Designing Geospatial Tools to Address Maternal and Infant Health Disparities: Analyzing Low Birth Weight Patterns

Katja Crusius(✉), Maria Assumpta-Komugabe, Paniz Herrera, and Samir Chatterjee

Claremont Graduate University, Claremont, CA 91711, USA
katja.crusius@cgu.edu

Abstract. This study explores the use of geospatial analysis to address regional disparities in low birth weight (LBW) rates across California. By creating a spatial visualization tool, the research aims to highlight the socioeconomic and environmental factors influencing LBW such as income, healthcare access and education. The tool will provide policymakers and healthcare providers with actionable insights to inform targeted interventions and is evaluated by subject matter experts in public health to determine its usability and effectiveness. The research seeks to improve maternal and infant health outcomes by promoting data-driven, region-specific interventions.

Keywords: Maternal health · Infant health · Visualization · Design · Geo-spatial

1 Introduction

Low birth weight (LBW), defined as a birth weight of less than 5.5 pounds (2500 g), is a significant public health concern in California and all the United States. Infants born with LBW face a higher risk of neonatal mortality, developmental challenges, and long-term health issues such as respiratory problems, cognitive impairments, and chronic diseases like diabetes and heart conditions. LBW also contributes to nearly 30% of newborn healthcare costs, placing an economic burden that exceeds $13.4 billion annually [1]. Despite advances in maternal and neonatal healthcare, the rates of LBW have not seen a significant decline in recent years, raising concerns about the effectiveness of existing public health interventions.

Thorsen et al. explore how U.S. Community Health Centers' (CHCs) operational efficiency, patient demographics, and regional context affect access to early prenatal care and LBW rates. The study finds that rural CHCs serving predominantly White populations provide better access to prenatal care and report lower LBW rates, while urban CHCs serving poor racial minorities in affluent areas face higher LBW rates and reduced access to care. The research highlights that racial and regional inequalities, particularly for Black and Hispanic patients, have a greater impact on birth outcomes than CHC efficiency alone [10]. This shows that LBW is disproportionately prevalent

S. Chatterjee et al. (Eds.): DESRIST 2025, LNCS 15703, pp. 137–150, 2025.
https://doi.org/10.1007/978-3-031-93976-1_9

in certain regions, influenced by a combination of socioeconomic, environmental, and healthcare access factors. Areas with lower income, limited access to quality healthcare, and higher pollution levels tend to experience higher rates of LBW.

Addressing these regional disparities requires targeted, location-specific interventions rather than broad national strategies. However, many existing approaches lack the integration of geospatial analysis and technology-driven solutions that can identify high-risk areas and tailor interventions. This research seeks to bridge that gap by utilizing geospatial analytics and socioeconomic data to develop a targeted approach specific to certain areas to improve awareness and education in affected communities.

LBW remains a critical public health issue in the U.S., disproportionately affecting certain regions and socioeconomic groups. Despite the availability of diverse datasets covering health records and different socio-economic indicators, current policy interventions often fail to incorporate geospatial analysis that accounts for location-specific factors. Many interventions remain general, without addressing the unique needs of different communities. This gap underscores the importance of a targeted, data-driven approach for regional disparities in LBW, one that utilizes geospatial tools to reveal complex relationships between geographic and socioeconomic factors. Identifying these disparities through geospatial analysis is essential to targeting interventions and reducing health risks for newborns. This research project addresses the absence of a comprehensive spatial data visualization tool that can link regional factors with LBW outcomes, informing data-driven regionally tailored interventions by policy makers. The research questions are as follows:

1. How can geospatial analysis reveal regional disparities in LBW rates across California, and what specific socioeconomic factors (like income, healthcare access, and education) are linked to these disparities?
2. How effective is the spatial data visualization tool in supporting policymakers and healthcare providers in identifying LBW disparities and informing region-specific interventions to improve maternal and infant health outcomes?

The significance of this research lies in its potential to transform how public health data is analyzed and applied in real-world contexts. By moving beyond traditional statistical methods and embracing geospatial technologies, this study provides a multidimensional perspective on health disparities. This approach not only enhances the precision of data interpretation but also empowers stakeholders to implement interventions with greater efficacy and accountability. Furthermore, the integration of geospatial analysis into public health practice fosters a culture of evidence-based policymaking, where decisions are informed by comprehensive, location-specific insights.

