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Objectively-measured Environmental Support for Physical Activity, Healthy Eating, and Breastfeeding in the Rural United States: A Scoping Review to Inform Opportunities for Public Health Surveillance

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Abstract
The purpose of this scoping review was to identify objectively-measured environmental initiatives or features that impact physical activity (PA), healthy eating (HE), and/or breastfeeding practices among rural communities in the United States. A secondary aim was to assess measurement approaches for assessing rural environments and resources. Searches, informed by a scientific librarian, occurred from February to July 2020. Grey literature was identified using Google, Google Scholar, Google government pages, public health, federal nutrition assistance program, Cooperative Extension Services, and related webpages. Medline, PubMed, Web of Science, and Agricola academic databases were selected to identify peer-reviewed research. ProQuest Global was used to identify dissertation/thesis research. Inclusion criteria included: (1) focus on PA, HE, and/or breastfeeding; (2) environmental features assessed using objective measures; (3) specific to U.S. rural populations/contexts; and (4) English language. PA environment results (n=49) focused on initiatives in parks and recreational settings, streets or sidewalks, schools, trails and greenways, workplaces, and churches. HE environment results (n=84) focused on retail environments, schools/childcare settings, food assistance programs, local food producers, and hospital or healthcare settings. Breastfeeding environment results (n=11) focused on healthcare settings, workplace settings, and food retail settings. To measure PA, HE, and breastfeeding environments, audits, scans, and administrative data were mostly used. Results from this scoping review were used to create recommendations for environmental interventions related to PA, HE, and breastfeeding in under-resourced, rural communities. Researchers and practitioners can also use findings from this study to understand best practices for objectively measuring environmental resources in rural contexts.

Keywords: Review, environment, surveillance, breastfeeding, physical activity, healthy eating

Due to high rates of chronic disease in the United States (U.S.), efforts to address the most prevalent chronic diseases, including heart disease, cancer, chronic lung disease, stroke, Alzheimer's disease, diabetes, and chronic kidney disease, have been increasing locally and nationally (Boersma, 2020; Centers for Disease Control and Prevention, 2022, January 27; 2022, July 21). High rates of chronic disease can be addressed by intervening on key lifestyle risk features, such as physical activity (PA) and healthy eating (HE). Breastfeeding also has a crucial role in reducing the risk of chronic diseases (e.g., obesity, type 2 diabetes) and improving well-being among both mothers and infants (Centers for Disease Control and Prevention, 2022, January 27; Romieu et al., 2017; Schmidt, 2016). Given that many people have limited access to resources to support PA, HE, and breastfeeding, addressing resource disparities is paramount (Roubal, 2015; Karpyn et al., 2019; Centers for Disease Control, 2018; Dunn et al., 2015; Bradford et al., 2017; Sallis & Glanz, 2009; Sallis et al., 2008; Casey et al., 2008). For example, people living in rural and more remote areas have disproportionately lower access to environmental PA, HE, and breastfeeding resources compared with to people living urban areas (Wen, Fan et al., 2018; Wen, Zhang et al., 2013; Shores & West, 2010; Dean & Sharkey, 2011; Burgoine et al., 2017; Walker et al., 2010; Grubesic & Durbin, 2017; Grubesic & Durbin, 2020; Allen et al., 2015; Wiener & Wiener, 2011, May 2; Johnston & Esposito, 2007; Kaczynski et al., 2020; Fan, Wen, & Wan, 2017; Wende, Stowe, Eberth et al., 2020; Wende, AlHasan et al., 2020; Houghtaling et al., 2017). Rural environments are also often perceived as more unsafe due to higher rates of crime, are saturated with unhealthy food outlets (e.g., convenience stores), and show low support for breastfeeding (Grubesic & Durbin, 2020; Sampson, 1997; Pratt & Cullen, 2005; Lamichhane et al., 2013; Fraser et al., 2010; Sparks, 2010).

Lacking environmental resources combined with higher rates of poverty and lower income status has translated into rural residents being less likely to meet PA, HE, and breastfeeding recommendations and experiencing higher rates of heart disease, cancer, chronic lower respiratory disease, and stroke (U.S. Census Bureau, 2016a; U.S. Census Bureau, 2016b; Whitfield, 2019; McCormack, 2016; Hartley, 2004; Do, 2009; Centers for Disease Control and Prevention, 2019; Garcia, 2017). As a result, public health experts are increasingly focused on ensuring health-promoting resources are equitably distributed in rural communities, and employing policy, systems, and environmental change approaches (Springer et al., 2017; Paskett et al., 2016; United States Department of Health & Human Services, n.d.; Lyn et al., 2013; Honeycutt, 2015). Policy, systems, and environmental change approaches highlight the importance of intervening on more distal features, such as environmental resource access and related policies, to improve PA, HE, and breastfeeding in rural communities.

