advancing the art & science of medicine in the midwest

WMJ

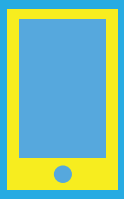
volume 119 · no. 2 · june 2020

# Bicycling & Helmet Use

## How Safe Are We When We Ride?

We may be keeping our distance,
but we are in this together.

Stay Calm.



Stay Connected.

Stay Active.

#AloneTogether

ad COUNCIL

Go to AloneTogether.com for ways
to take care of yourself and others.


## COVER THEME
## Bicycling & Helmet Use

Bicycling is associated with both health and environmental benefits but also poses a risk of injury—something helmet use can mitigate. Yet not all riders choose to wear helmets. In this issue of *WMJ*, authors explore the sociodemographic differences associated with ridership and helmet use throughout Wisconsin.

**Cover design by Kendi Neff-Parvin**

The mission of *WMJ* is to provide an opportunity to publish original research, case reports, review articles, and essays about current medical and public health issues. *WMJ* is published through a partnership between the Medical College of Wisconsin and the University of Wisconsin School of Medicine and Public Health.

Volume 119, no. 2 • June 2020

# WMJ

## advancing the art & science of medicine in the midwest

### EDITORIALS



### ORIGINAL RESEARCH

The *WMJ* (ISSN 1098-1861) is published by the Medical College of Wisconsin and the University of Wisconsin School of Medicine and Public Health and is devoted to the interests of the medical profession and health care in the Midwest. The managing editor is responsible for overseeing the production, business operation and contents of the *WMJ.* The editorial board, chaired by the medical editor, solicits and peer reviews all scientific articles; it does not screen public health, socioeconomic, or organizational articles. All articles published herein, including commentaries, letters to the editor, and editorials represent the views of the authors, for which neither *WMJ* nor the publsiher and its affiliates unless specified. *WMJ* is indexed in Index Medicus, Hospital Literature Index, and Cambridge Scientific Abstracts.

**Submit manuscripts at www.wmjonline.org** or email wmj@med.wisc.edu.



**SUBSCRIPTION RATES**
Print subscription: $149. Digital subscription for Wisconsin Medical Society members included in membership dues. Previous years' single copies, when available, $12 each.

Published 4 times a year and online, beginning in February. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917. Authorized August 7, 1918.

Address all correspondence to: University of Wisconsin School of Medicine and Public Health, Attn: WMJ Editor, Health Sciences Learning Center, 750 Highland Ave, Madison, WI 537055; e-mail: wmj@med.wisc.edu

**POSTMASTER**
Send address changes to: University of Wisconsin School of Medicine and Public Health, Health Sciences Learning Center, 750 Highland Ave, Madison, WI 53705

ISSN 1098-1861 • Established 1903



## BRIEF REPORTS



## CASE REPORTS



## REVIEW



## YOUR PROFESSION

# 'Knowing What's Best': Community Partnerships Against COVID-19

Dear Editor:

Milwaukee is fortunate to have an academic medicine complex like Milwaukee Regional Medical Center, as described previously.[1] Given the city's history of racial and socioeconomic segregation, it is critical that this complex serve all communities equitably. Unfortunately, COVID-19 mortality rates have disproportionately affected people of color locally and nationally.[2,3] Motivated to make an impact on these sobering statistics, we developed grassroots community-engaged partnerships and language accessibility tools in the fight against COVID-19 that we highlight below.

As medical students, we recognize the importance of aligning our medical education with community engagement. As daughters and sons of immigrants, we are personally aware of the everyday challenges underserved communities face. The north and south sides of Milwaukee have lower median incomes, decreased educational attainment, greater population density, and disproportionately lower numbers of individuals who can work from home in the Greater Milwaukee area.[4] In the south side specifically, more than 50% of households primarily speak Spanish.[5] To see how we could help, we contacted community partners, including Ayuda Mutua, Sixteenth Street Community Health Centers, United Migrant Opportunity Services, and United Community Center, to take inventory of their needs to avoid the common pitfall of "knowing what's best." As mediators within an academic institution, we gave voice to their needs and joined efforts with the Medical College of Wisconsin (MCW) Kern Institute and Office of Communications to best serve our at-risk communities.

One of the greatest community needs was culturally responsive COVID-19 medical information for Spanish-speaking and Latinx communities in Milwaukee. We worked with the Office of Communications to enhance translation, cultural sensitivity, and health literacy of information sheets on their webpages. We collaborated with the Kern Institute to provide printed information sheets and thousands of masks for community distribution. By amplifying the spread of medical information, dispelling myths, strengthening truths, and distributing masks to vulnerable areas of the city, we strove to "flatten the curve" and limit people in hospitals for our community's health and safety.

The lack of access to reliable health information is dangerous for all, especially for patients with social barriers. All communities have a right to know when and how to seek care. Additionally, recognizing the power of mutual aid work and collaboration across systems provides pathways to respond proactively to prevent negative biopsychosocial outcomes. Let us continue to bring strength in diversity through teams, perspectives, and solutions and join forces for a better future for all.

*—Nathalie Abenoza, Christian Hernandez, Eli Martinez, Javier Mora, Malika Siker, MD*

• • •

**Author Affilations:** Medical College of Wisconsin, Milwaukee, Wis (Abenoza, Hernandez, Martinez, Mora, Siker).

**Corresponding Author:** Nathalie Abenoza, Medical College of Wisconsin, Milwaukee, WI 53226; email nabenoza@mcw.edu.

## REFERENCES

**1.** Kerschner J. Local efforts making a global impact in the fight against COVID-19. *WMJ*. 2020;119(1):69-70.

**2.** Coronavirus Disease (COVID-19). Milwaukee County, Wisconsin website. Accessed May 27, 2020. https://county.milwaukee.gov/EN/COVID-19.

**3.** The Color of Coronaviurs: COVID-19 Deaths Analyzed by Race and Ethnicity in the U.S." APM Research Lab. Accessed May 22, 2020. Updated June 24, 2020. https://www.apmresearchlab.org/covid/deaths-by-race

**4.** Vila P, et al. Health Disparities in Milwaukee by Socioeconomic Status. *WMJ*. 2007;106(7):366–372.

**5.** 53215 Zip Code (Milwaukee, WI) Detailed Profile. City-data.com. Accessed May 27, 2020. https://www.city-data.com/zips/53215.html

# COVID-19 Poses Challenges to Immigrant Physicians in the United States

Sonal Chandratre, MD; Aamod Soman, MD

These are unprecedented times, and health care professionals everywhere are doing admirable work to save lives and provide care for patients fighting coronavirus disease (COVID-19). However, for one group of physicians—International Medical Graduates (IMG)—the fight is not limited to COVID-19. In fact, COVID-19 has compounded their existing struggles, and many IMGs find themselves torn between saving lives and complying with existing restrictive immigration policies. IMGs play a vital role in providing health care to many Americans, and as states grapple with surge staffing to fight COVID-19, it is prudent to utilize the existing IMG workforce effectively.

### Practice Characteristics of IMGs

An IMG is a physician who graduated from a medical school located outside the United States and Canada.[1] Currently, they comprise 25% (n=250,000) of the total active physician population in the United States, including 33% of all primary care physicians;[2] and 24% of residents and fellows in ACGME-accredited programs are IMGs.[3] IMGs constitute 39% of all internists, 25% of pediatricians, 23% of family physicians, 30% of pulmonologists, 41% of critical care physicians, 21% of anesthesiologists, 51% of geriatricians, 34% of infectious disease pulmonologists, and 30% of psychiatrists—physicians who are directly providing services to COVID-19 patients.[2] Furthermore, in New York, New Jersey, and California—the states with maximum COVID-19 impact—the representation of IMGs is twice that of the national average.[4] In Wisconsin, IMGs make up 19.3% of the physician workforce.[5]

What's more, IMGs constitute 33% of all physicians in areas with the highest poverty rates (where more than 30% of the population lives below the federal poverty level), 42.5% of physicians where per capita income is below $15,000 per year, 36.2% of physicians where 75% or more of the population is nonwhite, and 33% of physicians where 10% or less of the population has a college degree.[6] Nearly 21 million (20.8 million) Americans live in areas where more than half of the physicians are IMGs, and nearly 70% of the primary care physicians in these areas are IMGs.[7] For example, in Cudahy, Wisconsin, 61% of physicians are IMGs. It's likely this trend will continue, with the projected shortfall of 61,700 to 94,700 physicians by 2025,[7] including many in primary care in underserved and rural areas.[6]

> International Medical Graduates play a vital role in providing health care to many Americans, and as states grapple with surge staffing to fight COVID-19, it is prudent to utilize the existing IMG workforce effectively.

### Challenges for IMGs Posed by COVID-19

IMGs face many challenges that are currently worsened by COVID-19. For example, if they lose their visa status because of layoffs or death, their dependents automatically become illegal, start to accrue unlawful presence, and face deportation. Dependents are unable to seek jobs because of their illegal status, so their only option is to return to their country of origin with their dependent minors, who may be American citizens—something easier said than done.

IMGs on a temporary work visa can work only at the address provided in their approved visa document. This prohibits them from working in any other department or location—even within the same employer system. IMGs working at home also risk noncompliance if they work at any location not previously listed as

• • •

**Author Affiliations:** Pediatric Endocrinology, Medical College of Wisconsin-Central Wisconsin Regional Campus, Wausau, Wis (Chandratre); Ascension Saint Michael's Hospital, Stevens Point, Wis (Soman).

**Corresponding Author:** Sonal Chandratre, MD, 1900 Westwood Dr, Suite 3166, Wausau, WI 54401; phone 715.870.0900; email schandratre@mcw.edu; ORCID ID 0000-0001-7309-1976.

a worksite in their approved visa document.

IMGs scheduled for a visa extension in the upcoming months face the risk of lapsed status. Typically, one cannot apply for a status extension prior to 6 months from their visa expiration date. With physical distancing measures leading to office closures, there are delays in processing of extension requests. The government could use the biometric identifiers from an IMGs initial application to extend the current application, but that does not help first-time petitioners who need biometrics. Additionally, even if IMGs could legally still work with a pending application, they cannot drive because their driver's license is valid only with approved visa status.

An H-1B temporary work visa is issued for 6 years to work in a specialty occupation and, once exhausted, the applicant must leave the United States and reapply after a year. There are several American-trained IMGs with an exhausted H-1B status completely capable of serving in this pandemic. Despite being willing to save lives, they are limited to being silent observers.

In addition, many IMGs who are certified physicians in their country of origin from prestigious hospitals with a vast clinical experience remain without a residency position or are preparing for the 2021 residency process. Despite being trained physicians, they are unable to help with the current crisis, regardless of their clinical capabilities. Meanwhile, there are 4,222 IMGs scheduled to start their residency in July, but with physical distancing implemented in several countries, consulate offices are closed and processing of applications for these incoming physicians is limited.

### Possible Strategies to Maximize IMG Contributions During COVID-19

There are several measures that can help maximize IMGs' participation against COVID-19. COVID-19 should be treated as an extenuating circumstance, and the government should implement temporary authorization for IMGs to work in COVID-19-affected areas without complicating the required paperwork. For example, easy, hassle-free changes in an IMG's practice location—irrespective of visa status—would help an IMG immediately serve in COVID-19 hot spot areas. The fastest way to do this is to approve existing pending permanent residency applications. United Kingdom immigration has announced free automatic 1-year visa extensions for health care workers whose visas are expiring in October 2020.[8] The United States also should allow automatic extensions of employment authorization extension applications for all immigrant health care workers.

For incoming IMGs scheduled to start their residency in July 2020, the government should take measures to promptly process visa applications. Consular offices overseas should interview these IMGs on a virtual platform or, if not feasible, they should waive that requirement temporarily.

As already initiated in the state of New York,[9] states anticipating their COVID-19 surge should preemptively issue an executive order that temporarily allows IMGs with 1 year of American clinical experience to join the workforce. The government should give temporary permits to work in COVID-19 areas to IMGs with completed licensure exams and adequate overseas clinical expertise equivalent to American training. American-trained IMGs with exhausted 6-year visas should be given temporary licenses to serve in COVID-19 areas.

In summary, IMGs are pleading desperately with American policymakers to decrease visa restrictions to bolster their ability to contribute during the COVID-19 pandemic. IMGs are dedicated to serving American patients and to their solemnity in being true to the Hippocratic Oath they once took. It may be illegal to stay in a country, but saving lives should not become illegal.

**Funding/Support:** None declared.

**Financial Disclosures:** None declared.

## REFERENCES

**1.** Certification - Definition of an IMG. Educational Commission for Foreign Medical Graduates. Updated August 27, 2019. Accessed April 9, 2020. https://www.ecfmg.org/certification/definition-img.html

**2.** Active Physicians Who Are International Medical Graduates (IMGs) by Specialty, 2017. Association of American Medical Colleges. April 1, 2020. Accessed May 8, 2020. https://www.aamc.org/data-reports/workforce/interactive-data/active-physicians-who-are-international-medical-graduates-imgs-specialty-2017

**3.** 2018 Physician Specialty Data Report. Executive Summary. Association of American Medical Colleges. Accessed February 11, 2020. https://www.aamc.org/system/files/2019-08/2018executivesummary.pdf

**4.** Harris P. Doctors will beat COVID-19. Let's bring more of them to the fight. American Medical Association. Accessed May 8, 2020. https://www.ama-assn.org/about/leadership/doctors-will-beat-covid-19-let-s-bring-more-them-fight

**5.** Wisconsin Physician Workforce Profile. Association of American Medical Colleges. Accessed May 8, 2020. https://www.aamc.org/system/files/2019-12/state-physician-Wisconsin-2019%5B1%5D.pdf

**6.** Foreign-Trained Doctors are Critical to Serving Many U.S. Communities. American Immigration Council. Published January 17, 2018. Accessed May 8, 2020. https://www.americanimmigrationcouncil.org/research/foreign-trained-doctors-are-critical-serving-many-us-communities

**7.** Mann S. AMC Research Confirms Looming Physician Shortage. Association of American Medical Colleges. September 27, 2016. Accessed May 8, 2020. https://www.aamc.org/news-insights/aamc-research-confirms-looming-physician-shortage

**8.** Coronavirus (COVID-19): advice for UK visa applicants and temporary UK residents. GOV.UK. Published March 24, 2020. Accessed April 9, 2020. https://www.gov.uk/guidance/coronavirus-covid-19-advice-for-uk-visa-applicants-and-temporary-uk-residents

**9.** COVID-19 Pandemic and Professional Practice. Important Information for Licensees Impacted by COVID-19. Office of the Professions. New York State Education Department. Accessed April 10, 2020. http://www.op.nysed.gov/COVID-19_EO.html

# Health by ZIP Code

Sarina Schrager, MD, MS, *WMJ* Interim Editor-in-Chief

Despite the fact that we spend almost 90% of our health care dollars on medical care, it is estimated that only 10% to 20% of health outcomes are due to access to care and medical interventions.[1] Social determinants of health, or non-medical factors that affect health, account for the remaining 80% to 90% of health outcomes.[2] These social determinants of health include where someone lives, what kind of work they do, what they eat, if they have access to food, whether they smoke, and race and socioeconomic status.

Healthypeople.gov categorizes social determinants of health into 5 areas: economic stability, education, social and community context, health and health care, and neighborhood and built environment (human-made surroundings that define where we live and work, ranging in scale from buildings, streets, and parks to cities and beyond).[3,4] All of these factors contribute to health outcomes and exist primarily outside of the clinic examination room. If your patient does not have access to healthy food or a safe neighborhood to walk in, the quality of the health care they receive may not effectively balance their high risk of adverse health outcomes. Several papers in this issue of *WMJ* provide information about the effects of social determinants of health on the overall health of people in Wisconsin.

The paper by Ezenwanne et al compares health outcomes in Wisconsin to the rest of the country based on similar surveys, performed first in 1990 and again in 2018.[5] The survey, performed by "America's Health Rankings," rated Wisconsin as the 7th healthiest state in the US in 1990 and the 23rd healthiest in 2018. The difference in health ranking was related to several factors, including infant mortality, obesity, smoking, occupational fatalities, and infectious disease. The 2 surveys were not exactly the same, which could account for some of the variation, but the authors argue that health indicators have worsened in Wisconsin over the last 30 years. According to America's Health Rankings, 25% of Wisconsinites drink excessively compared to the national average of 18%.[6] Alcohol is the third leading cause of preventable deaths, after tobacco use and physical inactivity. Health care is excellent for most people in Wisconsin, so one must presume that much of the decrease in health rankings are related to social determinants of health.[7]

> "When it comes to your health, your ZIP code matters more than your genetic code."
>
> *—Dr. Anthony Iton*

The paper by Krawisz entitled, "Health Effects of Climate Destabilization" provides information about the science behind climate destabilization, as well as a description of how climate changes can affect human health.[8] The author examines how floods and changes in air quality and temperature can lead to increased incidences of infectious diseases and respiratory illnesses. Changes in temperatures can provide an enhanced environment for ticks and mosquitos, which, in turn, can lead to more disease. The paper also discusses the mental health effects of climate changes—namely an increase in anxiety levels.

Maurice et al use a case example of how price changes at the University of Wisconsin Hospitals and Clinics cafeteria affected changes in dietary habits.[9] When there was a simultaneous increase in the price of fried foods and a decrease in the salad bar's cost, the authors observed a significant increase in consumption of the salad bar and decreased consumption of fried foods. A similar finding was observed from decreased prices of bottled water as consumption increased. These changes had a neutral effect on revenue but could significantly improve health outcomes.

Bicycling is associated with both health and environmental benefits but also poses a risk of injury. Schmidt et al explore ridership and helmet use throughout Wisconsin and found that differences between sex, race or ethnicity, and education level were associated with both.[10]

Researchers at the University of Wisconsin School of Medicine and Public Health have developed a website called the Wisconsin Health Atlas (wihealthatlas.org), where people can find health indicators broken down by ZIP code throughout the state. The site also ranks where Wisconsin health indicators fall compared to other states (eg, 30 out of 51 for adult obesity, 16 out of 51 for percentage of minors who live in poverty, and 10 out of 51 for percentage of adults meeting weekly physical activity goals). It is time for the medical community to recognize and emphasize the effect that social determinants of health have on our patients. We can work together to help make sure that all ZIP codes in Wisconsin are equally healthy.

***References continued page 140***

# The Impact of the COVID-19 Pandemic on Medical Student Education in Wisconsin

William J. Hueston, MD; Elizabeth M. Petty, MD

The rapidly evolving COVID-19 pandemic has challenged health systems and created socioeconomic devastation worldwide. Medical student education has not been immune to these disruptive forces. Medical schools and medical students have had to quickly adapt to frequently changing conditions that have significantly affected the timely delivery of planned hands-on education and student learning in clinical settings.

For students engaged in nonclinical portions of their curriculum, restrictions on public gatherings designed to slow community spread of the SARS-CoV-2 virus made in-person face-to-face large and small group learning sessions impossible. Students engaged in clinical education across most of the United States, including Wisconsin, were abruptly removed from hospital and clinic settings in mid-March 2020, as guided by the Association of American Medical Colleges and public health experts, to reduce viral spread, ensure their safety, and reserve limited supplies of personal protective equipment (PPE) for experienced providers. These actions urgently challenged medical educators to find new ways to continue meaningful education. Simply pausing students' educational progression was not a viable or desirable option given physician shortages across Wisconsin and beyond. Students need to progress through medical school in a timely manner to replenish the physician workforce.

Both the University of Wisconsin School of Medicine and Public Health (UWSMPH) and the Medical College of Wisconsin (MCW) rapidly deployed novel means of curriculum delivery. This commentary provides summaries of how COVID-19 has reshaped education in these two institutions.

## UWSMPH

In 2016, the UWSMPH launched an innovative, integrated 3-phase, 4-year medical education curriculum: the ForWard Curriculum. This curriculum incorporates learner-driven flipped classroom and blending learning activities, especially during Phase 1. It includes many new, regularly updated online resources (Enduring Learning Objects) to deliver core content virtually and asynchronously. These resources augment in-person small- and medium-sized group hands-on learning activities that focus on collaborative problem solving, professional development, and independent critical thinking. The curriculum integrates meaningful basic science, public health, and clinical content throughout all phases, including Phase 2 clinical immersion blocks. It provides ample opportunities for career exploration, basic science knowledge solidification, advanced public health understanding, and internship preparation during Phase 3.

While the ForWard Curriculum includes plentiful online and distance learning resources across the UWSMPH statewide campus, it also includes many in-person learning activities to provide longitudinal professional and skill development, stimulate self-directed learning through facilitated case-based problem solving peer group exercises, and develop strong relationships with faculty teachers, mentors, and coaches. Thus, UWSMPH education leaders and teachers had to make significant swift curricular changes to meet program objectives when shelter-at-home and social distancing practices began and clinics closed doors to students.

For Phase 1 preclinical students, all in-person large and small group sessions were transformed within 1 week to online virtual sessions that allowed opportunities for meaningful discussions. Phase 2 students, who had just begun 12-week integrated clinical blocks in January 2020 across statewide campus sites, were removed from clinical rotations. Their curriculum was restructured, shifting core didactic content from all Phase 2 blocks to virtual online delivery, allowing students to build knowledge outside clinical settings, and providing opportunities for faculty and staff to create focused clinical 8-week rotations that will begin during the summer of 2020, when safety protocols, resources, and telehealth modalities should permit patient-centered clinical learning. Hands-on clinical skills exams and national board exams

• • •

**Author Affiliations:** Medical College of Wisconsin, Milwaukee, Wis (Hueston); University of Wisconsin School of Medicine and Public Health, Madison, Wis (Petty).

**Corresponding Author:** William J. Hueston, MD; Medical College of Wisconsin; 8701 Watertown Plank Rd, Milwaukee, WI 53266; email whueston@mcw.edu; phone 414.955.8220; ORCID ID 0000-0001-8545-317X.

**Table.** Effects of COVID-19 on Medical Student Education

| COVID-19 Restrictions | Effect on Student Education | Medical Schools' Responses |
|---|---|---|
| Safer at Home orders for state | 1) Students no longer permitted to come to campus for learning activities<br>2) Students barred from clinical activities at hospitals and clinics | 1) Shift from live groups and lectures to virtual teaching<br>2) Clinical rotations replaced with virtual learning, clinical simulations, telehealth exercises |
| Shortage of PPE | Students not permitted to participate in some procedures and surgeries or care for patients with conditions requiring PPE, including proven or suspected COVID-19 | Virtual presentations of procedures and clinical cases substituted where appropriate; students included when servicing as key provider (eg, assistant) on case and adequate PPE for safety |
| Suspension of USMLE testing with limited phased-in reopening of national testing sites | Testing sites not readily available for Step 1, Step 2CK (Clinical Knowledge), and for Step 2CS (Clinical Skills) of USMLE examinations | Medical schools working with AAMC and NBME to develop alternate testing sites at medical schools<br>Student clinical rotations may be adjusted to provide time for students to study and take these high-stakes examination |
| The newly formed "Work Group on Medical Students in the Class of 2021 Moving Across Institutions for Post Graduate Training" established by The Coalition for Physician Accountability[a] provided new guidance for student away rotations, residency application timeline, and residency interview process for 2020-2021 year | 1) Away rotations should be discouraged with exceptions for students who have a specialty interest and do not have access to clinical experiences with a residency program in their school's system and students for whom away rotations are required for graduation or accreditation purposes<br>2) Submission of residency applications through the AAMC ERAS system is delayed to provide more time for schools and students to submit application materials<br>3) All residency interviews will now be conducted virtually rather than face-to-face | 1) School will work with students to communicate expectations regarding away rotations and, when they are needed, encourage a limited number of away rotations in geographically proximate programs when appropriate<br>2) Schools will support students in obtaining needed clinical experiences and in preparing residency applications on new timeline<br>3) Schools to work with students using simulated online interviewing formats so that students can be comfortable with the process<br>Career counseling stepped up for students to assist in evaluating residency programs without on-site visits possible |

Abbreviations: PPE, personal protective equipment; AAMC, Association of American Medical Colleges; USMLE, United States Medical Licensing Examination; NBME, National Board of Medical Examiners; ERAS, Electronic Residency Application Service.

[a] Coalition for Physician Accountability members: Accreditation Council for Graduate Medical Education, American Association of Colleges of Osteopathic Medicine, American Medical Association, Assembly of Osteopathic Graduate Medical Educators, Association of American Medical Colleges, Council of Medical Specialty Societies/ Organization of Program Directors Associations, Education Commission for Foreign Medical Graduates National Resident Matching Program.

suspended in March are resuming in new ways to monitor student progress.

Early Phase 3 students have, perhaps, been most greatly affected by the uncertainty of COVID-19 as they had just begun intensive career exploration, including clinical rotations and acting/sub-internships important for residency applications. Cancellation of these key rotations has been difficult, but their curriculum has continued through several existing and new online courses, allowing students to gain advanced public health and basic science knowledge required for graduation that is relevant to their careers, including courses in clinical therapeutics and preparedness. School leaders and department faculty have been developing individualized learning plans to help students meet timely career milestones, with clinical rotations starting early summer. The majority of late Phase 3 students had already met most graduation requirements and matched into residencies. Thus, with minor curriculum adjustments, they will be entering their residencies on time this summer.

Fortunately, the ForWard Curriculum is a competency-based pass-fail curriculum that supports equitable assessment on virtual learning platforms. However, scheduling of national licensing exams continues to be challenging due to limited operations of testing centers.

## MCW

Similar challenges confronted MCW when large group gatherings were prohibited and student were removed from clinical sites. In contrast to the UWSMPH curriculum, the MCW medical school curriculum provides 2 years of foundational science instruction and clinical preparation, followed by 1 year of core clerkships and a final year of acting internships and electives. The majority of the foundational science is taught using large group lectures supplemented with some small group activities. Because MCW already delivered the large group learning sessions that comprise most of the curriculum in the preclinical years via synchronous distance learning with live streaming to our 2 regional campuses, transitioning to providing these sessions virtually to all students across the 3 campuses was straightforward. Unfortunately, the inability

to bring lecturers on campus to produce new sessions meant that we have had to rely on taped presentations from the previous year. The previously given lectures are reviewed by faculty members and updated either by supplemental videos or with printed materials that are distributed to the students at the end of each week.

Material covered in the small group setting has been more problematic. Where possible, objectives can be met by switching from small group learning to lectures that can be posted online for students. Clinical learning groups, such as physical examination training and early clinical rotations, have been suspended, with the material deferred to the summer or early fall when students may again come to campus. These changes will result in a short delay in students acquiring these skills but should not significantly impact their clinical progression.

The biggest disruption in education has been for the students in the third and fourth year of training, when they are generally assigned to hospital or clinic locations. With these unavailable, we have turned to the use of simulated patient experiences, online case learning, supervised telehealth visits, and virtual lectures. Additionally, students have been able to participate in novel experiences that we have adapted for testing clinical competencies, including a virtual "night on call" that we have conducted in collaboration with colleagues from New York University. While we have found that these activities can fill in some gaps in learning, they are not always sufficient to meet all the objectives of clinical courses. Students will have to return in the summer to complete some of their core clerkships since several competencies simply cannot be attained or assessed without a live patient encounter. These clerkship extensions will interfere with some early student elective time, which is distressing to students who look forward to these early electives to help them establish their career choice.

## UWSMPH and MCW

In addition to issues within the control of the medical schools, other changes beyond the health care industry have affected students. The temporary closure of online testing centers has made it impossible for students to schedule their United States Medical Licensing Examinations, for example. The uncertainty about when these centers will reopen and the anticipated diminished capacity because of social distancing has made it impossible for most students to plan ahead for their examinations. Since the scores on these examinations are often used by residency programs to influence residency selection, this has caused increased anxiety for medical students.

Additionally, the Association of American Medical Colleges, along with other national stakeholders (see Table), has issued a guidance strongly discouraging schools from offering away rotations to visiting students, except under circumstances where that rotation is not available at the student's school. Finally, the guidance also will restrict all residency programs to virtual interviews rather than in-person interviews for the next residency cycle. This extends even to students at the institution's affiliated medical school. These developments may impact students' and residency programs' ability to assess student-program fits, as well as costs of the interviewing process. We will need to assess how these changes affect both residency satisfaction and residency program outcomes during subsequent years of training. The guidance also announced a short delay in the residency application process to allow schools and students more time to prepare application materials.

## Summary

Thanks to the quick, collaborative work of innovative, committed faculty and staff within and across sites and schools, as well as the remarkable resilience and adaptability of understanding students, medical education has continued with modifications to allow all students to progress and to meet education program objectives. Medical school is more than curriculum, however. Students affected by this pandemic have felt the harsh realities of social isolation; experienced stresses caring for family and friends; missed major in-person milestone events – such as match day and graduation celebrations; lacked opportunities to build in-person connections with faculty, staff, and peers; needed to create virtual research projects; lost desired away rotations and global health experiences; witnessed closures of student-run free clinics while watching health disparities grow; and missed the joys of in-person socialization associated with learning, studying, and working together. Students are, however, gaining significant first-hand knowledge about the harsh realities of pandemics.

We hope that students are learning invaluable lessons about an ever-changing world, pressing public health issues, principles of novel infectious agents and immunology fundamentals, complex health equity and health economic problems, global health responses, and ethical principles in acute, real-world ways. They, along with all of us, will be forever changed by this unique and unprecedented experience in our lives. These lessons are ones that no curriculum could have adequately taught. Our ongoing curriculum can, however, continue to prepare students to become competent and caring professionals, critical thinkers, evidence-based problem solvers, actively engaged lifelong learners, nimble and innovative leaders, interprofessional team players, and champions of equitable health outcomes.

These changes, brought on by necessity, may also have lasting impact on medical training. Schools have learned that many curricular elements can be delivered just as well virtually as in small or large group settings. Additionally, new resources have been developed to provide foundational science and clinical opportunities that could expand student learning opportunities. Finally, innovative assessment methods that have been adopted for off-site students may provide additional opportunities to conduct ongoing student assessment even when students are back in clinics and hospitals. So, like many other activities permanently reshaped by COVID-19, positive lessons learned will be embraced by medical schools to create a new normal in medical education that includes more virtual learning and assessments in both classroom and clinical settings.

**Author Disclosures:** Both Drs Hueston and Petty serve on the Publishing Board for *WMJ*.

**Financial Disclosures:** None declared.

**Funding/Support:** None declared.

advancing the art & science of medicine in the midwest

# WMJ

## CALL FOR PAPERS & REVIEWERS


Since 1903, *WMJ* has served as a forum for professional communication and continuing education for physicians and other health professionals. This tradition continues today, but with a broader focus that extends across the country and even around the world.

Published quarterly by the Medical College of Wisconsin and the University of Wisconsin School of Medicine and Public Health, *WMJ* is a peer-reviewed, indexed scientific journal available via printed subscription and in full text online at www.wmjonline.org and PubMed through the National Library of Medicine.

*WMJ* invites original research, case reports, review articles, essays and "Health Innovations"—brief reports that showcase the results of initiatives being tested to improve quality, patient safety and satisfaction, cost efficiency and more in clinics and communities throughout the Midwest.

*WMJ* also seeks health care professionals who can be objective and insightful to add to our list of highly qualified reviewers. To sign up, visit www.wmjonline.org.

Become part of the tradition: submit a manuscript, serve as a reviewer and become a reader.

**Visit www.wmjonline.org or e-mail wmj@med.wisc.edu for more information.**

# Investigating the Trajectory of the COVID-19 Outbreak in Milwaukee County and Projected Effects of Relaxed Distancing

Amin Bemanian, PhD; Kwang Woo Ahn, PhD; Mallory O'Brien, PhD, MS; Darren J. Rausch, MS; Benjamin Weston, MD, MPH; Kirsten M. M. Beyer, PhD, MPH, MS

## ABSTRACT

**Introduction:** The coronavirus pandemic has placed enormous stresses on health care systems across the United States and internationally. Predictive modeling has been an important tool for projecting utilization rates and surge planning. As the initial outbreak begins to slow, questions are being raised regarding long-term coronavirus mitigation plans. This paper examines the current status of the coronavirus outbreak in Milwaukee County, Wisconsin, and simulates several scenarios where physical distancing measures are removed.

**Methods:** The outbreak's doubling time, reproductive numbers at several points, and incidence curve were calculated to assess outbreak progression. Compartmental models were used to estimate the number of hospitalizations and critically ill patients in Milwaukee County if distancing policies were removed.

**Results:** The compartmental models predict a substantial spike in cases and overwhelming medical resource utilization with an abrupt end to social distancing. Partial reduction in social distancing policies would likely result in a smaller spike, with less severe strain on available medical resources.

**Conclusions:** Milwaukee County remains very susceptible to a resurgence of COVID-19 cases. Removing physical distancing policies poses significant risks with regard to resource management.

## INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has placed an unprecedented strain on health care systems across the nation and around the globe. In order to help assess the impact COVID-19 could have on hospital beds and critical care services, multiple teams have developed model-based projections or projection tools to inform policy and decision-making as the pandemic has progressed.[1–5] These projections have been accomplished using a variety of approaches, including compartmental models such as the suspected-infected-recovered and suspected-exposed-infected- recovered (SIR, SEIR) models,[3–5] stochastic agent models,[2] and curve-fitting methods.[1] In particular, projections shared by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington suggest that many states will have passed their peak of new deaths during the early part of April.[1] For Wisconsin, the IHME model placed the peak of new deaths on April 5 and peak health care utilization on April 14, both dates that have passed at the time of this writing. Other projection approaches, when applied to the Wisconsin setting, have predicted a less optimistic outcome, with much higher potential case counts and loss of life, as well as a greater strain on local health systems.[3,5] Milwaukee County, in particular, has had a very high burden of cases relative to the rest of the state. As of May 17, 39% of the state's 12,543 cases of coronavirus were in Milwaukee County (4945), despite the county comprising only 16% of the state's population. Furthermore, the county has 56% of the 453 fatalities in the state.

In order to mitigate the outbreak, Wisconsin and many other states enacted policies to encourage physical distancing. In Wisconsin, efforts have included the closure of schools and banning of gatherings greater than 10 people beginning on March 18 and the Safer at Home order issued by Governor Tony Evers, which took effect March 25. Subsequently, Wisconsin has experienced economic decline and individuals across the state have struggled with the impact of these policies for their jobs, families, and

• • •

**Author Affiliations:** Institute for Health and Equity, Medical College of Wisconsin, Milwaukee, Wis (Bemanian, Ahn, O'Brien, Beyer); Greenfield Health Department, Greenfield, Wis (Rausch); Department of Emergency Medicine, Medical College of Wisconsin, Milwaukee, Wis (Weston).

**Corresponding Author:** Kirsten M. M. Beyer, PhD, MPH, MS, 8701 W Watertown Plank Rd, Milwaukee, WI 53226, phone 414.955.7530; email kbeyer@mcw.edu; ORCID ID 0000-0002-7513-8528.

lifestyles. Thus, while physical distancing policies are essential to stop the spread of the novel coronavirus, there are immense pressures to consider future scenarios for opening the economy and returning to some sense of normalcy, while limiting the burden of the virus on populations and systems. Ultimately, the Wisconsin Supreme Court overturned statewide distancing measures on May 13, 2020, and counties and municipalities across Wisconsin are developing new policies to balance economic reopening with public health concerns. The objective of this analysis is to examine information currently available about the COVID-19 outbreak in Milwaukee County and provide projections that consider how case counts and resource utilization may occur in several different practical scenarios of relaxing physical distancing policies.

## METHODS

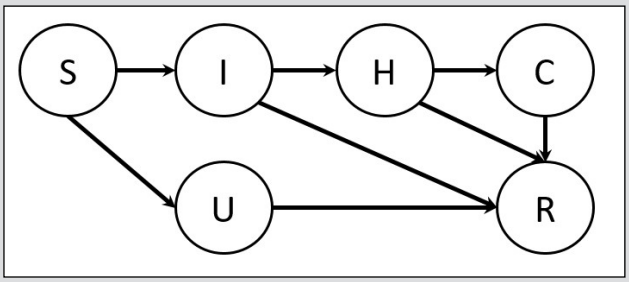
This study focuses on projecting COVID-19-related health care utilization in Milwaukee County. Public case data from the Wisconsin Department of Health Services were used to determine the daily number of cases. Case information from the Wisconsin Electronic Disease Surveillance System (WEDSS) was used to make estimates of typical hospitalization parameters. Since this research involved no contact with individuals and all data sources were either anonymous or deidentified, it was not considered human subjects research,

Basic characterization of the outbreak was done using the *incidence* package in R.[6] Reproductive numbers ($R_t$) were calculated using the *EpiEstim* package in R based on a method previously used for the calculation of the basic reproductive number of the Diamond Princess cruise liner COVID-19 outbreak.[7–9] Mean serial interval of 4.0 with a standard deviation of 0.5 was used for estimation of $R_t$.[10] Reproductive numbers were calculated at 3 points in the outbreak: (1) early in the outbreak from March 16 to March 22, when the first distancing orders would likely not have had enough time to affect incidence given the incubation period of coronavirus;[11] (2) March 23 to March 29, in the week following the first distancing orders and prior to the full effect of the Safer at Home order; and (3) May 9 to May 16 for the current effect of distancing policies.

### Projection Methods

The projection model is based on a classical SIR model. The SIR model dynamically simulates the 3 primary stages of an infection: susceptible, infected, and recovered. Using differential equations, it is possible to estimate what proportion of the population is in any stage of the disease at one time. The number of new daily infections is a function of how many people remain susceptible and how many people are currently infectious. Infected people remain infectious for a fixed amount of time and then transition into the recovered compartment, where they no longer can be infectious. This simulation continues until all of the population is infected or the susceptible population is too small to sustain the growth of the outbreak (ie, sufficient immunity is achieved). The threshold for when the outbreak ends is dependent on the effective reproductive number ($R_t$), which is the average number of individuals infected by a case at the current time of the outbreak. This is distinct from the basic reproductive number ($R_0$), which represents the initial reproductive rate of the virus.

