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The Wisconsin Obesity Prevention Initiative

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COVER THEME
The Wisconsin Obesity Prevention Initiative

In this special issue of *WMJ*, which was supported by the University of Wisconsin School of Medicine and Public Health through the Wisconsin Partnership Program and its Obesity Prevention Initiative, authors report on the prevalence of obesity in Wisconsin and describe efforts underway to address this important issue.

Cover design by
Mary Kay Adams-Edgette

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EDITORIAL

OBESITY CAUSES AND CONSEQUENCES

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OBESITY PREVENTION INTERVENTIONS

YOUR PROFESSION

This issue is dedicated to the memory of our friend and colleague, John Stedman (1949-2016), a tireless advocate for social justice and health.

Addressing Obesity Must Go Beyond Advising Patients to Eat Healthy and Exercise

John J. Frey III, MD, *WMJ* Medical Editor

The health risks of being overweight or obese have been in front of the public for decades, with the Centers for Disease Control and Prevention emphasizing the links to acute and chronic diseases and a risk for all-cause mortality. Eating too much, walking too little is the simple answer, but of course if it were that simple, it wouldn't be a problem. Billions of dollars have been spent on education, research, and clinical care to decrease the prevalence of obesity and overweight. Many more billions are spent on diet and gadgets unsuccessfully trying to correct the problem. Now the country faces the specter of a surgical solution for increasing numbers of people.

But the constant mentioning of obesity may be having the effect of tuning the public out. Life is difficult with stresses of work, family, economic struggle, and other pressures, and the well-known link of overweight and obesity to socioeconomic status and other social determinants of health make finger wagging by clinicians and advice to eat healthier fall flat. In his extraordinarily sympathetic essay in the October 31, 2016 issue of *The New Yorker* on the increasing cultural and economic divide in our country, George Packer writes, "When you visit a farm-to-table restaurant and order the wild-nettle *sformato* for 30 dollars, the line between social consciousness and self-gratification disappears. Buying synthetic-nitrate-free lunch meat at Whole Foods is also a way to isolate yourself from contamination by the packaged food sold at Kmart and from the overweight, downwardly mobile people who shop there. The people who buy food at Kmart know it."[1] Physicians, as a group, are coming from family backgrounds more familiar with Whole Foods than Kmart, and our patients know it.

So if clinicians are going to be successful in changing the trajectory of obesity in their communities, they have to engage in what Walker Percy called "zone crossing;"[2] stepping out of comfortable hospitals and clinics and into parts of society that have the biggest risks not only for obesity, but for every chronic illness that relates to it. They need to shop and walk and even live where their patients live, or at least engage in honest and open ways that might decrease the professional and economic isolation that Packer writes about. A historic town in the mountains of New Mexico had a public hearing on a petition for Family Dollar to build a store just down the road from the center of town. At the hearing, the people who argued against it were almost exclusively Anglos, and those who argued for it were Latinos and Native Americans. But the difference was socioeconomic, not racial. One man put it succinctly, "I can't afford to drive 30 miles to Walmart to buy milk or buy it at the local general store for twice what I should pay. I shouldn't have to decide between milk for my family or pay my electric bill."[3] If society is going to honestly address obesity, it needs to understand it as a symptom, not a cause.

If society is going to honestly address obesity, it needs to understand it as a symptom, not a cause.

Fortunately, in this special issue of *WMJ,* many of the articles discuss strategies and attitudes about obesity that at least offer the possibility of engaging with people in communities in a way that is respectful, understanding, and has a higher chance of success in changing things for the better. Whether through research strategies that include patients and communities or using data to address issues of availability of food or significant adjustment in the attitudes of clinicians away from condescension and toward empathy, the manuscripts in this issue acknowledge the struggle to improve outcomes through collective action. The effort will take a long time and a great deal of work, but it has a greater likelihood of positive change than end of visit diet advice for patients who go back to a reality their doctors don't understand.

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The Obesity Prevention Initiative: A Statewide Effort to Improve Child Health in Wisconsin

Alexandra K. Adams, MD, PhD; Brian Christens, PhD; Amy Meinen, MPH, RDN; Amy Korth, MS, RDN; Patrick L. Remington, MD, MPH; Sara Lindberg, PhD, MS; Dale Schoeller, PhD

ABSTRACT

Background/Significance: Obesity rates have increased dramatically, especially among children and disadvantaged populations. Obesity is a complex issue, creating a compelling need for prevention efforts in communities to move from single isolated programs to comprehensive multisystem interventions. To address these issues, we have established a childhood Obesity Prevention Initiative (Initiative) for Wisconsin. This Initiative seeks to test community change frameworks that can support multisystem interventions and provide data for local action as a means for influencing policies, systems, and environments that support individuals' healthy eating and physical activity.

Approaches/Aims: The Initiative is comprised of three components: (1) infrastructure to support a statewide obesity prevention and health promotion network with state- and local-level public messaging and dissemination of evidence-based solutions (healthTIDE); (2) piloting a local, multisetting community-led intervention study in 2 Wisconsin counties; and (3) developing a geocoded statewide childhood obesity and fitness surveillance system.

Relevance: This Initiative is using a new model that involves both coalition action and community organizing to align resources to achieve health improvement at local and state levels. We expect that it will help lead to the implementation of cohesive and sustainable policy, system, and environment health promotion and obesity prevention strategies in communities statewide, and it has the potential to help Wisconsin become a national model for multisetting community interventions to address obesity. Addressing individual-level health through population-level changes ultimately will result in reductions in the prevalence of childhood obesity, current and future health care costs, and chronic disease mortality.

INTRODUCTION

Data from the Centers for Disease Control and Prevention (CDC) demonstrates that the prevalence of obesity is 14% among Wisconsin children 2 to 5 years old and 12% among adolescents.[1] The rate of increase in childhood obesity prevalence has slowed but has not stopped, thus efforts to reduce the prevalence of childhood obesity cannot be relaxed.[2]

Multiple national organizations including the CDC, the National Institutes of Health (NIH), the Robert Wood Johnson Foundation, the Institute of Medicine, and the White House Task Force on Childhood Obesity have emphasized the importance of a multisector approach to preventing childhood obesity.[3,4] Doing so, however, to reduce the prevalence of childhood obesity has not been easy and the traditional public health approach is proving insufficient.

Perhaps this was best exemplified by the failure a well-designed study conducted in 8 European Union countries in 2006-2011 (the IDEFICS study).[5] This study examined the effectiveness of school-based interventions that promoted more fruit and vegetable consumption, greater water consumption, increased physical activity, reduced TV viewing time, and lengthened sleep duration. A second control city was selected in each of the countries. The resulting cohort included over 16,000 children between 2 and 10 years of age.

The intervention had no effect on the prevalence of obesity, which actually increased 5 percentage points in both intervention and control cities. The investigation attributed the lack of effectiveness of the focus only on schools, the "top-down" design with interventions selection done by investigators, and the intervention's short duration. Our experience with community-based research indicates that engaging communities during the process of designing, selecting, and evaluating interventions in critical to increase individual commitment and have the desired effects. In addition, effective interventions to reduce and prevent obesity need to address multiple levels of the social-ecological model, with a focus on policy, systems, and environment strategies, with a particular focus on children.[6,7]

To address these issues, the Obesity Prevention Initiative

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(Initiative) has both a statewide reach and a focus at the individual community level. These prevention efforts are placing a premium on community engagement and leadership at the grassroots level via community organizing as well as at the broader, more institutional levels via coalition action in pursuit of collective impact. We hypothesize that this approach will reach more people, be more sustainable, and lead to more long-term positive health outcomes than the alternative of more narrowly focused interventions.

The Initiative's ultimate goal is to reduce the pediatric obesity rate in Wisconsin by creating a healthier environment for healthier children by making physical activity and healthy eating easier and more fun. By working to build strength with local and statewide partners, we expect that this effort will help lead to implementation of cohesive and sustainable policy, system, and environment health promotion that will change communities and support families in efforts to prevent pediatric obesity. Herein we describe the overall design and methods being used by this comprehensive initiative, and a compare this Initiative's work with other large-scale obesity prevention initiatives worldwide.

APPROACH

The Initiative uses a multifaceted approach including community-based participatory research, outreach, surveillance, and dissemination to influence childhood obesity in Wisconsin (Figure 1). Each aim has faculty leadership and community partner engagement. This project has 3 core components, including an administrative core that link the cores by creating common goals. Evaluation strategies are being used within each core to assess impact. Our team comprises 14 faculty, 15 staff, and 9 graduate and other students, 11 community staff, and over 1500 community partners.

This work addresses 2 key gaps in current obesity prevention research: understanding what works in multisystem approaches to obesity, and how these approaches can be implemented through community-led change strategies. The potential to generalize our research to other public health issues is high; if successful, this work will provide not only quantitative evidence of the effectiveness of a comprehensive approach, but also will give other investigators validated tools and a new model to collaboratively engage communities in health behavior change.

Scientific Model

The Initiative uses a model that galvanizes resident leadership and seeks greater alignment of existing organizational and agency leadership. This model is built on the community-change frameworks of community organizing and coalition action, or "collective impact", is described in detail by Christens et al.[8] The Initiative builds upon principles of community organizing, which encourages broad community participation in selecting priorities for change, conducting applied research, and taking collective action. Collective impact, on the other hand, is a framework for building coalition infrastructure to align stakeholders in order to leverage resources, promote a common agenda, establish shared measures, and design continuous communications and feedback loops for expediting large-scale community change.[9-11] Our work implements both approaches in the same communities and seeks opportunities for synergy. Thus, the Initiative utilizes the most successful aspects of Shape Up Somerville, including intervention in a wide range of systems (collective impact) along with reliance on community leaders (community organizing) to both strengthen policy and environmental change and perhaps also to support behavior change in support of healthier lifestyles. We expected this to contrast with other initiatives that are focusing their coalition efforts primarily on achieving collective impact[12-17] without dedicated initiatives to expand grassroots leadership.

Core Efforts

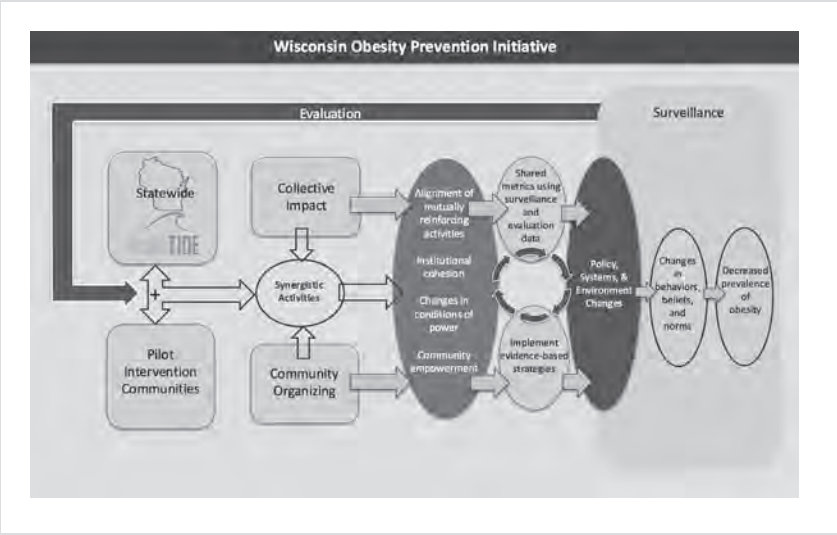
The Initiative's 3 core components are healthTIDE, Intervention, and Surveillance/Evaluation.

healthTIDE supports and expands a prior effort to initiate a statewide network of leaders from multiple institutions and organizations that began in 2012 as the Wisconsin Obesity Prevention Network. In its current form, healthTIDE works collectively through alignment of activities, building a common agenda, and engagement of community partners to disseminate and implement evidence-based obesity prevention strategy (Figure 1).

A major function of healthTIDE is to provide "backbone staff" who serve to convene, connect, and facilitate aligned efforts among partners and organizations. Specifically, staff provide infrastructure for statewide obesity prevention efforts by convening and helping form connections between diverse partners in research, governmental public health, advocacy, communities, and nonprofit organizations addressing change in the following systems: early childhood care and education, schools, active communities, healthy food retail, and advocacy.[12]

A case study of a single system collective impact team is the Wisconsin Early Childhood Obesity Prevention Initiative, presented in this issue.[18] Backbone staff convened a collective impact team consisting of partners working on obesity prevention in the early childhood setting. Team members reviewed available evidence-based interventions, local and state policy strategies, ongoing research, and expert opinion, and set statewide priorities and an agenda for ongoing collective work. This has led to several completed and current research projects as well as statewide policy changes related to nutrition and physical activity in YoungStar, the new quality rating improvement system for childcare sites. This same process of convening diverse partners and organizations has been replicated with additional collective impact teams including schools, health care, food retail, and active communities. Many of the teams have set priorities, which are posted on the healthTIDE website (healthTIDE.org).

Figure 1. Core Aspects of the Obesity Prevention Initiative and Their Multiple Feedback Loops



healthTIDE (hT) works statewide; Intervention is working with 2 pilot communities. They connect their work via the ongoing involvement of community partners in identifying priorities. The Intervention Core is developing the intervention menu and providing technical support for pilot communities collective impact and community organizing initiatives. Evaluation occurs at all levels. Results are critical to understanding the Initiative's progress. Surveillance data will assist hT and communities in deciding where to focus, and in understanding the Initiative's impact.

To extend its impact to Wisconsin residents, healthTIDE also has begun creating messages and communication platforms in collaboration with the Intervention and Surveillance/Evaluation cores for evidence-based solutions to obesity, including state- and local-level public dissemination through its own platforms and other outlets including the University of Wisconsin School of Medicine and Public Health and its Wisconsin Partnership Program and Population Health Institute. Social media (Facebook and Twitter) and marketing are being used to convey that tackling the problem of obesity is both worthwhile and solvable. This coordinated and comprehensive web-based communication plan is central to creating a movement comprised of individuals and partners who are unified and aware of the identified statewide priorities

Intervention—As indicated above, intervention includes both community organizing and coalition action as frameworks to catalyze community change.[8] Implementation of the 2 pilot intervention studies includes 2 longstanding community partners, Marathon and Menominee counties (Figure 1). A literature analysis revealed that a comprehensive mix of strategies in a variety of settings is the most effective approach for addressing obesity in communities. These counties are involved in a pilot study that involves selecting a mix of evidence-based and evidence-informed strategies that span several different settings (schools, early childhood sites, worksites, community, health care) for the communities to implement and evaluate.[19] Through the Initiative, training on community action has been provided to groups of residents using a relational model of community organizing that prioritizes resident leadership.[20]

Researchers have compiled an evidence-based and evidence-informed intervention system that consists of a menu of multisetting strategies with corresponding evaluation methods.[19] As part of the intervention system creation, a group of researchers, practitioners, and community partners determined a number of potential obesity prevention interventions and created a menu of possible targeted strategies for communities. This menu, which includes different settings/systems—early childhood, schools, health care, worksites, built environment, and food systems—is being used by the pilot communities to determine strategies in a minimum of 3 sites for their community. This will ensure that each pilot community can choose evidence-based and evidence-informed strategies that they deem most appropriate for their community yet enable consistent evaluation across communities in collaboration with the Surveillance/Evaluation core.

Surveillance/Evaluation—No current system is sufficiently comprehensive or geographically specific to allow for adequate longitudinal examination of trends in child obesity at the community level. There are several systems in place aiding in childhood obesity tracking, but these do not cover all pediatric ages, and there is no coordination of datasets, despite an Institute of Medicine panel call for the establishment of action-focused surveillance systems that can inform regional disease prevention effort.[21] To support and document the Initiative's work, an obesity surveillance system called the Wisconsin Heath Atlas has been developed. This platform for aggregating and sharing data can be used by anyone across the state to track obesity and related community-health indicators.[22] Working in cooperation with multiple community partners and stakeholders, a sustainable infrastructure is being created that will allow for evaluation of current interventions in the field, identification of secular trends, and identification of communities, neighborhoods, or subpopulations in need of targeted resources and interventions. Data also will be used to inform and track policy, systems, and environmental change. Figure 1 illustrates the multiple components of the surveillance system which includes data for the state as a whole,[1,23] as well as for specific subpopulations and geographic regions.[24] In addition to developing the surveillance system, this core is working to develop shared metrics and is evaluating healthTIDE and community intervention outcomes (Figure 1).

UW-Madison faculty with expertise in community research, evaluation, and obesity prevention are assisting in the strategy selection process and are working with communities to set up evaluation indicators with specific reporting indicators at pre-, mid-

point, and post-3 years of intervention work, and beyond. Since the evidence base around comprehensive approaches to obesity is still building, outcome data from these pilot communities will be used to inform other Wisconsin communities.

National Advisory Board

The Initiative has a national scientific advisory board comprised of 6 nationally respected university faculty with expertise in obesity prevention, health promotion, and health communications. Two faculty are current or former directors of university-based CDC-funded Prevention Research Centers. This board meets biannually to provide feedback on the strengths and weaknesses of the Initiative's efforts. Individual faculty experts also meet with and advise the cores. In addition to this academic advisory board, healthTIDE has a leadership council comprised of 18 members from state and local public health departments, state and local nonprofits, UW-Extension, and the Healthy Wisconsin Leadership Institute. This group convenes biannually and on an ad-hoc basis to guide healthTIDE staff.

Relevance

This approach has strong similarities in scope to Shape Up Somerville. We have chosen a model similar to, but more comprehensive than Shape Up Somerville, which involved multiple systems and resulted in a decrease in the body mass index (BMI) of children and their parents, although parents were not the primary focus.[25,26] The Initiative's central aim is to reduce childhood obesity because it is a major risk factor for adult obesity, and both childhood obesity and adult obesity are risk factors for insulin resistance, type 2 diabetes, dyslipidemia, and other chronic diseases. Changes at the statewide and community levels will improve individual-level nutrition and physical activity behaviors directly associated with weight and fitness. Furthermore, through the multi-setting, comprehensive community pilot interventions, research faculty will be able to pilot, test, and determine the population-level improvements in health.

Through this initiative, Wisconsin can be a national model for multisetting community interventions to address obesity by mobilizing resident leaders and aligning institutions and resources to achieve health improvement at local and statewide levels. Addressing these individual-level indicators through population-level changes ultimately will result in reduction in the prevalence of childhood obesity, reduced current and future health care costs, and future reductions in chronic disease mortality. Lessons learned regarding the community change processes and how they affect obesity will be helpful for other health-related efforts.

Progress

To date, healthTIDE backbone staff have been able to leverage over $2 million in additional grant and in-kind funds to make progress on the statewide priorities identified and have set up web-based communications including a website and social media platforms to reach the over 1500 partners statewide connected with the work of healthTIDE and to the public. The 2 pilot communities are in the process of choosing intervention strategies and giving feedback on the intervention system menu, which is being developed as an interactive website that can serve as a point of access for strategy selection criteria, evidence, technical assistance, and Wisconsin case studies. Community organizing initiatives and coalition initiatives have taken root in the communities with the goal of becoming drivers of changes in the local policies, systems, and environments that can promote healthy eating and physical activity. The surveillance system has amassed publicly available data and established agreements with Wisconsin health systems to analyze BMI data from electronic health records. Data dissemination will occur via reports, fact sheets, and an interactive website. New data sources are being added regularly.

By creating a comprehensive infrastructure and engaging multiple community, academic, and private sector partners with the Obesity Prevention Initiative, there is movement towards more comprehensive and strategic priority setting and mutually reinforcing activities statewide. This special issue of *WMJ* illustrates both the methodology we are using as well as early progress towards more comprehensive and collective work on obesity prevention with multiple local and statewide partners.

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Development of an Obesity Prevention Dashboard for Wisconsin

Karissa Ryan, BS; Parvathy Pillai, MD, MPH; Patrick L. Remington, MD, MPH; Kristen Malecki, PhD, MPH; Sara Lindberg, PhD, MS

ABSTRACT

Importance: A comprehensive obesity surveillance system monitors obesity rates along with causes and related health policies, which are valuable for tracking and identifying problems needing intervention.

Methods: A statewide obesity dashboard was created using the County Health Rankings model. Indicators were obtained through publicly available secondary data sources and used to rank Wisconsin amongst other states on obesity rates, health factors, and policies.

Results: Wisconsin consistently ranks in the middle of states for a majority of indicators and has not implemented any of the evidence-based health policies.

Conclusions and Relevance: This state of obesity report shows Wisconsin has marked room for improvement regarding obesity prevention, especially with obesity-related health policies. Physicians and health care systems can play a pivotal role in making progress on obesity prevention.

INTRODUCTION

Public health surveillance encompasses a systematic collection and interpretation of data in order to enact change to improve the health of a population.[1] Progress reports, such as dashboards, have been used in many settings to provide quick reference for managers to assess progress and identify areas for improvement.[2] This Wisconsin obesity dashboard aims to provide a new group of indicators to measure obesity through data that can be found through publicly available sources.

Systems to monitor obesity typically have focused on measuring individual indicators; energy expenditure, energy intake, and weight status.[3] However, we now recognize there are multiple upstream determinants that impact childhood obesity rates.[4,5] Thus, a comprehensive childhood obesity surveillance system is needed that incorporates not only obesity rates, but also upstream determinants of childhood obesity. We wanted to develop a list of sentinel indicators of childhood obesity that might be used both in Wisconsin and nationally to look at clinical and public health prevention programs.

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METHODS

This state obesity dashboard design was based on the County Health Rankings (Rankings) model, a population health model which highlights key factors that, if improved, would make the counties and communities healthier places to live.[6] The Rankings measures health based on 3 elements: health outcomes, health factors, and policies and programs.[7] While in the Rankings model adult obesity rates are considered a health factor for many chronic diseases, we adapted the model such that age-based obesity rates were considered the primary outcomes of interest, because of the low prevalence of chronic disease in childhood.

A broad list of possible indicators was developed through a literature review of obesity prevention and intervention programs, noting measures commonly used to evaluate these programs. Potential indicators were evaluated with respect to both their relevance to ongoing obesity prevention efforts in Wisconsin and to the obesity-adapted Rankings model. In selecting the final subset of sentinel indicators, criteria for potential inclusion the need to be modifiable, accessible through publicly available data, and available at a spatial scale that would allow for state-to-state comparisons. The list ultimately was narrowed to include 3 health outcome indicators, 6 health factor indicators, and 4 policy indicators (Table 1) through consensus discussion with the Obesity Prevention Initiative surveillance and evaluation team members. The health factors were divided into 3 categories: behavior, clinical, and environment. However, a more comprehensive list of indictors we identified can be found through the

Table 1. Obesity Outcomes and Health Factors

Indicator	Indicator Summary (n=states with data available)	Data Source*	Best Rate %	Worst Rate %	Wisconsin Rate (Rank) %	National Rate	Healthy People 2020 Goal
% obese by BMI preschool or toddler (2-5)	Outcome (n=44)	Pediatric Nutrition Surveillance System 2011	Utah 9.0 %	California 16.8%	(21st /44) 14.0%	14.4%	9.4% Reduce % children aged 2-5 who are obese
% obese by BMI adolescents (12-17)	Outcome (n=42)	Youth Risk Behavior Surveillance System 2013	Utah 6.4%	Kentucky 18.0%	(14th/42) 11.6%	13.7%	16.1% Reduce % children aged 12-19 who are obese
% obese by BMI adults (18+)	Outcome (n=51)	Behavior Risk Factor Surveillance System 2013	Colorado 21.3%	Arkansas 35.9%	(Tied 37th/51) 31.2%	28.1%	30.5% Reduce % adults who are obese
% infants breastfed or fed breast milk (initiation)	Breastfeeding (n=51)	National Inpatient Sample	Washington 93.6%	Mississippi 57.6%	(30th /51) 79.9%	80.0%	81.9% Increase % infants who are breastfed
% Children who consume sugar-sweetened beverages daily	Diet (n=39)	Youth Risk Behavior Surveillance System 2013	New Jersey 12.2%	West Virginia 38.0%	(13th/39) 19.6%	27.0%	N/A
% children (12-17) who have <3 hours screen time	Behavior (n=40)	Youth Risk Behavior Surveillance System 2013	Utah 85.1%	Mississippi 60.5%	(6th/40) 77.5%	67.5%	73.9% Increase % of children (grades 9-12) that have screen time <2 hours/ day
% children (12-17) who partake in >60 minutes of structured physical activity/day (in past 7 days)	Physical Activity (n=41	Youth Risk Behavior Surveillance System 2013	Oklahoma 38.5%	Utah 19.7%	(28th/41) 24.0%	27.1%	31.6% Increase the proportion of adolescents who are meeting activity guidelines
% pregnant women with > recommended weight gain	Quality of Care (n=26, Including DC)	Pediatric Nutrition Surveillance System 2011	New York 41.5%	New Hampshire 53.3%	(13th/26) 49.7%	48.0%	N/A
Neighborhood amenities	Environment (n=51)	National Survey of Children's Health 2011	DC 94.3%	Mississippi 64.1%	(16th/51) 88.7%	83.5%	N/A

Abbreviations: BMI, body mass index; HS, high school; N/A, not applicable.
*See http://www.wihealthatlas.org/wmjindicators/ for more information about these data sources. Accessed Nov 1, 2016.

Obesity Prevention Initiative website: www.wihealthatlas.org/WMJindicators.

Health outcome and health factor data were collected from 5 publicly available national data sources: the Pediatric Nutrition Surveillance System (PedNSS), Youth Risk Behavioral Surveillance System (YRBSS), Behavioral Risk Factor Surveillance System (BRFSS), National Survey of Children's Health (NSCH), and National Immunization Survey (NIS). Data from each source for the identified sentinel indicators were extracted as raw percentages. For those with data available, all states and the District of Columbia were then ranked for each indicator using the raw percentages. The states were ranked with low scores (ie, 1) being the best. Healthy People 2020 goals also were included as the future benchmark for each indicator where available.

Data regarding the health policy indicators were collected from the Centers for Disease Control and Prevention and Smart Growth America. These were subsequently examined as dichotomous yes/no variables depending on whether or not there was a state-level policy in place.

Approval by the University of Wisconsin-Madison Review Board for Human Subjects Research was not required as determined by the "Not Research Determination Decision Tool."

