



Creating a sense of urgency and provoking action – An example on the use of heat maps to address perinatal health inequalities

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ABSTRACT

Health outcomes of mothers and their (unborn) children in the perinatal period, i.e., during pregnancy and shortly after birth, can vary by geographical location. This is often due to differences in exposure to medical and social risk factors. Policies aimed at reducing inequalities in perinatal health can provide significant long-term health benefits, especially for (unborn) children. However, a lack of insight into regional perinatal health inequalities means that perinatal health is not always a priority in policy formulation. Novel methods should be used to draw attention to these inequalities, spark interdisciplinary debate and encourage collaborative initiatives. In this commentary, we propose that the development of heat maps that visualize perinatal health outcomes, and risk factors for those outcomes, could be a valuable tool in doing this. Heat maps are a data visualization technique that uses color variations to emphasize value differences between areas. Visualizing health inequalities could potentially create a sense of urgency among (local) stakeholders to initiate policies aimed at improving perinatal health. We illustrate the targeted use of heat maps with an example from the city of Rotterdam, the Netherlands. Large perinatal health inequalities between neighborhoods were visualized in heat maps by a team from the Erasmus Medical Center to bring these inequalities to the attention of the municipality of Rotterdam. Local collaborative initiatives were set up to reduce perinatal health inequalities. These local initiatives formed the foundation for later national policies, including proposals to online implement heat maps regarding perinatal health topics, that are still ongoing today.

1. Background

Inequalities in the health of women and their (unborn) children during pregnancy and after birth, i.e., the perinatal period, are evident between and within countries, including those of high income. Adverse (perinatal) health outcomes are more common among women in socially disadvantaged positions (de Graaf et al., 2013). These adverse outcomes can have further long-lasting consequences for their children in terms of health and development. A growing body of evidence shows that adverse perinatal health outcomes, for example having low birth weight or being born prematurely, are associated with suboptimal health during the entire life cycle (Braveman and Barclay, 2009). Furthermore, this unfavorable start in life can affect the development of human capital such as educational attainment, which subsequently influences labor market participation and social engagement (Case et al., 2005).

Within the Netherlands, urban areas deal with higher rates of adverse perinatal health outcomes compared to the national average. Within large cities, inequalities are also seen on neighborhood level.

Deprived neighborhoods, i.e., neighborhoods with disadvantageous social, physical and/or economic characteristics, have a substantial higher prevalence of perinatal mortality and morbidity compared to non-deprived neighborhoods (Denktas, 2012; Waelput, 2017). Although national perinatal mortality and morbidity rates have been declining for more than a decade, relative inequalities between areas continue to exist and are not noticeably decreasing (Bertens, 2020).

Considering that adverse perinatal outcomes cluster in certain (deprived) areas, it is important that local governments collaborate with medical and social care professionals to improve these outcomes. However, local governments are not always aware of existing regional inequalities within their city. Perinatal health is thus not always a political priority in determining public health policies (Makanga, 2016; Patel, 2018; Hoivik, 2021). It is therefore important to introduce new, less frequently used, methods which draw attention to these inequalities, thereby initiating policies focused on their reduction. Heat maps are one way to potentially achieve this. Heat maps are a data visualization technique. By assigning different shades of color to certain

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value criteria, variations in values between areas are emphasized. Developing heat maps that display differences in health outcomes can provide insight into regional inequalities, allowing wise allocation of resources and interventions (Rezaeian, 2007). With this commentary we illustrate how heat maps can be used to draw attention to perinatal health inequalities and help set-up and inform local multidisciplinary collaborations.

