Dengue: The Devil’s Disease • 3 Questions for Haiti’s Future • Race vs. Place

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TWENTY PRIORITIES FOR THE NEW DECADE

CHALLENGES

10 years
In the 1960s, only 10 percent of couples around the world used contraception; today, the rate is 63 percent. In the last 50 years, most regions of the world have embraced family planning, with measurable benefits: Birth rates have declined, rates of adolescent childbearing have dropped, and every year 188 million unwanted pregnancies are prevented through contraception.

In countries such as China, South Korea and Thailand, where family planning was widely adopted—up to 80 percent of couples there now use contraceptives—the positive effect is clear. As fertility and family size decreased, education (especially for girls) improved, per capita income rose, life expectancy increased, and the nations prospered. Latin America has moved quickly in the same direction.

Despite its many successes, though, interest in and support of family planning has flagged in recent years. “Generally, the U.S. has been the leading voice on family planning,” says Amy Tsui, director of the Bill and Melinda Gates Institute for Population and Reproductive Health. But conservatism about family planning during the Reagan administration “put a pall on the movement in the 1980s,” says Tsui, PhD. As family planning became politically linked with abortion in the 1990s, it lost more momentum and retreated further during the George W. Bush era.

But now it looks as if family planning is back. The Obama
administration has begun to re-invest in not only contraception, but also “safe motherhood,” which covers maternal and newborn health. In January, Secretary of State Hillary Clinton announced the U.S.’s re-dedication to international family planning, while President Barack Obama requested $716 million for family planning and reproductive health programs for fiscal year 2011.

Further signaling a return to this development topic was the International Conference on Family Planning (ICFP) held in Kampala, Uganda, in November 2009 (2009fpconference.wordpress.com). Organized by the Gates Institute, Makerere University and other partners, the conference was the first of its kind in 15 years. With more than 1,300 participants from 61 countries, it focused on research and best practices. At the conference, School researchers announced the launch of a three-year collaborative effort—Advance Family Planning—to revitalize the family planning global agenda, empower developing countries, and ensure universal access to reproductive health.

The ICFP seems to have accelerated interest in family planning, especially in sub-Saharan Africa, where families still face many challenges: a dearth of clinics that offer family planning services; a short supply of contraceptives; and knowledge gaps, myths and taboos that thwart progress. But, says Tsui, African policymakers have become very committed to family planning: “We’re seeing a lot of movement after Kampala.”  

—Christine Grillo
Spiking fever, searing muscle and joint pain, blood seeping through the skin, shock and possibly death—the severest form of dengue fever can inflict unspeakable misery. Once rare, dengue fever now threatens more than 2.5 billion people. What will it take to stop an old disease spreading with a new vengeance?
From witnesses hundreds, even thousands, of years ago to recent research observations, a theory begins to take shape about the origins of *ka-dinga pepo*.

Some 2,000 years ago in the Nile region of Egypt, a deadly pathogen confined within a specific species of mosquito found a way to thrive in a new host: human beings. Curiously, a legend among peoples in those ancient times bears striking parallels. In it, Allah punishes a sinful leader called Nimrod by inserting a mosquito into his brain. Driven mad by the insect’s buzzing, Nimrod begs a servant to crack open his skull, allowing the mosquito to fly free.

*Ka-dinga pepo*, marked by its bright red rash, first appeared in isolated epidemics in tropical and subtropical regions. But as the centuries passed, the mosquito that transmitted the virus stowed away with slave traders and rum-runners, slowly taking hold in new surroundings across the world. By the 17th century, it reached the docks of Boston and Philadelphia.

Everywhere, it infected humans—most frequently children—with spiked fevers, terrible pain in joints, muscles, bones and behind the eyes. It could even cause blood to ooze through the pores. It acquired a variety of graphic names, the best known of them attributed to Dr. Benjamin Rush, a signer of the Declaration of Independence. Rush treated an outbreak in 1780 Philadelphia and, observing the misery afflicting its victims, called it “Break Bone Fever.” In Swahili, however, it was still known as *ka-dinga pepo*, a disease of the devil. It was but a short linguistic jump for it to become known worldwide as dengue fever.

Whatever its origins, scientists, medical professionals and disease control experts are concerned now with the most recent history of dengue (pronounced DEN-ghee). Before 1950, a typical world map depicting affected regions contained few flecks of color. A dab in Africa, a small glob in Southeast Asia, a sliver of color in South America. Today, it’s as if a can of paint spilled across the bottom half of the map.

As it has spread, the most dangerous form of the disease—dengue hemorrhagic fever (DHF)—has appeared with alarming regularity. According to Anna Durbin, MD, an associate professor in International Health, the often-fatal DHF causes vascular leak syndrome where fluid in the blood vessels leaks through the skin and also into spaces around the lungs and belly. Blood pressure falls, shock sets in and death often follows.

DHF ran rampant in Southeast Asia in the 1960s and 1970s, and has increased its presence ever since. The WHO estimates that 2.5 billion people are at risk annually for dengue infections. Between 50 million and 100 million contract the disease each year. More than half a million of those are diagnosed with DHF.

Compared to malaria, dengue has a rela-
Dengue fever is rare in the U.S. even though a small outbreak was reported in the Texas border city of Brownsville in 2005. But generally, dengue is rare in the U.S. even though Aedes aegypti, which is common in the South, is immune. In fact, a small outbreak in Texas in 2005 was reported in the Texas border city of Brownsville in 2005. But generally, dengue is rare in the U.S. even though Aedes aegypti is immune.

Many scientists refer to it as a disease of poverty. Dengue has reached endemic status, says Durbin, the senior scientist in the W. Harry Feinstone Department of Molecular Microbiology and Immunology (MMI), in 2003 by Scott Halstead, MD, a world authority on dengue research and an adjunct senior scientist in the W. Harry Feinstone Department of Molecular Microbiology and Immunology (MMI).

Dengue's spread is only part of the story. For dengue fever is not just a virus, it is four viruses. And in a given year, a region may experience an outbreak of one or two of those virus serotypes, and sometimes all four at the same time.

The challenge of a virus, according to George Dimopoulos, PhD, an MMI associate professor, “is its ability to rapidly mutate, making it difficult for the human immune system to resist it.”

With most viruses, a survivor is usually immune to subsequent infections because of antibodies that alert the body to resist new viral invasions. Vaccines—usually weakened forms of a virus—build similar antibodies for resistance. With the eradication of smallpox and near-eradication of polio, vaccine-fostered immunity is a sacred given in public health.

But dengue fever commits sacrilege and it even has its own name: antibody-dependent enhancement. “There’s one thing we are fairly certain of,” says Durbin. “If you have an antibody to a serotype, say Dengue 1, and you are infected with Dengue 2 virus, your Dengue 1 antibody won’t protect you.”

That’s because, says Durbin, the antibody binds itself to the new dengue strain, in effect joining forces with the new virus and helping it gain entry into target cells where it can then replicate. As a result, the bloodstream now contains higher levels of the virus than during the first infection. Often this triggers dengue hemorrhagic fever. Any of the four dengue serotypes can combine with the antibody from any other serotype to cause DHF.

It is, according to Halstead, “a most amazing perversion of the immune response.”

“The cells that are supposed to scout out and kill viruses and the antibodies that are supposed to destroy viruses form an unholy complex to defeat our immune system and promote the life of the dengue virus,” he told a New York Academy of Sciences gathering last year.

The ramifications for dengue fever vaccine development are daunting: A dengue vaccine must be able to combat all four serotypes at the same time. But the hazards only begin there.

“In the vaccine world, two big questions overhang our studies,” says Durbin. “One is close to being answered: If we introduce a live vaccine into people who have a pre-existing antibody, can that vaccine cause severe disease?”

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Because a vaccine will essentially be a weakened form of the disease, she says, most researchers believe it’s not likely to occur.

“The greater concern,” she adds, “is what happens if the vaccine we introduce doesn’t produce a balanced immune response in individuals and, over time, their antibodies to vari-
ous serotypes decline at different levels? And supposing an individual never did develop a good response to one of the serotypes. Are we going to put people at risk for more severe disease months or years down the road? Nobody knows the answer. The only thing that will answer it is long-term surveillance studies of vaccinated populations.”

