A Descriptive Assessment of Public Maternal Health Dashboards in the United States

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Submitted to: Journal of Medical Internet Research
on: January 26, 2024

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Abstract

Background: Data dashboards have become more widely used for public communication of health-related data, including in maternal health.

Objective: We evaluated the content and features of existing publicly-available maternal health dashboards in the U.S.

Methods: Through systematic searches, we identified 80 publicly-available, interactive dashboards presenting U.S. maternal health data. We abstracted and descriptively analyzed the technical features and content of identified dashboards across four areas: a) scope and origins; b) technical capabilities; c) data sources and indicators; and d) disaggregation abilities. Where present, we abstracted and qualitatively analyzed dashboard text describing the purpose and intended audience.

Results: The majority of reviewed dashboards reported state-level data (73%) and were hosted on a state health department website (60%). Most dashboards reported data from only one (41%) or two (29%) data sources. Key indicators—such as the maternal mortality rate (13%) and severe maternal morbidity rate (15%)—were absent from most dashboards. Included dashboards utilized a range of data visualizations, and most allowed some disaggregation by time (81%), geography (81%), and race/ethnicity (69%). Among dashboards that identified their audience (38%), legislators/policymakers and public health agencies/organizations were the most common.

Conclusions: While maternal health dashboards have proliferated, their designs and features are not standard. This national scoping review of maternal health dashboards in the U.S. found substantial variation among dashboards, including inconsistent data sources, health indicators, and disaggregation capabilities. Opportunities to strengthen dashboards include integrating a greater number of data sources, increasing disaggregation capabilities, and considering end user needs in dashboard design.

(JMIR Preprints 26/01/2024:56804)
DOI: https://doi.org/10.2196/preprints.56804

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ABSTRACT

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Conclusions: While maternal health dashboards have proliferated, their designs and features are not standard. This assessment of maternal health dashboards in the U.S. found substantial variation among dashboards, including inconsistent data sources, health indicators, and disaggregation capabilities. Opportunities to strengthen dashboards include integrating a greater number of data sources, increasing disaggregation capabilities, and considering end user needs in dashboard design.

Key Words: dashboard; maternal health; data visualization; data communication

INTRODUCTION

Data dashboards are “visual displays that feature the most important information needed to achieve specific goals captured on a single screen” [1]. The term dashboard is borrowed from the vehicle dashboard, highlighting the expectation that a data dashboard will display key indicators used to understand performance and make decisions. Data dashboards can be designed to meet different types of goals, including informing strategic decisions, monitoring organizational performance, and communicating information to raise awareness and motivation [1–3]. Like businesses, healthcare organizations and public health agencies have widely adopted dashboards to support internal operations [4,5]. More recently, dashboards are being developed for public communication of health-related data, a practice which accelerated during the COVID-19 pandemic [6,7]. Examples of public health dashboards include the City Health Dashboard [8], national and state substance use and overdose dashboards [9–11], and various COVID-19 dashboards [12,13].

The interest in public health dashboards has also expanded to the area of maternal health. The status of maternal health in the United States (U.S.) has been characterized as a crisis [14], with outcomes much worse than peer nations as well as large racial/ethnic disparities across perinatal outcomes [15,16]. National plans for improving maternal health have highlighted the need for better, more timely maternal health data [14,15]. Public reporting of maternal health data has also been proposed as a key mechanism for enabling quality improvement and empowering patient decision making [17]. Consistent with these priorities, recent federal investments in maternal health have supported improving data systems. Several federal agencies are partnering on maternal data infrastructure projects to standardize measurement and to expand surveillance to include underreported conditions and outcomes across settings [18]. At the state level, the Centers for

Disease Control and Prevention (CDC) granted 39 awards to support Maternal Mortality Review Committees in collection and reporting of data on the causes of maternal deaths [19]. In the same year, the Health Resources and Services Administration awarded 9 new state maternal health innovation awards, with an emphasis on maternal health data. One of the primary suggested data-related innovations is development of a state-focused maternal health dashboard “to easily access and report on maternal health outcomes ” [20].

Maternal health data in the U.S. currently comes from multiple sources that are typically disconnected outside of limited data linkage efforts [18,21]. These include maternal mortality reviews conducted by state committees [22], national and state vital statistics systems [15], hospital discharge data [23], claims data [24], and surveys such as the Pregnancy Risks Assessment Monitoring System [25]. Additional sources of health system, demographic, and social data may also identify risks and opportunities for improving maternal health. Maternal health dashboards have the potential to reduce access barriers to these data, particularly when integrating multiple sources of information in one location. Dashboards may also support efforts to address maternal health disparities through disaggregation and comparison features [26].

Alongside the growth of public health dashboards, questions have been raised regarding the extent to which dashboards present the most valuable data in a way that meets users’ information needs [4,7,13]. Published assessments of dashboards in other health areas have identified substantial heterogeneity and gaps in their actionability [7,27]. Segmenting data presentations for different audiences is considered essential for the utility of data dashboards, as audiences may differ on their information needs as well as their health and data literacy levels [3,4]. However, dashboard developers are often disconnected from public users and may have limited understanding of users’ needs and abilities [4]. Given that there are few published reports of the development process for maternal health dashboards [28,29], little is known about the factors considered in maternal health dashboard design.

To inform the development of a maternal health dashboard for the state of Arkansas, we undertook a rigorous descriptive assessment of existing publicly-available maternal health dashboards in the United States. This study, the first step in a user-centered design process, allowed the team to identify the range of data sources and technical features in existing dashboards of similar scope. This paper provides an evaluation of the content and features of existing publicly-available maternal health dashboards in the U.S. Given the strong interest in improving access to maternal health data [17] and the importance of maintaining and continually improving current dashboards [6], the results of this review of public dashboards are relevant to all stakeholders concerned with dissemination of maternal health data.