2. Geographical clustering of risk factors and adverse outcomes

Regional inequalities in perinatal health can be the result of biological risk factors, for example genetic predisposition for diseases or nutritional deficiencies, as well as (psycho)social risk factors, such as living in poverty. Women living in poverty experience, for example, more stress, have less access to healthy food, and have a higher risk of substance abuse. These women more often live in deprived neighborhoods. Similarly, the neighborhood context affects (perinatal) health through features such as access to education and health services, housing quality, safety and quality of air and water (Kind and Buckingham, 2018). The combination of neighborhood deprivation and risk factors at the individual level enlarges (perinatal) health inequalities between deprived and non-deprived neighborhoods (Kind and Buckingham, 2018; Pickett and Pearl, 2001).

3. Utilization of heat maps in (public) health care

The use of heat maps can help to create more insight into geographical differences in (perinatal) health outcomes between and within municipalities. A combination of socio-economic, geographical and biological factors that affect the health of a population can be visualized and help explain variation in health outcomes (Makanga, 2016; Najafabadi, 2009). Using heat maps in the (public) health domain has a long history (Fletcher-Lartey and Caprarelli, 2016). It originally started with mapping the spread of infectious diseases, but is nowadays increasingly used to map the distribution of varying health outcomes or the accessibility to health care services. A scoping review by Makanga et al (Makanga, 2016) on the use of geographically informed data in maternal health research revealed that heat maps are mostly used to evaluate interventions, such as optimization of maternal health care accessibility. Geographical insights are, however, almost never used to aid policy formulation in advance (Makanga, 2016). Yet, heat maps can form the basis for evidence-based decision making and be used to consciously start a conversation and initiate local governmental policies aimed at improving maternal and child health (Makanga, 2016; Molla, 2017; Matthews, 2019).

Public health policy makers recognize the potential usefulness of heat maps that visualize the geographical distribution of risks and adverse health outcomes. They consider heat maps to be especially helpful when decision-making processes are carried out by diverse parties since the visualization makes information more comprehensible and less complex (Joyce, 2009; Ben Ramadan et al., 2017). Using heat maps further enables the specific targeting of interventions in areas that are most affected by adverse outcomes. By targeting the interventions at high-risk populations and locations, and by taking the specific circumstances of those areas into account, a higher effectiveness can be reached (Cromley and McLafferty, 2012). As health and risk factors vary by geographic area, local policies should adapt accordingly (Wang, 2020; MacQuillan et al., 2017).

4. From local to national implementation

An example of the use and effect of heat maps to address perinatal health inequalities occurred in Rotterdam in 2007. A national study had revealed that Rotterdam experienced higher perinatal mortality and morbidity rates than other areas in the Netherlands (de Graaf et al., 2008). More in-depth analyses of perinatal health outcomes in

Rotterdam were conducted by a research team from the department of Obstetrics and Gynaecology of the Erasmus Medical Center, which discovered large differences between neighborhoods. For instance, perinatal mortality rates varied from 0.2 % to 3.4 %, with the higher rates found in deprived neighborhoods. These findings were translated into heat maps that visualized the distribution of perinatal health outcomes between neighborhoods in Rotterdam. The maps were used to communicate these large inequalities to the local government, creating a shared feeling that it was time to act (Poeran et al., 2011; Schreiber, 2022). A local action plan in the city of Rotterdam was developed, called "Ready for a Baby", to improve perinatal outcomes. Part of this program focused on enhancing collaboration between previously semi-isolated medical and social care professionals and policy makers, to improve the quality of care for women at high risk of unfavorable pregnancy outcomes (Denktas, 2012; de Jonge et al., 2019). Later, this local initiative served as foundation for the, still ongoing, Dutch nationwide program "Healthy Pregnancy 4 All" (HP4All) (Vos et al., 2016; Hanson et al., 2017; Barsties et al., 2021).

In 2018 another nationwide action program called "Solid Start" (Kansrijke Start) was launched by the Ministry of Health, Welfare and Sports. This program aims to improve the development and health of children during the first thousand days of life, a period crucial for optimal development later in life. Special attention is being paid to vulnerable families, for whom the risk of adverse (perinatal) health outcomes is higher. Online implementation of heat maps to gain insight in, and further improve, perinatal health have been given a permanent place within this action program, by the development of two initiatives: the "Perinatal Atlas" and the "Vulnerability Atlas" (Ministerie van Volksgezondheid, 2018).