There are other troubling questions. “We think a vaccine will reduce transmission of dengue or reduce the circulation of dengue in endemic areas,” she says. “But what happens if it reduces the transmissibility below the level that will sustain dengue in a given community? If people aren’t being exposed, will their immunity drop and make them more susceptible should somebody come into their region and reintroduce dengue? We just don’t know. We won’t until we follow them over years and see if they are able to maintain antibody levels or not.”

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George Dimopoulos has built an international reputation as an authority on mosquitoes that carry pathogens for malaria and dengue. In 2001, he started the Dimopoulos Group, a research lab at the Imperial College of London. In 2003, his group became part of the Johns Hopkins Malaria Research Institute in the School’s MMI Department.

“I truly believe,” he says, “that we will never be able to design an efficient strategy to eliminate dengue and other mosquito-borne diseases if we don’t understand the biology of the pathogen and how it interacts with the human and the mosquito.”

Dimopoulos carries out his research in CDC-approved, Biosafety level 2 and 3 facilities housing tens of thousands of mosquitoes. Collected during field trips to tropical regions, some of the mosquitoes are Anopheles gambiae that can carry Plasmodium, the malaria-causing parasite; others are Aedes aegypti. Most are harmless, not yet infected with a pathogen.

Those that have been infected—in one of four brightly lit, white-on-white contaminated labs—are kept in carefully screened cages in small closets off the labs. Temperature and humidity level have been adjusted to tropical conditions. Here the mosquitoes lay eggs in special trays and are fed on human or mouse blood.

To an untrained eye, the Anopheles and Aedes mosquitoes look the same. But, it’s what’s inside of them that intrigues Dimopoulos. He notes that the Plasmodium parasite that causes malaria cannot infect the Aedes mosquito nor can the dengue virus infect the Anopheles.

“It’s not known why that is,” says Dimopoulos. “A pathogen may, for example, require certain receptors in the mosquito’s gut—factors that are present in one species but not in the other—to establish infection.”

A virus cannot propagate independently of its host. The malaria parasite, with its 6,000 genes, replicates its DNA on its own while dengue, with only 10 genes, has to use the machinery of the host cell to propagate.

Unlike the malaria parasite, once the dengue virus has taken hold in the mosquito’s cells, says Dimopoulos, the way it interacts parallels the way it behaves in a human cell. “It’s probably utilizing very similar cellular machinery in [both] its hosts,” he says. “That is why research we do on dengue in the mosquito may also be used to understand how dengue infects humans. The actions are quite similar.”

In a manner very close to the way the human immune system tries to fight off an invasion by a dengue virus, the Aedes aegypti flexes its own defenses against viral pathogens. Researchers know of three immune-related cellular pathways in the Aedes mosquito. In previous work, Dimopoulos’s group has shown that two of them—the Toll and JAK-STAT pathways—defend against the dengue virus. “These defense systems do not seem to be sufficient in the Aedes mosquito,” says Dimopoulos. If they were, the mosquito could fight off the infection. “But these pathways are doing something.”

It’s even probable, that this anti-dengue response may be sufficient against dengue in different mosquito strains and species, explaining why they can’t be infected by the virus. “But we have just started to understand these defenses and their pathways and we don’t really understand the resistance mechanisms yet.”

Historically, notes Dimopoulos, wherever dengue and malaria have been controlled it has been through the mosquito—either through avoidance strategies or with insecticides. But he

Curing Mosquitoes of Dengue
Why does Aedes aegypti transmit the dengue virus, while other mosquitoes do not?

One of the theories pursued by scientists is that cells in the mosquito’s gut may contain unique factors that are necessary for virus replication and permit dengue to establish infection. Another possibility is that the virus can circumvent the immune system of specific mosquito species and strains.

George Dimopoulos, an MMI associate professor, suggests that if these factors could be pinpointed, they could be manipulated to prevent the virus from propagating. Last year he and other dengue experts broke new ground in this area. Oddly, they made their discoveries with the help of an old and much-studied insect friend of researchers: the Drosophila fruit fly.

Because scientists lack some molecular tools and a detailed body of mosquito immune system research, they haven’t been able to fully understand the workings of cellular pathways in a mosquito that trigger an immune response. Instead, they used fruit flies, which have a large number of genes similar to mosquitoes, suggesting their immune systems would function similarly.

Funded by the NIH, the researchers began their immune system research, they haven’t been able to fully understand these defenses and their pathways and we don’t really understand the resistance mechanisms yet.”

Historically, notes Dimopoulos, wherever dengue and malaria have been controlled it has been through the mosquito—either through avoidance strategies or with insecticides. But he identified 116 specific characteristics of the fruit fly genes that responded either for or against the infection. Only five of those 116 had been previously suspected by researchers.

Dimopoulos and his team then deactivated the same suspected genes in live mosquitoes and injected them with the dengue virus. “In this way we could identify the genes that, when inactivated, would either make the cell more resistant or more susceptible to an infection.” As hoped, they found that the very same genes that reacted to dengue in the fruit fly reacted to it in the mosquito.

In parallel work, the Dimopoulos Group showed that two other immune pathways are key players in the mosquito’s defense against dengue, putting science one step closer to a dengue “cure” for the mosquito. —PM
basic dynamics of how the incidence of dengue builds a mathematical model that captures the features of the epidemic. "Ultimately, what you want to do is understand how you can control it. If I have a model that captures the features of the epidemiology I can start to test ideas."

For instance, he says, if he knew of a vaccine that performed in a certain way, he could build a mathematical model that captures the basic dynamics of how the incidence of dengue cycles through a population. He could then hypothesize as to how much of an impact that vaccine might have, or what is the best age to use it—at what time and in what place—to minimize transmission.

Cummings splits his time between computer modeling in Baltimore and field studies in Thailand. There he works with the Ministry of Public Health and with the U.S. Army’s Armed Forces Research Institute of Medical Sciences, which partners with the Royal Thai Army.

Among the records he reviews are longitudinal studies of dengue involving schoolchildren. Blood tests show which children have serological evidence of dengue. Analyzing data going back three decades, Cummings discovered that in Bangkok the incidence of dengue showed a much larger peak than normal every two to four years.

"It's thought to be driven by the cycling of immunity in the population," he says, using the predator-prey model to illustrate. "You have foxes and rabbits. The fox eats the rabbits, the rabbit population goes down. So then the fox population crashes. Because foxes have disappeared, the rabbits begin to grow and then the foxes return."

A large dengue outbreak immunizes people to a specific serotype. When that serotype shows up again the next year, not as many people are infected. Cummings also found a shift in the age group most affected by dengue. Historically in Thailand, 7- to 9-year-olds have shown the highest incidence. Surprisingly, surveillance data shows that the mean age of dengue cases is now 18. Cummings used a dengue transmission model to determine the cause of this shift. The model considered factors such as climate, socioeconomic indices and demography. Cummings says the most plausible explanation is that changes in population structure have altered dengue transmission to reduce the rate at which people become infected. The results were published last fall in the journal *PLoS Medicine*.

The results are classic for a developing country, says Cummings. "From the 1960s to today, Thailand went through some pretty dramatic changes in its population structure. What that means for dengue transmission is that the number of kids being born who are completely naïve to dengue and can be infected by any serotype is proportionally less than used to be because birth rates are down. Older people have immunity because they had it when they were kids," he says. "It makes it less likely that a mosquito that’s bit ten someone infectious will go and bite a naïve kid. As a population, Thailand has hung onto its immunity longer because of lower death and birth rates."

Because the only treatment for dengue is supportive care, efficient case management of severe form of dengue hemorrhagic fever, which can cause bleeding, shock and death.

"Essentially," says Norris, "the idea is to get ahead of the typical epidemic season, to identify infected mosquitoes early enough to provide local authorities with the time necessary to implement existing mosquito control strategies to reduce the infected vector/mosquito population."