Several literature reviews have been conducted to summarize existing research focused on environmental change approaches to improve PA and HE in rural areas. Five reviews have been completed related to environmental strategies or conditions that may influence PA or active living, and three reviews have been completed related to environmental strategies or conditions that may influence HE and obesity (Frost et al., 2010; Hansen et al., 2015; Neville et al., 2016; Umstattd, Perry et al, 2016; Olsen, 2013; Pinard et al., 2016; Calancie et al., 2015; Lenardson et al., 2015). There are no existing literature reviews published, to our knowledge, on environmental supports or strategies to improve breastfeeding in rural areas. Nonetheless, literature reviews that are not specific to rural contexts or those that focus on urban locations indicate that environmental resource access is important for promoting breastfeeding (Hadisuyatmana et al., 2021; Kaunonen et al., 2012; Haroon et al., 2013; Almohanna et al., 2020; Butzner & Cuffee, 2021; Sinha et al., 2015). More broadly, existing reviews have looked at environmental features related to PA, HE, and breastfeeding (Wendel-Vos et al., 2007; Barnett et al., 2017; Addy et al, 2004; Perry, Saelens, et al., 2011; Smith, Hosking, et al., 2017; Humpel et al., 2002; Gubbels, 2020; Marcone et al., 2020; Belon et al., 2016; Kvalsvik et al., 2021; Larson & Story, 2009; Zorbas et al., 2018; Giskes et al., 2011; van der Horst et al., 2006; Standish & Parker, 2022; Cohen et al., 2018). While existing literature reviews highlight the importance of environmental support for PA, HE, and breastfeeding, a scoping review that also captures environmental change strategies not published in peer-reviewed scientific journals is needed. Scoping reviews synthesize peer-reviewed publications, grey literature, and graduate theses and dissertations focused on environmental interventions, research, and surveillance that advance our understanding of health promotion strategies in rural areas.

Research is also needed that compiles and describes existing tools being used to measure PA, HE, and breastfeeding environments in rural areas, to inform evaluation efforts for environmental change strategies. Existing literature describing environmental approaches to improve PA, HE, and breastfeeding includes objective and subjective measures (Arriola et al., 2017; Bowen et al., 2015; Holston, 2020). While objectively and subjectively assessed data are helpful to describe settings and inform decisions, there are inherent differences between these two methods that should be considered. An objective measurement of the environment is defined as a quantifiable and impartial assessment of natural or built surroundings (e.g., park audit tools, locations of local food outlets, lactation room accessibility) and is typically based on empirical data, observations and standardized criteria (Peters et al., 2020; Orstad et al., 2017). This is opposed to subjective measurement of the environment, which communicates perceptions of the environment and can include ratings of the quality of an area or environmental features (Jahedi & Méndez, 2014; Lin & Moudon, 2010). Objective measures are often used to assess environmental resources since most are publicly available (e.g., government data, Geographic Information Systems), can be collected by research staff (e.g., environmental scans/audits), and require a lower participant burden compared to subjective measures (e.g., surveying residents on neighborhood conditions) (Gustafson, Sharkey et al., 2011). Although the number of objective tools to assess

environments has greatly increased in recent years, most were developed for urban settings and are not adequately employed among practitioners to inform rural community initiatives (Charreire et al., 2014; O'Halloran et al., 2020; Brownson et al., 2009; Lane et al., 2020; Pontin et al., 2022; Simon & Fielding, 2009; Institute of Medicine, 2012). A review of objective measures of rural environments is crucial for assessing the state of rural environments, identifying trends, evaluating the effectiveness of environmental policies and regulations, and informing decision-making processes.

Novel approaches to improving or examining PA, HE, and breastfeeding environments in rural U.S. areas have been published in recent years. Still, limited research has reviewed this rural-specific literature to understand which strategies have been most widely used and which are effective. Since objectively-measured environmental supports are often used due to data availability and low participant burden, a synthesis of objectively-measured environmental change approaches that influence PA, HE, and breastfeeding behaviors would significantly contribute to existing literature. There are currently no *scoping* reviews on PA, HE, and breastfeeding supports in rural areas to determine the coverage, volume, and focus of literature on rural environments impacting these modifiable risk factors (Munn et al., 2018). Given these considerations, this scoping review aimed to identify objectively-measured environmental features that impact PA, HE, and/or breastfeeding practices among rural communities in the U.S. A secondary aim was to assess objective measurement approaches used to assess rural environments and resource access.