Additionally, the adaptability of the developed tool allows for its application beyond LBW analysis. It can serve as a model for addressing other public health challenges, such as tracking the spread of infectious diseases, analyzing vaccination coverage, or assessing environmental health risks. By demonstrating the versatility and utility of geospatial tools in public health, this research contributes to a broader understanding of how technological innovations can drive systemic improvements in health outcomes.

Ultimately, the goal of this research is not only to address current LBW disparities but also to establish a foundation for future studies that leverage geospatial data to tackle complex health issues. This aligns with the broader objectives of public health to reduce

health inequities, promote social justice, and enhance the well-being of populations through data-driven, contextually relevant strategies.

2 Background and Literature Review

Multiple studies emphasize socioeconomic and maternal health factors as primary determinants of LBW. Maternal education is consistently associated with birth outcomes, as evidenced by Grady & Enander, who found an inverse correlation between maternal education and LBW in Michigan [6]. Similarly, maternal age is a key risk factor, with adolescent mothers (<20 years) and older mothers (>34 years) exhibiting higher LBW prevalence [9]. Racial disparities are also well-documented, particularly among African American women, who face significantly higher LBW rates compared to white women [4].

Additionally, prenatal care access plays a crucial role in mitigating LBW risk. Burns et al. found that inadequate prenatal care, measured by the Kotelchuck Index, was strongly associated with LBW, particularly in low-income and racially segregated areas. Maternal obesity, smoking, and poverty were also identified as significant contributors to LBW, highlighting the interplay between individual health behaviors and broader social determinants [4].

Geographic disparities in LBW rates have been a focal point of recent research. In Michigan, high LBW rates were concentrated in metropolitan areas such as Detroit, Flint, and Kalamazoo, reflecting racial and economic segregation [6]. Similarly, in Ghana, spatial hotspot analysis revealed higher LBW prevalence in rural northern and middle zones compared to urban coastal areas, suggesting critical healthcare access disparities [3]. In São Paulo, LBW infant mortality rates were paradoxically highest in developed municipalities, indicating that economic growth alone does not translate to improved maternal and child health outcomes [3].

A crucial gap identified in multiple studies is the mismatch between healthcare resource allocation and LBW risk areas. One study found a significant lack of prenatal care facilities within LBW clusters in Florida, despite overwhelming evidence supporting prenatal interventions [4]. Similarly, in Ghana, rural regions with the highest LBW rates had the poorest healthcare infrastructure, emphasizing the need for region-specific health system improvements [3].

3 Methodology

The problem was approached by utilizing the three-cycle view of design science research as outlined by Hevner [8]. The environment, which includes the application domain, people, organizational systems, technical systems, and the associated problems and opportunities, is connected to design science through the relevance cycle. This cycle encompasses requirements and field testing, ensuring that the solution artifact remains practically relevant and usable. Design science involves the development of design artifacts and processes, followed by their evaluation, which occurs in the design cycle. The rigor cycle connects to the knowledge base, grounding the research in existing knowledge and contributing to it. The knowledge base forms the foundation of research,

including scientific theories, methods, experience, expertise, and meta-artifacts such as design products and processes.

When identifying persistent problems in the context of LBW, both the environment and knowledge base were considered. A thorough review of the literature revealed previous findings and existing gaps, which opened a space for this project. Insights were also gained about the environment where LBW policy decisions are made, identifying the tool's target population and the necessary technologies and features to create the most effective artifact. The relevance cycle was applied to determine the artifact's requirements, such as providing actionable insights into the persistence of LBW across different counties in California. An important requirement was the user-friendliness of the tool, ensuring that anyone in public health, regardless of prior geospatial tool experience, could use it. The rigor cycle ensured that the research was grounded in literature, contributing to the knowledge base, which will be discussed later. The design cycle involved an iterative process of building and evaluating the tool, beginning with a first version, followed by feedback collection through formative evaluation. Adjustments were made, and a second version was developed based on this feedback, addressing user concerns and suggestions.

The DSR Knowledge Contribution Framework [7] was also considered during the solution's development, with the aim of evaluating the research's contribution through this framework. In this context, DSR research is classified into invention, improvement, exaptation, and routine design, as explained further in the evaluation.

The solution was centered around creating a visual tool that layers various regional factors influencing LBW in California. The primary artifact involved developing a comprehensive spatial data visualization platform, which included multiple types of maps and graphical representations. The GIS tool ArcGIS Pro by Esri was used to create bivariate maps.