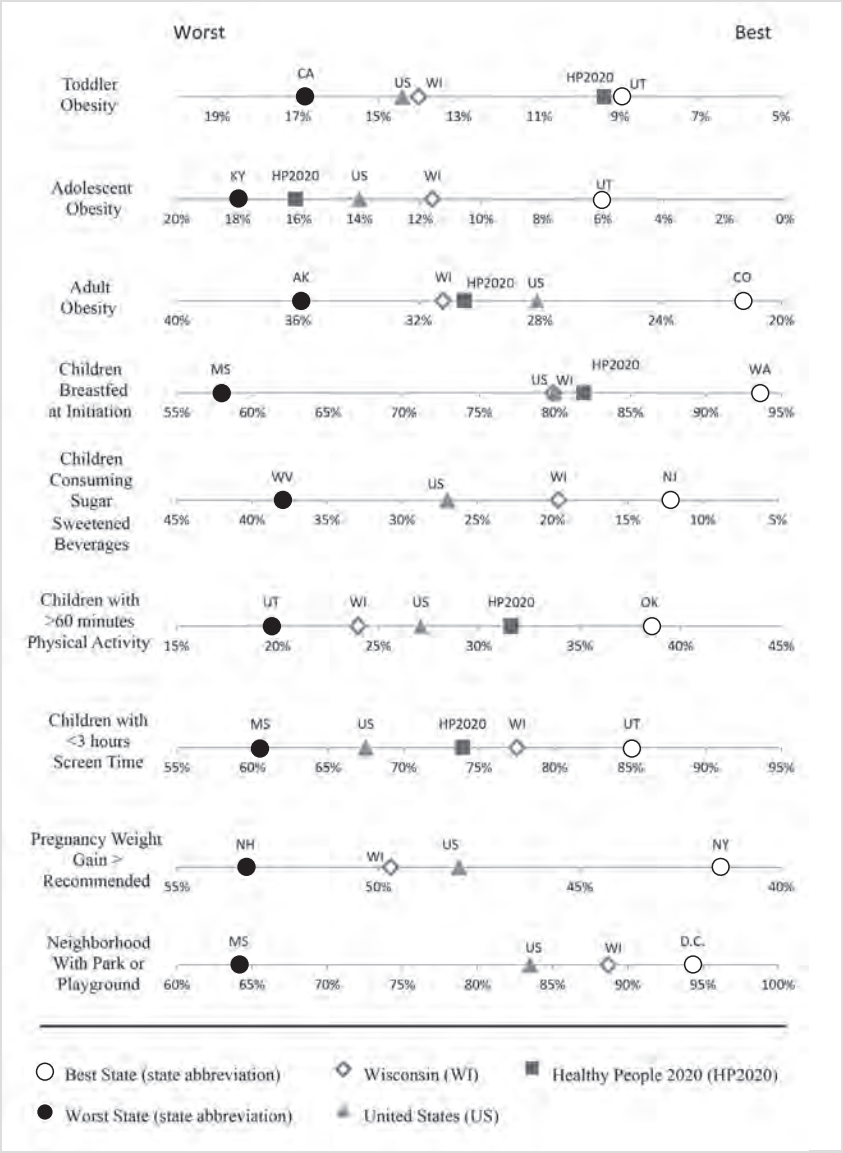
RESULTS

The state dashboard uses a horizontal bar to illustrate how Wisconsin ranks among other states in regards to each sentinel indicator. National average and Healthy People 2020 targets also are provided for each indicator when available in order to provide greater context to the rankings (Figure 1). We applied these indicators to the state of Wisconsin and describe the results below.

Health Outcomes and Health Factors

Figure 1 illustrates how Wisconsin ranks among other states based on the sentinel indicators of obesity. Wisconsin falls in the middle

Figure 1. Wisconsin's Obesity Prevention Dashboard, 2016



of the nation with regard to all 3 weight status indicators within all 3 age groups, ranking 21st of 44 in preschool/toddler obesity, 14th of 42 in adolescent obesity, and 37th of 51 in adult obesity.

Figure 1 also provides the rankings among indicators regarding upstream health factors. The health factors for obesity risk were divided into 3 categories: behavior, clinical, and environment. Among the behavioral categories, Wisconsin ranks among the best in regard to children who watch less than 3 hours of television (6th of 40 states). Under clinical care, Wisconsin ranked 13th of 26 states on the percentage of women with more than the recommended weight gain during pregnancy. Representing the environmental indicators, Wisconsin ranked 16th of 51 states in percentage of neighborhoods in which parks or playgrounds exist.

Policy

Table 2 summarizes select health policies and if they have been adopted in Wisconsin, as well as how many other states have adopted similar policies. Of note, Wisconsin had adopted none of the indicator policies. The most frequently adopted policy by other states was some form of a complete streets policy with 32 states (including the District of Columbia and Puerto Rico).

DISCUSSION

This Wisconsin obesity dashboard, the new collection of measures described, allows for easy comparison of Wisconsin to other states on the multiple upstream indicators of obesity, as well as obesity as a health outcome. Compared with other states, Wisconsin still has marked room for improvement with regard to obesity prevention. It consistently ranks in the middle of states reported regarding most of the health outcome and health factor indicators and is neither the best nor the worst in the nation for any selected indicator. However, Wisconsin remains behind other states in adopting obesity-related health policies, which strongly indicates that state government policy represents a high priority place to promote obesity prevention efforts. Wisconsin has not enacted any of the 4 policies that support healthy environments and support communities and individuals in their attempts to eat healthy foods and be active.

A strength of this dashboard is that much of the data for each of these indicators is publicly and readily available. Indeed, it has been noted that due to the number of data sources and the lack of a universal or central hub of obesity data, these sources often go underused.[8] By compiling data from these various sources into 1 comprehensive surveillance system, we will provide a preliminary framework and infrastructure for more rigorous evaluation of obesity trends and factors. Our current analysis focuses on national and state comparisons, but this model could be adopted at the local community level as well. Using a ranking approach for this surveillance system provides a greater likelihood that the results will mobilize a community action response.

While this is a first step towards compiling consistent national data for tracking childhood obesity surveillance in a comprehen-

Table 2. Obesity-Related Policies

Health-Related Policy and Data Source	Does Wisconsin Have the Policy? (yes/no)	Number of States With Policy
State policy at least partially follows Institute of Medicine guidelines for competitive foods and beverages in US schools. http://www.cdc.gov/healthyyouth/nutrition/pdf/compfoodsbooklet.pdf[9]	No	34 with at least some Institute of Medicine standards partially met
Child care regulations meet Caring For Our Children Guidelines of moderate- to vigorous-intensity physical activity for preschoolers in all settings http://www.cdc.gov/physicalactivity/downloads/pa_state_indicator_report_2014.pdf[10]	No	0 (including District of Columbia)
Adopted some form of Complete Streets policy http://www.smartgrowthamerica.org/complete-streets-2014-analysis[11]	No	32 (including Puerto Rico and District of Columbia)
Healthier Food Retail Legislation http://www.cdc.gov/obesity/downloads/Healthier_Food_Retail.pdf[12]	No	12 (including District of Columbia)

sive way, several limitations exist. How each of the indicators was operationalized was dependent on what was available in each of the data sources. Not all sources included data from all states and/or territories; therefore, the ranking of states may not be generalizable to the nation, and there may be some inherent bias due to unique characteristics of those states that could not be ranked due to missing data. Furthermore, we recognize that the raw estimates might not lead to an accurate ranking of the states.

Another limitation we are working to overcome is that the data sources are not always broken down to geographic units smaller than a state, and local communities might want to adapt indicators to their own efforts. To obviate this limitation, we are building an obesity surveillance system that incorporates comprehensive, community-level data. We hypothesize that local data will be especially valuable for Wisconsin communities, health systems, and policymakers in the future, enabling citizens to monitor and track obesity prevention and intervention efforts within their own communities.

This state of obesity report shows Wisconsin has marked room for improvement regarding obesity prevention, especially with obesity-related health policies. Physicians and health care systems can play a pivotal role in making progress on obesity prevention.

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Prevalence of Pre-pregnancy Obesity, 2011-2014

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ABSTRACT

Importance: Obesity before and during pregnancy increases risk among mothers for poor health outcomes, such as diabetes, high blood pressure, and cardiovascular disease.

Objective: To describe trends in pre-pregnancy obesity rates among women in Wisconsin.

Methods: Cross-sectional data from Wisconsin birth certificates were analyzed. Prevalence of pre-pregnancy obesity (defined as body mass index ≥30) among Wisconsin women who gave birth from 2011 through 2014 was compared across demographic and geographic dimensions.

Results: Overall, 27.8% of Wisconsin women who gave birth during 2011-2014 were obese. Obesity rates were highest among 40- to 44-year-old women (31.8%), women with a high school/GED diploma (32.8 %), American Indian/Alaska Native women (43.9%), and women with 5 or more pregnancies (35.4%). Obesity rates varied by county of residence (highest in Forest County, 45.2%) and city of residence (highest in the city of Racine, 34.8%).

Conclusions: There are significant socioeconomic, racial, and geographic disparities in pre-pregnancy obesity among women who give birth in Wisconsin.

INTRODUCTION

Obesity rates of 31.8% have been reported recently among women ages 20 to 39.[1] This creates a public health concern because obese women are more likely to enter pregnancy with hypertension or diabetes—both which increase pregnancy risks. During pregnancy, gestational diabetes, preeclampsia, and cesarean section are more common among obese women, as well as spontaneous abortion and unexplained stillbirth.[2] Furthermore, gestational weight gain, gestational diabetes, and smoking during pregnancy increase risk for childhood obesity.[3] Although childhood obesity is well researched, there remains a dearth of research describing pre-pregnancy obesity trends. Our objective is to describe these trends among Wisconsin women, which should inform further research and community initiatives to improve the health of women and children across the life course.

METHODS

We used cross-sectional data from 2011 through 2014, published in the Wisconsin Interactive Statistics on Health (WISH) database by the Wisconsin Department of Health Services.[4] The sample was limited to women who gave birth during 2011-2014, as these were the only years that included information on pre-pregnancy body mass index (BMI). Data from the WISH system came from resident birth certificates, vital records/electronic health records, the Office of Health Informatics, Division of Public Health, and the Wisconsin Department of Health Services. Pre-pregnancy BMI was calculated by the database curators using the mother's height and weight, which are often reported retrospectively within the first trimester.[4]

For all births during or after 2011, the data system grouped races and ethnicities into 7 categories: white (non-Hispanic), Black/African American (non-Hispanic), American Indian/Alaska Native (non-Hispanic), Hispanic, Laotian/Hmong (non-Hispanic), other (non-Hispanic), and 2 or more races (non-Hispanic). The highest education level of mothers also was collected on the birth certificate and grouped into 6 categories: 8th grade or less, some high school, high school graduate/GED certificate, some college, college graduate, and post-graduate. Number of previous pregnancies includes live births, miscarriages, and other outcomes.[5]

The relationships between pre-pregnancy obesity (defined as a BMI ≥30) and 7 demographic variables were examined. These variables were race/ethnicity, maternal education, age, number of previous pregnancies, county, city, and ZIP code. The tables provided by the query system were then used to calculate the crude obesity prevalence as a function of each demographic variable.

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Rates for obesity by race/ethnicity were adjusted by age to control for confounding effects that may result from differences in rates of teen pregnancies across the demographic strata, as prevalence of obesity increased with age.[5]

RESULTS

There were 268,655 live births documented between 2011 and 2014. Of these, 4,301 were missing data for BMI and were excluded from the analysis, leaving 264,354 births in the analytic sample. As shown in Figure 1, among the women who gave birth in Wisconsin during 2011-2014, 27.8% were obese. Table 1 shows the prevalence of pre-pregnancy obesity by race/ethnicity, education, age, and number of previous pregnancies. Tables 2 and 3 show the prevalence of pre-pregnancy obesity by geographic location, including all Wisconsin counties and the 38 most populous Wisconsin cities. Finally, Figure 2 illustrates the variation in average pre-pregnancy BMI across Wisconsin by county, as well as by ZIP codes within the city of Milwaukee.

Disparities in pre-pregnancy obesity by maternal age, education, race/ethnicity, and number of previous pregnancies—As shown in Table 1, rates of pre-pregnancy obesity increased with age, from a rate of 10.8% among teenagers less than 15 years old to a rate of 31.8% among 40- to 44-year-old women. Obesity rates were highest among women giving birth with a high school/GED diploma (32.8%). Overall, the rate of pre-pregnancy obesity decreased with increasing levels of maternal education, with the lowest rates of pre-pregnancy obesity among women with a post-graduate degree (16.3%). Obesity rates were highest among American Indian/Alaska Native (non-Hispanic) women giving birth (43.4%), followed by non-Hispanic black/African American women (38.2%), compared to Laotian/Hmong women with the lowest rate of pre-pregnancy obesity (21.0%). When adjusted for age, the magnitude of these racial disparities was even greater. Finally, women who had 5 or more previous pregnancies had the highest obesity rates when comparing by parity (35.4%). Overall, the pre-pregnancy obesity rate was higher among women with more children.

Disparities in pre-pregnancy obesity by geographic location—As highlighted in Tables 2 and 3, as well as Figure 2, our data indicated a stark contrast in pre-pregnancy obesity prevalence by Wisconsin county, city, and Milwaukee ZIP code of residence. As depicted in the map of Wisconsin counties (Figure 2), high prevalence of pre-pregnancy obesity among women giving birth is found in north-central and northeastern Wisconsin. Forest County had the highest pre-pregnancy obesity prevalence at 45.2%, whereas Ozaukee County had the lowest prevalence at 20.3%. Among Wisconsin's 38 largest cities, Racine had the highest rate of pre-pregnancy obesity (34.8%) and Mequon/Thiensville had the lowest rate (13.7%).

Figure 1. Pre-pregnancy Body Mass Index (BMI) Distribution Among Women Giving Birth in Wisconsin, 2011-2014

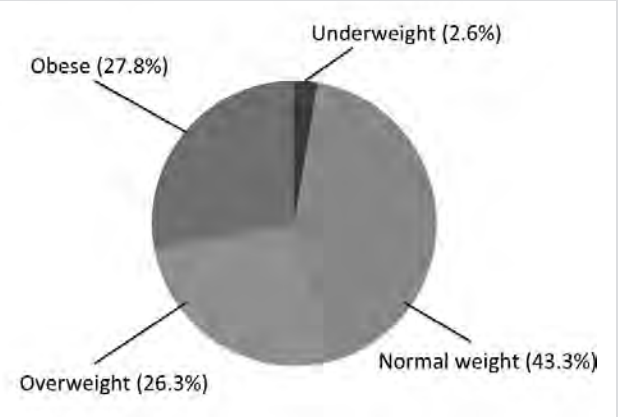


Table 1. Body Mass Index (BMI) Distribution by Race/Ethnicity, Education, Age, and Number of Previous Pregnancies Among Women Giving Birth in Wisconsin, 2011-2014

	No. of Births	Obesity % (Crude)	Obesity % (Age-Adjusted)
Age			
<15 years	166	10.8	—
15-19 years	3,989	15.1	—
18-19 years	11,387	21.0	—
20-24 years	54,561	27.9	—
25-29 years	83,639	28.3	—
30-34 years	75,369	27.6	—
35-39 years	29,215	30.8	—
40-44 years	5,678	31.8	—
45+ years	350	27.7	—
Education[a]			
8th grade or less	9,376	23.1	22.6
Some high school	22,261	30.0	36.3
High school graduate/ GED diploma	65,265	32.8	35.1
Some college	80,309	32.4	32.3
College graduate	58,997	21.4	20.6
Post-graduate	27,364	16.3	17.2
Race/Ethnicity[b]			
White	194,089	26.6	26.4
Black (non-Hispanic)	24,710	38.2	43.0
American Indian/Alaska Native	2,839	43.9	46.4
Hispanic	25,007	30.7	32.8
Laotian/Hmong	6,215	21.0	29.5
Other	6,438	11.3	11.3
2 or more races (non-Hispanic)	4,866	31.2	32.8
Parity (number of previous pregnancies)[c]			
0	79,597	23.9	24.8
1	74,891	27.1	27.0
2	48,980	29.0	28.7
3	27,982	31.5	30.8
4	14,894	33.1	32.3
5	17,670	35.4	35.4

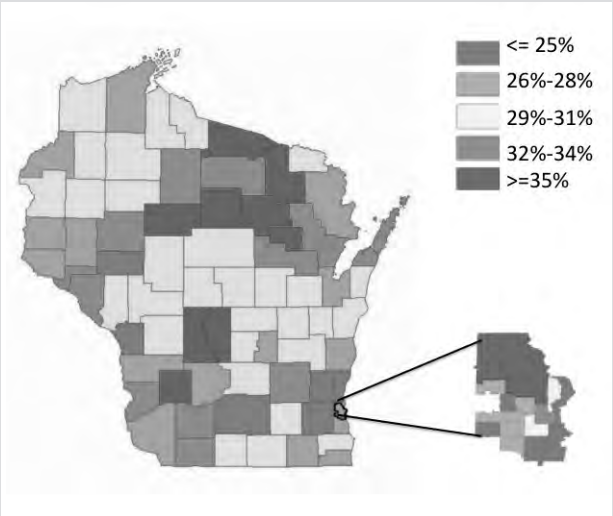
[a]Excludes 782 women with missing education data.
[b]Excludes 190 women with missing race/ethnicity data.
[c]Excludes 340 women with missing parity data.

Table 2. Body Mass Index (BMI) Distribution by County Among Women Giving Birth in Wisconsin, 2011-2014

County	No. of Births	% Obese	Rank
Ozaukee	3,223	20.3	1
Dane	24,325	21.6	2
Waukesha	14,942	21.9	3
La Crosse	4,991	23.0	4
Florence	112	25.2	5
Vernon	1,631	25.3	6
Washington	5,272	25.3	7
St. Croix	4,106	25.6	8
Eau Claire	4,685	25.9	9
Walworth	4,107	26.1	10
Sauk	2,921	26.3	11
Marinette	1,518	26.9	12
Grant	2,119	26.9	13
Sheboygan	4,972	27.7	14
Brown	13,539	27.8	15
Sawyer	649	28.1	16
Clark	2,256	28.3	17
Green Lake	798	28.4	18
Polk	1,684	28.4	19
Milwaukee	54,862	28.4	20
Kenosha	7,756	28.6	21
Burnett	505	28.6	22
Portage	2,756	28.6	23
Manitowoc	3,315	28.7	24
Dunn	1,797	28.8	25
Green	1,551	28.8	26
Iron	154	28.9	27
Waushara	906	29.0	28
Wood	3,251	29.1	29
Outagamie	8,978	29.2	30
Rock	7,517	29.3	31
Trempealeau	1,545	29.4	32
Jefferson	3,563	29.4	33
Columbia	2,377	29.4	34
Barron	2,055	29.4	35
Calumet	2,197	29.6	36
Pierce	1,492	29.8	37
Kewaunee	776	30.0	38
Douglas	1,637	30.1	39
Rusk	560	30.1	40
Iowa	1,060	30.2	41
Door	777	30.3	42
Fond du Lac	4,390	30.4	43
Marathon	6,409	30.5	44
Bayfield	497	30.7	45
Jackson	970	30.8	46
Monroe	2,358	30.8	47
Washburn	599	31.0	48
Racine	9,458	31.2	49
Marquette	606	31.4	50
Winnebago	7,405	31.6	51
Waupaca	2,067	31.6	52
Dodge	3,320	31.8	53
Ashland	697	31.9	54
Richland	696	32.0	55
Chippewa	2,815	32.2	56
Pepin	306	32.6	57
Oneida	1,199	33.1	58
Oconto	1,402	33.1	59
Lafayette	834	33.4	60
Adams	524	33.5	61
Taylor	884	34.0	62
Price	429	34.2	63
Langlade	775	34.4	64
Crawford	646	34.6	65
Juneau	1,082	35.8	66
Shawano	1,686	35.9	67
Lincoln	1,042	36.7	68
Buffalo	542	36.9	69
Vilas	711	37.8	70
Menominee	324	41.1	71
Forest	439	45.2	72

Excludes 5 women with missing county identifier.

Figure 2. Pre-pregnancy Body Mass Index (BMI) Distribution by County and Milwaukee ZIP Code Among Women Giving Birth in Wisconsin, 2011-2014



DISCUSSION

The overall rate of pre-pregnancy obesity among women giving birth during 2011-2014 was 27.8%, which is lower than averages previously reported.[1] However, our results show that pre-pregnancy obesity rates in Wisconsin vary significantly by demographic and geographic factors. The highest prevalence of pre-pregnancy obesity in Wisconsin is among American Indian/Alaska Native women and African American women. These results are consistent with previous research in Wisconsin[6] and elsewhere in the United States.[7,8] Furthermore, these trends highlight persistent disparities and inequality faced by American Indian and African American women in Wisconsin that are at least partially explained by the disproportionate economic hardship experienced by these racial/ethnic groups.

Parity and maternal age at the time of birth are closely related variables, and it is difficult to isolate the two influences in these data. Our results indicate that pre-pregnancy obesity

rates were highest among mothers who already had 5 or more children. These results are consistent with previous research showing that parity is a strong, positive predictor of maternal obesity.[9] The difficulty is that women who are older will likely have had more prior pregnancies than younger women giving birth. Because women tend not to lose all weight gained during each pregnancy, prior pregnancy likely results in a higher BMI, but it also is associated with greater age. Given that parity and maternal age are positively related, we also see a corresponding linear trend with increasing rates of obesity as maternal age increases.

Consistent with previous research, rates of pre-pregnancy obesity were generally greatest among women with less education in Wisconsin.[10] Additionally, the stark socioeconomic disparities pertaining to pre-pregnancy obesity were best highlighted by our data enumerating pre-pregnancy obesity rates by geographic location. These data indicate that pre-pregnancy obesity affects both rural and urban impoverished populations. The finding that rates are highest among women in north-central and northeastern Wisconsin is not surprising, given the social, demographic, and racial composition of these counties.

The map of Milwaukee ZIP codes also provides elucidating information, as the ZIP codes with the highest rates of pre-pregnancy obesity are largely low-income, Black/African American non-Hispanic and Hispanic neighborhoods. These data highlight geographic areas that are most underserved in terms of pre-pregnancy obesity. Although it is outside the scope of this paper, these results may direct further research into food security, economic hardship, and the built environment to investigate related causes to the wide disparities in pre-pregnancy obesity in these counties, cities, and Milwaukee ZIP codes.

Strengths of this descriptive study include a large, diverse, and robust sample size. In addition, as these data are compiled from birth certificate data, future research may be able to access individual-level data in order to provide a more complete picture of pre-pregnancy obesity in Wisconsin, as well as examine the relationship between pre-pregnancy obesity of women and their children.

The results of this study should be considered in light of their limitations. First, mothers' height and weight measurements may be obtained inconsistently by hospitals. Additionally, weight measurements are often obtained retrospectively in the first trimester and may not truly reflect the mother's weight immediately prior to conception. Recent validation studies suggest that most hospitals record self-reported measurements from mothers, and these estimates can result in substantial misclassification of pre-pregnancy BMI.[10] Finally, this cross-sectional data cannot establish a causal relationship between pre-pregnancy obesity and race/ethnicity, maternal education, age, number of previous pregnancies, county, city, and ZIP code. A multivariable analysis would control for confounding factors and may be useful in teasing apart the complexity of the variables used in this analysis; this presents a further direction of study.

Table 3. Body Mass Index (BMI) Distribution by City Among Women Giving Birth in Wisconsin, 2011-2014

City	No of Births	% Obese	Rank
Mequon/Thiensville	772	13.7	1
Wauwatosa	2,443	14.2	2
Brookfield	1,261	15.3	3
New Berlin	1,405	18.8	4
Franklin	1,341	19.2	5
Oak Creek	1,703	20.0	6
Fitchburg	1,525	20.2	7
Menomonee Falls	1,419	20.8	8
Madison	12,251	21.3	9
Muskego	822	22.1	10
De Pere	1,620	22.8	11
Caledonia	596	23.0	12
Mount Pleasant	731	23.8	13
Greenfield	1,504	24.0	14
La Crosse	2,355	24.2	15
Sun Prairie	1,988	25.5	16
South Milwaukee	877	26.0	17
Eau Claire	3,456	26.1	18
Steven's Point	1,289	26.2	19
West Bend	1,721	26.7	20
Grand Chute	269	27.1	21
Waukesha	3,962	28.1	22
Manitowoc	1,813	28.5	23
Janesville	3,308	29.2	24
West Allis	2,961	29.3	25
Sheboygan	2,823	29.8	26
Green Bay	8,473	29.8	27
Appleton	5,343	29.8	28
Kenosha	5,792	30.0	29
Wausau	2,528	30.0	30
Oshkosh	3,207	30.5	31
Beloit	2,195	31.0	32
Milwaukee	39,222	31.3	33
Superior	1,193	31.3	34
Fond du Lac	2,526	31.6	35
Watertown	1,168	33.2	36
Neenah/Menasha	2,765	34.0	37
Racine	5,781	34.8	38

These results have important implications with regards to the life course approach to epidemiology, which is an interdisciplinary framework that examines the long-term outcomes of exposures during gestation, childhood, adolescence, and adulthood.[11] In 2013, Ehrenthal et al conducted a historical cohort study of mothers who gave birth between 2004 and 2007 and followed up with their children when they were 4 years old. Their results indicated that preconception risk factors of mothers—such as pre-pregnancy obesity—were more predictive of childhood obesity than prenatal factors.[12] Therefore, promoting healthy BMI in women before pregnancy has the potential not only to increase the health of mothers, but also the health of their children.

Although these results can only highlight associations, they do point to populations within Wisconsin that are most in need

of targeted intervention. Pre-pregnancy obesity is linked with complications that lead to extra procedures and extended hospital stays that incur higher medical costs than low-risk births. Additionally, there is a well-established relationship between increased BMI and incident chronic diseases such as hypertension, diabetes, and cardiovascular disease that incur higher health care costs. Recent studies have found these costs to be substantial. In a recent study published in 2015, the short-term economic burden of maternal overweight, gestational diabetes, and related conditions was estimated to be more than $1.8 billion. Although this estimate did not account for long-term consequences, it is reasonable to conjecture that the long-term economic costs present a burden to our country's health care system as well.[13] The relationship between pre-pregnancy obesity and direct/indirect health care costs presents another future research direction.

Obesity is complex and multifaceted. Biological, socioeconomic, and behavioral factors alone are unable to encompass the entire scope of obesity. However, our results indicate that pre-pregnancy obesity is associated with socioeconomic and geographic factors that are likely related. Given the direct health and economic burden to individual women, families, and communities, and that obesity in mothers increases the obesity risk in the next generation, further research and community interventions are needed.