The traps may collect 20 to 30 different species of insects a day, says Norris, most likely attracted by the scent of the bait and the carbon dioxide the trap is also baited with. Many blood-feeding arthropods are attracted to carbon dioxide [exhaled from hosts], so we might expect many other mosquitoes and biting flies in the traps.

"The idea for using the trap and its attractant came from Jorge Arias, PhD, of the Fairfax County, Virginia Health Department. Arias has worked with mosquito control related to the West Nile virus and is active in PAHO. Norris, Glass and Arias are working with Paula Pimenta, PhD, from the Centro de Pesquisas Rene Rachou, in Belo Horizonte."

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**Bait and Predict: Bracing for Dengue in Brazil**

Every year since 1996, a serious epidemic of dengue fever has struck Belo Horizonte, a city of 2.2 million and the third largest in Brazil. Without a dengue vaccine, control of the disease there—as in most of Brazil—is all about mosquito control.

But from year to year, authorities are never sure which dengue serotype will be borne by the annual attack of mosquitoes, when it might come and in what intensity. Thus they are forced into a deadly game of catch-up, applying their control strategies mostly after the fact.

Two MMI scientists, however, are heading an early warning project in Belo Horizonte that may give citizens a jump on the type of disease coming, the severity and, to some extent, a time frame for when it may strike.

With a $2 million Gates Foundation grant, associate professor Douglas Norris and professor Gregory Glass, both in Molecular Microbiology and Immunology, are using a relatively new “olfactory attractant” mosquito trap in Brazil. Baited with a proprietary scent known to attract the *Aedes aegypti* mosquito that carries the dengue pathogen, the 60 strategically placed traps are expected to snare thousands of mosquitoes. The captured insects will be sorted and identified by a corps of Brazilian collaborators, then “whisked back to the lab.” There they will be analyzed to see if they are carrying dengue and, if so, which serotype. “It’s a matter of warning people that conditions may be building for an epidemic,” says Norris, the project’s principal investigator.

Knowing ahead of time which serotype infects the annual mosquito swarm may give investigators an idea of the severity of the coming epidemic season. “If the mosquitoes we find are carrying a serotype that circulated last year,” says Norris, “we know that it may not build up to epidemic proportions, because the population may have built up immunity.”

But if the new crop of mosquitoes is carrying a different serotype, it could not only threaten the same people who were infected in the previous year, it could turn their illness into the most
the disease can mean the difference between a patient surviving the severest form of dengue or dying. “Thailand really does case management well,” says Cummings, “but the doctors who learn to manage dengue cases are pediatricians.” Because of his study, Thai health officials recognize the need to train regular internists in dengue care.

Cummings has also identified patterns in which dengue epidemics spread through Thailand. “It appears to peak first in the center of the country in Bangkok,” he says. “Then there is a lag as the pathogen moves north and south. It sort of appears as a traveling wave moving out into the country.”

“I’m interested in what drives those waves,” says Cummings. “If you can understand that, you might understand what’s really driving transmission to a particular location. You then might understand how best to allocate resources to reduce incidence of dengue in the country.”

While computer models can help analyze data and lead to an understanding of transmission dynamics, he says, sometimes it takes old-fashioned, face-to-face detective work to get a fuller picture.

“There’s a lot of interest in investigating people’s behaviors during outbreaks,” says Cummings. “You try to understand who interacts with who. You ask people over the course of 24 hours who they talked to in the morning, how old were they, how often do you see them. If you find one person who’s infected, how much more likely are you to find another infected person right around them, defining the spatial scale of transmission?”

In the Nile valley two millennia ago, people knew nothing of transmission waves or spatial scales or disease dynamics. Slowly, across most of those 2,000 years, scientific knowledge based on the accumulation of incremental advances in research has struggled to outpace ancient legends of evil spirits. But when circumstance triggered a new life for dengue, it also sparked a new urgency to come to grips at last with this complex virus. With the fight fully engaged comes the question: how close are we to winning?

“That’s a tough question,” says Cummings. “I think we know a lot about dengue. But there are still basic things we don’t know. It’s incremental. The thing I’m proud of at the end of a year is if I can explain something new that could potentially be important in designing control measures to reduce incidence.”

Ultimately, just as a victim of dengue has but one course to follow, so goes the course for science. Says Cummings: “You have to be patient.”

Online: Read about the clinical quandaries of counting dengue cases: magazine.jhsph.edu/denguecount
How Will Haiti Survive Future Disasters?

The best way to be prepared for disasters is to have a strong government and infrastructure that includes a health and emergency care system. Even before the earthquake Haiti didn’t have those things. The Haitian government has been weak for decades, and it has a great dearth of resources. So the country exists in a chronic, low-grade disaster state with very poor health, public health and economic indicators. To make matters worse, it has frequent natural disasters—hurricanes, and now earthquakes—which further prevent development.

The most important thing Haiti needs is a stronger, more reliable government and the funding to rebuild its infrastructure. Unfortunately, both seem pretty unlikely. Without these fundamental changes, the lives of the Haitian people will not improve.

How the world chooses to approach Haiti is a difficult dilemma. No one, including the U.S., wants to take over the management of the government; but the government has been unstable for years. The world has to provide some political and economic stability to allow infrastructure to be built.

From a health care and public health perspective, there are also fundamental infrastructure needs that must be addressed. Some experts have predicted that Haiti will rely on health care from other countries and agencies for years. Many nurses, physicians and public health workers died in the earthquake. The nursing school at the University Hospital collapsed and killed the entire annual class of nurses. There is now the great need to rebuild the physical infrastructure for health care, but also rebuild its intellectual capital through training and schools.

Despite years of aid and billions of dollars in the last decades, Haiti remains the least developed nation in the Western Hemisphere. Unfortunately, corruption has been a great contributor to this. Haiti is ranked as one of the most corrupt countries in the world. This has led to terrible hospitals, dirt roads, a weak power grid and unemployment of greater than 40 percent. But the people I met there were strong and kind and resourceful despite the devastation and overwhelming personal loss. Once again, the country needs a political solution. My big hope is that because of the devastating nature of the event, Haiti and the world will wake up and finally make some of the critical decisions that need to be made.

Thomas Kirsch, MD, MPH ’87, is an associate professor in the Department of Emergency Medicine at the Johns Hopkins School of Medicine and the Bloomberg School’s Department of International Health; co-director of the Center for Refugee and Disaster Response; and the Johns Hopkins Disaster Response team leader in Port-au-Prince.
Where Will Haitians Be Educated?

As a Johns Hopkins student, I have been listening attentively to the ongoing discussions about the role that Hopkins and other universities might play in the rebuilding of Haiti. Essentially, every institution of higher learning in Haiti has been flattened. In a situation like this, Port-au-Prince's university students are already asking, where will they continue their education?

An important question we must ask on a broader level is, Who will lead Haiti out of this disaster with no schools—literally no buildings—left to train and educate future leaders? Even before the earthquake, graduate students dealt with crowded classrooms and few opportunities. But with many schools still indefinitely closed, rising Haitian physicians, accountants and business leaders have little hope for continuing their schooling.

Institutions like Hopkins have much to offer. Much as Tulane's students were accepted at universities across the nation after Hurricane Katrina, schools of public health might save spaces or scholarships for Haitian students. While Haiti overflows with innumerable NGOs, few U.S. institutions of higher education have satellite or partner institutions in Haiti. Any involvement could not be timelier.

Haiti's reaction to the earthquake is a testament to the fact that Haitians will move on, survive this tragedy and sustain themselves. My fervent hope is that the Haiti that emerges will display real economic, human rights and public health progress.

Jane Andrews, an MPH student, was researching iodine deficiency in Département of Artibonite when the earthquake hit. Soon after the quake, she and three fellow MPH students rushed to Port-au-Prince to help with relief efforts.

Rebuild a City or Build a Nation?

After the quake, my brother and his family had to leave Port-au-Prince. They moved back to our hometown of Gros-Morne, Département of Artibonite. Like them, thousands of families in Port-au-Prince are moving out of the city and migrating to other smaller cities and towns across Haiti. The towns are trying to handle the influx of people, but there are almost no existing services in these small towns and cities. Gros-Morne never had electricity, except for a very brief time when electric power was provided intermittently to less than half of the population for a few hours at night.