**Figure 1.** Schematic of Model

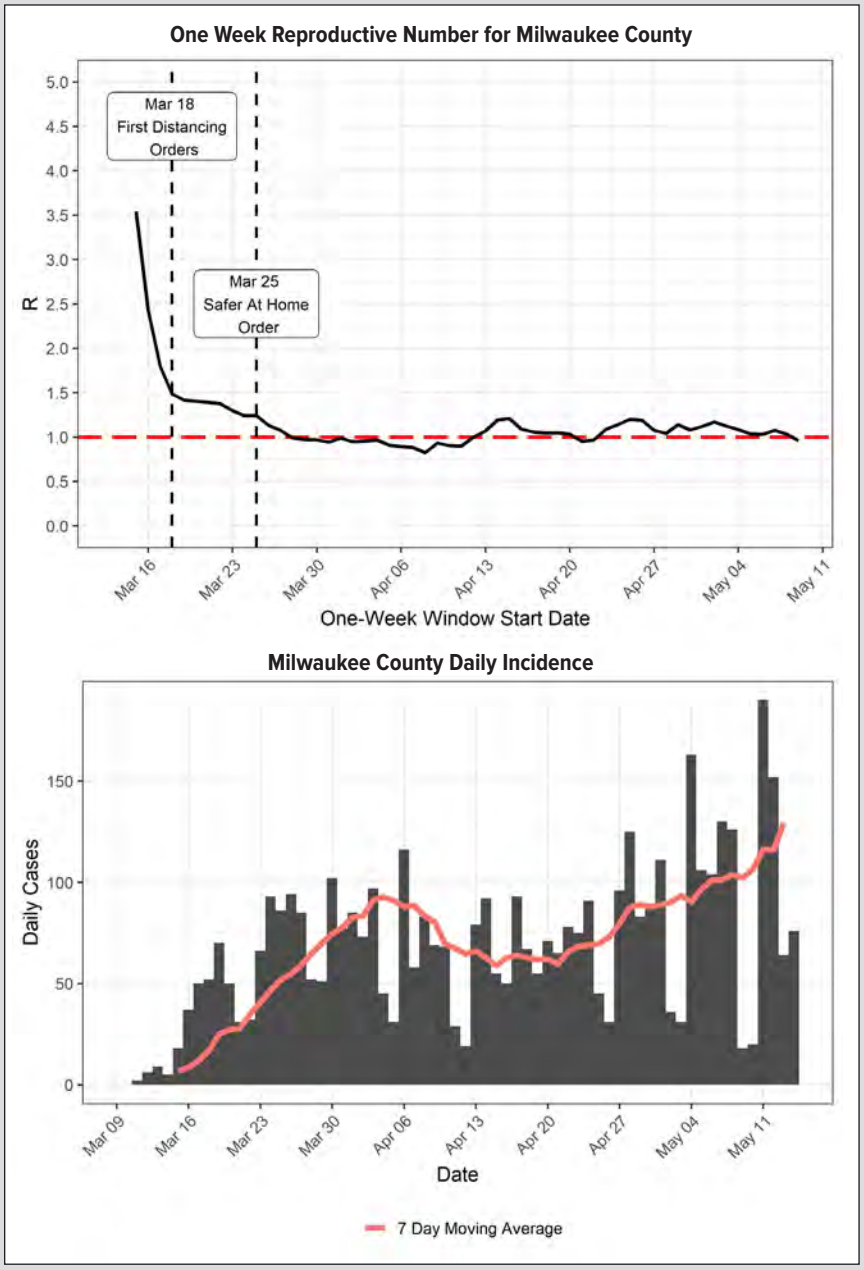



S – susceptible, I – confirmed infected, H – acute bed hospitalized, C – critically ill (intensive care unit), U – unconfirmed infected, R – recovered.

Our model has been modified to have 2 additional compartments for acutely hospitalized patients (H) and critical care patients (C). A proportion of the infected population enters the hospitalized pool, while the rest recover. There is a similar progression of hospitalized patients to either critical care or recovery. Additionally, there is a compartment for persons infected or exposed to SARS-CoV-2 (COVID-19's virus) who do not get tested (U). This includes patients whose condition is so mild that they are not eligible to receive testing or those who do not seek testing on their own. This model diagram is shown in Figure 1. Progression through the model follows the differential equations below. $\beta$ is the infection rate, dependent on the reproductive number ($R_t$). $\gamma_i$ is the transition rate from the infected compartments (both confirmed and unconfirmed) to either hospitalized or recovered. It is calculated as the reciprocal of the infection duration. Similarly, $\gamma_h$ is the transition rate of hospitalized patients to either critically ill or recovered, and $\gamma_c$ is the transition rate of critically ill patients to recovered. These are calculated as the reciprocal of the length of stay for each kind of hospitalization. $\eta_h$ is the hospitalization rate among infected persons, and $\eta_c$ is the critical care rate among hospitalized patients. The recovered pool in this SIR model includes deaths. Deaths were not modeled separately due to the lack of enough fatalities to properly estimate a fatality rate from each compartment in the model. $c$ is the testing coverage level, which is defined here to be the proportion of cases of SARS-CoV-2 confirmed by testing.

$$\frac{dS}{dt} = -\frac{\beta S(I+U)}{\mathrm{N}}$$
$$\frac{dI}{dt} = \frac{c\beta S(I+U)}{N} - \gamma_i I$$
$$\frac{dU}{dt} = \frac{(1-c)\beta S(I+U)}{N} - \gamma_i U$$
$$\frac{dH}{dt} = \eta_h \gamma_i I - \gamma_h H$$
$$\frac{dC}{dt} = \eta_c \gamma_h H - \gamma_c C$$
$$\frac{dR}{dt} = (1-\eta_h)\gamma_i I + \gamma_i U + (1-\eta_c)\gamma_h H + \gamma_c C$$
$$N = S + I + U + H + C + R$$
$$\beta = R_0 \gamma_i$$

**Figure 2.** COVID-19 Reproductive Number and Daily Incidence for Milwaukee County




Line indicates the 7-day moving average of the incidence curve.

We have fit certain parameters to the Milwaukee County outbreak data. The current $R_t$ (based on May 9-15) was used for the transmission rate at the beginning of the projection. We first tested the unlikely scenario where the current level of physical distancing persists indefinitely. We then tested several scenarios where physical distancing relaxes. We tested the total relaxation of distancing measures by using the reproductive number for the week of March 16-22, starting just before the first set of distancing orders was placed. We tested the partial relaxation of distancing using the week of March 23-29, which is after the initial distancing orders and as the Safer at Home order was becoming active. The loosening of physical distancing was tested at May 21, based on plans by several Milwaukee County municipalities to end their distancing orders on that date.

The hospitalization rate (median estimate: 19.0% of all cases) and intensive care unit (ICU) rate (median 26.5% of all hospitalizations) are estimated as binomial variables based on the proportion of cases in Milwaukee County that have been hospitalized so far. The average duration for mild cases (both for the I and U compartments) is assumed to be 13 days, based on a consensus estimate of 3 days of infectivity during the incubation period and 7 to 14 days of infectivity after symptom onset.[2-4] Using the Wisconsin Electronic Disease Surveillance System (WEDSS) and internal hospitalization data, average length of stay for hospitalization was set at 5 days and length of stay for critical patients at 4 additional days. We assume the unconfirmed cases remain mild, and they do not become hospitalized or die. Based on the relatively high rates of hospitalization in Wisconsin earlier in the outbreak (~30%) relative to other areas with closer to only 10% of hospitalizations, we estimate that $c$ (the testing coverage level) is a binomial variable with a median of 20% and a standard deviation of 4%. Our capacity estimates are based on aggregated data compiled by hospitals in the county and assume there is a maximum of 2475 acute care beds and 475 ICU beds, prior to any surge planning.

We assume that spread of the infection occurs evenly across the entire region (Milwaukee County), as this is a core assumption of SIR models. We also assume that spread from neighboring counties is not a significant cause of new infections. Hospitalized patients are not considered to be a significant cause of infections either and, therefore, are modeled as noninfectious after they enter the H and C compartments. The starting population for the recovered pool is estimated as all infected cases whose onset is 3 weeks earlier than the projection start date. All patients who have been infected and transition into the recovered pool are thought to be permanently immune. Projections are made using a Runge-Kutta numerical solver in the R programming language with the *deSolve* package.[12] For each scenario, 1000 simulations were conducted. In each simulation, the estimated parameters were resampled to cre-

ate a distribution of projections. All projections use data up to May 15, 2020, to set initial conditions.

## RESULTS

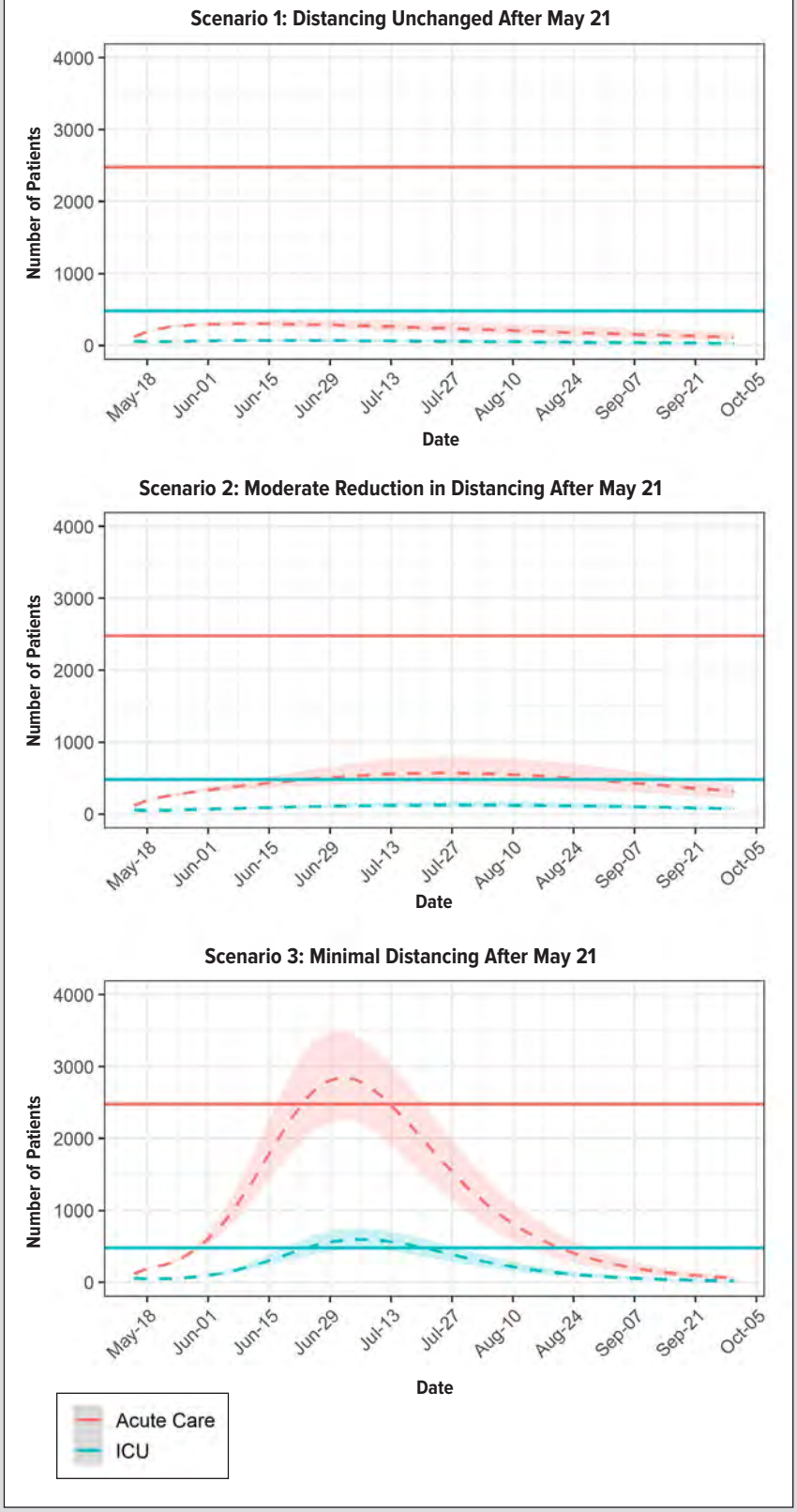
### Current Outbreak Status

The first confirmed case of coronavirus in Milwaukee County was identified on March 11, 2020. Due to the lack of testing kits and the range of clinical presentation (from mild self-resolving illness to critical respiratory failure), it is unclear whether cases of coronavirus were present in the county prior to the first confirmed case. Initial reproductive numbers were over 3, as shown by Figure 2, but quickly decreased as testing expanded. After initial distancing measures were placed, the reproductive number dropped under 1.5 and stabilized around 1 following the Safer at Home order. The incidence curve (Figure 2) shows that new daily cases rapidly increased during the first 2 weeks of the outbreak. Incidence initially peaked during the week of April 5 and began to decrease over the next 2 weeks. However, since late April, the incidence has begun to rise again.

### Projection Results

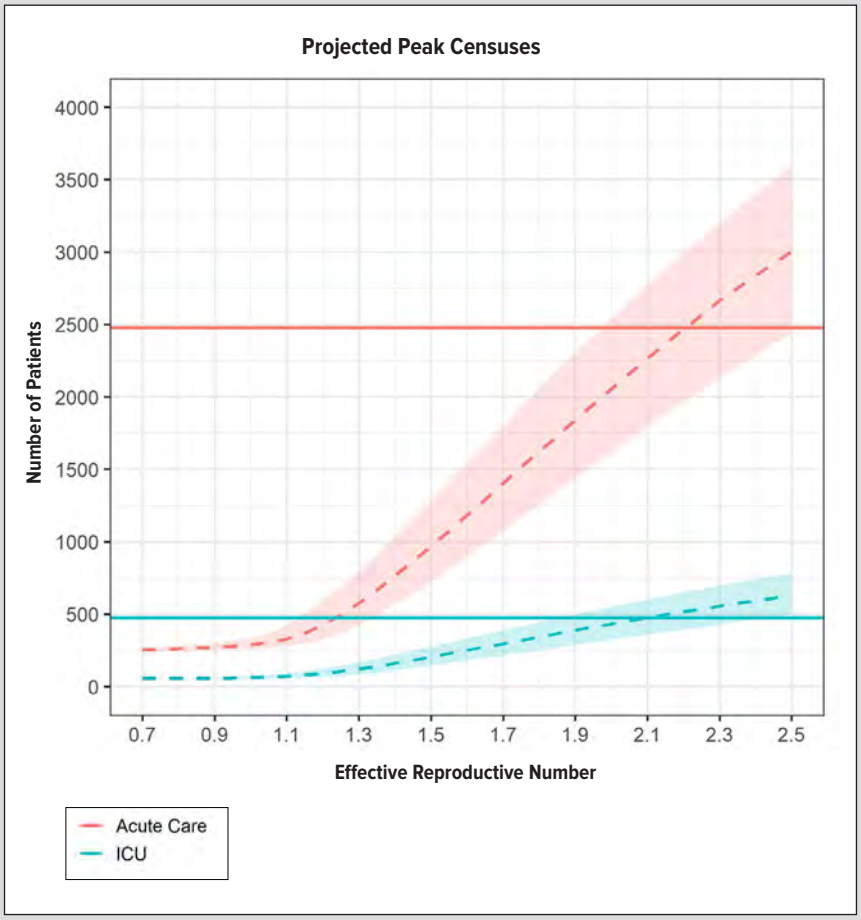
Our 3 projection scenarios are shown in Figure 3, with hospitalization peak summaries shown in the Table. For all of the following scenarios, we assume the peak has not yet occurred in the outbreak. In Scenario 1, all physical distancing policies remain unchanged through October 1. If this policy approach is taken, we project only a minor peak of hospitalizations in June. Some hospitalizations would continue through summer. By the end of the simulation duration, we project, on average, that 80.6% of Milwaukee County residents would still be susceptible to SARS-CoV-2 in this scenario (95% CI, 74.6%-85.3%). In Scenario 2, we assume a moderate amount of physical distancing to be relaxed on May 21. This scenario also assumes distancing returns to the March 23-29 levels (ie, limitations on restaurants and businesses, small gatherings

**Figure 3.** Projected Scenario Time Courses




Hospitalization census refers to acute care patients and is separate from ICU patients. Dashed lines indicate the median simulation with bands indicating 95% of simulation range. Solid lines are the capacity of acute care beds and intensive care unit (ICU) beds, without any additional surge capacity.

**Figure 4.** Projected Peaks as a Function of the Effective Reproductive Number ($R_t$)




Simulations were run for a range of $R_t$ from 0.7 to 2.5. Each reproductive number was simulated 200 times. Dashed line indicates peak census with bands indicating 95% of simulation range. Solid lines are the capacity of acute care beds and intensive care unit (ICU) beds, without any additional surge capacity.

**Table.** Projections for Peak Hospitalizations in Milwaukee County Based on 3 Different Scenarios

| | Median | 2.5 percentile | 97.5 percentile |
|---|---|---|---|
| S1: Distancing unchanged after May 21 (Rt: ~1.0) | | | |
| Peak acute bed census | 298 | 266 | 352 |
| Peak ICU census | 64 | 57 | 77 |
| Peak date (2020) | June 10 | June 3 | June 27 |
| S2: Moderate distancing after May 21 (Rt: ~1.3) | | | |
| Peak Hospitalization Census | 569 | 414 | 800 |
| Peak ICU census | 121 | 86 | 171 |
| Peak date (2020) | July 25 | July 14 | August 2 |
| S3: Minimal distancing after May 21 (Rt: ~2.4) | | | |
| Peak acute bed census | 2858 | 2255 | 3515 |
| Peak ICU census | 596 | 466 | 747 |
| Peak date (2020) | July 2 | June 28 | July 6 |

Median indicates the median simulation for each scenario.
Abbreviation: ICU, intensive care unit.

<10 individuals permitted, schools remain closed). We expect a spike in cases in late May, but this spike would still be within normal capacity of the county's health care systems. Finally, in scenario 3, we model a total relaxation of distancing on May 21. Here there is a spike in late June/early July that would significantly exceed both acute care and ICU bed capacities. We also calculate the peak censuses for a range of $R_t$ values, as shown in Figure 4. Based on these simulations, we expect that COVID-19 cases alone reach 50% of acute care capacity for $R_t$ values between 1.6 and 1.7, and they exceed acute care capacity for $R_t$ values above 2.2.

## DISCUSSION

The Milwaukee County COVID-19 outbreak presented with an initial rapid rise of new daily cases. The incidence curve plateaued in April and then continued to rise into early May. There are early signs that physical distancing behaviors were successful at preventing a more severe outbreak. The effective reproductive number rapidly decreased in the first weeks of the outbreak and has remained around 1 since enactment of the Safer at Home order. We are limited in our ability to identify each policy's effects since they were enacted in rapid succession. We also cannot isolate the impact of the April 7 election, which was held during the Safer at Home order. The City of Milwaukee's Election Commission reported that there were 18,803 in-person voters at 5 election sites.[13] This was a substantial exposure risk. There is a rise in the daily incidence beginning 2 weeks after the election, but this also coincides with the expansion of testing.[14]

Projecting the future course of the COVID-19 epidemic, as well as the impact of potential policy changes, is challenging due to multiple sources of uncertainty, including each policy's effect on the virus's reproductive rate and the number of actual COVID-19 cases covered by testing. It is difficult to predict how the population will respond to future policy changes, such as the removal of the Safer at Home order, as few places have attempted these changes. Given that Wisconsin and many other places have not levied travel restrictions, there remain opportunities for cases to continue to enter the population through travel. However, there is evidence that there has been decreased mobility during this outbreak; Milwaukee County and its neighbors all have 60% or greater decreased mobility based on cellphone GPS data.[15]

Another limitation of our approach is that the SIR model assumes homogeneity of infections across the study population. In reality, we have seen the clustering of new cases in different neighborhoods throughout Milwaukee. Furthermore, with the early removal of the Safer at Home order, different municipalities within the county are approaching distancing differently. This will likely cause spatial variation in the amount of spread. However, since the neighborhoods and cities within a county are so tightly interconnected, we believe the county is an ideal unit for SIR model, especially compared to statewide and nationwide projections.

We do not incorporate the effect of seasonality, which may result in a second peak in the fall or winter,[16] as it is currently unknown whether this specific virus is subject to seasonal changes. We chose not to model deaths because the primary purpose of these models was to gauge health care utilization. Additionally, the limited number of fatalities in Milwaukee County makes it difficult to properly estimate the case fatality rate for each of the compartments. The fatality rate may change significantly over the course of the outbreak, depending on the amount of strain on the health care infrastructure. Similarly, we do not model how health care systems manage non-COVID-19 patients. Currently, many nonemergent procedures and visits have been postponed to ensure enough capacity for potential COVID-19 surges. However, much of this care is essential and will need to be conducted before the pandemic ends. Finally, we cannot and have not incorporated the potential effects of future developments such as mass antibody testing; increases in remote work to sustain physical distancing; or general changes to workplace, social, or behavioral practices as of yet unknown. Despite these limitations, we believe that these projections are a useful tool to frame discussions of policy moving forward. Importantly, the goal of our projections is not to give specific point estimates on how many hospitalizations there will be on any given date, but rather to highlight the risks associated with policy changes based on the best available information.

Our projections show that if physical distancing policies were maintained in full through the end of September, the continued burden of cases would remain well within the capacity of health care systems in Milwaukee County. However, realistically continuing the current levels of physical distancing through the summer would have potentially catastrophic economic costs. Unfortunately, since the vast majority of the county's population remains susceptible to this infection, the pandemic course is very sensitive to the degree of relaxation. Full relaxation of these policies (ie, removal of Safer at Home with no other distancing policies) and a return to preoutbreak activity levels will almost assuredly cause a new wave that would likely overwhelm our health systems. Furthermore, seemingly small increases in $R_t$ can have exponential effects on future hospitalizations. If reopening can be done in a cautious and phased manner while keeping the $R_t$ under 1.5, then future peaks will likely be well within the county's health care capacity.

Policymakers must consider what public health infrastructure is necessary to prevent a resurgence of cases as plans are made to reopen the economy. Public health functions essential to outbreak control include robust testing and contact tracing capabilities and adequate personal protective equipment for health care workers and all essential employees at significant risk of exposure. Additionally, novel economic and business policies that encourage physical distancing during the limited reopening of restaurants and shops or staggering which days of the week individuals can go to nonessential businesses should be considered. Finally, any reopening requires awareness that a second outbreak may happen and contingency plans to reimplement more stringent physical distancing policies if the daily incidence were to increase too quickly. We recommend monitoring the current effective reproductive number to determine whether the outbreak remains controlled.

## CONCLUSION

Continuing the current levels of physical distancing through the summer is unrealistic due to the long-term economic costs and the judicial revocation of the Safer at Home order. Relaxation of these distancing policies risks a significant resurgence in COVID-19 cases. Removal of the Safer at Home order will likely require some additional new policies that continue at least a moderate level of physical distancing. Prior to Safer at Home, this level was achieved through closures of schools, restaurants, and bars and a ban of mass gatherings. Other combinations of policies could achieve similar effects on disease suppression. However, without such efforts, Milwaukee County will likely see a significant surge that will strain our health care resources beyond capacity. These are exceptionally difficult decisions affecting the health, livelihoods, and quality of life of all Wisconsinites. We hope this analysis can provide evidence to assist decision-makers as these policies are determined.

**Acknowledgements:** We would like to thank John R. Raymond, Sr., MD, Laura Cassidy, MS, PhD, John Meurer, MD, MBA, Amanda Simanek, PhD, MPH, and Geoffrey Swain, MD, MPH, for their support in the development of this paper.

**Funding/Support:** This research was funded in part by the Advancing a Healthier Wisconsin Endowment at the Medical College of Wisconsin.

**Financial Disclosures:** None declared.

## REFERENCES

**1.** IHME COVID-19 Health Service Utilization Forecasting Team. Forecasting COVID-19 impact on hospital bed-days, ICU-days, ventilator-days and deaths by US state in the next 4 months. Preprint. medRxiv. Posted online March 2020. doi:10.1101/2020.03.27.20043752

**2.** Ferguson NM, Laydon D, Gemma N-G, et al, on behalf of the Imperial College COVID-19 Response Team. Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College London; March 16, 2020. https://spiral.imperial.ac.uk:8443/bitstream/10044/1/77482/14/2020-03-16-COVID19-Report-9.pdf

**3.** Predictive Healthcare. COVID-19 Hospital Impact Model for Epidemics (CHIME). Penn Medicine, The University of Pennsylvania. Published March 13, 2020. Accessed April 12, 2020. https://penn-chime.phl.io

**4.** Hill A. Modeling COVID-19 spread vs healthcare capacity. Updated March 21, 2020. Accessed April 12, 2020. https://alhill.shinyapps.io/COVID19seir/

**5.** Henderson M, Carlson E. Covid Act Now Model. CovidActNow.com. March 20, 2020. Updated April 12, 2020. Accessed April 12, 2020. https://data.covidactnow.org/Covid_Act_Now_Model_References_and_Assumptions.pdf

**6.** Kamvar Z, Cai J, Pulliam J, Schumacher J, Jombart T. Epidemic curves made easy using the R package incidence. F1000Res. 2019;8(139). doi.10.12688/f1000research.18002.1

**7.** Zhang S, Diao MY, Yu W, Pei L, Lin Z, Chen D. Estimation of the reproductive number of novel coronavirus (COVID-19) and the probable outbreak size on the Diamond Princess cruise ship: A data-driven analysis. *Int J Infect Dis.* 2020;93:201-204. doi:10.1016/j.ijid.2020.02.033

**8.** Jombart T, Cori A, Nouvellat P. EarlyR: Estimation of Transmissibility in the Early Stages of a Disease Outbreak; 2017, version 0.0.1. Accessed May 16, 2020. https://rdrr.io/cran/earlyR/

**9.** Cori A, Ferguson NM, Fraser C, Cauchemez S. A new framework and software to estimate time-varying reproduction numbers during epidemics. *Am J Epidemiol.* 2013;178(9):1505-1512. doi:10.1093/aje/kwt133

**10.** Nishiura H, Linton NM, Akhmetzhanov AR. Serial interval of novel coronavirus (COVID-19) infections. *Int J Infect Dis.* 2020;93:284-286. doi:10.1016/j.ijid.2020.02.060

**11.** Guan W, Ni Z, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med.* 2020;382:1708-1720. doi:10.1056/nejmoa2002032

**12.** Soetaert K, Petzoldt T, Setzer RW. Solving differential equations in R: package deSolve. *J Stat Softw.* 2010;33(9):1-25. doi:10.18637/jss.v033.i09

**13.** Klein T. Nearly 19,000 in Milwaukee brave polls for Election Day. WTMJ-TV. April 8, 2020. Accessed April 12, 2020. https://www.tmj4.com/news/coronavirus/nearly-19-000-in-milwaukee-brave-polls-for-election-day

**14.** Marshall J. Gov. Evers says Wisconsin is taking big steps to increase COVID-19 testing. *WTMJ-TV.* April 20, 2020. Accessed May 16, 2020. https://www.tmj4.com/news/coronavirus/gov-evers-says-wisconsin-is-taking-big-steps-to-increase-covid-19-testing

**15.** GeoDS Lab. Mapping mobility changes in response to COVID-19. University of Wisconsin-Madison. Accessed May 16, 2020. https://geods.geography.wisc.edu/covid19/physical-distancing/

**16.** Neher RA, Dyrdak R, Druelle V, Hodcroft EB, Albert J. Potential impact of seasonal forcing on a SARS-CoV-2 pandemic. *Swiss Med Wkly.* 2020;150:w20224. doi:10.4414/smw.2020.20224

# Bicycling Rates and the Prevalence of Bicycle Helmet Usage in Wisconsin

Christian W. Schmidt, MS; Traci R. Snedden, PhD, RN; Kristen M. Malecki, PhD, MPH; Ronald E. Gangnon, PhD; Shoshannah I. Eggers, PhD; Marty S. Kanarek, PhD, MPH

## ABSTRACT

**Introduction:** Bicycles are a source of transportation, recreation, and exercise throughout the world. Bicycling is associated with both health and environmental benefits but also poses a risk of injury. The use of bicycle helmets has been shown to reduce morbidity and mortality associated with cycling. It is unknown if helmet use differs across Wisconsin geographic areas and sociodemographic groups.

**Methods:** Data were obtained from the Survey of the Health of Wisconsin (SHOW). Bicycle use and helmet use frequency were determined from a self-administered questionnaire that contained questions specific to preventative health behaviors. Descriptive statistics summarized overall bicycle ridership. Chi-square and Student *t* tests were performed to assess relationships between bicycle and helmet use across geographic categories and sociodemographic groups.

**Results:** Differences between sex, race or ethnicity, and education level were found to be associated with bicycle ridership and the frequency of helmet use. Men were significantly more likely to report riding a bicycle and never wearing a helmet. Individuals from urban communities reported always wearing a helmet more often than rural communities. Higher education levels were associated with higher levels of bicycle and helmet use. Race or ethnicity was not associated with bicycle ridership but was associated with differences in helmet use frequency.

**Conclusion:** Nearly half of those who ride bicycles in Wisconsin report never wearing a helmet. Since bicycle ridership and helmet use were found to be associated with a number of sociodemographic characteristics, any solution should consider the role of equity when attempting to increase ridership or helmet use.

## BACKGROUND

Bicycles are a popular source of recreation, exercise, and transportation throughout the United States and the world. Cycling is related to many health cobenefits pertaining to physical activity and improved environmental air quality.[1,2] However, it is also a common mechanism of trauma in the United States. In 2009, bicycle-related injuries accounted for nearly 600,000 emergency department visits, 20,000 hospital admissions, and 630 fatalities in the United States.[3] The majority of bicycle-related injuries affect the extremities, followed by injuries to the head, face, or spine.[4] The injuries to the head, face, or spine accounted for nearly 50% of all hospitalizations, having more significant morbidity and mortality than injuries of the extremities.[3] It is believed that many of these injuries can be reduced by the use of bicycle helmets. A meta-analysis of the effects of bicycle helmets on injuries found that helmets reduced overall head injury by 48%, traumatic brain injuries by 53%, and facial injuries by 23%.[5] Helmet usage also was found to reduce serious head injuries and the total number of cyclists that were seriously injured or killed by 60% and 34%, respectively.[5]

Despite the health benefits of cycling and the protective effects of bicycle helmet use, usage rates vary dramatically across the United States and other countries. Some studies have found that trip length—in both time and distance—was strongly associated with helmet use, where cyclists going on a longer trip were more likely to use a helmet.[6,7] Cyclists who reported not wearing a helmet on short trips stated that they trusted their bicycling ability and did not think they would be injured on their trip.[8] The path used while cycling also affects helmet usage, where cyclists who ride on roads with traffic were more likely to report wearing a helmet than those on the sidewalk or a bicycle path.[9] Other characteristics associated with helmet usage in adults are education, income, and age, where, higher levels of education, higher income levels, and older age were associated with increased helmet usage.[10]

• • •

**Author Affiliations:** Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, University of Wisconsin-Madison, Madison, Wis (Schmidt, Malecki, Gangnon, Eggers, Kanarek); School of Nursing, University of Wisconsin-Madison, Madison, Wis (Snedden); Department of Environmental Medicine and Public Health, Icahn School of Medicine at Mount Sinai, New York, NY (Eggers).

**Corresponding Author:** Christian Schmidt, 610 Walnut St, 707 WARF Building, Madison, WI 53726; phone 651.829.1542; email cwschmidt@wisc.edu.

**Figure 1.** Bicycle Ridership

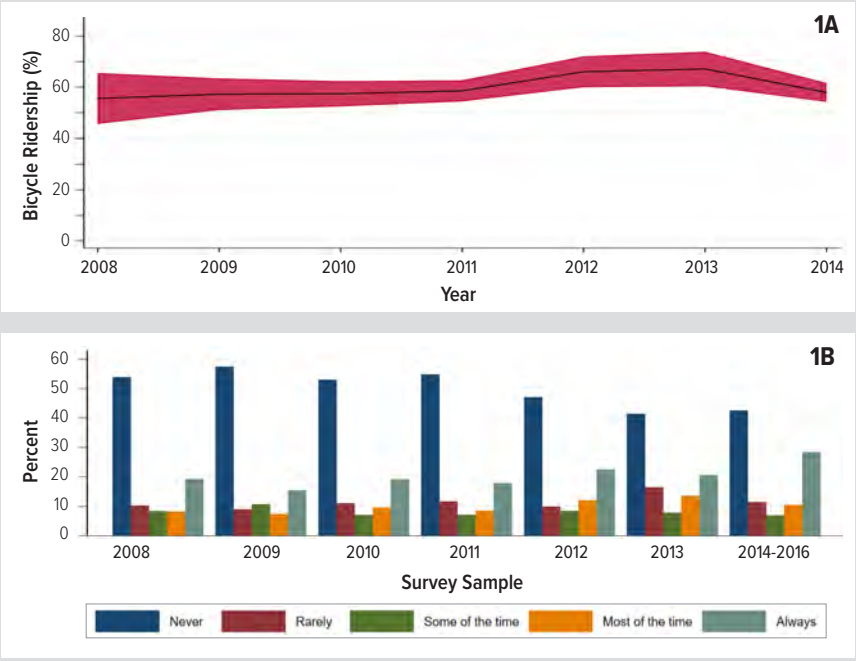



Figure 1A: Ridership over time with the estimates corresponding 95% confidence interval.
Figure 1B: Bicycle helmet usage frequency over time.

Many studies have examined helmet usage outside the United States or focused solely on urban centers of the US coasts, limited municipalities, or school districts. Few studies have examined helmet use in a statewide adult population that includes both urban and rural residents. Using data from the Survey of the Health of Wisconsin (SHOW), and coupled with SHOW's unique sampling methodology, the results of this study narrow the gap of knowledge concerning helmet usage in the Midwestern United States.

## METHODS

Data were collected by the Survey of the Health of Wisconsin (SHOW)—an annual research survey that gathers information on the health and health determinants of representative samples of the general population in Wisconsin.[11] SHOW has been conducted through the University of Wisconsin School of Medicine and Public Health since 2008 in order to provide a statewide demographic and geographic representation of participants. Data are collected under a Certificate of Confidentiality obtained from the US Department of Health and Human Services.

Analysis was performed on samples collected between 2008 and 2016. Due to changes in the sampling methodology during the 2014-2016 sample, conclusions about the 2008-2013 and 2014-2016 samples are drawn independently, despite their unequal lengths, to maintain the accuracy of the weighting techniques. Study details have been discussed previously by Nieto et al.[11] The University of Wisconsin-Madison Health Sciences Institutional Review Board approved the study protocol and informed consent documents. Additional information can be obtained from the Survey Protocol and Manual of Operations downloadable from http://www.show.wisc.edu/protocol.

### Variables

Rates of bicycle ridership and helmet use were determined per a self-administered questionnaire. Bicycle usage was determined from the respondents who indicated they ride a bike. Helmet use frequency was reported on a 5-point Likert-type scale including "Always," "Most of the time," "Some of the time," "Rarely," and "Never."

Categorization for urban, suburban, or rural setting was determined from rural-urban commuting area (RUCA) codes. RUCA codes utilize measures of urbanization, population density, and daily commuting in determining and assigning codes for communities.[12] A location is considered urban if it is part of the core of a metropolitan area, whereas suburban locations are urban areas not part of the core metropolitan area, and rural locations consist of large, small, and isolated rural locations.

### Analysis

Results are reported as weighted means, and statistical analyses were performed using SAS version 9.4 (Cary, North Carolina). Chi-square and Fisher exact tests were used to analyze correlations between helmet use and potential use frequency predictors where appropriate. Student *t* tests were performed to identify differences between the means of bicycle and helmet use for different subpopulations.

## RESULTS

### Bicycle Ridership

As seen in Figure 1a, the overall mean bicycle ridership in the 2008-2014 sample was 60% (SE 1.4%). The 2014-2016 sample estimated bicycle ridership at 58% (SE 1.8%). In both samples, males were significantly more likely to ride a bicycle than females, with 13.9% higher ridership in the 2008-2013 sample (95% CI, 9.1%-18.7%) and 11.7% higher ridership in the 2014-2016 sample (95% CI, 5.5%-17.9%). In the 2008-2013 sample, non-Hispanic whites were 18.9% (95% CI, 8.7%-29.2%) more likely to ride a bicycle than non-Hispanic blacks or African Americans and 15.7% (95% CI, 3.8%-27.5%) more likely in the 2014-2016 sample. There was a significant difference between participants in urban and rural settings in 2008-2013, with urban residents reporting an 8.2% (95% CI, 2.7%-13.8%) higher ridership than rural residents. Participants with an income of ≥400% of the federal poverty level (FPL) reported the highest ridership rates; and those whose income was <100% FPL reported the second-highest ridership in both samples. The largest difference in ridership came from those ≥400% FPL and 100% to 199% FPL, with an 11.5% difference in the 2008-2013 sample (95% CI, 4.4%-18.6%) and 14.5% difference in the 2014-2016 sample (95% CI, 7.1%-21.9%).

Analysis of the 2008-2013 sample for the relationship of education level and bicycle ridership revealed significantly lower levels

of bicycling in those with a high school-level education or less than those with some college education or an associate's degree (-8.8%; 95% CI, -14.7% to -2.9%), those with a bachelor's degree (-18.7%; 95% CI, -25.6% to -11.9%), and those with post-graduate education (-20.8%; 95% CI, -29.2% to -12.3%). Additionally, there were significantly lower rates of bicycle ridership between those with some college education or an associate's degree and those with either a bachelor's degree (-9.9%; 95% CI, -16.3% to -3.6%) or some post-graduate education (-12.0%; 95% CI, -20.0% to -3.9%). The 2014-2016 sample revealed similar trends. Those with a high school education or less were significantly less likely to ride than those with a bachelor's degree (-20.4%; 95% CI, -30.8% to -10.1%) and those with post-graduate education (-19.6%; 95% CI, -29.6% to -10.0%). There were also significant differences between those with some college or an associate's degree and those with a bachelor's degree (-15.2%; 95% CI, -24.7% to -5.7%) and those with post-graduate education (-14.5%; 95% CI, -23.5% to -5.4%).

### Helmet Use Frequency

Over the entire sample, those who reported "never wearing a helmet" comprised the largest helmet use frequency group, averaging approximately 51% in the 2008-2013 sample (Table 1) and 43% in the 2014-2016 sample (Table 2). Those who reported always wearing a helmet were the next-largest subgroup, with 19% of the 2008-2013 sample and 28% of the 2014-2016 sample.

Similar to overall bicycle use, participants' sociodemographic traits correlated with different helmet use frequencies (Tables 1 and 2). In 2008-2013, the rate of males who reported never wearing a helmet was 9.4% (95% CI, 2.5%-16.3%) higher than females, and females were 6.2% (95% CI, 0.9%-11.5%) more likely than males to report always wearing a helmet.

