altitudes is not yet known.

If highland newborns make it beyond that first critical week, though, they seem to do as well as lowland youngsters—especially well, in fact, considering that many of them receive minimal medical care. Yet high-altitude adolescents grow slower than lowland adolescents. (The IBP team recently found that Sherpan and Andean children grow about the same rate. Both live at 11,000 to 13,000 feet.) Highland youngsters also tend to walk later, get their teeth later and mature sexually in the late instead of early teens.

In spite of the "old man in the mountain" myth, Baker reports that his team has not been able to confirm stories of extraordinary longevity; birth records are not kept by these peoples. Nonetheless the team, on the basis of observation, staunchly concurs there is probably some truth to the myth. When highlanders finally do die, they appear to nearly always succomb from respiratory complications.

Some surprising things happen to highlanders moving down. For one thing, high-altitude resistance to heart disease seems to be at least partially retained. Even after highlanders have been living near sea level for up to 20 years, they still tend to maintain low-blood pressure and low-blood levels of cholesterol and fatty acids. Baker is now analyzing the data to determine whether they take on the high-fat diet of lowlanders, or continue to eat the low-cholesterol foods they ate up in the mountains.

Seven years of age tends to be critical in the adaptation of lungs as one moves down from high altitudes. If a highland child moves to the lowlands by age seven, he will probably never be stimulated to increase his breathing rate by the low-oxygen content in his blood. Conversely a lowland child who moves to high altitudes by age seven tends to develop an oxygen absorption capacity comparable to highland peoples. However inheritance may also enter into lung adaptation at high altitudes. The IBP team found that lowlanders from high-altitude stock who had never lived at high levels themselves lost only 10 percent of their oxygen absorption capabilities when exposed to high altitudes, compared with newcomers' usual 20 percent loss.

The IBP team has also been looking at social organization, cold tolerance, disease patterns and other general health aspects of high-altitude natives and migrants—all the things necessary for a population to survive. Baker anticipates it will take at least six months to a year to fully analyze and interpret the results. But when finished, Baker says, "they should help peoples coming from and going to high altitudes adapt better to their new environments. Hopefully it will also help physicians recognize their medical problems and to treat them more effectively."

Some other IBP teams—British, Italian, Peruvian and Russian—have also been looking at high-altitude effects on man. Many of their findings are dovetailing nicely with those from the American IBP studies. Says Baker: "We hope to integrate all the results as part of the worldwide effort of IBP." □

IBP researcher conducting hematology research on a high-altitude migrant.