

The local signals within bone marrow that induce quiescence in blood stem cells were already well known, but the fact that exercise could trigger them was not. Nahrendorf next wanted to learn the identity of the trigger linking exercise to blood stem cell quiescence. Further investigation revealed that the only receptors with enhanced activity in the bone marrow niche where most blood stem cells exist were binding to a well-known hormone called leptin; it is produced by fat cells and regulates hunger.

Leptin is like the fuel gauge in a car. When the tank is full—meaning energy (and food) are abundant—leptin levels run high. As exercise uses up the gas in the tank, this lowers leptin levels, which signal that reserves are running low, thereby inducing hunger and the urge to eat in order to replenish depleted energy stores. Nahrendorf and his co-authors speculate in their 2019 *Nature Medicine* paper that leptin's "role in regulating energetically costly hematopoiesis may have evolved to produce blood cells" only when whole body energy was abundant—not when people are exerting themselves. "Contemporary sedentary behavior," they continue, "which increases leptin and consequently hematopoiesis, may have rendered this adaptation a risk factor for cardiovascular disease (CVD) and perhaps also for other diseases with inflammatory components."

But with fewer circulating immune cells, would exercising mice be more vulnerable to infection? Nahrendorf challenged them with a protocol designed to induce infection in the blood, and found just the opposite: exercising mice had a *more robust* immune response, as semi-dormant blood stem cells swiftly sprang into activity and produced infection-fighting leukocytes, improving survival of the active mice as compared to those with no running wheels in their cages. Next, they investigated whether exercise would help mice with established atherosclerosis, and found that exercise was not only protective, it also reduced the size of existing plaques in the aorta.

Whether these associations would hold up in humans remained an open question. For answers, Nahrendorf turned to a study known as CANTOS, which had measured levels of inflammation in 4,892 patients who suffered heart attacks (see "Raw and Red Hot," May-June 2019, page 46). When

By linking exercise to reduced white blood cell production, Nahrendorf shows how a lifestyle factor can modulate cardiovascular risk.

he approached the study's co-authors, Mallinckrodt professor of medicine Peter Libby and Braunwald professor of medicine Paul Ridker, he learned, serendipitously, not only that they possessed self-reported exercise levels for the participants, but also that they had tested leptin levels as well. They analyzed their raw data and found "the same relationship among exercise, leptin, and leukocytes as in the mice." Data from a second human study cemented the result.

By identifying a previously unknown mo-

lecular mechanism linking voluntary exercise to reduced white blood cell production, Nahrendorf and his colleagues have highlighted how a lifestyle factor can modulate cardiovascular risk. Their discovery, the researchers hope, will point the way to wider adoption of healthy exercise regimens, and health-enhancing anti-inflammatory drugs.

—JONATHAN SHAW

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LIVES APART

The Risks of Homeschooling

A RAPIDLY INCREASING number of American families are opting out of sending their children to school, choosing instead to educate them at home. Homeschooled kids now account for roughly 3 percent to 4 percent of school-age children in the United States, a number equivalent to those attending charter schools, and larger than the number currently in parochial schools.

Yet Elizabeth Bartholet, Wasserstein public interest professor of law and faculty director of the Law School's Child Advocacy Program, sees risks for children—and society—in homeschooling, and recommends a presumptive ban on the practice. Homeschooling, she says, not only violates children's right to a "meaningful education" and their right to