Methods

Study Design

A scoping review was conducted in 2020 as part of a large project to identify policy, systems, and environmental features or changes related to for PA, HE, and breastfeeding promotion among rural people and places in the U.S. to inform public health surveillance strategies, described in a previously published manuscipt (Umstattd, Houghtaling, et al., 2024). To summarize here, this project was contracted by the Division of Nutrition, PA, and Obesity Centers for Disease Control and Prevention (CDC). Both the 2018 Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR), and guidance published by Arksey & O'Malley (2005), were used to inform the review strategy and reporting (Tricco et al., 2018). A review protocol for this large effort was pre-registered using Open Science Framework (OSF; DOI:10.17605/OSF.IO/VXMDC) and the associated PRISMA diagram has been previously published.

Search Strategy

Our search strategy has been previously published, and is summarized briefly here. A scientific research librarian (RLM) helped construct the search strategy for this scoping review. Peer-reviewed scientific literature, grey literature, and thesis and dissertation research were all of interest. Searches occurred between February and July 2020. Trained graduate research assistants identified and reviewed sources for relevant information.

Peer-reviewed and thesis research was identified using the following databases: Medline via the EBSCOhost interface, PubMed, Web of Science, Agricola via the EBSCOhost interface, and ProQuest Dissertations & Theses (PQDT) Global. Between March and June of 2020, translated keyword searches were applied to databases by one researcher, with terms focused on topic area (e.g., breastfeed*, diet*, "physical activ*"), geography (e.g., rural*, "United States"), and setting (e.g., policy, environment*) (Meyer et al., 2020).

The year 2000 was used as a search restriction for peer-reviewed research to ensure up-to-date and relevant environmental PA, HE, and breastfeeding features were identified. ProQuest searches were limited by topic area: search restrictions for HE and PA included only dissertation research and the year 2018 and, for breastfeeding, only the year 2015 was used due to fewer retrieved results compared to the other topic areas. Thesis and dissertation results prior to these years were assumed to be published as peer-reviewed research. The complete search strategy is available at DOI:10.17605/OSF.IO/VXMDC (Meyer et al., 2020).

Search results were downloaded to EndNote X9 for title and abstract review. Due to the large scope of the review, full-text reviewing occurred independently among project team members. Trained research team members (HD, SE, CM, RS, KHK) completed abstract review, full text review and extraction, with liberal inclusion of source materials, and then three project leads (BH, KJK, and MRUM) and trained research team members (KHK, MEW) checked eligibility of all extracted full text articles. The flow diagram regarding academic and ProQuest sources reviewed and included in our synthesis among all behaviors and policy, systems, and subjective environmental areas is published elsewhere.

To supplement the systematic search, literature recommendations were solicited from an advisory group, including both original research and related systematic/scoping reviews. Research team members reviewed and determined if advisory group recommendations met inclusion criteria. Grey literature searches spanned Google, Google Scholar, Google government pages (inurl:gov) and public health, federal nutrition assistance program, Cooperative Extension Services (Extension – a nationwide educational network that addresses public needs by providing non-formal higher education, learning activities, and policy, systems, and environmental change supports to farmers, ranchers, communities, youth, and families), and other webpages (see DOI:10.17605/OSF.IO/VXMDC) (Meyer et al., 2020; United States Department of Agriculture, n.d.a.). Search lists were generated for PA, HE, and breastfeeding topic areas with some overlap (e.g., U.S. Department of Agriculture's Special Supplemental Nutrition Assistance Program for Women, Infants, and Children (WIC) for both healthy eating and breastfeeding information).

Graduate research assistants visited webpages, identified grey literature documents, and reviewed sources for relevant information. Using an iterative process, trained research team members (HD, SE, CM, RS) completed a review of all grey literature sources (with liberal inclusion of source materials) and then three project leads (BH, KK, and MRUM) and trained research team members (KK, MEW) checked these standardized Excel 2024 spreadsheets for clarity/completeness and inclusion eligibility.

Inclusion and Exclusion Criteria

All sources were required to meet five criteria for inclusion. Specifically: (1) a focus on at least one of three topic areas (PA, HE, and/or breastfeeding); (2) about policy, systems, or environmental features (rather than individual behaviors); (3) relevant results clearly specific to rural populations or places; (4) population/setting based in the U.S. due to the focus on potential CDC surveillance; and (5) English language publication. Given the number of sources identified, social environment factors were excluded after the search to narrow the review focus, as social factors (e.g., peer support, social marketing) were considered less consistent indicators for potential public health surveillance (Thorpe et al., 2022).