This artifact consisted of the following key outputs: (1) Immediate Intervention Maps and (2) LBW Ratio Maps which are both illustrated below with an example from the tool. By leveraging spatial data visualization, the tool aims to communicate data effectively and facilitate targeted interventions that can significantly improve maternal and infant health outcomes in California (Fig. 1).

1. **Immediate Intervention Map**: These maps show areas with the highest needs for intervention regarding alcohol use and smoking providing policymakers with clear guidance on where to focus their efforts in preventing LBW (Fig. 2).

2. **LBW Ratio Maps**: These maps illustrate the ratio of the percentage of Black women experiencing LBW to the percentage of White women, as well as the ratio of Hispanic and Black women to White women. These maps help highlight racial and ethnic disparities in LBW rates, fostering a deeper understanding of the socio-demographic factors at play.

The DSR Kernel Theory utilized in this project is the Theory of Cognitive Fit [11]. It suggests that decision-making and problem-solving effectiveness improve when the representation of information aligns with the cognitive processes required for a given task. In this context, policymakers, healthcare providers, and community stakeholders

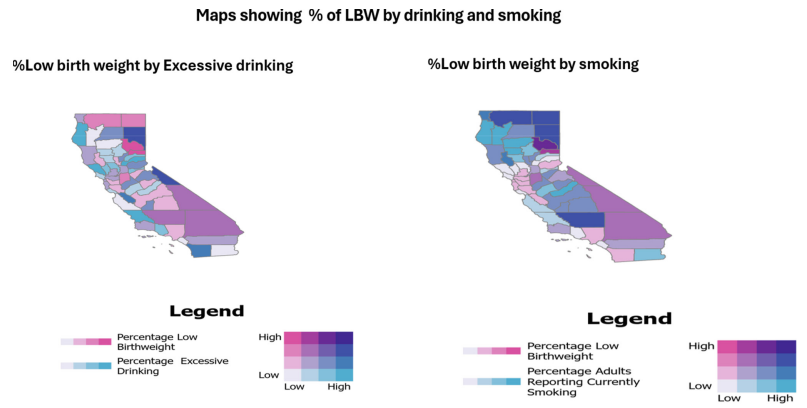

Fig. 1. Example of immediate intervention maps

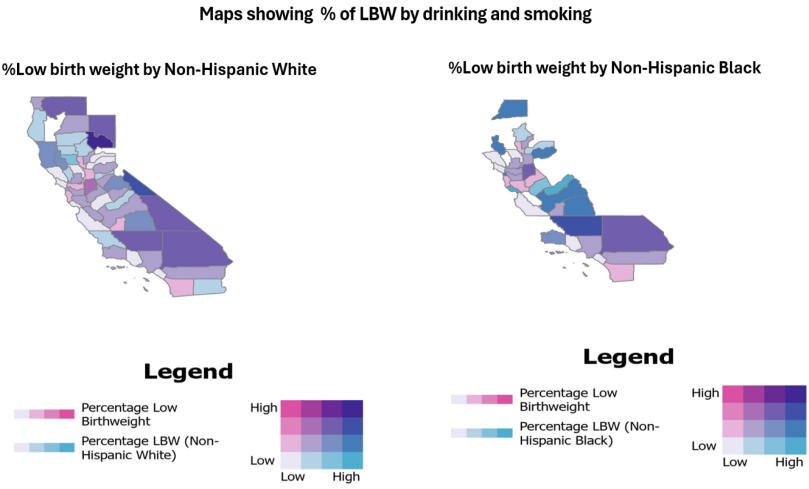

Fig. 2. Example of a LBW ratio map

need to interpret maternal health data to make informed decisions. The tool leverages geospatial analysis and visualization techniques to present risk factors in a format that enhances cognitive fit. By aligning the data representation with user needs, the tool aims to improve the accuracy and efficiency of LBW interventions.

4 Artifact Design and Build

Substance use during pregnancy has been a persistent public health issue for decades, yet many expectant mothers continue to expose their unborn children to harmful substances. Alcohol, tobacco, and illicit drugs significantly increase the risk of LBW due to their adverse effects on fetal development. Heavy alcohol consumption is linked to fetal alcohol syndrome (FAS), occurring in 1–3 per 1000 live births, with severe consequences

such as growth retardation and neurological impairments [5]. Women consuming three to five drinks per day have a twofold increased risk of delivering a LBW infant, while those drinking six or more drinks daily face an almost threefold risk. Tobacco use (20–25% of pregnant women) leads to intrauterine growth restriction (IUGR) and preterm birth, while illicit drugs like cocaine (2.3–3.4%) and heroin (2–4%) are associated with placental abruption, preterm labor, and stillbirth. Marijuana use (3–12%) has inconclusive effects, but some studies suggest an increased risk of preterm labor and LBW. Despite these well-known risks, 14% of pregnant women engage in multiple high-risk behaviors, such as combining smoking, drinking, and drug use [5].