4.1. Development of the perinatal Atlas

The Perinatal Atlas is a collection of online color grading heat maps of the Netherlands with data on relative perinatal health outcomes per region, municipality, and down to neighborhood level. These key figures on perinatal health, including perinatal mortality, premature birth and/or low birth weight, and the start of antenatal care, were derived from the Netherlands Perinatal Registry (Perined). Before the development of the Perinatal Atlas, data on perinatal mortality and morbidity rates were mainly accessible to medical professionals, who could use it to monitor their performances, or researchers, for scientific research. These data had not yet been used much by other relevant stakeholders, such as municipalities. The Perinatal Atlas and the underlying data on perinatal outcomes are integrated in an online platform called "How does my municipality rank?" (www.waarstaatjegemeente.nl) and will be updated every year (Fig. 1). Municipal data on various topics such as health, safety and finance can be found and compared with the national average or other regions. Perinatal health data can be presented in tabular form or by means of heat maps.

4.2. Development of the Vulnerability Atlas

Perinatal health inequalities are often a reflection of pre-existing health inequalities; necessitating improvement in the well-being and health of the current generation of (future) parents (de Graaf et al., 2008). The well-being and health of (future) parents are affected by biological and social risks. Social risks in particular are important for the design of national or local public health policy. Vulnerable (future) parents, who deal with varying social risk factors, are more susceptible to adverse health. Additionally, adverse social circumstances can act as an unfavorable environment in which future children are born (Murray, 2003; Willson and Shuey, 2019). With the Vulnerability Atlas, the risk of vulnerability among future parents is mapped.

The risk of vulnerability is determined by a developed model that predicts the degree of vulnerability in the population of reproductive age, based on the occurrence of (social) factors that are identified in