Race and ethnicity were also strongly related to the frequency of helmet use. In the 2008-2013 sample, non-Hispanic whites were 20.0% (95% CI, 6.8%-33.1%) less likely to report never wearing a helmet than non-Hispanic blacks or African Americans. Non-Hispanic "other" race or multiracial participants were less likely to report never wearing a helmet than non-Hispanic whites (-19.3%; 95% CI, -35.4% to -3.2%), non-Hispanic blacks or African Americans (-39.3%; 95% CI, -59.3% to -19.2%), or Hispanics of any race (-27.8%; 95% CI, -50.6% to -4.9%). In the 2014-2016 sample, non-Hispanic whites reported never wearing a helmet significantly less than Hispanics of any race (-29.1%; 95% CI, -42.3% to -15.8%). Additionally, race and ethnicity correlated with how often participants reported always wearing a helmet. In 2008-2013, the rate of non-Hispanic blacks or African Americans who reported always wearing a helmet was significantly lower than non-Hispanic whites (-17.1%; 95% CI, -21.8% to -12.4%) and non-Hispanic other or multiracial participants (-33.1%; 95% CI, -51.0% to -15.1%). In the same sample, non-Hispanic other or multiracial participants reported always wearing a helmet at a significantly higher level than those of Hispanic ethnicity (24.7%; 95% CI, 4.6%-44.9%). In the 2014-2016 sample, those of Hispanic ethnicity reported always wearing a helmet at significantly lower levels than non-Hispanic whites (-25.8%; 95% CI, -33.1% to -18.5%), non-Hispanic blacks or African Americans (-21.4%; 95% CI, -39.7% to -3.0%), and non-Hispanic other or multiracial participants (-20.0%; 95% CI, -32.3% to -7.6%).

In both samples, urban-rural categorizations were related to helmet use. Participants in rural communities reported the highest levels of never wearing a helmet—13.3% (95% CI, 5.0%-21.5%) and 21.8% (95% CI, 12.7%-30.9%) higher than those who live in urban settings and 13.6% (95% CI, 0.9%-26.4%) and 14.3% (95% CI, 8.2%-20.4%) higher than those from suburban communities, respectively. In 2008-2013, urban participants reported an 11.5% (95% CI, 6.3%-16.7%) higher frequency of always wearing a helmet vs those from rural communities. The 2014-2016 sample supported this; rural participants reported significantly lower levels of always wearing a helmet than those from urban (-21.4%, 95% CI, -29.3% to -13.6%) and suburban communities (-17.0%; 95% CI, -23.1% to -10.8%).

Helmet use frequency increased with income in both samples. Participants with an income ≥400% FPL were significantly more likely to report always wearing a helmet than those with incomes of <100%, 100% to 199%, 200% to 299%, and 300% to 399% FPL. The greatest difference was found between those with an income ≥400% FPL vs those with an income of 100% to 199% FPL in the 2008-2013 sample (15.0%; 95% CI, 9.0%-20.9%) and between ≥400% FPL and <100% FPL in the 2014-2016 sample (28.2%; 95% CI, 20.1%-36.3%).

Participants with the highest incomes were also the least likely to report never wearing a helmet. Specifically, those ≥400% FPL reported significantly lower levels than those <100% and 100% to 199% in both samples, in addition to those 200% to 299% and 300% to 399% FPL in the 2014-2016 sample. In both samples, the largest variation occurred between those ≥400% FPL and <100% FPL (-16.4%; 95% CI, -28.3% to -4.5% and -28.3%; 95% CI, -43.0% to -13.5%, respectively).

Education level was associated with bicycle helmet use as well. In the 2008-2013 sample, a significantly higher proportion of those with a high school education or less reported never wearing a helmet than those with some college or an associate's degree (12.5%; 95% CI, 4.0%-21.0%), those with a bachelor's degree (28.5%; 95% CI, 19.8%-37.3%), and those with post-graduate education (42.8%; 95% CI, 32.9%-52.7%). Having some college or an associate's degree was associated with higher levels of never wearing a helmet than having a bachelor's degree (16.1%; 95% CI, 7.8%-24.3%) or post-graduate education (30.3%; 95% CI, 20.9%-39.8%). Additionally, having only a bachelor's degree was associated with a higher rate of never wearing a helmet than having post-graduate education (14.3%, 95% CI, 4.6%-24.0%).

The same trend emerged in the 2014-2016 sample. Those with a high school education or less or some college experience or an associate's degree reported a higher rate of never wearing a helmet than those with a bachelor's degree (39.1%; 95% CI, 30.5%-47.7%; and 27.5%; 95% CI, 18.1%-36.9%, respectively) and those with post-graduate experience (47.6%; 95% CI, 39.7%-55.6%; and 36.0%; 95% CI, 27.2%-44.9%, respectively). Having some post-graduate education vs a bachelor's degree also correlated with significantly lower reported rates of never wear-

**Table 1.** Frequency of Helmet Use Based on Sociodemographic Traits (2008-2013)

| Variable | N | Always (%, SE) | Most of the Time (%, SE) | Some of the Time (%, SE) | Rarely (%, SE) | Never (%, SE) |
|---|---|---|---|---|---|---|
| Overall | 1661 | 19.34 (1.40) | 10.06 (1.13) | 8.26 (0.99) | 11.51 (0.97) | 50.83 (1.89) |
| Sex | | | | | | |
| Male | 806 | 16.61 (1.75) | 10.51 (1.44) | 7.22 (1.14) | 10.71 (1.40) | 54.95 (2.56) |
| Female | 855 | 22.82 (2.04) | 9.50 (1.28) | 9.59 (1.38) | 12.51 (1.34) | 45.58 (2.41) |
| Age (mean, SE) | 1661 | 47.37 (0.89) | 43.64 (1.25) | 42.19 (1.25) | 40.00 (1.23) | 41.31 (0.69) |
| Race | | | | | | |
| Non-Hispanic white | 1479 | 19.45 (1.40) | 10.22 (1.25) | 8.11 (1.04) | 11.49 (1.09) | 50.73 (1.99) |
| Non-Hispanic black or African American | 67 | 2.35 (1.97) | 5.17 (2.88) | 8.47 (3.21) | 13.29 (4.98) | 70.72 (6.41) |
| Hispanic (any race) | 43 | 10.67 (5.07) | 20.16 (8.02) | 6.20 (4.46) | 3.75 (2.67) | 59.22 (8.49) |
| Non-Hispanic other or multiracial [a] | 70 | 35.41 (8.94) | 4.76 (2.68) | 12.52 (4.82) | 15.83 (6.18) | 31.47 (7.97) |
| Urban-rural classification | | | | | | |
| Urban | 857 | 23.28 (2.09) | 9.73 (1.27) | 8.20 (1.19) | 11.67 (1.35) | 47.13 (2.67) |
| Suburban | 252 | 18.99 (3.63) | 13.04 (3.89) | 7.02 (1.71) | 14.21 (1.85) | 46.75 (5.61) |
| Rural | 552 | 11.76 (1.63) | 9.11 (2.03) | 9.06 (2.28) | 9.70 (1.53) | 60.38 (3.28) |
| Income level | | | | | | |
| <100% FPL | 166 | 18.55 (4.78) | 5.61 (2.61) | 6.23 (2.47) | 8.79 (2.86) | 60.81 (5.47) |
| 100%-199% FPL | 267 | 8.93 (1.76) | 6.63 (1.75) | 10.37 (2.16) | 14.27 (2.55) | 59.79 (3.36) |
| 200%-299% FPL | 250 | 16.78 (2.78) | 10.99 (2.93) | 9.66 (2.12) | 9.69 (2.22) | 52.89 (4.24) |
| 300%-399% FPL | 282 | 21.94 (2.77) | 9.95 (2.25) | 4.43 (1.39) | 12.99 (2.38) | 50.68 (3.80) |
| 400+% FPL | 289 | 23.92 (2.47) | 12.23 (1.79) | 9.46 (1.60) | 9.98 (1.80) | 44.41 (2.64) |
| Education level | | | | | | |
| High school or less | 386 | 10.86 (1.90) | 2.98 (0.98) | 3.98 (1.07) | 13.51 (2.24) | 68.67 (3.24) |
| Some college or AA | 630 | 13.75 (1.74) | 8.34 (1.83) | 9.74 (1.82) | 11.96 (1.48) | 56.20 (2.88) |
| Bachelor's degree | 427 | 28.59 (2.57) | 11.69 (1.83) | 9.31 (1.71) | 10.28 (1.72) | 40.13 (3.06) |
| Post-graduate studies | 218 | 31.56 (4.02) | 24.13 (3.38) | 9.27 (2.12) | 9.18 (2.83) | 25.86 (3.88) |

Abbreviations: FPL, federal poverty level; AA, associate's degree.
[a] Not black or African American.

**Table 2.** Frequency of Helmet Use Based on Sociodemographic Traits (2014-2016)

| Variable | N | Always (%, SE) | Most of the Time (%, SE) | Some of the Time (%, SE) | Rarely (%, SE) | Never (%, SE) |
|---|---|---|---|---|---|---|
| Overall | 932 | 28.49 (2.71) | 10.54 (1.25) | 6.93 (0.95) | 11.46 (0.74) | 42.59 (3.06) |
| Sex | | | | | | |
| Male | 447 | 25.38 (3.15) | 9.87 (1.44) | 7.10 (1.27) | 11.73 (1.62) | 45.93 (3.72) |
| Female | 485 | 32.17 (3.05) | 11.32 (1.52) | 6.72 (1.53) | 11.14 (1.02) | 38.65 (3.19) |
| Age (mean, SE) | 932 | 47.48 (0.88) | 44.23 (1.02) | 43.29 (2.14) | 40.50 (2.24) | 41.91 (1.15) |
| Race | | | | | | |
| Non-Hispanic white | 803 | 30.04 (2.80) | 10.90 (1.23) | 7.22 (1.05) | 11.76 (0.60) | 40.08 (3.03) |
| Non-Hispanic black or African American | 42 | 25.60 (9.04) | 2.78 (2.78) | 2.81 (2.15) | 8.82 (4.64) | 60.00 (12.26) |
| Hispanic (any race) | 35 | 4.23 (2.47) | 10.37 (5.88) | 8.32 (3.78) | 7.95 (3.29) | 69.13 (6.04) |
| Non-Hispanic other/ or multiracial [a] | 50 | 24.21 (5.80) | 11.46 (4.50) | 4.53 (0.98) | 12.12 (6.12) | 47.68 (8.89) |
| Urban-rural classification | | | | | | |
| Urban | 519 | 34.89 (3.58) | 12.57 (1.54) | 5.67 (1.12) | 11.22 (1.50) | 35.64 (4.26) |
| Suburban | 152 | 30.42 (2.58) | 9.59 (1.63) | 7.59 (2.36) | 9.23 (1.04) | 43.16 (2.53) |
| Rural | 261 | 13.45 (1.80) | 6.63 (1.19) | 9.29 (1.54) | 13.22 (0.87) | 57.42 (1.81) |
| Income level | | | | | | |
| <100% FPL | 78 | 14.67 (3.09) | 5.40 (1.56) | 5.62 (2.67) | 16.79 (4.86) | 57.53 (6.34) |
| 100%-199% FPL | 136 | 16.93 (2.64) | 11.01 (3.51) | 6.22 (0.94) | 12.77 (2.73) | 53.07 (3.82) |
| 200%-299% FPL | 145 | 19.32 (4.12) | 7.55 (2.38) | 8.34 (2.69) | 11.90 (3.82) | 52.90 (5.18) |
| 300%-399% FPL | 115 | 16.81 (3.12) | 11.51 (4.34) | 10.67 (3.22) | 11.63 (3.43) | 49.37 (5.38) |
| 400+% FPL | 423 | 42.87 (2.76) | 12.88 (1.70) | 5.95 (1.01) | 9.03 (1.73) | 29.27 (4.07) |
| Education level | | | | | | |
| High school or less | 189 | 8.91 (1.73) | 8.38 (2.88) | 5.66 (1.74) | 11.98 (2.44) | 65.07 (3.52) |
| Some college or AA | 311 | 20.66 (2.68) | 7.94 (1.97) | 5.95 (1.58) | 11.99 (1.58) | 53.46 (4.03) |
| Bachelor's degree | 272 | 38.25 (3.43) | 13.72 (1.84) | 9.09 (1.73) | 12.96 (1.67) | 25.98 (2.60) |
| Post-graduate studies | 160 | 55.14 (4.33) | 13.48 (2.86) | 6.96 (1.59) | 6.99 (2.22) | 17.44 (2.03) |

Abbreviations: FPL, federal poverty level; AA, associate's degree.
[a] Not black or African American.

ing a helmet (-8.5%; 95% CI, -15.0% to -2.1%).

In fact, the higher the participants' education level, the more likely they were to report always wearing a helmet. In both samples, those with post-graduate education or a bachelor's degree were significantly more likely to report always wearing a helmet than those with a high school education or less or those with some college education or an associate's degree. In the 2014-2016 sample, there were also significant differences between those with a high school education or less and those with some college education or an associate's degree (-11.8%, 95% CI, -18.0% to -5.5%) as well as between those with a bachelor's degree vs post-graduate education (-16.9%; 95% CI, -27.7% to -6.1%), with the higher education level more frequently reporting always wearing a helmet.

## DISCUSSION

Wisconsin has a sizable bicycle-riding population, which our study estimates between 55% and 67% statewide. Historically, Wisconsin also has been ranked one of the most bicycle-friendly states by organizations such as The League of American Bicyclists.[13] However, approximately half of bicycle riders report never wearing a helmet. These factors are influenced by sociodemographic characteristics such as sex, race and ethnicity, urban-rural categorizations, and education level. Because Wisconsin and the United States are both in the midst of an obesity epidemic—over 30% of Wisconsin adults are obese—interventions to increase bicycle ridership should be of interest with regard to public health.[14]

Despite the desirability of increasing bicycle ridership across Wisconsin, an equally important public health issue is the low rate of helmet use. Although the level seems to be decreasing over time, approximately half of the state's bicycle-riding population report never wearing a helmet. Additionally, it is evident that disparities in helmet use frequency exist between different subpopulations. Both of these factors prompt solutions.

One factor that has been shown to influence bicycle helmet usage is the presence of helmet-use legislation. A systematic review from Karkhaneh, et al determined

an odds ratio of 4.60 (95% CI, 2.87-7.36), where helmet usage increases more than 4 times after legislation was put into place.[15] Currently, 21 states, along with the District of Columbia, have some sort of helmet-requirement law in place for minors.[16] These laws require cyclists ranging from 11 years old and younger to 17 years old and younger to wear a helmet while riding a bicycle. However, no states currently have legislation that requires adults to wear a helmet while cycling, and legislation alone does not necessarily increase helmet usage. An important aspect of improving usage rates further is having some sort of enforcement or incentive program in place.[15] For example, a longitudinal study done by Huybers, et al found that after all-age helmet legislation was put into place in Nova Scotia, helmet usage did not improve until police began issuing more tickets to noncompliant cyclists.[17] The new program allowed citizens to forgo a fine or court appearance in exchange for attending an educational program delivered by health professionals, police officers, and injury survivors.

Different enforcement techniques have been developed to improve helmet usage, ranging from fines for nonadherence, to supplying helmets to minors at no cost, or giving incentives for wearing helmets. When designing such legislation and interventions, it is important to remember that sociodemographic characteristics affect helmet usage and to seek equitable solutions that will improve the health for all.[18]

### Study Limitations

One limitation of this study arises from how the rates of bicycle use were defined by the SHOW study and the lack of other information pertinent to bicycle use, such as the purpose (eg, commuting or recreation), frequency of use, and length of trips. Instead, all bicycling activities are categorized similarly, despite the assumption that different activities may predispose certain individuals to greater risks where one may be more or less likely to wear a helmet. For example, those who participate in mountain biking may have different helmet use than those who ride only on roads or bicycle paths, or those who regularly commute via bicycle may have different use than those who rarely ride. Because the inherent risks of bicycling activities may be higher for certain individuals, this lack of other information may limit the effectiveness of any interventions.

Another study limitation is that the sample sizes pertaining to certain demographic groups are small due to a lower rate of overall bicycle ridership, which can make conclusions about them less precise and generalizable. Additionally, survey research can be affected by other biases, such as social desirability bias, recall bias, and differences in survey response rate by certain populations.

## CONCLUSION

The low rates of bicycle ridership and helmet usage throughout Wisconsin are concerning to public health professionals. The findings of this study contribute knowledge specific to population-level demographic characteristics that affect helmet usage and serve as an important first step in reducing bicycle morbidity and mortality through improved helmet usage. Implementing public health initiatives and policy recommendations may help improve rates of bicycling and helmet use; however, such policies must acknowledge the differences between population groups in order to reduce these disparities while also promoting equity.

**Acknowledgements:** Funding for the Survey of the Health of Wisconsin (SHOW) was provided by the Wisconsin Partnership Program PERC Award (233 AAG9971), the National Institutes of Health's Clinical and Translational Science Award (1UL1TR002373) and the National Heart Lung and Blood Institute (1 RC2 HL101468). The authors would also like to thank the University of Wisconsin Survey Center, SHOW administrative, field, and scientific staff, as well as all the SHOW participants for their contributions to this study.

**Funding/Support:** None declared.

**Financial Disclosures:** None declared.

## REFERENCES

**1.** Grabow M, Spak S, Holloway T, Stone B, Mednick A, Patz J. Air quality and exercise-related health benefits from reduced car travel in the midwestern United States. *Environ Health Perspect.* 2012;120(1):68–76. doi:10.1289/ehp.1103440

**2.** Patz JA, Frumkin H, Holloway T, Vimont DJ, Haines A. Climate change: challenges and opportunities for global health. *JAMA*. 2014;312(15):1565-1580. doi:10.1001/jama.2014.13186

**3.** Melo N, Berg RJ, Inaba K. Injuries sustained by bicyclists. *Trauma*. 2014;16(3):183-188. doi:10.1177/1460408614530953

**4.** Thompson MJ, Rivara FP. Bicycle-related injuries. *Am Fam Physician*. 2001;63(10):2007-2014.

**5.** Høye A. Bicycle helmets – To wear or not to wear? A meta-analyses of the effects of bicycle helmets on injuries. *Acc Anal Prev*. 2018;117:85-97. doi:10.1016/j.aap.2018.03.026

**6.** Teschke K, Brubacher JR, Friedman SM, et al. Personal and trip characteristics associated with safety equipment use by injured adult bicyclists: a cross-sectional study. *BMC Public Health.* 2012;12:765. doi:10.1186/1471-2458-12-765

**7.** Bungum TJ, Bungum NW. Predictors of bicycle helmet usage among seniors. *J Community Health.* 2003;28(3):221-228. doi:10.1023/a:1022912408753

8. Chow R, Hollenberg D, Pintilie A, Midroni C, Cumner S. Helmet use of adolescent cyclists at Crescent School in Toronto, Canada. *Int J Adolesc Med Health*. 2016;29(4). doi:10.1515/ijamh-2015-0123

**9.** Cathorall ML, Schulz M, Dingman DA, Pelligra K, Keyworth A. Prevalence and predictors of bicycle helmet use in a southeastern, US city. *Int J Inj Contr Saf Promot.* 2016;23(4):400-404. doi:10.1080/17457300.2015.1047868

**10.** Dagher JH, Costa C, Lamoureux J, de Guise E, Feyz M. Comparative outcomes of traumatic brain injury from biking accidents with or without helmet use. *Can J Neurol Sci*. 2016;43(1):56-64. doi:10.1017/cjn.2015.281

**11.** Nieto FJ, Peppard PE, Engelman CD, et al. The Survey of the Health of Wisconsin (SHOW), a novel infrastructure for population health research: rationale and methods. *BMC Public Health*. 2010;10:785. doi:10.1186/1471-2458-10-785

**12.** Rural-Urban Commuting Area Codes. United States Department of Agriculture Economic Research Service. Published July 3, 2019. Accessed July 31, 2019. https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/.

**13.** Bicycle friendly state report card: Wisconsin. The League of American Bicyclists. Published 2017. Accessed December 17, 2018. https://bikeleague.org/sites/default/files/BFS2017_ReportCard_Wisconsin.pdf

**14.** Overweight & obesity. Centers for Disease Control and Prevention. Published September 12, 2018. Accessed November 18, 2018. https://www.cdc.gov/obesity/data/prevalence-maps.html

**15.** Karkhaneh M, Kalenga JC, Hagel BE, Rowe BH. Effectiveness of bicycle helmet legislation to increase helmet use: a systematic review. *Inj Prev*. 2006;12(2):76-82. doi:10.1136/ip.2005.010942

**16.** Pedestrians and bicyclists. Insurance Institute for Highway Safety. Updated March, 2020. Accessed November 16, 2018. http://www.iihs.org/iihs/topics/laws/bicycle-laws.

**17.** Huybers S, Fenerty L, Kureshi N, et al. Long-term effects of education and legislation enforcement on all-age bicycle helmet use: a longitudinal study. *J Comm Health.* 2017;42(1):83-89. doi:10.1007/s10900-016-0233-3

**18.** Kraemer JD. Helmet laws, helmet use, and bicycle ridership. *J Adolesc Health*. 2016;59(3):338-344. doi:10.1016/j.jadohealth.2016.03.009

# What Do Emergency Department Patients and Their Guests Expect From Their Health Care Provider in an Active Shooter Event?

Kevin Kenney, MD, MPH, MEd; Kevin Nguyen, MD; Erin Konecki, MPH; Corion Jones, MBA; Edward Kakish, DO; Brian Fink, PhD; Paul P. Rega, MD

## ABSTRACT

**Background:** "Run-Hide-Fight" is the summative life-saving mantra taught by governmental and private agencies in active shooter training. Initial research focused on patient expectations of health care provider responses in life-threatening situations suggests patients believe health care providers will take significant action to protect patient well-being. The potential disparity between expectations of the public and health care practitioner training must be examined, as conflict, confusion, and delays may have mortal consequences in active shooter situations.

**Objective:** Public perceptions of the extent of health care practitioners' duties and responsibilities to themselves and their patients during an active shooter event were investigated.

**Methods:** A survey that queried perceived expectations of health care provider response efforts in 4 emergency department patient case scenarios interrupted by an active shooter event was developed and implemented to patients and retinue of the University of Toledo Emergency Department. Responses were grouped into provider-centric or patient-centric actions.

**Results:** One hundred twenty-seven participants responded to the survey and were included in the analysis: 82 patients and 45 guests. In all 4 scenarios, a mean of 87.4% responses was patient-centric. Frequency of patient-centric responses differed significantly by scenario, and women were more likely to have patient-centric expectations.

**Discussion:** The public has significant expectations that the health care provider will assist them during active shooter situations. Providing for the security of the health care provider and patient simultaneously is in conflict with common hospital crisis training. Efforts must be taken to bring patient expectations and provider training into greater alignment.

## INTRODUCTION

Active shooter and mass casualty events have increased in both frequency and severity throughout the United States over the past several decades.[1-3] Unfortunately, this has been accompanied by an associated increase in the number of shootings that occurred in hospital or clinical settings.[2,4,5] Annual rates for active shooter incidents in a hospital setting increased from 9 per year in 2000-2005 to 16.7 per year in 2006-2011, respectively, with a total of 161 lives lost.[1,2] Additionally, there were reports of 154 shootings at American hospitals during 2000-2011, primarily in outdoor areas on hospital campuses, the emergency department (ED), or on inpatient units. One study found that 75% of perpetrators had a prior connection with the individual or multiple individuals that were targeted, and more than a quarter of the events involved a shooter with a grudge as the primary motivation.[6] Other instances were motivated by suicide, assisted suicide of a sick relative, or even prisoner escape, while "ambient society violence or mentally unstable patients were comparatively infrequent."[6] While these events are rare, they are at odds with the general public perception that a hospital setting is one of sanctuary where the risk of external harm is minimized.[2,5]

Health care facilities face unique challenges in the prevention, response to, and management of active shooter situations. The hospital environment serves as a mixing bowl for the local community in which members of diverse socioeconomic strata are interposed in ways otherwise unseen in other settings. Patients

• • •

**Author Affiliations:** Emergency Medicine, University of Toledo Medical Center, Toledo, Ohio (Kenney, Nguyen, Konecki, Jones, Kakish); Department of Population Health, College of Health and Human Sciences, University of Toledo, Toledo, Ohio (Fink, Rega).

**Corresponding Author:** Kevin C. Kenney, MD, University of Toledo Medical Center, Emergency Medicine, Dowling Hall 2455 Mail Stop 1088, 3000 Arlington Ave, Toledo, OH 43614; phone 419.383.6383; email kevin.kenney@utoledo.edu.

and visitors are more vulnerable than the general population.[2,6] Patients exhibit a wide variety of morbidities that may reduce or limit mobility or the ability to follow directions in a crisis. Additionally, patients and visitors disproportionately evidence psychiatric conditions that may predispose them to violent confrontations.[4,7] Health care facilities often have multiple points of ingress, with a wide variety of visitors, adding further difficulty to regulating security.[4,6]

Coordinated efforts in response to these circumstances have resulted in the development and implementation of standardized active shooter guidelines. They present a simplified response system that is implemented across various public health facilities, with the summative catchphrase "Run-Hide-Fight" when confronted with an active shooter situation.[8] No single response fits all active shooter situations, as these situations depend on a variety of factors, including medical state of the patient, number of people in the room, location of the event, proximity to the shooter or a potential exit, and how secure a room can be made. "Although many variables…will ultimately dictate which of the responses should be selected, the first recommendation has been to run."[9] By minimizing exposure to a shooter and only directly engaging with them "as a last resort and if your life is in imminent danger,"[8] this approach necessarily reduces an individual's risk for personal harm. The option to "hide" is reserved for when fleeing the danger area safely is not possible, and electing to "fight" is done only as a last resort when directly confronted by the shooter. Training focuses on quick and appropriate reactions, as delays could mean the difference between life and death. The "Run-Hide-Fight" concept empowers individuals "to protect their own lives,"[8] where the care and protection of others is a secondary priority. Contrary to other settings, there is an inherent ambivalence within the health care profession and unique challenges in health care facilities.[9] This may feel like an abdication of responsibility by some health care providers. Furthermore, patients have trusted their care and wellness to health care providers. Those with limited mobility, who are weak or infirm, or who are otherwise incapacitated have trusted their care to others with an expectation of being brought to wellness when they are at their most vulnerable. They look to health care providers to care for them, even to the point of accepting "very high personal risk."[5,10-14] This is in direct conflict with current institutional protocols.

The objective of this study is to expand on previously reported literature that investigates public consensus of provider obligations, specifically as they pertain to crisis scenarios such as an active shooter event.[5] We investigate perceptions as they relate to 4 common clinical encounters often seen in an emergency medicine setting to which respondents were asked to express their expectation of health care provider responses in a crisis event. These findings may also inform further development and design of mass casualty response efforts.

**Box.** Patient Case Scenarios

Your patient care room is 30 feet from the waiting room and 20 feet from the ambulance entrance.

1) Imagine you are an unaccompanied patient with a severely injured ankle (tripping over a crack in the sidewalk). Your vital signs are completely normal. You have no other medical problems. However, you are in pain (7/10), your ankle is swollen twice its size, and walking from Point A to Point B takes 2 times as long as usual. One health care practitioner is in your room examining your ankle when you both hear and identify gunshots close by, but no one can deduce the exact location of the shooter. What would you expect your health care professional to do?

2) Imagine you are an unaccompanied patient with a foreign body that just flew into your eye on a windy day. Your vital signs are completely normal. Your vision out of one eye is slightly blurred. You have no other medical problems. However, you are in some discomfort (3/10). One health care practitioner is in your room checking visual acuity when you both hear and identify gunshots close by, but no one can deduce the exact location of the shooter. What would you expect your health care professional to do?

3) Imagine you are a parent bringing your 10-year-old child to the ED because of RLQ abdominal pain, fever, and vomiting. His/her vital signs are unremarkable save for a fever of 101.2°F. Your child was able to ambulate, but slowly. He has no other medical problems. One health care practitioner is in your room telling you that the results of the ultrasound indicate your child has an acute appendicitis when you all hear and identify gunshots close by. None of you can deduce the exact location of the shooter. What would you expect your health care professional to do?

4) Imagine you are with a very close relative (parent, spouse, child) who has just been resuscitated from a catastrophic event (cardiac arrest, overdose, stroke, car accident). The patient is comatose, on a ventilator, and multiple medications are being administered to sustain life. You, on the other hand, have no medical impediments. One health care practitioner is in your room telling you that the ICU is ready to receive your loved one when you both hear and identify gunshots close by. Neither of you can deduce the exact location of the shooter. What would you expect your health care professional to do?

Abbreviations: ED, emergency department; RLQ, right lower quadrant; ICU, intensive care unit.

## METHODS

This cross-sectional study was approved by the Biomedical Sciences Institutional Review Board. Lay public opinion was investigated across the University of Toledo Medical Center (Toledo, Ohio) through implementation of a survey instrument involving 4 active shooter scenarios (Box).

### Instrument Design

Four case scenarios were developed, with input from simulation certified educators, that demonstrated diverse clinical triage severity consistent with commonly encountered emergency department diagnoses. The cases were developed to emphasize the patient's ability or inability to assist with or even impede response efforts. Each scenario required the survey participant to assume the role of a patient or guest during which the participant (1) had a severely injured ankle, (2) incurred a foreign body to the eye, (3) was accompanying their 10-year-old child with appendicitis, or (4) accompanying a close relative with recently resuscitated status post catastrophic event. The setting of the scenarios was an exam

**Table 1.** Demographic Characteristics of Survey Participants

| | N | % |
|---|---|---|
| Sex | | |
| Female | 79 | 62.2 |
| Male | 48 | 37.8 |
| Race | | |
| White | 80 | 63.0 |
| African-American | 36 | 28.3 |
| Hispanic | 5 | 3.9 |
| Asian | 1 | 0.8 |
| Arab-American | 2 | 1.6 |
| Mixed | 2 | 1.6 |
| Other | 1 | 0.8 |
| Marital status | | |
| Single/never married | 51 | 40.2 |
| Married | 50 | 39.4 |
| Divorced | 15 | 11.8 |
| Widowed | 9 | 7.1 |
| Separated | 1 | 0.8 |
| Divorced/Widowed | 1 | 0.8 |
| Highest completed education level | | |
| Professional or doctoral | 2 | 1.6 |
| Master's degree | 5 | 3.9 |
| Bachelor's degree | 28 | 22.0 |
| Associate's degree | 8 | 6.3 |
| High school | 74 | 58.3 |
| Elementary or junior high | 10 | 7.9 |
| Household yearly income | | |
| Less than $20,000 | 41 | 32.3 |
| $20,000-$34,999 | 34 | 26.8 |
| $35,000-$49,999 | 21 | 16.4 |
| $50,000-$74,999 | 11 | 8.7 |
| $75,000-$99,999 | 11 | 8.7 |
| Over $100,000 | 8 | 6.3 |
| Missing | 1 | 0.8 |
| Hospital role | | |
| Patient | 82 | 64.6 |
| Family | 35 | 27.5 |
| Friend | 5 | 3.9 |
| Other | 2 | 1.6 |
| Missing | 3 | 2.4 |
| Active/former military | | |
| Yes | 6 | 4.7 |
| No | 121 | 95.3 |
| Ever victim of targeted violence? | | |
| Yes | 18 | 14.2 |
| No | 109 | 85.8 |
| Ever received training in active shooter defense? | | |
| Yes | 12 | 9.4 |
| No | 115 | 90.6 |
| | **Mean** | **Range** |
| Age (years) | 46.85 | 21-87 |

room in the emergency department (ED), with the health care provider in the room with the subject. Within each scenario, the location of the shooter was left deliberately ambiguous to reflect the uncertainty and multiple factors to consider. Clinical case scenarios varied in criticality from levels 1 to 5 on the Emergency Severity Index, emphasizing degree of patient ability to assist with or impede response efforts.[15,16]

There were 4 responses to each scenario, with the optional opportunity to select "other" if none of the responses reflected participants' expectations. The 4 responses were further categorized as either provider-centric or patient-centric actions. Provider-centric responses collectively described answers in which the provider elects to escape alone, either immediately or after initially giving some instruction to the patient on how to protect themselves while remaining alone in the room. Patient-centric responses were those in which the health care provider either escapes alongside or remains in the room with the patient.

The resulting questionnaire surveyed perceived clinician responsibilities in these crisis scenarios, as well as collecting patient demographic data. Demographic information included age, sex, race, marital status, highest level of education, annual household income, military status, past history of targeted violence, and past history of active shooter defense training. Responses to the aforementioned clinical scenarios included options for the clinician to escape without the patient, escape after conferring with the patient, escape alongside the patient, or to remain with the patient and barricade the room in anticipation of a confrontation.

In accordance with our best research practices, we attempt to utilize previously established and externally validated survey instruments when possible; however, this instance represents a situation in which novel investigation required the design of our own patient assessment tool. In adherence to research principles outlined in McColl et al, the design and creation of this instrument addresses all of the specific areas of study.[17]

### Survey Implementation

Survey administrators received consistent training in wording and explanation of instrument questions. Questionnaires were distributed to a convenience sample of patients and accompanying guests who consented during a clinical encounter in the ED of a Level I Trauma Center at an academic hospital, the University of Toledo Medical Center. Responders were 18 years old or older, spoke and read English, and agreed to participate. (Data were not collected on how many individuals declined to participate.) Responders were deemed appropriate candidates by the objective clinical team and were physically and mentally fit to answer questions. In addition to electing not to participate, exclusion criteria included those for whom English was not a native or proficient language as determined by patient self-identification, those with high acuity triage status (level 1 and 2), or those who were determined too unwell by their health care provider. Survey responses were deidentified for analysis to ensure patient anonymity. Participation had no influence upon quality of medical care received.

Survey administrators read questionnaires to respondents, who were instructed that the term "health care provider" (HCP) had broad application and included physicians, physician assistants (PA), nurse practitioners (NP), and nurses. With each scenario,

participants were provided with the HCP's possible response options and asked to select which option they expected the HCP to choose. If necessary, the term "expect" was differentiated from "hope" or "would like." Respondents also were provided space to add free text comments as needed.

**Table 2.** Responses to Active Shooter Case Scenarios

| Response | Sprained Ankle N | Sprained Ankle % | Ocular Foreign Body N | Ocular Foreign Body % | Child With Appendicitis N | Child With Appendicitis % | Family Member in Coma N | Family Member in Coma % |
|---|---|---|---|---|---|---|---|---|
| Escape and leave you to your own devices | 3 | 2.4 | 1 | 0.8 | 1 | 0.8 | 2 | 1.6 |
| Escape but tell you what you should do to protect yourself in the room | 8 | 6.3 | 6 | 4.7 | 9 | 7.1 | 14 | 11.0 |
| Escape with you | 63 | 49.6 | 84 | 66.1 | 59 | 46.5 | 21 | 16.5 |
| Barricade the room with both inside and prepare to fight | 50 | 39.4 | 34 | 26.8 | 51 | 40.2 | 82 | 64.6 |
| Other | 3 | 2.4 | 2 | 1.6 | 6 | 4.7 | 7 | 5.5 |
| Missing | | | | | 1 | 0.8 | 1 | 0.8 |
| **Total** | 127 | 100 | 127 | 100 | 127 | 100 | 127 | 100 |

### Analysis

Convenience sampling was utilized to construct total patient cohort. The division into patient-centric and provider-centric categories was done to facilitate the binomial analysis of the nominal data. The primary outcomes measured were frequencies of selected responses. Secondary outcomes were correlations with responses by population subsets. SPSS was used to conduct a cross-tab analysis with chi-square values, as well as a nonparametric binomial test.

## RESULTS

This analysis consists of 127 complete responses representing all individuals surveyed, of which 82 (64.6%) were patients and 45 (35.34%) were guests (Table 1). The respondents ranged in age from 18 to 88 years (mean = 46.14), with an approximate 2:1 female to male distribution. In each of the 4 patient case scenarios (Box), at least 86.6% of respondents expected the health care provider to have a patient-centric response to an active shooter in their facility (range: 86.6%-94.4%, catastrophic scenario vs ocular foreign body scenario, respectively). Statistically significant differences were observed between provider-centric and patient-centric answer choices for all scenarios ($P < 0.1$). In scenario 1, in which subjects imagined having a severely injured ankle and slow mobility, 91.3% (n = 116) expected their health care provider to make a patient-centric response. Scenario 2 described an ocular foreign body obscuring the subject's vision; 94.4% (n = 118) expected a patient-centric response. In scenario 3, in which the subject was not the patient but instead was with a child with appendicitis associated with abdominal pain, 91.7% (n = 110) expected their health care provider to take a patient-centric response. In the 4th scenario, the subject was in the room with a family member who had a catastrophic injury and was on a ventilator. The expectation of a patient-centric response was lowest for this scenario (86.6%, n = 103).

These differences were further supported by analyses within patient-centric responses. Escape with the patient was selected more frequently in scenario 2 (ocular foreign body) and least in scenario 4 (catastrophic). This pattern was inverted for respondents, selecting more commonly instead barricading the room with the patient in scenario 4.

Significant gender differences in responses to patient-centric clinician expectations were seen in scenario 3: Child with appendicitis, where female respondents were more likely to select patient-centric answers ($\chi^2 = 5.022$, d.f. = 1, $P = 0.022$).

The breakdown of responses to each patient case scenario is reported in Table 2.

## DISCUSSION

The analysis of the survey responses suggests that of the subjects interviewed, there was an overwhelmingly and statistically significant expectation that health care providers would respond to an active shooter situation with a patient-centric response, taking deliberate steps to protect their patient.

This study further substantiates and expands upon results previously presented in the literature in which the public has an expectation of ensured safety during such crises.[5] Collaboration through the American College of Surgeons has established the Hartford Consensus, a result of the Joint Committee to Create a National Policy to Increase Survivability in Intentional Mass Casualty and Active Shooter Events.[5,10-14] Their findings reported that respondents believe the health care provider's responsibility constitutes a special duty to protect the public, similar to police officers and firefighters.[5] Our findings are in agreement with those identified in the Hartford Consensus and are able to further contextualize which, if any, variables may affect perceived clinician obligations. Administering this study in an ED added a certain sense of immediacy and urgency to participants' responses, while the case scenarios added texture, specificity, and granularity lacking in previous research and enhanced by these results.

In each of the 4 scenarios presented, the clinician is with the patient and any friends, family, or other visitors in a typical ED exam room. The shooter's location is intentionally ambiguous. There is no stipulation in current literature suggesting certain actions are more appropriate in certain locations. This is by design, as every situation is unique and generalized protocols allow for flexibility. For instance, in the Federal Emergency

Management Agency educational program IS-907,[8] there is no well-defined exclusion criteria for when to take one action over another.

Authors previously have suggested alternative paradigms to "Run-Hide-Fight" in mass casualty events, as hospital environments may be uniquely suited to fail implementation of this protocol.[9] Their counsel advises that a new paradigm be instituted in certain parts of the hospital where patients are at their most vulnerable (eg, surgery, intensive care unit, emergency department). In those areas, the "Run-Hide-Fight" paradigm may not be a viable option, and the more patient-centric approach of "Secure-Preserve-Fight" would be more consistent with health care providers' moral and ethical precepts.[4,9] Both our research and the Jacobs' survey validate Inaba's and McSwain's treatise that when caring for vulnerable patients, alternative guidelines should be a topic for a frank and open discussion between provider and administration.[5,9]

There is conflict between what typical active shooter training suggests is appropriate action (specifically, Run-Hide-Fight), what clinicians feel is appropriate, and what patients expect. This conflict increases the risk for confusion in an already dire situation wherein rapid decision-making and action is required to prevent injury and loss of life.