Efforts to prevent LBW face systemic, psychosocial, biological, and knowledge-based barriers. Poverty, lack of healthcare access, and misinformation make it difficult for women to adopt healthier behaviors, with 50% of pregnant women abstaining from alcohol, tobacco, and drugs, while 2.5% engage in all three. Psychosocial factors, including stress, domestic violence (8–17%), and lack of family support, further discourage positive change. Substance dependence, affecting 105,000 (2.6%) pregnant women using cocaine, also plays a role, as does misinformation, with 40–60% of women consuming alcohol underestimating its risks. Healthcare barriers, such as negative provider attitudes and language difficulties, make it harder for women to seek help. Addressing these challenges requires comprehensive social, medical, and policy interventions to ensure accessible healthcare, education, and strong support systems for pregnant women [5].

The dashboard was designed to assist policymakers in identifying counties facing significant challenges related to maternal health, substance abuse, and LBW, enabling the implementation of targeted interventions and support programs. Addressing these challenges necessitates comprehensive social, medical, and policy interventions to ensure accessible healthcare, education, and robust support systems for pregnant women.

The artifact was developed as a visual tool that layers various regional factors influencing LBW, aiming to equip policymakers with actionable insights for targeted interventions to improve maternal and infant health. Throughout the iterative design process, we gathered user feedback from key stakeholders, including public health officials and healthcare providers, to ensure the tool's user-friendliness and alignment with their needs. This feedback led to the incorporation of several design improvements, such as interactive maps, clearer legends, and the integration of socioeconomic data to enhance user navigation.

The tool stands out by leveraging spatial data visualization to highlight regional disparities in LBW rates across California. It uniquely compares LBW rates with other key socio-economic factors, such as excessive alcohol consumption, smoking, and uninsured adults, displaying these variables alongside LBW data on the same layer. The tool also generates impactful visualizations, including choropleth and bivariate maps, which effectively communicate data-driven insights to policymakers and healthcare providers, facilitating informed decision-making.

In addition to identifying geographic areas with high LBW rates, the tool informed the development of tailored interventions addressing the unique needs of different regions, thereby promoting health equity. By emphasizing the geographic context of health outcomes, the artifact provided actionable insights that contributed to meaningful improvements in maternal and infant health outcomes across the state.

Users are able to navigate the tool by selecting a county from the list on the left in order to see both the maps and the metrics updated to display the information for that particular county. Also, users can enlarge each of the maps and metrics when clicking on the upper right corner to see any of the aspects on the dashboard in more detail.

Based on the tool, public health experts and policy makers can identify location-based factors that are influencing LBW depending on the county in California. Given the identified gap in location-specific interventions, the insights provided by the tool can help develop targeted interventions by offering policymakers a clearer understanding of which factors influence LBW in specific locations (Fig 3).