When the earthquake hit, approximately 9 million people were living in Port-au-Prince. It's extremely overcrowded—but people move to the capital because it's the only place in Haiti with basic services and jobs. The medical school is there, and the agriculture school is there. In Haiti, if you want your child to be somebody, you have to move to Port-au-Prince. But give me a break—if Port-au-Prince breaks, the whole country is broken. And that's what happened. People are leaving the city now; it makes no sense to bring them back.

In my opinion, we should not rush into rebuilding Port-au-Prince. Instead, let's build up the towns across the nation. Let's build roads; right now, everything is so expensive in Haiti because the roads are so bad. We need a rail system. Let's build airports somewhere other than Port-au-Prince. Let's build homes and infrastructure. Let's break the vicious cycle.

Let's build a nation.

Born and raised in Haiti, Pierre K. Alexandre, PhD, MPH, MS, is an economist and associate professor in the Department of Mental Health. He has a background in economics, public health, environmental sciences and agriculture.
From today’s vantage, it’s at once easy and impossible to survey humanity’s health needs 10 years from now. Ensuring nourishing food for the hungry, safe water for the thirsty, protection for those threatened by malaria and HIV—these and other familiar challenges persist. Yet a slew of new problems require attention as well: the hazards of nanomaterials, the risks of aquaculture, the specter of epidemics driven by economic development . . . To gauge public health’s top research priorities for the new decade, we asked Bloomberg School faculty to tell us about their great challenges and most promising research. The following 20 topics (culled from dozens of responses) may not always surprise, but we think the creative methods being employed to save lives certainly will.

—The Editors

Hear the Future
Listen as Dean Michael J. Klag explores trends in public health research: magazine.jhsph.edu/top20

Read the Full Story
Expanded stories about our 20 challenges for public health are online: magazine.jhsph.edu/top20
The Hazards of Thinking Small

Engineered nanomaterials promise to revolutionize medicine, manufacturing and electronics. But as these nanoscopic particles enter the environment and our bodies, we run the risk of suffering unanticipated impacts on health because of a lack of research and funding for assessing potential hazards and exposures.

At Johns Hopkins’ Institute for NanoBioTechnology, researchers are developing novel nanoscale materials that could lead to new medical treatments. They are also studying whether nanomaterials could harm our health.

“Something doesn’t have to be ubertoxic to be a big risk to the population, if a lot of people are exposed,” says medical physicist Jonathan M. Links. “In that regard, nanotechnologies and engineered nanomaterials are in an amazing number of consumer products.”

Indeed, engineered nanomaterials have quietly crept into more than 1,000 consumer products—everything from tennis rackets to sunscreen to clothing. But the same novel properties that make nanomaterials useful also pose health risks that researchers have only begun to examine.

By definition, engineered nanomaterials are made of parts in which one dimension is 100 nanometers (nm) or smaller. (A nanometer is one-billionth of a meter.)

Because of their minute size, they behave differently than materials at the macroscale, which is why they are fabricated for specific uses. For instance, carbon nanotubes are made entirely out of simple carbon atoms. But they can be formed into an exceptionally strong material, used in tennis rackets and many other consumer products. They are also utilized in tiny electronic devices, and might someday be used to deliver medicine to individual cells.

The problem, Links says, is that regulators shouldn’t assume that we understand the risks of carbon nanotubes just because we understand how carbon works.

“The whole reason for working at the nanoscale is that the physical and chemical properties change, compared to the macro scale,” Links says. Unfortunately, that means a lot isn’t known about the effects of nanomaterials on health. Some initial studies have shown that such materials are absorbed and excreted by the body differently than their macroscale counterparts, and can have different toxicities.

Links says that he and others at the Institute are trying to determine how nanomaterials escape into the environment, how they get into the body and what their effects are once there.

Online: Explore the health risks of nanomaterials in consumer products.

"IF WE ARE GOING TO FEED THE WORLD, WE ARE GOING TO HAVE TO CHANGE THE WAY WE THINK ABOUT PRODUCING AND CONSUMING FOOD."

—RONI NEFF, RESEARCH AND POLICY DIRECTOR, CENTER FOR A LIVABLE FUTURE

Online: Why an industrial food system based on cheap land, cheap oil and cheap labor cannot last.
“POPULATION GROWTH WILL COME TO ZERO SOMEHOW. BEST CASE SCENARIO, FERTILITY DECLINES. WORST CASE, MORTALITY GOES UP.”

—STAN BECKER, DEMOGRAPHER

Online: How family planning can prevent humanity from hurtling past its demographic tipping point.
Farming Fish, Reaping Risk

The human hunger for seafood has very nearly emptied the oceans. About 90 percent of large carnivorous ocean fish are gone, says public health microbiologist David Love (above). "We've basically tapped out the resources, overfishing all these big predatory fish like bluefin tuna, cod and sharks," he says. "Now we're starting down the trophic levels to smaller fish like herring and sardines."

Because wild-caught seafood harvests have been stagnant since 1995, people are turning to aquaculture—fish farming—to fill the demand. Fish farming has increased by 7 percent each year over the past decade, and represents 40 percent of all fish consumed globally.

Like other forms of industrial food production, aquaculture poses substantial environmental and public health risks. From antibiotic-resistant bacteria to bioaccumulation of toxins and pollutants in fish feed, aquaculture can endanger human health. And some practices, Love says, "pose a huge environmental burden."

"A lot of times, the way we raise seafood is unsustainable," he says. For example, Love notes that it takes 2 to 3 kilograms of wild fish to produce 1 kilogram of farm-raised salmon or shrimp.

"We shouldn't be farming fish out in the ocean because the waste and antibiotics in the feed are released into the ocean and piles of waste build up under the farm," says Love. Recirculating systems—in which all waste is filtered and treated in an enclosed biosecure system—offer a more sustainable practice.

The Center for a Livable Future (CLF) researcher is currently gathering data on the scope of the problem by examining seafood imports into the U.S., Canada and the European Union over the past decade. "I'm analyzing the [failed inspection] list to identify the major violations to better understand the role of chemicals and antibiotics as pollutants in farmed fish."

In the years ahead, Love and his CLF colleagues will be investigating ways to make aquaculture more viable, including a fish-vegetable farming technique called aquaponics, that works well in urban settings. "Aquaculture is great in theory and most of the time it's done correctly," he says, "but just as in land-based food animal production, there are bad actors."

Online: Phasing out feeding fish to fish.

From Development to Disease

New tools, such as remote sensing, geographic information systems (GIS) and spatial analysis, are helping scientists do fine-grained analysis that is turning up startling results about development's link to disease.

In the past, public health experts placed clear transparencies atop each other to "see" how development, such as urbanization, impacted disease patterns. Today, with sophisticated imaging technology, biostatisticians analyze many layers of data simultaneously.

William Kuang-Yao Pan, for instance, is evaluating the impact of rapid land development on the health of people in the Amazon River basin. Nearly one-fifth of the Amazon rainforest has disappeared since the 1970s. Pan and his team have found that deforestation and land alteration were conducive to Anopheles darlingi—the most important vector of malaria in the Amazon—which prefers less forested ground cover.

Pan's team now is analyzing data that looks at the development of a new highway through the Amazon. "Road construction … alters the local ecology, biodiversity and conditions in which people live," says Pan (left). "There is the potential for widespread implications for human health."

Online: Investigating the health impact of climate change.
Horrible but Fascinating
In the beginning, scientists had a simple hope: one gene, one disease.

Then they discovered that hundreds of genes might play roles in causing disease.

Then they found that epigenes—chemical modifications to genes that control their expression—have a part as well.

Then they learned that whether a genetic mutation is inherited from the mother or father may be important in disease causation.

Then they learned that toxins—perhaps even stress—can alter epigenes, which can then lead to disease.

Now, they think the timing of an environmental exposure may determine whether or not the disease cascade begins.