METHODS

This descriptive assessment was conducted by a team of researchers with expertise in information systems, software engineering, maternal health surveillance, and quantitative and qualitative methods. Similar to scoping reviews of published literature [30], we sought to identify the scope and key attributes of public dashboards presenting maternal health data for the United States. The methods for this assessment were also informed by prior studies of hospital patient safety dashboards [27] and public COVID-19 dashboards [7,31].

Identification of Dashboards

Between January and March 2023, the research team performed multiple searches of publicly-available maternal health dashboards using the Google search engine. The topical keywords included in each search were “dashboard,” “maternal,” “perinatal,” and “birth.” Given the geographic focus of the study, each search contained a geographic keyword—either “United States” or the name of one of the 50 states (e.g., Alabama, Alaska, Arizona . . .). A total of 51 separate searches were performed, and each search was completed independently by two team members. Team members accessed and reviewed the first ten results for each search they performed to determine whether the sites met eligibility criteria.

We adapted Sarikaya et al.'s functional definition of a dashboard—"an interactive display that enables . . . monitoring of dynamically updating data"[3]— as the basis for our inclusion criteria. A dashboard was eligible for inclusion if it: 1) reported data related to maternal health; 2) included data from the U.S.; 3) was accessible by the public; and 4) included at least one interactive feature for data presentation. A dashboard was considered ineligible if it: 1) was a password-protected, non-public website; 2) provided data only as downloadable files (e.g., PDF reports, Excel spreadsheets); 3) did not contain any interactive features; 4) did not include any U.S. data. All dashboards determined to be eligible by the team were included in a list for data extraction. Seventy-six sites were identified through the searches. An additional four dashboards were identified during review of the content of included dashboards and state health department websites and were added to the abstraction list for a total of 80 dashboards (see Supplemental File 1).

Abstraction of Dashboard Characteristics

The features and content of identified dashboards were abstracted using a standardized form in REDCap. After a preliminary review of the first quarter of identified dashboards, the team developed an abstraction form to capture the variability in features and data observed across this subset of dashboards. Following initial abstraction of all dashboards, the form underwent a revision to explicitly include dashboard features/content that were most commonly included in "other" categories, as described below. The final form included over 250 fields across four areas: a) scope and origins; b) technical capabilities; c) data sources and indicators; and d) disaggregation capabilities (see Supplemental File 2).

"Scope and origin" fields addressed the geographic areas and health topics included in the dashboard, the dashboard's stated purpose and audience, and the hosting organization/site. "Technical capabilities" fields included types of visualizations, export and download features, responsiveness/mobile friendliness, and available comparisons (e.g., longitudinal trends, benchmarks). Both the "scope and origin" and "technical capabilities" fields were assessed for the

site as a whole, with the exception of visualizations, which were abstracted only for maternal health data. “Data sources and indicators” fields addressed the maternal health data sources explicitly reported on the dashboard as well as the presence, time period, and format of specific maternal/perinatal indicators. Forty indicators were abstracted in four categories—health status/outcomes (11 indicators), health behaviors and utilization (11), individual characteristics and risk factors (12), and health system characteristics (5). “Disaggregation capabilities,” also assessed for maternal health data, included fields for abstracting disaggregation by race, geography, and multiple perinatal characteristics. A variable that could be used for disaggregation was only considered to additionally be an indicator on the dashboard if the variable was also presented independently of disaggregation functions. The majority of fields on the abstraction form were assessed as binary variables indicating the presence or absence of a data point or feature. “Other” options were included for each section on the abstraction form, with text specification of the variable or feature observed. A small set of fields, related to the stated purpose and audience of each dashboard, also required abstraction of textual information. Operational definitions were developed by the team for select abstraction fields that required interpretation by abstractors.

The original abstraction process was completed by five team members between February and May 2023. Two Master’s-trained team members were responsible for primary abstraction of all dashboards. Three PhD-trained team members, each with at least five years of experience working with U.S. maternal health data, completed a thorough secondary review for each dashboard. All corrections made during secondary review were logged by REDCap with a note of explanation from the reviewer. Given that website features may change, or sites may become unavailable at any time, one team member also completed brief videos demonstrating the primary features of each site at the time of abstraction. A second round of abstraction for an additional nine variables was completed in May 2024 to respond to reviewer comments. Five of the included dashboards were no longer accessible and additional abstraction for those sites was completed to the extent possible using the

recorded videos.

Analysis

Following the completion of reviews, the abstracted data were exported from REDCap into R version 4.3.1 [32] for analysis. The number and proportion of dashboards with each characteristic was calculated. To characterize the stated purpose and audience, the team followed a qualitative content analysis approach, led by a PhD-trained team member with fifteen years of qualitative and mixed-methods research experience. The abstracted text that described purpose and audience was exported into a matrix and read for familiarization and inductive identification of common themes. Eight thematic categories were identified in the dashboard purpose descriptions, and six categories were identified in the dashboard audience descriptions. Operational definitions were developed for each of these 14 categories. After the REDCap form was modified to add these categories, one team member reviewed all definitions again to apply the relevant categories, and a second team member checked all purpose and abstract characterizations with reference to the abstracted text and original websites, as needed. Illustrative quotes for each purpose category were selected for presentation in the results.