Link to the Geospatial Tool

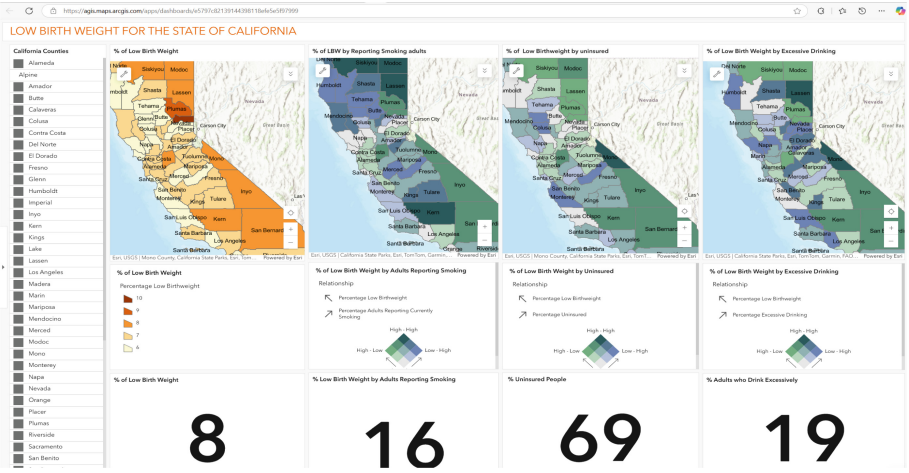

Fig. 3. Screen capture of the geospatial tool

5 Evaluation

To evaluate the first version of the artifact, pilot study in form of a survey testing the usability and efficiency of the tool was conducted. It includes questions on clarity and comprehension, ease of use, relevance to policy planning, and effectiveness of communication in the form in a multiple-choice format, with participants rating these aspects on a Likert Scale. Additionally, there are three open-ended questions about usability, suggestions for improvement, and insights for policy evaluation. Lastly, two questions on the respondents' professional background as well as their familiarity with similar tools are included.

This survey focuses on public health experts and policymakers with experience in maternal and infant health, health disparities, or geospatial data analysis. The conclusions are intended to apply to professionals working in public health, healthcare planning, and policy development, particularly those addressing issues related to LBW disparities.

This includes public health officials, healthcare providers, academic researchers, and community advocates who utilize data-driven insights to inform interventions and allocate resources effectively. The findings aim to support decision-making processes that promote health equity and improve maternal and infant health outcomes across diverse regions.

The recruitment process involved reaching out to 30 public health experts, including professionals and academic researchers with relevant expertise in maternal and infant health, health disparities, or geospatial data analysis. Participants were recruited via email. Recruitment emails will contain a brief description of the project, eligibility requirements, and a link to the tool and the survey. The survey and all accompanying materials were submitted to the Institutional Review Board (IRB #4920) and it was found that a review was not required.

A survey with a larger participant pool will be conducted in the future. The survey questions will be further refined, drawing on existing surveys from the literature. While the initial survey was brief to gather preliminary feedback on aspects like usability and efficiency, the second round will provide a more in-depth evaluation of each aspect, contributing comprehensive feedback as part of the summative evaluation.

6 Result and Findings

Of the 30 potential respondents, 8 have completed the survey to date. The respondents represented various professional fields, including public health practice, healthcare, health education and promotion, as well as geospatial analysis and geographic information systems. To maintain anonymity, further demographic details are not provided. However, their diverse backgrounds enabled the evaluation of both the public health aspects of the tool and the specific considerations related to geographic information systems.

In the figures below answers to the questions regarding clarity and comprehension, ease of use, and effectiveness of communication are illustrated (Figs. 4 and 5).

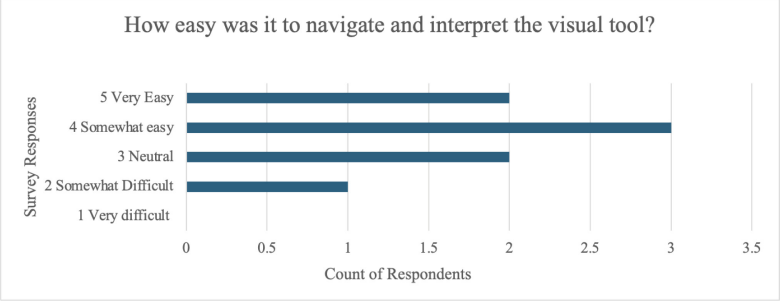

Fig. 4. Clarity and comprehension

6/8 respondents found the visualizations to be at least moderately clear, indicating that the visual representations were effective in conveying regional disparities in LBW.

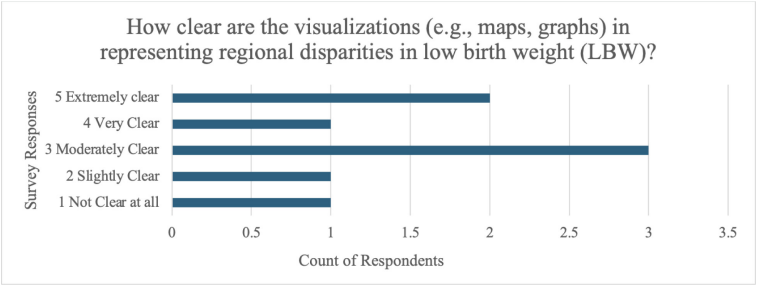

Fig. 5. Ease of use

5/8 respondents found the visual tool to be very easy or somewhat easy to navigate and interpret, suggesting that the interface was user-friendly. 7/8 respondents rated the visuals as at least moderately effective in communicating the impact of socio-economic and environmental factors on LBW. This indicates that the tool successfully conveyed the complex relationships between these factors and LBW (Figs. 6 and 7).