Wildly complex? Genetic epidemiologist M. Daniele Fallin agrees: “It’s horrible but fascinating at the same time. It really is a challenge of, How are we ever going to solve this? The best advice I have is to tackle one thing at a time while realizing there is a broader context.”

So Fallin is starting at the beginning. Actually, before the beginning. Her EARLI study will follow children at risk of autism from before they are even born through their third birthday (by which time autism symptoms usually are manifest). By following a group of 1,000 pregnant women who already have given birth to an autistic child, Fallin and colleagues from three sites across the nation hope to elicit patterns in the intricate interplay of genes, epigenes, environment and time that can result in autism.

The only way to make breakthroughs in the thicket of disease causation is to involve experts from biostatistics, environmental epidemiology, genetic epidemiology and other fields, says Fallin, above with colleagues Rafael Irizarry (left) and Andy Feinberg.

Online: Following 100,000 children from before birth to age 21 to unlock disease mysteries.

In Search of Vigor
In April 1513, conquistador Juan Ponce de León arrived in Florida during his famous quest for the mythical fountain of youth.

In this century, the quest continues. However, scientists say vigor comes from within.

The need for gerontologists will expand exponentially in the next decades, and at the heart of their research is the question of why some people seem to decline faster than others. “We want to understand why some people roll with the punches, and others don’t,” says epidemiologist Paulo Chaves. “The study of the physiological aspects of aging is key.”

The concept of frailty underscores this research; why, for example, do some older people adapt to a heat wave, while others are taxed more intensely? Or why do some people recover from hip fractures much more quickly?

Longitudinal epidemiological research, such as the Women’s Health and Aging Study I and II, is helping to shed light on frailty status and physiological responses to stress.

The goal is to compress the illnesses associated with aging. “We want people to live longer, but spend less time in a frail state,” says Chaves.

Online: How do we measure frailty—and prevent it?
“THE MOST COST-EFFECTIVE WAY TO DEAL WITH INFECTIOUS DISEASE IS TO PREVENT IT FROM EVER HAPPENING.” —DIANE GRIFFIN, VIROLOGIST

Online: What will it take to develop vaccines against three of the world’s most pernicious infectious diseases—HIV, malaria and TB?
"SEVERAL TIMES A YEAR I HEAR ABOUT A DATA SET THAT’S ABOUT 10 TIMES WHAT I THOUGHT WAS ENORMOUS.” —CIPRIAN CRAINICEANU, BIOSTATISTICIAN

Online: As genomics, high-resolution medical imaging and other advances spawn massive amounts of data, how can researchers find a needle in an information explosion?
Hard-Wired in the Womb?
Researchers have long understood the critical importance of the 40 weeks of fetal development. Now they are piecing together how maternal health, fetal development and the fetal environment set the course for health problems as late as the fifth decade of the child’s life.

Evidence supports the idea of “fetal programming,” which acknowledges that the fetus’s time in utero affects development of diseases later in life including coronary artery disease, type 2 diabetes, hypertension and chronic lung disease.

Recent studies suggest that autoimmune diseases in the mother during pregnancy may program the fetal immune system and thereby predispose the infant to autism.

Online: Decoding the risk for low birthweight babies by examining mothers’ lifestyles.

When the Body Attacks Itself
An enormous public health problem originates from an unlikely source: the human immune system. When the immune system turns on the body and attacks itself, the result can be autoimmune diseases like celiac disease or multiple sclerosis. “Collectively, autoimmune diseases affect between 15 and 23 million Americans,” says immunologist Noel Rose, one of the field’s pioneers.

The vast majority of autoimmune diseases have no cure and are seldom diagnosed before major damage has set in. That makes them both hard to treat and hard to understand.

“If we know the immune factors that help set off one of these diseases, we can tailor therapies or preventatives to moderate those factors,” says fellow immunologist DeLisa Fairweather (left).

Researchers have long known that most autoimmune diseases are triggered when a person with a genetic susceptibility encounters an immune-stimulating factor in the environment, perhaps an infection or a chemical in food.

To learn more about these triggers, and to detail the reactions they cause, researchers use animal models. But the current autoimmune animal models may not be accurate enough. Therapies that slow or stop the autoimmune process in these animals don’t seem to work as well in humans, says Fairweather.

Typically in these models, researchers provoke an autoimmune reaction with a general immune stimulant known as an adjuvant. This conveniently sends the animal’s immune system into overdrive, but with a pattern of immune activation that may not be representative of human autoimmunity.

Fairweather and her colleagues recently developed an adjuvant-free mouse model of myocarditis, a common autoimmune condition that damages the heart. The model appears to be more representative of its human counterpart, and uses the coxsackie virus to trigger an immune reaction, but she thinks that other infectious agents and environmental toxins might work as triggers too.

Online: About 80 percent of autoimmune disease cases occur in women—does estrogen play a role?

Boost Immunity, Not Disease
Eliminating micronutrient deficiencies among children is one of the easiest ways to improve public health. But researchers increasingly recognize that the effects of micronutrient supplements can be complex and sometimes unexpected.

“A micronutrient might help boost a child’s immunity, but if it is given during acute illness, it might in some cases also empower an infectious organism,” explains infectious disease epidemiologist Christian Coles.

In Bangladesh, Coles is studying whether vitamin A given to newborns admitted to the hospital with bacterial bloodstream infections reduces the duration and severity of illness.

Online: Developing quick, “field-friendly” methods for assessing micronutrient levels.
Death on the Road

Because road crashes aren’t diseases, they haven’t always been seen as a public health issue. But there is no disputing their impact. About once every second on average, they injure someone; about twice per minute, they kill. Worldwide, road crashes claim more than 1.2 million lives every year.

In December, the Bloomberg Philanthropies announced that it would fund a $125 million, 5-year Global Road Safety Program. A consortium led by WHO will launch projects in 10 countries targeting some of the main factors that lead to crash casualties: driving too fast, driving without a seatbelt or child restraint, driving a motorcycle without a helmet and driving drunk.

“This is the first international road safety investment of anywhere near this size,” says injury prevention researcher Adnan Hyder, who directs the School’s International Injury Research Unit (jhsph.edu/IIRU), which will evaluate the program’s impact.

Public education campaigns will be an important aspect of the interventions. But, says Hyder, “education alone has not been found to make huge impacts in the absence of specific interventions and law enforcement, so enforcement is key.” WHO representatives therefore will work with local law enforcement ministries, as well as with legislatures, to add or tighten safety laws. Improving the availability of helmets, seatbelts and child restraints in some of the target countries will also be part of the program.

A related challenge is to make the driving experience safer regardless of driver and pedestrian behavior. “Engineering roads and cars to protect people is just as important in developing countries as it has been here in the U.S.,” says injury prevention expert Susan Baker. “It can be very tempting, for example, to build roads to enable higher speeds, but then not to build dividers to keep opposing streams of traffic from colliding.”

Baker, a pioneer of road safety studies, points out that the cultural change leading to better driver behavior can take a long time, and typically requires stricter law enforcement, while engineering efforts see immediate results. “Enforcement has to be done 365 days a year,” she says, “while engineering approaches have to be done only once.”

Online: What will be the impact of the global traffic program?

Optimal Mix to Nix Smoking

Since 1965, the prevalence of cigarette smoking in America has been cut in half, to about 20 percent. That cultural shift was achieved with enormous effort by attacking smoking as a public health problem, with taxes, smoke-free public places, TV ads, even 24/7 call-in “quitlines.”

So what’s next? “One challenge is to find out the optimal combination of these interventions,” says health behavior expert David Holgrave. “That’s a new frontier. The goal is to mix interventions to get the greatest effect as quickly as possible.”

Cost-effectiveness analyses, which compare intervention costs to the health care and other costs they save, is of prime importance. Holgrave recently led a study of a high-profile smoking prevention ad campaign. “Even with a relatively pessimistic estimate of the impact, we found that it could be considered a cost-effective use of resources,” he says.

Knowing that an intervention not only improves public health but will pay for itself is important in these days of shrinking budgets. Says tobacco expert Frances Stillman: “Coalitions that have been built and have functioned successfully in many states are being disbanded.”