RESULTS

Among the 80 publicly-available maternal health dashboards included in this review, 24 (30%) were solely focused on maternal health, 28 (35%) included both maternal and child health data, and 28 (35%) included data for health areas outside of maternal and child health, such as environmental health and chronic diseases (Table 1). Forty-six (58%) dashboards included the term “dashboard” in the site title or description while 32 (40%) did not. The majority of dashboards had a focus on state-level data (58; 73%), eight (10%) presented national or multinational data and 14 (18%) presented data for a sub-state region (e.g., city, multiple counties, tribal area). The most common hosting site for included dashboards was a health department website (48; 60%), followed by a nongovernmental organization or program website (14; 18%). Other types of hosting sites

included federal agencies and universities (see Supplemental File 3). The software platforms used to create reviewed dashboards included Tableau (30; 38%), unspecified or custom systems (26; 33%), and off-the-shelf solutions (16; 20%) such as Conduent, Clear Impact, MySidewalk, and IBM Cognos. A small number of dashboards were created with PowerBI (4; 5%) or ArcGIS (4; 5%).

Table 1. Design and Features of Reviewed Dashboards (n=80)

Characteristic[1]	No. (%)
Topical scope	
Maternal and child health	28 (35%)
Broader than maternal and child health	28 (35%)
Maternal health only	24 (30%)
Geographic scope	
National or multinational	8 (10%)
State focus	58 (73%)
Region or other area	14 (18%)
Use of "dashboard" in title or description[2]	
Includes the term "dashboard"	46 (58%)
Does not include the term "dashboard"	32 (40%)
Hosting organization/site	
Health department webpage	48 (60%)
NGO/program webpage	14 (18%)
Other/unspecified	18 (23%)
Visualizations of maternal health data	
Table	63 (79%)
Bar chart	58 (73%)
Line graph	52 (65%)
Map	46 (58%)
Pie chart	14 (18%)
Large numbers/card visualizations	9 (11%)
Arrows representing direction of change	7 (9%)
Gauge chart	5 (6%)
Other visualization type	9 (11%)
Confidence intervals in any visualizations	24 (30%)
Software platform	
Tableau	30 (38%)
Unspecified or custom system	26 (33%)
Off-the-shelf solutions[3]	16 (20%)
PowerBI	4 (5%)
ArcGIS	4 (5%)
Technical capabilities	
User can download data	46 (58%)

User can download complete dashboard view	43 (54%)
All indicators visible on one page	38 (48%)
Responsive interface	37 (46%)
Instructions for interactive features	35 (44%)
Mobile-friendly interface	31 (39%)
User can download individual visualizations	26 (33%)
User can select visualization type	16 (20%)
Adaptive visualization (select to filter)	8 (10%)
Full screen	6 (8%)
Other	21 (26%)
Statements of purpose and audience	
Statement of purpose	55 (69%)
Statement of intended audience	30 (38%)
Stated audience categories[4]	
Legislators/policy makers	17 (57%)
Public health agencies/ organizations	16 (53%)
General audience descriptor	15 (50%)
Healthcare organizations/providers	11 (37%)
Community members/healthcare consumers	10 (33%)
Researchers	7 (23%)
Other	8 (27%)

Notes:[1]All characteristics assessed for the dashboard as a whole except visualizations, which was restricted to maternal health data; [2]Could not be assessed for two dashboards that were no longer accessible during second round of abstraction; [3]Off-the-shelf systems include Conduent and MySidewalk; [4]Percentages calculated among the subset of 30 dashboard with a stated audience. Acronyms: NGO=nongovernmental organization.

Included dashboards utilized a range of data visualizations and technical features (Table 1). Four visualization types were present on the majority of dashboards: tables (63; 79%), bar charts (58; 73%), line graphs (52; 65%), and maps (46; 58%), predominantly choropleth maps. Less common visualizations included pie charts (14; 18%), large numbers/card visualizations (9; 11%), directional arrows (7; 9%), and gauge charts (5; 6%). The most common technical features observed for included dashboards were the ability to download data (46; 58%) and the ability to download the dashboard view as a contained (e.g. PDF) file (43; 54%). The classic dashboard style of presenting all indicators on one page was observed in roughly half of reviewed dashboards (38; 48%). Some dashboards also accommodated different screen sizes with responsive interfaces (37; 46%) and mobile-friendly interfaces (31; 39%). Less common technical features included allowing the user to

select the type of visualization (16; 20%), adaptive visualizations (8; 10%), and full screen mode (6; 8%).

While the majority of included dashboards provided an explicit statement regarding the purpose of the dashboard (55; 69%), descriptions of the intended audience were less common (30; 38%), with close to two-thirds of dashboards not specifying their audience (Table 1). Eight categories of audience were identified from dashboards' textual statements regarding audience. Audience categories specified in at least half of audience statements included legislators/policy makers (17; 57%), public health agencies/organizations (16; 53%), and general audience descriptors such as "stakeholders," "partners," or general "public" audiences (15; 50%). Healthcare organizations/providers (11; 37%) and community members/healthcare consumers (10; 33%) were identified in around one-third of statements, while the least common category was researchers (7; 23%).

The thematic analysis of dashboards' purpose statements identified eight distinct categories of purpose: data accessibility, program planning/needs assessment, accountability for government/organizations, program evaluation/monitoring, research, quality improvement, policymaking/goal setting, and individual decision making (Table 2). Among the 55 dashboards with a statement of purpose, general data accessibility was the most common purpose and was noted in 35 (64%). Often, the dashboard was described as a tool to achieve a public agency's goals or mandates for data accessibility. The second most common purpose was program planning and/or needs assessment (24; 44%), which included identifying health needs, developing plans to address those needs, and applying for funding to support program plans. Accountability for government-supported programs (e.g., Medicaid) and healthcare organizations was included in some purpose statements (14; 26%), as was program evaluation and monitoring (14; 26%). The least common purpose categories were research (8; 15%), quality improvement for healthcare organizations (7; 13%), and policy making/goal setting (4; 7%). Supporting individual decision making by healthcare consumers

or community members, such as selecting a healthcare provider or identifying a healthy behavior, was observed in a small proportion of purpose statements (4; 7%). Other types of purpose included journalism and promoting residency and/or tourism in the area (Supplemental File 3).