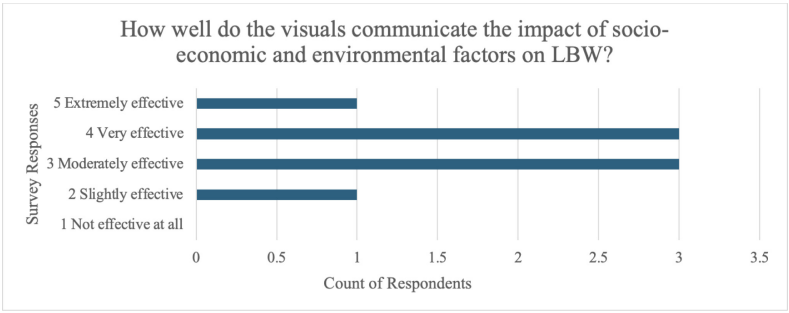

Fig. 6. Effectiveness of communication

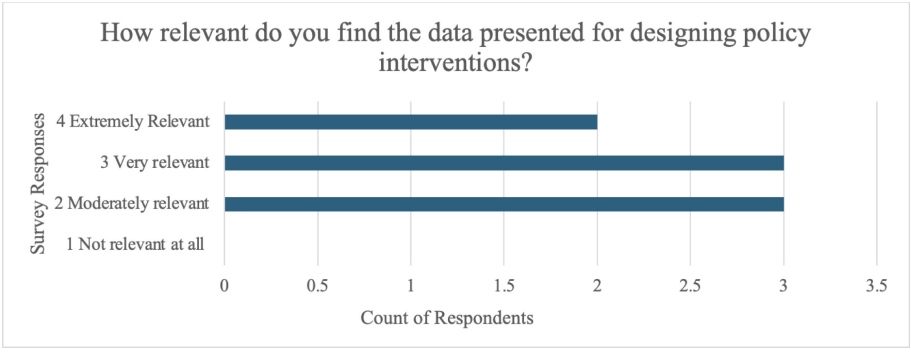

Fig. 7. Relevance for policy planning

Further, the respondents were asked about the perceived relevance of the tool for policymaking. The results can be found in the figure below.

5/8 respondents considered the data presented extremely relevant or very relevant to policy planning, which suggests that the tool is fulfilling its purpose of informing policy interventions.

In addition to these questions, five short-answer questions are part of the survey.

When asked "Which aspects of the visual tool were the most helpful or user-friendly", users pointed out the interactive nature of the map and the ability to zoom into specific regions. Additionally, the inclusion of layered socio-economic data was pointed out as well as the possibility to switch back and forth between counties and visualizing the data on a county level in addition to the data in the state overall. The map legends and indicator numbers being clear and straightforward were mentioned as well.

In response to the prompt, "What changes or additions would you suggest enhancing the tool's clarity, usability, or relevance?", participants recommended several changes. They suggested simplifying the interface, providing a user guide or tutorial, adding a feature to compare regions side-by-side, enabling the download of region-specific data, and incorporating a splash screen.

When asked, "Based on the visualizations, what regional factors do you think should be prioritized for addressing LBW disparities?", respondents identified several key regional factors such as access to prenatal care, socioeconomic factors, environmental factors, and insurance status as key regional factors to prioritize.

To better understand the background of the respondents, we asked, 'What is your area of expertise (e.g., maternal health, geospatial analysis, data analytics, health policy, healthcare)?' Respondents represented a broad spectrum of expertise, including maternal health, geospatial analysis, data analytics, health policy, healthcare, public health practice, public health policy, and GIS development.

To assess respondents' familiarity with geospatial tools, we asked, 'Have you previously used geospatial or data visualization tools in your work? If yes, briefly describe your experience.' The majority of respondents had prior experience with geospatial and data visualization tools, using them for purposes such as analyzing health disparities, assessing environmental factors, and conducting public health research. A few respondents were new to geospatial tools but reported positive experiences.

In addressing the primary research question, the geospatial tool developed highlights the impact of various socio-economic factors on LBW, particularly smoking, lack of insurance, and excessive drinking. The tool clearly demonstrates that in counties with higher percentages of these risk factors, LBW rates are also notably higher. We are working on expanding the tool to incorporate additional factors in future iterations to further explore these relationships.