Online: The near-future of smoking intervention research.
Obesity Goes Global

In China, changing lifestyles are fueling an obesity epidemic that rivals the U.S. in absolute numbers, says nutritional epidemiologist Youfa Wang. Improved living standards and migration to big cities are factors in China's steady increase in obesity rates since 1992. About 30 percent of Chinese are now overweight or obese.

Unlike social trends in the U.S., well-off Chinese—not the poor—are bulking up. “They can afford to have more sedentary lifestyles and better access to higher calorie foods,” says Wang. “There is not as much opportunity for them to engage in exercise.”

Wang is currently developing an Internet- and cell phone-based intervention among adolescents in China to promote healthy eating. He is also working to adapt a school-based intervention study (which modifies the physical and social environments in schools) that he first tested in Chicago. That study showed promising results in preventing obesity.

*Online: How supermarkets’ absence can fatten U.S. communities.*
Gray Matters
In the last decade, two concepts have turned our understanding of the human brain on its head.

In 1999, we learned that the adult brain is plastic; it can grow new neurons. And recently, the “social brain” theory has argued that the cerebral cortex is stimulated by social activity.

An optimistic theorem results: Social activity can strengthen brainpower. Psychologist Michelle Carlson is demonstrating exactly this. Her study placed eight older participants in Experience Corps, a national volunteer service program that helps children in urban public schools. The participants spent 15 hours a week mentoring students in reading and math. They were tested upon enrollment, and again six months later. After six months, they showed significant gains in executive function compared to nine matched controls.

Functional magnetic resonance imaging (fMRI) allowed researchers to see how those gains were achieved. “After volunteering in Experience Corps schools, participants showed a 54 percent improvement beyond their baseline, a huge effect by any intervention standard,” she says.

Online: Why crossword puzzles aren’t enough to bolster aging brains.
Rx for Coordinating Chronic Care
The American medical system is designed to provide acute care. But the heaviest users of the health care system are the 128 million Americans who suffer from one or more chronic diseases, and the system does a poor job dealing with them.

“The United States is a country of specialists,” says Gerard F. Anderson, a health policy expert who studies the treatment of chronic conditions. “You go to a whole variety of different specialists to take care of your chronic conditions, but they don’t talk with one another very well. The more chronic conditions you have, the more important care coordination is, and the less likely it is to occur.”

Some 85 percent of U.S. health dollars are spent on people with one or more chronic conditions. Two-thirds of all Medicare spending is on people with five or more chronic conditions. People with that many conditions will on average see 13 different physicians in a year.

Patients with conditions like diabetes, asthma, heart disease and some kinds of cancer require long-term management. But for patients with multiple chronic conditions, the treatments might conflict with one another, causing adverse drug interactions.

A number of improvements could be made to the system, Anderson says. For instance, central electronic health records would make it easier to manage a patient’s overall care. Researchers should also conduct clinical trials in which they attempt to treat people with multiple conditions, he says. Medical schools have already begun to train doctors in methods for managing multiple conditions.

Anderson believes the changes required are likely to take 30 years or more to complete, but he’s optimistic. “We’re going to get there. It just takes a long time,” he says.

One change that might be made quickly is for doctors to better utilize the family members of patients with chronic conditions, says gerontologist Jennifer Wolff.

Her studies show that 40 percent of older adults are accompanied by a family member when they visit the doctor. Those who are accompanied tend to be sicker, less educated and more disabled than others—and they tend to be more satisfied with their care. The reason? The family member is probably helpful in making sure the care plan is followed and in coordinating care from other doctors.

Looking to the future, Wolff suggests training programs (for patients, families and doctors) that could allow family members to provide the coordination that the system lacks.

Online: Coordinated care as a cost-effective solution to a complex system.

HEALTH DISPARITIES

“MAYBE THE DIFFERENCE WE OBSERVE BETWEEN BLACKS AND WHITES REGARDING, SAY, HYPERTENSION, ISN’T A RACE STORY, BUT WHERE THEY LIVE.”
— SARA BLEICH, HEALTH POLICY EXPERT

Full story on page 37: National data have long shown that African Americans have higher rates of hypertension, diabetes and other conditions. However, data from an integrated Baltimore neighborhood show disparities may have less to do with race, than with place.

Cutting the Costs of Care
Scary fact: U.S. health care expenditures surpassed $2.3 trillion in 2008, more than three times what was spent in 1990. To help public agencies and insurance companies allocate increasingly scarce resources more fairly, health services researcher Jonathan Weiner and his team have developed the widely used Adjusted Clinical Group (ACG) System. It enables organizations to better understand health-condition distributions and to apply predictive modeling and risk adjustment to better manage care for entire populations.

With the expected widespread adoption of electronic health records (EHRs), researchers will make use of more in-depth data on patients’ co-morbid conditions and treatments. For example, they may be able to determine more quickly the best treatment for a particular ailment or adopt more cost-effective treatment protocols for an entire population.

What’s more, Weiner’s team and Johns Hopkins University and Health System colleagues are in the early phases of developing “population health IT systems.” These systems would share Johns Hopkins-based health care expertise, such as treatment protocols, with health care providers through emerging digital technologies such as advanced software applications, EHRs and telecommunication devices.

Online: Zeroing in on the best treatment protocols.
"IN THE U.S., WE ASSUME HIGH-QUALITY, POTABLE DRINKING WATER WILL COME OUT OF THE TAP. WE’RE ASSURED THAT IF WE DRINK THE WATER, WE’RE NOT GOING TO DIE IN A COUPLE OF DAYS. IN MANY AREAS OF THE WORLD, THAT’S NOT THE CASE.” —KELLOGG SCHWAB, WATER EXPERT

Online: Can water kiosks in Ghana serve as a model for safe water delivery in developing countries?

Faculty Sources for Print and Online Stories

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What’s your top research priority for public health? Share your ideas: magazine.jhsph.edu/top20

Illustrations by Joe Cepeda, Dung Hoang, Michael Morgenstern ■ Photos by Chris Hartlove, Saikat Mojumder, Shhezad Noorani, Pablo Yori; Getty; Photo Researchers
Can an integrated neighborhood in southwest Baltimore help overturn decades of race-based assumptions about the origins of health disparities?

From both terra firma and Google Earth’s satellite view of the world, census tracts 1902 and 1903 are entirely bleak, drained of color and vitality. Street after street of this impoverished Southwest Baltimore neighborhood reeks of unrelenting hardscrabble existence, of teenage mothers, cigarettes and sodas in hand, walking the same cracked pavement as prostitutes and drug dealers—all within eyeshot of millionaires’ homes and Baltimore’s major league baseball and football stadiums.

“Half the people out here have guns,” admits a 15-year-old of this area bordering on Washington Village, known to the locals as Pig-town for the 19th-century swine that used to be herded through its streets. Such is life when the only easily available resources to the local citizenry are hazardous to their health. Smiley & Nancy’s liquor store, the Gilmore Pleasure Club … no shortage of bars here. But there’s a huge dearth of beneficial fare. The bullet-proofed corner store across the street sells high-priced Spaghetti O’s by the score, but “fresh” food is limited to four lonely loaves of white bread and a shoebox-sized array of cold cuts and cheese—little surprise from a food store whose only outside advertisements are for cigarettes.

Above: Cecelia Battaglia (left), who first moved to Southwest Baltimore in 1962, talks about her neighborhood with Bindu Dennis, a volunteer at a nearby community center.
Even on a gorgeous Sunday afternoon, the pain of this place is hard to miss. It sings out from every nail slammed into the boarded row houses that, on some streets, outnumber inhabited homes. It glitters in the broken glass strewn across the blue bottom of a drained city wading pool, ignored by two youngsters standing in its midst tossing a football. Buildings or people, it’s all the same; neglect, benign or otherwise, has—like rain on limestone—eroded the health of this neighborhood. And no one here, black, white or otherwise, is exempt.

That’s not opinion. It’s fact. And the researchers who have come to this neighborhood to investigate this long-suspected but never before proven notion—that poor health is not so much about race, as place—may eventually rewrite the way health disparities are viewed and treated in this country.