Table 2. Purpose Categories and Example Statements among Dashboards that Provided a Statement of Purpose (n=55)

Purpose Category	No. (%)	Example Statements [Ref. No.]*
Data accessibility	35 (64%)	• Idaho Vital Statistics Natality Dashboard [20]: "The Division of Public Health's Strategic Plan has identified priority areas which include leveraging and using data more effectively across the Division as well as improving data accessibility for use by stakeholders (i.e., public health agencies, health systems, decision-makers, and the public). The data found on this website are intended to help the Division of Public Health achieve those priority area strategic goals." • Oregon Health Authority Dashboard [51]: "The [Vital Statistics] Annual Report had evolved into several pages of narrative and dozens upon dozens of static data tables. This new format will rely less on narrative descriptions of the data, and focus instead on presenting the data through interactive data visualizations. This will allow the reader to examine the data in new ways, focus on topics of interest, and allows easier comparisons to earlier data than was possible with static reports."
Program planning/ needs assessment	24 (44%)	• Georgia Online Analytical Statistical Information System (OASIS) [18]: "OASIS plays an integral role in program planning, which includes determining target population areas, formulating financial plans, monitoring program effectiveness, program evaluation and reporting program outcomes. Use OASIS data querying tools to: develop profiles and report cards for counties or districts; assess community health needs, prioritize health problems, and evaluate programs; assemble data for grant writing, health analysis, special projects or state legislative reporting." • Iowa Public Health Tracking Portal [25]: "The Iowa Public Health Tracking Portal serves as a centralized source for public health data, resulting in: . . . Healthier Iowans in healthier communities: Use data to perform thorough community health needs assessments and to create and implement impactful health improvement plans; Increased opportunities for funding: Use data to support grant applications and ensure secured funds are used on programs that provide the most value to Iowans."
Accountability for government/ organizations	14 (26%)	• Missouri HealthNet Managed Care Quality Dashboard [37]: "The purpose of the Medicaid Managed Care Quality Dashboard is to provide transparency and accountability in the health care provided to Missouri's Medicaid participants." • Nebraska Healthy People 2020 [43]: "Built on the concepts of the Results Based Accountability™, our Performance Dashboard is made up of scorecards that display

		desired results or outcomes, activities or strategies, population indicators and performance measures. This scorecard is created to track performance, therefore the demonstration of data within color markers identifies the boundaries of what we define as success."
Program evaluation/ monitoring	14 (26%)	• Georgia OASIS [18]: "OASIS plays an integral role in program planning, which includes determining target population areas, formulating financial plans, monitoring program effectiveness, program evaluation and reporting program outcomes. Use OASIS data querying tools to: develop profiles and report cards for counties or districts; assess community health needs, prioritize health problems, and evaluate programs" • Montana Children's Health Data Dashboard [42]: "The Montana Children's Health Data Dashboard highlights ten shared measures identified by early childhood health stakeholders. Stakeholders and early childhood coalitions can use these measures to track outcomes and demonstrate the impact of their work."
Research	8 (15%)	• Hawai'i Health Data Warehouse [19]: "The Hawai'i Health Data Warehouse is dedicated to providing useful data to support public health professionals, researchers, the community and health agencies to become more effective in the application of health data." • Health Compass Milwaukee [70]: "[The Health Compass] serves as the comprehensive source of health-related data about Milwaukee county residents and communities. Health Compass Milwaukee Goals: . . . Elevate the importance and availability of ongoing community health status information to support research, planning and community-wide health improvement."
Quality improvement	7 (13%)	• Agency for Healthcare Research and Quality Perinatal Dashboard [1]: "This rich data source makes it possible to identify and track patient safety concerns for the purpose of learning how to mitigate patient safety risks and reduce harm across healthcare settings nationally." • South Carolina Birth Outcomes Initiative [54]: "The BOI interactive dashboard provides users with an instant visual representation of the statewide maternal and birth outcomes metrics - across payment, individual, facility-level, and geographical characteristics. By connecting data to quality improvement information, the dashboard is a tool that facilitates data-driven collaborative decisions to improve the clinical outcomes of mothers and babies in SC."

Policymaking/goal setting	4 (7%)	• Kansas Health Matters [27]: “Kansas Health Matters is intended to help hospitals, health departments, community members and policy makers learn about the health of the community and ways to help improve it . . . Master planners and government representatives can use this data to establish community goals on a variety of platforms.” • Texas Health Data Pregnancy Risk Assessment Monitoring System [56]: “This site contains public data and statistics on various health topics. The data are intended to help you plan and improve delivery of services, evaluate health care systems, inform policy decisions, and aid in research.”
Individual decision making	4 (7%)	• New Jersey Maternal Health Hospital Report Card [46]: “This is an informational resource tool that provides important data on maternal health care provided in New Jersey licensed birthing general acute care hospitals. In determining the best hospital for you, you may review the information provided in this report.” • New Mexico Environmental and Public Health Tracking Data Portal [47]: “The NMTracking portal can help you learn how the environment may be affecting health. Learn about environmental health issues in your community and what you can do to protect yourself and your family.”
Other	10 (18%)	• Kansas Health Matters [27]: “ . . . Community groups, schools, health associations, chambers of commerce, tourism and many other organizations can use this information to show the great benefits of living in Kansas as well as opportunities for improvement, with specific information.” • March of Dimes Peristats [5]: “ Data are updated throughout the year, and useful for multiple tasks, including fact-finding, . . . lectures and presentations”

*Reference number refers to the order in which the dashboard appears in the complete list provided in Supplemental File 1.