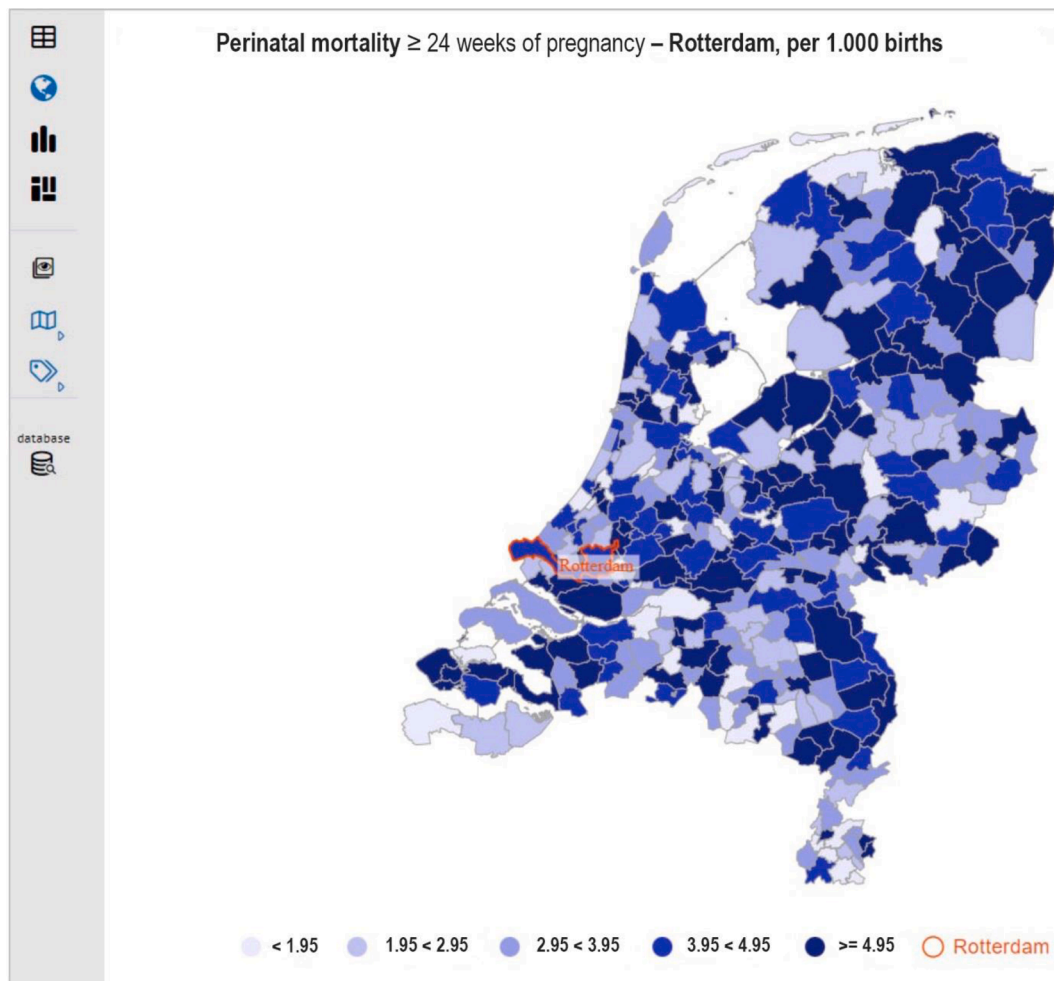


Fig. 1. A screenshot of the Perinatal Atlas as integrated into www.waarstaatjegemeente.nl, displaying differences in perinatal mortality (≥ 24 weeks of pregnancy) per 1000 births between municipalities, with Rotterdam highlighted in red ([Waarstaatjegemeente.nl](http://www.waarstaatjegemeente.nl), 2022). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

scientific literature as vulnerability increasing factors (van der Meer, 2022). The data used for model development was obtained through Statistics Netherlands (CBS) and can be updated every-four years (Erasmus Medical Center, 2020). The Vulnerability Atlas is freely accessible on <http://kwetsbaarheid.kansenkaart.nl/kwetsbaarheidsindex> (Fig. 2). Gradations of color indicate if the risk of vulnerability in a given municipality is lower, higher or comparable with the national average. When zooming in, differences within municipalities appear at the neighborhood level compared to the municipal average. The Vulnerability Atlas can serve as an informative tool for municipalities to conduct further analysis in high-risk areas. Additionally, it offers the opportunity to organize a sufficient supply of (preconception) care in those areas, to optimize the well-being of future parents and, indirectly, the well-being of future children.

4.3. Uptake of regional data

Since regional data on perinatal health topics have become easily accessible, local governments have actively used these data to get a detailed overview of the present state of their municipality. This knowledge has helped to formulate recommendations to stimulate local collaborations between different organizations and optimize maternity and perinatal health care (IJmond Geboortezorg, 2021; Gemeenten Achtkarspelen en Tytsjerksteradiel, 2021; GGD Regio Utrecht, 2021). Furthermore, they intend to use these data for monitoring purposes, to

observe developments in maternal and perinatal health over time and to assess whether local initiatives are still aimed at the right places. These initial insights into geographic inequalities can also act as stimulus for other professionals, such as spatial epidemiologists, to conduct more in-depth research into the geographic relationship between adverse outcomes and risk factors from different life domains.

5. Conclusion

With this commentary, we debate that the use of heat maps visualizing perinatal health topics can generate a renewed focus on tackling (perinatal) health inequalities and stimulate multidisciplinary collaborations. Mapping inequalities between geographical areas creates a sense of urgency among professionals of different domains and local and national governments. It can further stimulate the development of policies and initiatives aimed at improving perinatal health, especially in those areas where perinatal health outcomes are suboptimal.