"Environments" were defined as "built or physical environments which are visual/observable, but may include economic, social, normative or message". Only results for "objective" assessments of the environment, including environmental audits or scans, administrative or Census data, Geographic Information Systems data, and other tools that gather consistent and reproducible information on real-world phenomena, were reported for this manuscript. Objective measures are observable, quantifiable, reliable, valid, and reproducible as a result of their standardized procedures and calibrated and validated instruments/tools. Articles that included "subjective" assessments of the environment, with "subjective" being defined as any qualitative interviews (e.g., focus groups, semi-structured interviews) or assessments based on participant perceptions (e.g., survey, ratings), are published elsewhere (Wende, Umstattd, et al., n.d.). Articles including both subjective and objective assessments, or articles using environmental assessment tools with both subjective and objective components, are included in both the objective and subjective focused papers. Settings were identified as rural using standardized definitions of rural (e.g., Rural-Urban Continuum Codes (RUCC) and source authors' descriptions of the study site as "rural." If there was no clear description/classification of rural and a location (town, county) was reported, the "Am I Rural" search tool was used to determine source inclusion (if study location met at least one of the rural categories). Study sites were also characterized, when possible, using a rural-urban typology: African American South; Aging Farmlands; Evangelical Hubs; Graying America; Hispanic Centers; Latter Day Saints Enclaves; Native American Lands; Rural Middle America; and Working Class Country. Some sources met criteria for "rural," although met criteria for an urban/less rural typology, including: Big Cities; College Towns; Exurbs; Middle Suburbs; Military Posts; and Urban Suburbs (Bennett et al., 2019; Chinni & Pinkus, 2019).

Results Synthesis

As previously reported, outcomes were extracted to standardized spreadsheets. Information collected included the study or source design, study objective, setting or sector, population characteristics, behavioral focus, and results specific to rural policy, systems, and environmental features. Definitions for policy, systems, and environmental approaches were sourced from Supplemental Nutrition Assistance Program Education (SNAP-Ed) guidance (United States Department of Agriculture, n.d.b.). An assessment of study quality was not conducted. All outcomes were extracted by one researcher; however, this process was also iterative as sources were revisited if extracted data was found unclear or incomplete.

Results

The studies identified in this review assessed food and breastfeeding environments, PA resources, and health-promoting practices across various settings, emphasizing rural versus urban comparisons. Sample sizes range from as few as 4 to 9,254 units, with an average of about 569, covering diverse settings such as schools, stores, counties, and communities. Most studies employed observational surveys, environmental scans, and geospatial analyses to evaluate access to healthy food and PA opportunities, identifying specific environmental needs in rural communities.

Physical Activity

A total of 36 original research articles and 13 grey literature sources were identified that include objectively-measured environments for PA (Table 1, Table 2, Table 3) (Perry, Saelens, et al., 2011; Atkinson et al., 2010; Baker et al., 2017; Bevans et al., 2010; Bungum et al., 2009; Carlton et al., 2017; Comstock et al., 2016; Dalton et al., 2011; Davis, Cruz, et al., 2014; Demment et al., 2015; Edwards et al., 2013; Fan, Wen, & Kowaleski-Jones, 2015; Findholt, et al., 2011; Hafoka, 2017; Hege et al., 2017; Hill, Chau, et al., 2012; Hill, Waters, et al., 2016; Jilcott Pitts, Keyserling et al., 2017; McGuirt, Jilcott, et al., 2011; Michimi & Wimberly, 2012; Moore et al., 2013; Nelson et al., 2006; Perry, Nagel, et al., 2015; Poulsen, Knapp, et al., 2018; Poulsen, Glass, et al., 2019; Robinson et al., 2014; Scanlin et al., 2014; Thomson et al., 2019a, 2019b; Wallace et al., 2019; Wells & Yang, 2008; Wilson et al., 2004; Yousefian et al., 2010; Robert Wood Johnson Foundation, 2013, 2017; Foundation for Healthy Communities, n.d.; National Physical Activity Society, 2016a, 2016b, 2016c, 2016d, 2016e; Rural Helath Information Hub, n.d.b, 2019; University of Missouri Extension, 2018; Alabama Extension at Auburn University SNAP-Ed, 2018). Objectively-measured settings for PA included streets and sidewalks (n=31), parks and recreational facilities (n=24), schools (n=20), trails and greenways (n=14), natural environment (n=3), workplaces (n=2), and churches (n=2).

For rural streets and sidewalks, included sources focused on the presence of walkability

infrastructure/characteristics, street/sidewalk connectivity, sidewalk quality/condition, population density, destination/land use diversity, signage, green space, hazards, safety features, bike lanes, crosswalks, sidewalk buffers/shoulders, lighting, route connections, access to sidewalks, wider sidewalks, and narrower roads.