Change that recognizes the unique needs, vulnerabilities, and conflicts inherent in health care facilities is necessary. Safety guidelines and teaching response protocols should incorporate the unique challenges facing clinicians and their patients, while recognizing the limitations of typical standardized protocols for public spaces. A clear and deliberate appreciation of patient expectations also must be taken into consideration, without which there is an increased risk for harm in mass casualty events. This also will reduce potential psychological trauma experienced by health care providers torn between self-preservation and obligations to their patients. Hospital administrators should conduct frequent Hazard and Vulnerability Assessments, guided by recommendations from the Department of Homeland Security.[18] These steps, in conjunction with a more patient-centered frame of mind, will help craft more meaningful policy that will better protect patients and health care providers alike.

Future studies are recommended to further investigate health care providers and their perceptions of their role during a crisis situation, such as an active shooter scenario. An initial survey study[19] was conducted with a multidisciplinary group of health care students (N=245). Most students surveyed preferred "patient-centric" actions to "provider-centric" actions (range: 66%-94% and 4%-17%, respectively). An additional opportunity for research is to survey hospital security sites and investigate what actions they will take during an active shooter scenario. However, it is worth noting that some training protocols, such as ALICE training,[20] suggest that in an active shooter scenario, security will be primarily directed towards neutralizing the perpetrator. Assistance to others will be delayed until the perpetrator is neutralized.

### Limitations

This study is limited by the small size of the study population, which was constructed by convenience sampling. This allowed researchers to conduct the survey when ED resources were at their maximum, thereby minimizing any adverse impact on any logistical issues relative to the department. And while a convenience sample may introduce bias, the difference in percentage between the patient-centric and provider-centric responses was large enough that the authors thought enlisting additional subjects would not change the significance of the data.

Those who consented to participate were present only when surveyors were available to conduct research. However, the study sampling was conducted during both day and night shifts at all hours to reflect the usual patient influx during each time period.

As this sample was not randomly selected and was constructed from a regional medical center, there may be demographic variability that limits generalization to the wider public. For instance, the convenience sample did not reflect the desired sex and racial diversity of the population at-large. Some demographic variables were included, and their influence could be investigated further. Additional studies also could include wider recruitment of subjects. However, using this population in the ED setting shifted the results from the theoretical category to more concrete, and provided more gravitas to the results.

Further research is advisable to determine whether the results and attitudes are similar in other hospitals in other parts of the nation. Additionally, while survey administrators received training in consistent language to use during patient encounters in an effort to maintain standardization, it is possible distortions could have occurred. To address this matter, efforts to further validate the survey instrument are underway

## CONCLUSIONS

The general public has an expectation that health care providers will take steps to ensure patient and guest safety in the event of an active shooter situation. This remains at odds with the central tenet of active shooter training. "Run-Hide-Fight" may not apply adequately in health care facilities where the sick or infirm have placed trust in their clinical provider team and are uniquely vulnerable.[9]

The public's perception of a health care provider's duty in these extraordinary circumstances, coupled with the clinicians' ethical conundrum, support the importance of continued development of health care-specific training for active shooter scenarios and exploration of alternative protocols, with "Secure-Preserve-Fight" as a possible answer. The difference between the 2 protocols is significant. In "Run-Hide-Fight," for instance, the top priority is exiting the danger area, and other issues including patient safety become secondary. With "Secure-Preserve-Fight," the focus is on the health care provider-patient dyad, working to make the area they are in "secure." Clinicians, including phy-

sicians, nurses, physician assistants, and nurse practitioners, in conjunction with hospital administrators, should strive for better educational resources and develop improved strategies specific to their own institution to ensure the safety of both health care providers and their patients.

The issues we present cross multiple boundaries: medical, ethical, moral, psychological, and legal. Without further investigation and development of safety protocols unique to a health care setting that also takes into account complicating elements such as conflict between provider training and patient expectations, there will continue to be an elevated risk for confusion and potentially mortal harm to both health care providers and the patients in their care.

**Funding Support:** None declared.

**Financial Disclosures:** None declared.

## REFERENCES

**1.** Blair JP, Schweit KW. *A Study of Active Shooter Incidents in the United States, 2000-2013.* Texas State University and Federal Bureau of Investigation; 2014. Accessed January 9, 2019. https://www.fbi.gov/file-repository/active-shooter-study-2000-2013-1.pdf/view

**2.** Adashi EY, Gao H, Cohen IG. Hospital-based active shooter incidents: sanctuary under fire. *JAMA*. 2015;313(12):1209-1210. doi:10.1001/jama.2015.1733

**3.** *Active Shooter Incidents in the United States in 2018*. Federal Bureau of Investigation; 2019. Accessed April 20, 2019. https://www.fbi.gov/file-repository/active-shooter-incidents-in-the-us-2018-041019.pdf/view

**4.** Phillips JP. Workplace violence against health care workers in the United States. *N Engl J Med*. 2016;375(7):e14. doi:10.1056/NEJMc1606816

**5.** Jacobs LM, Burns KJ. The Hartford Consensus: survey of the public and healthcare professionals on active shooter events in hospitals. *J Am Coll Surg.* 2017; S1072-7515(17)30591-4. doi:10.1016/j.jamcollsurg.2017.06.009

**6.** Kelen GD, Catlett CL, Kubit JG, Hsieh Y-H. Hospital-based shootings in the United States: 2000 to 2011. *Ann Emerg Med.* 2012;60(6):790-798.e1. doi:10.1016/j.annemergmed.2012.08.012

**7.** Sanello A, Gausche-Hill M, Mulkerin W, et al. Altered mental status: current evidence-based recommendations for prehospital care. *West J Emerg Med.* 2018;19(3):527-541. doi:10.5811/westjem.2018.1.36559

**8.** Federal Emergency Management Agency. IS-0907 - Active shooter: what you can do. FEMA web-based course. December 28, 2015. Accessed January 1, 2020. https://training.fema.gov/is/courseoverview.aspx?code=IS-907

**9.** Inaba K, Eastman AL, Jacobs LM, Mattox KL. Active-shooter response at a health care facility. *N Engl J Med*. 2018;379(6):583-586. doi:10.1056/NEJMms1800582

**10.** Jacobs L. Strategies to enhance survival in active shooter and intentional mass casualty events. *Bull Am Coll Surg*. 2015;100(1 Suppl):16-17.

**11.** Jacobs LM. The Hartford Consensus III: implementation of bleeding control: if you see something do something. *Bull Am Coll Surg*. 2015;100(1 Suppl):40-46.

**12.** Jacobs LM Jr; Joint Committee to Create a National Policy to Enhance Survivability From Intentional Mass Casualty Shooting Events. The Hartford Consensus IV: a call for increased national resilience. *Conn Med.* 2016;80(4):239-244.

**13.** Jacobs LM, McSwain NE Jr, Rotondo MF, et al. Improving survival from active shooter events: the Hartford Consensus. *J Trauma Acute Care Surg*. 2013;74(6):1399-1400. doi:10.1097/TA.0b013e318296b237

**14.** Jacobs LM, Rotondo M, McSwain N, et al; Joint Committee to Create a National Policy to Enhance Survivability from Mass-Casualty Shooting Events. Active shooter and intentional mass-casualty events: the Hartford Consensus II. *Bull Am Coll Surg.* 2013;98(9):18-22.

**15.** Tanabe P, Gimbel R, Yarnold PR, Adams JG. The Emergency Severity Index (version 3) 5-level triage system scores predict ED resource consumption. *J Emerg Nurs.* 2004;30(1):22-29. doi:10.1016/j.jen.2003.11.004

**16.** González J, Soltero R. Emergency Severity Index (ESI) triage algorithm: trends after implementation in the emergency department. *Bol Asoc Med P R.* 2009;101(3):7-10.

**17.** McColl E, Jacoby A, Thomas L, et al. Design and use of questionnaires: a review of best practice applicable to surveys of health service staff and patients. *Health Technol Assess.* 2001;5(31):1-256. doi:10.3310/hta5310

**18.** Office of the Assistant Secretary for Preparedness and Response. *Incorporating Active Shooter Incident Planning Into Health Care Facility Emergency Operations Plans.* US Department of Health and Human Services; November 2014. Accessed March 4, 2019. https://www.phe.gov/Preparedness/planning/Documents/active-shooter-planning-eop2014.pdf

**19.** McKenzie N, Wishner C, Sexton M, Saevig D, Fink B, Rega P. Active shooter: what would health care students do while caring for their patients? Run? Hide? Or fight? *Disaster Med Pub Health Prep*. 2019:1-5. doi:10.1017/dmp.2019.67

**20.** ALICE Training. Navigate 360. Accessed May 11, 2020. https://www.alicetraining.com/about-us/

# Prescribed Opioid Use in Wisconsin 2008-2016: Findings From the Survey of the Health of Wisconsin

Tanvee Thakur, PhD, BPharm; Jodi H. Barnet, MS; Tamara LeCaire, MS, PhD; Andrew Bersch, MS; Paul Peppard, MS, PhD; Kristen Malecki, PhD, MPH; D. Paul Moberg, PhD

## ABSTRACT

**Background:** The opioid epidemic is a national crisis. The objectives of this report were to describe prescription opioid use in Wisconsin from 2008 through 2016 using unique population-representative data and to assess which demographic, health, and behavioral health characteristics were related to past 30-day prescribed opioid use.

**Methods:** Data were obtained from the Survey of the Health of Wisconsin (SHOW), a statewide representative sample of 4,487 adults. Prescription medication use was ascertained via in-person interviews that included an inventory of all prescription medications used by the respondent in the past 30 days. The data were weighted to represent the adult population of Wisconsin, aged 21 to 74. Chi-square, logistic regression, and descriptive statistics were used to analyze data.

**Results:** From 2008 to 2016, 6.4% (95% CI, 5.5-7.3) of adults age 21 years or older reported using a prescribed opioid in the past 30 days. Hydrocodone was the most prescribed opioid class followed by oxycodone. People 50 years of age and older, self-identified black or Hispanic, urban dwellers, those with a high school education or less, and those having incomes below 200% of the federal poverty level (FPL) reported significantly higher rates of prescribed opioid use relative to others. Participants reporting physician-diagnosed drug or alcohol abuse, current smokers, and those currently suffering from depression also reported significantly higher use.

**Conclusion:** These data from 2008-2016 demonstrate concerning levels of prescription opioid use and provide data on which population groups may be most vulnerable. While policies and clinical practice have changed since 2016, ongoing evaluation of prescribing practices, including consideration of behavioral health issues when prescribing opioids, is called for.

• • •

**Author Affiliations:** University of Wisconsin-Madison School of Pharmacy, Madison, Wis (Thakur); Survey of the Health of Wisconsin, University of Wisconsin School of Medicine and Public Health, Madison, Wis (UW SMPH) (Barnet, LeCaire, Bersch, Malecki); Population Health Sciences, UW SMPH, Madison, Wis (Peppard, Malecki); Population Health Institute, UW SMPH, Madison, Wis (Moberg).

**Corresponding Author:** D. Paul Moberg, PhD, Research Professor and Senior Scientist, University of Wisconsin Population Health Institute, 610 Walnut St, 885 WARF Building, Madison, WI 53726; phone 608.263.1304; email dpmoberg@wisc.edu; ORCID ID 0000-0002-7475-7909.

## INTRODUCTION

Opioids are a class of drugs that include the illegal drug heroin, synthetic opioids such as fentanyl, and pain relievers available legally by prescription, such as oxycodone (OxyContin), hydrocodone (Vicodin), codeine, morphine, and many others.[1] Opioids interact with nerve cells to relieve pain; prescription opioids are used to treat moderate to severe pain. They also produce pleasurable effects and are associated with serious risks of addiction, abuse, and overdose.[2] Opioid medications are subsequently prone to misuse, that is, taken in a manner or dose other than prescribed; used by other than the person being prescribed, even if for a legitimate medical complaint such as pain; or taken to feel euphoria (ie, to get high).[2] Roughly 21% to 29% of patients prescribed opioids for chronic pain misuse them, with 8% to 12% developing an opioid use disorder.[3]

Every day, on average, 130 people in the United States die after overdose on opioids, and more than 46 people die from an overdose of prescription opioids.[4] The Midwest, and specifically Wisconsin, is at increased risk. In Wisconsin, the rate of opioid use disorder more than tripled during 2005 to 2016.[4] The Midwestern region as a whole more recently experienced a 70% increase in opioid overdose cases from July 2016 through September 2017.[3] The death rate in Wisconsin attributed to opioid overdose has also been higher than the US overall; in 2016, 15.8 deaths per 100,000 persons occurred in Wisconsin compared to 13.3 deaths per 100,000 nationally.[4]

Wisconsin providers wrote 69.1 opioid prescriptions per 100

persons (4 million prescriptions) in 2015,[4] similar to the average US rate of 70 opioid prescriptions per 100 persons.[5] Opioid prescribing in Wisconsin has been reduced since 2016 (the last year of data in this study). The number of opiate prescriptions reported to the Prescription Drug Monitoring Program (PDMP) in 2019 declined by 13.7 % since 2016.[6]

While the rate of prescriptions and number of pills per prescription have declined, patients continue to head home daily from hospitals and clinics furnished with opioid pain prescriptions. After they have recovered from their procedures and no longer need opioid-based pain relief, roughly 70% of people hold on to their unused medication. The percentage of stockpiling rises to 86% for older adults.[7] In Wisconsin, as many as 33% of all households may have unused opiates on hand.[8] These unused pills are a primary source of diversion for nonmedical use and are a major source of prescription opioid abuse fueling the crisis of opioid addiction in the United States.[9,10] Thus, in addition to potential harm to the individual patient, there is risk for prescribed opioids being diverted and misused.

### Specific Aims/Objectives

The statewide representative Survey of the Health of Wisconsin (SHOW), which included data on prescription drug use, allowed an analysis estimating population-level prescribed opioid use and an examination of the characteristics of those who used these medications. Specifically, we (1) describe prescription opioid use in Wisconsin adults aged 21 to 74 during 2008-2016; and (2) assess which demographic, health, and behavioral health characteristics were related to past 30-day prescribed opioid use.

## METHODS

### Study Design

SHOW was funded beginning in 2006 by the Wisconsin Partnership Program to establish an infrastructure for annual statewide surveys to monitor the health and health determinants of Wisconsin residents.[11] A probability-based sampling approach is used to randomly select households and gather data on a wide variety of health conditions and exposures, as well as on health care access and utilization. SHOW includes an in-home interview, physical exam, and biospecimen collection. The program is modeled after the National Health and Nutrition Examination Survey (NHANES), which has provided key information on the nation's health for over 40 years. With the launch of SHOW, Wisconsin became the first state to monitor the health of its residents with an ongoing examination survey of this magnitude.

Details on SHOW's study design have been published previously.[11] In brief, survey participants are selected from a random sample of households using a probability-based cluster sampling approach. From the household sampling frame, addresses are selected using simple random sampling. Recruitment of SHOW participants begins with in-person contact by study staff at the selected household address.[11] An effort is made during the recruitment process to enumerate all household members, and screen and enroll noninstitutionalized adults where the selected household was their place of residence for more than 6 months during that calendar year and who are mentally capable of informed consent and being interviewed.[11] There is no requirement that all eligible members of the household participate. Data collection continues throughout the year.

Data collection is divided into 3 major components: a private in-home interview, a self-administered questionnaire, and a mobile exam center or fixed clinic visit that includes biospecimen collection. SHOW enrolled participants aged 21 to 74 years in 2008-2013; beginning in 2014, adults aged 18 years or older were invited to participate. For comparability over time, the analyses here have been restricted to adults ages 21 to 74 years. All data collection protocols are approved by the University of Wisconsin Health Sciences Institutional Review Board (IRB ID# 2013-0251).

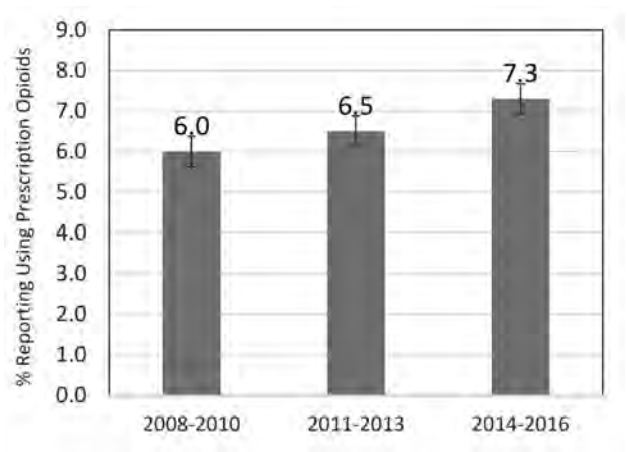
### Survey Topics and Reporting

Topics covered in the surveys include demographics, such as age, sex, race, body mass index (BMI), education, employment status, poverty level, and geographical area, as well as information on health and health history, mental health, health care, health

**Table 1.** Three-Year Groupings of Overall Reported Use of Prescription Opioids in the Past 30 Days

| | | Opioid Use | | |
|---|---|---|---|---|
| | N all | n | % | 95% CI |
| Overall | 4487 | 321 | 6.4 | 5.5-7.3 |
| 2008-2010 | 1368 | 89 | 6.0 | 4.6-7.4 |
| 2011-2013 | 1591 | 115 | 6.5 | 5.0-8.0 |
| 2014-2016 | 1528 | 117 | 7.3 | 5.7-8.8 |

**Figure.** Prescribed Opioid Usage Within the Past 30 Days as Reported in the Survey of the Health of Wisconsin (SHOW)




*Total n= 4487, data weighted to reflect Wisconsin population ages 21 to 74. Differences between time periods were not significant at $P<.05$.

**Table 2.** Specific Opioid Use Within the Past 30 Days by 3-Year Groupings

| Type of Opioid | 2008-2010 % (95% CI) n=1368 | 2011-2013 % (95% CI) n=1591 | 2014-2016 % (95% CI) n=1528 | Overall % (95% CI) N=4487 |
|---|---|---|---|---|
| Hydrocodone/ acetaminophen | 2.19 (1.30–3.09) | 2.59 (1.58–3.59) | 3.40 (2.33–4.48) | 2.55 (1.96–3.14) |
| Oxycodone | 1.11 (0.41–1.81) | 1.81 (1.00–2.61) | 1.69 (1.25–2.12) | 1.49 (0.87–1.86) |
| Hydrocodone | 1.59 (0.67–2.51) | 1.27 (0.57–1.97) | 1.01 (0.60–1.43) | 1.37 (0.87–1.86) |
| Oxycodone/ acetaminophen | 0.31 (0.00–0.66) | 0.54 (0.17–0.91) | 0.71 (0.05–1.38) | 0.47 (0.23–0.71) |
| Propoxyphene [a] | 0.53 (0.19–0.87) | - | - | 0.23 (0.08–0.37) |
| Acetaminophen/ codeine | 0.41 (0.03–0.78) | 0.54 (0.13–0.95) | 0.32 (0.07–0.57) | 0.45 (0.21–0.37) |
| Morphine sulphate | 0.28 (0.00–0.62) | 0.12 (0.00–0.26) | 0.28 (0.05–0.51) | 0.21 (0.05–0.37) |
| Fentanyl | 0.05 (0.00–0.15) | 0.17 (0.00–0.36) | 0.19 (0.00–0.39) | 0.12 (0.02–0.22) |
| Others [b] | 0.21 (0.04–0.37) | 0.24 (0.00–0.47) | 0.48 (0.23–0.73) | 0.26 (0.13–0.39) |

[a] Propoxyphene was banned from market in 2010 by the FDA.
[b] "Others" were reported by fewer than 5 participants over the entire time period and included acetaminophen/propoxyphene, aspirin/butalbital/caffeine/codeine, cheratussin AC, codeine, codeine/phomethazine, hydrocodone/ibuprofen, hydromorphone, and norco.

insurance, behavioral health, and other economic and social determinants. Geographical area divisions followed the health regions defined by the Wisconsin Department of Health Services for data analysis.[12] For data regarding opioid medication use, participants were asked to show all bottles of their prescription medications they personally used in the past 30 days. The interviewer recorded verbatim the names of these medications and reviewed the list with the participant. Participants also were asked to recall any prescription medications taken within the past 30 days for which they no longer had the bottle; these also were recorded. The interviews did not collect data on the use of illicit drugs (including diverted prescribed opioids). For purposes of this analysis, the complete free-text list of all prescription medications recorded by interviewers was reviewed by a pharmacist with training in health services research. Medications that could be classified as opioids were identified. The National Library of Medicine's RxNorm system data for opioid or opioid-containing medications was reviewed and a listing of RxCUI (RxNorm Concept Unique Identifier) codes for opioid-containing medications was determined by the pharmacist. Medication names were matched to the specific RxCUI codes for opioid medications. Based on these data, each participant was coded as having used or not used prescribed opioids in the past 30 days.[13]

### Analysis

All analyses were conducted in SAS® 9.4.[14] The descriptive data were analyzed by cross-tabulation; chi-square and logistic regression were used to determine significance in differences of opioid use. All calculations were weighted to represent the population of Wisconsin and to adjust for spatial clustering and survey design-based factors.[11] Raw numbers of cases are reported in the tables, with weighted percentages. To smooth out year-to-year variation in sampling, 3-year intervals (2008-2010, 2011-2013, 2014-2016) were used for comparison over time. Differences in reported frequency of opioid use between the 3 time periods were assessed using chi-square statistics. Data also were analyzed for time by personal characteristic interactions using logistic regression.

Multivariate logistic regression modeling of opioid use by rural/urban classification was conducted with adjustments for demographic characteristics (sex, age, race), socioeconomic factors (education, poverty level), reported drug abuse, reported alcohol abuse, and health region. Interactions between rural/urban classification and the other model parameters were investigated.

## RESULTS

Across all 9 years, 6.4% (95% CI, 5.5-7.3) of participants reported using a prescribed opioid in the past 30 days. Opioids were used by 6.0% (95% CI, 4.6-7.4) of individuals in 2008-2010 and by 7.3% (95% CI, 5.7-8.8) in 2014-2016 (Table 1). Differences over time in the percentage of people reporting use of prescription opioids in the past 30 days were not significant ($P = 0.29$) when the 3 separate time intervals were compared (Figure).

Hydrocodone/acetaminophen was the most reported opioid medication across time, followed by oxycodone, hydrocodone, and oxycodone/acetaminophen (Table 2).

We examined opioid use by a number of participant characteristics. Except for sex, there was a significant ($P < 0.05$) relationship of opioid use in each of the characteristics examined in Table 3. These variables were also examined for interaction with time to assess whether there were shifting patterns in the relationship between individual characteristics and rates of opioid use. The only significant interaction found was health region by time, with increased use in the Northern Region over this time period.

The mean age for people who reported opioid use (mean = 48.1 years, SD = 0.9 years) was higher than that of the overall sample (mean = 45.8 years, SD = 0.4 years). Prescription opioid use was significantly higher in people ages 50 and above relative to younger age groups. Married individuals had the lowest rate. People with higher BMIs (30+) reported higher rates of opioid use (9.0%) compared to those with BMIs < 30 (4.6%).

A significantly higher rate of prescription opioid use was reported by individuals self-reporting as black (11.5%) or Hispanic (9.8%) compared to white individuals (5.8%). People belonging to other races (8.8%) also showed significantly higher rates of prescribed opioid use.

People with higher education (bachelors or graduate degree)

**Table 3.** Characteristics Associated with Prescribed Opioid Use in the Past 30 Days

| | | | Opioid Use – Yes [a] | | | | |
|---|---|---|---|---|---|---|---|
| **Characteristic** | **Level** | **N all** | **n** | **%** | **LCL** | **UCL** | ***P* value < 0.05** |
| Overall | Overall | 4487 | 321 | 6.4 | 5.5 | 7.3 | |
| Sex | Male | 1956 | 135 | 6.4 | 4.9 | 7.9 | |
| | Female | 2531 | 186 | 6.4 | 5.2 | 7.6 | |
| Age (years) | 21-49 | 2214 | 133 | 5.4 | 4.3 | 6.6 | * |
| | 50-74 | 2273 | 188 | 7.7 | 6.3 | 9.1 | |
| Body Mass Index (kg/m^2) | <=29 | 2626 | 143 | 4.6 | 3.6 | 5.6 | * |
| | 30+ | 1802 | 169 | 9.0 | 7.1 | 11.0 | |
| Racial and Hispanic status | White (non-Hispanic) | 3863 | 255 | 5.8 | 4.9 | 6.8 | * |
| | Black (Hispanic, non-Hispanic) | 235 | 28 | 11.5 | 6.6 | 16.3 | |
| | Hispanic (not black) | 138 | 12 | 9.8 | 3.1 | 16.4 | |
| | Other (none of the above) | 251 | 26 | 8.8 | 3.9 | 13.7 | |
| Marital status | Single/never married | 721 | 52 | 6.1 | 4.2 | 7.9 | * |
| | Married/living with partner | 3048 | 182 | 5.4 | 4.4 | 6.4 | |
| | Widowed | 156 | 18 | 10.0 | 3.7 | 16.3 | |
| | Divorced/separated | 557 | 69 | 12.5 | 8.7 | 16.2 | |
| Education level | High school or less | 1182 | 115 | 8.7 | 6.6 | 10.8 | * |
| | Some college or associate degree | 1708 | 143 | 7.4 | 5.7 | 9.0 | |
| | Bachelor's degree or more | 1595 | 63 | 3.6 | 2.1 | 5.2 | |
| Smoking status | Current | 774 | 101 | 11.9 | 8.9 | 14.9 | * |
| | Former | 1216 | 100 | 7.3 | 5.5 | 9.0 | |
| | Never | 2424 | 112 | 4.1 | 3.1 | 5.1 | |
| Employment status | Employed | 2955 | 146 | 4.8 | 3.8 | 5.7 | * |
| | Not employed, looking for work | 270 | 20 | 6.5 | 2.8 | 10.1 | |
| | Not employed, not looking for work | 1248 | 152 | 11.3 | 9.0 | 13.7 | |
| 200% poverty level | Below | 1212 | 141 | 10.2 | 8.1 | 12.3 | * |
| | Above | 3102 | 167 | 4.9 | 3.9 | 5.8 | |
| Any health insurance in the past 12 months | No | 302 | 25 | 6.9 | 3.7 | 10.1 | |
| | Yes | 4175 | 296 | 6.4 | 5.4 | 7.4 | |
| Rural/urban classification | Urban | 2298 | 183 | 7.5 | 6.1 | 9.0 | * |
| | Suburban | 735 | 49 | 6.1 | 3.7 | 8.6 | |
| | Rural | 1454 | 89 | 4.5 | 3.1 | 6.0 | |
| Wisconsin region (DHS health regions) | Southeastern | 1349 | 123 | 8.5 | 6.5 | 10.5 | * |
| | Southern | 843 | 39 | 4.1 | 2.5 | 5.7 | |
| | Western | 873 | 71 | 8.1 | 5.3 | 10.8 | |
| | Northern | 551 | 35 | 6.0 | 3.7 | 8.2 | |
| | Northeastern | 871 | 53 | 4.3 | 2.7 | 5.9 | |
| Posttraumatic stress disorder (PTSD) diagnosis [b,c] | No | 3321 | 213 | 6.2 | 5.2 | 7.2 | * |
| | Yes | 451 | 63 | 10.9 | 7.6 | 14.2 | |
| Number of alcoholic drinks per week | 0 | 1525 | 162 | 10.4 | 8.4 | 12.5 | * |
| | 1-7 | 1724 | 85 | 4.3 | 3.2 | 5.5 | |
| | 8-14 | 477 | 26 | 4.0 | 2.3 | 5.6 | |
| | 15+ | 370 | 20 | 5.9 | 2.1 | 9.7 | |
| Doctor-diagnosed alcohol abuse [b] | No | 3797 | 260 | 6.4 | 5.4 | 7.4 | * |
| | Yes | 155 | 28 | 14.8 | 7.5 | 22.0 | |
| Doctor-diagnosed drug abuse [b] | No | 3880 | 271 | 6.4 | 5.4 | 7.4 | * |
| | Yes | 72 | 17 | 22.1 | 9.5 | 34.7 | |
| SF12: General health fair/poor | No | 3879 | 181 | 4.3 | 3.5 | 5.1 | * |
| | Yes | 531 | 131 | 23.1 | 18.8 | 27.3 | |
| Any chronic condition [d] | No | 2506 | 102 | 4.3 | 3.3 | 5.4 | * |
| | Yes | 1897 | 214 | 9.5 | 8.0 | 11.1 | |
| Depression [e] | No | 3465 | 213 | 6.0 | 5.0 | 7.1 | * |
| | Yes | 304 | 58 | 14.5 | 9.9 | 19.0 | |

Abbreviations: LCL, 95% lower confidence limit, UCL, 95% upper confidence limit; DHS, Department of Health Services; TIA, transient ischemic attack.

* Chi-square *P* value < 0.05 for comparison of opioid use within participant characteristic.

[a] Individuals with more than 1 opioid prescription in the last 30 days were counted only once.

[b] This question was first asked starting in 2010.

[c] Post-traumatic stress disorder diagnosis is based on scoring 14 or higher on the 6-item PCL-C (PTSD Checklist) Civilian version.

[d] Any chronic condition includes heart attack or angina, stroke or TIA, diabetes, asthma, chronic bronchitis or emphysema, rheumatoid arthritis or osteoarthritis, or cancer.

[e] Depression is determined from first 2 items on the Patient Health Questionnaire (PHQ)-9 depression screener, which asks about frequency of depressed mode and anhedonia over the past 2 weeks.

**Table 4.** Multivariate Model of Prescribed Opioid Use

| Characteristic | Level | OR | LCL | UCL | *P* value |
|---|---|---|---|---|---|
| Sex (ref=men) | Women | 1.12 | 0.75 | 1.69 | 0.58 |
| Age (ref=21-49 years) | 50-74 years | 1.72 | 1.26 | 2.34 | 0.0007 |
| Education [a] | | 0.80 | 0.63 | 1.03 | 0.08 |
| Race (ref=white) | Black | 0.82 | 0.42 | 1.60 | 0.56 |
| | Hispanic (not black) | 0.94 | 0.38 | 2.35 | 0.89 |
| | Other (not black or Hispanic) | 0.89 | 0.47 | 1.67 | 0.71 |
| Drug abuse (ref=no) | Yes | 1.57 | 0.75 | 3.28 | 0.23 |
| Alcohol abuse (ref=no) | Yes | 3.14 | 1.30 | 7.59 | 0.011 |
| Poverty level (ref=above 200% FPL) | Below 200% | 2.29 | 1.59 | 3.31 | <0.0001 |
| Health region (ref=Southeastern) | Southern | 0.61 | 0.36 | 1.03 | 0.064 |
| | Western | 0.82 | 0.49 | 1.36 | 0.43 |
| | Northern | 1.19 | 0.69 | 2.03 | 0.52 |
| | Northeastern | 0.44 | 0.27 | 0.72 | 0.001 |
| Rural/urban classification (ref=urban) | Suburban | 0.95 | 0.61 | 1.47 | 0.81 |
| | Rural | 0.60 | 0.38 | 0.95 | 0.029 |

Abbreviations: OR, odds ratio; LCL, 95% lower confidence limit; UCL, 95% upper confidence limit; ref, reference group; FPL, federal poverty level.
[a] Education was coded as a 3-level ordinal variable (high school to some college to college graduate).

used prescribed opioids at a rate significantly lower than people without a college degree (some college, high school or less) across all 9 years of data collection.

People who were not employed and not looking for work reported a significantly higher percentage of opioid medication use compared to those who were working or looking for jobs. There was a significant difference in opioid use by people who reported lower income levels. We used a cut-point of 200% federal poverty level (FPL); in 2015 this was $23,540 for 1 person and $8,320 for each additional household member.[15] Among those below 200% FPL, 10.2% reported opioid use, compared to 4.9% of those who were above 200% FPL.

People from urban and suburban Wisconsin reported higher prescription opioid use compared to rural residents. The Southeastern and Western regions of the state had the highest rates of prescribed opiate use (8.5%; 8.1%).

We also examined health insurance status for its association with prescribed opiate use. There was very little difference in use of prescribed opiates among the 93.3% who were insured (6.4% opiate use) and the 6.7% who reported not having any health insurance in the past 12 months (6.9% opiate use). However, type of insurance was associated with prescribed opiate use—those with employer-sponsored health insurance had the lowest rate of opiate use (4.7%), while those with Medicare reported 12.3% opiate use, and those with Medicaid reported 13.5% past 30-day opiate use. Since type of insurance is highly related to age, income, and chronic conditions, this was not included in multivariate analysis.

A U-shaped relation was observed with significantly more people using prescribed opioids among those not consuming any alcohol (10.4% used opioids) and among those consuming the highest amounts of alcohol (5.9% used opioids), compared to about 4% opioid use among mild to moderate drinkers. Data were collected beginning in 2010 on whether the participant reported having been medically diagnosed with alcohol abuse or drug abuse. Those medically diagnosed for alcohol abuse (14.8% used opioids) or drug abuse (22.1% used opioids) reported a significantly higher rate of prescription opioid use in the past month compared to those not diagnosed with either of these disorders (6.4% used opioids). Current and former smokers were also significantly more likely to use prescribed opiates than persons who had never smoked.

People who reported their health to be "fair or poor" had significantly higher opioid use (23.1%) relative to those reporting good, very good, or excellent general health (4.3%). Consistent with poor health, people who reported having chronic conditions reported higher opioid use.

Multivariate analyses using logistic regression were performed to further investigate the significant results from the bivariate analysis. After adjustment, age, education, drug abuse, poverty level, health region, and urbanicity remained significantly related to the odds of prescription opioid use. Race, education, and alcohol abuse were no longer statistically significant at the $P = 0.05$ level. Persons aged 50 and older were more likely to use prescription opioids (OR 1.72; 95% CI, 1.26-2.34) than younger people. Persons with household income below 200% FPL were significantly more likely to use prescribed opiates ($P = <0.0001$; OR 3.14; 95% CI, 1.30-7.59). Respondents in the Northeastern Region had significantly lower opioid use relative to the Southeastern Region (OR 0.44; 95% CI, 0.27-0.72), while those in the remaining regions did not significantly differ relative to the Southeastern Region. After adjusting for other variables, rural dwellers were significantly less likely to use prescribed opiates (OR 0.60; 95% CI, 0.38-0.95) than urban respondents. While there were differences in reporting prescription opioid use by race, these differences did not hold after adjustment for the related variables of education, urbanicity, and poverty level. Interactions between urbanicity and other variables in the model were examined; no statistically significant interactions were found between urban/rural status and any of the other model parameters.

## DISCUSSION

Between 2008 and 2016, approximately 6.4% of Wisconsin residents reported using prescription opioids in the past 30 days. The prevalence of opioid use varied greatly by demographic factors; older individuals, persons of color, and those who reported lower socioeconomic status had higher rates of opioid use.

These findings may be reflective of overall health status across the state's population. Use of opioids in the last 30 days is not reflective of abuse, but rather identifies populations at greater or lower risk of potential abuse and opioid diversion potential in households. These population estimates would be much higher if annualized, considering both new and refill prescriptions across the entire population. Another recent study found that 33% of respondents to a Wisconsin-based convenience survey had prescribed opioids in their homes.[8] That study included unused opioids stockpiled in the home, while the SHOW survey specifically asked about prescriptions used in the past 30 days. These data highlight the high diversion risk of plentiful unused but retained prescribed opiates.

Examining levels of use over 3-year intervals, the slight increased trend in use over time was not significant at $P < 0.05$. While the rate of prescribed use was thus relatively stable, the Wisconsin Department of Health Services (DHS) reported that deaths due to opioid overdose increased in Wisconsin over these years, from 414 deaths in 2008 to 916 deaths in 2017 alone.[4] These rates include both prescribed and illicit opiates.

Several of our results regarding the characteristics of those who use prescription opiates are easily explained. Older individuals (age 50 and above) suffer from more chronic conditions, have more medical procedures (in particular surgeries) and, hence, may require use of opioid pain relievers. Given this, seniors are at higher risks of overdose and dependency from opioids.[16-18] In 2017, first responders transported almost 1000 Wisconsin seniors for suspected unintentional opioid overdose.[4] The higher rate of prescribed opioid use reported by individuals who are unemployed and not looking for work is also easily explained. These may be retired older adults or individuals with severe chronic pain leading to unemployment. Similarly, participants who reported being in poor or fair health reported significantly more use of prescription opioids relative to those reporting good to excellent health. In this analysis, we were not able to differentiate opioid prescriptions for chronic versus acute conditions.

Several national studies have reported the existence of racial bias in opioid prescribing and use; African American and Hispanic individuals were perceived by prescribers to use more opioids but were prescribed fewer opioids than white individuals.[19-22] Results from our study point to higher prescribed opioid use by black and Hispanic individuals. This contrast with evidence in the national literature warrants further investigation. While race/ethnicity became insignificant in our multivariate model, the collinear variables of urbanicity, Southeastern Wisconsin residence, and lower education and income remain as significant correlates of prescribed opioid use. These variables reflect socioeconomic determinants of health risk. The insignificance of race in this model likely reflects the strong association of race with residential patterns and socioeconomic status in Wisconsin. The association of higher rates of prescribed opioid with this constellation of socioeconomic variables warrants further study.

Education is a well-established indicator of overall health and health literacy. The data show that as educational attainment went from high school graduate to some college to college graduate, the frequency of prescribed opioid use decreased. People with higher levels of education may be better informed about risks of opioids, may be healthier, have more access to preventive care, and/or may participate in conversations about pain management and opioid use with their health providers, which might lead to less prescribed opioid medication use than those with lower education levels.[23] This suggests a gap in knowledge, attitudes, and medication use practices of people related to their education level, a factor addressed in the health literacy literature as well as in literature on prescribed opioid use.[24-27] It also may reflect a difference in provider prescribing patterns related to characteristics of the patient.

The bivariate data indicate significantly lower use of opioids in rural and suburban regions than in urban areas. This may reflect less access to providers in rural areas. After adjustment for urbanicity and other demographic variables, the Northeastern Region tended to yield lower prescribed opioid use than the Southeastern Region. Higher rates in the Southeastern Region are consistent with DHS reports of the highest ambulance runs due to opioid overdose in that region in 2018.[4] Due to the interaction of urbanicity, health region, and other population characteristics, these results are tentative. A limitation of our data is the lack of information on illicit (non-prescribed, diverted or illegal) opiate use in this population.