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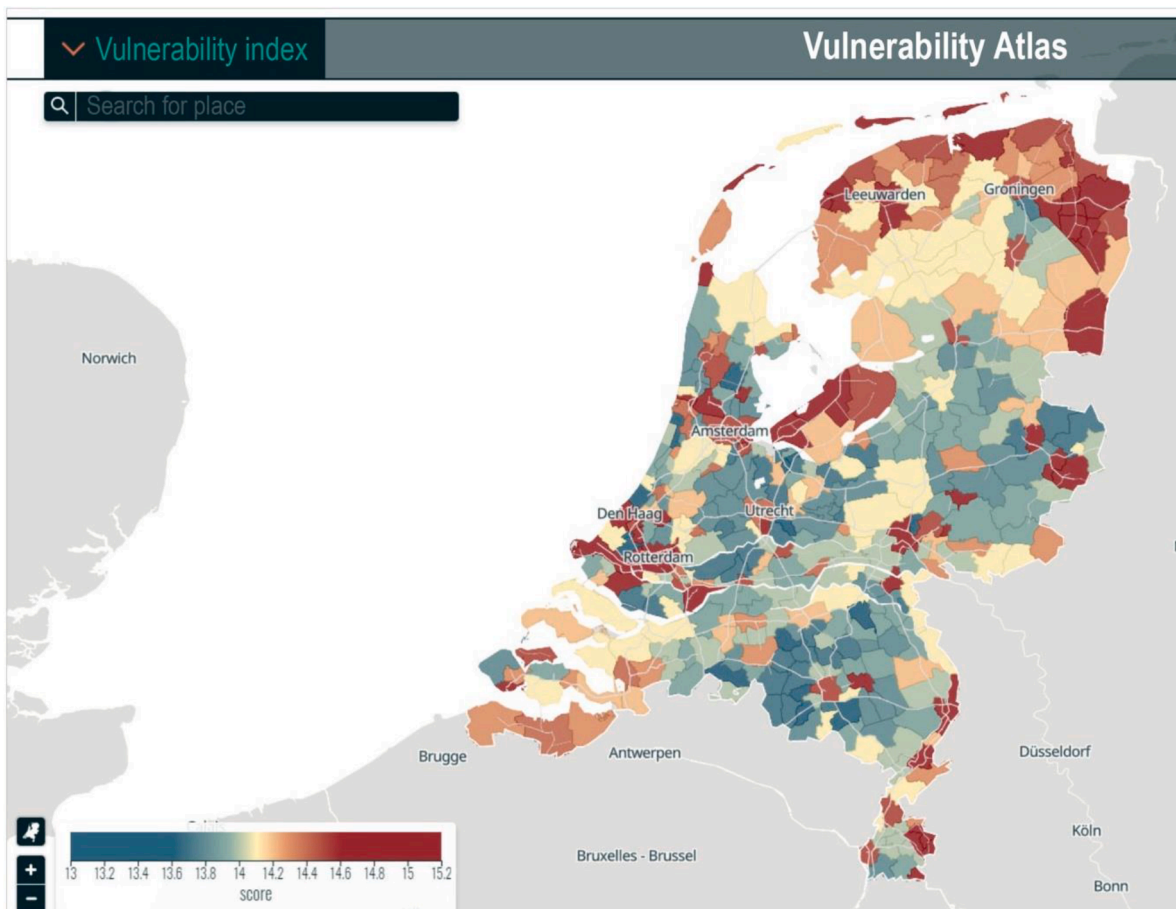


Fig. 2. A screenshot of the online available Vulnerability Atlas, displaying the geographic distribution of risk of vulnerable situations among reproductive aged individuals in the Netherlands (Kansenkaart.nl, 2022).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The authors were supported by the Bernard van Leer Foundation (NET-2017-096). The funding source had no role in the development or writing of this paper.

Data availability

No data was used for the research described in the article.

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