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Prevalence and Predictors of Unhealthy Weight Gain in Pregnancy

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ABSTRACT

Importance: Weight gain during pregnancy affects obesity risk in offspring.

Objective: To assess weight gain among UW Health prenatal patients and to identify predictors of unhealthy gestational weight gain.

Methods: Retrospective cohort study of women delivering at UW Health during 2007-2012. Data are from the UW eHealth Public Health Information Exchange (PHINEX) project. The proportion of women with excess and insufficient (ie, unhealthy) gestational weight gain was computed based on 2009 Institute of Medicine guidelines. Multivariable logistic regression was used to identify risk factors associated with excess and insufficient gestational weight gain.

Results: Gestational weight gain of 7,385 women was analyzed. Fewer than 30% of prenatal patients gained weight in accordance with Institute of Medicine guidelines. Over 50% of women gained excess weight and 20% gained insufficient weight during pregnancy. Pre-pregnancy weight and smoking status predicted excess weight gain. Maternal age, race/ethnicity, smoking status, and having Medicaid insurance predicted insufficient weight gain.

Conclusions and Relevance: Unhealthy weight gain during pregnancy is the norm for Wisconsin women. Clinical and community interventions that promote healthy weight gain during pregnancy will not only improve the health of mothers, but also will reduce the risk of obesity in the next generation.

INTRODUCTION

Unhealthy weight gain during pregnancy creates health problems for both mother and child, including incident maternal obesity,[1] pediatric obesity,[2] and lifelong elevated cardiovascular and metabolic risk for mother and child.[3] The health risks associated with unhealthy weight gain during pregnancy are in addition to the risks posed by pre-pregnancy weight status, which are detailed elsewhere.[4,5] The current Institute of Medicine (IOM) guidelines attempt to balance the competing risks of insufficient versus excess weight gain during pregnancy and are tailored to reflect the different metabolic needs and risk profiles of women based on pre-pregnancy body mass index (BMI) and fetal number.[3] Fewer than half of pregnant women in the United States currently achieve a healthy gestational weight gain within IOM recommendations.[3,6]

The social ecological model provides a framework for understanding why so few women gain weight within IOM guidelines. It emphasizes that health outcomes are not solely the result of individual characteristics and behaviors, but also the various environments in which people work, live, play, and develop.[7] The model has been employed extensively and successfully in obesity prevention and health promotion research, yet individual- and community-level determinants of gestational weight gain are not well understood. Previous research suggests that gestational weight gain is patterned on demographic characteristics such as race and education.[8-10] A few studies have examined associations with individual-level psychological factors such as stress,[11,12] and behavioral factors such as diet and exercise.[13,14] However, little attention has been paid to environmental contexts that promote or inhibit healthy gestational weight gain. This study addresses this gap by identifying predictors of gestational weight gain across multiple levels of the social ecological model.

The purpose of this study was to use electronic health record data to evaluate the current prevalence of insufficient and excess (ie, unhealthy) gestational weight gain among pregnant women who received care in a large, statewide health system in the Midwest during 2007-2012. The study also connected clinical data about pregnancy-related weight gain to patient-, provider-,

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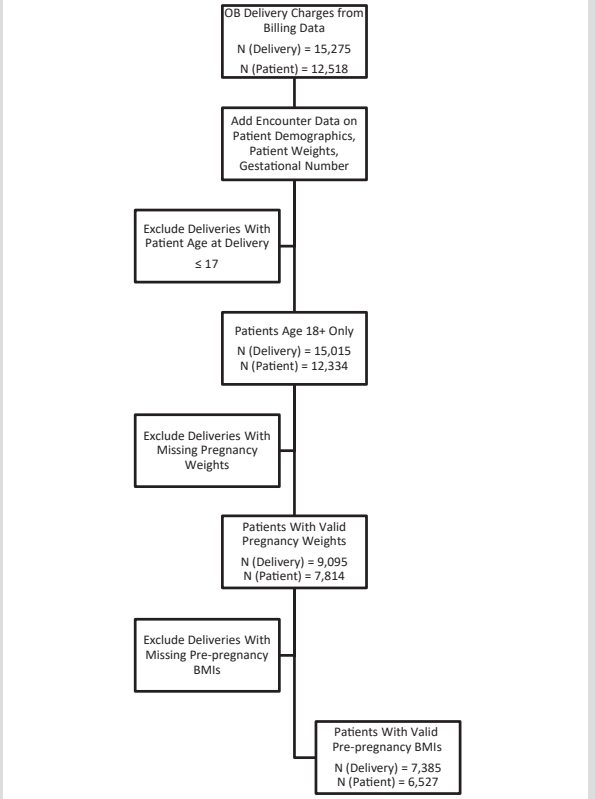
Figure 1. Sample Selection



and community-level data to describe multiple determinants that contribute to risk for insufficient and excess gestational weight gain.

METHODS

Data Source—Data are from the UW eHealth Public Health Information Exchange (PHINEX), which combines patient- and clinic-level data from UW Health electronic health records with community-level data from commercially available datasets, eg, US Census data. The resulting dataset contains information on over 11 million encounters with more than 500,000 patients during 2007-2012. The study was reviewed and approved by the University of Wisconsin–Madison Health Sciences Institutional Review Board.

Participants—Billing data identified 15,275 deliveries to 12,518 patients. Participants were excluded from this analysis if the patient was a minor, if they had no recorded pre-pregnancy BMI, or if they had no recorded pregnancy weights (Figure 1). Our final analytic sample comprised 7,385 deliveries to 6,527 patients. Sample characteristics are in Table 1.

Measures—The primary outcome—gestational weight gain—was calculated as the last weight prior to delivery (within 8 weeks of delivery) minus the pre-pregnancy weight. If pre-pregnancy weight was missing, it was imputed from the most recent ambulatory visit up to 12 months prior to the patient's last menstrual period (so long as the weight did not overlap with a previous pregnancy). Gestational weight gain was classified as insufficient, ideal, or excess based on the patient's pre-pregnancy BMI, gestational number, and IOM guidelines.[3]

Independent variables included age, race/ethnicity, pre-pregnancy BMI, gestational number, smoking status, payor, neighborhood median income, neighborhood economic hardship index, and neighborhood urbanicity. Age was defined as the patient's age at delivery. Race/ethnicity was classified as non-Hispanic white, non-Hispanic black, Hispanic, or non-Hispanic other. Pre-pregnancy BMI was classified as underweight (BMI < 18.5), normal weight (BMI 18.5-24.9), overweight (BMI 25.0-29.9), Class I obesity (BMI 30.0-34.9), Class II obesity (BMI 35.0-39.9), or Class III obesity (BMI > 40.0). Smoking status was classified as never, current, former, or passive. Payor was classified as commercial, Medicaid/Medicare, or no insurance. Neighborhood median income was classified as < $50,000, $50,000 to $75,000, or > $75,000. Neighborhood economic hardship was based on an economic hardship index comprising variables such as unemployment, crowded housing, percentage of households below the poverty line, and percentage of households with less than a high school education.[15] For the purpose of this analysis, neighborhood economic hardship was classified as low hardship (Index < 20), moderate hardship (Index 20-30), or high hardship (Index > 30). Neighborhood urbanicity was classified as urban, suburban, or rural using the Esri Tapestry classification method for Census Block Groups.[16]

Data Analyses

The proportion of patients with insufficient, ideal, and excess gestational weight gain was computed. Then multivariable logistic regression analyses were conducted to identify predictors of insufficient and excess gestational weight gain. Separate regression models were run predicting insufficient gestational weight gain and excess gestational weight gain. Each regression model used a stepwise forward selection procedure based on Fischer's scoring optimization to select from our candidate predictors all that independently predicted gestational weight gain.[17]

RESULTS

Approximately half of the 7,385 deliveries between 2007 and 2012 were to women who were overweight or obese at the time of conception (Table 1). Pre-pregnancy BMIs ranged from 14.7 to 82.1. Less than half (48.1%) of the sample was normal weight at conception, with 2.0% underweight, 26.5% overweight, 13.2% Class I obese, 5.8% Class II obese, and 4.3% Class III obese.

Mean gestational weight gain was 30.5 pounds (SD = 13.7), but there was substantial variation (range: 52 pounds lost to 135

pounds gained). Gestational weight gain varied by pre-pregnancy BMI, such that patients who began pregnancy at lower BMIs tended to gain more weight than those who began pregnancy at higher BMIs (Table 2). Overall, 19.8% of the sample gained insufficient weight, 29.5% gained ideal weight, and 50.8% gained excess weight during pregnancy. The prevalence of insufficient, ideal, and excess weight differed significantly by pre-pregnancy BMI, $P < .0001$. Based on the more restrictive guidelines for overweight and obese women, these groups actually were more likely to exceed target weight gain recommendations (Figure 2) despite having gained less weight on average than those who were underweight or normal weight before pregnancy (Table 2). Overweight and obese women were particularly likely to gain excess weight, with 65.5% of overweight women and 65.6% of Class I obese women gaining excess weight, compared to 50.8% of Class II obese, 42.8% of Class III obese, 40.2% of normal weight, and 22.2% of underweight women gaining excess weight, respectively. In contrast, women at either extreme of BMI were most likely to gain insufficient weight, with 36.9% of underweight women and 37.5% of Class III obese women gaining insufficient weight, compared to 22.7% of normal weight, 12.2% of overweight, 13.8% of Class I obese, and 25.5% of Class II obese women gaining insufficient weight.

Results of the multivariable logistic regression analyses are summarized in Figure 3. The effect of pre-pregnancy BMI on the risk of insufficient and excess gestational weight gain remained robust after controlling for the other predictors. In addition, age, gestational number, smoking status, payor, and neighborhood economic hardship uniquely contribute to the likelihood that a woman will gain insufficient or excess weight during pregnancy. Factors that increased risk for excess weight gain included maternal age 20-29; non-Hispanic white race/ethnicity; overweight, Class I or Class II obesity prior to pregnancy; single fetus (vs twins); past smoking; commercial insurance; and living in a neighborhood with low economic hardship. Factors that increased risk for insufficient weight gain included maternal age > 40, non-Hispanic black or other race/ethnicity, underweight or Class III obesity prior to pregnancy, multiple gestation, current smoking, Medicaid insurance, and living in a neighborhood with high economic hardship.

Table 1. Clinical, Demographic, and Community-Level Characteristics of the UW eHealth Public Health Information Exchange (PHINEX) Analytic Sample

Patient-Level Characteristics	N	%
Age		
18-19	196	2.7
20-24	909	12.3
25-29	2275	30.8
30-34	2671	36.2
35-39	1112	15.1
40+	222	3.0
Race/Ethnicity		
Non-Hispanic white	5758	81.8
Non-Hispanic black	423	6.0
Hispanic	367	5.2
Non-Hispanic other	491	7.0
Pre-pregnancy BMI		
Underweight	149	2.0
Normal weight	3549	48.1
Overweight	1959	26.5
Class I Obese	977	13.2
Class II Obese	431	5.8
Class III Obese	320	4.3
Multiple Gestation		
No	7285	98.7
Yes	100	1.4
Smoking		
Never	4736	64.1
Former	2056	27.8
Current	519	7.0
Passive	73	1.0
Payor		
Commercial	5930	80.3
Medicare/Medicaid	1388	18.8
No Insurance	67	0.9
Community-Level Characteristics		
Median Income		
< $50,000	1275	18.1
$50,000-$75,000	3598	51.0
> $75,000	2179	30.9
Economic Hardship		
Low	507	7.2
Moderate	5971	84.7
High	576	8.2
Urbanicity		
Urban	2370	33.6
Suburban	3669	52.0
Rural	1013	14.4

Abbreviation: BMI, body mass index.

DISCUSSION

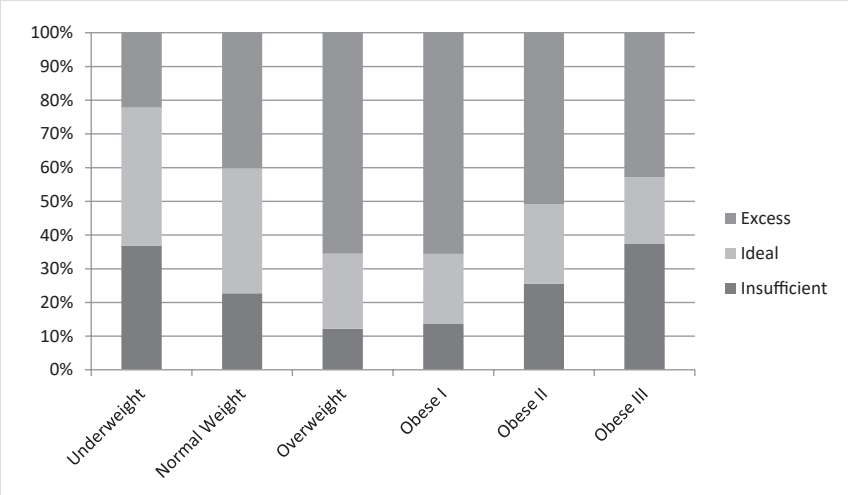
Our finding that 2 out of 3 obstetric patients in this regional, population-based sample gained an unhealthy amount of weight during pregnancy is consistent with other US samples.[18,19] Predictors of excess and insufficient gestational weight gain included both individual- and community-level risk factors.

Like previous studies,[6,19] we found that women who began pregnancy overweight and obese were at greater risk for excess gestational weight gain compared to normal weight women. A novel contribution of this study is that our large sample allowed us to disaggregate risk estimates by obesity severity. Women who began pregnancy with Class II or III obesity had lower risk for excess weight gain than with Class I obesity. This trend suggests that providers and patients may already be attempting to manage weight gain in response to severe obesity, and perhaps these women were being advised to gain less than guidelines, as some new evidence supports.[20]

Table 2. Gestational Weight Gain (in Pounds) by Pre-pregnancy Body Mass Index

	n	Minimum	Maximum	Mean ± SD	Guideline[3]
Underweight	149	5.0	90.0	33.0 ± 11.7	28-40
Normal weight	3549	-14.5	130.5	33.4 ± 11.7	25-35
Overweight	1959	-17.0	134.5	31.2 ± 14.4	15-25
Obese Class I	977	-34.0	132.4	26.7 ± 15.9	11-20
Obese Class II	431	-52.0	79.2	21.1 ± 16.9	11-20
Obese Class III	320	-29.4	86.2	17.6 ± 17.6	11-20
Overall	7385	-52.0	134.5	30.5 ± 13.7	

Figure 2. Prevalence of Insufficient, Ideal, and Excess Gestational Weight Gain by Pre-pregnancy Body Mass Index



Previous research on the link between smoking and gestational weight gain has been inconsistent.[9,12,19] Our findings clarify that former smokers are at increased risk for excess gestational weight gain and current smokers are at increased risk for insufficient weight gain, relative to people who have never smoked.

Racial/ethnic disparities in patterns of gestational weight gain have been demonstrated previously, but with different patterns in different communities.[21,22] In this region, ethnic minority women are at elevated risk for insufficient weight gain rather than excess weight gain. This finding may partially explain regional disparities in preterm birth and adverse birth outcomes.[23]

Our findings regarding risk patterns across age groups likely reflect the strong association between maternal age and parity. Women over age 40 are at greater risk for insufficient weight gain than younger women, whereas women ages 20-29 had greater risk for excess weight gain. This trend is consistent with evidence that women gain more weight with their first baby and less for each subsequent pregnancy.[18]

Most previous studies examining predictors of gestational weight gain were limited to singleton pregnancies. A novel finding of this study is that that women carrying a single fetus were more likely to gain excess weight but less likely to gain insufficient weight than those carrying twins. One possible explanation is that women carrying multiples may be receiving more or better guidance about nutrition and weight gain in pregnancy. Nonetheless, the elevated risk for insufficient weight gain among twin pregnancies is notable, given that insufficient weight gain has been associated with shorter gestations and lower twin birth weights.[3]

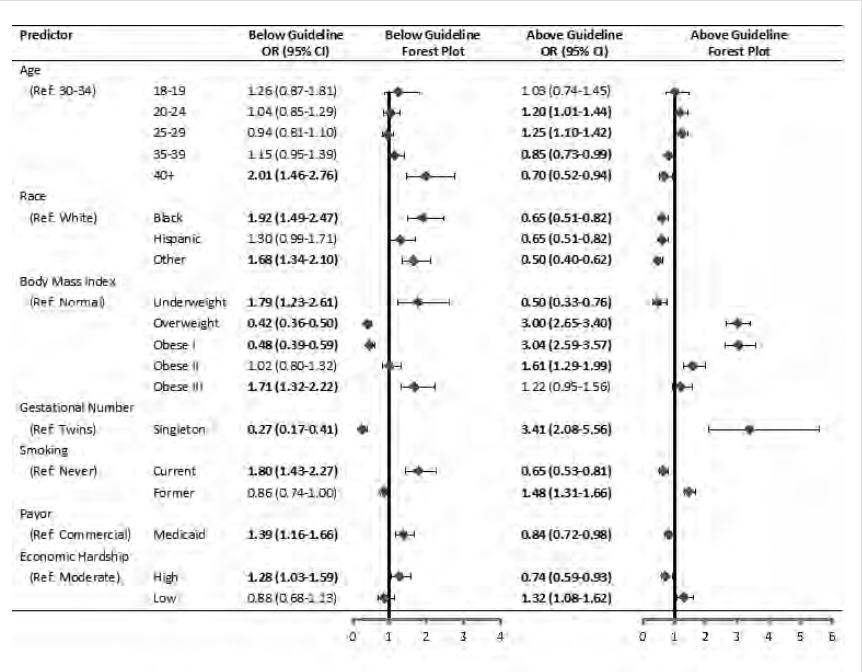
Previous studies were inconsistent about the link between socioeconomic status and gestational weight gain.[8,10,13] In this study, we found that both individual-level and neighborhood-level economic indicators independently predicted weight gain, even after controlling for race, pre-pregnancy BMI, and other confounding factors. Specifically, low socioeconomic status increased risk for insufficient weight gain, whereas high socioeconomic status increased risk for excess weight gain.

These findings should be considered in light of some limitations, which suggest questions for further research. First, the volume of missing data in this sample may raise concerns about selection bias. However, a recent validation study in the same sample showed obesity risk gradients similar to National Health and Nutrition Examination Study (NHANES), a national gold standard.[24] A second limitation is the racial homogeneity of this sample, with a large majority consisting of non-Hispanic white patients. We are confident that these data are representative of the health system and the region, but some findings may not generalize to other populations in other regions or other countries with greater diversity. Moreover, these limitations are outweighed by the many assets of this data source, eg, the inclusion of community-level data, the substantial sample size, and the utility of electronic health record data for surveillance of this large, population-based, low-risk cohort.

This study demonstrates that clinical, sociodemographic, and community-level factors converge to predict weight gain during pregnancy. Combined with the high prevalence of unhealthy weight gain during pregnancy, this suggests the need for multilevel, multicomponent intervention strategies, including both clinical and community strategies to promote healthy weight gain in women,[25-27] thereby curbing obesity risk of the next generation.

Acknowledgements: The authors thank the entire research team, especially research assistants Alexa DeBoth and Rebecca Raj for their contributions.

Figure 3. Adjusted Odds of Unhealthy Gestational Weight Gain (ie, Above or Below Guidelines), Based on Multivariable Regression Analyses



Boldface text denotes $P < .05$.

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Obesity Prevalence and Health Consequences: Findings From the Survey of the Health of Wisconsin, 2008-2013

Shoshannah Eggers, BS; Patrick L. Remington, MD, MPH; Karissa Ryan, BS; F. Javier Nieto, MD, PhD, MPH; Paul Peppard, PhD, MS; Kristen Malecki, PhD, MPH

ABSTRACT

Importance: Although the trends in obesity in Wisconsin overall are well described, less is known about characteristics and health consequences of different degrees of obesity. The Survey of the Health of Wisconsin is a novel population-based health examination survey that provides reliable and valid objective measurements of body mass index.

Objective: Data from the Survey of the Health of Wisconsin is used to characterize the prevalence and consequences of different levels of obesity and track trends over time.

Methods: A total of 3,384 participants age 21-74 years and living in Wisconsin at the time of data collection were surveyed in 2008-2013. Participants completed computer-assisted interviews and physical exams. Predictors and comorbidities of different levels of obesity were measured as prevalence, odds ratios, and population-attributable prevalence.

Results: Of Wisconsin adults, 1.2% (CI, 0.7-1.7) are underweight, 26.1% (CI, 23.8-28.4) are normal weight, 33.4% (CI, 31.0-35.7) are overweight, and 39.4% (CI, 35.0-43.7) are obese—with 20.1 % (CI, 18.4-21.9), 10.3% (CI, 9.0-11.7), and 8.9% (CI, 7.6-10.2) in Class I, Class II, and Class III obesity categories, respectively. Obesity rates are higher in people who are older, poor, less educated, minorities, or who live in a community with high economic hardship. There is a dose response relationship between level of obesity and prevalence of all 9 comorbidities that were examined.

Conclusions and Relevance: Measured rates of obesity in Wisconsin adults are higher than previously reported for the state, and obesity accounts for a significant proportion of chronic diseases.

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CME available. See page 244 for more information.

INTRODUCTION

It is well established that the growing obesity epidemic is associated with a host of complex chronic conditions and rising health care costs.[1-3] Despite extensive information that the obesity epidemic continues to pose significant health threats, there is limited population-specific data by which to characterize populations at greatest risk of both obesity and its complications. Self-reported data are known to underestimate the population-based burden of disease, and reliable and valid data are needed in order to generate targeted, effective, and efficient prevention programs and policies.[4] Further, surveillance systems that focus on reporting singular outcomes without examining obesity in relationship to other comorbidities often fail to truly capture the magnitude of deleterious effects that obesity poses to population health.

While some estimates suggest that overall efforts to reduce obesity in the United States may be experiencing some success, there has been an increased focus on understanding the health impacts among individuals with different degrees (or "classes") of obesity. The most common definition classifies individuals as obese if they have a body mass index (BMI, in kg/m^2) greater than 30. Within the category of obesity, the risks of poor health outcomes are not uniform among Class I (mild), Class II (severe), and Class III (morbid) obese individuals.[5] Understanding the burden of different degrees of obesity also is important to estimate the additional risk and costs of obesity, particularly in a population with a high prevalence of individuals with Class II and Class III obesity. Despite the value to policy and planning, few surveillance systems are systematically tracking objectively assessed obesity prevalence by degree of severity.

This study aims to provide more accurate statewide estimates of obesity prevalence overall and by degree of obesity, using data collected by the Survey of the Health of Wisconsin (SHOW). SHOW is a population-based health survey that includes a physical exam to measure height and weight to determine objective BMI estimates in a statewide representative sample.[6] By examining the relationship between obesity and its determinants and comorbidities in Wisconsin, this study provides a baseline for evaluation of public health efforts in the state. Additionally, this study provides novel estimates of the burden of each degree of obesity in Wisconsin.

METHODS

Data Source

Data included were from 3,384 adults age 21 to 74, from the annual (2008-2013) serial cross-sections of SHOW households. Details of SHOW methods have been published previously.[6] Briefly, households are selected using a 2-stage cluster method to ensure both geographic and demographic representation of the study sample. Households are randomly selected and all age eligible adults in the household are invited to participate. Data are gathered via an in-home interview in which tracking information, demographics, housing characteristics, and health history are collected. Participants also travel to a mobile exam or local clinic for bio-specimen collection, and additional personal and health history data are collected via audio computer-assisted interviews. A sample of blood is processed by the Marshfield laboratories for various health measurements, including hemoglobin A1c (HbA1c). The clinic visit also includes a physical exam to gather objective measurements of height, weight, blood pressure, and lung function (FEV1) using a peak flow meter. The SHOW protocol was approved by the University of Wisconsin Institutional Review Board, and all participants consented to study participation.

Variables

Measures of Obesity—The measures of obesity were determined using BMI, calculated by the ratio of weight (in kg) divided by height (in m^2) square derived from standardized anthropometric measurements obtained during the in-person exam, completed by a total of 2930 participants. We used standard cut-points for BMI-based weight classifications as defined by the Centers for Disease Control and Prevention and using the National Heart, Lung and Blood Institute definitions to classify obesity severity (Table 1).[7,8]

Determinants—To describe the distribution of obesity across the population, demographic variables included gender, race/ethnicity, and highest level of education. Family income was determined by total income reported by each person in the household divided by the total number of individuals reported in the household. This number was then divided by the federal poverty level (FPL), provided by the Wisconsin Department of Health Services, and multiplied by 100 to get a percentage. Walkability is based on the neighborhood Walk Score® and divided into tertiles.[9]

Table 1. Range of Body Mass Index (BMI) Included in Each Category

Category	BMI (kg/m^2) Range
Underweight	< 18.5
Normal	18.5-24.9
Overweight	25-29.9
Class I (mildly obese)	30-34.9
Class II (severely obese)	35-39.9
Class III (morbidly obese)	≥ 40

Community-level determinants of socioeconomic status are operationalized using a census block group level estimate of the Economic Hardship Index. The Index was derived using data from the 2000 US Census and includes a combination of 6 metrics: crowded housing, poverty status, employment, education, dependency, and individual annual income.[10,11] Crowded housing is the percentage of occupied housing with more than 1 person per room. The poverty status measurement is the percentage of people living below 100% of the FPL. The employment metric is the percentage of individuals over age 16 who are unemployed. Education is the percentage of people over age 25 without a high school education. Dependency is the percentage of the population under 18 years or over 64 years of age. Individual annual income is reported in categories of < $20,000, $20,000 to $44,900, and ≥ $45,000. Once census block groups are scored, they are then ranked and split into tertiles of hardship.

Health Outcomes—Comorbid conditions, all of which previously have been associated with obesity,[12–15] were defined using data from the interview and physical exam. Self-rated health was dichotomized as fair or poor health (yes vs no) using the question, "In general would you say your health is: Excellent, Very Good, Good, Fair, Poor." Sleep apnea is based on self-report of physician diagnosis. Occasional or frequent snoring was based on the question, "In the past 12 months, how often did you snore while you were sleeping?" Depression, anxiety, and stress were measured using the Depression Anxiety Stress Scales instrument, an assessment tool commonly used in surveillance and epidemiologic studies.[16] Participants' responses regarding symptoms of depression, anxiety, and stress over the last 7 days were scored and then categorized into normal, mild, moderate, severe, or extremely severe—the latter 3 categories being the event of interest for each variable.