The traditional approach to health disparities always left investigator Thomas LaVeist, PhD, with a half empty feeling. (NIH defines health disparities as any “significant disparity in the overall rate of disease incidence, prevalence, morbidity, mortality or survival rates” in one population compared to the general population.) On one hand, LaVeist, director of the Center for Health Disparities Solutions, was grateful to have any data at all. It wasn’t until the 1980s that the government began collecting large-scale health disparities data that included information on all ethnicities. That effort, the National Health Interview Survey (NHIS), gave researchers like LaVeist their first comprehensive glimpse of how different populations manifested illness.

But the NHIS survey also provided LaVeist with a dilemma. It created reams of data pointing out racial differences in health disparities, especially when comparing minorities to whites. But that’s as far as the data went—in essence delivering a whole lot of “who” and precious little “why.” For a researcher who had spent his whole career trying to unravel “why,” the data was, in LaVeist’s opinion, leading policymakers and scientists to seek medical explanations and solutions where none existed. “It’s not that the data was faulty,” says LaVeist, “but rather, the way we explained how the data came to be was faulty. It’s perfectly accurate to look at the national statistics and say that African Americans have three times the death rate from a certain condition as do whites. But then you have to ask why that’s so.”

For LaVeist, the William C. and Nancy F. Richardson Professor of Health Policy, his 20-plus years of research intimated that the effects of poverty and other social factors played a huge role in creating health disparities. His first papers suggested that by addressing socioeconomic factors as well as medical issues, differences in infant mortality rates between poor African Americans and other races could be reduced. Later he would document the overabundance of liquor stores that pockmark impoverished communities, and the lack of supermarkets—creating so-called “food deserts”—in such areas. Though these were mostly African-American communities, LaVeist was working to define a problem—poverty, lack of access to healthy resources—that knew no color.

It wasn’t theory alone that suggested this approach, but personal experience. Early in his
career, LaVeist worked for a time in a hospital in the same Baltimore community he would later survey. For all the talk and commonly held belief that blacks were sicker and more pathologic than whites, LaVeist’s eyes told him that both groups were distressed. “I got to know that part of the city pretty well,” he says. “I knew that there were a lot of sick white people in that area. There was a lot of obesity; if you just walked down the street you’d see it. A lot of smoking. I started wondering, if they’re all living in these same conditions… It looked pretty unhealthy here, and I wondered, if you studied it, what would you find?”

LaVeist knew that to move the health disparities discourse beyond a biological conceptualization of race, to consider instead the role of place, he had to create a methodologically sound survey that might yield such data. The Exploring Health Disparities in Integrated Communities (EHDIC) study is an effort to take race and standard socioeconomic differences such as income out of the health disparities picture and to investigate the following hypothesis: If people live in the equivalent of an urban war zone, is everyone a casualty?

The analogy isn’t so far-fetched. Roland J. Thorpe Jr., PhD, an assistant scientist who worked on the study with LaVeist and fellow Center colleagues Darrell Gaskin, PhD, and Tiffany Gary-Webb, PhD, often uses military examples to illustrate the indiscriminate effects of environment. “You have whites and blacks over in Iraq fighting a war. When they come back home, the rates of whites with PTSD and blacks with PTSD are the same. Because they’ve been in the same environment together,” says Thorpe.

LaVeist saw EHDIC as a prototype and a gamble: To propose research that might contradict long-held notions that environment, not biology, was the root cause of health disparities could have career-damaging consequences if the numbers didn’t pan out. “It’s risky to think outside the box. It truly is. Suppose I do the study and it shows disparities are no different than in the previously done national studies? How do I even get that published?” asks LaVeist. He chose to attack the problem with a meticulous, conservative methodology. His goal was to mimic NHIS’ data collection rigor to safeguard his results.

“It’s always been my practice to use very traditional research methods to study nontraditional, unconventional questions,” he says. “If I use the same techniques you are using, then you might not like my results, but to say my study is invalid, you’d have to say your own study is invalid.”

Originally, LaVeist thought he’d have to leave Baltimore to find a census tract that would meet his methodological requirements, but then the area sandwiched between Washington Village and the Union Square area popped up on the radar. With nearly equal levels of blacks and whites (51 percent and 44 percent), and nearly identical median incomes ($24,002) and high school graduation rates (just over 20 percent), the area was fertile territory for data mining. In the summer of 2003, with funding from the National Center for Minority Health and Health Disparities and the Pfizer Corporation, surveyors

medical solutions where none existed, says researcher Thomas LaVeist.
whereas NHIS showed that African Americans' diabetes in blacks and whites were comparable, and others used EHDIC to show that rates of hypertension between blacks and whites were significantly lower than that measured by the National Health and Nutrition Examination Survey that adjusted for socioeconomic status. In a 2009 article, LaVeist, Thorpe and others examined in EHDIC was nearly a third lower than that measured by the National Health and Nutrition Examination Survey that adjusted for socioeconomic status. In a 2009 Journal of General Internal Medicine article, LaVeist, Thorpe and others used EHDIC to show that rates of diabetes in blacks and whites were comparable, whereas NHIS showed that African Americans were far more likely than whites to contract the disease. Obesity rates comparing African-American and Caucasian women in the EHDIC study are also being culled by Sara Bleich, PhD, an assistant professor in Health Policy and Management, to see if the trend toward shrinking racial disparities holds true.

LaVeist sees these studies as moving toward a critical mass that could tilt possible policy solutions away from medical investigations of inherent biological differences between races, a concept LaVeist vehemently rejects. He agrees with colleague Darrell Gaskin, who uses sickle cell anemia as an example of a disease that many view as an illness solely affecting African Americans. In fact, it’s a regional disease found in parts of the world where the sickle cell trait developed to ward off malaria. This includes Greece, South America and other areas outside of Africa. “There are whites with sickle cell disease,” notes LaVeist.

The medicalization of health disparities grew out of national studies completed prior to EHDIC, he says. When those studies had been adjusted for socioeconomic differences and found large racial disparities in health status, LaVeist says the medical conclusion was, “It must be genetic.”

“But what is that gene that produces these outcomes?” he asks. “The solution isn’t isolating some gene that’s somehow producing diabetes and heart disease and obesity and stroke and homicide … all of which to me seems unlikely. Maybe the solution is that we need to understand the social and perhaps the behavioral factors that are accounting for these differences.”

Josef Coresh, MD, PhD ’92, MHS ’92, a cardiovascular epidemiologist who has focused on genetic and non-genetic biomarkers of disease, sees LaVeist’s work as complementing biomarker studies. As an example, he cites extensive efforts to parse the causes of the up to four-fold higher rates of kidney failure among African Americans, a line of research begun more than 20 years ago by Paul Whelton, MD, and Dean Michael J. Klag, MD, MPH ’87. Linda Kao, PhD ’99, MHS ’97, an associate professor in Epidemiology, and others discovered that a mutation in the MYH9 gene made people twice as likely to develop non-diabetic kidney failure. African Americans were far more likely to have the mutation than whites (60 percent vs. 4 percent). Overall, this difference is estimated to account for 70 percent of the excess risk of non-diabetic kidney failure in African Americans.

While those findings might suggest medical interventions including genetic screening targeting African Americans, Coresh notes that a tremendous amount of kidney disease might still be related to neighborhood factors that interest LaVeist. These include lack of access to health care that could control hypertension and blood glucose levels. In fact, when it comes to diabetic-related kidney disease, Coresh says epidemiologic studies suggest that nearly all of the excess risk is accounted for by conditions directly related to how people live, and not their genes. “I think it’s absolutely true that environment and particularly the impact of poverty and access to care are very important to study,” says Coresh of LaVeist’s work, adding that these
environmental issues could also trigger disease among both the genetically susceptible and the general population.

LaVeist’s message and methodologies are being carried forth by the many colleagues he’s mentored. Some, such as Thorpe, note that LaVeist’s research dovetails with the past work of another Hopkins researcher, Marsha Lillie-Blanton, DrPH ’88, MHS ’82. In 1993, Lillie-Blanton found that crack cocaine, while far more available in poor African-American communities, was actually used almost equally, on a percentage basis, by blacks and whites within those blighted borders. So much for the common perception that crack was solely an African-American issue.