7 Contribution of the Research

The presented dashboard makes a significant contribution to research by providing an innovative tool for analyzing and visualizing the factors influencing LBW in California. It integrates geospatial visualization techniques with public health data, allowing researchers and policymakers to uncover regional disparities in LBW rates alongside

social and behavioral determinants such as smoking, excessive alcohol consumption, and uninsured populations. This layered approach bridges a gap in existing research by offering a multi-dimensional analysis that highlights correlations between LBW and socio-economic variables, paving the way for more targeted and data-driven public health interventions.

In addition, the artifact contributes to methodological advancements in the field of health informatics and visualization. By employing techniques like choropleth and bivariate mapping, it demonstrates the power of spatial data to communicate health information effectively. The ability to interact with and filter data by counties provides researchers with deeper insights into patterns that might be obscured in traditional datasets or tabular representations. This aligns with current trends in research emphasizing user-centric and interactive tools for knowledge discovery, particularly in health equity and public health planning.

The dashboard serves as a practical instantiation of research concepts in public health visualization. It not only facilitates hypothesis generation by showcasing correlations between variables but also supports translational research by providing actionable insights for stakeholders. Its potential to guide interventions and policies, particularly in underserved or high-risk areas, highlights its value as both a research tool and a decision-support system. As such, this artifact stands as a model for how visualization can enhance understanding, communication, and application of health data in research and practice.

In Design Science Research, the knowledge contribution of research is often measured through the DSR Knowledge Contribution Framework [7]. In this context, DSR research can be classified into the categories of invention, improvement, exaptation, and routine design based on the level of solution maturity and application domain maturity. The model can be found in the figure below.

The prototype research tool developed falls into the Improvement quadrant, as the application domain maturity is high, and the solution maturity is low. The goal of the research was to develop new solutions, in this case the visual tool, for the known problem of LBW. Out tool refines geospatial analytics in public health by integrating visualizations of LBW disparities with socioeconomic and racial factors. As it makes the relationships between variables more actionable for stakeholders, it represents an improvement of existing methods as the field is missing targeted interventions based on those relationships. The incorporation of different features and the incremental development of the tool based on user feedback advances the visualization of dashboards in public health and adds to the knowledge of how such tools can be evaluated and used in real-world settings.

One key attribute enabling the solution is the integration of multi-layered data visualization, which allows users to analyze LBW rates alongside key social determinants of health such as the percentage of LBW cases correlated with smoking adults, uninsured populations, and excessive drinking rates. This attribute fosters a holistic understanding of health disparities, moving beyond isolated metrics to reveal complex interdependencies between behavioral health risks and maternal-infant outcomes. Additionally, the tool's interactivity (enabling dynamic filtering, zooming, and region-to-region comparisons) enhances user engagement and facilitates real-time exploration of health

data. By visualizing these layered relationships, policymakers can identify high-risk areas where these behavioral factors converge, supporting the development of targeted, evidence-based interventions to address LBW disparities effectively.

Since geospatial techniques are popular in other fields such as urban planning or environmental studies, the study could also be seen as exaptation, applying known solutions to new contexts. By developing a geospatial tool for investigating LBW in detail, the tool exemplifies how technology can be re-contextualized to address LBW (Fig. 8).

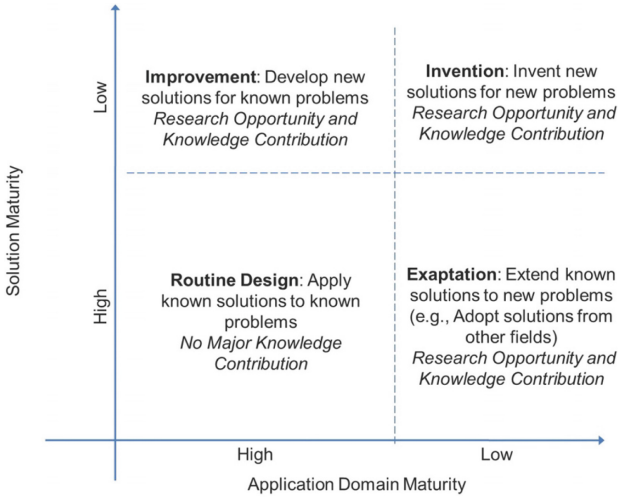

Fig. 8. DSR knowledge contribution framework [7]

8 Conclusion and Future Work

In conclusion, this study highlights the potential of geospatial visualization tools to address LBW disparities in California. The initial development and evaluation of the tool demonstrated its clarity, usability, and relevance in supporting data-driven interventions as evidenced by feedback from public health experts. The tool's ability to integrate spatial analysis with socioeconomic data underscores its value in identifying high-risk areas and informing tailored strategies to improve maternal and infant health.