Participants with diagnosed alcohol use disorders had significantly higher rates of prescription opioid use. Alcohol can interact with opioids, leading to adverse reactions that include respiratory depression, and can be fatal.[28] The Centers for Disease Control and Prevention (CDC) recommends that providers warn patients about risks of alcohol consumption when prescribing an opioid medication.[1] Pharmacists in Wisconsin are mandated by law to counsel patients with new and refill medications on current use, adverse effects, risks, and drug interactions every time the patient fills a prescription at the pharmacy.[29] Patients who are heavier alcohol users warrant more caution for clinicians prescribing opioids and enhanced counselling about medication interactions and risks. One of the more alarming findings of this study was the significantly higher rates of opioid use in people reporting doctor-diagnosed alcohol abuse and drug abuse. These findings are worrisome as they depict an acute need for communicating potential risks of opioids to these patients, which has been demonstrated in other nationwide studies as well.[30-32] It is possible that these patients were prescribed opioids without knowledge of their medical history and diagnoses.[33] Of some further concern in the behavioral health arena is the higher use

of opioids in people reporting clinical depression, given that opioids have been shown to aggravate depression.[34]

### Limitations

Although a rigorous sampling frame for inviting household participation was used, those agreeing to participate in SHOW may be a biased segment of the population. To overcome measurable bias, a weighting protocol was used to reflect the demographics of the state's population. The results are limited to the household dwelling population ages 21 to 74 years. While the actual prescription bottles were examined in most cases, a few participants self-reported the medications in absence of a pill bottle, which might have led to misreporting the medications used. Further, these results do not reflect nonprescribed opioid use, including illicit and diverted medications. The SHOW interview protocol did not include questions regarding illicit drug use; analysis of biospecimens would be necessary to assess the role of illicit opiate use. The data are limited to 2008 through 2016 interviews, so do not reflect recent changes in prescribing practices and policies, most notably limiting the total number of pills prescribed. Finally, the multivariate models are suggestive of patterns but due to multicollinearity of variables—in particular race, low income, and geographic location—these models are difficult to interpret.

Real time tracking of opiate prescribing behavior and forward extension of the time series data reported here should continue to assess the impact of changing policies and clinical practice. The SHOW data can be further exploited to provide population-level data on multiple health issues in Wisconsin in more depth than can be gleaned from administrative records. Analysis of SHOW data can provide professional and lay audiences with a more comprehensive understanding of the epidemiology of many health concerns.

## CONCLUSION

This study is unique because the analysis reports on opioid prescription use based on representative respondent surveys and actual names of medications from pill bottles, rather than relying on medical records, self-report surveys, or administrative data such as the Prescription Drug Monitoring Program. A 2019 report[6] indicates a recent reduction in opioid prescribing (including reduced number of pills prescribed). However, the rate of prescribed opiate use remained fairly constant over the 9 years of SHOW data with no significant reduction as of 2016 and, in 2019, 3.3 million prescriptions were written for opioids in Wisconsin.[6] The recent reduction is unlikely to be sufficient to resolve the epidemic. The association of higher rates of prescribed opiates among individuals with behavioral health issues suggests the need for enhanced counseling and communication with patients about risks of these medications. Health providers should be vigilant of patient's health history—especially behavioral health issues—when prescribing opioids, should apply the CDC guidelines, and communicate with patients about opioid risks. Patients with chronic conditions and behavioral health issues need to be given particular attention to assure adequate pain relief and consideration of alternative approaches to pain management. Clinical practice modification and public health and community initiatives, especially in the counties and areas reporting more opioid prescribing and use, should be undertaken to control the problem of prescription opioid overdose in the state.

**Acknowledgments:** The authors would like to thank the University of Wisconsin Survey Center; SHOW administrative, field, and scientific staff; and all the SHOW participants for their contributions to this study.

**Funding/Support:** Funding for the Survey of the Health of Wisconsin (SHOW) was provided by the Wisconsin Partnership Program PERC Award (233 PRJ 25DJ), the National Institutes of Health's Clinical and Translational Science Award (5UL RR025011), and the National Heart Lung and Blood Institute (1 RC2 HL101468). Awards from the Centers for Disease Control and Prevention (U17-CE002741) and the Substance Abuse and Mental Health Services Administration (U79-SP020781), via the Wisconsin Department of Health Services, provided partial support of Dr Moberg's participation in this effort.

**Financial Disclosures:** None declared.

## REFERENCES

**1.** Communicating with patients: applying CDC's guideline for prescribing opioids. Centers for Disease Control and Prevention. Updated March 26, 2020. Accessed February 3, 2020. https://www.cdc.gov/drugoverdose/training/communicating/

**2.** Prescription opioids DrugFacts. National Institute of Drug Abuse. Updated May 2020. Accessed February 3, 2020. https://www.drugabuse.gov/publications/drugfacts/prescription-opioid

**3.** Opioid overdose crisis. National Institute on Drug Abuse. Updated May 27, 2020. Accessed February 3, 2020. https://www.drugabuse.gov/drugs-abuse/opioids/opioid-overdose-crisis

**4.** Opioids: summary data dashboard. Wisconsin Department of Health Services. Updated March 23, 2020. Accessed February 3, 2020. https://www.dhs.wisconsin.gov/opioids/dashboards.htm

**5.** Wisconsin Department of Health Services. Select opioid-related morbidity and mortality data for Wisconsin. Published November 2016. Accessed February 3, 2020. https://www.dhs.wisconsin.gov/publications/p01690.pdf

**6.** Statistics: controlled substance dispensing. Wisconsin Department of Safety and Professional Services. Updated March 31, 2020. Accessed February 3, 2020. https://pdmp.wi.gov/statistics/controlled-substance-dispensing

**7.** Malani P KJ, Solway E. National Poll on Healthy Aging. University of Michigan. 2018. Published July/August 2018. Accessed june 24, 2020. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/145684/NPHA-Opioids-Report_072518.pdf?sequence=1&isAllowed=y

**8.** Linnan S, Walsh-Felz A, Moberg DP. Perceptions, awareness, and use of substances in Wisconsin: results of a survey conducted for the Wisconsin Strategic Prevention Framework Partnerships for Success 2015. University of Wisconsin Population Health Institute. February 2018: 1-48. Accessed February 3, 2020. https://uwmadison.app.box.com/s/jo0pmtxljqpisbut4zky2nsw83z2rly3

**9.** Hill MV, McMahon ML, Stucke RS, Barth RJ, Jr. Hill MV, McMahon ML, Stucke RS, Barth RJ Jr. Wide variation and excessive dosage of opioid prescriptions for common general surgical procedures. *Ann Surg*. 2017;265(4):709-714. doi:10.1097/SLA.0000000000001993

**10.** McCabe SE, West BT, Boyd CJ. Leftover prescription opioids and nonmedical use among high school seniors: a multi-cohort national study. *J Adolesc Health*. 2013;52(4):480-485. doi:10.1016/j.jadohealth.2012.08.007

**11.** Nieto FJ, Peppard PE, Engelman CD, et al. The Survey of the Health of Wisconsin (SHOW), a novel infrastructure for population health research: rationale and methods. *BMC Public Health*. 2010;10:785. doi:10.1186/1471-2458-10-785

**12.** DHS regions by county. Wisconsin Department of Health Services. Updated July 26, 2018. Accessed February 3, 2020. https://www.dhs.wisconsin.gov/aboutdhs/regions.htm

**13.** Nelson SJ, Zeng K, Kilbourne J, Powell T, Moore R. Normalized names for clinical drugs: RxNorm at 6 years. *J Am Med Inform Assoc*. 2011;18(4):441-448. doi:10.1136/amiajnl-2011-000116

**14.** SAS/ACCESS® Interface to ADABAS. Version 9.4. SAS Institute Inc.; 2013.

**15.** Annual update of the HHS poverty guidelines. *Fed Regist*. 2015;80(14): 3236-3237. 42 USC § 9902(2). https://www.govinfo.gov/content/pkg/FR-2015-01-22/pdf/2015-01120.pdf

**16.** Vogel L. Seniors and self-harm factor in the opioid crisis. *CMAJ*. 2017;189(1):E42-E43. doi:10.1503/cmaj.109-5357

**17.** West NA, Severtson SG, Green JL, Dart RC. Trends in abuse and misuse of prescription opioids among older adults. *Drug Alcohol Depend*. 2015;149:117-121. doi:10.1016/j.drugalcdep.2015.01.027

**18.** West NA, Dart RC. Prescription opioid exposures and adverse outcomes among older adults. *Pharmacoepidemiol Drug Saf.* 2016;25(5):539-544. doi:10.1002/pds.3934

**19.** Singhal A, Tien YY, Hsia RY. Racial-ethnic disparities in opioid prescriptions at emergency department visits for conditions commonly associated with prescription drug abuse. *PLoS One*. 2016;11(8):e0159224. doi:10.1371/journal.pone.0159224

**20.** Pouget ER, Fong C, Rosenblum A. Racial/ethnic differences in prevalence trends for heroin use and non-medical use of prescription opioids among entrants to opioid treatment programs, 2005-2016. *Subst Use Misuse*. 2018;53(2):290-300. doi:10.1080/10826084.2017.1334070

**21.** Todd KH, Deaton C, D'Adamo AP, Goe L. Ethnicity and analgesic practice. *Ann Emerg Med*. 2000;35(1):11-16. doi:10.1016/s0196-0644(00)70099-0

**22.** Austin F, Toni MA. A 'rare case where racial biases' protected African-Americans. *New York Times*. November 25, 2019. Accessed November 26, 2019. https://www.nytimes.com/2019/11/25/upshot/opioid-epidemic-blacks.html

**23.** Parsells Kelly J, Cook SF, Kaufman DW, Anderson T, Rosenberg L, Mitchell AA. Prevalence and characteristics of opioid use in the US adult population. *Pain*. 2008;138(3):507-513. doi:10.1016/j.pain.2008.01.027

**24.** Ho JY. The contribution of drug overdose to educational gradients in life expectancy in the United States, 1992-2011. *Demography*. 2017;54(3):1175-1202. doi:10.1007/s13524-017-0565-3

**25.** Svendsen K, Fredheim OM, Romundstad P, Borchgrevink PC, Skurtveit S. Persistent opioid use and socio-economic factors: a population-based study in Norway. *Acta Anaesthesiol Scand.* 2014;58(4):437-445. doi:10.1111/aas.12281

**26.** Platts-Mills TF, Hunold KM, Bortsov AV, et al. More educated emergency department patients are less likely to receive opioids for acute pain. *Pain*. 2012;153(5):967-973. doi:10.1016/j.pain.2012.01.013

**27.** Krebs EE, Lurie JD, Fanciullo G, et al. Predictors of long-term opioid use among patients with painful lumbar spine conditions. *J Pain.* 2010;11(1):44-52. doi:10.1016/j.jpain.2009.05.007

**28.** Kreek MJ. Opioid interactions with alcohol. *Adv Alcohol Subst Abuse.* 1984;3(4):35-46. doi:10.1300/J251v03n04_04

**29.** Wis Admin Code Phar § 7.11-7.14.13 (2017).

**30.** Hughes HK, Korthuis PT, Saha S, et al. A mixed methods study of patient-provider communication about opioid analgesics. *Patient Educ Couns.* 2015;98(4):453-461. doi:10.1016/j.pec.2014.12.003

**31.** Matthias MS, Krebs EE, Bergman AA, Coffing JM, Bair MJ. Communicating about opioids for chronic pain: a qualitative study of patient attributions and the influence of the patient-physician relationship. *Eur J Pain.* 2014;18(6):835-843. doi:10.1002/j.1532-2149.2013.00426.x

**32.** Smith RJ, Rhodes K, Paciotti B, Kelly S, Perrone J, Meisel ZF. Patient perspectives of acute pain management in the era of the opioid epidemic. *Ann Emerg Med*. 2015;66(3):246-252.e1. doi:10.1016/j.annemergmed.2015.03.025

**33.** Moss C, Bossano C, Patel S, Powell A, Chan Seay R, Borahay MA. Weaning from long-term opioid therapy. *Clin Obstet Gynecol.* 2019;62(1):98-109. doi:10.1097/GRF.0000000000000425

**34.** Sullivan MD. Depression effects on long-term prescription opioid use, abuse, and addiction. *Clin J Pain.* 2018;34(9):878-884. doi:10.1097/AJP.0000000000006032015;66:246-252.e241.

# Early Childhood Obesity Prevention: Challenges and Barriers of Implementing Child and Adult Care Food

Elizabeth White, MD; Ryan Potter; Cary Rasmussen, MS; Jennifer Kleven, MD


## ABSTRACT

**Introduction:** The Child and Adult Care Food Program requirements promote healthy eating behaviors and increased physical activity in the daycare setting to help prevent childhood obesity. Some of these standards can be difficult to meet for early childhood education centers. This study examines the challenges and barriers daycare centers face when implementing these guidelines.

**Methods:** Focus groups consisting of participants from early childhood education centers within our community were conducted in April and May of 2018.

**Results:** Three focus groups were conducted, with a total of 7 childcare center directors. Eight themes that affect nutrition and physical activity curriculums at early childhood education centers arose: teacher philosophy and involvement, training/expertise of staff, parental involvement, financial constraints, children's interests, food availability, physical environment, and regulations/guidelines. Overall, participants expressed their sense that child care facilities are undervalued. They agreed that healthy, fresh food choices are expensive, difficult to obtain due to the volume needed, and require additional training to prepare. Emphasis on gross motor development has a varied level of support from families and teachers. Challenges and barriers to providing adequate gross motor activities include limited financial support, lack of physical space, lack of teacher willingness to engage in outdoor activity, and parental resistance.

**Conclusions:** Financial constraints and the "undervaluing" of childcare contribute greatly to many of the challenges and barriers early childhood education centers face in meeting nutrition and physical activity standards. Findings from this study shed light on the significant role early childcare centers play in nurturing child development and the efforts these centers undertake in the interest of children.


## INTRODUCTION

In 1968, the federal government established the Child and Adult Care Food Program (CACFP) to ensure healthy and sufficient food would be available in care settings outside the home.[1] In the United States today, over 25% of preschool children are overweight or obese.[2] As malnutrition in the context of obesity has become increasingly prevalent, the US Department of Agriculture has updated CACFP regulations to address the obesity epidemic among children.[1] And as a part of the Healthy, Hunger-Free Kids Act of 2010, the CACFP requires care programs that receive funding to limit added sugars and fats, increase physical activity for children, and encourage a child's innate self-regulation and satiety cues during meal times.[1]

Over 12 million children in the United States spend over 70% of their waking hours in an early childhood education setting outside of their home.[2] During this time, they consume 50% to 75% of their total caloric intake.[2] Financial constraints, varied parental support, and challenges with space and fresh food availability contribute to many of the challenges and barriers early childhood education centers face in meeting nutrition and physical activity standards.

Childcare centers enrolled in the CACFP are more likely to meet minimum standards for healthy eating and physical activity.[2] This pilot study examines a small sample of childcare directors to better understand their experience implementing CACFP requirements for healthy behaviors within their childcare settings. Through small focus groups, we explored the following: (1) challenges and successes in implementing CACFP guidelines, (2) what childcare directors need to better implement healthy behaviors, and (3) opportunities for health care systems and communities to better support early childhood education.

• • •

**Author Affiliations:** Gundersen Health System, La Crosse, Wis (White, Potter, Rasmussen, Kleven).

**Corresponding Author:** Jennifer Kleven, MD, Gundersen Health System, 1900 South Ave, La Crosse, WI 54601; Phone 608.775.4492; email jekleven@gundersenhealth.org.

## METHODS

### Study Design

Focus groups were conducted with directors of local in-home and center-based early childhood education programs. Discussions focused on the participants' experiences with healthy lifestyle-based CACFP regulations that aim to decrease childhood obesity rates.[3] Approval for this study was obtained from the Gundersen Health System Institutional Review Board.

### Regional Demographic Characteristics

The study community is an upper Midwest urban area (>80% urban) with an estimated population of 51,567; 89.6% of residents are white, and 4.9% of the population is under the age of 5 years. The city experiences 4 distinct seasons and has a combined total of 34 certified in-home and licensed daycare centers.[4,5] Approximately 30% of children aged 2 to 4 years in the study area's Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) are overweight or obese.[6]

### Participant Selection

With the assistance of a local nonprofit organization, purposeful sampling identified local site directors or owners who displayed engagement in the early childhood education community and had worked toward continuous improvement for the benefit of child development. A neutral member of the research team extended personal invitations to these potential participants.

### Demographics

Three focus groups comprised of 2 to 3 participants were conducted with a total of 7 childcare center directors (Table). The majority of clientele for 6 of the centers represented qualified for state and federal assistance programs and all were predominantly white (88%).

### Focus Groups

Focus groups were held at the community YMCA. Informed consent was obtained, and each participant completed a short demographic questionnaire prior to starting each session (Appendix A). Names were not recorded. Two main researchers served as moderators during discussions and followed an outline of predetermined questions that focused on nutrition and physical activity within the childcare environment (Appendix B). Moderators guided the conversation using probe questions to focus on the discussion topic. Later, a digital audio recording of the discussion was transcribed verbatim to allow for analysis while maintaining anonymity. Discussions lasted approximately 1 hour.

### Data Analysis

The grounded theory method guided the qualitative analysis of transcriptions.[7] Transcriptions were labeled by group. Three members of the research team, including the topic expert, independently reviewed each transcription and identified main themes for coding. These themes were then compared and agreed upon. Independent analysis of random samples was completed, and coding of the main themes was tested for greater than 70% fidelity across all researchers and the entire sample. After proven fidelity, 1 researcher completed the coding process for main themes. Subthemes were then agreed upon through discussion between all 3 researchers and final coding was completed.

**Table.** Daycare Center and Participant Demographics

| | n | (%) |
|---|---|---|
| Daycare center | | |
| CACFP supported | 6 | (86) |
| Non-CACFP supported | 1 | (14) |
| Daycare setting | | |
| Daycare center | 6 | (86) |
| In-home | 1 | (14) |
| Meal and snack responsibility | | |
| Daycare | 6 | (86) |
| Parents and daycare | 1 | (14) |
| Participant primary role | | |
| Direct childcare contact/provider | 2 | (28.5) |
| Administrative/indirect childcare provider | 3 | (43.0) |
| Both | 2 | (28.5) |
| Participant trained on nutrition and activity recommendations | | |
| Yes | 5 | (71) |
| No | 2 | (29) |

Abbreviation: CACFP, Child and Adult Care Food Program.
Note: One participant reported parents are responsible for providing lunch for their child/children and the daycare center is responsible for all other meals and snacks.

## RESULTS

Eight themes emerged on nutrition and physical activity policies and practices at the childcare facilities: teacher's philosophy and involvement, staff training/expertise, parental involvement, financial aspects of childcare management, interest of the child, food availability, physical environment, and regulations and guidelines. Within the themes, directors expressed their sense that child care facilities are undervalued and, therefore, face challenges related to limited funds for staff, food and equipment, varied parental support of curriculum, and lack of physical space for play. Themes were divided and analyzed under the categories of nutrition or gross motor development. Findings for each theme are summarized below.

### Teachers' Philosophy and Their Involvement – Nutrition

Children explore new foods best in the setting of family style meal formatting. Directors emphasized that family style eating provides an opportunity for social development between peers and adults. "They [the kids] all have to sit down and wait for everybody to be there. We sing a song at lunch and that's a cue that they can dig in," said one participant. However, facilitating family style meals is difficult due to the required coordination of multiple activities

simultaneously. Participants reported that home practices, who supplies the meals (the center or the family), and space all impact success of the family style approach. A few centers have children supply their own food for some meals, making family style mealtime more challenging for teachers, and others reported that they do not have family style eating due to space limitations.

#### Teachers' Philosophy and Their Involvement – Gross Motor

To meet physical activity standards and to allow for creativity, teachers utilize structured activities, such as music, movement, yoga, and Stimulating Maturity Through Accelerated Readiness Training (SMART) indoors, as well as unstructured outdoor activities. "We…get them out just doing imaginative play…our philosophy [is] everything should be play-based," said one participant. Some also reported taking children on walks around the community or to the park.

All participants discussed the challenge of preparing children for outdoor play. For some teachers, "It's easier to not have to put all [the kids'] stuff on [for outdoor play]." Directors reported a generalized lack of interest among the teachers in being outside because outdoor play is sometimes uncomfortable due to temperature, inconvenient due to the necessary outerwear, and difficult due to minimal staff.

#### Training/Expertise of Staff – Nutrition

Early childhood education center teachers and cooks do not necessarily have experience with meal planning and/or preparation of locally sourced, fresh, seasonal foods. One director described an open-minded cook: "She knows how to cook anything; you give it to her and she'll cook it. We are [retraining her] to cook a little healthier [be]cause she uses a lot of canned soups and…vegetables… she is enjoying the process too, and she likes showing the kids." However, serving fresh foods also increases costs. "I can't pay my cook [competitive wages], and trying to find that match of someone who is awesome and has that passion of working with kids and someone who wants to put in a lot of effort in the kitchen…chopping vegetables…[is difficult]," said another participant.

#### Parental Involvement – Nutrition

A nutrition curriculum that includes healthy, fresh food choices garners overall support from parents. However, when parents provide food, some still send prepackaged, processed foods. Two participants reported concerns about lack of parental encouragement of healthy food choices and lack of family style meal modeling. Parents voice frustrations with mess, pickiness, and the meal preparation time as a primary driver for choosing prepackaged, less nutritious foods. Children report that they "get to run around with [their] food [at mealtime while at home]" and act as decision-makers for what they will be offered as food choices.

#### Parental Involvement – Gross Motor

Parents generally support their children being outside; however, some parents express concerns about exposure to extreme weather. One focus group participant reported setting the expectation at the onset of enrollment – children will go outside often and get dirty. All participants agreed that parents often do not send children to school with appropriate outdoor gear. "[Parents] think if they don't bring their stuff, we just won't go outside."

Despite general support for outdoor activities, participants perceived a lack of parental support for gross motor activities. "We recognize that the gross motor…gets pushed on the back burner because [parents] really want to know what you're doing with their mind [or] fine motor [development]," said one director. All participants indicated that parents do not appear to understand the importance of gross motor development and the role it plays on future academic performance.

#### Financial Aspects of Childcare Management/Physical Environment – Nutrition

Costs associated with food storage and updating facilities for food preparation present challenges for early childhood education centers. "I have an old building, [with only] one outlet [in the kitchen that] we can use; it was really hard to maneuver," said one director. Local grants may temporarily fill the financial gap for centers to purchase freezers, create larger spaces for food preparation, purchase supplies to grow fresh food, and provide training for cooking.

#### Financial Aspects of Childcare Management – Gross Motor

Particpants reported limited funding as a barrier to providing space for gross motor development, participating in field trips, and updating current physical spaces to create a safer environment. "I would love to redo our playground… [surface with rubber chips] so…I would feel that they were safe," said one director. Participants also reported meeting needs for capital improvements mainly through grants and fundraising, which are used for physical building updates and to fund spaces such as food storage, leaving spaces for gross motor activities low on the priority list.

#### Physical Environment – Gross Motor

Successful promotion of gross motor activities depends on the appropriate physical environment.[8] One participant reported using community green spaces for outdoor activities. Three others said they feel lucky to have large playgrounds to avoid needing to play in shifts. One director said, "We have a garden [with] a grassy hilly area…traditional playground equipment…[and] a bike path [for] bikes and scooters. We are also fortunate enough to be attached to the recreation center at [the local university], we very often have access to a more gymnasium-type facility." Other participants reported adapting to their environment through wearing "mud suits" (rain gear), playing with SMART tracks indoors, or utilizing hallways for activities.

All participants indicated challenges relating to limited indoor

space. One said, "By the time you've got all your toy shelves and all the other requirements you have to have in the classroom, it doesn't leave you a lot of space." Three others agreed. All-weather exposure creates additional challenges to providing an appropriate space for children at play. "All of the equipment is left untouched because it is in the bright sun. … [We aren't allowed] to plant a tree on the playground," added one participant.

### Interest of the Child – Nutrition

All participants agreed about children's willingness to try new foods when encouraged, especially if exposed at a young age. "I was surprised when we introduced hummus for the first time … the kids just loved it," said one participant, and the others agreed, noting that the children are receptive, it's just other people who aren't.

### Food Availability – Nutrition

Participants described creative approaches to overcoming challenges surrounding access to fresh, locally sourced food—including utilizing grant money for "farm to early care and education" programs in order to grow and serve their own food, visiting local produce auctions, or relying on home canning or frozen foods. One provider said, "…we will [go to the local] produce auction… [where] you can buy pallets of [affordable food]." Another participant agreed, "I think the biggest [struggle] is…trying to find someone that will recognize you for being a smaller company and [provide access to affordable foods]." Unless the center is associated with a larger company, most participants agreed with this statement.

### Regulations and Guidelines – Nutrition

Three directors described frustrations with regulations regarding menu-planning. "…you have to make your [5-week] menu out [in advance] and…it's Thursday, we are supposed to have bananas, but I have a case of apples, so we are having apples. I have to cross off bananas and write in apples, or [we] get [marked as noncompliant]," reported one director. Another described limitations due to a lack of safe food handling training while freezing leftover chicken breasts as a cost-saving measure. "I was told that we couldn't do that because we were not trained to properly."

Changes in recommendations for feeding infants and young toddlers are confusing as well. "There used to be…guidelines [by age group] ...but with new [CACFP] guidelines…there is not necessarily any sort of guideline of what you're giving kids under 12 months; it's all parent recommendations," said one participant.

### Regulations and Guidelines – Gross Motor

Participants expressed frustration with not being allowed to use "common sense" to adapt to particular situations based on resources available to support gross motor activities. For example, "if it feels like 90 degrees you are not supposed to be outside [per regulations]" despite having open access to water play, said one director. Another described her dilemma regarding regulations that bar them from having a playground on their property, due to a requirement that the playground be attached to the building.

## DISCUSSION

As medical providers who care for children, the authors want to partner with early childhood educators caring for children in our community as they work to promote healthy lifestyle behaviors. To increase our baseline knowledge of the challenges childcare providers face in carrying out CACFP requirements and implementing healthy eating and physical activity routines, we started with small focus groups and gathered subjective, personal insights on 3 focus areas. Based on our discussions, childcare centers' financial constraints and sense of being undervalued are the most prevalent concerns. With current regulations and standards in the setting of unfunded mandates, participants express a disconnect between the market cost and market price of childcare. Directors report that providing healthy, fresh food is expensive and logistically challenging. Obtaining the appropriate resources to prepare and serve this food remains difficult. Funding through community grants and the CACFP make bridging financial gaps possible for some; however, food preparation and storage challenges still exist.

Children do well with the current CACFP nutrition recommendations. It takes some effort to overcome the hesitation of trying new foods, but, having the right environment and teacher support provide learning opportunities through engagement in growing and cooking food. Parents seem to support recommendations and exposure to healthy, fresh foods and family style eating at school/daycare, but—based on focus group participants' perceptions—this is not necessarily true at home. This dichotomy may be due to a lack of education among parents about recommendations for child development and the benefits of family meals for obesity prevention and general health.[9]

Parent and caregiver engagement and active participation is necessary for childhood weight management and developmental growth.[10] However, the directors interviewed reported that parents describe barriers, such as fatigue and lack of time, that prevent implementation of recommendations for fresh foods and family style meals at home.

Gross motor development depends on extensive involvement in physical activities. Participants indicated that they provide teachers with a general awareness and understanding of the importance of gross motor activities and their contribution to brain development. Teachers are willing to obtain additional training/education for instituting these tools, however, challenges to providing gross motor opportunities include limited financial support, small physical spaces, lack of teacher engagement during outdoor play, parental resistance to outdoor activities, and regulations that support safety for children.

The directors in these focus groups suggested that they need local businesses and health care organizations to recognize the

important role early childhood education centers play in the community. They would like to collaborate with community stakeholders to determine viable options for implementing ideas, such as group purchasing agreements with wholesale food suppliers, increased child-friendly outdoor spaces, and reuse/recycling programs for items such as industrial kitchen supplies or gross motor equipment.

Limitations of this pilot study include its small size and potential sampling bias. All participants were white women, leading to a homogenous sample that may not be broadly representative of the population. The information reported is not necessarily generalizable to other communities or those with a more diverse population. Focus groups contained only engaged early childhood education center directors, potentially resulting in an underestimate of barriers faced by the centers. Further studies that include teachers, parents, and directors would help provide a more complete picture. Focus group questions were limited to the topics of nutrition and physical activity. Other social determinants that may play a role in child development were not specifically explored. More detail regarding the demographics of a particular setting and the physical environment could provide a deeper understanding of the challenges to providing a healthy environment for children.

## CONCLUSION

Individual and community resources are often limited. Early childhood education serves an important role in nurturing child development and promoting healthy lifestyle behaviors from a young age. This study provides initial insight into the day-to-day needs of childcare centers and the children they serve from the perspective of those "in the trenches." Challenges they face include limited space, lack of teacher expertise and time, unpredictable access to fresh foods, and complying with regulations. According to study participants, financial constraints and the "undervaluing" of childcare significantly contribute to these challenges.

The themes that emerged can be used to create a broader needs assessment and lay a foundation for further research. Areas of study may include surveys to all licensed childcare centers to gauge interest in group food purchasing, need for shared play space, or access to industrial kitchen equipment. This initial information, in combination with further study, can help to assure that community and health care organizations are directing resources to areas of most need, supporting early childhood education, and thereby helping to provide the best care for children.

**Funding/Support:** None declared.

**Financial Disclosures:** None declared.

**Appendices:** Appendices are available online at wmjonline.org.

## REFERENCES

**1.** Food Nutrition Service. Child and adult care food program: meal pattern revisions related to the Healthy, Hunger-Free Kids Act of 2010. *Fed Regist.* 2016;81(79):24347-24383.

**2.** Dev DA, McBride BA, Harrison K; STRONG Kids Research Team. Academy of Nutrition and Dietetics benchmarks for nutrition in child care 2011: are child-care providers across contexts meeting recommendations? *J Acad Nutr Diet.* 2013;113(10):1346-1353. doi:10.1016/j.jand.2013.05.023

**3.** Krueger RA, Casey MA. *Focus Groups: A Practical Guide for Applied Research*. 4th ed. SAGE Publications; 2009.

**4.** QuickFacts: La Crosse city, Wisconsin; La Crosse County, Wisconsin. United States Census Bureau. Accessed June 29, 2019. https://www.census.gov/quickfacts/fact/table/lacrossecitywisconsin,lacrossecountywisconsin/PST045218

**5.** YoungStar. Wisconsin Department of Children and Families. Accessed June 29, 2019. https://childcarefinder.wisconsin.gov/Search/Search.aspx

**6.** Wisconsin Public Health Profiles: La Crosse County. 2017. Accessed February 2020. https://www.dhs.wisconsin.gov/publications/p4/p45358-2017-lacrosse.pdf

**7.** Chapman AL, Hadfield M, Chapman CJ. Qualitative research in healthcare: An introduction to grounded theory using thematic analysis. *J R Coll Physicians Edinb.* 2015;45(3):201-205. doi:10.4997/JRCPE.2015

**8.** Gordon Biddle KA, Garcia-Nevarez A, Roundtree Henderson WJ, Valero-Kerrick A. Play and the learning environment. In: Gordon Biddle KA, Garcia-Nevarez A, Roundtree Henderson WJ, Valero-Kerrick A, eds. *Early Childhood Education: Becoming a Professional.* SAGE Publications; 2013. Accessed August 23, 2019. https://www.sagepub.com/sites/default/files/upm-binaries/53567_ch_10.pdf

**9.** Benjamin Neelon SE, Briley ME; American Dietetic Association. Position of the American Dietetic Association: benchmarks for nutrition in child care. *J Am Diet Assoc.* 2011;111(4):607-615l. doi:10.1016/j.jada.2011.02.016

**10.** Hoelscher DM, Kirk S, Ritchie L, Cunningham-Sabo L; Academy Positions Committee. Position of the Academy of Nutrition and Dietetics: interventions for the prevention and treatment of pediatric overweight and obesity. *J Acad Nutr Diet.* 2013;113(10):1375-1394. doi:10.1016/j.jand.2013.08.004

# Hmong Cross-Cultural Adaptation of Stroke Educational Material

Haitham M. Hussein, MD, MSc; Carol Droegemueller, MS, APRN, CNS, OCNS, CNRN; Pakou Xiong, BA; Sidney VanDyke, MA; Jeanne Mettner, MA, ELS; Zong Xiong, BAN, RN, PHN; Gloria Catha, BS

## ABSTRACT

**Background:** The presence of significant cultural and language barriers can affect timely, effective dissemination of stroke education for Hmong patients. Our aim was to design stroke educational material suitable for the Hmong community, using culturally sensitive strategies and patient education best practices.

**Methods:** We collaborated with the American Heart Association/American Stroke Association to adapt existing English educational material for use among Hmong patients. A team of experts in stroke care, patient education, and interpreter services—along with Hmong community members and health care providers—modified the original documents for health literacy and cultural relevance. The revised materials were translated into Hmong. Final edits were made using feedback from the Hmong community.

**Results:** Eight patient education documents on stroke-related topics were disseminated throughout our health care system and shared with various regional community partners for Hmong patients.

**Discussion:** Incorporating cultural humility principles is key to providing effective patient education tools for reducing disparities and engaging at-risk populations in disease prevention.

## INTRODUCTION

Hmong is an ethnic group originally from mountainous areas of Southeastern China, Northern Vietnam, Laos, and Thailand.[1] Large numbers of Hmong people have resettled in the United States since the Vietnam War, with the majority in California, Minnesota, and Wisconsin. According to the 2017 American Community Survey, the US Census Bureau estimated the US Hmong population to be around 320,000, with about 85,000 in Minnesota,[2] mainly in the city of St. Paul, the location of our hospital. In a previous study, we retrospectively reviewed our institutional "Get With The Guidelines" database and found that Hmong patients presenting with stroke are, on average, 10 years younger than the majority, have poorly controlled risk factors, high rates of particular subtypes of stroke (intracerebral hemorrhage, intracranial atherosclerosis, and small vessel disease), and low rates of utilization of ambulances and rehabilitation facilities.[3]

In a health literacy survey focused on stroke, we identified not only a knowledge gap among members of the Hmong community, but also a significant language and cultural barrier to closing this gap. For example, there is no equivalent in the Hmong language for the word "stroke," and about a quarter of respondents either did not know or gave the wrong answer when asked to define or explain stroke. When asked about stroke symptoms, some participants described atypical symptoms, such as fever and pain, and others did not know. Only three-quarters of the survey participants indicated that they would seek medical care immediately if stroke is suspected; 72% thought that a doctor could help and 18% thought a shaman could help. None of the participants indicated knowledge of any of the acute stroke treatments that can reverse the effect of stroke, namely intravenous thrombolysis and mechanical thrombectomy.[4]

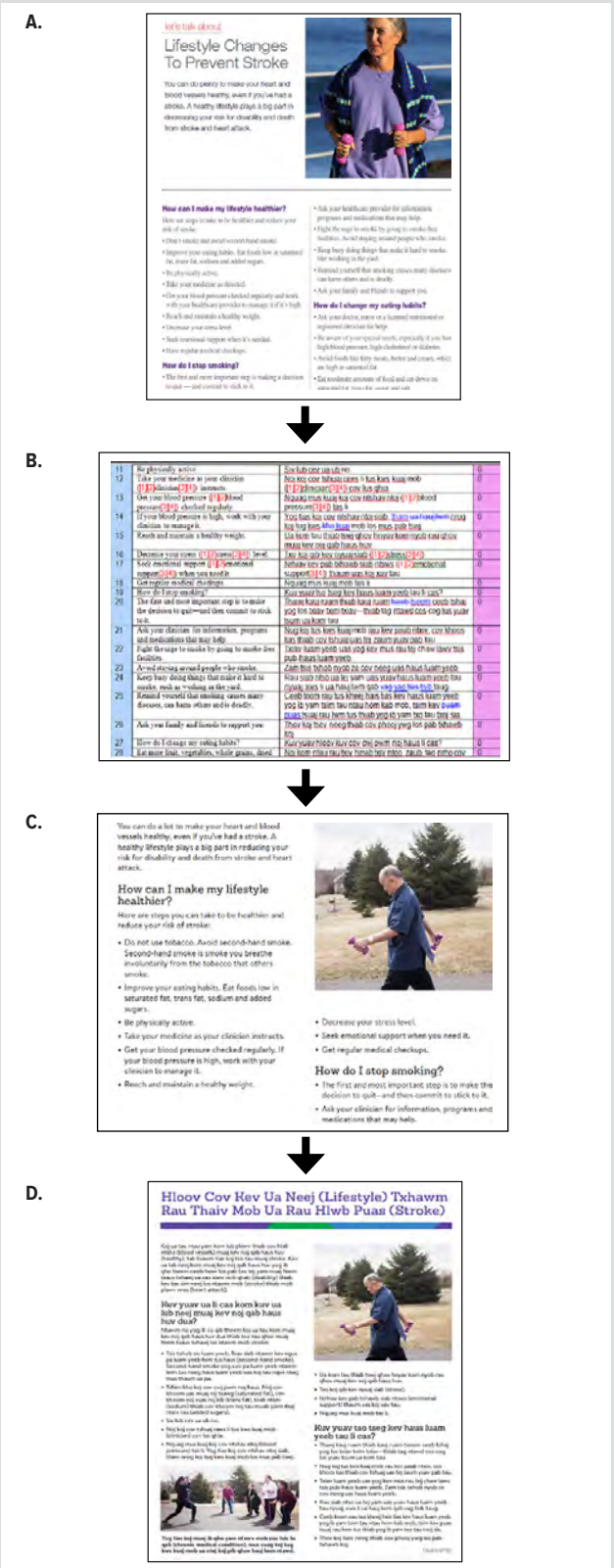
We embarked on the current project to close these gaps and to meet our standard of care for providing stroke patients with ade-

• • •

**Author Affiliations:** Regions Hospital Comprehensive Stroke Center, St Paul, Minn (Hussein, Droegemueller, VanDyke); HealthPartners, Bloomington, Minn, (Xiong); Park Nicollet Health Services, St Louis Park, Minn (Mettner); Ramsey County Public Health, Department of Family Health, Maplewood, Minn (Xiong); American Heart Association, Dallas, Tex (Catha).

**Corresponding Author:** Haitham M. Hussein, MD, MSc, Medical Director, Regions Hospital Comprehensive Stroke Center, HealthPartners Neuroscience Center, Mail Stop: 41203A, 295 Phalen Blvd, St Paul, MN 55130; phone 651.495.6300; email Haitham.M.Hussein@HealthPartners.com.

**Figure.** Phases of Cross-Cultural Adaptation of Stroke Education Material




A) Original document: American Heart Association/American Stroke Association *Let's Talk About Stroke: Lifestyle Changes to Prevent Stroke*; B) word-for-word review and modification of the original document to suit the Hmong reader; C) modified English version after changing the photo to be more relatable to Hmong reader; D) final product in Hmong.

quate stroke education. (No stroke education material was available in Hmong.) The aim was to create material customized for the Hmong community, with clear content and relatable images to be used in educating Hmong stroke patients and their caregivers.