The majority of dashboards reported data from only one (41%) or two (29%) sources (Table 3). Over half of dashboards reported state vital statistics as a data source (47; 59%). The second most common data source was the state Pregnancy Risk Assessment Monitoring System (22; 28%), followed by state health departments (12; 15%), the U.S. Census (9; 11%), the CDC's Wide-ranging ONline Data for Epidemiologic Research (WONDER) system (9; 11%), and the National Center for Health Statistics (8; 10%). Data sources reported in fewer than ten percent of dashboards include hospital discharge data (6; 8%), the Health Resources and Services Administration (5; 6%), and insurance claims data (4; 5%). Two dashboards (3%) reported the state Maternal Mortality Review Committee as a source of data. Narrative interpretations of the meaning of maternal health data were more commonly included on reviewed dashboards than narrative interpretations of data quality.

Table 3. Sources, Comparisons, and Disaggregation Capabilities for Maternal Health Data within Reviewed Dashboards (n=80)

Characteristic	No. Dashboards (%)
Number of data sources reported	
One	33 (41%)
Two	23 (29%)
Three	5 (6%)
Four	6 (8%)
Five or more	10 (13%)
None stated	3 (4%)
Specified data sources	
State vital statistics	47 (59%)
PRAMS	22 (28%)
State health department	12 (15%)
U.S. Census	9 (11%)
CDC WONDER	9 (11%)
National Center for Health Statistics	8 (10%)
Hospital discharge data	6 (8%)
Health Resources and Services Administration	5 (6%)
Insurance claims data	4 (5%)

Maternal mortality reviews	2 (3%)	
Other[1]	31 (39%)	
Narrative interpretations of data quality		
Completeness and/or validity	31 (39%)	
Privacy protections	16 (20%)	
Biases	2 (3%)	
Narrative interpretations of meaning		
Definition of variable	51 (64%)	
Normative interpretation of value	32 (40%)	
Contextualization/factors influencing value[2]	52 (65%)	
Comparisons		
Temporal	63 (79%)	
Other geographic areas	42 (53%)	
National data	25 (31%)	
Benchmarks/targets	18 (23%)	
Disaggregation capabilities by	**Any data**	**All data**
Time interval	65 (81%)	54 (68%)
Geography	65 (81%)	53 (66%)
Race/ethnicity	55 (69%)	26 (33%)
Maternal age	42 (53%)	14 (18%)
Insurance status/type	24 (30%)	13 (16%)
Education	18 (23%)	5 (6%)
Marital status	16 (20%)	5 (6%)
Receipt of social support	10 (13%)	3 (4%)
Birthweight	9 (11%)	0 (0%)
Level of poverty	7 (9%)	3 (4%)
Sex or gender of mother or baby	7 (9%)	2 (3%)
Household income	7 (9%)	2 (3%)
Plurality	7 (9%)	1 (1%)
Healthcare facility	7 (9%)	1 (1%)
Nativity or citizenship	7 (9%)	1 (1%)
Gestational age	6 (8%)	1 (1%)
Healthcare provider	5 (6%)	1 (1%)
Other characteristics[1]	21 (26%)	7 (9%)

Notes: [1]See Supplemental File 3 for a description of other responses; [2]Includes discussion of the influence of sample size on the reliability of estimates as well as policy/environmental influences Acronyms: PRAMS=Pregnancy Risk Assessment Monitoring System; CDC=Centers for Disease Control and Prevention; WONDER=Wide-ranging ONline Data for Epidemiologic Research.

The comparison and data disaggregation capabilities also varied considerably between dashboards (Table 3). While a large majority of dashboards provided temporal comparisons for

included indicators (63; 79%), roughly half allowed for comparisons between geographic areas (42; 53%). Some dashboards also provided comparisons against national data (25; 31%) and benchmark or target values (18; 23%) such as the Healthy People goals. The predominant time period for reporting data was annual, followed by multiyear reporting periods (see Supplemental File 4). Data disaggregation by race and/or ethnicity was possible for any data on 55 (69%) dashboards and for all data on 26 (33%). The next most common disaggregation variables for any data were maternal age (42; 53%) and insurance status/type (24; 30%).

Table 4 displays the presence of 40 specific perinatal health indicators in four groups—health status/outcomes, health behaviors and healthcare utilization, individual characteristics and risk factors, and health systems characteristics—along with the format and geographic level with which each is reported. Rates or percentages were more commonly used as the reporting format than frequencies for almost all health indicators. The most common geographic level for reporting health indicators was the state, followed by county and regions within states. Among health status indicators, birthweight, preterm birth, and infant mortality were reported in at least half of reviewed dashboards. Birth statistics were reported in 48% of dashboards and mode of delivery (e.g., vaginal or cesarean delivery) was included in 26%. Indicators of any pregnancy-related problems, such as gestational diabetes or pre-eclampsia, were reported in 16 (20%) dashboards, while maternal mental health conditions were reported in 14 (18%). Severe maternal morbidity and maternal mortality were each reported in fewer than 1 in 5 (20%) of the reviewed dashboards.