For rural parks and recreational facilities, sources focused on park additions, park/recreational facility renovations, park/recreational facility proximity, number of recreational resources, quality, installing bike racks, and developing age-appropriate facilities (e.g., adult exercise stations).

For school settings, sources focused on access to PA facilities (e.g., walking/running tracks, sports), recreational programming, access to PA equipment, walkability resources, and prioritization of physical education and recess.

For rural trails and greenways, sources focused on implementing trails within parks, integrating trails and nature, multiple and well-spaced trailheads, wider trails, using trails to increase connectivity, grade, safety, convenient access, parking, scenic beauty, degree of difficulty, signage (e.g., StoryWalk features), and extending trail systems.

Additional rural settings where environmental changes were studied included natural environments, workplaces, and churches. For rural natural environments, sources focused on the importance of creating recreational opportunities in areas with natural amenities. For rural workplaces, sources focused on connecting worksites to other destinations via trails or walkable routes, and creating exercise space at the workplace. For rural churches, sources focused on the installation of a community garden, and access to PA resources within the church.

Objective tools or methods were used in peer-reviewed research to capture environmental features related to PA in rural U.S. communities (Supplemental Table 4). The types of tools used to assess environmental features related to PA included environmental audits or scans (e.g., windshield tours, Rural Active Living Assessment (RALA)), administrative data (e.g., U.S. Census data), ArcGIS and Environmental System Research Institute (ESRI) data, and Walk Score® (Griffin et al., 2011; Shores, Moore, & Yin. 2010).

Healthy Eating

A total of 75 original research articles and nine grey literature sources were identified that included objectively-measured environments for HE (Supplemental Table 1, Supplemental Table 2, Supplemental Table 3) (Adachi-Mejia et al., 2013; Ahern et al., 2011; Ahmed & Byker, 2017; Amerson et al., 2014; Anderson et al., 2015; Askelson, Brady, et al., 2019; Bardenhagen et al., 2017; Barnes, Freedman, et al, 2016; Bontrager et al., 2014; Bower et al., 2014; Bustillos et al., 2009; Byker et al., 2015; Creel et al., 2008; D'Angelo et al., 2017; Davis, Spurlock, et al., 2017; David, Jossefides, et al., 2019; Deller et al., 2015; Dunn, Sharkey, & Horel, 2012; Dunn, Kalich, et al., 2015; Escaron et al., 2016; Flamm, 2011; Fretts et al., 2018; Gantner et al., 2011; Gibson, 2011; Graves et al., 2008; Gustafson, Lewis, et al., 2012; Gustafson, Jilcott Pitts, et al., 2017; Hanawa & Procter, 2019; Honeycutt et al., 2012; Hosler, Rajulu, et al., 2008; Hosler, 2009; Hosler Varadarajulu, et al., 2006; Hubley, 2011; Izumi, 2015; Jilcott Pitts, Wu, Demarest, et al., 2015; Jilcott Pitts, Wu, McGuirt, et al., 2018; Jilcott Pitts, Wu, Truesdale, et al., 2018; Jithitikulchai et al., 2012; Katapodis et al., 2019; Ko et al., 2018; Lu et al., 2016; Mann et al., 2015, 2017; Martínez-Donate et al., 2015; Mayo et al., 2013; McCormack, Eicher-Miller, et al., 2019; McCormack, Igoe, & Stahre, 2017; McGuirt, Pitts, et al., 2015; Nanney et al., 2019; Nollen et al., 2009; Novotny et al., 2011; Pereira et al., 2014; Powell et al., 2007; Rigby et al., 2012; Rivera et al., 2018; Ruelle et al., 2011; Rushakoff et al., 2017; Sharkey & Horel, 2008; Sharkey, Johnson, et al., 2011; Sharkey, Horel, & Dean, 2010; Thatcher et al., 2017; Yeager & Gatrell, 2014; Zenk et al., 2015; Blanchard & Lyson, 2006; Holston, Cater, & Broyles, 2020; Rural Health Infomration Hub, n.d.a; United States Deaprtment of Agriculture, 2018, 2019). Settings for HE included food retail (n=65), schools (n=19), food assistance programs (n=7), hospitals or healthcare settings (n=2), community gardens (n=5), churches (n=2), workplaces (n=2), home environment (n=1), and local food producers (n=1) (Thomson, 2020; Michimi & Wimberly, 2010).

For rural food retail settings, included sources focused on access to healthy food outlets (e.g., small grocers, farmers markets), absence of unhealthy food outlets (e.g., fast food, full-service restaurants, convenience stores), fruit and vegetable quality, stocking of heathy foods, healthy food variety, promotional materials or advertisements, fruit and vegetable samples, canned fruits and vegetables, price/affordability, distance or travel time to food retail, stocking of unhealthy foods, and providing pre-prepared healthy food.