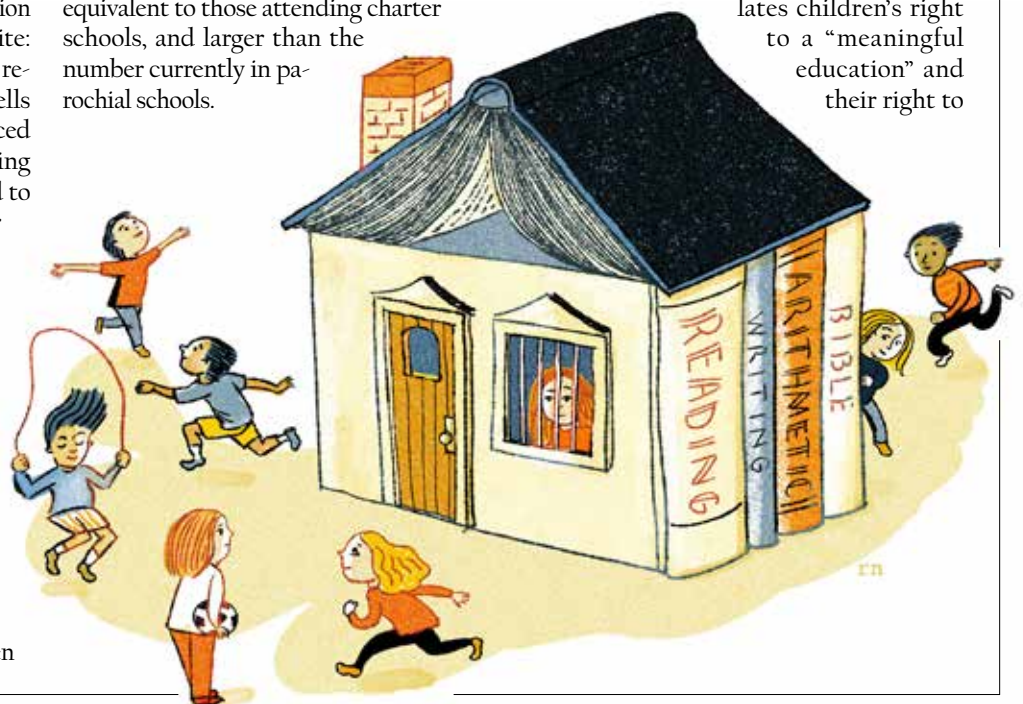


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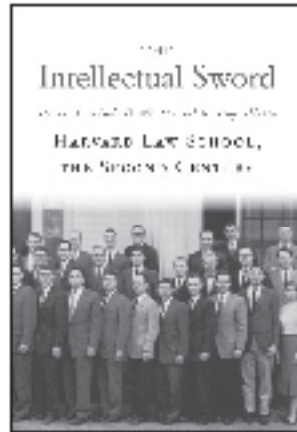
be protected from potential child abuse, but may keep them from contributing positively to a democratic society.

"We have an essentially unregulated regime in the area of homeschooling," Bartholet asserts. All 50 states have laws that make education compulsory, and state constitutions ensure a right to education, "but if you look at the legal regime governing homeschooling, there are very few requirements that parents do anything." Even apparent requirements such as submitting curricula, or providing evidence that teaching and learning are taking place, she says, aren't necessarily enforced. Only about a dozen states have rules about the level of education needed by parents who home-school, she adds. "That means, effectively, that people can homeschool who've never gone to school themselves, who don't read or write themselves." In another handful of states, parents are not required to register their children as homeschooled; they can simply keep their kids at home.

This practice, Bartholet says, can isolate children. She argues that one benefit of sending children to school at age four or five is that teachers are "mandated reporters," required to alert authorities to evidence of child abuse or neglect. "Teachers and other school personnel constitute the largest percentage of people who report to Child Protective Services," she explains, whereas not one of the 50 states requires that homeschooling parents be checked for prior reports of child abuse. Even those convicted of child abuse, she adds, could "still just decide, 'I'm going to take my kids out of school and keep them at home.'"

As an example, she points to the memoir *Educated*, by Tara Westover, the daughter of Idaho survivalists who never sent their children to school. Although Westover learned to read, she writes that she received no other formal education at home, but instead spent her teenage years working in her father's scrap business, where severe injuries were common, and endured abuse by an older brother. Bartholet doesn't see the book as an isolated case of a family that slipped through the cracks: "That's what can happen under the system in effect in most of the nation."

In a paper published recently in the *Arizona Law Review*, she notes that parents choose homeschooling for an array of reasons. Some find local schools lacking or want to protect their child from bullying. Others do it to give their children the flexibility to pursue sports or other activities at a high level. But

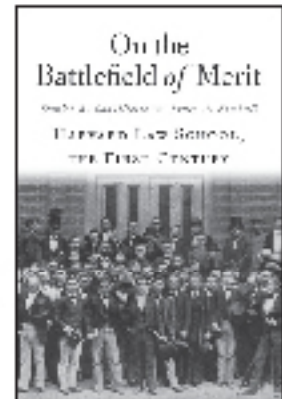


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surveys of homeschoolers show that a majority of such families (by some estimates, up to 90 percent) are driven by conservative Christian beliefs, and seek to remove their children

from mainstream culture. Bartholet notes that some of these parents are “extreme religious ideologues” who question science and promote female subservience and white supremacy.