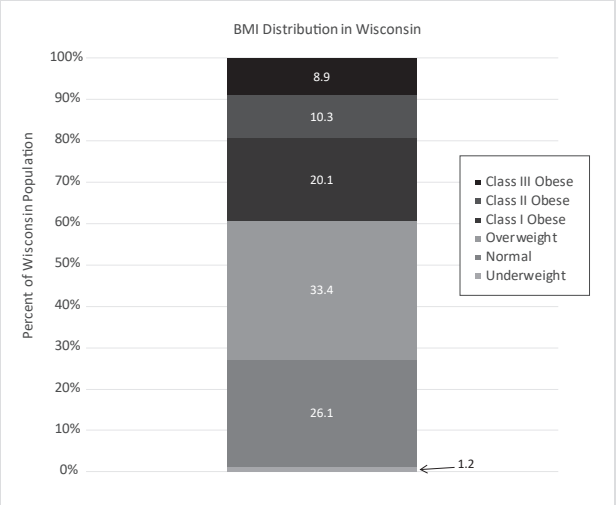
Hypertension was defined as a measured systolic blood pressure ≥ 140, diastolic blood pressure ≥ 90 mmHg, or self-report of any antihypertensive medication use. Asthma is classified as having a previous diagnosis of asthma, or FEV1 < 80% of predicted value. Diabetes mellitus is classified as having a previous

Table 2. Prevalence of Obesity (BMI ≥30%) by Demographic and Socioeconomic Factors, N=2930, Survey of the Health of Wisconsin (SHOW) 2008-2013.

	Total (n)	BMI ≥30 (%)	SE
Demographics			
Overall	1188	39.4	1.3
Age			***P*=0.001**
21-24	52	25.5	3.3
25-34	168	33.0	2.8
35-44	200	42.0	3.2
45-54	305	42.3	2.5
55-64	261	40.8	2.6
65-74	202	45.0	3.3
Gender			***P*=0.843**
Male	493	39.3	1.7
Female	695	39.7	1.7
Race/Ethnicity			***P*=0.067**
Non-Hispanic white	1015	38.9	1.3
Non-Hispanic African American	91	54.9	6.1
Hispanic	35	44.9	7.4
Other	47	34.3	7.3
Health Region			***P*=0.315**
Southeastern	356	40.9	2.7
Southern	228	35.1	2.5
Western	171	40.2	3.3
Northern	178	39.0	3.4
Northeastern	255	42.6	2.5
Year			***P*=0.768**
2008-2009	201	38.4	2.4
2010	327	38.2	1.9
2011	340	41.3	2.1
2012-2013	320	40.4	2.7
Socioeconomic Factors			
Family Income			***P*=0.001**
<100% FPL	140	48.3	3.8
100%-199% FPL	229	44.6	2.8
200%-399% FPL	434	42.6	2.1
≥ 400% FPL	339	32.5	2.1
Unknown	44	39.5	5.9
Education			***P*=<0.001**
≤ High school	384	48.0	2.5
Some college	272	44.0	2.4
≥ college	531	33.8	1.7
Community Economic Hardship			***P*=0.013**
Least Hardship (bottom tertile)	355	34.8	2.4
Median Hardship	414	43.0	2.0
Most hardship (top tertile)	419	41.5	2.1
Neighborhood Walkability			***P*=0.445**
Least walkability (bottom tertile)	403	37.0	1.8
Median walkability	405	39.7	2.1
Most walkability (top tertile)	374	40.7	2.4

P-value shown is from Rao-Scott chi-square test.
Abbreviations: BMI, body mass index; SE, standard error; FPL, federal poverty level.

Figure 1. The Prevalence of Each Body Mass Index Category, Survey of the Health of Wisconsin 2008-2013



diagnosis of type 1 or 2 diabetes or HgbA1c ≥6.5%. Analysis of comorbid conditions did not examine underweight individuals, as etiology of disease is likely different.

Data Analysis

Descriptive estimates of the burden of obesity were determined using prevalence, adjusted odds ratios, and population-attributable prevalence, using obesity cut-points previously described for each of the demographic and health conditions. Adjusted odds ratios were calculated using logistic regression, and adjusted for age and gender. Percent popoulation attributable prevalence was calculated using the following formula:

$$\%\ \text{Population Attributable Prevalence} = \frac{\sum_{i=0}^{k} (Pi)(PRi\text{-}1)}{1+\sum_{(i=0)}^{k} (Pi)(PRi\text{-}1)} *100.$$

Where P_i is the prevalence of each category of excess BMI, PR_i is the unadjusted prevalence ratio of the category of BMI compared to the normal BMI level, and k references the 4 categories of excess BMI.[17]

All calculations were weighted to represent the population of Wisconsin and to adjust for spatial clustering and survey design-based factors. Statistical analysis was performed using SAS version 9.3 (SAS Institute Inc., Cary, North Carolina, USA) and Microsoft Excel 2013 (Microsoft Corp, Redmond, Washington, USA).

RESULTS

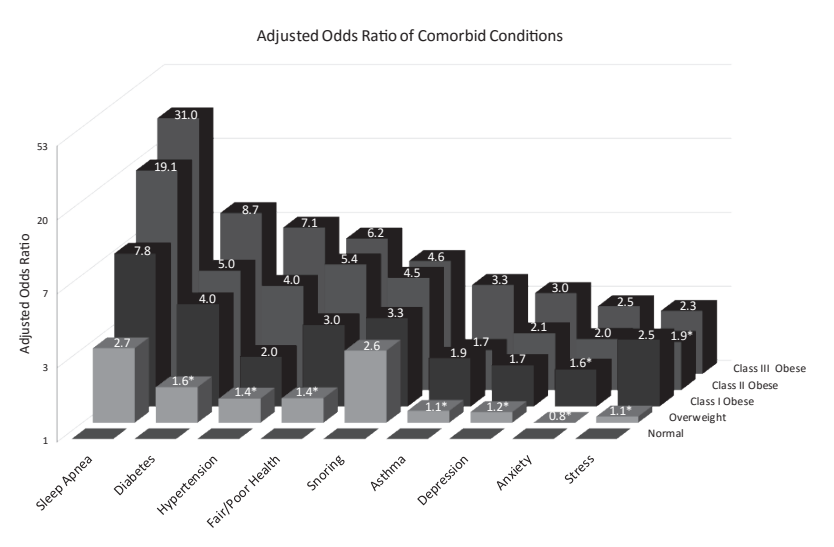
Figure 1 illustrates the prevalence of BMI categories in Wisconsin. Only about a quarter of Wisconsin residents are in the normal weight range, while around three-fourths are overweight or obese. A very small percent of the population is underweight. Among the proportion of the population that are classi-

fied as obese, the prevalence decreases as degree of obesity increases.

Table 2 shows the prevalence of obesity among demographic and socioeconomic factors. Generally, as age increases, so does obesity prevalence, with the highest prevalence in the 65-74 age group. With regard to race and ethnicity, prevalence is highest in non-Hispanic African Americans and lowest in the "other" category. Prevalence of obesity across regions of the state were similar, with the southern region having the lowest prevalence, and the northeastern region having the highest. There were no notable differences in prevalence among year of survey participation. We see the highest prevalence of obesity for the lowest family income level and lowest obesity in the highest family income level. Prevalence is highest among those living in communities with the median economic hardship, with the lowest prevalence in census block groups with the least hardship. Estimated prevalence of obesity was similar across the 3 tertiles of walkability. Expanded statistics by BMI category are available upon request.

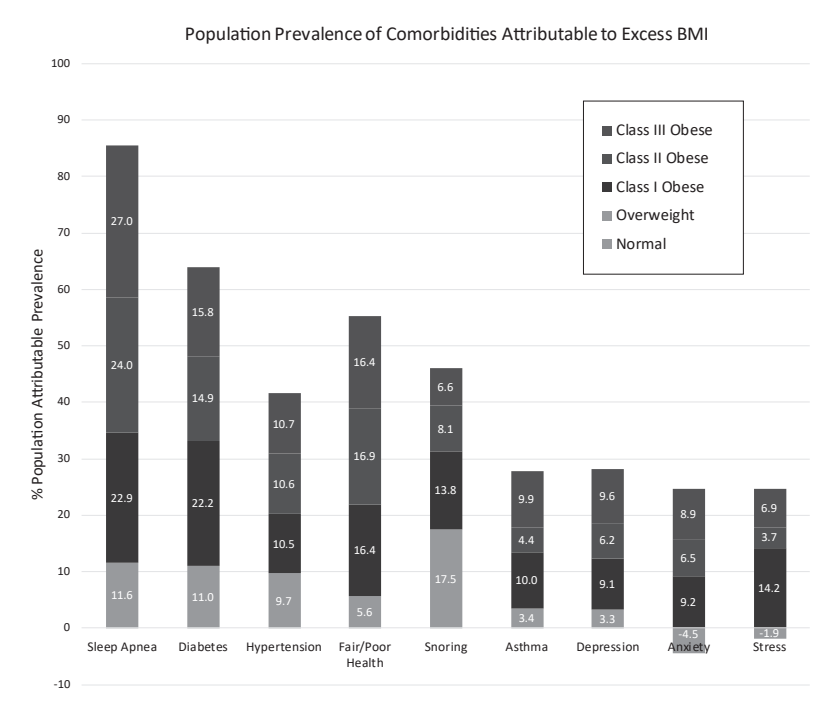
Figure 2 illustrates the burden of obesity in Wisconsin by reporting adjusted odds ratios of various comorbid conditions by BMI category. Increasing degrees of obesity are associated with increased risk of comorbid conditions, particularly those conditions previously associated with metabolic syndrome such as asthma, diabetes, and hypertension. The odds of having these conditions among individuals with Class III obesity vs those with normal BMI is approximately double the odds of individuals with Class I obesity having these conditions compared to those with normal BMI. The association between obesity and reporting fair or poor health, a standard quality-of-life measure, is similar in magnitude to having hypertension and diabetes among morbidly obese.

Figure 2. Odds Ratio of Having Each Comorbid Condition in Each Body Mass Index (BMI) Category Compared to the Normal BMI Category, SHOW 2008-2013



Odds ratios are adjusted for age and gender, and shown on the natural log scale. * Indicates that the 95% CI crosses 1.0.

Figure 3. Percent Crude Population-Attributable Prevalence Due to Excess BMI, shown by BMI Category, SHOW 2008-2013



There is a clear dose-response relationship of odds of having a comormid condition for every health outcome examined as severity of obesity increases. Obesity status is strongly associated with sleep apnea in the study population, with dramatically increasing odds as BMI level increases. While overall odds of depression, anxiety, and stress symptoms appear to be greater in obese vs non-obese, degree of obesity only slightly appears to increase odds of symptoms.

Class I and Class III obese have the largest unadjusted

population-attributable prevalence (Figure 3) for most comorbidities. This is fairly expected as Class I obesity has a high overall prevalence with moderately high prevalence of comorbidities, and the Class III obesity group has lower overall prevalence than the other obesity groups but much higher prevalence of comorbidities.

DISCUSSION

Data from this study are important to set a basis for monitoring trends and addressing population health over time. These baseline objective estimates of obesity from the ongoing SHOW program are important in that they illustrate the true magnitude of the obesity epidemic and related health conditions across Wisconsin. BMI is a standard and consistent measure used across most studies of obesity, making it a useful indicator for examining trends and identifying risk in a population.[18] Results from the statewide survey can serve as a basis for comparison for future statewide obesity prevention initiatives, as well as community-specific comparisons. The quality and precision of SHOW data in comparison to less granular national data sets provide an accurate baseline for future community- and state-specific obesity research. While efforts are underway at the state, local, and national levels to address obesity, analysis of future survey waves will provide important data for measuring and tracking the efficacy of these efforts.

The objective measurement of obesity and its classes along with comorbidities helps illustrate the true magnitude of the obesity epidemic in Wisconsin. Comparing the SHOW population estimates to those of the National Health and Nutrition Examination Survey (NHANES) suggests obesity rates across all racial and ethnic subgroups are higher in Wisconsin compared to the nation as a whole.[19,20] While obesity rates are widely reported, few studies describe how classes of obesity modify risk. Our results, while not consistently significant for all categories of comorbidities, did find a dose-dependent relationship between prevalence of comorbid condition and degree of obesity. Wisconsin's high prevalence of Class III obesity (8.6%) suggests Wisconsin has a greater burden than nationally (7.7%).[19] We confirmed individuals with Class III obesity are at much higher risk of comorbidities and a potential source of increased health care expenditures in Wisconsin.[21,22] Thus, as we look towards prevention and intervention, a focus on reducing obesity among these high-risk individuals can be considered a priority.

Despite the strengths and contributions to understanding the burden of obesity in Wisconsin, there are some limitations to this analysis. The data were collected cross-sectionally, and longitudinal trends were not investigated. Aditionally, the calculation used to estimate population-attributable prevalence, while helping to illustrate the health burden of obesity in the Wisconsin population, is unadjusted for potential confounders, some of which we show to be significantly different between groups. The data used for this study were limited to adults only. In 2014, SHOW started collecting data for children as well as adults, and we hope to evaluate the data around obesity in Wisconsin children in the coming years. However, given that environmental factors play a major role in obesity, and parents are an essential part of a child's microenvironment, examining the burden of obesity in adults can be a helpful indication of obesity in children as well.

CONCLUSION

Obesity prevalence in Wisconsin adults is higher than previously reported from telephone surveys for the state and higher than national prevalence. Obesity in Wisconsin is associated with people who are older, poor, less educated, minorities, or who live in a community with high economic hardship. Similar to the National Health and Nutrition Examination Survey (NHANES), this is a statewide issue that affects both urban and rural communities alike. The concurrence of obesity with high chronic disease burden suggests the growing obesity epidemic is affecting health and well-being and can be attributable to high health care costs and loss of productivity.[2,3] Wisconsin needs more concerted efforts to prevent and reduce obesity, particularly for the most severely obese, minorities, and those with fewer resources.

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CME

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Quiz: Obesity Prevalence and Health Consequences: Findings From the Survey of the Health of Wisconsin, 2008-2013

EDUCATIONAL OBJECTIVES

Upon completion of this activity, participants will be able to:

1. Identify current state and national obesity trends.
2. Identify which body mass index (BMI) categories are at highest risk of comorbid conditions.
3. Identify which comorbid conditions are most highly associated with increased BMI.

PUBLICATION DATE: November 15, 2016

EXPIRATION DATE: November 15, 2017

QUESTIONS

1. The percent of Wisconsin adults who are overweight or obese is approximately:
   - ❑ 25%
   - ❑ 40%
   - ❑ 75%
   - ❑ 90%

2. The prevalence of Class III obesity is _____ in Wisconsin than/as in the U.S. as a whole.
   - ❑ Lower
   - ❑ Higher
   - ❑ The same

3. Which comorbid condition appears only to increase slightly with increased levels of obesity?
   - ❑ Anxiety
   - ❑ Sleep Apnea
   - ❑ Diabetes
   - ❑ Asthma

4. Which two comorbid conditions are most highly associated with increasing level of obesity?
   - ❑ Anxiety and Sleep Apnea
   - ❑ Sleep Apnea and Diabetes
   - ❑ Diabetes and Hypertension
   - ❑ Asthma and Diabetes

5. Which BMI categories contributed most to the population-attributable prevalence of most comorbid conditions?
   - ❑ Overweight and Class I
   - ❑ Class I and Class II
   - ❑ Class II and Class III
   - ❑ Class I and Class III

• • •

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Disparities in Fitness and Physical Activity Among Children

John Bowser, PhD; Ana P. Martinez-Donate, PhD; Aaron Carrel, MD; David B. Allen, MD; D. Paul Moberg, PhD

ABSTRACT

Background: Adequate physical activity and cardiorespiratory fitness aid in the prevention of type 2 diabetes mellitus and obesity. Large sociodemographic/economic disparities exist for these conditions, which develop over time beginning in childhood. This paper examines disparities in both activity and fitness levels among children and adolescents in Wisconsin.

Methods: The Wisconsin Partnership for Childhood Fitness collected cardiorespiratory fitness and physical activity data on 3,798 6th grade students in 37 schools in fall 2011. Fitness data were collected via testing in physical education classes. Activity data were collected via self-report, 1-day activity logs administered during school. Using hierarchical linear models, disparities in fitness and physical activity by race/ethnicity and school-level characteristics were investigated.

Results: Widespread race and ethnic disparities exist in aerobic fitness, as well as more limited disparities in physical activity levels. In addition, students from schools with higher overall socioeconomic status (SES) were more active and had higher fitness levels than those from schools with overall lower SES levels.

Conclusions: Among Wisconsin adolescents, race/ethnicity and school-level SES contribute to significant differences in both fitness and physical activity levels. Modifiable elements of the school environment to increase physical activity, and potentially fitness, may provide opportunities to reduce health disparities among children, contributing to improved long-term health outcomes among Wisconsin adults.

BACKGROUND

Physical activity and cardiorespiratory fitness are commonly cited as factors in the prevention of obesity-related diseases, particularly type 2 diabetes mellitus, early-onset cardiovascular disease and, to a lesser degree, obesity itself. Racial and ethnic differences exist in the prevalence of these conditions,[1] and in general, minorities are more likely than white Americans to be obese and to suffer from conditions such as diabetes[2,3]—a difference that is particularly stark between black and white adults.

A majority of studies on the racial and ethnic disparities in fitness and activity among adolescents indicate that minorities are less active and physically fit than their white/non-Hispanic peers.[4-7] However, results are not entirely consistent[8,9] due to factors that include methodological differences and illustrate the need for continued investigation.

It would be beneficial to know if well-documented racial and ethnic disparities in adults are predicted by cardiorespiratory fitness and/or physical activity disparities among children. A link of low fitness among 18 year olds extending to an increased risk of type 2 diabetes later in adulthood has been investigated and shown to have merit among men.[10] Therefore, the relationship of fitness disparities in children contributing to disparities in adult health outcomes also is plausible. This study addresses this relationship, asking if—and to what degree—racial and ethnic disparities in physical activity and cardiorespiratory fitness are present among a sample of 6th grade students from 37 Wisconsin middle schools.

A complete understanding of disparities by race/ethnicity requires evaluation within the context of socioeconomic status (SES), as evaluation based on race/ethnicity alone would mask the influence of SES, which has been suggested previously.[11] In the case of the school environment, SES influences include resources available within the school itself and the surrounding neighborhoods in which the students reside. Therefore, this evaluation takes into account both race/ethnicity and a broader community-level variable: school-level SES.

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METHODS

Data reported in this paper were collected as part of the Wisconsin Partnership for Childhood Fitness (Phase II), a collaborative project between state agencies (Wisconsin Department of Public Instruction, Wisconsin Department of Health Services), the University of Wisconsin, and schools throughout the state designed to increase activity and fitness levels while reducing disparities among Wisconsin students.

To recruit schools, the Department of Public Instruction (DPI) sent a request for application to all eligible Wisconsin schools, which were schools with a minimum of 40% economically disadvantaged students. In Wisconsin, "economically disadvantaged" students are those who are eligible for free or reduced lunch. This skewed the sample population towards lower SES levels than Wisconsin as a whole.

Thirty-seven schools participated. While schools from many geographic regions of Wisconsin were included, a higher number were condensed in urban areas (as defined by US Census criteria), resulting in under representation of white students and overrepresentation of Hispanic students in the race/ethnicity demographic.

Data analyzed were from fall 2011, which represents project baseline data. It was the first of 6 biannual waves of data collected during the 3-year project.

This research was determined to be exempt by the University of Wisconsin-Madison Minimal Risk Health Services Institutional Review Board.

Variables and Measurement—Individual-level data on fitness, activity, age, race/ethnicity, grade, and gender all were gathered via self-report in a *Student Activity Log Booklet* developed for the project. Students completed the booklet in school under the supervision of a teacher (physical education or other). The booklets were then submitted to the University of Wisconsin Population Health Institute (Institute) for data coding and analysis.

For measurement of physical activity, a 1-day physical activity recall was used. Students listed all activities from the previous school day that they felt were "physical," including their intensity and length. From their logs, minutes of Moderate to Vigorous Physical Activity (MVPA) were calculated by the Institute by cross-referencing activities listed in the *Compendium of Physical Activities*[12] to determine if an activity rose to the level of moderate or higher. Criterion validity of the 1-day recall was assessed through comparison with same-day pedometer readings and found to be adequately valid ($r = .433$; $P < .001$), with correlation comparable to other activity logs for similar populations.[13,14] This validity assessment was conducted using 6th grade logs from a related project, "Active Schools," from which the Wisconsin Partnership for Childhood Fitness log was adapted.

Physical fitness was assessed through the use of *Fitnessgram*, a fitness assessment tool developed for use in schools.[15] The Progressive Aerobic Cardiovascular Endurance Run (PACER) test of aerobic fitness was employed during the students' physical education classes to measure their fitness. The PACER test involves running 20-meter distances, in succession, with the required average speed to complete the distance in the allotted time increasing by 0.5 kilometers per hour at growing lap intervals. Upon failure to complete the distance in the allotted time twice, the test is concluded. Following the test, students recorded their PACER score (in laps attained) in their activity booklet. The PACER score was then converted to VO_2 max, an indicator of cardiorespiratory fitness that refers to the maximum amount of oxygen consumed during physical exertion (in ml/kg/min). This has been validated previously among American children and adolescents.[16]

Self-reported individual variables, age, grade, gender, and race/ethnicity were used for our analyses. Race and ethnicity were reported by the students through 2 standard questions used in school-based instruments: (1) students were asked if they consider themselves Hispanic (yes/no); (2) they were asked to report their race/ethnicities, checking all that apply. Based on these responses, students' racial/ethnic backgrounds were coded for analysis. Categories used were white/non-Hispanic, black/non-Hispanic, Hispanic, mixed race/non-Hispanic, American Indian/non-Hispanic, other/non-Hispanic (Asian and Pacific Islander/Native Hawaiian).

School-level SES was dichotomized based on Wisconsin DPI data on students eligible for free or reduced price lunch. Schools with 49% to 59% economically disadvantaged students were referred to as "higher income" schools; those with 60% or greater economically disadvantaged students were referred to as "lower income" schools.

School-level control variables also were included in the analyses. Schools were classified as urban (vs rural) if they were located in an "urbanized area" as defined by the 2000 US Census.[17] This variable was determined to hold a confounding influence in analysis on physical activity. No other available school-level variable (eg, percent minority population) was significant in the analyses.

Statistical Analyses—All 6th grade students who submitted a valid previous-day activity recall and PACER score converted to VO_2 max in their log were included in analyses (N = 3,798; 37 schools). The analysis of interest is differences between race/ethnicity for activity and fitness. Preliminary analysis conducted a 1-way analysis of variance (ANOVA) and found significant differences between groups in fitness ($F = 14.3$, $P \leq .001$) and activity ($F = 6.65$, $P \leq .001$)

In our data structure, clustering is present due to having students nested within schools, and observations cannot be assumed

to be independent. Hence, we used hierarchical (mixed) linear models to estimate correct standard errors. Intraclass correlation coefficients were computed and showed correlation within schools of 0.21 for MVPA and 0.26 for VO_2 max, indicating a significant, but relatively low level of within-school dependence.

Analysis was run using Hierarchical Linear Modeling, version 7 (Scientific Software International Inc; Skokie, Illinois).

RESULTS

Analysis Based on Race/Ethnicity—The overall sample (Table 1) contained 56% white/non-Hispanic students and 20.8% Hispanic students. This compares to the state average of 78.5% white/non-Hispanic students[18] and 9.7% Hispanic students, respectively. Remaining distributions were largely in line with state figures. For physical activity, the sample had an average MVPA level of 70.3 minutes (SD = 66.2), 49.2 of which were after school. Mean aerobic fitness levels (VO_2 max) were 43.9 ml/kg/min (SD = 4.4). For the PACER test, the average number of laps completed was 30.7 among boys and 24.2 among girls. Relative to established norms in Wisconsin among 12-year-old children, our sample had fitness levels that were at the 50th percentile level (31 laps) of boys and slightly above the 50th percentile (22 laps) among girls.[19]

Fitness and Activity Descriptive Statistics—Levels of physical activity and physical fitness indicate that the most active and fit students were the referent group (white/non-Hispanic). Students in the Asian/non-Hispanic category were the least active (n = 210). Descriptive statistics of VO_2 max show the lowest fitness levels are among American Indian/non-Hispanic (42.6 ml/kg/min) and black/non-Hispanic (42.7 ml/kg/min) students.

Physical Activity (Regression Analysis)—Results for physical activity showed few significant differences by race/ethnicity. The only groups with physical activity levels significantly lower than white/non-Hispanic students were Hispanic and Asian students. A secondary analysis limited to after-school activity was conducted, the rationale being that while within the school day there is a level of uniformity, after-school activity may introduce sociological variables that would influence levels of activity. Results, however, did not differ (Figure 1).

Cardiorespiratory Fitness (Regression Analysis)—Levels of aerobic fitness (VO_2 max) showed widespread disparities relative to the referent group of white/non-Hispanic students. With the exception of Hispanic students, all racial/ethnic groups were significantly less fit than white/non-Hispanic students (Figure 2).

Differences by SES—An additional analysis looked at differences in mean levels of fitness and activity by SES and by race/ethnicity between SES groups. For activity, students in the higher income schools were more active (73.3 minutes vs 68.2 minutes) than those in lower income schools. When analyzed by SES and race/ethnicity, differences were limited to white/non-Hispanic students.

Table 1. Descriptive Statistics (Wisconsin Partnership for Childhood Fitness – 6th Grade)

	Overall
Total students	3,798
Number of schools	37
Female	47.2%
White, non-Hispanic	55.6%
Black, non-Hispanic	7.2%
Hispanic	20.8%
Mixed race, non-Hispanic	9.3%
American Indian, non-Hispanic	1.5%
Other, non-Hispanic (primarily Asian)	5.8%
Urban schools	56.5%
Calculated VO_2 max (ml/kg/min), mean (SD)	43.9 (4.4)
MVPA (in minutes) – Total, mean (SD)	70.3 (66.2)

Abbreviation: MVPA, Moderate to Vigorous Physical Activity.