Table 4. Maternal Health Indicators and Reporting Format among Reviewed Dashboards (n=80)

		Format[1]		Geographic Level[1]					
Category	Any Indicator	Frequency	%/Rate	National	Regional	State	State Region	County	Smaller Than County
Health status/outcomes									
Birthweight	54 (68%)	27 (34%)	50 (63%)	15 (19%)	2 (3%)	48 (60%)	20 (25%)	37 (46%)	7 (9%)
Preterm birth	45 (56%)	20 (25%)	41 (51%)	11 (14%)	2 (3%)	42 (53%)	17 (21%)	30 (38%)	3 (4%)
Infant mortality	42 (53%)	19 (24%)	39 (49%)	16 (20%)	3 (4%)	35 (44%)	13 (16%)	31 (39%)	3 (4%)
Births	38 (48%)	32 (40%)	23 (29%)	7 (9%)	3 (4%)	30 (38%)	13 (16%)	30 (38%)	7 (9%)
Mode of delivery	21 (26%)	11 (14%)	19 (24%)	8 (10%)	1 (1%)	20 (25%)	5 (6%)	10 (13%)	4 (5%)
Pregnancy-related problems	16 (20%)	8 (10%)	15 (19%)	2 (3%)	1 (1%)	15 (19%)	6 (8%)	8 (10%)	3 (4%)
Maternal depression/anxiety	14 (18%)	5 (6%)	14 (18%)	2 (3%)	0 (0%)	14 (18%)	6 (8%)	4 (5%)	1 (1%)
Severe maternal morbidity	12 (15%)	5 (6%)	9 (11%)	4 (5%)	0 (0%)	12 (15%)	3 (4%)	2 (3%)	1 (1%)
Maternal mortality	10 (13%)	4 (5%)	9 (11%)	4 (5%)	0 (0%)	9 (11%)	1 (1%)	6 (8%)	0 (0%)
Birth defects	9 (11%)	5 (6%)	9 (11%)	2 (3%)	1 (1%)	6 (8%)	1 (1%)	4 (5%)	0 (0%)
Neonatal abstinence syndrome	8 (10%)	3 (4%)	8 (10%)	4 (5%)	0 (0%)	8 (10%)	3 (4%)	3 (4%)	0 (0%)
Other	14 (18%)	9 (11%)	13 (16%)	2 (3%)	0 (0%)	12 (15%)	4 (5%)	9 (11%)	2 (3%)
Health behaviors and healthcare utilization									
Receipt of prenatal care	57 (71%)	21 (26%)	54 (68%)	13 (16%)	2 (3%)	53 (66%)	20 (25%)	35 (44%)	3 (4%)
Maternal smoking	42 (53%)	16 (20%)	41 (51%)	10 (13%)	1 (1%)	39 (49%)	16 (20%)	22 (28%)	0 (0%)

Breastfeeding	22 (28%)	8 (10%)	21 (26%)	6 (8%)	0 (0%)	21 (26%)	7 (9%)	7 (9%)	2 (3%)
Substance use	14 (18%)	5 (6%)	13 (16%)	2 (3%)	0 (0%)	14 (18%)	6 (8%)	5 (6%)	0 (0%)
Oral health	13 (16%)	4 (5%)	13 (16%)	1 (1%)	0 (0%)	12 (15%)	3 (4%)	2 (3%)	0 (0%)
Postpartum care	12 (15%)	4 (5%)	10 (13%)	2 (3%)	0 (0%)	11 (14%)	3 (4%)	2 (3%)	0 (0%)
Maternal nutrition	11 (14%)	4 (5%)	11 (14%)	1 (1%)	0 (0%)	11 (14%)	4 (5%)	4 (5%)	0 (0%)
Immunization	10 (13%)	5 (6%)	10 (13%)	1 (1%)	0 (0%)	10 (13%)	3 (4%)	3 (4%)	1 (1%)
Contraception	9 (11%)	3 (4%)	9 (11%)	2 (3%)	0 (0%)	9 (11%)	5 (6%)	4 (5%)	1 (1%)
Preventative healthcare visit	5 (6%)	1 (1%)	5 (6%)	1 (1%)	0 (0%)	5 (6%)	1 (1%)	2 (3%)	1 (1%)
Smoking household	5 (6%)	2 (3%)	5 (6%)	1 (1%)	0 (0%)	5 (6%)	3 (4%)	3 (4%)	2 (3%)
Other	19 (24%)	9 (11%)	17 (21%)	3 (4%)	0 (0%)	18 (23%)	7 (9%)	8 (10%)	3 (4%)
Individual characteristics and risk factors									
Maternal age	43 (54%)	19 (24%)	37 (46%)	14 (18%)	1 (1%)	36 (45%)	14 (18%)	26 (33%)	5 (6%)
Preconception health	18 (23%)	8 (10%)	17 (21%)	1 (1%)	2 (3%)	16 (20%)	5 (6%)	6 (8%)	3 (4%)
Maternal BMI	17 (21%)	6 (8%)	17 (21%)	2 (3%)	1 (1%)	16 (20%)	4 (5%)	10 (13%)	2 (3%)
Health insurance status	17 (21%)	9 (11%)	17 (21%)	3 (4%)	0 (0%)	15 (19%)	3 (4%)	8 (10%)	3 (4%)
Maternal education	17 (21%)	11 (14%)	14 (18%)	4 (5%)	0 (0%)	16 (20%)	5 (6%)	11 (14%)	3 (4%)
Pregnancy intention	13 (16%)	5 (6%)	13 (16%)	2 (3%)	0 (0%)	13 (16%)	5 (6%)	3 (4%)	0 (0%)
Stress/abuse	11 (14%)	5 (6%)	11 (14%)	2 (3%)	0 (0%)	10 (13%)	2 (3%)	3 (4%)	1 (1%)
Maternal marital status	10 (13%)	9 (11%)	8 (10%)	1 (1%)	0 (0%)	10 (13%)	4 (5%)	9 (11%)	1 (1%)
Plurality	9 (11%)	7 (9%)	8 (10%)	1 (1%)	0 (0%)	9 (11%)	3 (4%)	8 (10%)	2 (3%)
Birth spacing	7 (9%)	6 (8%)	6 (8%)	1 (1%)	0 (0%)	6 (8%)	3 (4%)	6 (8%)	2 (3%)
Number of prior births	7 (9%)	5 (6%)	7 (9%)	0 (0%)	0 (0%)	7 (9%)	3 (4%)	4 (5%)	1 (1%)
Maternal race/ethnicity	5 (6%)	2 (3%)	4 (5%)	0 (0%)	0 (0%)	5 (6%)	2 (3%)	1 (1%)	1 (1%)
Other	2 (3%)	1 (1%)	2 (3%)	1 (1%)	0 (0%)	1 (1%)	0 (0%)	1 (1%)	0 (0%)
Health systems characteristics									
Population characteristics	18 (23%)	7 (9%)	17 (21%)	3 (4%)	0 (0%)	16 (20%)	5 (6%)	13 (16%)	4 (5%)
WIC access	16 (20%)	4 (5%)	16 (20%)	3 (4%)	0 (0%)	11 (14%)	3 (4%)	9 (11%)	0 (0%)