While the study's findings affirm the tool's potential, they also highlight areas for further refinement to enhance its effectiveness and user experience. Moving forward, additional features such as the integration of real-time data and advanced analytics will be explored to improve the tool's impact.

This research represents an important first step toward leveraging geospatial analytics to address health disparities, but additional work is needed to optimize its functionality and maximize its impact.

In response to the feedback from the survey, several improvements were implemented in the visual tool. Key updates included the addition of guidelines for users

unfamiliar with ArcGIS and the alignment of variables to better match the map legends and indicators. These changes directly addressed concerns about usability and the need for a user guide. Additionally, the clarity of the maps was enhanced, as most respondents identified this as an area for improvement. After incorporating these enhancements, we distributed an updated survey to an expert professor for further feedback on the revised version.

Future work will expand the tool's scope to include additional maternal health outcomes and assess its adaptability across diverse geographic regions. This phase will also gather feedback from a wider user base, incorporating a larger sample size to ensure broader applicability. A second survey will be conducted to evaluate the revised version of the tool, with a larger sample than the pilot survey. While maintaining the same overall objectives, the survey questions will be updated to align with established metrics from the literature, focusing on clarity, ease of use, relevance, and effectiveness. You can access the latest version of the tool here: Low Birth Weight in California .

Acknowledgments. There are no acknowledgements to be made.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. America's Health Rankings: Birthweight. https://www.americashealthrankings.org/explore/measures/birthweight. Accessed 29 March 2025
2. Bloch, J.R.: Using geographical information systems to explore disparities in preterm birth rates among foreign-born and U.S.-born black mothers. J. Obstet. Gynecol. Neonat. Nurs. **40**(5), 544–554 (2011). https://doi.org/10.1111/j.1552-6909.2011.01273.x
3. Boateng, D., Oppong, F.B., Senkyire, E.K., Logo, D.D.: Spatial analysis and factors associated with low birth weight in Ghana using data from the 2017 Ghana maternal health survey: spatial and multilevel analysis. BMJ Open. **14**(8), e083904 (2024). https://doi.org/10.1136/bmjopen-2024-083904
4. Burns, J.J., Livingston, R., Amin, R.: The proximity of spatial clusters of low birth weight and risk factors: defining a neighborhood for focused interventions. Matern. Child Health J. **24**(8), 1065–1072 (2020). https://doi.org/10.1007/s10995-020-02946-y
5. Chomitz, V.R., Cheung, L.W.Y., Lieberman, E.: The role of lifestyle in preventing low birth weight. Futur. Child. **5**(1), 121–138 (1995). https://doi.org/10.2307/1602511
6. Grady, S.C., Enander, H.: Geographic analysis of low birthweight and infant mortality in Michigan using automated zoning methodology. Int. J. Health Geogr. **8**(1), 10 (2009). https://doi.org/10.1186/1476-072X-8-10
7. Gregor, S., Hevner, A.R.: Positioning and presenting design science research for maximum impact. MIS Q. **37**(2), 337–355 (2013)
8. Hevner, A.R.: A three cycle view of design science research. Scand. J. Inf. Syst. **19**(2), 4 (2007)
9. Rodríguez, E.Y.A., Rodríguez, E.C.A., Marins, F.A.S., da Silva, A.F., Nascimento, L.F.C.: Spatial patterns of mortality in low birth weight infants at term and its determinants in the state of São Paulo, Brazil. Rev. Brasil. Epidemiol. **26**, e230034 (2023). https://doi.org/10.1590/1980-549720230034

10. Thorsen, M.L., Thorsen, A., McGarvey, R.: Operational efficiency, patient composition and regional context of U.S. health centers: associations with access to early prenatal care and low birth weight. Soc. Sci. Med. **226**, 143–152 (2019). https://doi.org/10.1016/j.socscimed.2019.02.043
11. Vessey, I.: The theory of cognitive fit: one aspect of a general theory of problem solving? In: Human-Computer Interaction and Management Information Systems: Foundations, pp. 155–197. Routledge (2015)
12. Zhuang, M., Concannon, D., Manley, E.: A framework for evaluating dashboards in healthcare. IEEE Trans. Vis. Comput. Graph. **28**(4), 1715–1731 (2022). https://doi.org/10.1109/TVCG.2022.3147154