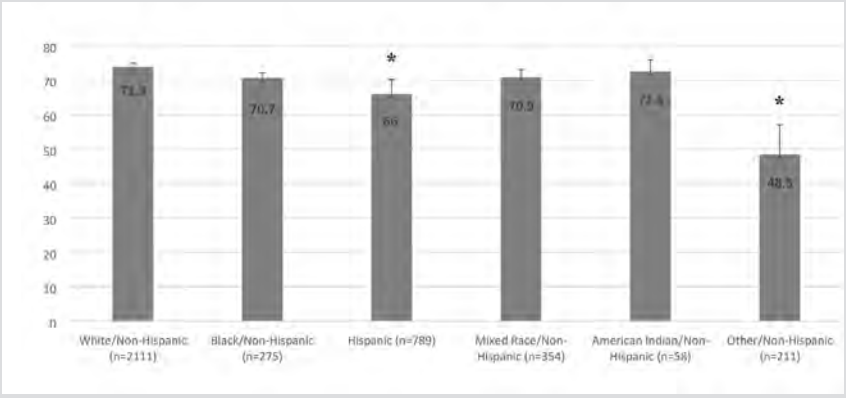
Students in higher SES schools scored higher on aerobic fitness than those in lower SES schools (44.5 ml/kg/min vs. 43.4 ml/kg/min). Unlike with activity, differences by SES among individual racial/ethnic groups were more pronounced. White/non-Hispanic students, Hispanic, and American Indian/non-Hispanic students from lower SES schools were significantly less fit than those in higher SES schools (Table 2).

As described earlier, the primary method of analysis was a hierarchical (mixed) linear modeling methodology. All potential risk factors were included in original models, and using backward selection methods, those factors that remained significant were retained. Analysis on VO_2 max (Table 2) controlled for age and gender. Similar analysis on MVPA controlled for gender and urban vs rural setting, which was retained due to its influence in a confounding role. For analyses stratified by SES, gender and age were retained. Additionally, the necessity of variable transformation into root or natural log forms was investigated and found to hold minimal differences to results and determined to be unnecessary.

DISCUSSION

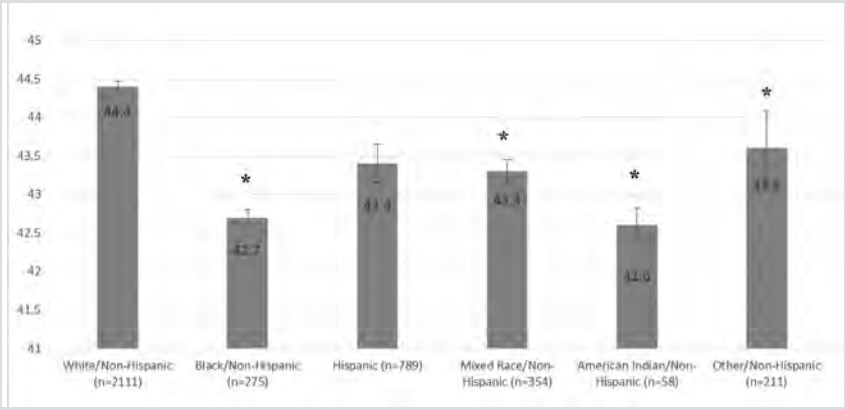
There are clear racial disparities in aerobic fitness; black, American Indian, mixed race, and Asian children are statistically significantly less fit than their white/non-Hispanic peers in Wisconsin. The disparity is greatest among black/non-Hispanic and American Indian/non-Hispanic children. Our results suggest that disparities in aerobic fitness across ethnic/racial groups are present among children and support interventions to reduce or eliminate these differences as part of a long-term strategy to reduce disparities in health outcomes among children and, in the future, adults.

Figure 1: Moderate to Vigorous Physical Activity by Race/Ethnicity Mean (+/- SE) Minutes Per Day



* Differences significant (*P*<.05) relative to white/non-Hispanic: hierarchical linear modeling methods; controlling for gender and urbanized area.

Figure 2: Aerobic Fitness by Race/Ethnicity: Calculated VO_2 Max (Mean and SE ml/kg/min)



* Differences significant (*P*<.05) relative to white/non-Hispanic: hierarchical linear modeling methods; controlling for gender and age.

Table 2. Descriptive Statistics (Mean, SD) by Measure, Socioeconomic Status (SES), and Race/Ethnicity

	VO_2 Max (In ml of O2/kg/min)		MVPA (In Minutes)	
	Lower SES (n=2210)	Higher SES (n=1588)	Lower SES (n=2210)	Higher SES (n=1588)
Total	43.4 (4.3)	44.5 (4.5)*	68.2 (63.8)	73.3 (69.3)*
White, non-Hispanic	43.8 (4.6)	44.9 (4.6)*	68.7 (64.2)	78.9 (72.3)*
Black, non-Hispanic	42.7 (4.0)	43.1 (4.5)	71.0 (68.3)	68.7 (78.5)
Hispanic	43.1 (4.1)	44.0 (4.2)*	66.0 (62.9)	66.0 (56.5)
Mixed race, non-Hispanic	43.1 (4.1)	43.8 (4.3)	72.5 (61.8)	67.7 (60.4)
American Indian, non-Hispanic	41.2 (2.8)	44.0 (3.9)*	62.2 (47.4)	82.9 (78.8)
Other, non-Hispanic	43.6 (3.7)	43.6 (3.6)	58.3 (63.0)	42.8 (55.3)

*Differences significant (*P* < .05) between SES categories: hierarchical linear modeling methods, controlling for age and gender.
Abbreviation: MVPA, Moderate to Vigorous Physical Activity.

The importance of the level of difference that exists at this age between white/non-Hispanic and black/non-Hispanic (~2 ml/kg/min) is difficult to assess; however, research has indicated associations of VO_2 max with markers of disease. In particular, VO_2 max levels among healthy adolescents, and differences within this group, are associated with favorable levels of aortic intima-media thickness and elasticity.[20] Also, longitudinally, the relationship between fitness and risk factors for cardiovascular disease indicates that VO_2 max is inversely related to total cholesterol and skinfold measurements,[21] both of which are markers for chronic disease later in life.

For physical activity, more limited differences exist. Two racial/ethnic groups—other/non-Hispanic and Hispanic (contingent on nontransformed MVPA values) children—reported disparities in minutes of moderate to vigorous physical activity. Similar results showing low physical activity levels among Asian children have been reported elsewhere.[22-24]

Analysis by SES indicates disparities in both fitness and activity. Those students from lower SES environments (schools) have lower levels of fitness and activity than those in higher SES environments, findings that have been reflected elsewhere as well.[6,25] Somewhat surprisingly, the differences based on SES are more consistent across racial/ethnic strata for fitness than activity. Significant differences by SES for activity are present only among the overall sample and among white/non-Hispanic students. This somewhat counterintuitive finding is due to the greater level of direct influence that the environment has on physical activity versus fitness.

We found that significant differences in fitness and activity exist between SES categories, as well as by race/ethnicity within each SES category. The combination of these differences within and between groups suggests that targeting specific races and/or SES groups in isolation may have limited impact, a conclusion that also has been found when addressing disparities in obesity.[26]

LIMITATIONS

This study has several limitations. A 1-day physical activity recall is used. It is often recommended that a minimum of 4 days of activity collection is needed for reliability of measurements to reach 0.80[27] among children and adolescents, although more days

adds to the level of reliability. The use of a 1-day recall also may limit the opportunity to find potential disparities in activity, as evidenced by the large standard deviations. The recalls used are limited to a day when children are in school. With hierarchical linear modeling controlling for school impact, this leaves time outside of school as the primary driver of disparities.

Another limitation involves the lack of information on the individual's developmental stage. A measure of maturity, such as Tanner Stage, may have provided a better adjusted figure of aerobic fitness, as its use has been included previously to control for fitness testing.[7]

The sample represents a self-selected sample of Wisconsin schools with a large percentage of low-income children. To be eligible for the Wisconsin Partnership for Childhood Fitness project, a minimum of 40% of the school's student body had to be economically disadvantaged. This skews the population toward lower SES levels, and with SES subsequently dichotomized, it may attenuate the influence of SES. Further, SES is measured on the level of the school, so differences in SES among students within individual schools are not accounted for.

Finally, data on students' height and weight were not collected. While it is likely a significant predictor of aerobic fitness, the exclusion of body weight measures does not counter the surveillance value of these data. Additionally, for population health purposes, the impact of fitness and fitness improvement on insulin resistance has been shown to be independent of body composition metrics.[28,29]

CONCLUSION

In summary, disparities in both physical activity and aerobic fitness are present among children in Wisconsin, existing within 2 realms: individual and school-level. These results indicate the need for future research to increase understanding of the mechanisms underlying these disparities and to identify effective interventions to reduce and ultimately eliminate them. Future attention also may be warranted towards maximizing opportunities for physical activity among this age group and expanding into high school, which shows disparities in physical activity opportunities such as sports participation and attrition.[30,31]

While fitness does have a genetic component, our results also indicate that SES plays a role in individual fitness levels. Unlike race/ethnicity, an individual's socioeconomic status (via social mobility) and the environmental effects of their SES, currently are modifiable. With this in mind, since SES is a part of the "problem," it also can be a part of the solution in reducing fitness disparities and potential negative health outcomes that may arise from it.

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Neighborhood Disparities in the Restaurant Food Environment

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ABSTRACT

Importance: Restaurant meals account for a significant portion of the American diet. Investigating disparities in the restaurant food environment can inform targeted interventions to increase opportunities for healthy eating among those who need them most.

Objective: To examine neighborhood disparities in restaurant density and the nutrition environment within restaurants among a statewide sample of Wisconsin households.

Methods: Households (N = 259) were selected from the 2009-2010 Survey of the Health of Wisconsin (SHOW), a population-based survey of Wisconsin adults. Restaurants in the household neighborhood were enumerated and audited using the Nutrition Environment Measures Survey for Restaurants (NEMS-R). Neighborhoods were defined as a 2- and 5-mile street-distance buffer around households in urban and non-urban areas, respectively. Adjusted linear regression models identified independent associations between sociodemographic household characteristics and neighborhood restaurant density and nutrition environment scores.

Results: On average, each neighborhood contained approximately 26 restaurants. On average, restaurants obtained 36.1% of the total nutrition environment points. After adjusting for household characteristics, higher restaurant density was associated with both younger and older household average age ($P < .05$), all white households ($P = .01$), and urban location ($P < .001$). Compared to rural neighborhoods, urban and suburban neighborhoods had slightly higher (ie, healthier) nutrition environment scores ($P < .001$).

Conclusions and Relevance: The restaurant food environment in Wisconsin neighborhoods varies by age, race, and urbanicity, but offers ample room for improvement across socioeconomic groups and urbanicity levels. Future research must identify policy and environmental interventions to promote healthy eating in all restaurants, especially in young and/or rural neighborhoods in Wisconsin.

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INTRODUCTION

The food environment influences dietary choices[1,2] and represents a modifiable factor to reduce the obesity epidemic in the United States.[3] Approximately 30% of Americans' caloric intake comes from restaurant meals, which are generally more energy dense compared to meals prepared at home.[4] The restaurant food environment comprises the number and types of restaurants in an area (ie, density), as well as the availability and promotion of healthy food, and the facilitators and barriers to healthful eating within restaurants.[5] The density of restaurants in an area is associated with the diet and weight status of residents.[6,7] Low-income and minority-populated neighborhoods appear to have a higher density of fast-food restaurants.[6,7] However, less is known about neighborhood differences in the environment consumers find within restaurants (eg, availability, affordability of healthy food, signage, and barriers). A few studies have found that affluent neighborhoods have restaurants with more healthy options and better environments compared to those located in poorer neighborhoods.[8,9] Most research has focused on fast-food restaurants,[6] used secondary data,[10,11] and/or relied on aggregate data for large areas.[6,11] Few studies have linked primary restaurant food environment data to individual- or household-level characteristics. There is also limited knowledge about the restaurant food environment in rural areas, despite these having higher obesity rates than urban and suburban areas.[12,13]

This study—"Assessing the Nutrition Environment in Wisconsin Communities"—aimed to examine disparities in the food environment surrounding a statewide sample of Wisconsin households. We used population-based sampling methods covering urban, suburban, and rural areas. Food environment data (eg,

restaurant location, type) were collected using ground-truthing methods and a validated observational tool to audit the environment within all restaurants located in the study areas. The data were linked to individual and household data from a statewide health examination survey, thus allowing for the investigation of differences in the food environment by socioeconomic characteristics. By investigating differences in the restaurant food environment of Wisconsin communities, we hoped to illuminate barriers to, and opportunities for, healthy eating among different population groups and allow the targeting and tailoring of future interventions aimed at improving the restaurant food environment surrounding population groups most in need.

METHODS

Sampling—This was an ancillary study to the Survey of the Health of Wisconsin (SHOW), a statewide health examination survey of a representative sample of Wisconsin adults ages 21-74.[14] Briefly, SHOW households are selected using 2-stage cluster sampling, including random selection of households within census block groups.[14] To facilitate pilot testing of our methods, we selected all the households in the 2009 SHOW located in 4 counties. The next year, two-thirds of households in the entire 2010 SHOW sample were selected at random.

Data Collection—Number of adults and number of children living in the household and the gender of all household residents were determined during the SHOW eligibility screening. Additional sociodemographic data were collected from participating adults (age 21-74).[14] Study methods were approved by the University of Wisconsin-Madison Health Sciences Institutional Review Board. Written informed consent was obtained from participants.

Food environment data were collected during the summer months of 2010 and 2011. We defined a 2- or 5-mile street network buffer around each household, depending on census block group, urban or non-urban designation, respectively. Heretofore, we refer to these buffers as "neighborhoods." In defining neighborhoods, urban areas were those within 40 minutes travel time from a populated area (≥ 50,000 residents) with all other regions classified as non-urban.[15,16]

Lists of restaurants within neighborhoods were compiled using various data sources, including ArcGIS business analyst and phone book records. Trained raters visited each neighborhood and ground-truthed these data sources, adding and removing restaurants based on direct observation.

Measures—Restaurant density was defined as the number of restaurants located in a neighborhood. Restaurant types included sit-down, fast-casual, fast-food, or other. Sit-down restaurants offer a full menu with table service by wait staff. Fast-casual restaurants serve food that is considered higher quality compared to fast-food and do not offer table service. Fast-food restaurants cook food in bulk, provide it quickly, and do not offer table service.[5] Trained raters completed the Nutrition Environment Measures Survey for Restaurants (NEMS-R) in all restaurants.[5] The survey is a reliable and validated audit tool that assigns points to 7 food environment dimensions within restaurants (Table 2).[5] Dimension subscores were summed to obtain a total score representing the overall healthfulness of the nutrition environment. A Children's Menu score was computed separately. Similar to other research, scores were rescaled to positive numbers.[9] Higher values indicate a nutrition environment more conducive to healthy eating, although there is no point threshold that defines a "healthy restaurant."[5,9,12] We computed neighborhood-level scores (ie, average scores and subscores for all restaurants within each household's neighborhood).

Based on SHOW eligibility screening of all household residents and data from SHOW participants, households were categorized as all female, all male, or containing both male and female adult residents. An indicator variable was used to signify the presence of children (< 21 years) in the household. The average age of adult household residents was described in 3 levels: younger adults (21-30 years), middle age adults (31-60 years), and older adults (> 60 years). Households were classified as having all racial minority residents, both white and minority residents, or all non-Hispanic white residents. Based on the educational status of adults 25 or older, households were described as containing all residents with a college degree, some residents with a college degree, or no residents with a college degree. Households were classified as below 100% federal poverty level (FPL), between 100% and 400% FPL, and ≥ 400% FPL based on the combined income of all household residents relative to FPL guidelines.[17] Household location was defined as urban, suburban, and rural areas according to Rural-Urban Commuting Area Code values of 1, between 2 and 6, or > 6, respectively.[15]

Analyses—The neighborhood-level food environment data were linked to household-level data. Descriptive statistics were computed. Unadjusted analyses of variance (ANOVA) were conducted. The resulting F test statistics and their corresponding P values were used to test whether mean nutrition environment scores corresponding to different types of restaurants were significantly different. Post hoc multiple pairwise comparisons using the Bonferroni correction method also were run to identify specific types of restaurants whose mean food environment scores differed.

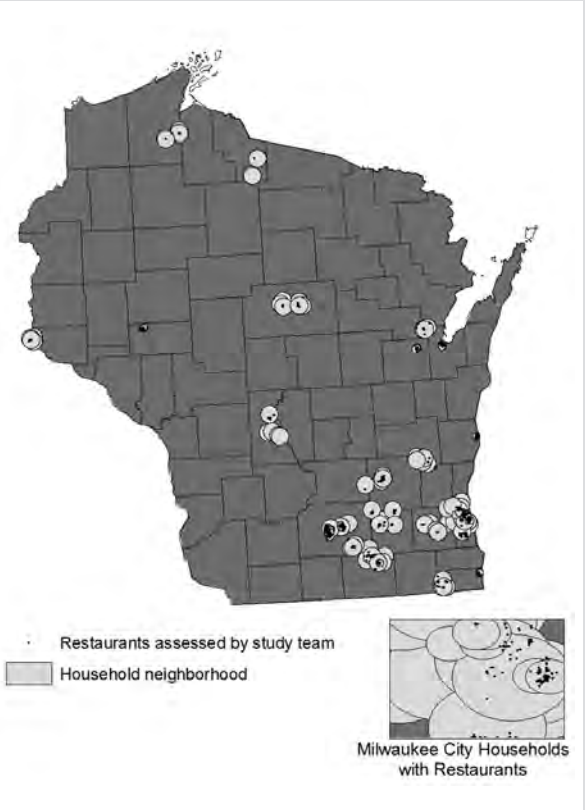
Using the household as the unit of analysis, we estimated multivariate linear regression models. We included gender, age, racial, and educational composition of household residents, as well as household income level and location in all multivariate models to investigate independent associations between each household characteristic and food environment indicators. The resulting unstandardized regression coefficients B and P values indicate the direction, magnitude, and statistical significance

Table 1. Household-Level Sociodemographic Characteristics in the Assessing the Nutrition Environment in Wisconsin Communities Study Sample (N = 259 households)

Characteristics	%	Mean (SD)
Gender of adult household residents[a]		
All females	40.2	
All males	15.8	
Both females and males	44.0	
Number of adult residents per household		2.6 (1.4)
Number of children per household		0.8 (1.1)
Average age of adult household residents[b]		
Younger age (21-30)	16.6	
Middle age (31-60)	62.2	
Older age (> 60)	21.2	
Households with children (< 21 yrs.)[a,c]	40.2	
Race of adult residents[b]		
All non-Hispanic white	86.9	
All minority	13.1	
Education of adult residents[b]		
All college degree	48.3	
No college degree	40.9	
Some college degree	10.8	
Combined household income[a]		
< 100% FPL	16.2	
100% - 400% FPL	48.5	
≥ 400% FPL	35.3	
Urbanicity (based on household location)		
Rural	18.5	
Urban	61.0	
Suburban	20.5	

Abbreviations: SD, standard deviation; FPL, federal poverty level.
[a] Descriptive of all enumerated individuals in the household.
[b] Restricted to adult residents that participated in the Survey of the Health of Wisconsin (SHOW).
[c] Children were defined as minors under the age of 18 as well as those 18-20 years in the household, yet ineligible for participation in SHOW.

Figure 1. Statewide Sample of Household Neighborhoods and Restaurants in the Assessing the Nutrition Environment in Wisconsin Communities Study



Note: Household neighborhood is defined as a 2- or 5-mile street-network buffer surrounding urban and non-urban households, respectively. Urbanicity was based on the census tract, where the household was located. The neighborhoods displayed have been moved 1 to 3 miles north, south, east, or west to mask the exact location of participating households.

of change in outcome associated with a household characteristic compared to the respective reference category. Analyses were conducted in IBM SPSS Statistics version 22 (IBM Corporation, Armonk, New York).

RESULTS

Household-Level and Neighborhood-Level Characteristics—The sample included 259 households, with 672 adults and 186 children, located in 17 counties (Table 1 and Figure 1). On average, the neighborhood around each household contained 25.7 restaurants: 10.3 sit-down, 3.0 fast-casual, 8.2 fast-food, and 3.98 other restaurants. Thirty urban households and 12 rural households had no restaurants in their neighborhoods.

Restaurant Characteristics—Trained staff identified 1,083 restaurants located within the study neighborhoods (Figure 1). Most were sit-down (40.2%) or fast-food restaurants (32.0%); 11.4% were fast-casual and 15.4% were other types of restaurants. A small percentage (1.4%) of the restaurants could not be classified due to missing data. Mean nutrition environment scores varied significantly by type of restaurant (Table 2). On average, both fast-casual and fast-food restaurants scored up to 8 points higher on the nutrition environment total score compared to sit-down and other restaurants, with higher scores equating to "healthier" environments. Statistically significant differences in specific food environment dimensions also were observed. These differences showed slightly higher (ie, healthier) scores in fast-food (eg, nutrition information, price incentives) and fast-casual restaurants (eg, healthier snacks/drinks, barriers to healthy eating) compared to sit-down and other restaurants.

Differences in Restaurant Density by Household-Level Factors—Age, race, and urbanicity were independently associated with restaurant density (Table 3). Additionally, households with older average age or younger average age had approximately 10 to 15 more restaurants in their neighborhoods than households with middle

Table 2. Nutrition Environment Measures Survey for Restaurants (NEMS-R) Scores and Subscores by Type of Restaurant (N=1083)[a]

	Mean (SD)							
	All Restaurants (N = 1083)[b]	Sit-Down Restaurants (N = 435)	Fast-Casual Restaurants (N = 119)	Fast-Food Restaurants (N = 347)	Other Restaurants (N = 167)	F (*p*)[c]	Multiple Comparisons (*p*)[d]	
Total (0-90)[e]	32.5 (10.2)	31.1 (7.8)	33.9 (8.7)	35.7 (13.5)	28.4 (6.0)	25.8 (<.001)	Sit-down<Fast-casual	(.030)
							Sit-down<FF	(<.001)
							Fast-casual<Fast-food	(.020)
							Other<Fast-casual	(<.001)
							Other<Fast-food	(<.001)
Nutrition information (0-12)	1.5 (2.8)	0.6 (1.7)	1.1 (2.0)	3.4 (3.5)	0.1 (0.8)	114.4 (<.001)	Sit-down<Fast-food	(<.001)
							Fast-casual<Fast-food	(<.001)
							Other<Fast-casual	(.003)
							Other<Fast-food	(<.001)
Signage identifying healthy options (0-18)	8.5 (2.2)	8.3 (1.7)	8.8 (2.3)	8.6 (2.8)	8.5 (1.6)	2.3 (0.08)	Not applicable	
Healthier snacks/drinks (0-12)	3.4 (3.3)	3.5 (2.8)	4.2 (3.9)	3.1 (3.9)	3.2 (2.5)	4.2 (0.006)	Fast-food <Fast-casual	(.006)
							Other<Fast-casual	(.042)
Healthy menu options (0-18)	6.2 (3.5)	6.4 (3.1)	6.2 (3.2)	6.8 (4.1)	4.5 (2.6)	17.2 (<.001)	Other<Sit-down	(<.001)
							Other<Fast-casual	(<.001)
							Fast-food<Other	(<.001)
Facilitators of healthy eating (0-9)	1.0 (1.7)	1.0 (2.0)	1.1 (1.6)	1.3 (1.8)	0.3 (0.9)	12.4 (<.001)	Other<Sit-down	(<.001)
							Other<Fast-casual	(.001)
							Fast-food<Other	(<.001)
Barriers to healthy eating (reversed, 0-9)	8.1 (1.6)	7.9 (1.8)	8.5 (1.20)	8.1 (1.6)	8.4 (1.3)	8.3 (<.001)	Sit-down<Fast-casual	(.001)
							Sit-down<Other	(<.001)
Price incentives for unhealthy eating (reversed, 0-12)	4.0 (1.8)	3.5 (1.7)	4.2 (1.7)	4.7 (1.9)	3.4 (1.2)	37.4 (<.001)	Sit-down<Fast-casual	(.001)
							Sit-down<Fast-food	(<.001)
							Fast-casual<Fast-food	(.038)
							Other<Fast-casual	(<.001)
							Other<Fast-food)	(<.001)
Children's Menu (0-30)[f]	10.8 (5.8)	10.3 (4.8)	12.3 (5.7)	11.4 (6.9)	8.8 (4.7)	3.8 (.010)	Other<Fast-casual	(.030)

Abbreviations: NEMS-R, Nutrition Environment Measures Survey for Restaurants.

[a] Range of scores possible is described within parentheses. Higher scores represent environment more conducive to healthy eating.

[b] "All restaurants" also includes restaurants that could not be classified into a specific type due to missing data. These are not shown in the table.

[c] Based on unadjusted analyses of variance (ANOVA) using type of restaurant as the independent variable and NEMS-R scores as the dependent variables.

[d] Based on post hoc multiple pairwise comparisons using the Bonferroni correction method. The symbol < indicates the direction of significant differences in NEMS-R scores found between specific types of restaurants.

[e] NEMS-R Total Score is the sum of other NEMS-R dimensions except the Children's Menu score.

[f] Only calculated for restaurants with a separate Children's Menu.

age residents. On average, the neighborhoods of households with all white residents included 14 more restaurants compared to those with minority residents. Households in urban areas had approximately 30 additional restaurants in their neighborhoods than rural households.

This pattern of findings held for the density of sit-down, fast-casual, and fast-food restaurants. On average, households with younger adult residents had 5.8 additional fast-food restaurants and households with older adults had 2.7 additional fast-food restaurants in their neighborhoods compared to households with middle age residents. Neighborhoods around households with all white residents had greater sit-down restaurant density compared to households with minority residents. Urban households had, on average, 13.2 more sit-down and 9.6 additional fast-food restaurants within their neighborhoods than households in rural areas (Table 3).

Differences in Nutrition Environment Scores by Household-Level Factors—Mean nutrition environment scores were 2.5 points higher (ie, healthier) in neighborhoods surrounding urban households and 3.8 points higher for suburban neighborhoods compared to rural neighborhoods (Table 4). Children's Menu scores were, on average, 1.8 points higher (ie, healthier) in restaurants in urban neighborhoods compared to rural. Nutrition Information and Facilitators subscores were also slightly higher for urban and suburban areas than rural areas. Signage and Price Incentives subscores were slightly higher for suburban households than rural households. Finally, households with all college graduates had higher subscores for Barriers—a reversed measure—meaning the restaurant food environment for college graduates is more supportive of healthy eating compared to the environment surrounding households with no college graduates. Nutrition environment scores did not vary significantly by race or income level.