## METHODS

To oversee this work, we created a core team that met monthly throughout the project's 14-month course. This team included stroke experts, members of the hospital interpretive services, Hmong health care professionals who are bilingual/bicultural in Hmong/English, and members of the hospital's patient education team. The team reviewed several educational resources available to patients and chose the American Heart Association (AHA)/American Stroke Association (ASA) *Let's Talk About Stroke* series because of its updated information, brevity, and clear message. The team selected eight 1-page documents from the series that best addressed the gaps identified through previous work and obtained permission through a contractual agreement from AHA/ASA to proceed.

Adapting the text from English to Hmong proceeded in 3 stages. The first stage was to rephrase the original text to better relate to Hmong culture. The goal was to maintain the integrity of all the conceptual content but to articulate these concepts in language and contexts relatable to the Hmong community. For concepts that do not have an equivalent in Hmong language, we used a definition or a description of the term. For example, there is no Hmong equivalent to "oxygen," so it was replaced with "the air you breathe" (Figure).

The second phase was translation to the Hmong language. There are 2 Hmong dialects: Green Hmong and White Hmong. We chose White Hmong based on feedback from our bilingual team members that it is the more prevalent and understandable dialect. A certified professional translation firm was hired to translate the modified English version to Hmong. Due to the lack of a Hmong-equivalent, some of the English words were retained. For example, the word "stroke" has no equivalent in Hmong, so it appeared in the Hmong version and was defined upon first appearance in each document. The first Hmong version was reviewed by the project core team and members of the Hmong community for accuracy and readability. After further edits were made, the final Hmong version of the text was created.

The final phase was changing the images included in the original documents to make them more relatable to the target audience. Since this was a cross-cultural adaptation—not just a mere translation—we elected to use different images that depict individuals, activities, and foods relevant to the Hmong culture. A professional photographer from the Hmong community was hired. Hmong community members at an adult daycare were invited to appear in the photographs, and those who volunteered were asked to sign a photo release form. The photoshoot took place at a Hmong adult daycare, the Hmong local market, and the rehabilitation unit of

HealthPartners Neuroscience Center in Saint Paul, Minnesota. Final photo selection for each educational document was reached through team consensus.

This work was funded by Regions Hospital ONE Patient Care allocation grant.

## RESULTS

After the images were incorporated with the final version of the Hmong-translated text, the final version of the documents was created (Appendix). The Hmong version and the modified English equivalent were bundled together electronically in a PDF format so that they print together, allowing an English-speaking health care professional to know the content of the Hmong version when providing education.

The final documents were shared with the Minnesota Department of Health, state of Minnesota stroke coordinators, local health care providers, and the Hmong Health Care Professionals Coalition, a community organization comprised of volunteers. Our team returned to the Hmong daycare and shared the final product with the organization and its clients, including those individuals who participated in the photoshoot. The 8 documents are currently in use. Colleagues who used these documents to educate their patients in hospital and clinical settings reported that feedback from patients and families has been positive. A formal evaluation is underway.

## DISCUSSION

This project is in response to gaps in patient education and health literacy that our research identified as compromising our standard of care. To our knowledge, this project was the first formal effort to actively target the Hmong population in the United States with stroke-specific education.

Before initiating this project, we questioned the value of print educational material in Hmong, given the realities that (1) migration waves have receded; (2) younger generations of Hmong can communicate in English; and (3) the older generation has relied on oral tradition more than writings. However, the feedback we received from the Hmong community was that print material would be useful as a conversation starter, as well as a resource that provides the talking points and necessary vocabulary for the conversation to be informative. Aside from the educational benefits, we viewed this work as an important effort to reach out to, build trust among, and further develop our institution's relationship with the Hmong community.

Previous research has shown that the lack of effective communication with non-English-speaking stroke patients through professional interpreters is associated with lower quality of care.[5] We learned from our experience working on this project that effective communication is not only dependent on language, but that important cultural aspects must be taken in account, which makes word-for-word translation of health literacy material insufficient, if even possible. These cultural differences cannot be fully realized without employing the cultural humility construct, which is defined as having an interpersonal stance that is other-oriented rather than self-focused, and is characterized by respect and lack of superiority toward an individual's cultural background and experience.[6] Cross-cultural adaptation of the National Institutes of Health Stroke Scale to different languages/cultures, including Spanish[7] and Arabic,[8] has taken these cultural concepts into account. Both adaptations did not translate only the language, but also changed the figures used for testing language function and articulation. For example, instead of unfamiliar items such as a glove and hammock, more familiar items such as a horse and football were used. Another important change was the choice of words to be the standardized words for testing dysarthria, as the original English words had to be changed to words from the target audience's language, keeping in mind that the new words needed to comprehensively test the language-specific phonetic setting. We followed the same model, supplementing it with feedback and active contribution from Hmong community members.

The 8 translated documents cover a wide range of stroke-related topics—from risk factors and prevention to treatment and recovery. Through this publication, we make them available for use by all health care providers and the public (Appendix). Yet, these documents remain educational tools, not the educational process itself. To achieve a culturally competent stroke educational process for the Hmong, further studies need to explore the optimal timing and frequency of exposure, the impact of the surrounding conditions (acute illness versus recovery), role of family members and social network, and the influence of the educator.

In another relevant project, our institution collaborated with the AHA to place a blood pressure kiosk at the local Hmong market (Hmong Village) in St. Paul. This kiosk was supplemented with the Hmong stroke education material we developed so that Hmong individuals who check their blood pressure have immediate access to information about vascular risk factors, stroke warning signs, stroke treatment, and recovery.

Our plan is to formally evaluate the educational material through a survey of patients and their families. The survey will focus on assessing comprehension of the main concepts in each document immediately after first exposure and retention of these concepts in follow-up clinic visits. We also intend to produce a series of short educational videos to be distributed through social media outlets commonly visited by the Hmong community.

**Acknowledgements:** The authors wish to thank Blia Elderly Care Center, LLC, and its residents, for hosting the study team and volunteering to be included in the new images; Lor (Anthony) Lee for final proofreading of the translated text; and Maryann Esh for overseeing design and production of the patient education materials.

**Funding/Support:** The translation of this educational material from English to Hmong with permission from the American Heart Association, Inc. This work was funded by Regions Hospital ONE Patient Care allocation grant.

**Financial Disclosures:** None declared.

**Appendix:** Available online at www.wmjonline.org.

## REFERENCES

**1.** Tapp N. Hmong. *Encyclopaedia Britannica*. Updated March 15, 2010. Accessed June 2019. https://www.britannica.com/topic/Hmong

**2.** United States Census Bureau. Accessed May 26, 2020. https://data.census.gov/cedsci/table?t=020%20-%20Hmong%20alone%20%28422%29%3A039%20-%20Hmong%20alone%20or%20in%20any%20combination%20%28422%29%20%26%20%28100-299%29%20or%20%28300,%20A01-Z99%29%20or%20%28400-999%29%3APopulations%20and%20People&tid=ACSSPP1Y2018.S0201&vintage=2018&hidePreview=true

**3.** Hussein HM, Kashyap B, Erickson LO, Droegemueller C, Hanson L. Clinical characteristics of Hmong patients presenting with acute ischemic stroke. *Stroke*. 2017;48(suppl 1):AWP228.

**4.** Droegemueller C, Xiong Z, Xiong P, et al. Hmong Stroke Knowledge Survey. *Neurology*. 2018;90(15 Suppl):P3.236.

**5.** Luan Erfe BM, Siddiqui KA, Schwamm LH, Kirwan C, Nunes A, Mejia NI. Professional medical interpreters influence the quality of acute ischemic stroke care for patients who speak languages other than English. *J Am Heart Assoc.* 2017;6(9):e006175. doi:10.1161/JAHA.117.006175

**6.** Hook JN, Davis DE, Owen J, Worthington EL, Utsey SO. Cultural humility: measuring openness to culturally diverse clients. *J Couns Psychol*. 2013;60(3):353-366. doi:10.1037/a0032595

**7.** Domínguez R, Vila JF, Augustovski F, et al. Spanish cross-cultural adaptation and validation of the National Institutes of Health Stroke Scale. *Mayo Clin Proc.* 2006;81(4):476-480. doi:10.4065/81.4.476

**8.** Hussein HM, Abdel Moneim A, Emara T, et al. Arabic cross cultural adaptation and validation of the National Institutes of Health Stroke Scale. *J Neurol Sci.* 2015;357(1-2):152-156. doi:10.1016/j.jns.2015.07.022

# The Race to the Bottom: Wisconsin's Long-Term Trends in Health Rankings

Odilichi Ezenwanne, MD, MPH; Rich Crawford, MD, MPH; Patrick L. Remington, MD, MPH


## ABSTRACT

**Background:** Wisconsin's health ranking dropped from 7th healthiest in 1990 to 23rd in 2018. The purpose of this paper is to identify the contributory factors to this decline.

**Methods:** Trends in Wisconsin's health rank for 1990 to 2018 were compared overall and for only identical measures used in both years.

**Results:** Of the identical measures used in both years (n=10), the median rank declined from 8.5 (range 6-21) in 1990 to 19 (range 9-43) in 2018, with the greatest declines for infectious diseases, infant mortality, and smoking. The ranks were lower in 2018 for the similar measures used and for measures used only in 2018 compared to measures used only in 1990.

**Discussion:** Wisconsin's drop in health ranking is real and calls for action to address the root causes.


## BACKGROUND

The United Health Foundation's America's Health Rankings provides an annual ranking of health determinants and outcomes for all 50 states.[1] These health rankings use objective measures of population health to summarize performance and enable comparisons. Complex data obtained from various surveillance systems are synthesized into an easily interpretable format for widespread dissemination. From its first benchmark edition in 1990, America's Health Rankings have provided a platform for initiating a broad discourse on health among health professionals, leaders, policymakers, and the general public on the health of their communities.[2]

Since the first report was released in 1990, Wisconsin's overall health ranking has declined steadily from 7th healthiest in 1990 to 23rd in 2018. The purpose of this analysis is to determine the reasons for this decline.

• • •

**Author Affiliations:** Preventive Medicine Residency Program, University of Wisconsin School of Medicine and Public Health (UW SMPH), Madison, Wis (Ezenwanne, Crawford, Remington).

**Corresponding Author:** Odilichi Ezenwanne, MD, MPH, University of Wisconsin-Madison, WARF Building, Rm 1032, 610 Walnut St, Madison, WI, 53726; phone 608.772.1216; email oezenwanne@wisc.edu; ORCID ID 0000-0001-7752-6519

## METHODS

The America's Health Rankings uses measures of health determinants and outcomes to assess the health of each of the 50 states. These individual measures are weighted and then combined into a single summary measure, eg, smoking contributes 7.5% to the overall health of a state. More detailed methods are available online.[1]

Wisconsin's overall health ranking from 1990 to 2018 was obtained from the America's Health Rankings website.[1] For each of the 32 measures used in the ranking for 1990 and/or 2018, we obtained the value of that measure (eg, percent smokers), the weight that the measure contributed to the overall rankings (eg, 7.5%), and Wisconsin's rank among the 50 states. These measures varied over the period of analysis and were categorized as follows:

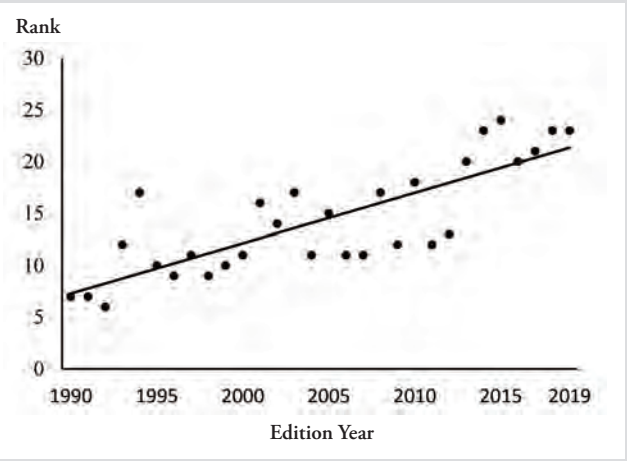
1. Identical and used in both years (n=10).
2. Similar and used in both years (n=3).
3. Used only in 1990 (n=4).
4. Used only in 2018 (n=15).

The change in Wisconsin's rank for the measures used in both 1990 and 2018 was calculated. In addition, Wisconsin's rank within each of these 4 categories (median and range) was deter mined, as well as the weights used in the models. Actual values of the measures also were included to quantify the absolute change in the health measures over this time period.

## RESULTS

Wisconsin's overall health ranking dropped from 7th in 1990 to 23rd in 2018 (see Figure), representing an average drop of about 1 place every 2 years over the 28-year period. The first report in 1990 used 17 measures categorized into 5 domains: mortality, lifestyle, access, disease, and disability. In contrast, the 2018 report used 33 measures categorized into 5 different domains: outcomes, plus 4 categories of health determinants—community and environment, policy, behaviors, and clinical care. In addition, the rela-

**Figure.** Trends in Wisconsin's Overall Health Ranking, 1990-2018




The line is a linear regression, where y = 0.48x + 6.8 and $R^2$ = 0.65.
Source: America's Health Rankings.[1]

tive weights of some of the measures—including 3 of the 10 identical measures—changed from 1990 to 2018.

### Trends in Measures Used in Both Years

The median rank for the 10 identical measures used in both years was 8.5 (range 6-21) in 1990 and dropped to 19 (range 9-43) in 2018. Of these measures, the greatest declines were noted in infectious diseases (down 37 places), infant mortality (down 16 places), smoking (down 14 places), and violent crime (down 11 places) (see Table 1). The weights remained the same for 7 of these measures, while weights for the other 3 were reduced, with smoking being lowered from 10% to 7.5%, and infant mortality and premature deaths being reduced from 7.5% to 3.125%. The proportion of the overall health of a state represented by these 10 identical measures declined from 57.5% in 1990 to 46.25 % in 2018.

The 3 measures that were similar but not identical in both years also declined overall, from a median rank of 21 (range 9-23) in 1990 to 25 (range 23-47) in 2018. Of these measures, the greatest declines were noted in public health funding (down 38 places) and cancer deaths (down 4 places). All 3 similar measures had a reduction in their individual weights, with support for public health being lowered from 5% to 2.5% and cancer deaths and heart deaths being lowered from 7.5% to 3.125%. The proportion of the overall health of a state represented by these measures decreased from 20% in 1990 to 8.75% in 2018.

### Comparing Measures Used Only in 1990 or 2018

Wisconsin's median rank for measures used only in 2018 was 13 places lower when compared with the median rank in measures used only in 1990. Four measures were unique to 1990, accounting for 22.5% of the overall health of the state, with a median rank of 8 (range of 4-16). The 15 measures unique to 2018 had a median rank of 21 (range of 8-50) and accounted for 45% of the state's overall health ranking.

## DISCUSSION

Our analysis demonstrates that Wisconsin's national health ranking is dropping as a result of declines in the ranking for a broad spectrum of health outcomes, such as infant mortality, infectious diseases, violent crime, occupational fatalities, and premature mortality, as well as health determinants including smoking, obesity, percentage of uninsured, and children with poverty. A previous analysis of this trend was conducted in 2002 by the University of Wisconsin's Population Health Institute. It concluded that Wisconsin's decline was largely a result of not keeping pace with reductions in tobacco use and infant mortality seen in the United States as a whole.[3]

The drop in Wisconsin's overall health ranking must be interpreted with caution. The specific measures and weights used in the America's Health Rankings model have changed over time. The decision to change the measures used in the rankings may reflect a better understanding of the determinants of health or increasing availability of data. The decreases in the weights for the 3 measures that were used in both years (smoking, infant mortality, and premature deaths) are most likely a consequence of the addition of 16 measures in 2018.

Regardless of the rationale for these changes, it makes it difficult to evaluate changes in the overall state health rankings. For example, although "public health funding" fell from a rank of 9th to 47th, the definitions of this measure changed substantially. It is also difficult to interpret the impact of dropping some of the measures from 1990 and adding others in 2018. The fact that the average rank of these measures was lower in 2018 compared with 1990—21 versus 8—certainly contributed to the drop in Wisconsin's overall health ranking. More research is needed to determine the trends for each of these measures to identify their impact on Wisconsin's overall decline in health rankings. Erwin et al also noted the changes in measures used over time and reported that a greater proportion of the measures used in the initial edition were related to health outcomes, while more recent editions had a predominance of measures associated with health determinants.[2]

Despite Wisconsin's decline in ranking for many health factors, most of the comparable, individual, measures improved in absolute terms. This discordance indicates greater overall improvement in the U.S. compared to Wisconsin. Similar findings were noted in the 2002 analysis report.[3] In contrast, 3 measures showed concomitant worsening absolute trends, including the rate of obesity, the percentage of children living with poverty, and violent crimes.

Over the past 3 decades, America's Health Rankings has been shown to be useful by state health policymakers. A study carried out to evaluate the utility of the America's Health Rankings among various state health agencies using key informant interviews of state health workers reported that the rankings were used as a resource for problem identification (54%), as a source for data (47%), and to track annual changes in health (59%).[2] The model of population health used in the America's Health Rankings was adapted in 2003 by the University of Wisconsin Population Health Institute to rank the counties in Wisconsin, highlighting the usefulness of this model as an important tool in monitoring the overall health of a state.[4] Based on this experience in Wisconsin, and with support from the Robert Wood Johnson Foundation, the County Health Rankings were developed in 2010, ranking the health of all counties in the nation.[5]

**Table 1.** Trends in Wisconsin's Health Rankings, 1990 to 2018

| | Value | | | Rank | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2018 | Change | 1990 | 2018 | Change | 1990 | 2018 | Change | |
| **Measure (identical)** | | | | | | | | | | |
| Infectious disease (z-score) | -1.25 | 0.52 | 1.77 | 6 | 43 | -37 | 5.00% | 5.00% | 0 | |
| Infant death rate/1000 births | 8.9 | 6 | -2.9 | 8 | 24 | -16 | 7.50% | 3.25% | -4.25% | |
| Smoking (%) | 26.3 | 16 | -10.3 | 6 | 20 | -14 | 10.00% | 7.50% | -2.50% | |
| Violent crime rate [a] | 250 | 320 | 70 | 11 | 22 | -11 | 5.00% | 5.00% | 0 | |
| Premature death rate [a] | 7143 | 6821 | -322 | 7 | 17 | -10 | 7.50% | 3.25% | -4.25% | Favorable |
| Children with poverty (%) | 12.6 | 14.5 | 1.9 | 9 | 18 | -9 | 5.00% | 5.00% | 0 | |
| Obesity (%) | 11.3 | 32 | 20.7 | 21 | 30 | -9 | 5.00% | 5.00% | 0 | Not favorable |
| Uninsured (%) | 8.3 | 5.4 | -2.9 | 6 | 10 | -4 | 5.00% | 5.00% | 0 | |
| Occupational fatality rate [a] | 7.8 | 4.3 | -3.5 | 14 | 17 | -3 | 2.50% | 2.50% | 0 | * No change |
| High school graduation (%) | 83.7 | 88.2 | 4.5 | 9 | 9 | 0* | 5.00% | 5.00% | 0 | |
| **Median (Range)** | | | | **8.5 (6-21)** | **19 (9-43)** | | | | | |
| **Measure (similar)** | | | | | | | | | | |
| Support for public health | 0.89 [b] | 52 [c] | | 9 | 47 | -38 | 5.00% | 2.50% | -2.50% | |
| Cancer death rate [a] | 196 | 191 | 5 | 21 | 25 | -4 | 7.50% | 3.25% | -4.25% | |
| Heart death rate [a] | 306 | 239 | 67 | 23 | 23 | 0* | 7.50% | 3.25% | -4.25% | |
| **Median (Range)** | | | | **21 (9-23)** | **25 (23-47)** | | | | | |

[a] Per 100,000 population.
[b] Ratio of state health care expenditures to low-income population.
[c] State and federal dollars directed to public health per person.

Monitoring long-term trends in health rankings can be used to assess relative progress in health outcomes, determinants, and related public health investments at the state and local levels.[6-8] Even though Wisconsin improved in absolute values in most of the domains, the magnitude of these improvements was insufficient to preserve Wisconsin's initial top 10 ranking in 1990. However, these gains were eclipsed by greater improvements across similar domains recorded by several US states. Obesity, children living with poverty, and violent crime rate were the only measures that recorded negative absolute changes within this period directly contributing to the decline. However, more research is required to determine the effects of the introduction of new measures on Wisconsin's change in ranking. The decline serves as a call for action to address the inciting root causes and to keep abreast of advances achieved by other states to improve overall population health.

**Funding/Support:** Support for this work was provided to the Preventive Medicine Residency Program by the Wisconsin Partnership Program, Middleton VA Hospital, and School of Medicine and Public Health.

**Financial Disclosures:** None declared.

**Table 2.** Wisconsin State Health Rankings, 1990 and 2018

| Measure | Value | Rank | Weight |
|---|---|---|---|
| **1990 only** | | | |
| Total death rate [a] | 833 | 16 | 10% |
| Motor vehicle death rate [b] | 1.9 | 8 | 5% |
| Limited activity days/month | 2.9 | 8 | 2.5% |
| Adequate prenatal care (%) | 78.6 | 4 | 5% |
| **Median (range)** | | **8 (4-16)** | |
| **2018 only** | | | |
| Excessive drinking (%) | 24.2 | 50 | 2.5% |
| Disparity in health status (%) | 31.3 | 41 | 3¼% |
| Immunization – children (%) | 69.2 | 36 | 2.5% |
| Mental health providers [a] | 191 | 34 | 3% |
| Drug deaths [a] | 16.4 | 24 | 2.5% |
| Frequent physical distress (%) | 11.9 | 23 | 3¼% |
| Immunization–adolescent (z-score) | 0.197 | 21 | 2.5% |
| Dentists [a] | 58.2 | 21 | 3% |
| Primary care physicians [a] | 150 | 20 | 3% |
| Low birthweight (%) | 7.4 | 17 | 3% |
| Preventable hospitalizations/ 1000 | 45 | 17 | 3% |
| Frequent mental distress (%) | 11.6 | 17 | 3¼% |
| Air pollution (μg/$m^3$) | 6.8 | 12 | 5% |
| Diabetes (%) | 9.1 | 12 | 3¼% |
| Physical inactivity (%) | 22.4 | 8 | 2.5% |
| **Median (range)** | | **21 (8-50)** | |

[a] Per 100,000 population.
[b] Per 100,000 miles driven.

## REFERENCES

**1.** United Health Foundation. America's Health Rankings. Accessed March 21, 2019. www.americashealthrankings.org/

**2.** Erwin PC, Myers CR, Myers GM, Daugherty LM. State responses to America's Health Rankings: the search for meaning, utility, and value. *J Public Health Manag Pract.* 2011;17(5):406-412. doi:10.1097/PHH.0b013e318211b49f

**3.** Peppard P, Kindig D, Remington PL. Why did Wisconsin fall in state health rankings? Population Health Institute Working Paper. University of Wisconsin, 2002.

**4.** Peppard PE, Kindig D, Jovaag A, Dranger E, Remington PL. An initial attempt at ranking population health outcomes and determinants. *Wis Med J.* 2004;103(3):52-56.

**5.** Remington PL, Catlin BB, Gennuso KP. The County Health Rankings: rationale and methods. *Popul Health Metr.* 2015;13(11):1-12. doi:10.1186/s12963-015-0044-2

**6.** Sharfstein JM. Using health care data to track and improve public health. *JAMA.* 2015;313(20):2012-2013. doi:10.1001/jama.2015.4795

**7.** Peppard PE, Kindig DA, Dranger E, Jovaag A, Remington PL. Ranking community health status to stimulate discussion of local public health issues: the Wisconsin County Health Rankings. *Am J Public Health.* 2008;98:209-212.

**8.** Oliver TR. Population health rankings as policy indicators and performance measures. *Prev Chronic Dis.* 2010;7:A101.

# The Potential Impact of Hospital Cafeterias on Dietary Habits: A Case Study of the University of Wisconsin Hospitals and Clinics

Phillip M. Warsaw, PhD; Alfonso Morales, PhD


## ABSTRACT

**Background:** Recent research indicates that hospitals are serving an increased role in retail food markets. This article examines the potential effects of pricing strategies on consumer behavior at the University of Wisconsin Hospitals and Clinics.

**Methods:** Biweekly point-of-sales data from 2015-2017 were collected for the University of Wisconsin Hospitals and Clinics' largest retail cafeteria. *T* tests were used to identify differences in consumer behavior in response to price changes for bottled water, cheeseburgers, and the salad bar and potential impacts for alternatives.

**Results:** Purchases of bottled water and salad increased after price decreases were implemented; cheeseburger purchases decreased following the price increase.

**Discussion:** Foodservice pricing strategies can drive significant change in consumer behavior. However, consumer sensitivity to price changes may affect the financial viability of price-centric approaches.


## INTRODUCTION

Recent retail trends suggest that hospitals have a growing influence on the behavioral and nutritional outcomes of their communities. The number of nonpatient meals served by hospitals through retail and food security efforts has increased, and hospitals have begun to diversify the sources of food they serve, specifically increasing the proportion of regionally produced food products they procure.[1]

Since 2013, administrators at the University of Wisconsin Hospital and Clinics and American Family Children's Hospital (UWHC) have overhauled their food service operations to 2 primary ends: (1) to encourage increased consumption of fresh produce, bottled water, and lean proteins, along with reduced consumption of sugar-sweetened beverages, processed foods, and red meat in their food retail spaces; and (2) to increase the share of their food budget allocated to locally produced food, to reduce their environmental impact, and strengthen local economies within Wisconsin.[2-3] To these ends, nutritional and culinary service staff at UWHC have employed several behavioral "nudges" to steer visitors towards these "healthier" options.

In this study, we provide an evaluation of one such policy: a 2016 pricing strategy that reduced the prices of the salad bar and bottled water while increasing the price of cheeseburgers. In this work, we analyzed the impact of these price changes on the purchase and suggested consumption of the targeted food and beverage items and other alternatives within UWHC's foodservice operations.

## METHODS

In 2016, UWHC implemented permanent pricing changes for food and beverage products across their food service retail spaces, with the intent of encouraging healthier eating habits among patrons. In January 2016, UWHC decreased the salad bar price from $8/lb to $4.99/pound and bottled water from $1 to $0.75. In November 2016, the price of cheeseburgers was increased from $4.25 to $5.50.

For this study, we obtained biweekly point-of-sale data for the Four Lakes Café—the largest food retail space associated with UWHC—from August 2015 to December 2017. Data

• • •

**Author Affiliations:** Department of Community Sustainability, Michigan State University, East Lansing, Mich (Warsaw); Department of Planning and Landscape Architecture, University of Wisconsin-Madison, Madison, Wis (Morales).

**Corresponding Author:** Phillip M. Warsaw, PhD; 480 Wilson Rd, Room 314, East Lansing, MI 48824; phone 517.353.1916; email warsawph@msu.edu; ORCID ID 0000-0003-1686-181X

included prices, revenue, and quantities sold for each product sold during the study period (t = 63 biweekly periods). We used a 2-sample *t* test to compare the average quantity sold for each item before and after the pricing changes.

We divided the study period into 3 segments to analyze the individual effects of the salad and cheeseburger policies: the time period prior to implementation of the salad bar policy (August 2015 to December 2015, t = 11), the period after implementation of the salad bar policy and prior to the implementation of the cheeseburger policy (January 2016 to October 2016, t = 22), and the period after the cheeseburger price increase (November 2016 to December 2017, t = 30). In the case of beverage consumption, we compare the time periods before and after the bottled water price decrease (August 2015 to December 2015, t = 11 vs January 2016 to December 2017, t = 52).

**Table.** Food and Beverage Purchases (Quantity Sold in Units)

| Salad Bar Pricing Policy | Pre-Price Change (t = 11 biweekly periods) | | Post-Price Change (t = 22 biweekly periods) | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | T-stat |
| Salad Bar | 3070.73 | 267.34 | 5292.23 | 611.34 | -11.45[a] |
| Cheeseburger | 931.36 | 78.26 | 843.95 | 99.59 | 2.54[a] |
| French Fries | 1190.27 | 139.39 | 1040.27 | 116.71 | 3.27[a] |
| Asian Entree | 895.82 | 48.29 | 879.95 | 91.68 | 0.36 |
| Chipotle Entree | 649.00 | 97.77 | 581.32 | 53.80 | 2.58[a] |
| **Cheeseburger Pricing Policy** | **Pre-Price Change (t = 22 biweekly periods)** | | **Post-Price Change (t = 30 biweekly periods)** | | |
| | Mean | SD | Mean | SD | T-stat |
| Salad Bar | 5292.23 | 611.34 | 6083.43 | 575.52 | -4.77[a] |
| Cheeseburger | 843.95 | 99.59 | 691.90 | 55.10 | 7.04[a] |
| French Fries | 1040.27 | 116.71 | 977.23 | 82.21 | 2.28[a] |
| Asian Entree | 879.95 | 91.68 | 1173.90 | 318.13 | -4.20[a] |
| Chipotle Entree | 581.32 | 53.80 | 568.77 | 73.86 | 0.68 |
| **Water Pricing Policy** | **Pre-Price Change (t = 11 bi-weekly periods)** | | **Post-Price Change (t = 52 bi-weekly periods)** | | |
| | Mean | SD | Mean | SD | T-stat |
| Still Water | 1009.36 | 91.59 | 1220.64 | 133.83 | -4.98[a] |
| Fountain Drinks | 842.36 | 122.62 | 731.79 | 59.26 | 4.53[a] |
| Diet Coke | 1153.36 | 125.29 | 1288.60 | 144.35 | -2.88[a] |

[a] Measured difference significant at the 5% level.

Finally, we also performed *t* tests on three of the most popular fresh-made items and beverages for which we had consistent records throughout the study period: fountain drinks, bottled Diet Coke, french fries, and 2 entrees prepared at the Four Lakes Café Global Harvest station: Asian and chipotle.

## RESULTS

The Table lists the total food and beverage units purchased at the Four Lakes Café both before and after pricing changes. Biweekly sales at the salad bar increased from $16,888 to $18,508 after the price decrease (T = -2.24, $P = 0.05$), and again to $21,962 after the increase in cheeseburger prices (T = -5.40, $P = 0.001$). Biweekly sales of cheeseburgers decreased from $3,787 to $3,458 with the salad price decrease, but increased to $3,677 (T = -2.39, $P = 0.05$) after the cheeseburger price increase. Figure 1 illustrates the change in salad and cheeseburger purchases over the study period.

Revenue generated by water bottle sales decreased from $1,009 to $918 with the price decrease (T = 2.75, $P = 0.01$). Figure 2 illustrates the change in bottled water purchases during the study period.

## DISCUSSION

The results of the analysis suggest a shift in consumer purchases in each of the cases presented: increases in salad and water purchases and a decrease in cheeseburger purchases. Further, while the number of comparable products in the data were limited, the results indicated a change in the purchase of other competing products as a result of the pricing changes, specifically for french fries and fountain drinks, which both sustained a decrease in purchases as a result. These findings are in line with previous studies. In particular, two other case studies examining the effects of a price drop for salad in retail settings found that reducing salad price by 50% increased salad consumption by 100% to 300%.[4-5] Fewer studies have considered the direct effect of pricing on bottled water and cheeseburgers, though previous research has found that demand for sugar-sweetened beverages is particularly sensitive to price,[6] likely explaining the observed shift from fountain drinks in light of the price decrease for bottled water.

While these results indicate the potential for nudging consumer behavior via price mechanisms, budgetary concerns are a primary barrier to their large-scale implementation. Food service directors operate with limited budgets, thus must weigh financial viability with their broader nutritional objectives.[7] This case highlights that tension; in some instances, a price decrease is counteracted by a larger increase in the quantity purchased, as with the salad bar. In other cases, such as with bottled water, the increase in quantity of purchases is not sufficient to compensate for the decreased price. A 2010 meta-analysis of the price sensitivity of food products indicated that the demand for fruits, sodas, vegetables, and beef is relatively sensitive to price changes.[8] However, these estimates vary significantly across the studies analyzed and, on average, suggested that significant price decreases were unlikely to lead to increases in revenue.

## CONSIDERATIONS AND CONCLUSION

There were 2 primary limitations to this study. First, a change in the software used to collect point-of-sale data by UWHC in late

**Figure 1.** Change in Salad and Cheeseburger Purchases Over the Study Period

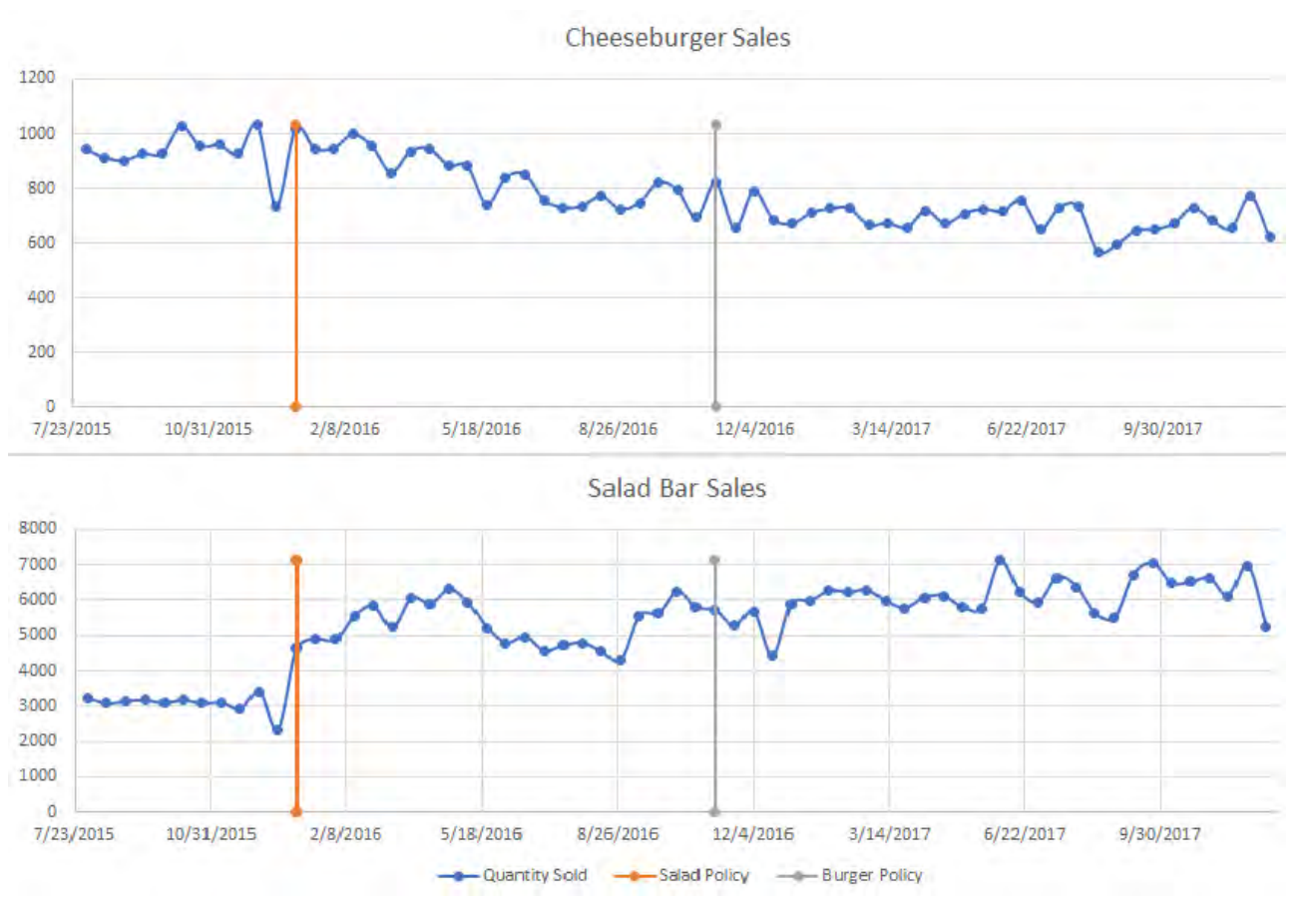
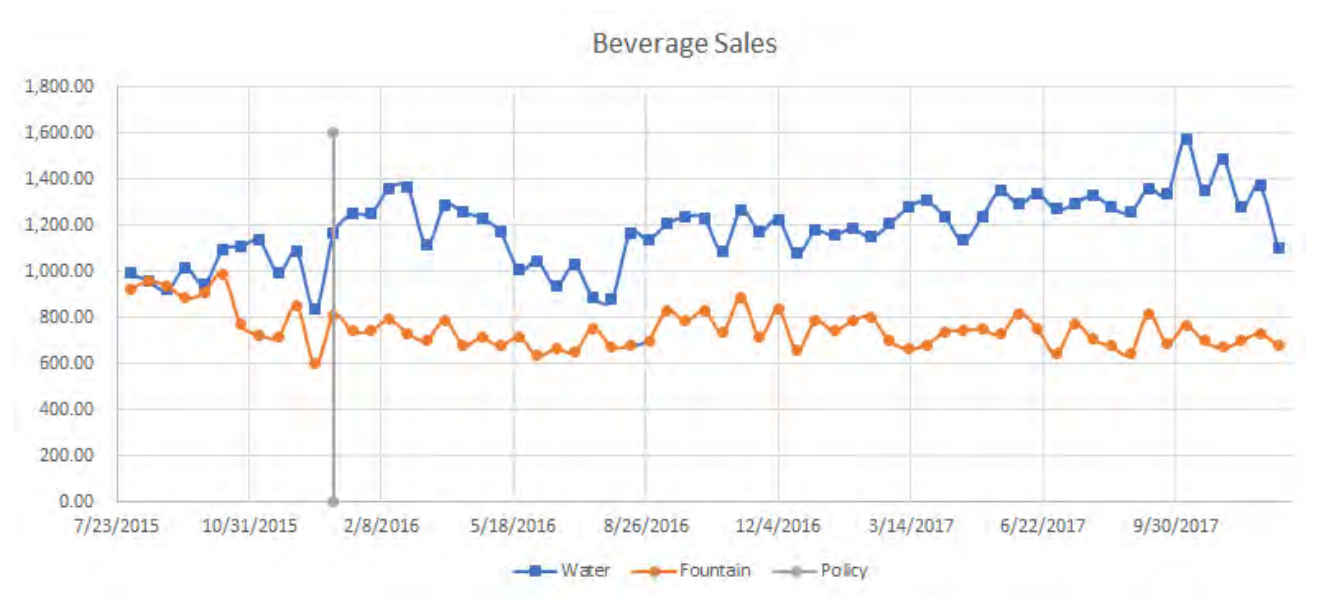



**Figure 2.** Change in Bottled Water Purchases Over the Study Period



2015 made data prior to August unavailable, limiting the number of observations available for analysis. Second, the policies investigated in this paper were part of a larger program of change implemented by UWHC throughout their culinary services program. As an example, in 2017, UWHC introduced the "Harvest of the Month" campaign, which highlights locally sourced produce in menu items sold in the cafeteria. While the campaign occurred a year after the policies evaluated here, such initiatives could bias the estimates presented.