Availability of maternity care	12 (15%)	6 (8%)	6 (8%)	2 (3%)	1 (1%)	9 (11%)	3 (4%)	8 (10%)	3 (4%)
Policy measures	4 (5%)	3 (4%)	1 (1%)	3 (4%)	0 (0%)	2 (3%)	2 (3%)	1 (1%)	0 (0%)
Healthcare expenditures	2 (3%)	2 (3%)	0 (0%)	0 (0%)	0 (0%)	2 (3%)	1 (1%)	2 (3%)	1 (1%)
Other	3 (4%)	1 (1%)	2 (3%)	0 (0%)	0 (0%)	3 (4%)	3 (4%)	2 (3%)	1 (1%)

Notes: [1]The denominator for all percentages reported in this table is 80 dashboards. Dashboards may use more than one reporting format and more than one geographic level. Acronyms: BMI=body mass index; WIC=Special Supplemental Nutrition Program for Women, Infants, and Children.

Among health indicators grouped under the “health behaviors/healthcare utilization” and “individual characteristics/risk factors” groups, only three were reported on half or more of the reviewed dashboards—receipt of prenatal care (57; 71%), maternal smoking (42; 53%), and maternal age (43; 54%). Indicators reported in 20 to 30% of dashboards include breastfeeding (22; 28%), preconception health (18; 23%), maternal body mass index (17; 21%), health insurance status (17; 21%), and maternal education (17; 21%). The remaining 21 health indicators in the “health behaviors/healthcare utilization” and “individual characteristics/risk factors” groups were reported in fewer than 20% of dashboards. Finally, “health systems characteristics” was the least commonly included group of indicators. Indicators of population characteristics (e.g., sex ratios, fertility rates, pregnancy rates) and access to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) were reported in 18 (23%) and 16 (20%) dashboards, respectively. The availability of maternity care was reported in 12 (15%) dashboards, while policy measures and expenditures related to maternal health care were only reported in fewer than 5 dashboards.

DISCUSSION

This study demonstrates that public dashboards presenting U.S. maternal health data are widespread. While most reviewed dashboards are hosted by state or local health departments, the content and features across maternal health dashboards are not uniform. Reviewed dashboards were developed with various software platforms and offered diverse technical capabilities. Only half of maternal health dashboard designs reflected the traditional, single-view presentation of key metrics, demonstrating the expanding conceptualization of dashboards [3]. The included dashboards also presented a range of maternal health indicators, generally reflective of their reported scope and included data sources. The heterogeneity in design and content of maternal

health dashboards is similar to that observed in public COVID-19 dashboards [7,31].

In addition to mapping the breadth of options for U.S. maternal health dashboards, this review also suggests opportunities for improving the utility of current and future dashboards. Greater integration of multiple data sources is the first opportunity for improvement suggested by these results. Seventy percent of included dashboards in this review provide data from only one or two sources, yet individual data sources provide an incomplete picture of maternal health in the U.S. Birth records, the primary vital statistics data reported on dashboards, exclude key outcomes—notably maternal mortality rates. It is particularly striking that only two dashboards included data from maternal mortality review committees (MMRCs), the gold standard assessment of state-level maternal mortality [33]. Similarly, hospital discharge data files, the primary data source for calculating severe maternal mortality rates using the CDC's algorithm [23], were a reported data source in only six dashboards. State-focused dashboards, in particular, could enable more efficient access to maternal health data by including key maternal indicators from all state data sources—vital statistics (including death certificates), PRAMS, MMRCs, and hospital discharge data files—in one comprehensive dashboard.

A second area where public maternal health dashboards can be strengthened is their ability to identify disparities through data disaggregation. Maternal health disparities in the U.S. are of grave concern, with Black women and American Indian/Alaska Native women having two to three times greater risk of maternal death compared to white non-Hispanic women [14] and increased likelihood of receiving poor quality care [34]. Women residing in rural areas [35] and those with public insurance [34] also experience worse maternal outcomes. The ability of data systems to detect these disparities is considered critical for efforts aimed at reducing adverse perinatal outcomes overall as well as disparities in these outcomes [34,36,37]. While most of the

reviewed dashboards permitted disaggregation of all indicators by geography, only one-third had the capability of disaggregation by race/ethnicity for all indicators. Disaggregation by other social determinants of maternal health, such as insurance type, education, and language spoken, was even less common. Although privacy protections may prohibit the stratified presentation of infrequent outcomes [38], such as maternal mortality, most individual-level indicators reported on reviewed dashboards would not require such data suppression.