Table 3. Differences in Restaurant Density by Household-Level Factors: Adjusted Multivariate Linear Regression Analyses[a]

Household-Level Characteristics	B (*p*) All Restaurants	Sit-Down Restaurants	Fast-Casual Restaurants	Fast-Food Restaurants	Other Restaurants
Mean Age of Adult Residents[b]					
Middle age (31-60)	REF	REF	REF	REF	REF
Younger adults (21-30)	15.0 (.001)	4.6 (.037)	1.4 (.048)	5.8 (<.001)	2.9 (<.001)
Older adults (>60)	10.5 (.015)	5.0 (.021)	1.4 (.039)	2.7 (.043)	1.0 (.181)
Gender Composition[c]					
All males	REF	REF	REF	REF	REF
All females	-6.4 (.181)	-3.1 (.198)	-0.6 (.394)	-2.1 (.161)	-0.5 (.570)
Both	-2.5 (.609)	-0.3 (.915)	-0.3 (.710)	-1.2 (.432)	-0.6 (.498)
Children (<21 years)[c,d]					
No	REF	REF	REF	REF	REF
Yes	5.3 (.143)	1.7 (.335)	0.4 (.538)	1.0 (.383)	1.6 (.011)
Racial Composition[b]					
All minority	REF	REF	REF	REF	REF
All non-Hispanic white	14.4 (.010)	6.0 (.034)	1.6 (.074)	1.6 (.352)	4.8 (<.001)
Education Composition[b]					
None college degree	REF	REF	REF	REF	REF
All college degree	0.4 (.908)	1.1 (.551)	0.1 (.845)	0.9 (.425)	-1.5 (.025)
Some college degree	-1.0 (0.873)	0.2 (.949)	0.4 (.684)	-0.6 (.750)	-0.7 (.489)
Combined Income[b]					
Below FPL	REF	REF	REF	REF	REF
100% - 400% FPL	-9.4 (.065)	-4.7 (.070)	-1.2 (.129)	-0.6 (.714)	-2.3 (.013)
≥ 400% FPL	-8.4 (.135)	-4.3 (.132)	-0.8 (.344)	-0.8 (.637)	-1.9 (.055)
Urbanicity					
Rural	REF	REF	REF	REF	REF
Urban	30.7 (<.001)	13.2 (<.001)	3.9 (<.001)	9.6 (<.001)	3.6 (<.001)
Suburban	7.0 (.163)	1.8 (.462)	0.9 (.254)	2.2 (.170)	2.0 (.021)

Abbreviations: REF, Reference category; FPL, federal poverty level.

[a] Restaurant density total number of restaurants located in a neighborhood (defined as the area comprised within a 2- or 5- mile street network buffer surrounding urban and non-urban households, respectively). B coefficients and *P* values based on linear regression models with number restaurants surrounding households in the sample as dependent variable and household gender, age, race/ethnicity, education, income, and urbanicity as predictors. Separate models were fitted for overall density (total number of restaurants) and number of each type of restaurant (eg, sit-down, fast-casual, etc).

[b] Restricted to adult residents that participated in the Survey of the Health of Wisconsin (SHOW).

[c] Descriptive of all enumerated individuals in the household.

[d] Children were defined as minors under the age of 18, as well as those 18-20 years in the household, yet ineligible for participation in SHOW.

DISCUSSION

This is the first study to examine disparities in restaurant density and nutrition environment in neighborhoods surrounding urban, suburban, and rural households across an entire state. On average, households in our sample had 26 restaurants within a 2- or 5-mile street distance neighborhood, 8 of which were fast-food restaurants. While we found that fast-food restaurants had slightly healthier nutrition environment scores relative to other types of restaurants, we found that all types of restaurants scored fewer than 50% of the possible points. Our findings are consistent with previous research[9] and underscore that there are many opportunities to improve the environment and promote healthy eating in all restaurants, regardless of type and location.

Our analyses revealed statistically significant differences in restaurant density and nutrition environment around households with different urbanicity levels and sociodemographic characteristics. Despite their smaller neighborhood size, urban households—compared to rural households—had approximately 30 additional restaurants within their neighborhoods, 13 and 9 of which were sit-down and fast-food establishments, respectively. Interestingly, urban and suburban households were surrounded by restaurants with better nutrition environments according to the NEMS-R audit tool. Stated differently, individuals in rural areas had fewer fast-food and sit-down restaurants in their neighborhoods, yet were systematically exposed to poorer nutrition environments within restaurants compared to individuals in urban areas.

The fast-food restaurants audited often had better availability of nutrition information and more healthy menu options compared to all other restaurants. Other studies have found that fast-food restaurants are more likely to provide nutrition information and have greater availability of healthy menu options

Table 4. Differences in Nutrition Environment Measures Survey for Restaurants (NEMS-R) Scores[a] by Household-Level Factors: Adjusted Multivariate Linear Regression Analyses[b]

	B (*p*)								
Household-Level Characteristics	**Total Score (0-90)[c]**	**Nutrition Information (0-12)**	**Signage Identifying Healthy Options (0-18)**	**Healthier Snacks/ Drinks (0-12)**	**Healthy Menu Options (0-18)**	**Facilitators of Healthy Eating (0-9)**	**Barriers to Healthy Eating (Reversed, 0-9)**	**Price Incentives for Unhealthy Eating (Reversed, 0-12)**	**Childrens Menu (0-30)[d]**
Mean Age[e]									
Middle age	REF	REF	REF	REF	REF	REF	REF	REF	REF
Younger adults	0.4 (0.486)	0.2 (0.229)	0.0 (0.919)	0.2 (0.251)	-0.3 (0.108)	0.1 (0.171)	0.1 (0.586)	0.1 (0.539)	0.6 (0.215)
Older adults	0.3 (0.613)	0.1 (0.494)	0.3 (0.028)	-0.1 (0.752)	-0.1 (0.824)	0.0 (0.871)	-0.1 (0.305)	0.0 (0.992)	0.1 (0.915)
Gender Composition[f]									
All males	REF	REF	REF	REF	REF	REF	REF	REF	REF
All females	0.7 (0.329)	0.2 (0.33)	-0.0 (0.896)	0.2 (0.406)	0.2 (0.177)	-0.0 (0.836)	-0.2 (0.167)	0.1 (0.481)	0.2 (0.748)
Both	0.7 (0.325)	0.2 (0.450)	0.1 (0.621)	0.2 (0.261)	0.2 (0.102)	0.0 (0.978)	-0.2 (0.130)	-0.0 (0.831)	0.6 (0.262)
Children (<21 years)[f,g]									
No	REF	REF	REF	REF	REF	REF	REF	REF	REF
Yes	-0.1 (0.880)	0.0 (0.849)	0.2 (0.076)	-0.1 (0.511)	-0.1 (0.255)	-0.1 (0.462)	-0.1 (0.445)	0.0 (0.929)	-0.2 (0.626)
Race Composition[e]									
All minority	REF	REF	REF	REF	REF	REF	REF	REF	REF
All non-Hispanic white	-1.6 (0.065)	-0.6 (0.053)	-0.3 (0.151)	0.1 (0.633)	0.1 (0.272)	-0.2 (0.248)	-0.1 (0.649)	-0.3 (0.113)	0.4 (0.585)
Education[e]									
None college	REF	REF	REF	REF	REF	REF	REF	REF	REF
All college	0.2 (0.728)	-0.0 (0.819)	0.0 (0.783)	0.1 (0.699)	0.1 (0.423)	-0.0 (0.907)	0.2 (0.017)	0.0 (0.722)	0.1 (0.902)
Some college	-1.1 (0.201)	-0.5 (0.055)	-0.3 (0.114)	0.2 (0.558)	0.2 (0.505)	-0.1 (0.515)	0.2 (0.163)	-0.3 (0.120)	0.6 (0.364)
Combined Income[e]									
Below FPL	REF	REF	REF	REF	REF	REF	REF	REF	REF
100% - 400% FPL	1.0 (0.178)	0.4 (0.093)	0.1 (0.637)	-0.2 (0.34)	-0.2 (0.283)	0.2 (0.519)	-0.0 (0.922)	0.3 (0.102)	0.7 (0.208)
≥400% FPL	0.9 (0.269)	0.3 (0.238)	0.1 (0.770)	-0.2 (0.397)	-0.2 (0.146)	0.1 (0.692)	0.0 (0.821)	0.1 (0.542)	0.2 (0.798)
Urbanicity									
Rural	REF	REF	REF	REF	REF	REF	REF	REF	REF
Urban	2.5 (<.001)	0.5 (0.030)	0.1 (0.490)	-0.2 (0.277)	-0.2 (<.001)	0.5 (<.001)	0.0 (0.86)	0.3 (0.066)	1.8 (0.001)
Suburban	3.8 (<.001)	0.9 (<.001)	0.4 (0.008)	0.1 (0.658)	0.1 (<.001)	0.6 (<.001)	-0.2 (0.186)	0.5 (0.001)	0.4 (0.479)

Abbreviations: REF, Reference category.

[a] Range for each nutrition environment score and subscore are described in parentheses. Higher scores represent environment more conducive to healthy eating.

[b] B coefficients and *P* values based on linear regression models with nutrition environment scores as dependent variables and household gender, age, race/ethnicity, education, income, and urbanicity as predictors. A separate model was fitted for each nutrition environment dimension.

[c] NEMS-R Total Score is the sum of other NEMS-R dimensions except the Children's Menu score.

[d] Only calculated for restaurants with a separate Children's Menu.

[e] Restricted to adult residents that participated in the Survey of the Health of Wisconsin (SHOW).

[f] Descriptive of all enumerated individuals in the household.

[g] Children were defined as minors under the age of 18, as well as those 18-20 years in the household, yet ineligible for participation in SHOW.

compared to other food outlets.[5,9] However, these findings must be interpreted with caution. Despite offering information and providing healthy options, research has shown that fast-food restaurants encourage large portions and unhealthy eating through price discounts.[5] Furthermore, fast-food consumption is associated with poor diet and body weight.[6,18,19] Overall, the evidence justifies the need for interventions to limit the density of fast-food restaurants and improve other dimensions of their nutrition environment.

Our study revealed that older adults (> 60 years) and younger adults (21-30 years) in Wisconsin live in more restaurant-dense areas and are surrounded by more fast-food restaurants. Few studies have examined differences in the food environment by age.[6] Future research can shed light on whether or not these findings reflect younger and older adults' residential preferences or if this finding is a result of restaurant owners situating restaurants near these consumers. Our results suggest that older and young adults may be exposed to environments that impede a healthy diet and lead to excessive body weight gain at critical age periods.[6,7,19]

Unlike previous research,[6-9,20,21] we found only limited evidence of differences in restaurant density or nutrition environment by household-level income, education, and minority composition. Other studies have found that low-income individuals and racial

minorities are exposed to more obesogenic environments such as higher numbers of fast-food restaurants. We did not find such associations, perhaps in part because of the little racial diversity in our sample (13%), which reflects similarly low levels of diversity among the Wisconsin population (17%). The limited racial/ethnic diversity and high correlation with urbanicity in Wisconsin restrict our ability to disentangle the independent association of these variables with the food environment and limit our ability to generalize our findings to other regions.

Other limitations of this study include a moderate 51% SHOW response rate, possible seasonal changes in the food environment during summer months, and the inability to capture the environments around household residents' workplaces or schools. We chose to average the nutrition environment scores of all restaurants within a neighborhood, while other methods of handling aggregate data exist (eg, proportion of restaurants that use specific health promotion strategies, highest nutrition environment scores).[8,12] Future studies may consider using different methods and examine neighborhood- or county-level contextual factors that may interact with household-level characteristics.

Our use of ground-truthing methods, direct observation of the environment within restaurants, and analysis using statewide household-level data represent unique and valuable contributions to understanding exposure to healthy food environments. Ground-truthing reduced error in estimating restaurant density. The rich nutrition environment data revealed some ways in which fast-casual and fast-food establishments encourage healthy eating, adding to our interpretation of a relatively blunt measure like restaurant density or type. Our choice of the NEMS-R as a food environment audit tool allowed us to report findings regarding Children's Menus, which are an active area in obesity prevention research.[22]

CONCLUSION

The healthiness of the restaurant food environment surrounding Wisconsin households varies according to age, race/ethnicity, and urbanicity, but is generally unhealthy across sociodemographic groups and urbanicity levels. Overall, the nutrition environment in restaurants in Wisconsin can be greatly enhanced in order to promote healthy eating. Using the data reported in this study as a baseline, we may be able to evaluate the effects of future interventions such as the enforcement of federal menu labeling regulations for chain restaurants.[23] Future comparative research could be conducted to examine the restaurant food environment of communities across states in the United States and to identify factors, particularly policies, associated with healthier nutrition environments. The results of such research could lead to the development of effective interventions to promote healthier nutrition environments in restaurants across Wisconsin and beyond.

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Community-Led Collaborative Action to Prevent Obesity

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ABSTRACT

At the population level, turning the tide on obesity requires not only health education and promotion programs, but also systemic changes in our society. However, few of these changes can be implemented by single agencies or organizations acting in isolation. Broader community-driven efforts are needed to advance and maintain systematic changes across multiple settings.

We introduce 2 promising approaches for local action to achieve changes: coalition action and community organizing. Understanding differences between the two approaches makes it clear that while each has distinct advantages, there are also possibilities for synergies between them.

We also clarify how community-driven efforts can be catalyzed and supported, and describe our efforts as part of the Wisconsin Obesity Prevention Initiative to identify and implement best practices for building and sustaining the necessary local community capacity to carry out systematic changes. We are working with communities to launch initiatives in which residents are engaged through grassroots organizing, and local agencies, businesses, and other institutions are engaged in pursuit of collective impact on obesity prevention. This will allow us not only to compare the effectiveness of the 2 types of initiatives for driving local changes, but also to explore the potential for the two to work together in pursuit of systemic changes for preventing obesity.

INTRODUCTION

Early responses to elevated rates of childhood overweight and obesity in the United States centered on informational and educational efforts to change individual health behaviors.[1] However, as understanding has progressed, it has been recognized that to prevent obesity at a population level, changes must occur across multiple settings (eg, schools, restaurants, homes, food vendors, recreational settings), and to the policies and systems that affect these settings.[2] For example, increases in the availability and affordability of fresh foods, creation of physical infrastructure for recreation and active transportation, and changes in school policies on nutrition and physical activity all can have compounding positive preventive effects. Systemic changes such as these can have reinforcing effects that shift behavioral norms through social diffusion across the population, even if focused primarily on preventing childhood obesity.[3] Just as rising obesity rates in recent decades have not had a single cause, there is no single simple solution to this pressing public health problem. Achieving policy, systems, and environmental changes across multiple settings is a challenge that requires not only action on the part of clinicians, public health professionals, and educators, but also sustained action by local residents and leaders representing multiple sectors.

Yet, there is little agreement about best practices for mobilizing local capacity toward action directed at changing policies, systems, or environments.[4] Furthermore, locally led efforts are likely to confront entrenched interests in their attempts to intervene for obesity prevention. For example, the corporate political activity of the food industry often runs counter to the policy goals of obesity prevention efforts.[5] There is a gap between the acknowledged need and the ability to successfully implement multisector partnerships that can build community capacity, sustain action, and overcome barriers to the systemic changes that are needed to prevent obesity.[6]

Part of the difficulty in achieving these goals is a lack of clear distinctions between different approaches to community capacity building and action.[7] Many preventive initiatives seek to galva-

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nize community coalitions. Yet in many instances, work toward implementation falls mostly on the small number of people coordinating the initiative instead of being collectively owned among the full range of leaders of different sectors. Likewise, many preventive initiatives seek to engage families and community residents. In some cases, residents are involved merely for passive input or the sake of "buy-in," while in other cases they are deeply engaged as strategists and leaders. These differences, while not always clear, are critical for building the necessary local capacity for sustained action for childhood obesity prevention.

In this report, we examine 2 promising approaches to community-led action to prevent obesity: agency-level coalition action and community organizing. Although these approaches have similarities, looking at both brings to light some salient differences—differences that can create opportunities for synergy between the two approaches. In the first phase of the Wisconsin Obesity Prevention Initiative (Initiative), we are taking a 2-pronged approach—(1) supporting local coalition initiatives aiming to achieve collective impact, and (2) supporting community organizing initiatives aiming to build power among residents to make change. This multifaceted approach to community capacity building and action is intended to produce more systemic changes in the factors that lead to obesity than either of these approaches could have on their own. Yet, implementation of either one of these models alone is complicated, and new challenges arise when implementing multiple approaches simultaneously.[8]

CAPACITY BUILDING FOR OBESITY PREVENTION

Pursuing policy, systems, or environmental changes for childhood obesity prevention requires multiple strategies.[9] To identify 2 strategies of particular interest, we sought community-driven rather than expert-driven approaches (although expert-driven approaches such as informational campaigns and media advocacy are also valuable). Among community-driven approaches, we were particularly interested in those that are asset-based rather than deficit-based. We sought approaches that engage diverse stakeholders in local communities with a successful history in achieving systemic change. Finally, we were interested in approaches that have potential to sustain activity beyond a particular funding cycle. Over the course of several years, our team learned from and experimented with different approaches, ultimately deciding that coalition-led efforts (ie, collective impact) and community organizing held particular promise for capacity building and action for childhood obesity prevention.[10]

Before defining and explaining these approaches, it is important to emphasize that we do not propose universal formulae for community capacity building and action. Rather, we propose 2 conceptual models that can act as touchstones for reflective practitioners and community leaders. Each community organizing or coalition initiative is unique because it is adapting the model for application in its local context, although initiatives are working toward similar goals. In other words, these models for capacity building cannot convert otherwise complicated and unpredictable work into single linear processes with standardized outcomes, particularly because obesity is complex as a social and environmental issue, and its prevention requires multifaceted approaches that are flexible enough to adapt to local context.

COLLECTIVE IMPACT ("GRASS TOPS" APPROACHES)

Collective impact refers to groups of decision-makers and leaders from multiple sectors in a community coming together and committing to a common agenda for addressing a specific social issue.[11] This can be considered a "grass tops" approach, since it primarily engages decision-makers and leaders of organizations.[12] It is an approach that is particularly well-suited to making progress on issues whose causes cut across multiple levels, settings, or systems in a community. For instance, coalitions around the United States are working toward collective impact on poverty reduction, increased high school graduation rates, and reduced childhood overweight and obesity. The term collective impact was introduced relatively recently, but the phenomenon to which it refers has a longer history and has been described variously as coalition action, interorganizational alliances, and partnership synergy.[12] Here we use the term collective impact to describe this type of coalition action. Successful initiatives have been described according to 5 conditions: (1) all participants share an agenda for change, (2) the initiative has developed a shared measurement system, (3) participants are coordinating their activities so that they are mutually reinforcing, (4) regular high-level participants sustain continuous communication, and (5) the activities of the initiative are supported by a "backbone" organization with dedicated staff and coordination skills.[11]

Coalitions' actions have shown promising results for childhood obesity prevention and have become central to current practice. At the municipality level, coalitions have shown success at achieving systemic changes with the goal of childhood obesity prevention. For instance, the San Diego *Childhood Obesity Prevention Initiative*[13] has implemented Safe Routes to School[14] and Farm-to-School[15] programs and has helped to pass healthy beverage policies for school campuses. It also has helped to shape local policies around community development, recreation, early childhood education, transportation, and workplace lactation. Several coalition-driven initiatives have sought to galvanize action for childhood obesity prevention at the state level. These include *Lets Go!* in Maine,[16] which has changed a number of local policies and systems resulting in levels of childhood obesity holding steady or falling for some age groups, *LiveWell* in Colorado,[17] and many others.[18] Partly as a result of the successes of these initiatives, collective impact is increasingly a mainstream approach for locally

driven obesity prevention initiatives, as demonstrated by the fact that it was the theme of the most recent *Biennial Conference on Childhood Obesity Prevention*.[19]

Coalitions are likely to be able to make some systems changes relatively quickly, particularly when those changes involve program delivery or incremental shifts in agencies' and organizations' activities. By engaging current leaders in local agencies and building toward greater alignment, coalitions may be able to identify efficiencies and opportunities in service delivery. However, because many initiatives pursuing collective impact primarily seek to convene those who already hold formalized institutional power in the community, they are unlikely to pursue transformative changes or efforts that would require mobilization and political action, as controversial policy changes often do.[20]

COMMUNITY ORGANIZING ("GRASSROOTS" APPROACHES)

Community organizing initiatives involve groups of residents collaborating to investigate and undertake sustained social action on social issues of mutual concern.[21] Organizing seeks to change the balance of power in local communities so that residents (as opposed to institutional decision-makers) have a greater say in the policies and systems that affect their daily lives—thus the term "grassroots." To build power, organizing initiatives engage the local populace through one-to-one meetings in which residents listen to each other's hopes and concerns for their community. The themes from these meetings inform participatory research on pressing community issues, which in turn inform strategic selection of specific issues that the initiative seeks to address through public actions. In large public actions, often with media present, residents put pressure on decision-makers to commit to policy and systems changes that will enhance local quality of life and hold these decision-makers accountable to their commitments. Many community organizing initiatives in US cities have sustained these activities for decades, tackling a variety of issues related to housing, health care, transportation, education, lending, community development, employment, recreation, and neighborhood safety.

One recent example of community organizing applied to obesity prevention is the *Communities Creating Healthy Environments* initiative[22] funded by the Robert Wood Johnson Foundation. This initiative has supported 22 local organizing initiatives (in 2 cohorts) with 3-year grants to build capacity—particularly in communities of color—to implement systemic changes related to obesity prevention. The progress of one of these organizing initiatives, the *Southwest Organizing Project*[23] in Albuquerque, New Mexico, is described in a recent article by Subica and colleagues.[24] The Project is focused on building leadership in low-income communities, with particular emphasis on the Hispanic and American Indian cultures and leadership by young people. It has applied a food justice lens in its work toward obesity prevention and has converted vacant city properties into community gardens and changed school lunches to include healthier foods. One recent victory, which was a culmination of several years of work on school lunches, was passage of a $1.44 million appropriations bill in the state of New Mexico for public schools to purchase locally grown produce.

Reflecting on the work of the Southwest Organizing Project, as well as that of the other grantees, Subica and colleagues[24] conclude that community organizing is a particularly promising approach for addressing disparities and working toward equity in health promotion efforts through structural—rather than solely individual—change. They also emphasize that the model is different from other community-based health promotion efforts since it features leadership by the people most directly affected by local health issues. Therefore, it offers a vehicle for lower-income communities and communities of color to take action to address disparities, although the authors point out that "health professionals also benefit from being a co-journeyer in the grassroots health promotion process, thus gaining a deepened understanding of the trajectory and contextual realities of health disparities from the community's perspective."[24,p85] Community organizing has the potential to engage large numbers of residents in efforts to build power to change policies, systems, and environments to improve the health of their communities. It is therefore a promising strategy not only for addressing complex issues like obesity, but also to create conditions for greater health equity.

The leadership development and relationship-building processes in community organizing are time consuming, so organizing initiatives can take longer than some other approaches to build toward action.[10] Yet by prioritizing leadership of those whose stake in the discussion is primarily personal rather than institutional and who are often the intended audience of systemic changes in society, community organizing initiatives often view local issues differently (eg, food justice vs food security), are more likely to have broad community relevance, and are less hesitant to press for transformative changes, or those that require mobilization and public action. As indicated above, community organizing initiatives seek to change power relations in their local communities by building power among residents who do not already hold formalized institutional power. These features of community organizing make it a particularly promising approach for achieving greater health equity through action by those most affected by existing inequities on the social determinants of health—the shared living conditions of residents.[25]

LOCAL CAPACITY BUILDING MODEL

Through the Wisconsin Obesity Prevention Initiative, we are investing in local coalitions seeking collective impact and local community organizing initiatives to support action toward

broad-based changes across community settings with the goal of reducing rates of childhood obesity. We are doing this in collaboration with community partners, through realizing the strengths of both the community organizing and coalition-driven approaches. Engaging both the "grass tops" and "grassroots" in action toward systemic changes increases the likelihood that more changes will be made across settings in local communities, and that these changes will be sustained. Furthermore, it is possible that it also will speed the effects of systemic changes on health behavior changes since greater numbers residents are involved in action around health promotion and obesity prevention.[4,26,27] The parallel implementation of both approaches is leading to the identification of new strategies that leverage the relative strengths of both coalition action and community organizing initiatives.

Although we are continuing to learn from a pilot phase of implementing these approaches to local community change,[10] it's important to note several key points. First, the local coalition and community organizing initiatives, while supported by University of Wisconsin (UW) staff, faculty, and students, are led independently by local organizations and leaders. In the case of the coalitions, a local "backbone" organization has been designated to convene and guide the initiative. For the community organizing initiatives, a local organizer has been identified who supports the development of other local leaders and provides training and guidance. All four of the local initiatives (2 per county in 2 pilot counties) have technical support[28] from the UW team, as well as from national experts on coalition work and community organizing. Second, the community organizing and coalition teams are not required to coordinate their activities in each locality, although collaboration is encouraged when advantageous. This flexibility to fully implement each respective approach is critical to ensuring the integrity of each of these approaches, as well as to their ability to build capacity and to seek organic possibilities for collaboration across the two types of initiatives.

A primary aim of the Initiative's research and evaluation design is to assess how each of these approaches works to build local capacity and action to achieve and sustain policy, systems, and environmental changes for childhood obesity prevention. We also are studying the ways they can complement each other to produce or reinforce local changes. Learning from implementation of this new model in local communities is informing our planning for future work with additional Wisconsin communities. Meanwhile, the UW team is selecting and designing tools for periodic assessments to provide empirical insights into community-driven processes and the changes that they produce. These data on community change processes will provide insights with potential to increase efficacy to impact changes in nutrition, physical activity, and overweight and obesity.