Future research should investigate both price and nonprice promotions in hospital settings, and their impact on both consumer behavior and revenue generation. A growing body of literature indicates that nonprice behavioral strategies, such as product placement, samples, displaying caloric content, and other signage, affect consumer behavior[9] with less risk of revenue loss than changes to pricing strategies. However, the magnitude of their impact is typically lower than that of price-based strategies. Further, the long-term impact on consumer behavior remains unclear.[10]

With these limitations considered, the results presented in this research indicate a significant role for hospitals to use their culinary services as a tool for accomplishing their broader public health goals. Through a targeted pricing campaign, administrators at UWHC influenced a significant shift away from red meat, associated sides, and fountain drinks to increased consumption of fresh vegetables and bottled water.

**Acknowledgements:** The authors would like to recognize Sarah Schuit, Susan Gaeddert, Ocoee Huss, and Kayla Lewis for their work as research assistants and extend thanks to Megan Waltz, Lisa Bote, and the other members of the University of Wisconsin Hospital and Clinics Culinary Services team for their support with the analysis provided here.

**Funding/Support:** This work was supported by a grant from the Institute for Clinical and Translational Research at the University of Wisconsin-Madison, Improving Hospital Nutrition through Evidence Based Implementation of Behavioral Strategies.

**Financial Disclosures:** None declared.

## REFERENCES

**1.** 2016 Healthcare Census: Hospitals raise their game. Food Service director. Published May 16, 2016. Accessed September 3, 2017. https://www.foodservicedirector.com/operations/2016-healthcare-census-hospitals-raise-their-game

**2.** Stohs N. What happened when UW Hospital cafeteria made eating healthy easier? *Milwaukee Journal Sentinel.* Feb 27, 2017. Accessed March 20, 2018. https://www.jsonline.com/story/life/food/nancy-stohs/2017/02/27/what-happened-when-uw-hospital-cafeteria-made-eating-healthy-easier/98267660/

**3.** Mills S. Wisconsin hospitals want more local food for patient's plates. *Wisconsin Public Radio*. Published May 26, 2017. Accessed November 20, 2019. https://www.wpr.org/wisconsin-hospitals-want-more-local-food-patients-plates

**4.** Kottke TE, Pronk NP, Katz AS, Tillema JO, Flottemesch TJ. The effect of price reduction on salad bar purchases at a corporate cafeteria. *Prev Chronic Dis.* 2013;10:E25. doi:10.5888/pcd10.120214

**5.** Jeffery RW, French SA, Raether C, Baxter JE. An environmental intervention to increase fruit and salad purchases in a cafeteria. *Prev Med*. 1994;23(6):788-792. doi:10.1006/pmed.1994.1135

**6.** Colchero MA, Salgado JC, Unar-Munguía M, Hernández-Ávila M, Rivera-Dommarco JA. Price elasticity of the demand for sugar sweetened beverages and soft drinks in Mexico. *Econ Hum Biol.* 2015;19:129-137. doi:10.1016/j.ehb.2015.08.007

**7.** Sachs E, Feenstra G. Emerging local food purchasing initiatives in Northern California hospitals. UC Davis Agriculture Sustainability Initiative; 2008. Accessed July 10, 2019. https://asi.ucdavis.edu/sites/g/files/dgvnsk5751/files/inline-files/FarmToHospitalInitiativesWeb.pdf

**8.** Andreyeva T, Long MW, Brownell KD. The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. *Am J Public Health*. 2010;100(2):216-222. doi:10.2105/AJPH.2008.151415

**9.** Rozin P, Scott S, Dingley M, Urbanek JK, Jiang H, Kaltenbach M. Nudge to nobesity I: minor changes in accessibility decrease food intake. *Judgm Decis Mak*. 2011;6(4):323-332.

**10.** Liberato SC, Bailie R, Brimblecombe J. Nutrition interventions at point-of-sale to encourage healthier food purchasing: a systematic review. *BMC Public Health*. 2014;14:919. doi:10.1186/1471-2458-14-919

# Distribution of Dermatologists in Wisconsin: How Are We Doing in Providing Care to Our Most Vulnerable Communities

Sarah Mortimer, MD; Anne Rosin, MD


## ABSTRACT

**Background:** The specialty of dermatology has not been affected by initiatives to help recruit physicians rurally, even with the rising demand for dermatology services. The geographic density of dermatologists is distributed unevenly across the nation; however, the distribution has not been analyzed at the state level for Wisconsin.

**Methods:** We analyzed geographic distribution information obtained from the American Academy of Dermatology.

**Results:** The Southeastern region of Wisconsin has the greatest density of dermatologists, with 6.76 per 100,000 individuals. Northeastern, Southern, Western, and Northern regions follow with ratios of 4.32, 3.97, 3.53, and 3.50, respectively.

**Discussion:** Two of the 5 state public health regions are adequately served with a ratio of greater than 4 dermatologists per 100,000 individuals. Wisconsin's regions with the greatest rural counties contain the worst ratios.


## BACKGROUND

The physician shortage facing the United States and its disproportionate impact on rural communities is not a new issue. National initiatives including the Veterans Access, Choice, and Accountability Act of 2014 and the Resident Physician Shortage Reduction Act of 2019 have contributed to new residency positions and programs in Wisconsin in various specialties.[1] However, one specialty that has not yet been affected by this funding is dermatology.

There is a rising demand for dermatological care due to a number of factors, including the aging population, rising skin cancer and inflammatory skin disorder rates, as well as increasing complexity of therapeutics.[2] A decreased dermatologist density has been associated with higher melanoma mortality rates and inferior diagnosis of skin disease.[3] Rural areas are particularly prone to physician workforce shortages, and patients experience longer wait times and greater travelling distances to receive care.[4] Wisconsin is no exception; 46 of its 54 counties are considered rural by the US Health Resources and Services Administration (HRSA).[5]

Across the United States, the geographic density of dermatologists is distributed unevenly to larger cities and academic centers.[6] A ratio of 4 dermatologists to 100,000 individuals is considered adequate to care for a community.[6] It is important to understand how individual states are meeting the needs of their populations. In concordance with the Wisconsin Idea, this study analyzes how Wisconsin is doing in dermatological care beyond the academic centers.

## METHODS

The American Academy of Dermatology (AAD) provided geographic information consisting of city, states, and ZIP codes.[7] Physicians were then allocated to their respective counties. County population information was obtained from the US Census Bureau.[8] Counties were grouped based on 5 regions defined by the Wisconsin Department of Health Services

• • •

**Author Affiliations:** Department of Dermatology, University of Wisconsin School of Medicine and Public Health, Madison, Wis (Mortimer, Rosin); William S. Middleton Memorial Veterans Hospital (Rosin).

**Corresponding Author:** Sarah Mortimer, MD, Department of Dermatology, University of Wisconsin School of Medicine and Public Health, 1 S Park St, 7th Floor, Madison, WI 53705, phone 608.287.2620; email smortimer@uwhealth.org.

(DHS): Southern, Southeastern, Northeastern, Northern, and Western regions.[9] Because this study did not report on data involving human subjects, institutional review board approval was not applicable.

## RESULTS

The 2019 AAD database contains 289 registered American dermatologists in Wisconsin. The Southeastern region of Wisconsin has the greatest density of dermatologists, with 6.76 per 100,000 individuals (Table 1). Northeastern, Southern, Western, and Northern regions follow with ratios of 4.32, 3.97, 3.53, and 3.50, respectively. Milwaukee County boasts the greatest number of dermatologists at 68. There are 40 counties without a dermatologist (Table 2).

## DISCUSSION

Consistent with findings of other studies, Wisconsin dermatologists are unevenly geographically distributed, with most practicing in dermatology-dense areas (Figure).[6] Of the 5 DHS regions, 3 have approximately 4 dermatologists per 100,000 or greater, while 2 are markedly below. The Southern, Western, and Northern regions have the most counties considered rural and contain the lowest dermatologist-to-population ratios. The analysis reveals that compared to other states, Wisconsin is above average with respect to the number and distribution of providers throughout the state. Past studies looking at the nation as a whole have shown that 70% of the nation has less than 4 dermatologists per 100,000 individuals and 60% has less than 3 per 100,000.[6] However, it remains evident that rural Wisconsin populations endure longer driving distances to receive dermatological care.

There are limitations to this study. Firstly, the analysis is dependent on the location in which the dermatologists are registered with the AAD. It does not account for rural satellite locations and telemedicine, potentially underestimating the service to the rural populations. However, it also does not account for physicians working less than full-time in a given location in which the access is worse than calculated. Further, it is well known that dermatologists are now being supplemented by nonphysician clinicians.[10] It has been shown that dermatology physician assistants increase the average US dermatology provider density to more than 4 per 100,000 individuals.[10] Even with the increased density they provide, however, their distribution mirrors that of physicians with disparity remaining in the rural areas.[10] It should also be considered that the outcome of supplementation by nonphysician dermatology providers has not been fully elucidated in literature.

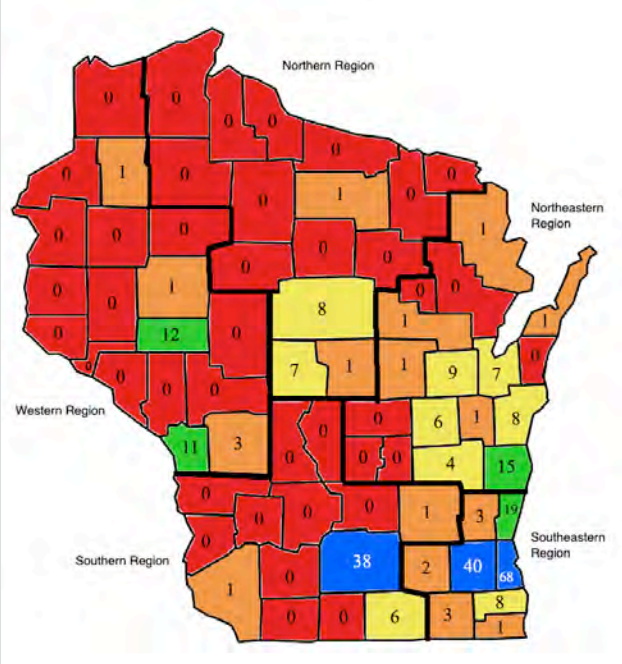
## CONCLUSION

Wisconsin is above average with respect to number and distribution of providers throughout the state in comparison to other states. Yet, the regions with the most rural counties have the lowest ratios. It is imperative that Wisconsin providers be increasingly aware of our response to the demand of health care services. In dermatology, the number of residency training positions has remained relatively stagnant while demand has increased, resulting in a projected unmet need.[5] This need is felt most acutely in our rural populations. This alone is not likely to fill the shortage gaps. The incorporation of teledermatology and adequately trained and supervised advanced practice providers may also be helpful in extending access. These findings demonstrate that the distribution of dermatologists in Wisconsin and access to dermatological care warrant initiatives to incentivize dermatologists to provide care to underserved regions.

**Table 1.** Ratio of Dermatologists by Public Health Region

| Region | No. Dermatologists per 100,000 Individuals |
|---|---|
| Southern | 3.97 |
| Southeastern | 6.76 |
| Northeastern | 4.32 |
| Northern | 3.50 |
| Western | 3.53 |

**Figure.** Number of Dermatologists per Wisconsin County




Red, orange, yellow, green and blue colors denote 0, 1-3, 4-10, 11-20, 21-68 dermatologists, respectively. Thick black outline denotes boundaries of the Public Health Regions defined by Wisconsin Department of Health.

**Funding/Support:** None declared.

**Financial Disclosures:** None declared.

**Table 2.** Dermatologist Distribution Based on Wisconsin County

| County | No. of Dermatologists | No. of Residents |
|---|---|---|
| **Southern Region** | | |
| Adams | 0 | 20,383 |
| Columbia | 0 | 57,358 |
| Crawford | 0 | 16,291 |
| Dane | 38 | 542,201 |
| Dodge | 1 | 87,847 |
| Grant | 1 | 51,554 |
| Green | 0 | 36,929 |
| Iowa | 0 | 23,771 |
| Juneau | 0 | 26,617 |
| Lafayette | 0 | 16,665 |
| Richland | 0 | 17,377 |
| Rock | 6 | 163,129 |
| Sauk | 0 | 64,249 |
| Vernon | 0 | 30,785 |
| **Southeastern Region** | | |
| Jefferson | 2 | 85,129 |
| Kenosha | 1 | 169,290 |
| Milwaukee | 68 | 948,201 |
| Ozaukee | 19 | 89,147 |
| Racine | 8 | 196,584 |
| Walworth | 3 | 103,718 |
| Washington | 3 | 135,693 |
| Waukesha | 40 | 403,072 |
| **Northeastern Region** | | |
| Brown | 7 | 263,378 |
| Calumet | 1 | 50,159 |
| Door | 1 | 27,610 |
| Fond du Lac | 4 | 103,066 |
| Green Lake | 0 | 18,918 |
| Kewaunee | 0 | 20,383 |
| Manitowoc | 8 | 79,074 |
| Marinette | 1 | 40,434 |
| Marquette | 0 | 15,434 |
| Menominee | 0 | 4,658 |
| Oconto | 0 | 37,830 |
| Outagamie | 9 | 187,365 |
| Shawano | 1 | 40,796 |
| Sheboygan | 15 | 115,456 |
| Waupaca | 1 | 51,128 |
| Waushara | 0 | 24,263 |
| Winnebago | 6 | 171,020 |

| County | No. of Dermatologists | No. of Residents |
|---|---|---|
| **Western Region** | | |
| Barron | 0 | 45,164 |
| Buffalo | 0 | 13,125 |
| Burnett | 0 | 15,392 |
| Chippewa | 1 | 64,135 |
| Clark | 0 | 34,709 |
| Douglas | 0 | 43,208 |
| Dunn | 0 | 45,131 |
| Eau Claire | 12 | 104,534 |
| Jackson | 0 | 20,478 |
| La Crosse | 11 | 118,230 |
| Monroe | 3 | 46,051 |
| Pepin | 0 | 7,289 |
| Pierce | 0 | 42,555 |
| Polk | 0 | 43,598 |
| Rusk | 0 | 14,147 |
| St. Croix | 0 | 89,694 |
| Trempealeau | 0 | 29,442 |
| Washburn | 1 | 15,878 |
| **Northern Region** | | |
| Ashland | 0 | 15,600 |
| Bayfield | 0 | 15,042 |
| Florence | 0 | 4,321 |
| Forest | 0 | 8,991 |
| Iron | 0 | 5,676 |
| Langlade | 0 | 19,268 |
| Lincoln | 0 | 27,689 |
| Marathon | 8 | 135,428 |
| Oneida | 1 | 35,470 |
| Portage | 1 | 70,942 |
| Price | 0 | 13,397 |
| Sawyer | 0 | 16,489 |
| Taylor | 0 | 20,412 |
| Vilas | 0 | 21,938 |
| Wood | 7 | 73,055 |

## REFERENCES


**1.** Kerschner JE. Helping to alleviate the projected physician shortage. *WMJ*. 2019;118(2):103-104.

**2.** Feng H, Berk-Krauss JJ, Feng PW, Stein JA. Comparison of dermatologist density between urban and rural counties in the United States. *JAMA Dermatol*. 2018;154(11):1265-1271. doi:10.1001/jamadermatol.2018.3022

**3.** Aneja S, Aneja S, Bordeaux JS. Association of increased dermatologist density with lower melanoma mortality. *Arch Dermatol.* 2012;148(2):174-178. doi:10.1001/archdermatol.2011.345

**4.** Kimball AB, Resneck JS Jr. The US dermatology workforce: a specialty remains in shortage. *J Am Acad Dermatol*. 2008;59(5):741-745. doi:10.1016/j.jaad.2008.06.037

**5.** Wisconsin Office of Rural Health. Wisconsin divided ten ways: a review of rural-urban classification systems. July 2019. Accessed on December 2, 2019. http://worh.org/sites/default/files/WIsconsinDividedTenWays2019.pdf

**6.** Glazer AM, Farberg AS, Winkelmann RR, Rigel DS. Analysis of trends in geographic distribution and density of US dermatologists. *JAMA Dermatol.* 2017;153(4):322-325. doi:10.1001/jamadermatol.2016.5411

**7.** Find a dermatologist. American Academy of Dermatology. 2019. Updated 2020. Accessed December 2, 2019. https://find-a-derm.aad.org

**8.** County population totals: 2010-2019. United States Census Bureau. Accessed December 2, 2019. https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-total.html

**9.** DHS Regions by County. Wisconsin Department of Health Services. Updated July 26, 2018. Accessed December 2, 2019. https://www.dhs.wisconsin.gov/aboutdhs/regions.htm

**10.** Glazer AM, Rigel DS. Analysis of trends in geographic distribution of US dermatology workforce density. *JAMA Dermatol.* 2017;153(5):472–473. doi:10.1001/jamadermatol.2016.6032

# Brodifacoum Poisoning Linked to Synthetic Marijuana Use in Wisconsin

Madison Kircher; Jude Perez, MD


## ABSTRACT

**Introduction:** Recent outbreaks of brodifacoum-induced coagulopathy resulting from the use of synthetic cannabinoids represents a growing public health concern. Brodifacoum is a commonly used and commercially available rodenticide that has anticoagulant properties. As new, unregulated synthetic cannabinoids enter the market, the potential for further outbreaks continues to rise.

**Case Presentation:** We report a case of severe bleeding secondary to inhalation of synthetic cannabinoids contaminated with brodifacoum. The patient had been evaluated for several months of ongoing, unexplained vaginal bleeding and developed hematemesis and rectal bleeding 2 weeks after her last reported use.

**Discussion:** There have been previous reports of hemorrhage after exposure to synthetic marijuana in rare cases, including an outbreak of severe bleeding and reported synthetic marijuana use in the Midwestern region of the United States in 2018.

**Conclusion:** While hemorrhaging after exposure to synthetic cannabinoids has been reported previously, we use this case to increase awareness of the potentially deadly exposures to brodifacoum from synthetic cannabinoids use in Wisconsin. By increasing awareness, emergency department physicians and state agencies can collaborate more effectively when responding in these cases.


## INTRODUCTION

Brodifacoum is a highly lethal vitamin K antagonist anticoagulant poison.[1] Vitamin K is an essential cofactor for the synthesis of blood-clotting factors.[1] Brodifacoum acts as a blood thinner by inhibiting vitamin K epoxide reductase, an enzyme required for the recycling of Vitamin K.[1] It has been called "superwarfarin" because it acts similarly to warfarin, the leading anticoagulation therapy. However, at the same molecular dose, brodifacoum is 100 times more potent than warfarin.[1] Developed in 1975 to combat warfarin-resistant rodents, brodifacoum has become one of the most widely used, commercially available rodenticides in the world. While the half-life of warfarin is between 20 to 60 hours, the half-life of brodifacoum is estimated to be between 20 and 130 days,[2] and it can remain active in the body for 2 to 9 months after exposure.[3] Recently, brodifacoum poisoning has been linked to synthetic cannabinoid use.

Synthetic cannabinoids are a class of manufactured chemicals that act on the same receptors as tetrahydrocannabinol (THC), the main active ingredient in marijuana.[2] Synthetic cannabinoids are typically manufactured abroad and were first reported in the United States in 2008.[2] There are hundreds of synthetic cannabinoids that have been widely available at convenience stores and through the internet under names such as "K2" and "Spice." However, there are no standards for manufacturing, packaging, or selling of synthetic cannabinoids. In recent years, many of these chemicals have been banned by federal and state governments.[4]

## CASE PRESENTATION

In 2019, a 29-year-old woman presented to the emergency department (ED) at a community hospital with vaginal bleeding, rectal bleeding, and hematemesis. She had been seen at an outside facility 2 months prior for vaginal bleeding and was diagnosed with

• • •

**Author Affiliations:** University of Wisconsin School of Medicine and Public Health, Madison, Wis (Kircher, Perez).

**Corresponding Author:** Madison Kircher, MPH Candidate, University of Wisconsin School of Medicine and Public Health, 4600 University Ave #305-D, Madison, WI 53705; phone 507.250.5462; email mrkircher@wisc.edu.

dysfunctional uterine bleeding and started on oral birth control. She also was seen in the same ED 2 days prior for continued vaginal bleeding. During this visit, she had an abdominal x-ray and lab work that were unremarkable, including a normal platelet count and negative pregnancy test. Her hemoglobin was 10.8 g/dL at that visit, so follow-up with her gynecologist was recommended and she was discharged home. She denied illicit drug use at this time.

The patient returned to the ED 2 days later reporting worsening vaginal bleeding in addition to new rectal bleeding and 1 episode of hematemesis during the previous night. She also had developed bruising to her bilateral lower extremities. She was confirmed to be previously healthy with no prior episodes of unexplained bleeding. During this visit, she reported recent use of synthetic marijuana. She stated that she initially withheld information about the drug use because she had been using synthetic marijuana intermittently since she was released from jail and was concerned it would be a violation of her probation.

During evaluation, the patient's hemoglobin was 5.6 g/dL, a marked decrease from 2 days prior. Her international normalized ratio (INR) resulted as "no clot detected," meaning it was above the highest detectable value. Her partial thromboplastin time was approximately 130 seconds, and her platelet count was slightly elevated at 477. Her basic metabolic panel was normal, with the exception of glucose of 159, bicarbonate of 21, and calcium of 7.8. Her liver function test was normal, and her fibrin split products level was negative. She was unable to provide a urine sample for a urine drug screen test and refused catheterization. Synthetic marijuana is not part of the typical urine drug screen testing. The medical team also contacted poison control, who advised that a blood sample be collected and sent to the Wisconsin State Lab of Hygiene for brodifacoum testing. She tested positive for brodifacoum with a level of 127. Expected concentrations in the population fall below the limit of quantification.

The patient was started on blood transfusions and intravenous vitamin K. She also was given 4-factor prothrombin concentrate complex (Kcentra). She was subsequently transferred to a trauma center that had hematologists and intensivists available. She was admitted to the intensive care unit for monitoring and management of blood loss in the setting of acute chemical induced coagulopathy. She remained in the hospital for 4 days until her INR stabilized. When she was discharged, she was started on 50 mg of vitamin K 3 times per day. She also was scheduled to have her INR checked weekly. Once her INR normalized about 3 to 6 months later, she was weaned off vitamin K. During her most recent visit, her INR was 1.02. At this point, she was lost to follow-up.

## DISCUSSION

Many recent outbreaks of brodifacoum-induced coagulopathy have been linked to synthetic cannabinoid use, including a multistate outbreak in the Midwest in 2018 of individuals suffering from severe bleeding and reported synthetic cannabinoid use. At least 324 individuals presented to health care facilities with serious bleeding from possible exposures, with the largest number of cases in Illinois (164) and Wisconsin (86).[5] Laboratory investigation confirmed brodifacoum exposure in at least 150 patients, and there were at least 8 fatalities associated with the outbreak.[5] At this time, no information is available about the factors contributing to differences in survival among these patients. The rationale for combining brodifacoum with synthetic cannabinoids also remains unknown.

There are 12 manufacturing sites for brodifacoum in the world, including 1 site in Madison, Wisconsin.[6] Thus, physicians in the area need to be aware of this potentially deadly condition to begin aggressive treatment as soon as possible. The prolonged half-life of this chemical requires extensive treatment with high-dose vitamin K supplements over long periods of time. Vitamin K supplements are currently the only available treatment option. However, this treatment is expensive, costing $24,000 to $34,000 for a 1-month supply, which can result in medication noncompliance and additional hospital visits.[3]

In response to the recent outbreaks, a laboratory test was developed at the Wisconsin State Lab of Hygiene to quantify the amount of brodifacoum in the blood.[7] By quantifying the amount of this chemical in the blood, patients with brodifacoum poisoning can be treated with a precisely calibrated dose of vitamin K, and treatment can be ended when it is no longer medically necessary. Additionally, this test provides better information on the threshold of brodifacoum that leads to excessive bleeding.[7] However, for this test to be useful and beneficial to patients, physicians must send blood samples to the State Lab of Hygiene.

Research has shown that social factors affect health, but physicians are not always made aware of social issues affecting their patient's lives. Physicians often face challenges obtaining accurate histories from patients who withhold relevant information, such as drug use. By reassuring patients that this information will not be used against them and may be vital to their health and safety, physicians may be able to obtain a more accurate history. This case demonstrates the importance of asking questions about social history when patients present to the ED, particularly if their chief complaint involves abnormal bleeding. It also highlights the difficulty of maintaining contact and providing appropriate care for patients with complex social histories.

## CONCLUSION

This case report seeks to increase awareness of brodifacoum exposure from synthetic marijuana use in Wisconsin. The number of cases has increased in recent years, and it will continue to be important for physicians to recognize these cases and respond efficiently and effectively. By increasing awareness of this con-

dition and increasing collaboration between local hospitals and state agencies, health care professionals in the region can be better prepared to address outbreaks and protect public health.

**Funding/Support:** None declared.

**Financial Disclosure:** None declared.

## REFERENCES

**1.** Shahid Z, Kalayanamitra R, Hanafi M, Anwar K, Jain R. Sugar, spice, and bleeding. *Cureus*. 2019;11(4):e4437. doi:10.7759/cureus.4437

**2.** Ross CH, Singh P, Simon EL. Hemorrhagic soft tissue upper airway obstruction from brodifacoum-contaminated synthetic cannabinoid. *J Emerg Med*. 2019;57(1):47-50. doi:10.1016/j.jemermed.2019.03.007

**3.** Kelkar AH, Smith NA, Martial A, Moole H, Tarantino MD, Roberts JC. An outbreak of synthetic cannabinoid–associated coagulopathy in Illinois. *N Engl J Med*. 2018;379(13):1216-1223. doi:10.1056/NEJMoa1807652

**4.** Alipour A, Patel PB, Shabbir Z, Gabrielson S. Review of the many faces of synthetic cannabinoid toxicities. *Ment Health Clin.* 2019;9(2):93-99. doi:10.9740/mhc.2019.03.093

**5.** Centers for Disease Control and Prevention. Update—outbreak of life-threatening coagulopathy associated with synthetic cannabinoids use. Health Alert Network CDCHAN-00416. December 10, 2018. Accessed July 24, 2019. https://emergency.cdc.gov/han/han00416.asp

**6.** Brodifacoum, CID=54680676. PubChem Database. National Center for Biotechnology Information. Accessed July 24, 2019. https://pubchem.ncbi.nlm.nih.gov/compound/brodifacoum

**7.** Klawitter J. Lab culture extra: how the Wisconsin state lab developed a test for brodifacoum and why it matters. Association of Public Health Laboratories Lab Blo. April 3, 2019. Accessed July 28, 2019. http://www.aphlblog.org/lab-culture-extra-wisconsin-state-lab-developed-test-brodifacoum-matters/

# Health Effects of Climate Destabilization: Understanding the Problem

Bruce Krawisz, MD


## ABSTRACT

Climate change is a public health emergency. Evidence that a mass extinction is underway, that global ecosystem productivity is deteriorating, and that the biosphere is damaged by human actions continues to accumulate. This review aims to provide a summary of the health consequences of climate destabilization, which include heat-related illness and death, wildfires with air pollution, floods, droughts, water scarcity, increased frequency of intense storms, reduction in agricultural and seafood harvests, spread of infectious diseases, and higher rates of mental illness.


## INTRODUCTION

Climate change is a public health emergency. The American College of Physicians Health and Public Policy Committee and the Lancet Commission on Health and Climate Change warn that climate change will harm human health by causing heat-related illness and death, wildfires with air pollution, floods, droughts, water scarcity, increased frequency of intense storms, reduction in agricultural and seafood harvests, spread of infectious diseases, and higher rates of mental illness.[1,2]

This review aims to provide a synopsis of the health consequences of climate destabilization and is intended for those who do not follow climate studies and seek a current summary.

## GREENHOUSE GASES: ATMOSPHERIC INSULATION, LOWER PH IN BODIES OF WATER

Combustion of fossil fuels and deforestation are changing the climate by adding greenhouse gases (carbon dioxide, methane, nitrous oxide) to the atmosphere and carbon dioxide to bodies of water. In the United States, sources of greenhouse gas emissions are transportation (29%), electricity (28%), industry (22%), residential and commercial (12%), and agriculture (9%).[3] Adding greenhouse gases warms the Earth and alters precipitation, glaciers, ocean temperature and pH, and sea level. See Table 1, Box, and Figure for information about the basic science of greenhouse gases in Earth's atmosphere.

## EXTREME HEAT, HYPERTHERMIA, WILDFIRES, AND POSSIBLY KIDNEY DISEASE

Global warming makes extended extreme heat more likely, leading to several potential health issues. Using mathematical models based on past climate changes, a doubling of atmospheric carbon dioxide ($CO_2$) concentration from 280 parts per million (PPM) to 560 PPM is predicted to cause an increase in the average global mean surface temperature of 2.2°C to 3.4°C.[4] Evaporation is the principal method of heat loss in a hot environment, but it becomes ineffective above 75% relative humidity.[5]

At an external temperature of 40°C, healthy adults may develop hyperthermia (see Table 2) after several hours. However, when humidity is high, they may develop hyperthermia at an external temperature of 35°C.[6] Global warming raises hyperthermia risk by increasing both temperature and humidity, and in the United States, premature heat-related deaths could increase by thousands to tens of thousands by the year 2100.[7]

Southwest Asia already has a hot climate. Near the coasts of the Arabian and Red Seas and Persian Gulf, temperatures are accompanied by high humidity. Assuming that greenhouse gas concentrations continue to rise, coastal Southwest Asia will experience extreme heat exceeding conditions for hyperthermia.[6] A regional climate simulator program was used to predict Middle

• • •

**Author Affiliations:** Marshfield Clinic Research Institute, Marshfield, Wis (Krawisz).

**Corresponding Author:** Bruce Krawisz, MD, Marshfield Clinic Research Institute, 1000 N Oak Ave, Marshfield, WI 54449; email krawisz.bruce@marshfieldresearch.org.

**Table 1.** Summary of Health Effects of Greenhouse Gas (GHG) Emissions From Combustion of Fossil Fuels and Deforestation

| Direct Effects | Indirect Effects | Social Effects |
|---|---|---|
| Raised global land and water temperatures[11] | Increased evaporation causing heavy rainfall, floods, soil erosion[15,16] | Loss of habitat and forced migrations due to heat, desertification, and sea level rise |
| Maximum temperature rise is determined by net cumulative GHG emissions[12,13] | More powerful hurricanes with more rainfall[17] | More people impoverished due to weather/climate disasters |
| Acidification of water[14,15] | Reduced seafood and agricultural harvests[14,16] | Grief and mourning due to personal, social, and natural losses |
| Deoxygenation of water | Less crop nutrient quality | More mental illness[15] |
| | Toxic blooms of microorganisms in water | Food scarcity and undernutrition[18,21] |
| | More vector-borne human disease[15,18] | Disruptions to fresh water resources, exhaustion of aquifers[15] |
| | Drought and wildfires | |
| | Ground water depletion | |
| | Loss of marine and terrestrial biodiversity = 6th extinction | |
| | Floods cause soil erosion and microorganism contamination of water[7] | |
| | Melting of cryosphere, sea level rise[19,20] | |

Adapted from Figure 1 of reference 22.

Eastern temperatures if there is no climate change mitigation (Intergovernmental Panel on Climate Change Representative Concentration Pathway 8.5, IPCC RCP 8.5). Later in this century, temperatures above 35° C with high humidity would be common in summer, possibly lasting for extended periods. Outdoor activities would be severely limited, even for healthy, younger adults.[6] In contrast, temperatures predicted using a climate model with reduced greenhouse gas emissions (IPCC RCP 4.5) are more tolerable.

Hyperthermia may cause acute kidney injury, and as world temperatures rise, outdoor laborers may be at risk for a new form of chronic kidney disease that does not appear to be associated with diabetes, hypertension, or other kidney diseases. Since 1990, cases of this disease have been reported among workers exposed to extreme heat in Central America, the Pacific Coast of South America, Sri Lanka, and central India.[8] Approximately 20,000 persons have died from the disease. Patients are often poor, work long hours in sun and heat, and may suffer from dehydration. They are usually previously healthy men who develop severe renal disease over 1 or 2 years of outdoor labor. So far, neither a toxin nor an infectious agent has been consistently identified, and a hot outdoor work environment seems to be present in every case.

Extended periods of warmer temperatures with longer summers and shorter winters, coupled with little rainfall, are also associated with larger and longer duration forest fires.[9] This is apparent in the western United States, where there has been a 5-fold increase in forest fires in states west of the Rocky Mountains in the last 50 years.[9] Wildfires not only cause human deaths, as well as damage to forests and homes, but they also dramatically increase air pollution near the fire.[10] Wildfire smoke includes carbon monoxide, nitrogen oxides, and small particles that can be inhaled into the pulmonary alveoli.[9] During the Sonoma-Napa, California wildfire in October 2017, the particulate air quality (PM2.5) in San Francisco was the worst ever recorded.[9] Inhalation of small particles is associated with exacerbations of acute myocardial infarction, cardiac arrhythmia, stroke, asthma, and chronic obstructive pulmonary disease. Carbon monoxide may kill persons close to the fire, so is a particular threat to firefighters.[9]

**Box.** Glossary

**Climate change/climate destabilization:** Includes all aspects of climate over a long time period, including precipitation, temperature, winds, storm intensity.[19,23]

**Global warming:** Rapid warming of the global mean surface temperature (GMST) of Earth caused by GHG emissions.[19,23]

**Climate adaptation:** Actions taken to manage the impacts of climate destabilization as distinguished from directly reducing atmospheric [$CO_2$] [14]

**Greenhouse effect:** Visible light travels through the windows of a greenhouse warming the interior, but infrared light cannot leave the greenhouse. This traps infrared light (heat) inside the greenhouse.[17,19]

**Greenhouse gases:** Greenhouse gases slow the movement of infrared light through the atmosphere warming the Earth; they insulate Earth.[3]

**Hyperthermia:** Elevation of core body temperature above the normal diurnal range of 36° C to 37.5° C due to failure of thermoregulation. Hyperthermia is not synonymous with the more common sign of fever, which is induced by cytokine activation during inflammation and regulated at the level of the hypothalamus.[5]

**Saffir Simpson hurricane wind scale:** Classifies hurricane severity by wind speed, with category 5 having the highest wind speeds. Each category is a range of wind speed. Wind speed multiplied by time is an estimate of hurricane power.[24]

**Water scarcity:** Less than 1,000 $m^3$ per person of available, renewable freshwater per year.[25]

## WATER SCARCITY, FLOODS, AND DROUGHT

Presently, about 17% of the global population (1.1 billion persons) experiences some degree of water scarcity as defined in the Box.[25,26] In North Africa, the Middle East, and South and East Asia, water scarcity is caused primarily by population pressure.[26] Climate change intensifies water shortages and threatens fresh

**Figure.** Diagram Depicting the Potential Effects of Climate Change on Human Health

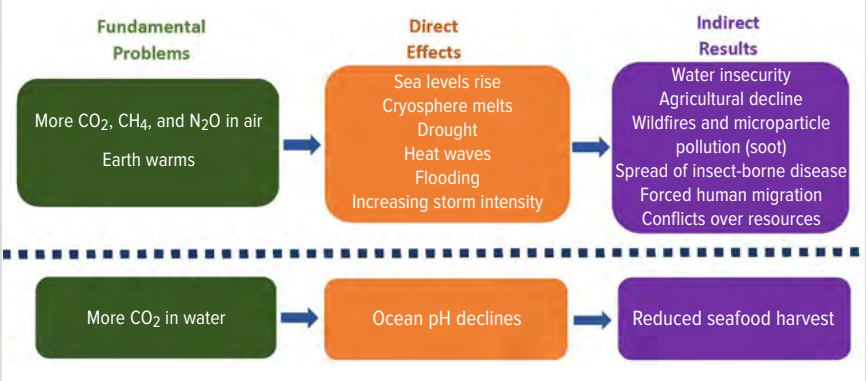



**Table 2.** Effects of Higher Ambient $CO_2$ Levels on Nutrients of Crop Plants[7,33]

| Photosynthesis Type | Crop | Genus | High [$CO_2$] Effect |
|---|---|---|---|
| C3: Photosynthesis begins with 3-carbon molecule; photorespiration | Wheat<br>Rice<br>Pea<br>Soybeans<br>Barley | Triticum<br>Oryza<br>Pisum<br>Glycine<br>Hordeum | 6%-15% less protein per calorie<br>Zinc, iron, calcium, copper, magnesium reduced per calorie |
| C4: Photosynthesis begins with 4-carbon molecule; no photorespiration | Maize<br>Sorghum | Zea<br>Sorghum | No change in protein or mineral concentrations per calorie |

Plants were grown in fields surrounded by open top chambers with $CO_2$ enrichment (free air $CO_2$ enrichment [FACE]), allowing modification of ambient air for experiements. There is an unusual third type of photosynthesis called Crassulacean acid metabolism that is not found in crop plants.

water sources that, in turn, reduce water available for drinking or irrigation. For example, floods and heavy precipitation can cause water-borne infections by contaminating fresh water sources with microorganisms from animal and human waste and by breaching infrastructure barriers between drinking water, wastewater, and storm water.[7] As fresh or marine waters warm, bacterial concentrations rise.

In the United States, the most common organisms associated with water-borne diarrheal illness are enteric viruses (norovirus, rotavirus, and adenovirus), bacteria (*Campylobacter jejuni*, *Escherichia coli* O157:H7, and *Salmonella enterica*), and protozoa (Cryptosporidium and Giardia).[7] Exposure occurs through ingestion, inhalation, or direct contact with contaminated drinking or recreational water. From 1948 to 1964, 68% of outbreaks of diarrheal illness were preceded by heavy precipitation or flooding.[7] More recently, during flooding in North and South Carolina in 2018 caused by Hurricane Florence, drinking water became contaminated with animal waste and coal ash toxins when flood water flowed into wastewater pits and coal ash deposits.

Rising temperatures also make drought more likely, although locations subject to drought are difficult to predict and may occur in unanticipated places.[26] Eastern Mediterranean countries experienced a severe drought from 2007 to 2010. Observations and modeling suggest that the Mediterranean basin (Southern Europe, Middle East, and North Africa) is dryer now than in the past and, unless there is additional rainfall, has an increased probability of drought in the future due to higher temperatures.[26] Modeling also suggests that southern Africa may become dryer.[26] China, India, and Pakistan depend on fresh water from snowmelt in the Himalayan mountains. If this snowmelt declines, water scarcity could affect these populous nations as well.[27]

In the United States, the Southwest is experiencing a "hot drought," meaning that drought is caused by higher temperatures without a proportional rainfall increase.[28] In the Midwest, hotter temperatures, rainfall with spring flooding, soil erosion, and shorter, milder winters are expected. As temperatures rise, more water evaporates from the Gulf of Mexico, causing more rainfall in the Midwest and Northeast.[16] Heavier precipitation and floods cause leaching and runoff into lakes and streams, delayed spring planting, and loss of soil nutrients.