For rural school and childcare settings, sources focused on the presence of healthy food options, the presence of sugar-sweetened beverages, rearranging the lunch line or coolers to feature healthier options, promoting or advertising healthier foods (e.g., adapting names of healthy menu items, signage, menu boards, tabletop signs with fruit and vegetable facts), precutting fruit, getting produce from local farmers, school gardens, healthy breakfast, food outlets around the school, reducing or removing sugar-sweetened beverage options, unhealthy snack options, agricultural setting, and food quality.

For food assistance program sources focused on increasing access to nutritional information, increasing access to healthy foods, ensuring healthy food outlets accept Supplemental Nutrition Assistance Program or other food assistance benefits, and distance to food outlets that were authorized to accept program food vouchers.

Additional rural settings where environmental changes were examined included healthcare settings, community gardens, churches, workplaces, and local food producers.

For rural hospital and healthcare settings, sources focused on informational messages or advertisements, and salt products (e.g., packets, shakers). For community gardens, sources focused on creating new community gardens, and growing a variety of fruits and vegetables. For churches, sources focused on providing healthy breakfast, installing a community garden at the church, and increasing the amount of greenhouse/shed space. For workplaces, sources focused on promoting/advertising healthy food options, and offering healthy food in vending machines and cafeterias. For local food producers, sources focused on connecting local farmers with schools.

Objective tools or methods were used in peer-reviewed research to capture environmental features related to HE in rural U.S. communities (Supplemental Table 4). The types of tools used to assess environmental features related to HE included environment audits or scans (e.g., recording content of beverage machines, windshield tours), administrative data, Nutrition Environment Measurement Surveys, ArcGIS and Environmental System Research Institute (ESRI) data, the spectrophotometric Folin-Ciocalteau reagent method to measure fruit and vegetable quality, food production records, vendor data (e.g., farmer's market prices), Food Retail Environment Index (mRFEI), USDA Food Environment Atlas, and ground truthing methods.

Breastfeeding

A total of seven original research articles and four grey literature sources were identified that included objectively-measured environments for breastfeeding (Supplemental Table 1, Supplemental Table 2, Supplemental Table 3) (Blair et al., 2020; Ray et al., 2019; Uscher-Pines et al., 2020; Anderson, n.d.; National Association of County and City Health Officials, n.d.; Oswego County Opportunities, Inc., 2019; S2ay Rural Health Network, n.d.). Objectively-measured settings for breastfeeding included hospitals or healthcare settings (n=8), workplaces (n=3), food retail settings (n=2), and county fairs (n=1).

For hospitals or healthcare settings, sources focused on access to certified lactation counselors/consultants, support groups (e.g., mother to mother), training for lactation counselors, and access to telehealth options for breastfeeding ("telelactation"). For workplaces, sources focused on the presence of a lactation room, and establishment of "Baby Cafes". Within food retail settings, the price and access to infant feeding resources in rural areas was measured.

Objective tools or methods were used in peer-reviewed research to capture environmental features related to breastfeeding in rural U.S. communities (Supplemental Table 4). The types of tools used to assess environmental features related to breastfeeding included administrative data, the Infant Feeding Resource Tool, and National Immunization Survey and the Infant Feeding Practices Survey.

Discussion

This scoping review outlines the existing body research and findings on objectively-measured environmental features or change strategies studied in relation to PA, HE, and/or breastfeeding in rural communities across the U.S. Overall, our results show that sources focused on PA environments mostly included street and sidewalk, park and recreational facility, and school settings, and were most commonly measured using environmental audits or scans and administrative data. Sources focused on HE environments often looked at food retail and school settings, and similar to PA environment measurement, most commonly measured environmental features using environmental audits or scans and administrative data. Sources focused on breastfeeding environments often occurred in healthcare, workplace, and food retail settings, and most commonly measured environments using administrative data. Overall, there was a wide range of environmental strategies or features that can be used to promote PA, HE, and breastfeeding in rural communities, reflecting a growing focus on research that informs policy, systems, and environmental change strategies in rural communities. Environmental audits and publicly available administrative data are increasingly being used to track environmental conditions, but there was a profound lack of standardization when measuring common environmental elements for each behavior, as is documented in our compiled list of environmental assessment tools (see Supplemental Table 4).