CONCLUSIONS

It is now widely acknowledged that in order to turn the tide on the obesity epidemic, sustained action and changes are needed in the settings and environments that people inhabit in their day-to-day lives. Rather than simply encouraging people to make healthier choices, policy and systems changes are needed that can make healthier choices easier and more desirable, as well as increase participation in decision making by those most directly affected by health issues. Some of these changes are simple, but others require concerted actions and sometimes significant changes in paradigms and approaches by nonprofit organizations, businesses, schools, voluntary associations, elected officials, and government agencies. Although researchers, clinicians, and public health practitioners have acknowledged the need for capacity building and cross-sector coordination of action, to date there has been very little specificity regarding approaches for this type of systems-oriented primary prevention.[6] Therefore, a great need exists for more specificity and clarity in the application of different collective action models for obesity prevention and other community health issues. The Wisconsin Obesity Prevention Initiative presents an opportunity to make long-lasting impact on the settings and environments in local communities that promote health, and to learn from rigorous study of multiple models for capacity building and action.

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Developing a Strategy Menu for Community-Level Obesity Prevention

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ABSTRACT

Childhood obesity is a complex problem influenced by policies, systems, and environments, and its prevention requires changes across a range of community settings. To address this, we developed an obesity prevention strategy menu and an ongoing study to pilot its use and provide technical support for its implementation.

The strategy menu is comprised of a set of effective approaches communities can use to develop tailored, context-specific health interventions based on local community needs and capacity. It was developed by a multidisciplinary team of researchers and practitioners who reviewed evidence and organized it to incorporate effective policy, systems, and environmental changes for reducing and preventing childhood obesity. Eventually, it will be part of a web-based point of access that complements the foundational relationships built between communities, researchers, and practitioners.

By developing a framework to engage communities in the selection and implementation of multisetting obesity prevention strategies, we aim to create and sustain momentum toward a long-term reduction in obesity in Wisconsin children.

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INTRODUCTION

The Obesity Prevention Initiative (Initiative) in Wisconsin is piloting a multisetting community intervention study for childhood obesity as 1 of 3 components of the larger initiative described in this issue by Adams and colleagues.[1] As an initial step, a team of University of Wisconsin researchers, community members, and practitioners (the intervention team) are conducting a pilot study using comprehensive community prevention strategies in 2 Wisconsin counties, Marathon and Menominee.[2] Herein, we present 2 aspects of this pilot study.

First, the intervention team, supported by a national advisory group of obesity prevention experts, has developed a menu of multisetting, evidence-based strategies (strategy menu) to address obesity. To do this, the team focused on identifying environmental and policy-related obesity prevention strategies that can be tailored to specific Wisconsin community needs and contexts. Second, the intervention team is working with the 2 initial communities in an ongoing study to pilot the strategy menu and provide technical support for its implementation.

Through a process of local capacity building, along with academic support for community-based participatory research, outreach, and surveillance, the Initiative will engage Wisconsin citizens in making policy, systems, and environmental changes at both the grassroots and institutional levels.[1] While this report focuses on the strategy menu, selection framework, and local implementation, the report by Christens and colleagues in this issue describes the engagement component in more detail.[3]

The Initiative's approach started with the acknowledgement that there is no "silver bullet" for reducing childhood obesity. The intervention team grounded its work in the social ecological

model of health, a theoretical framework for understanding the multiple factors that influence health and wellness of individuals, groups, and populations. The complex challenges of childhood obesity prevention cannot be addressed through clinical care and education alone.[4] Rather, a collaborative, multisetting approach that includes policy, systems, and environmental prevention strategies is vital. Such an approach also needs to be flexible and responsive to community needs rather than a top-down prescription for change. This report describes the development of the obesity prevention strategy menu, how pilot communities are using the menu, and future development of a web-based point of access for community technical assistance and resources.

Strategy Menu Development

Previous initiatives have shown that community-wide capacity building followed by the implementation of multiple strategies across settings is one of the promising approaches for obesity prevention initiatives.[5-8] This approach can influence individuals from diverse directions and extend reach to different groups within a community, but does come with challenges. First and foremost is how to provide an evidence-based foundation and the associated technical support to communities that differ in context, capacity, and resources.

To address this challenge, we identified 4 important steps: (1) leveraging expertise from multiple disciplines, (2) identifying and synthesizing evidence for multisetting interventions, (3) creating a menu of strategies, and (4) providing information and technical assistance to help communities select strategies that will be effective within their specific context.

Recognizing that no single discipline had all of the necessary expertise to identify potential obesity prevention strategies, the Initiative followed the lead of other transdisciplinary research programs in public health like the Center for Training and Research Translation at the University of North Carolina at Chapel Hill.[9] The intervention team included researchers and practitioners from nutritional sciences, urban and regional planning, landscape architecture, food systems, pediatrics, family medicine, public health, and community development, who collaboratively developed the initial menu for community feedback. Development reflected key aspects of other transdisciplinary initiatives by bringing together multiple perspectives on methodologies, theories, and working strategies.[1,10] A unique aspect of the Initiative's approach has been in identifying strategies with the ongoing involvement of community partners and practitioners—partnerships that have been supported by the work of healthTIDE staff members.[11]

Public health researchers and practitioners are increasingly recognizing the importance of people's environments in supporting or hindering health efforts, as well as the necessity for community leadership in sustaining health promotion related-activities.[12] Our approach seeks to mobilize communities in pursuit of changes that can catalyze healthy behaviors and positive outcomes. In this way, our approach is aimed at primary prevention through school food policies, transportation policies, access to affordable healthy food, land use policies, and other policy, systems, and environmental changes.

Identifying and Synthesizing Evidence for Multisetting Strategies

The intervention team reviewed existing resources, including *What Works For Health Wisconsin (What Works)*, the US Department of Health and Human Services *Guide to Community Preventive Services (Guide)*, community strategies to prevent obesity recommended by the Centers for Disease Control and Prevention, and others.[13-15] In cases where existing reviews from those resources were older, disciplinary experts on the team searched for newer studies. The team also examined systematic reviews and individual studies for various settings (schools and early childhood environments, the built environment, work sites, health and maternal care, and others) to identify strategies not included in *What Works* or other existing resources.

A specific challenge of the transdisciplinary approach is that different disciplines (and even researchers within the same disciplines) have different evidentiary standards. Also, population-level changes typically have not been studied using the designs that have been used in efficacy trials or behavioral interventions for clinical preventive services and medical care.[14,16] Therefore, the team developed a protocol for review of population-level environmental and policy-related health interventions based on that used in the *Guide*.[14,16,17] This protocol evaluates a variety of factors to determine the strength of evidence for an intervention, such as study execution, design, and the weight of expert opinion. Based on these reviews, the strength of evidence for an intervention is labeled as "strong," "sufficient," or "expert opinion." The recommendation reflects the confidence by the reviewers that changes in outcomes, such as increases in physical activity or consumption of fruits and vegetables are attributable to the intervention and not to other factors. The categories of "strong" and "sufficient" evidence are determined based on either a small number of available studies with better execution and more suitable design, or a larger number of studies with less suitable design or weaker execution. The "expert opinion" category is used when the intervention is in widespread use or important enough to consider, but there are too few studies or other evidence is not available. Examples of these categories assigned to specific strategies can be found in Table 1.

Strategy Menu Design

To address the challenge of organizing strategies that cut across settings or differ in scope or structure, the intervention team clustered the most promising strategies into 9 inclusive nutrition, physical activity, health care, and maternal care approaches.

Table 1. Example Summary for Comparing Strategies

Strategy	Likely Effect Size[1]	Immediacy[2]	Sustainability[3]	Evidence	Policy, Systems and Environment or Program
1.1: Complete Streets[18]	2	1	3	Strong	Policy/Environment
1.2: Safe Routes to School[21]	2	2	1	Strong	Program
1.3: Complete bike path networks	2	1	3	Strong	Environment/Program
1.4: Public transit	2	1	3	Strong	Policy/Environment

[1]Effect size is the measure of the strength or size of the potential results of a strategy. The scale for effect size ranges from 1 (weakest) to 3 (strongest). Scores are assigned based on evidence of effectiveness in the scientific literature or through expert opinion.
[2]Immediacy is the amount of time for a strategy to be fully implemented to the point where effects can be measured. The scale for immediacy ranges from 1 for a longer amount of time to 3 for a shorter amount of time. Scores are assigned based on evidence of immediacy in the scientific literature or through expert opinion.
[3]Sustainability is the long-term viability of a strategy. The scale for sustainability ranges from 1 when a strategy is unlikely to continue without long-term investments of money and resources to 3 for when little to no consistent investment of money and resources will be required to support the strategy. Scores are assigned based on evidence of sustainability in the scientific literature or expert opinion.

Box. Approaches and Strategies

Approach 1. Active Transportation
1. Complete Streets[18]
2. Safe Routes to School[21]
3. Complete bike path networks
4. Public transit

Approach 2. Recreational Spaces and Programming
1. Access to places for physical activity
2. Parks and open space
3. Recreational and community fitness programs

Approach 3. Active Settings
1. Active time in schools and early childcare environments
2. Workplace wellness initiatives
3. Physical activity policies

Approach 4. Community Design for Healthy Living
1. Mixed-use development
2. Public infrastructure
3. Comprehensive planning

Approach 5. Healthy Food Access and Consumption
1. School wellness policies
2. Healthy food standards in public places
3. Healthy food procurement
4. Early care nutrition policies
5. Healthy food standards in hospitals

Approach 6. Local Food Economies and Agriculture
1. Access to locally produced food
2. Local food production, processing, and distribution
3. Farm-to-institution
4. School gardens
5. Community farms and gardens

Approach 7. Food and Beverage Industry Change
1. Food store incentive and recognition programs
2. Healthy food stores in underserved areas
3. Restaurant menu labeling

Approach 8. Breastfeeding and Maternal Care Practices
1. Breastfeeding friendly maternity care
2. Breastfeeding friendly workplaces
3. Breastfeeding friendly childcare
4. Breastfeeding friendly public spaces
5. Healthy lifestyles for mothers

Approach 9. Clinical Care Practices
1. Body mass index screening
2. Team-based obesity care
3. Provider education, training, and resources
4. Patient self-management and counseling

In addition to encompassing the evidence base, approaches are designed to align with work being done by other Wisconsin organizations such as the Wisconsin Department of Health Services. Within each approach are 3 to 5 promising obesity prevention strategies for environmental or policy-related changes to promote healthy eating and physical activity in key settings, including schools, homes, childcare centers, health care organizations, work sites, and neighborhoods. While the focus of the Initiative is on childhood obesity, the intervention team recognized that to be successful, it is important to provide strategies benefiting all community members, because the health behaviors of children are strongly influenced by those of adults within their homes and communities.[5] (See Box for menu approaches and strategies.)

Each strategy includes information to help communities make informed decisions. Key details on likely effect size, immediacy, sustainability, and strength of evidence of effectiveness are displayed in the example in Table 1. The scale for effect size, immediacy and sustainability ranges from 1 (weakest) to 3 (strongest). For example, of the 4 active transportation strategies listed, Complete Streets[18] policies and projects are estimated to have a moderate effect size, a low level of immediacy (greater than 3 years to implement), and a high level of sustainability. Because no single strategy when implemented alone is likely to have a strong impact on childhood obesity at the population level, the Initiative encourages communities to implement a mix of programs, policies, and environmental changes.[19,20] For example, a Complete Streets project might be paired with a Safe Routes to School[21] program to ensure that neighborhoods near schools have walkable streets. Implementing strategies across multiple settings is most likely to result in population-level changes in overweight and obesity.

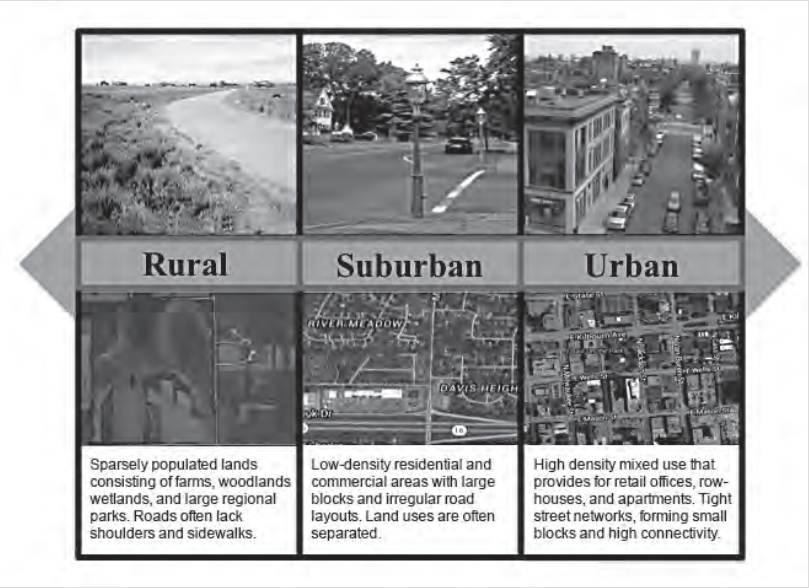
Using the Strategy Menu

Many Wisconsin communities are already implementing obesity prevention interventions and have expert knowledge of previous successes and challenges. As a key step in selecting and implementing strategies, communities are encouraged to inventory assets (eg, local champions, health coalitions) and barriers (eg, vested inter-

ests, land use policies that enable urban sprawl). The Initiative envisions communities using the menu to create a tailored set of obesity prevention strategies that takes into account past and present public health interventions, as well as current needs and priorities.

In Wisconsin, community context varies widely across the state for a number of demographic, cultural, and physical features (eg, ethnicity, population densities, cultural traditions, land use types, topography, transportation infrastructure). Assessing community context is an important step in determining which strategies are feasible and which are likely to be most effective for the local social, economic, and environmental conditions.[19] The rural-to-urban continuum as described by the transect model is an example of a tool that can help communities understand the importance of context in selecting strategies to improve mobility and physical activity within the built environment (Figure 1).[22] For instance, enhancing a public transit system may be an appropriate strategy for an urban setting, but may not be feasible in less populated areas. Similarly, a regional bike trail system may be a more appropriate strategy to increase physical activity along rural roads than adding sidewalks. Another important contextual consideration is how winter months affect physical activity and food consumption in regions that experience cold winters. Some communities may need to winterize physical activity or nutrition strategies to increase their benefits (eg, creating multiuse bike and cross-country ski trails).

Figure 1. Rural-to-Urban Continuum



Rural: Photo by James Van Hemert (CC BY-NC 4.0) Copyright 2003 American Planning Association. Suburban: Photo by Sylvia Lewis (CC BY-NC 4.0) Copyright 2008 American Planning Association. Urban: Photo by Carolyn Torma (CC BY-NC 4.0) Copyright 2015 American Planning Association. Aerial imagery: ©Copyright Digital Globe, Landsat, U.S. Geological Survey, USDA Farm Service Agency. Map data © Google.

Future Work

The Initiative's intervention team is developing an interactive website that includes strategy summaries, evidence, links to resources and assessment tools, suggested complimentary strategies, and a scoring system for comparing strategies. The site also will provide Wisconsin examples of implementation and allow communities to search for specific topic areas or settings. While it will provide a collective point of access for technical assistance and will be a useful resource, the website is not intended to replace the foundational relationships built between communities, scholars, and clinicians. Future iterations may expand its use beyond Wisconsin.

CONCLUSION

A transdisciplinary approach to obesity prevention, while vital to making progress in obesity prevention, can be challenging due in part to different disciplines having different evidentiary standards for effective strategies. To address this, the Initiative's intervention team has developed a strategy menu that encompasses important elements of various disciplines and provides evidence that has been systematically reviewed so that communities can choose from strategies likely to be effective in preventing childhood obesity. These strategies are clustered into 9 approaches and are inclusive of nutrition, physical activity, health care, and maternal care approaches.

Throughout the development of this menu, the intervention team has strived to balance strength of evidence with expert opinion and on-the-ground practice in Wisconsin communities. Practitioner feedback indicated that some promising strategies are hard to achieve in the context of particular communities and that smaller steps are sometimes easier. This kind of understanding is available only once community engagement occurs. For this reason, the intervention team considered not only strategies supported by scientific research and a rigorous evidence base, but also strategies that have demonstrated positive results based on practice-based evidence.[23]

The strategy menu developed as part of the larger Obesity Prevention Initiative will serve as a tool that communities can use to shift momentum toward a long-term reduction in obesity prevalence in children and adolescents. Ultimately, both policy and environmental changes will promote improved nutrition and physical activity behavior, which will, in turn, decrease childhood obesity.

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The Wisconsin Early Childhood Obesity Prevention Initiative: An Example of Statewide Collective Impact

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ABSTRACT

Introduction: The Wisconsin Early Childhood Obesity Prevention Initiative (Initiative), established in 2007, seeks to address and prevent obesity in the early care and education system through nutrition and physical activity environmental and policy changes. The collaborative includes professionals from 3 state of Wisconsin Departments, the University of Wisconsin-Extension, the University of Wisconsin-Madison, and public health and early care and education organizations. This paper explores the efforts of the Initiative to advance our understanding of collective impact in practice and its value to health promotion efforts.

Methods: Evaluators conducted a mixed methods case study to evaluate the application of collective impact principles by the Initiative. This included a survey of Initiative partners, review of archival documents, and qualitative interviews with Initiative leaders.

Results: Initiative partners noted progress in establishing the conditions for collective impact. Archival documents and interviews describe both formal and informal practices that helped set a common agenda, align and coordinate partner activities, and promote communication among Initiative leaders. Results also detail the important current and potential roles of "backbone" staff from healthTIDE to support the Initiative. Additionally, results suggest particularly challenging aspects of the Initiative's impact model related to shared measurement and broader stakeholder communication. While the Initiative is still setting in place the conditions for collective impact, it has achieved significant policy, systems, and environment changes since its formation. Inclusion of nutrition and physical activity criteria in the state's quality rating improvement system for child care centers is one of its outcomes.

Conclusions: This case study offers several important insights about the application of collective impact in health promotion efforts, particularly in relation to the transition from previous collaborative activities, the value of establishing a clear common agenda among partners, the roles of backbone staff, and time and partner relationships in collective impact.

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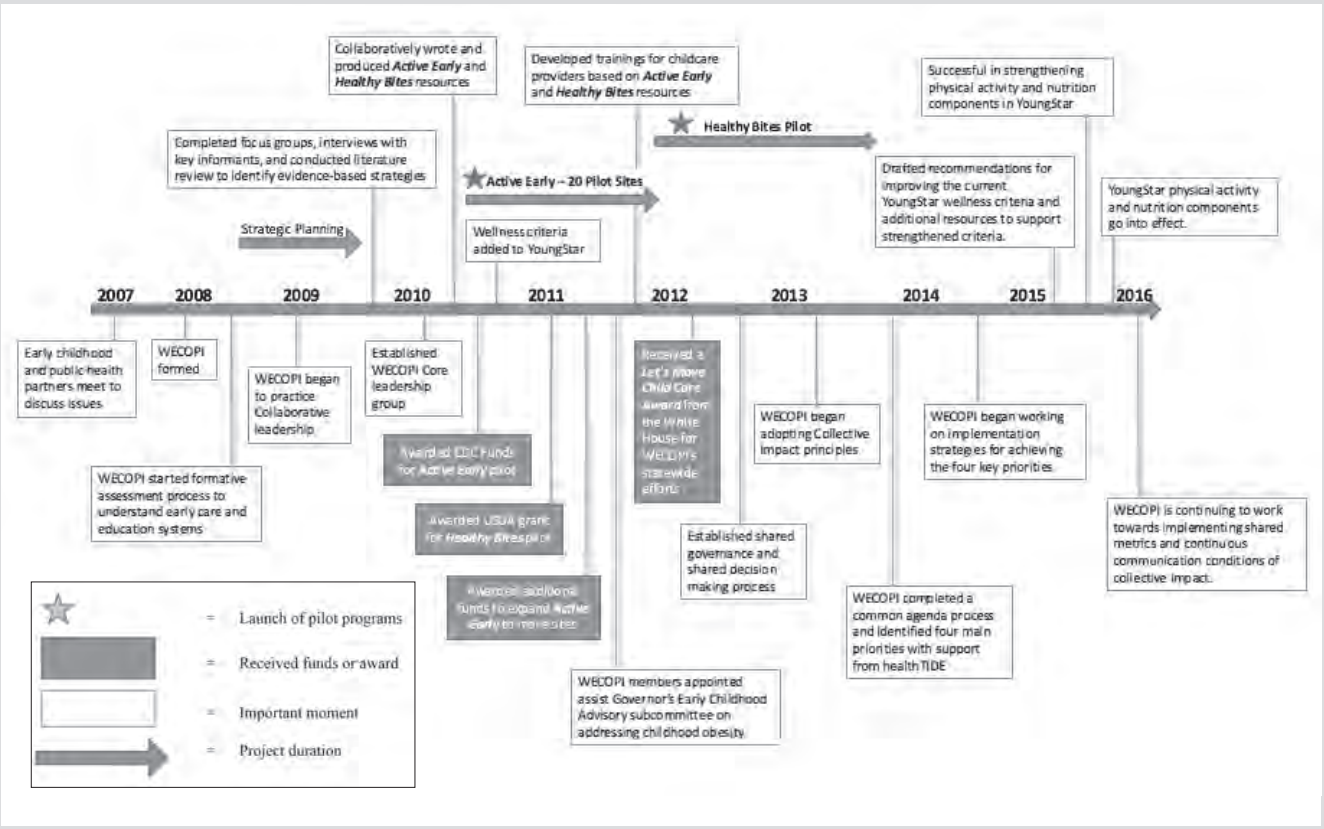
INTRODUCTION

Childhood obesity is a complex issue requiring a multisystem approach. Systems affecting children include early care and education, schools, health care, and communities. Collective impact has been introduced as a framework for broad-sector collaboration across systems as a means for addressing complex social issues.[1] The early care and education system, specifically childcare centers, reach large numbers of children for prolonged periods of time each day.[2] More than 50% of children under age 5 with a mother working full-time spend over 35 hours per week in childcare.[3] Additionally, childcare providers have existing infrastructure for meeting the nutritional and activity needs of children.[4] This system, which may be enhanced to more effectively impact obesity, offers points for intervention as well.[5] Implementing wellness policies and training caregivers in best practices for physical activity and nutrition can promote healthy weight for young children in childcare settings.[6]

With 32% of 2- to 4-year-old children overweight or obese in Wisconsin,[7] representatives from multiple sectors have come together since 2008 to seize the opportunity for preventing childhood obesity presented by the early care and education system. This collaborative, the Wisconsin Early Childhood Obesity Prevention Initiative (Initiative), works to develop and implement interventions to improve nutrition and levels of physical activity among 0 to 5 year olds in Wisconsin, especially children served in childcare settings. Key partners in the collaborative include 3 state agencies (the Wisconsin Departments of Health Services, Public Instruction, and Children and Families); nonprofit organizations that support and advocate for early care providers and educators such as the Wisconsin Early Childhood Association and

Figure. Wisconsin Early Childhood Obesity Prevention Initiative (WECOPI) Timeline



Supporting Families Together Association; and the University of Wisconsin-Extension and University of Wisconsin-Madison. The Initiative is supported by staff from healthTIDE, a "backbone" organization that supports efforts of several statewide groups seeking to address obesity and promote healthy living in multiple settings (eg, schools, food systems) through the use of collective impact.[8] The figure depicts the Initiative's historical evolution and notable impacts.

While the Initiative has always practiced shared leadership and governance, leaders saw the possibility for the collective impact approach[1] to build upon its existing practices in advantageous ways. In 2013, the Initiative began to take steps to integrate the conditions of collective impact into their work. These 5 conditions are a common agenda, mutually reinforcing activities, continuous communication, shared measurement systems, and backbone staff support. See Table 1 and Christens, et al, this issue for additional information on collective impact and its application to health promotion.[9]

Although collective impact has become an increasingly popular and utilized approach in health promotion,[10-12] there continues to be relatively few empirical studies of the application of the collective impact approach to coalition action, including the on-the-ground efforts required and implementation challenges. To this end, a case study of the Initiative was conducted to examine the utilization of the collective impact framework and consider how it may have influenced progress. Challenges experienced implementing the collective impact approach also are described.

METHODS

A case study was developed to understand evolution from a collaborative to a coalition using the collective impact framework and to measure qualitatively and quantitatively the impact of this change on the members and the function of the group. To develop this case study, evaluators from the Obesity Prevention Initiative (OPI) used a mixed methods design.[13] Case study research is valuable for answering questions of "how" and "why" and when understanding of real-life context is necessary for understanding a complex social phenomenon. To enhance empirical inquiry, case studies often draw upon multiple sources of evidence, including qualitative and quantitative data. As a well-established collaborative actively utilizing the collective impact framework and having experienced notable achievements (Figure 1), the Initiative was selected as a case for examining collective impact practices.

Qualitative data for the case study were drawn from the Initiative's archival documents,[14] emphasizing meeting minutes and participation records, both before and after the col-

Table 1. Examples of Collective Impact Practices in the Wisconsin Early Childhood Prevention Initiative (WECOPI)

Collective Impact Condition	Definition	Example from WECOPI
Common agenda	Partners have a shared vision for change, including a common understanding of the problem and approach for solving it.	Partners orient around a shared vision to prevent obesity and promote health in early childhood and develop four specific priority areas.
Mutually reinforcing activities	Alignment and coordination of partners' differentiated efforts towards achieving the common agenda.	Partners utilize a strategic planning process to detail activities and respective roles for each of the priority areas.
Continuous communication	Practices to insure regular and 2-way communication among partners that support shared understanding and trust.	Partners hold regular meetings and leaders communicate often through various means, including e-mails, telephone calls, and text messages.
Shared measurement systems	Collecting data and measuring progress consistently across partnering organizations on agreed upon indicators.	Partners discuss possible indicators for tracking progress, as well as potential challenges to address in developing a shared measurement system.
Backbone support	Staff outside of the collective impact partners that provide coordination, facilitation, and other logistical and administrative support.	Backbone staff from healthTIDE work to schedule meetings, facilitate group processes, provide collective impact resources, and assist in communication practices.