Given the growing pool of data, Sara Bleich says that focusing on race as the reason people suffer health disparities is, from a programmatic viewpoint, a nonstarter. “Maybe the difference we observe between blacks and whites regarding, say, hypertension, isn’t a race story but where they live. What that implies is something hugely different for public policy,” Bleich says. She notes that even if disparities turn out to have both biological and environmental components, it may make more sense to focus time and money on the latter. “You can’t make someone who is black into someone white. But you can modify environments,” says health policy expert Sara Bleich.

LaVeist’s team will head next to Prince George’s County, Maryland, which has an annual median income of $86,000. They intend to compare health disparities between upper-income African Americans and whites. LaVeist wants to see whether his findings from lower-income African Americans and whites to an integrated census tract around the country, and not just in the results they generate. One component of the work is dedicated to giving back to the communities being surveyed, the opposite of parachuting into a community, collecting data and disappearing.

The EHDIC team, for example, published The Southwest Baltimore Community Health Report and mailed it to every active address in the community. EHDIC also helped establish a community center for health and wellness where, LaVeist says, “the programs don’t take a race approach. They take a community approach.”

To address gangs, drugs, smoking and health care issues raised in the EHDIC report, the Faith Center for Community Wellness and Advancement has become a one-stop shop, running everything from smoking cessation and heart-healthy programs to a makeshift gymnasium—all under one small roof. One afternoon this spring, while teenagers pound weights upstairs, 53-year-old Cecelia Battaglia drags about how the Faith Center’s programs were helping her and her family. Battaglia, who has a weakened heart from a childhood bout with rheumatic fever, says that despite being familiar with her condition, she learned “things I never knew before,” such as the need for regular exercise versus the occasional long walk. She’s also visited the Center’s farmers market to buy fresh produce, something not often seen in her neighborhood. “It was great. The kids were just going up and buying it and eating it,” Battaglia says. “When’s the last time you saw a kid buy a tangerine and eat it?”

LaVeist hopes to use his meticulously collected scientific data to influence the decision-makers, be they on hospital boards or Capitol Hill.

“This is all about policy,” he says. “I’ve got this policy paper in my head that I want to write, but I don’t want to write it until I’ve done enough of these studies that the evidence is so overwhelming that it becomes difficult to debate. But eventually they’ll be a book or a series of policy papers that say, when it comes to health disparities, we have to look at social factors.”
How they make that journey while preserving their health is the main focus of Center for Adolescent Health director Freya Sonenstein, PhD, and the subject of a new book, *The Teen Years Explained*, published by the Center. During a March talk with Johns Hopkins Public Health editor Brian W. Simpson, the Population, Family and Reproductive Health professor discussed the latest research, the challenges of preventing teen pregnancy and tips for parents whose children are entering a “messy” but wondrous stage of life.

They are their own tribe—42 million in the U.S. alone—with their own social, behavioral and linguistic codes. Still developing in brain and body, they are physically and mentally different from us and, yet, they are us—or at least younger, risk-taking, energetic, less-experienced versions of us. Adolescents, defined as 10- to 19-year-olds by the WHO, undergo a tumult of physical, sexual and emotional changes as they negotiate their way from childhood to independence.

**What do we know today about adolescent health that we didn’t know 20 years ago?**

One of the big discoveries has been about brain development. During adolescence there’s a massive pruning of the synapses [neural connections] of the brain, and this process doesn’t really stop until around age 24. And the last part of the brain to develop is the prefrontal cortex, which helps us in cognitive thought and making good decisions in our behavior. So that partially explains why teenagers are sort of known worldwide for their risk-taking behavior.

**How can one best guide teens?**

In terms of preventing teen pregnancy, the simplest solutions try to change when they begin to have sex and to get them to use contraception when they do have sex. Clearly, if you think about kids being embedded in their social environment, you need to build a community that sends very clear messages to kids about the importance of waiting to have children until they’re ready. And teaching them the ways to do that. And motivating them to do that by providing hope for what their adult lives will be like if they wait.
Is that a confusing message for adolescents? Wait to have sex, but if you do have sex, then use contraception.

Over the last 20 years, we’ve done a lot of program evaluation and we actually have a whole series of programs that have been demonstrated to effectively reduce kids’ sexual behavior and increase their contraceptive behavior. And most of those programs are built on the dual messages. So kids apparently are able to deal with that complicated a message.

How successful are those programs?

Well, they’re modestly successful. They increase the age at first intercourse modestly, by on average a few months. In terms of contraceptive use, it’s the same kind of thing. So the effects are small, but they do mean that there are fewer pregnancies and when condoms are used, fewer sexually transmitted infections.

The effects are small. Do you think that we’ll ever make dramatic advances?

I think we can get a lot closer to a more ideal situation in terms of preparing kids. In many communities, youth are not getting full and complete information about how to prevent pregnancies. So in terms of basic knowledge we can do better. And in many communities, clinical services and emergency contraception are not readily available. If all that were to improve, we’d see some reduction in the rates. It wouldn’t make it go away, but … .

What about other high-risk behaviors like drinking, drug use and reckless driving?

There’s been a fair amount of research about problem behavior syndrome; basically kids who engage in a single high-risk behavior like drinking or drug use are also very likely to be engaging in other high-risk behaviors. There are interventions that look more universally at high-risk behaviors and work with kids to reduce substance abuse, violence and delinquency, for example, as well as sexual risk taking. The thing about sexual behavior is it’s something that’s expected in adults whereas the others are behaviors that are not encouraged [in adults]. When you try to keep people from smoking, you try to keep them from smoking forever. Whereas with teenagers and sex, you’re just trying to get them to wait and to be safe when they do have sex.

What are the key differences faced by young people in developing countries?

The recognition of adolescence as a period of life that we should think about differently is relatively new in our own society. Certainly, in many developing countries, there is less luxury for teens to have a long transition period. Early marriage is common in many countries. However, some cultures do a much better job symbolically than we do. Some have rites of passage that set up expectations about the transition to adulthood more clearly.

Are adolescents more receptive to certain public health messages?

Preaching what one should do (laughs) is apparently not the way to get a teenager’s attention. The way messages are delivered is as important as their content.

What do you mean?

Well, in the book, we are trying to encourage adults to listen to the kids and to provide space to the teens to think through for themselves the consequences of behavior. Instead of telling a kid not to smoke, it might be more useful to encourage the kid to think about what they were doing and weigh the pros and cons for themselves. [That way] they go through this process and potentially [learn] to make good decisions about their health. In good situations where kids come to you for advice, then (laughs) by all means provide advice. But usually they’re not seeking it!

Adults stereotype teenagers as surly, self-involved risk-takers who have to be endured. Well, all of those things are kind of true and they are driven by the developmental processes that they are going through, but the problem is the adults’ perspective—that they should just endure it, instead of understanding it, engaging it, and providing support so that kids can exercise their independence and learn how to do that well.

I think the major message [for adults] is not to be so frightened. There are things you can do to understand what’s going on in terms of their development. A lot can be accomplished if you approach it with a positive point of view.

This is a nice segue into the book that the Center is publishing. Why did you publish it?

We wanted to get some very basic, rigorously acquired information about adolescent development to parents and to people who work with young people so that they understand better the very complex and massive changes going on when kids when enter these years. As [a colleague] pointed out, over the years, parents have turned to Dr. Spock and then to other guides to know about stages of child development. But we’ve never had anything that laid it out for parents in terms of adolescents.

What is the book’s most important message?

It’s that there’s a lot of change going on in adolescence—cognitively, emotionally, and in terms of sexual, moral and spiritual development. And they don’t all occur in sync. It’s messy but it’s very normal.

Adolescents: By the Book

The Teen Years Explained: A Guide to Healthy Adolescent Development by Clea McNeely, DrPH, and Jayne Blanchard (Johns Hopkins University Press, 2010); $24.95
Download for free: jhsp.edu/adolescenthealth/