Third, maternal dashboards may increase attention to the information needs of their audiences and segmentation of information presented for different audiences. Fewer than half of the dashboards in this review provided statements about their intended audience; available audience statements typically listed multiple, diverse stakeholders. Critical assessments of public health dashboards have noted that "not all data are necessary for all users at all times, and often the information that citizens need to make informed decisions is absent" [4]. The interest and needs of policymakers and providers for publicly-reportable maternal health data are not well studied. For maternity patients, documented information needs include identifying geographically close healthcare providers that provide the services and quality that the patient prefers [39–41] These patient needs appear to be particularly underserved by current maternal health dashboards. Among reviewed dashboards, fewer than one in ten presented any data by healthcare facility. The technical features and visual displays of dashboards should also be differentiated for different audiences [42]—while program planners and researchers may prioritize access to a wide range of variables available through sophisticated queries, maternity patient decision-making has been shown to benefit from explanations about the relevance of included data [43]. Engaging intended audience members during dashboard design and development is a best practice that was followed in one [29] of the two reports of public maternal

dashboard development [28,29]. Future qualitative research with maternal health dashboard development teams, similar to COVID-19 dashboard studies [44], could lead to a better understanding of the factors guiding their decisions and opportunities to improve processes and dashboard actionability for intended users.

This study could not evaluate the impact of maternal health dashboards and was limited in the extent to which it could assess aspects of the user experience, such as usability. Although comprehensive usability standards have recently been proposed for public health data dashboards [45], further operationalization is needed before they can be consistently applied. The features of some dashboards suggest limited usability for many users. For example, fewer than half of dashboards had a responsive interface that would reformat for viewing on a mobile device. This review was also unable to address the usefulness of the data and features of maternal health dashboards from the perspective of intended users. We could not identify any published articles evaluating the user experience, interaction effectiveness, system efficacy [46], or actionability [13] of a deployed maternal health dashboard, although these evaluations are critical to understanding and optimizing the contribution of public health dashboards to patient- and system-level decision making [6].

For maternal health dashboards to successfully increase in sophistication and meet the expectations of multiple stakeholders, prior research suggests that it is important to involve collaborative interdisciplinary teams in dashboard design and development [44]. The expertise of systems analysts, software engineers specializing in backend and frontend web development, and user-interface designers, are likely to result in dashboards with improved usefulness and usability. These fields have established best practices for designing usable systems that are often neglected in health information systems [47]. When resources are limited, general-purpose data

analytics tools such as Tableau or Microsoft PowerBI are promising low-cost options for prototyping. Ongoing data improvement efforts by national funders and organizations may also contribute resources and standards to support the efficient development of maternal data dashboards. For example, data standards could facilitate sharing, reuse, and integration of maternal health data [48], and user interface standards could lead to more effective and efficient development by offering specific widgets and visualization solutions for certain maternal health data and/or for certain purposes (e.g., benchmarking).

CONCLUSION

This national descriptive assessment of maternal health dashboards in the U.S. found substantial variation among dashboards, including inconsistent data sources, health indicators, and disaggregation capabilities. Few dashboards included information regarding maternity patients as an intended dashboard audience. Careful consideration of the design of publicly-available health dashboards, with specific intent to develop dashboards that cater to end-user needs and to include data from multiple sources, is critical for ensuring that dashboards achieve their intended goals.

Acknowledgments

This work was made possible by Grant Number U7A46847 from the Maternal and Child Health Bureau of the Health Resources and Services Administration (HRSA). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Department of Health and Human Services. This work was also supported by University of Arkansas for Medical Sciences Translational Research Institute funding awarded through the National Center for Advancing Translational Sciences of the National Institutes of Health (NIH) (UL1 TR003107). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. The authors wish to thank Erin Gloster for assistance with manuscript submission.

Author's Contributions

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Conflicts of Interest

The authors declare that they have no competing interests.

Abbreviations

BMI = body mass index

CDC = Centers for Disease Control and Prevention

HRSA = Health Resources and Services Administration

MMRC = maternal mortality review committees

NGO = nongovernmental organization

NIH = National Institutes of Health

OASIS = Online Analytical Statistical Information System

PRAMS = Pregnancy Risk Assessment Monitoring System

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

WONDER = CDC's Wide-ranging ONline Data for Epidemiologic Research

U.S. = United States

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Supplementary Files

Untitled.
URL: http://asset.jmir.pub/assets/813e4c88a7fb8ae0a38fccea0c943212.docx

Multimedia Appendixes

Supplemental File 1. List of Reviewed Maternal Health Dashboards.
URL: http://asset.jmir.pub/assets/bf5d597df81bc36c8b79babb3894e747.docx

Supplemental File 2. REDCap Data Abstraction Instrument.
URL: http://asset.jmir.pub/assets/37ffb7a8f329b2a188c6b05ea5ae0b75.docx

Supplemental File 3. Description of Other Categories for Tables 1, 3, and 4.
URL: http://asset.jmir.pub/assets/e6cc4477ee99b91a143a012516f6239b.docx

Supplemental File 4. Indicator Reporting Time Periods.
URL: http://asset.jmir.pub/assets/7af7ddd48a1e041275cf08a62f059b37.docx

CONSORT (or other) checklists

PRISMA Scoping Review Checklist.
URL: http://asset.jmir.pub/assets/981e5bf541c4871842b97952767a7e37.pdf