Table 2. Survey Responses of Partners Regarding Collective Impact Practices in the Wisconsin Early Childhood Prevention Initiative

Survey Item	% Agree	% Neither Agree nor Disagree	% Disagree
The convened group is committed to a common agenda. (Common agenda)	88	8	4
The convened group engages in mutually reinforcing and complementary activities. (Mutually reinforcing activities)	68	28	4
The convened group engages in continuous and effective communication. (Continuous communication)	68	24	8
The convened group uses shared measures to document and examine progress. (Shared measurement systems)	60	36	4
The convened group has the structural support to ensure effective collective work. (Backbone support)	72	20	8

lective impact framework was explicitly utilized. Evaluators also sampled a small group of active leaders, representing a range of roles, affiliations, and years of involvement, and conducted in-depth, semistructured individual interviews (n = 7).[15] These interviews were designed to elicit further qualitative data about the utilization of the conditions for collective impact and associated results. Quantitative data were drawn from respondents who noted involvement in the Initiative (n = 25) in a 2015 survey of healthTIDE stakeholders (n = 310). A set of 5 items asked respondents to rate their level of agreement (Agree, Neither Agree nor Disagree, or Disagree) with statements about collective impact practices. These data contribute the perspectives of the broader membership regarding the Initiative's progress toward its goals.

Qualitative data from the archival documents and interviews were analyzed deductively and inductively to identify themes and patterns.[16] Survey data were analyzed primarily with descriptive statistics. These quantitative and qualitative results were then analyzed in an integrated manner to look for triangulation and complementarity in the data sets, to expand on the understanding offered by either set alone, and to assure the legitimacy of the findings.[17]

RESULTS

Results are organized according to the 5 conditions of collective impact,[1] integrating the results from qualitative and quantitative analyses. Results are summarized in Tables 1 and 2. Definitions of each of the 5 conditions also are provided in Table 1.

Common Agenda

Data show that the condition of common agenda, which requires all partners to develop a shared vision for change, has been achieved. Interviewees consistently described a common agenda for the Initiative's work, broadly describing a focus on preventing obesity and promoting health in early childhood and especially through intervention with early care and education providers. (See Box for information on the Initiative's priority areas.)

Interviewees reported that the Initiative had achieved this condition for collective impact through a process that was both deliberate and naturally emerging. In the survey, a high number of respondents (88%) also agreed to committing to a common agenda. A clearly stated and well understood common agenda assisted the Initiative in making decisions about new activities or grant opportunities to pursue, as well as in engaging other efforts and recruiting potential new members.

Mutually Reinforcing Activities

A majority of survey respondents (68%) agreed that partners engaged in mutually reinforcing activities. Evidence of mutually

Box. The Wisconsin Early Childhood Prevention Initiative's Statewide Priority Areas

Priority 1.	Scale up efforts to provide training and technical assistance on how to create more supportive environments for nutrition and physical activity.
Priority 2.	Strengthen nutrition, physical activity, and breastfeeding licensing and regulation standards for childcare programs.
Priority 3.	Strengthen nutrition and physical activity criteria in YoungSTAR, a quality rating improvement system.
Priority 4.	Create and align resources that support childcare centers in imploring family engagement strategies around breastfeeding, physical activity, and nutrition.

reinforcing activities encouraged partners to recognize and apply their diverse strengths in coordination with one another towards achieving a common agenda. In particular, asset mapping and formative assessment conducted early in the Initiative's work was cited as helpful to build shared understanding of engaged stakeholders and their respective skills, resources, and connections (Figure).

Additionally, the process of writing, applying for, and implementing grants has encouraged clear definition of roles and responsibilities among partners. The diversity of the group with respect to both "big thinkers" and the "detail people" has helped to develop plans to achieve the common agenda that take advantage of "our knowledge and skill sets and who can do what."

Continuous Communication

From the archival documents and the accounts of interviewees, data show a strong commitment to the tenet of continuous communication, especially among the Initiative's core team. This team includes about 25 members who guide and carry out strategies to achieve the common agenda. As described for the 2 previous collective impact conditions, this was facilitated by both formal efforts and informal practices. The Initiative has established routines of preparing and distributing meeting agendas and notes and makes use of a cloud-based file sharing system to facilitate partners' access to a growing body of materials. Additionally, partners have committed to meeting regularly (every other month as a core team and 3 times a year for the full collaborative), using distance technology to facilitate virtual participation from partners across the state, and utilizing a portion of each meeting time to communicate updates on current activities and to discuss opportunities or challenges. Interviewees reported that the relationships and trust developed over the years among leaders support and complement this high level of communication.

Most survey respondents (68%) agreed that partners practiced continuous and effective communication. However, several interviewees noted that communication with the broader group's members (approximately 50 additional individuals) has been more challenging and needs improvement. Communication with the full membership has been less frequent and more one-way in the form of sending announcements or other updates. One interviewee spoke to their aspirations and challenges:

> "We're trying to be transparent. We're trying to let everybody in the state know what's going on, but it's just tough to do and people can't be on all these [communications]. It just gets overwhelming."

Interviewees expressed hope that the backbone support offered may help achieve continuous communication with the full membership. Additionally, interviewees identified needed assistance in communicating with stakeholders beyond the collaborative, especially the families served by the early care and education system.

Shared Measurement Systems

Data indicate progress has been slow and challenging in establishing a shared measurement system. These systems identify progress indicators for collaborative work and consistently collect and review this data across partnering organizations to track progress, make adjustments as necessary, and hold partners accountable. Based on archival documents and interviews, focused work to develop shared measurement systems has begun only recently and interviewees noted this to be the most challenging of the conditions of collective impact to establish in their efforts. In comparison to the other collective impact conditions, fewer survey respondents (60%) agreed that the Initiative used shared measures to document and examine progress. Interviewees noted that partners individually collected and used data to support their own efforts, but coordination and sharing has generally occurred only when required by particular grants. In these cases, shared measurement was shaped around these grant requirements and not sustained afterwards. Additionally, the data often focused on deliverables and participant reach numbers rather than outcomes, limiting its utility.

While interviewees spoke of the value of shared measurement systems to their efforts today, they expressed uncertainty about which indicators would be most valuable to track and how to consistently collect and analyze data in a way that will be feasible and useful for the Initiative.

Support Staff from a Backbone Organization

The Initiative had a long history of shared leadership and distributed effort to support its operations, especially among core leaders. Since 2013 however, healthTIDE staff have provided explicit backbone support and eased some of the burdens of logistical coordination and process facilitation from the leaders. As mentioned previously, backbone staff have helped guide the Initiative through the process of agreeing on a common agenda and started a strategic planning process that includes efforts to detail mutually reinforcing activities, communicate more effectively to the network of partners and stakeholders, and make steps towards

shared measurement systems. Additionally, backbone staff provide general administrative support and seek out and connect new potential partners to the Initiative.

Interviewees described the backbone staff's efforts as highly valuable and they anticipate future benefits from their work going forward. Similarly, almost three-quarters of survey respondents (72%) agreed that the Initiative had well established structural support. One interviewee noted backbone staff "providing significant leadership to this group in terms of our vision work and our outcomes and measurements." Additionally, interviewees described other desires they thought the backbone staff could help meet, including assistance in conducting needs assessments and program evaluations, providing trainings in best practices for coalition action, facilitating grant writing processes, and advocacy and public messaging support.

DISCUSSION

This case study offers insights into long-term statewide coalition formation and the use of the collective impact framework. First, results demonstrate that a collaborative or an initiative does not need to start out operating under an explicit collective impact framework to achieve many of the conditions for collective impact and reap their benefits. The Initiative had successfully functioned for many years prior to formal utilization of the collective impact framework and demonstrated skill in shared leadership, role definition, resource and effort coordination, and internal communication, which carried over well in its shift towards the collective impact framework. Activities such as grant writing and partner relationship building may offer beneficial byproducts to developing the conditions for collective impact. Because many of these capacities had been developed prior to the Initiative's utilization of the collective impact framework, it is not possible to disentangle the specific effects of seeking to achieve those conditions. Furthermore, because the current analysis is organized around these 5 conditions of collective impact, many other facets of coalition functioning and success are not addressed in this report.

Nevertheless, the Initiative's case suggests that coming to an agreed upon and equally upheld common agenda is a valuable early focus in the process. Having consensus around a common agenda seems to ease the work of planning and implementing mutually reinforcing activities that will move towards shared goals, determining effective communication strategies for different subgroups of the collaborative, and helping the collaborative decide how best to respond to new opportunities or unanticipated challenges.

From this case study, insights were gained into the importance of "backbone" support to coalition initiatives. While the Initiative functioned well under a shared leadership model, the backbone support introduced by healthTIDE eased much of the burden from leaders around logistical coordination and group facilitation and guidance. Moving forward, backbone staff may provide support in additional areas of need or particular challenge, including broad communication strategies, advocacy and public messaging, continuing to leverage funding for identified priorities, and shared measurement.

Finally, this case reminds us that any successful collaborative effort requires time to develop and depends on trusting relationships among partners (Figure). This is consistent with research on effective coalitions and collaborations.[18-20] While the collective impact framework does not speak directly to timelines or relationship development, it is clear that these are key ingredients to a worthwhile collective impact effort. Collaboratives seeking to build coalition capacity, regardless of the particular models they are using, should reserve time for the development of work and build in efforts to explicitly develop relationships among partners.

CONCLUSION

In this case study, the Initiative's implementation of the collective impact framework and impressions of progress within that implementation were examined. Partners in this work generally recognized progress in the Initiative's establishment of the conditions for collective impact. Data from interviewees and archival documents offered detail of how this progress has been made, including formal and informal efforts that have helped to establish these conditions. From the case study, important insights have been gained as to how coalition capacity is developed on the ground, including how prior efforts can beneficially carry over into the adoption of new frameworks, the importance of common agenda setting, and the varied catalyzing roles of a backbone staff. These findings will inform the Initiative's next steps as well as those of other collaboratives supported by healthTIDE. Additionally, these findings can inform future multisystem work.

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Lessons From a Pilot Community-Driven Approach for Obesity Prevention

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ABSTRACT

Introduction: The Wisconsin Obesity Prevention Initiative has piloted a novel approach for community action for obesity prevention that incorporates both coalition and community organizing efforts in 2 counties. This article describes lessons learned to date from this experience.

Methods: A description of the progress made in these communities and the support provided by Initiative staff and other partners are drawn from process evaluation of the pilot from November 2014 through December 2015, as well as the reflections of community partners.

Results: In Marathon County, building towards coalition action required thoughtful re-engagement and restructuring of an existing obesity-focused coalition. Community organizing surfaced local concerns related to the root causes of obesity, including poverty and transit. In Menominee County, coalition and community organizing efforts both have drawn attention to cultural assets for health promotion, such as traditional food practices, as well as the links between cultural loss and obesity.

Conclusions: Building coalition action and community organizing varies across community contexts and requires addressing various steps and challenges. Both approaches require critical local examination of existing community action and stakeholders, attention to relationship building, and support from outside partners. In coalition action, backbone staff provide important infrastructure, including member recruitment and facilitating group processes towards collaboration. Community organizing involves broad resident engagement to identify shared interests and concerns and build new leadership. A community-driven systems change model offers potential to increase community action for obesity prevention.

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INTRODUCTION

To combat obesity—a complex problem with myriad intersecting causes—experts suggest multifaceted and multisetting interventions for comprehensive change in local policies, systems, and environments.[1,2] Recent efforts have demonstrated improvement in population-level obesity outcomes among children through multisetting interventions[3-5] and coordinated community action that can be facilitated through approaches like coalition action and community organizing. For instance, in Shape Up Somerville,[3,6] a cross-sectorial coalition reflecting the collective impact model[7] has been considered integral to the effort's success in reducing obesity among local children. The Community Creating Healthy Environments initiative supported by the Robert Wood Johnson Foundation supports community organizing as a mechanism for spurring policy change and addressing the root causes of childhood obesity in communities of color.[8,9]

The Wisconsin Obesity Prevention Initiative (Initiative), a project led by the University of Wisconsin–Madison since 2014, incorporates both coalition action and community organizing in a novel model focusing on obesity prevention.[1,10] Coalition action involves multisector representatives from across the community coming together for coordinated actions to address an issue of shared concern, or to have a "collective impact."[7] Community organizing, on the other hand, involves residents collaborating to examine and counteract shared local concerns through sustained social action.[11] The Initiative seeks to address obesity in Wisconsin by investing in a model that builds capacity for community action through coalitions and community organizing, and connects these groups to recommended interventions and resources, academic partnerships, and ongoing

support. (See Adams, et al,[1] Christens, et al,[10] and Spahr, et al[12] in this issue for more information on the Initiative.)

One part of the Initiative is a pilot intervention study in 2 Wisconsin communities—Marathon and Menominee Counties—that supports the development of multisectoral coalitions and community organizing efforts in each community to build and focus capacity for population-level obesity interventions. This article summarizes the pilot, drawing on process evaluation data from November 2014 through December 2015 and the reflections of lead community partners, some of whom are also coauthors. Lessons learned to date will help refine a community-driven model for health promotion that builds on the strengths of coalitions and community organizing and supports synergistic opportunities across approaches.[10]

METHODS

Partners and Community Contexts

In this pilot, faculty, staff, and students from the University of Wisconsin-Madison partnered with representatives of the Marathon County Health Department, the Menominee Tribal Clinic, and WISDOM, a statewide network of more than a dozen local community organizing groups. Staff from the Marathon County Health Department and the Menominee Tribal Clinic facilitate the coalition efforts in their counties, and local organizers trained by WISDOM galvanize the community organizing work in both counties. Partners from the Healthy Wisconsin Leadership Institute, healthTIDE, and the University of Wisconsin-Extension provide additional support and coaching to the local efforts.

Marathon County is a primarily rural county in north-central Wisconsin (population 134,063; 2010 US Census), but the largest county geographically in the state. The population is primarily white (approximately 90%), but includes a sizable Southeast Asian community and a growing Latino/Hispanic population. About one-half of the population lives in the Wausau, Wisconsin metropolitan area. The Healthy Eating Active Living (HEAL) coalition had been in existence for over 10 years, yet membership had dwindled to a small group of committed members who met quarterly to network and share information. As such, the Marathon County Health Department staff began a concerted effort to revitalize the coalition utilizing the collective impact framework.[7] While the Wausau area has a local WISDOM community organizing affiliate—"NAOMI"—it was decided that a new organizing effort that could focus on health promotion would most benefit the project.

Menominee County, in northern Wisconsin, is the home of the Menominee Nation and includes a population that is almost 90% indigenous (total population 4,232; US Census, 2010). The tribe is burdened by a high prevalence of overweight and obesity in children and adults, as well as other forms of chronic disease. The collective impact and community organizing efforts in Menominee County began from the ground up as neither a formal physical nor nutritional health-focused coalition or a formal community organizing effort existed previously.

Supporting Partner Communities

To build coalition infrastructure, Initiative staff from the university met monthly with partners from the Marathon County Health Department and Menominee Tribal Clinic to support their understanding of the collective impact model[7] and other resources for coalition action. Early activities included assessments of the local context and mapping key individual and organizational stakeholders for obesity prevention efforts. Initiative staff also assisted in developing understanding of the collective impact model's "backbone" support roles. While bearing similarities to familiar coalition coordinator roles, backbone roles are distinct in important ways, including their emphasis on identifying and convening potential members, and a heavy focus on facilitation of group processes and accountability rather than carrying out tasks for the group.[13] As it is unlikely for professionals to have past experience in backbone roles, this shift often required additional effort to identify and train staff.

Initiative staff have continued to support lead partners at the Marathon County Health Department and the Menominee Tribal Clinic as they have moved forward with their coalition efforts. Ongoing support has enabled a more nuanced understanding and application of collective impact and other coalition ideas. For example, conversations have explored strategies for facilitating group coalescence around a common agenda and effective engagement of different kinds of community partners, including residents. Additionally, Initiative staff keep an eye on the needs of community partners for support from others connected to the Initiative, such as data from researchers that can inform obesity prevention strategies or examples of coalition efforts from healthTIDE's statewide work.

WISDOM hired community organizers in each county and organizers began their work in March 2015. WISDOM is a statewide grassroots organization that supports broad participation of residents in the democratic process, especially through congregation-based community organizing. Its affiliates work to address criminal justice, immigrant rights, and economic justice, among other issues. Their work with the Initiative has built on and expanded grassroots efforts related to obesity, for example, addressing issues of transportation, the built environment, and access to healthy food.

WISDOM staff and mentor organizers have trained, resourced, encouraged, and challenged the organizers throughout the project—from their initial process of individual meetings with local residents, to recruiting leaders, to assessing and ranking potential campaigns. The community organizers completed in-depth weeklong trainings in organizing principles with

the Gamaliel Foundation, alongside other community leaders from across the country. WISDOM staff promote peer-to-peer learning and accountability between the local organizers through regular check-in meetings, sharing of weekly written reflections, and gatherings of WISDOM organizers from across the state. WISDOM staff and organizers have maintained connections with Initiative staff and local coalition partners throughout the project, and these connections have facilitated access to Initiative support and promoted shared learning and collaboration with the coalitions.

RESULTS

Progress in Community Organizing and Coalition Action

Marathon County—The process of building coalition and community organizing capacity has played out differently in each county owing to various distinctions of the local context. Efforts to revitalize the Healthy Eating Active Living coalition began with targeted outreach to agencies and groups important to local obesity prevention. In spring 2015, backbone staff invited identified stakeholders to a "World Café" event[14] (a model for large group generative discussions) focused on reshaping the vision for the coalition. Approximately 40 attended, including previous coalition members such as the University of Wisconsin-Extension Marathon County, as well as new potential partners that could support multisetting obesity prevention, like a local grocery store, the YMCA, and the Marathon County Conservation, Planning and Zoning Department. This process reasserted agencies' shared interests in promoting healthy eating and everyday physical activity for community members. Attendees also identified a major barrier to the coalition's past progress—a pattern in which initiatives were generally directed by health department grants and staff, which then discouraged member participation and ownership. This discussion underscored for staff the important distinctions between familiar coalition coordinator roles and those of backbone staff.

The coalition then conducted an asset mapping activity to identify existing healthy eating, physical activity, and other relevant community resources. With this information, the coalition strategically discussed how to expand on existing strengths and create momentum towards building a healthier community. Additionally, backbone staff assisted coalition members in reviewing other successful coalitions, such as the Early Years Coalition in Marathon County, and used these lessons to make decisions around communication and other practices. The backbone staff also facilitated activities to build alignment around a common agenda, including a dot prioritization activity and a coalition membership survey. This led the coalition to form 2 action teams–one focused on access to healthy food options and the other on access to places for physical activity–and helped the coalition select initial activities, specifically assessments of local community gardens and pedestrian infrastructure. Initiative staff continued to provide support throughout this time, including further guidance on collective impact principles and coaching on group facilitation. The coalition now meets monthly with an average attendance twice what it was prior to the Initiative (20 members vs approximately 10 active attending members, respectively).

In the Marathon County community organizing effort, the organizer began by conducting individual meetings with residents, or "one-to-ones." One-to-one meetings are a fundamental community organizing practice in which organizers or leaders in the community organizing group meet individually with residents—especially those typically marginalized and excluded from community decision-making—to get to know them and to identify shared areas of interest and concern across the population.[10,11] These meetings also serve to identify and recruit a broad network of leaders for the organization. Leader teams are then trained in community organizing practices and take responsibility for building action to address shared concerns.

The community organizer in Marathon County completed over 150 one-to-one meetings with residents from March 2015 through December 2015, and other community leaders recruited through the process completed additional one-to-one meetings. From these meetings, the organizer and leaders identified community concerns related to food insecurity, transit, and social isolation, especially affecting young adults and low-income families. As community organizing seeks to build capacity for action by aligning interests—especially among those marginalized and underserved—this orientation has helped turn focus to root causes of obesity (ie, social determinants of health such as poverty) as well as issues of health equity. The connections between the community organizer and the coalition backbone staff have helped remind coalition members of these root causes as well. To further explore these shared concerns and engage more residents, the organization has held gatherings to discuss food, food insecurity, and public transit.

Menominee County—As a small, rural community, lead community partners at the Menominee Tribal Clinic were able to expeditiously identify potential coalition members. Stepping into the role of backbone staff, clinic staff mapped stakeholders for obesity prevention and reached out to agencies with whom they had existing working relationships as well as new potential collaborators. Borrowing from the community organizer's one-to-one practices, backbone staff met with potential members individually to develop mutual understanding of their interests and build trust.

Coalition members began meeting and named their effort the Menominee Wellness Initiative. Members include the clinic, Head Start, the schools, the College of the Menominee Nation, Menominee Food Distribution, the recreation center, and the University of Wisconsin-Extension Menominee County. In early

meetings, members participated in trainings on collective impact and other coalition approaches supported by Initiative staff, and used these ideas to define their identity and functions. Meetings often included thoughtful discussions of the Menominee cultural context and the unique assets that cultural traditions and values offer. These assets include traditional gardening, food gathering, and hunting practices; a multigenerational orientation to community initiatives; and momentum in revitalizing the Menominee language. Through a series of facilitated discussions, the Menominee Wellness Initiative decided to focus its efforts on 3 areas: gardening and traditional food practices, local food systems, and increasing opportunity for physical activity. Initiative staff have connected the Menominee Wellness Initiative to researchers to help advance work in these areas, for example, by collaborating on a community survey of access to the recreation center.

The Menominee County community organizer completed over 100 one-to-one meetings with local residents, including many tribal elders, from March 2015 through December 2015. These meetings surfaced shared concerns around cultural identity, community cohesion, and language and culture revitalization, and identified several community leaders. The new organization named itself *Menikanaehkem*, or "community builders." After the original organizer left for another opportunity with the tribe, one of the recruited leaders filled the organizer role and took responsibility for one-to-one meetings with residents and guiding the organization's work.

Menikanaehkem leaders recognize links between obesity and forms of community, cultural, and linguistic violence inflicted since contact with Europeans. (Research also points to such links, including correlations between native language loss, cultural disruption, and diabetes rates in indigenous communities.[15]) To rebuild community connections and revitalize culture and language, while also re-embracing traditional and inherently wholesome food practices, the organization has hosted a series of community feasts. Held in towns and villages across the county and open to all community members, these feasts have spotlighted "pre-contact" foods; incorporated ceremonial, drumming, and storytelling traditions; and emphasized the cultural roots of individual and community health. The feasts have nurtured broad community engagement, developed new leaders, and sparked conversations around notions of health and underlying factors promoting or undermining health.

DISCUSSION

For physicians and other health care professionals who are increasingly becoming involved in community action to address obesity or other chronic conditions,[16,17] this pilot offers important lessons about the steps involved in building coalition action and community organizing and challenges that can arise along the way.

First, it is clear that developing understanding and then capacity in coalition action and community organizing takes time, both for those guiding their implementation (ie, backbone staff and community organizers) as well as for members. It is important to preserve separate identities of coalition and community organizing efforts as this understanding is developed, thereby ensuring that one does not inadvertently subsume or undermine the other.

Time also must be reserved to provide support to backbone staff and community organizers that may be outside of the coalition action and community organizing toolkits but is needed to get efforts off the ground, such as skill development in group facilitation or project management. In the Initiative, university staff have been able to identify and meet these needs or connect partners to others who can; other initiatives may need to build in such support mechanisms as well. These observations are consistent with recent coalition action and community organizing guidance in terms of preserving time for infrastructural development and adaptation to the local context, and anticipating ongoing technical assistance needs.[18,19]

This pilot experience also has made clear the importance of critically examining the local landscape of collaborative action and grassroots engagement before beginning new community-driven efforts. Neither community, of course, was a blank slate at the start; whether formal or informal, official or unofficial, collaborative and grassroots efforts existed in the communities and needed to be understood. This included identifying stakeholders in health- and community-related efforts and the relationships among them. In the community organizing model, understanding the power implicit in these relationships was another integral step, and one that coalition efforts may perhaps continue to learn from, as this understanding can influence partnership development and change-making strategies.[20] It was also important to remember that the collaborative and grassroots landscapes looked considerably different in each setting, owing to differences in local culture, history, urbanicity, socioeconomic and racial-ethnic diversity, and other factors. Community mapping and power mapping tools and a regular commitment to reexamine the local landscape will continue to be essential moving forward.

Understanding of the collaborative and grassroots landscapes also draws attention to the need to often look beyond the "usual suspects" for health promotion, such as local businesses, cultural organizations, and residents—especially those most impacted by the issues. However, effectively bringing diverse stakeholders to the table requires dedicated time, patience, and attention to relationship building. This is well understood in community organizing, as organizers conduct one-to-one meetings to understand the needs and motivations of residents and to more effectively engage them in grassroots efforts.[10,11] In the Initiative, coalition staff have seen the value of intentional relationship building to their work as well, and research of effective multisectorial partnerships for

health promotion also points to the importance of attention to trust building.[21]

Finally, lessons from this pilot encourage maintenance of an inclusive perspective of "health" and "obesity prevention" so that diverse partners are not excluded from these initiatives. Indeed, the engagement of partners who represent various community groups, their experiences and diverse resources, will be critical to effective, multisetting community health promotion.[2]

CONCLUSIONS

As the groups in this pilot move forward with specific efforts to promote health and address obesity locally, new understanding of the effects of community-driven approaches to health promotion can be gleaned through coalitions and community organizing, and the two together. Future evaluation will look for evidence of increased capacity for community action, associations between community action and changes in local policies, systems, and environments and, over time, changes in obesity-related physical activity and eating behaviors. This learning will support population-level change in these communities and help further develop community-driven systems change models for obesity prevention and health promotion.

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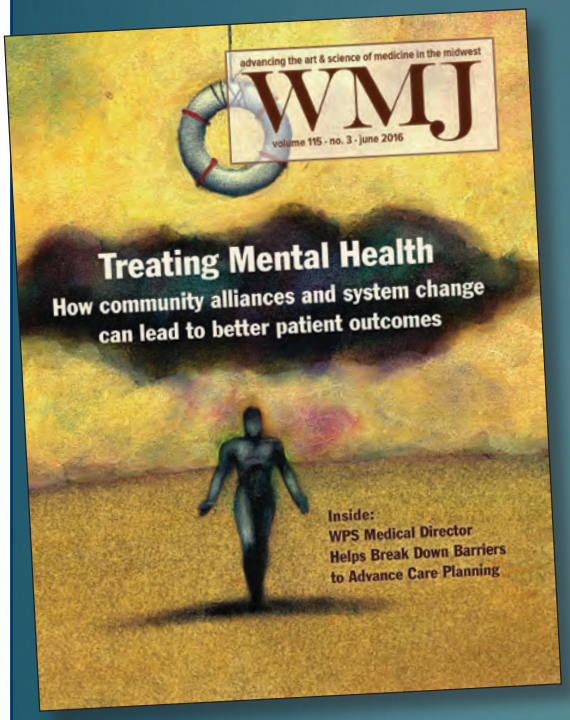

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