She views the absence of regulations ensuring that homeschooled children receive a meaningful education equivalent to that required in public schools as a threat to U.S. democracy. “From the beginning of compulsory education in this country, we have thought of the government as having some right to educate children so that they become active, productive participants in the larger society,” she says. This involves in part giving children the knowledge to eventually get jobs and support themselves. “But it’s also important that children grow up exposed to community values, social values, democratic values, ideas about nondiscrimination and tolerance of other people’s viewpoints,” she says, noting that European countries such as Germany ban homeschooling entirely and that countries such as France require home visits and annual tests.

Children should “grow up exposed to...democratic values, ideas about nondiscrimination and tolerance of other people’s viewpoints.”

In the United States, Bartholet says, state legislators have been hesitant to restrict the practice because of the Home Schooling Legal Defense Association, a conservative Christian homeschool advocacy group, which she describes as small, well-organized, and “overwhelmingly powerful politically.” During the last 30 years, activists have worked to dismantle many states’ homeschooling restrictions and have opposed new regulatory efforts. “There’s really no organized political opposition, so they basically get their way,” Bartholet says. A central tenet of this lobby is that parents have absolute rights that prevent the state from intervening to try to safeguard the child’s right to education and protection.

Bartholet maintains that parents should have “very significant rights to raise their children with the beliefs and religious convictions that the parents hold.” But requiring children to attend schools outside the home for six or seven hours a day, she argues, does not unduly limit parents’ influence on a child’s views and ideas. “The issue is, do we think that parents should have 24/7, essentially authoritarian control over their children from ages zero to 18? I think that’s dangerous,” Bartholet says. “I think it’s always dangerous to put powerful people in charge of the powerless, and to give the powerful ones total authority.”

She concedes that in some situations, homeschooling may be justified and effective. “No doubt there are some parents who are motivated and capable of giving an education that’s of a higher quality and as broad in scope as what’s happening in the public school,” she says. But Bartholet believes that if parents want permission to opt out of schools, the burden of proving that their case is justified should fall on parents.

“I think an overwhelming majority of legislators and American people, if they looked at the situation,” Bartholet says, “would conclude that something ought to be done.” ~ERIN O'DONNELL

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FRONTIERS...

Fractal Physiology

Wearable technologies that track physical activity are ubiquitous. But using them to generate medically useful information, such as predicting an elderly person’s risk of falling, is not straightforward: daily changes in schedules and weather alter activity. Associate professor of medicine Kun Hu, instructor in medicine Peng Li, and their colleagues, writing in *Science*, overcome this limitation using fractals: patterns that repeat themselves at different scales. They followed 1,275 patients, 56 to 100 years old, for as long as 13 years, and found that such patterns (with similar temporal, structural, and statistical properties) are “stable within individuals, and sensitive to pathological conditions” despite variations in average levels of physical activity. Specifically, they found that increased random fluctuations in activity, at timescales from about a minute to more than two hours, were associated with a higher risk of frailty, disability, and death for study participants, and might help spot people who could benefit from earlier intervention. The team previously showed that fractal fluctuations in activity could help predict a likely risk of Alzheimer’s years in advance.

Powering Coastal China

Electricity derived from land-based wind power instead of fossil fuels is often cheaper. Now, *offshore* wind farms are becoming cost-effective sources, too. In a recent *Science Advances* paper, researchers with the Harvard-China Project on Energy, Economy, and Environment note that much of China’s wind-power capacity is 1,000 miles from the coastal provinces that use 80 percent of the nation’s electricity—while meteorological data from 1980 to 2018 indicate that its offshore wind potential exceeds those provinces’ current demand more than fivefold. Senior author Michael McElroy, Butler professor of environmental studies, says much of that power can be developed “at costs competitive with existing coal-fired power plants.”

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