Rural PA environments have been studied extensively in recent years, and local rural communities demonstrate a commitment to evaluating current or changing environmental conditions that may promote health. According to our results, measuring or assessing the walkability of neighborhood environments and improving environments to be more pedestrian-friendly has been a priority for rural communities in recent years. There is a growing need for pedestrian-friendly environments in rural areas, given the increasing percentage of older adults residing in rural areas who engage mostly in outdoor walking for PA (Glasgow & Berry, 2013; Smith & Trevelyan, 2018). In addition, research shows that over 67% of rural residents walk in their neighborhoods, and have expressed a desire for additional neighborhood supports for walking (e.g., sidewalks, road buffers, lighting) (Fitzhugh et al., 2023; Whitfield et al., 2019; Doescher et al., 2014; Guarino et al., 2013). For parks and recreational facilities, our research shows that adding or improving parks and recreational facilities has been a priority in rural areas. Similarly, our research outlines the importance of trails and greenways that connect destinations and have appropriate amenities.

As many rural locations experience population growth as a result of the COVID-19 pandemic, these resources are increasingly acknowledged as important and address a growing concern that rural communities have reduced access to PA opportunities (Carson et al., 2023; Johnson, 2023, Veitch et al., 2013; Wende, Stowe, Hallum et al., 2021). There was also consideration for the accessibility of PA environments, specifically focusing on making sure these resources are useful for all ages, while

acknowledging the diversity of rural populations according to age, ability, gender, race, ethnicity, and income status (Bopp, 2018). Results show that improving PA facilities and equipment at schools and ensuring there is PA programming (e.g., physical education) and access to school facilities after school hours were all important school strategies. These environmental changes also need to be coupled with systems changes, such as joint use agreements and Safe Routes to School programs, to ensure PA opportunities are truly accessible in rural communities (Safe Routes Partnership, 2015; Lafleur et al., 2013; Lanza et al., 2021; Maddock et al., 2008; The Guide to Communtity Preventive Servicces, 2021).

HE environmental research identified in our search included both well-studied environmental interventions or features and research areas or intervention opportunities needing further exploration. Food retail was a commonly included HE environmental change setting, with most studies focused on measuring and/or addressing inequities in access to healthy food outlets (e.g., grocery stores, superstores) or fruits and vegetables within food retail outlets. There was limited research on promoting local food producers, of which most focused on connecting schools with local farmers for food supply. Environmental impacts of food sovereignty, or local control of food systems, small-scale farming over large agribusiness, sustainable agricultural practices, cultural appropriateness of food practices, equity, and justice, was an understudied strategy for increasing access to healthy foods (Condra, 2012). Food sovereignty or local food production practices are in alignment with the overall goals of improving access to healthy food among rural residents, who are often negatively affected by extractive practices that denigrate rural environments and their resources (Borras & Mohammad, 2020; Jernigan, Nguyen, et al., 2023). This is especially true for Native Nations and Indigenous communities residing in rural areas (Jernigan, Williams, et al., 2018; Jernigan, Salvatore, et al., 2012; Jernigan, Demientieffm & Maunakea, 2023; Maudrie et al., 2021).

Beyond connecting schools with local food producers, HE environmental changes outlined in our study focused on assessing healthy food options in schools, introducing promotional materials for healthy foods, decreasing access to unhealthy foods and drinks, and addressing unhealthy food environments around schools. Our results reinforce existing knowledge that schools provide consistent access to healthy foods, especially for children from disadvantaged backgrounds, and also highlight the need for increased investment in underfunded school food environments (Katz et al., 2022; Barnes, McCrabb, et al., 2021). Food assistance programs (e.g., SNAP, WIC) were also important for increasing healthy food access in rural communities and emphasized the importance of local food outlets accepting food vouchers so residents don't have to travel long distances to access these benefits.

Increasing access to hospital and healthcare settings was the most common rural breastfeeding environmental approach reported in this review. This included staffing trained lactation professionals on-site to provide consultation, creating support groups, and providing telehealth options. While workplaces employed similar changes, they also implemented physical spaces for breastfeeding (e.g., lactation rooms, Baby Cafes). Given that hospital and healthcare access is much lower in rural areas, it is important to acknowledge the importance of these settings for rural breastfeeding promotion (Cyr et al., 2019; Walsh et al., 2023). It is recommended that hospitals provide breastfeeding support across the perinatal period, so efforts should be made to consider rural-specific barriers to providing this type of health care. It should also be noted that accessibility to infant feeding resources could also be a factor in rural infant feeding decisions, although deserves more exploration.