## AGRICULTURAL IMPACT

Persistent heat, floods, droughts, and sea level rise are expected to reduce agricultural harvests and have a significant impact on the global food supply.[1,2]

Although some high latitude farms will benefit from warmer temperatures, higher ambient $CO_2$ concentrations, and longer growing seasons, average harvests worldwide are expected to decline.[29] In fact, in 2017, worldwide yields of some cereal crops declined because of climate-related disasters, and the number of hungry persons rose.[14,30]

Warming of 1.5° C will lead to reduced harvests of maize, rice, and wheat in sub-Saharan Africa, Southeast Asia, and Central and South America.[14,29] In parts of the American West, Midwest, and South, increased heat and evaporation during longer summers without a compensatory increase in rainfall will likely make agriculture more difficult. Climate change may also alter the distribution and incidence of pests, creating new sets of challenges.[31] And increasing storm intensity and greater flooding are likely to disrupt food production, storage, and transportation.[29] Food spoilage and foodborne illness are also associated with hotter temperatures.

What's more, higher atmospheric $CO_2$ concentrations diminish the nutrient concentration in important plants. If efforts are not made to reduce $CO_2$ emissions, ambient $CO_2$ could reach 550 PPM by 2050–2060 (Representative Concentration Pathway,

RCP 8.5). Some crops grown in $CO_2$ concentrations of 546 PPM to 584 PPM have less protein, iron, and zinc per calorie compared to crops grown at $CO_2$ concentrations of 363 PPM to 386 PPM (Table 2).[32,33] In addition, some crops grown in high $CO_2$ concentration of 689 PPM have less iron, phosphorous, calcium, magnesium, copper, zinc, and sulfur compared to crops grown when ambient $CO_2$ concentration is <400 PPM.[7] A modeling study suggests that more than 100 million persons could become zinc or protein deficient and hundreds of millions of people—particularly women and children—could become iron deficient as a result of $CO_2$-induced nutrient deficiencies.[32]

## OCEANS AND LAKES, RISING SEA LEVELS, ACIDIFICATION, DEOXYGENATION

The Earth's cryosphere—glaciers and polar ice—is melting. In fact, since 1970, the arctic ice cap has lost about 40% of its volume and, by 2040, may be completely gone during summer.[20] As water warms, its volume expands because the average distance between water molecules increases.[19] This thermal expansion, together with melting cryosphere, cause sea levels to rise.

Since 1901, the Earth's sea level has risen about 20 cm, including 7 cm since 1993.[20] Currently, the world's oceans are rising 3 mm to 4 mm per year, and the Intergovernmental Panel on Climate Change (IPCC) reports that a 1.5° C temperature increase will cause the sea level to rise 0.26 meters to 0.77 meters by 2100, compared to sea levels during 1986 to 2005.[14]

As coastal waters rise, forced migrations from affected areas will occur. Indeed, a rise of 0.9 meters could displace 100 million people.[17] Approximately 10% of the world's population (approximately 600 million people in 2007) lives in low-lying coastal regions within 10 meters elevation of sea level.[34] Much of this population resides in 17 of the world's 30 largest cities, including New York and London as well as Mumbai, India; Shanghai, China; Jakarta, Indonesia; and Bangkok, Thailand. Asia is most vulnerable to rising seas because large areas of Bangladesh, Viet Nam, Indonesia, the Philippines, and China are only slightly above sea level.[26] As many as 136 coastal cities, each with a population of 1 million persons or more, may be at risk of flooding by 2100.[26] In the US, tidal flooding affects 25 Atlantic and Gulf Coast cities.[11,35]

Climate change is also harmful to plants and animals. For example, in recent years, coral reefs throughout the world have experienced bleaching, including about 29% of the Great Barrier Reef.[36] Bleaching is caused by heat and acidification and is often followed by death. Initially, corals (phylum Cnidaria) lose the ability to perform photosynthesis because of loss of symbiotic photosynthetic algae.[37] Because numerous species inhabit reefs, which also protect immature fish from predators, the loss of corals to bleaching may cause unanticipated declines in ocean fish populations and marine biodiversity.

As water warms, less oxygen is dissolved in the water. This, in turn, can lead to "dead zones"—relatively anoxic areas in lakes, rivers, or the ocean that no longer support life. When molecular oxygen dissolves in water, heat is released; the reaction is exothermic. This is why molecular oxygen dissolves more into colder water.[38]Thus, reduced oxygen concentrations caused by warmer water may lead to loss of organisms in freshwater lakes and streams, as well as the ocean, causing reduced fish and shellfish harvests.

Blooms of "toxic algae" occur when unusually warm water receives a large influx of nutrients (eg, nitrogen and phosphorous).[7] These nutrients come from sewage, manure, or chemical fertilizers. In freshwater lakes and rivers, "toxic algae" are usually cyanobacteria, whereas in the ocean it is often the alga Karenia brevis. Rapid growth or "bloom" consumes oxygen and kills other organisms living in the affected water. Blooming microorganisms sometimes release metabolites that are toxic to other organisms and to humans. North America's Lake Erie experienced cyanobacteria blooms in 2019, while coastal blooms of Karenia brevis or "red tides" occurred in Florida in 2018.[39] Warmer waters due to climate change are partly responsible.[40] Toxic algal blooms most commonly harm children swimming in an affected freshwater lake. Toxins may cause fever, headache, rash, vomiting, diarrhea, wheezing, confusion, or paresthesia after skin exposure.[41] Drinking contaminated water produces vomiting and diarrhea. In salt water, toxins from Karenia brevis may contaminate shellfish and, if eaten, may produce diarrhea or neurologic symptoms of confusion, paralysis, or amnesia.[41]

Global warming and ocean acidification are different processes, but both occur as a result of anthropogenic $CO_2$ emissions. As $CO_2$ concentrations increase in air, more $CO_2$ dissolves into water. Some of this aqueous $CO_2$ reacts with water to form carbonic acid ($H_2CO_3$), which ionizes to form hydrogen ion and bicarbonate. The extent of ocean acidification is determined by tropospheric $CO_2$ concentration. So far, ocean pH has declined by 0.1 pH units since the beginning of the industrial revolution.[42] Ocean acidification harms not only corals, but starfish (phylum Echinodermata), squid and octopus (phylum Mollusca), and sea snails (Pteropods, class Gastropoda) as well.[26,43,44] Pteropods—pelagic molluscs abundant in polar and temperate waters—are a food source for fish, whales, and birds, and, thus, are critical to the ocean ecosystem. Acidification, warming of water, toxic blooms, and deoxygenation combine to harm fresh water and ocean organisms, reducing their biodiversity and causing seafood harvests to decline.[14]

## TROPICAL STORMS: EXTRA POWER AND ADDITIONAL RAINFALL

Recently, there have been unusually large and powerful hurricanes. In August, 2017, Hurricane Harvey produced the largest rainfall (132 cm) ever recorded in the city of Houston, Texas.[45] In nearby Nederland, Texas, 153.87 cm of rain fell—the largest rainfall ever recorded in the United States.[46] Hurricane Irma (Florida and Caribbean Islands) and Hurricane Maria (Puerto

**Table 3.** Hotter Climate Impact on Ranges of Insect/Arachnid Vectors of Disease

| Human Disease | Agent | Vectors | Climate Change Effect |
|---|---|---|---|
| Lyme[51,52] | Genus *Borrelia* | *Ixodes scapularis* (black-legged tick) (Arachnida) | Migration from US to Canada, northerly migration in Europe, more Lyme borreliosis in Canada and northern Sweden |
| Dengue[53] | Genus *Flavivirus* | *Aedes* mosquito (Insecta) | Migration from tropics toward poles |
| Malaria[53] | Genus *Plasmodium* | *Anopheles* mosquito (Insecta) | Migration to higher altitudes in Africa |
| West Nile Encephalitis[52] | Genus *Flavivirus* | *Culex* mosquito (Insecta) | Migration from US to Canada |

Rico)—both category 5 tropical cyclones—also occurred in September, 2017.

A hurricane (eg, tropical cyclone) extracts heat from warm ocean water at least 27.8° C,[47] converts some of this heat into wind energy, and returns cooler water as rain. Extracting heat to do work is a concept in thermodynamics called a Carnot heat engine.[48] Like a Carnot heat engine, a hurricane extracts heat to perform mechanical work (ie, wind).[49] This theoretical understanding of the relationship between water temperature and energy available to a cyclone suggests that as ocean waters warm due to climate change, hurricanes will become more powerful. Modeling studies support this theory.[17,26,49] This does not mean there will be more cyclones, but that the percentage of Saffir-Simpson category 4 and 5 cyclones (defined in Box) is likely to increase, as well as the volume of rainfall per cyclone.

Hurricane-related deaths are usually caused by drowning, injuries such as lacerations or fractures, and exposure to floodwaters containing sewage and industrial chemicals.[45] In New Orleans in 2005, Hurricane Katrina claimed 1200 lives, and 63 people died as a result of Hurricane Harvey in 2017.[17,45] Problems may be further exacerbated following a hurricane, if services such as clean water and sewer, medical care, garbage removal, and schools are lost for an indefinite time.[50] For example, following Hurricane Katrina, some municipal services took 5 years to repair and 196,000 children were required to change schools.[50]

## INFECTIOUS DISEASE, MIGRATIONS OF TICKS AND MOSQUITOES

Because insect and arachnid vectors are sensitive to temperature, a warmer climate may alter and expand the geographic ranges of vector-borne human diseases (Table 3). Consider, for example, Lyme borreliosis, which is caused by infection with the spirochete Borrelia and is transmitted to humans by black-legged ticks (genus *Ixodes*).

The geographic distribution of Lyme disease has increased from endemic to adjacent areas (Table 3).[51] In the United States, the number of reported cases of Lyme disease increased from 2007 to 2013 and was stable from 2013 to 2016.[51] In Canada, new cases of Lyme borreliosis have increased 10-fold since 2004.[52]

At the same time, the black-legged tick has migrated from Maine to southeastern Canada and from Minnesota to Ontario and Manitoba.[52] The mouse (ie, genus *Peromyscus*) that is the reservoir for *Borrelia* in the United States and the primary blood source for black-legged ticks also has migrated to Canada. It is possible that this expansion is due in part to global warming, though the life cycle of ticks and transmission of *Borrelia* to humans is complex and is influenced by many variables.[10] Meanwhile, in Europe, another species of tick–*Ixodes ricinus*–has migrated North during the past 30 years and caused emergence of Lyme borreliosis in northern Sweden.[52]

Human infections usually occur in the late spring and summer when ticks are active in the woods. Thus, a warming climate, longer warm season activity, and geographic expansion of ticks increase human exposure.[7,52]

As Earth becomes warmer, areas affected by mosquito-borne diseases also may expand.[7] The *Aedes* mosquito transmits dengue fever, zika virus, and yellow fever virus.[22,53,54] These are RNA viruses, genus *Flavivirus*. There are about 390 million cases of dengue fever each year. Since 1950, the vectorial capacity of *Aedes* mosquitoes has steadily increased[22] and could, in part, be caused by climate change.[53] Vectorial capacity is a measure of how many humans are susceptible to a vector-borne infectious disease. Geographic range and the size of the susceptible human population are included in this measure.

*Culex* mosquitoes transmit West Nile encephalitis, another *Flavivirus* disease, to humans and birds in the United States. Birds carrying West Nile virus had not been found in Canada prior to 2002.[52] Outbreaks there of West Nile encephalitis in 2007 and 2012 may have been related to unusually high rainfall and warm temperatures, respectively.[52]

The *Anopheles* mosquito transmits malaria (genus *Plasmodium*), and there are about 200 million new cases, 90% occurring in Africa.[55] Due to warmer average temperatures, this mosquito has migrated to higher altitudes in Africa, but a similar migration has not been detected in South America or Asia.[22] Still, the IPCC anticipates that global warming of 1.5° C or 2° C will cause the geographic ranges of malaria and dengue to continue to increase.[14]

## MENTAL HEALTH

People not directly affected by a climate disaster may fear the upheaval and uncertainty of climate change. A study of patients seen in a family practice clinic suggests a correlation between concern about climate change and emotional distress or inner tension.[56] It seems reasonable that people would mourn or feel grief ("ecological grief") when they learn about extinction of spe-

cies, forests burning, or consider how their children will inherit a diminished and more dangerous Earth.[57]

Climate destabilization increases the number of individuals exposed to disasters and, therefore, to subsequent psychological problems. People who experience extreme weather may become more susceptible to depression, anxiety, posttraumatic stress disorder, and suicidal thoughts.[10] For example, people whose homes flooded in the United Kingdom in 2013-2014 experienced depression (20%), anxiety (28%), or posttraumatic stress disorder (36%) when interviewed 1 year after the flood.[58] One month after Hurricane Katrina, 31% of persons interviewed who were directly affected by flooding had symptoms suggestive of an anxiety-mood disorder.[45] Persistent heat and resulting crop failures have been related to farmer suicides in India.[58] Violence and crime in individuals, social groups and nations may increase as resources diminish.[10,50] Migration forced by disaster may reduce mental health.[50,58] However, steps can be taken to mitigate some of the effects of disasters related to climate change. The United Nations' "Building Back Better" program has emphasized the importance of restoring housing, public services, and jobs to avoid prolonged mental effects after a disaster.[45] Repairing a damaged community improves community mental health.

## CONCLUSION

A United Nations report calls climate change "the greatest threat to global health in the 21st century."[59] This crisis increases the risks of famine, drought, flooding, infectious disease, contamination of fresh water, and forced migration of human populations. And as the century continues, more people will be affected, either directly or indirectly by one or more climate destabilization events.

Individual health care workers may help to address this problem by talking with others about climate change, reducing their personal carbon footprint, and participating in an organization that works to mitigate climate destabilization.

**Acknowledgements:** The author wishes to thank the following: Joseph Mazza, MD, for writing assistance and helpful advice; Marie Fleisner for assistance in preparing the final manuscript and for creating the figure; Emily Andreae, PhD, and Jennifer King, PhD, for critically reading the manuscript and providing excellent suggestions; Thomas Ackerman, PhD, for answering questions about atmospheric physics and for providing references; Maia McGuire, PhD, for answering questions about ocean acidification and for providing references; Paul J. Fischer, PhD, for explaining the solubility of molecular oxygen and carbon dioxide in ocean water; Kimberly Rand for essential help searching the National Oceanic and Atmospheric Administration (NOAA) website; and William F. Tracy, PhD, for explaining C3/C4 photosynthesis and heat effects on plant fertilization.

**Funding/Support:** None declared.

**Financial Disclosures:** None declared.

## REFERENCES

**1.** Crowley R, Health and Public Policy Committee of the American College of Physicians. Climate Change and Health: A Position Paper of the American College of Physicians. *Ann Intern Med*. 2016;164(9):608-610. doi:10.7326/M15-2766

**2.** Watts N, Adger WN, Agnolucci P, et al. Health and climate change: policy responses to protect public health. *Lancet*. 2015; 386(10006):1861–1914. doi:10.1016/S0140-6736(15)60854-6

**3.** Greenhouse Gas Emissions. Environmental Protection Agency. Accessed June 25, 2020. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

**4.** Cox PM, Huntingford C, Williamson MS. Emergent constraint on equilibrium climate sensitivity from global temperature variability. *Nature*. 2018;553:319-322. doi:10.1038/nature2545012

**5.** Mechem C. Severe nonexertional hyperthermia (classic heat stroke) in adults. Grayzel J (ed). UptoDate. Accessed June 25, 2020. https://www.uptodate.com/contents/severe-nonexertional-hyperthermia-classic-heat-stroke-in-adults

**6.** Pal JS, Eltahir EAB. Future temperature in southwest Asia projected to exceed a threshold for human adaptability. *Nat Clim Chan*g. 2015;6:197-200. doi:10.1038/NCLIMATE283doi:10.1038/NCLIMATE2833

**7.** *Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.* U.S. Global Change Research Program. Published April 2016. Accessed June 13, 2018. https://health2016.globalchange.gov/high/ClimateHealth2016_FullReport.pdf

**8.** Johnson RJ, Wesseling C, Newman LS. Chronic kidney disease of unknown cause in agricultural communities. *N Engl J Med*. 2019;380:1843-1852. doi:10.1056/NEJMra1813869

**9.** Balmes JR. Where there's wildfire, there's smoke. *N Engl J Med*. 2018;378(10):881-883. doi:10.1056/NEJMp1716846

**10.** *Medical Alert! Climate Change Is Harming Our Health.* The Medical Society Consortium on Climate and Health. Published March 15, 2017. Accessed January 26, 2018. https://medsocietiesforclimatehealth.org/reports/medical-alert

**11.** Wuebbles DJ, Fahey DW, Hibbard KA, DeAngelo B, et al. Executive summary. In: *Climate Science Special Report: Fourth National Climate Assessment, Volume I.* U.S. Global Change Research Program; 2017. Accessed January 16, 2018. https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf. doi:10.7930/J0J964J6.

**12.** Langmuir CH, Broecker W. *How to Build a Habitable Planet: The Story of Earth from the Big Bang to Humankind – Revised and Expanded Edition.* Princeton University Press; 2012.

**13.** Pierrehumbert RT. Infrared radiation and planetary temperature. *Physics Today*. 2011;64(1):33. doi.org/10.1063/1.3541943.

**14.** Summary for policymakers. In: Masson-Delmotte V, Zhai P, H-O Pörtner, et al (eds). *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* Intergovernmental Panel on Climate Change, World Meteorological Organization; 2018. Accessed June 25, 2020. https://www.ipcc.ch/sr15/

**15.** Patz JA, Frumkin H, Holloway T, Vimont DJ, Haines A. Climate change: Challenges and opportunities for global health. *JAMA*. 2014;312(15):1565-1580. doi:10.1001/jama.2014.13186

**16.** Angel J, Swanston C, Boustead BM, et al. Midwest. In: Reidmiller DR, Avery CW, et al (eds). *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment. Volume II*. U.S. Global Change Research Program; 2018:872–940. doi:10.7930/NCA4.2018.CH21

**17.** Emanuel K. *What We Know About Climate Change.* Massachusetts Institute of Technology Press; 2018:38-40.

**18.** McMichael AJ. Globalization, climate change, and human health. *N Engl J Med*. 2013;368:1335-1343. doi: 10.1056/NEJMra1109341

**19.** National Academy of Sciences Panel. *Advancing the Science of Climate Change.* The National Academies Press; 2010. Online Edition. Accessed May 29, 2018. https://www.nap.edu/catalog/12782/advancing-the-science-of-climate-change. doi.org/10.17226/12782

**20.** The National Academy of Sciences and The Royal Society. *Climate Change: Evidence and Causes.* The National Academies Press; 2014. doi:10.17226/18730

**21.** Watts N, Amann M, Arnell N, et al. The 2019 report of The Lancet Countdown

on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *Lancet*. 2019;394(10211):1836-1878. doi:10.1016/S0140-6736(19)32596-6

**22.** Watts N, Amann M, Arnell N, et al. The 2018 Report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. *Lancet*. 2018;392(10163):2479–2514. doi:10.1016/ S0140-6736(18)32594-7

**23.** Fahey DW, Doherty SJ, Hibbard KA, Romanou A, Taylor PC. Physical drivers of climate change. In: *Climate Science Special Report: Fourth National Climate Assessment, Volume 1.* U.S. Global Change Research Program; 2017. Accessed May 29, 2018. https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf. doi:10.7930/J0J964J6

**24.** Saffir-Simpson Hurricane Wind Scale. National Hurricane Center and Central Pacific Hurricane Center. Accessed June 26, 2020. https://www.nhc.noaa.gov/aboutsshws.php

**25.** UN Environment. United Nations Global Environmental Outlook 6. Cambridge University Press. 2019:240-243. Accessed June 25, 2020. http://www.unenvironment.org/resources/global-environment-outlook-6. doi:10.1017/9781108627146

**26.** Hoegh-Guldberg O, Jacob D, Taylor M, et al. Impacts of 1.5ºC global warming on natural and human systems. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* The Intergovernmental Panel on Climate Change; 2018:175-311. Accessed June 25, 2020. https://www.ipcc.ch/sr15/chapter/chapter-3/

**27.** Coats DR. *Worldwide Threat Assessment of the US Intelligence Community.* Presented to Senate Select Committee on Intelligence. January 29, 2019. Accessed June 25, 2020. https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf

**28.** Overpeck JT. Climate science: The challenge of hot drought. *Nature*. 2013;503:350-351. doi:10.1038/503350a

**29.** Brown ME, Antle JM, Backlund P, et al. Climate Change, Global Food Security and the U.S. Food System. US Global Change Research Program. Published December 2015. Accessed June 16, 2018. https://www.usda.gov/oce/climate_change/FoodSecurity2015Assessment/FullAssessment.pdf. doi:10.7930/J0862DC7

**30.** Friedrich MJ. Global hunger on the rise as climate extremes increase. *JAMA*. 2018;320(19):1969. doi:10.1001/jama.2018.17909.

**31.** Deutsch CA, Tewksbury JJ, Tigchelaar M, et al. Increases in crop losses to insect pests in a warming climate. *Science*. 2018;361:916-919. doi:10.1126/science.aat3466

**32.** Smith MR, Myers SS. Impact of anthropogenic $CO_2$ emissions on global human nutrition. *Nat Clim Chang.* 2018;8:834-839. doi:10.1038/s41558-018-0253-3

**33.** Myers, SS, Zanobetti, A, et al. Rising CO2 threatens human nutrition. *Nature*. 2014; 510:139-142. doi:10.1038/nature13179

**34.** McGranahan G, Balk D, Anderson B. The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. Environ Urban. 2007;19(1):17–37. doi:10.1177/0956247807076960

**35.** National Academy of Engineering. *Responding to the Threat of Sea Level Rise: Proceedings of a Forum*. National Academies Press; 2017. Accessed October 11, 2018. https://www.nap.edu/catalog/24847/responding-to-the-threat-of-sea-level-rise-proceedings-of. doi:10.17226/24847

**36.** Hughes TP, Kerry JT, Álvarez-Noriega M, et al. Global warming and recurrent mass bleaching of corals. *Nature*. 2017;543:373-377. doi:10.1038/nature21707.

**37.** Hoegh-Guldberg O. Climate change, coral bleaching and the future of the world's coral reefs. *Mar Freshwater Re*s. 1999;50(8):839-866. doi:10.1071/MF99078.

**38.** Silberberg MS. *Chemistry: The Molecular Nature of Matter and Change*. 3rd Ed. McGraw-Hill; 2003:499.

**39.** Pierce RH, Henry MS. Harmful algal toxins of the Florida red tide (*Karenia brevi*s): natural chemical stressors in South Florida coastal ecosystems. *Ecotoxicology*. 2008;17:623-631. doi:10.1007/s10646-008-0241-x.

**40.** Ho JC, Mickalak AM, Pahlevan N. Widespread global increase in intense lake phytoplankton blooms since the 1980s. *Nature*. 2019;574:667-670. doi:10.1038/s41586-019-1648-7

**41.** Marcus EN. Overview of shellfish and pufferfish poisoning. Wiley J (ed). UpToDate. Accessed June 25, 2020. https://www.uptodate.com/contents/overview-of-shellfish-and-pufferfish-poisoning?search=overview-of-shellfish-and-pufferfish-&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

**42.** What is Ocean Acidification? National Oceanic and Atmospheric Administration, US Department of Commerce. Accessed September 24, 2018. https://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F

**43.** Fujita R. 5 ways climate change is affecting our oceans. Environmental Defense Fund. Published October 8, 2013. Updated August 23, 2018. Accessed June 24, 2018. https://www.edf.org/blog/2013/10/08/5-ways-climate-change-affecting-our-oceans

**44.** Wittman AC, Portner H-O. Sensitivities of extant animal taxa to ocean acidification. *Nat Clim Chang*. 2013;3(11):995-1001. doi:10.1038/NCLIMATE1982

**45.** Shultz JM, Galea S. Mitigating the mental and physical health consequences of Hurricane Harvey. *JAMA*. 2017;318(15):1437-1438. doi:10.1001/jama.2017.14618.

**46.** Service Assessment: August September 2017 Hurricane Harvey. National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Published June 2018. Accessed date? www.weather.gov/media/publications/assessments/harvey6-18.pdf

**47.** Florence crossing warm waters on the way to the Carolinas. NASA Earth Observatory. Posted September 12, 2018. Accessed June 25, 2020. https://earthobservatory.nasa.gov/images/92739/florence-crossing-warm-waters-on-the-way-to-the-carolinas?src=nha

**48.** Feynman R, Leighton RB, Sands M. *The Feynman Lectures on Physics: Commemorative Issue.* Volume I. Addison-Wesley Publishing; 1963:44-4 to 44-7.

**49.** Kossin JP, Hall T, Knutson T, et al. Extreme storms. *Climate Science Special Report: Fourth National Climate Assessment, Volume I* U.S. Global Change Research Program; 2017:256-276. Accessed October 11, 2018. https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf. doi:10.7930/J0J964J6.

**50.** Manning C, Clayton S. Threats to mental health and wellbeing associated with climate change. In: Clayton S, Manning C (eds). *Psychology and Climate Change.* Academic Press; 2018:217-244.

**51.** Shapiro ED, Wormser GP. Lyme disease in 2018: what is new (and what is not). *JAMA*. 2018;320(7):635-636. doi:10.1001/jama.2018.10974

**52.** Ogden NH, Lindsay LR. Effects of climate and climate change on vectors and vector-borne diseases: ticks are different. *Trends Parasit.* 2016;32(8):646-656. doi:10.1016/j.pt.2016.04.015

**53.** Thomas SJ, Rothman AL. Dengue virus infection: Epidemiology. Hirsch MS (ed). UpToDate. Accessed date? https://www.uptodate.com/contents/dengue-virus-infection-epidemiology

**54.** LaBeaud AD. Zika Virus Infection: An overview. Hirsch (ed). UpToDate. Accessed June 25, 2020. https://www.uptodate.com/contents/zika-virus-infection-an-overview?search=LaBeaud%20AD.%20Zika%20Virus%20Infection.&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

**55.** Breman JG. Malaria: Epidemiology, prevention, and control. Daily J (ed). UpToDate. Accessed June 25, 2020. https://www.uptodate.com/contents/malaria-epidemiology-prevention-and-control

**56.** Temte JL, Holzhauer JR, Kushner KP. Correlation between climate change and dysphoria in primary care. *WMJ*. 2019;118(2):71-74.

**57.** Cunsulo A, Ellis NR. Ecological grief as a mental health response to climate change-related loss. *Nat Clim Chang*. 2018; 8(4):275–281. doi:10.1038/s41558-018-0092-2

**58.** Berry HL, Waite TD, Dear KBG, Capon A, Murray V. The case for systems thinking about climate change and mental health. *Nature Clim Chang*. 2018;8(4):282–290. doi:10.1038/s41558-018-0102-4

**59.** WHO Calls for Urgent Action to Protect Health from Climate Change. World Health Organization. Accessed June 25, 2020. https://www.who.int/globalchange/global-campaign/cop21/en/

Sheri Johnson, PhD

Robert N. Golden, MD

# A Health Equity Mindset

Sheri Johnson, PhD; Robert N. Golden, MD

Why should Wisconsin, where most people identify as white, include racial equity as a priority? What is the role of University of Wisconsin-Madison in advancing knowledge, practice, policy, and system change that can reduce unfair gaps in health between socially defined groups? Who decides what is fair or unfair? Do these topics blur the line between scholarship and advocacy?

The UW School of Medicine and Public Health is committed to expanding our knowledge and strengthening our commitment to advancing health equity. As the first school to fully integrate clinical medicine and public health training and research, we have a track record of foresight. Transformational change is an ongoing process. Upon the first author's arrival as the new UW Population Health Institute (PHI) director in 2018, these questions greeted her. Many stakeholders are eager to seek answers to the above questions together, while others may be concerned that any misstep might tarnish the well-earned reputation of the institute, school, and university. This is the reality of working to advance equity. There is often limited consensus. It is not easy work. As Geoffrey Canada from the Harlem Children's Zone noted, "It's not rocket science we're doing here, it's harder than rocket science." (We intend no disrespect to rocket scientists!)

• • •

Sheri Johnson, PhD, is the director of the UW Population Health Institute and an associate professor (CHS) in the Department of Population Health Sciences, UW School of Medicine and Public Health. Robert N. Golden, MD, is the dean of the School of Medicine and Public Health and vice chancellor for medical affairs, University of Wisconsin-Madison.

The UW School of Medicine and Public Health is committed to expanding our knowledge and strengthening our commitment to advancing health equity.

## What Does the Evidence Tell Us?

Gaps in health between socially defined groups are well documented. The PHI's triannual report card consistently demonstrates that the health of American Indian and African American people in Wisconsin is worse than that of white people. The Wisconsin Collaborative for Healthcare Quality (WCHQ) found that racial/ethnic disparities in health care quality and outcomes exist.[1]

Interestingly, the drivers of poor health across places in Wisconsin are strikingly similar. More than 60% of the state's 72 counties are considered rural, and Wisconsin's rural residents tend to be white. Yet, compared to Wisconsinites overall, residents of the state's rural areas and the large, urban Milwaukee County share common challenges. Those who live in rural or large metropolitan areas tend to have higher rates of smoking and obesity, experience higher rates of unemployment, and are less likely to have health insurance.

Despite these obstacles to health, the zeitgeist accentuates perceptions of a rural-urban divide. Pitting groups against each other in an effort to maintain power for a select few is not a new tactic. Groups defined by geography and/or race often collide in the pursuit of a mirage of public and private investments that could foster health. But we can leverage evidence to build alliances, as we emphasize "how systems of racial inequity" affect not only the health of people of color, but of white people, as well.[2] A 2019 article by David Kindig, MD, PhD, the founding director of our Population Health Institute, reflects this approach in analyzing the absolute numbers and relative rates of infant mortality among African American and white mothers in Wisconsin.[3] He argues that two types of systematic oppression—racism and classism—produce poor birth outcomes for urban African American mothers and for rural

white mothers. However, inherited blinders may interfere with our ability to find common cause.

### What Remains Unclear?

A growing body of research connects historical US policies to today's differences in health between groups. Yet, this remains unclear, even to those who work in population health and health care. A lack of knowledge about broken treaties and policies such as the 1819 Civilization Fund Act serves as an example. Beginning in the early 19th century, the US Congress passed a series of laws intended to assimilate American Indians by requiring that children be sent away to boarding schools. The systematic removal of American Indian children from their families and communities persisted in various and increasingly devastating and abusive forms into the 20th century. Scholars report that 29% of American Indian children were in boarding schools by 1931.[4]

These are not simply old wounds with no current relevance to health. Evidence links historic trauma and toxic and cumulative stress with poor physical, behavioral, and mental health. Recognizing the centrality of early-life experience on long-term outcomes, Adverse Childhood Experiences (ACEs) have been proposed as a Leading Health Indicator.[5] Yet, health consequences related to policy-driven experiences of Indigenous people and African Americans—including dehumanization and restricted opportunity to amass economic wealth—are not easily communicated. The dominant narrative attributes worse health outcomes for people of color to bad behaviors and poor choices, while a more empathetic lens is emerging for white populations. Despair, as a legitimate driver of poor health, is reserved for some but not for all.[6-7] Cultural and systemic racism have shaped dominant narratives, making it difficult to understand how the decisions we have made as a society confer advantages to some groups more than others.

### Is Racial Equity Everyone's Problem?

How might systems of racial inequity impact everyone? First, we must acknowledge that our ideas about "race" are social constructs that artificially elevate the value of some groups over others. Then, we can interrogate whether our policy choices serve overall population health. If evidence-based policies are rejected or implemented unevenly, primarily due to beliefs about which groups are "deserving," the harm to all in need cannot be contained.[2] While most of us believe that everyone should be treated fairly, our laws and practices are not always aligned with that belief.

### What's Next for the PHI?

Why should the PHI generate, test, and disseminate ideas that can reduce health inequities? We believe the stakes are high. Because there is evidence that too many people are dying prematurely and the burden of poor health is unevenly distributed, the PHI will:

- build a framework and metrics that uncover drivers of health and equity.
- create reports, tools, and resources.
- engage diverse stakeholders to create and advance a transformative narrative.

We have what it takes to make Wisconsin and the nation a place where everyone thrives. Shared values and aspirations form the foundation from which we can implement solutions together. Creating healthy and safe communities is within our reach.

We must be willing to test ideas, acknowledge mistakes, and start again. Sound familiar? Kind of like rocket science?

### REFERENCES


**1.** 2019 Wisconsin Health Disparities Report. Wisconsin Collaborative for Healthcare Quality and the University of Wisconsin Health Innovation Program. Published September 19, 2019. Accessed June 5, 2020. https://www.wchq.org/pdfs/Disparities_Report_2019_9-20_FINAL.pdf

**2.** Malat J, Jacquez F, Slavich GM. Measuring lifetime stress exposure and protective factors in life course research on racial inequality and birth outcomes. *Stress*. 2017;20(4):379-385. doi:10.1080/10253890.2017.1341871

**3.** Kindig D. Using uncommon data to promote common ground for reducing infant mortality. *Milbank Quarterly.* 2020;98(1):18-21; first published December 10, 2019. doi:10.1111/1468-0009.12441

**4.** Warne D, Lajimodiere D. American Indian health disparities: psychosocial influences. *Soc Personal Psychol Compass.* 2015;9(10):567-579. doi:10.1111/spc3.12198

**5.** Committee on Informing the Selection of Health Indicators for Healthy People 2030. National Academies of Sciences, Engineering, and Medicine. 2020. *Leading Health Indicators 2030: Advancing health, equity, and well-being.* The National Academies Press. doi:10.17226/25682

**6.** Case A, Deaton A. Mortality and morbidity in the 21st century. *Brookings Pap Econ Act*. Spring 2017;2017:397-476. doi:10.1353/eca.2017.0005

**7.** Gennuso KP, Blomme CK, Givens ML, Pollock EA, Roubal AM. Deaths of despair(ity) in early 21st century America: the rise of mortality and racial/ethnic disparities. *Am J Prev Med*. 2019;57(5):585-591. doi:10.1016/j.amepre.2019.06.018


## Health by ZIP Code

### REFERENCES *continued from page 79*


**1.** Bipartisan Policy Center. Accessed June 1, 2020. https://bipartisanpolicy.org/wp-content/uploads/2019/03/HEALTHY_0.pdf

**2.** Hayes TO, Delk R. Understanding the social determinants of health. American Action Forum. Published September 4, 2018. Accessed May 23, 2020. https://www.americanactionforum.org/research/understanding-the-social-determinants-of-health/#ixzz6NHi2jI2B

**3.** Impact of the built environment on health. National Center for Environmental Health, Division of Emergency and Environmental Health Services, Centers for Disease Control and Prevention. Published June, 2011. Accessed June 1, 2020. https://www.cdc.gov/nceh/publications/factsheets/impactofthebuiltenvironmentonhealth.pdf

**4.** Social determinants of health. Office of Disease Prevention and Health Promotion. Healthypeople.gov. Accessed May 28, 2020. https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health

**5.** Ezenwanne O, Crawford R, Remington PL. The race to the bottom: Wisconsin's long-term trends in health rankings. *WMJ*. 2020;119(2):199-121

**6.** Public Health Impact: Excessive Drinking. America's Health Rankings analysis of CDC, Behavioral Risk Factor Surveillance System. United Health Foundation. Accessed May 28, 2020. https://www.americashealthrankings.org/explore/annual/measure/ExcessDrink/state/WI

**7.** National health care quality and disparities report. Agency for Healthcare Research and Quality. US Department of Health & Human Services. Accessed June 1, 2020. https://nhqrnet.ahrq.gov/inhqrdr/Wisconsin/snapshot/summary/All_Measures/All_Topics

**8.** Krawisz B. Health effects of climate destabilization. *WMJ*. 2020;119(2):132-139.

**9.** Warsaw P, Morales A. The potential impact of hospital cafeterias on dietary habits: a case study of the University of Wisconsin Hospital and Clinics. *WMJ*. 2020;119(2):122-125.

**10.** Schmidt C, Snedden T, Malecki K, Gangnon R, Eggers S, Kanarek M. Bicycling Rates and the Prevalence of Bicycle Helmet Usage in Wisconsin. *WMJ*. 2020;119(2):91-95.

# Insurance Services for Medical Professionals
## by WisMed Assure

WisMed Assure is the only Wisconsin-based insurance firm exclusively serving the medical community. With more than 30 years of dedicated service, our sole mission is meeting the insurance needs of physicians, hospitals, clinics, related health care professionals, their employees and families. We have offices in Madison, Milwaukee and Appleton.

### Why Us

WisMed Assure focuses on working with health care professionals to better serve their specific needs. We recently developed an association health plan and a new group disability plan to alleviate premium costs and allow smaller practices some of the benefits that larger employers enjoy. It is our goal to provide innovative and customized products with outstanding customer service to professionals who care for the health of others.

### Our Mission

Profits generated by WisMed Assure benefit the Wisconsin Medical Society to further its mission: Improve the health of the people of Wisconsin by supporting and strengthening physicians' ability to practice high-quality patient care in a changing environment.

### Contact Us

WisMed Assure
608.442.3810 or
insurance@wismedassure.org.

### Insurance Product Lines Offered

- Professional Liability
- Business
- Long-Term Care
- Association Health Plan
- Group and Individual
    - Health
    - Life
    - Disability
    - Dental
- HR 360 Subscription for Group Benefit Clients

Wisconsin Medical Society

WISMED ASSURE

wismedassure.org


# thank you

*To all the* **doctors**
*nurses* *ICU staffers*
***practice managers*** *first responders*
*infectious disease specialists*
*intensivists* ***medical examiners***
*geriatricians* *nurse practitioners*
***respiratory technicians***
*ambulance drivers* *pulmonologists*
*epidemiologists* *social workers*
*life sciences engineers* ***microbiologists***
*vaccine research lab technicians*
***pharmacists*** *hospital administrators*
*public health officials* ***nursing homes***
*pathologists* *hospital housekeepers*
*microbiology researchers*
*PPE manufacturers* *immunologists*
***medical research scientists*** *paramedics*

**To the doctors, nurses, and other healthcare professionals battling COVID-19**—the employees of ProAssurance and our families are deeply grateful for your leadership, dedication, and sacrifices.

**To everyone else**—please be safe, wash your hands, and most importantly...

**Listen to the doctors.**

ProAssurance®
Treated Fairly

**Healthcare Professional Liability Insurance**

For ProAssurance policyholder information and resources ››› **ProAssurance.com/COVID-19**