Implications for Research and Practice

This scoping review identified various objective tools to measure PA, HE, and breastfeeding environmental features. There was also diversity in rural classification systems used to determine the rurality of study sites if a rural classification system or criteria was even noted (as opposed to just identifying sites as "rural" without justification). There is a strong need for standardization in measuring environmental health promotion resources and rural classification methods to allow for better comparisons across published findings and provide better opportunities for meta-analysis. Future researchers and practitioners need to consider how labor-intensive objectively-measured environmental audits are to inform interventions and evaluation, especially considering how vast the rural landscape is (making up over 95% of land area in the U.S.) and the potential exposure of auditors to safety hazards (United States Census Bureau, 2016b; Conressional Research Service, 2018; Adams et al., 2022). This could explain a trend in our results, where most assessments of rural pedestrian environment features occurred on smaller scales (i.e., were not generalizable). Researchers and practitioners should explore ways to scale up objective assessments of the environment using innovative new tools, for example, machine learning methodologies (i.e., computer vision combined with deep learning) to audit images of rural contexts or streetscapes (e.g., Google Street View) with greater speed, reliability, validity, and objectivity. This is especially important since existing machine learning algorithms were created using data from more urban settings which introduces bias when they are scaled up across the U.S. and applied in rural contexts (Koo et al., 2022). Finally, several behavioral settings were identified in our results that showed potential for environmental changes but had a limited body of research and, therefore, were not reflected in public health practice. Specifically, for PA environments, natural spaces, workplaces, and churches are understudied behavior or environmental change settings. For HE environments, healthcare settings, community gardens, churches, workplaces, and local food producers are understudied behavior or environmental change settings. Overall, there was a limited body of research or practice-based evidence on environmental change approaches for breastfeeding, suggesting that additional research is needed across all settings.

Limitations & Strengths

This study has some limitations. First, given the substantial number of articles on policy, systems, and environmental change approaches to enhance PA, HE, and breastfeeding, this review was divided into multiple papers for publication, each focusing separately on policies, systems, and subjectively and objectively assessed environments. We acknowledge that policy, systems, and environmental change approaches are often intersecting and overlapping, and additional research is needed to better understand these complex dynamics. Second, we did not perform reliability checks during the article selection or results synthesis, nor did we provide confidence or bias ratings for the selected articles in this scoping review. Although the project's scope restricted our ability to report these metrics, we adhered to a rigorous protocol and held regular meetings to ensure our inclusion/exclusion criteria and results synthesis process were well-defined. Last, our study reviewed the objective measurement methods to assess environmental changes for PA, HE, and breastfeeding in rural contexts and revealed a lack of standardized measurement techniques across studies. While this limited our ability to make direct comparisons across published work, it was an important finding of this scoping review and can help guide future research and evaluation of policy, systems, and environmental approaches in rural areas.

This review also has notable strengths. First, this study identified a wide variety of objective measurement tools and recorded the number of existing sources which used these tools. Compiling the objective tools being used in rural contexts is useful as it will serve as a resource for future research, implementation, and evaluationin within rural communities. Second, this scoping review used rigorous methods: the inclusion of a scientific librarian as a review partner, strict training protocols, and multiple reviewers for articles. Finally, this scoping review incorporated grey literature and graduate theses on rural-specific environmental change approaches related to PA, HE, and breastfeeding. Although there were very limited findings from graduate research, this study builds on existing systematic reviews focusing on peer-reviewed original research to include a wider variety of sources.

Conclusions

This scoping review underscores the need for improved and standardized measurement techniques for evaluating environmental changes to promote PA, HE, and breastfeeding in rural U.S. communities. Future research should focus on developing reliable and scalable methods for objectively assessing environmental changes across diverse rural communities. Additionally, researchers should investigate rural-focused environmental features or changes that increase the autonomy of rural communities and address persistent health disparities. As part of this, expanding research on understudied settings, such as natural spaces, workplaces, churches, community gardens, and local food producers, will provide a more comprehensive understanding of effective health promotion strategies in rural areas. These future efforts should be used to help inform robust opportunities for rural public health surviellence pertaining to environmental support for PA, HE, and breastfeeding.

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Conflicts of Interest

We have no conflicts of interest to disclose.

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Author Contributions

MEW synthesized review articles, drafted the manuscript, and edited, finalized, and approved the submitted manuscript. MRUM contributed to the conceptualization and design of the study methodology, interpreted study findings, drafted results, and edited, finalized, and approved the submitted manuscript. BH contributed to the conceptualization and design of the study methodology, interpreted study findings, drafted results, and edited, finalized, and approved the submitted manuscript. RLM contributed to the design of the study methodology, acquisition of data, and reviewed and approved the submitted manuscript. KJK contributed to the conceptualization and design of the study methodology, interpreted study findings, drafted results, and reviewed and approved the submitted manuscript.

Ethics Approval and Consent to Participate

Not applicable in this study. This review has been registered in the Open Science Framework Registration DOI:10.17605/OSF.IO/VXMDC.[97]

Availability of Data and Materials

The complete search strategy and all data generated or analyzed from articles meeting inclusion criteria for this study as it pertains to this manuscript, are included in this published article and its supplementary information files.

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