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Review Essay

Association of anemia, pre-eclampsia and eclampsia with seasonality: A realist systematic review

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ABSTRACT

Seasonal patterns influencing maternal health have been documented globally and are of particular importance for women in developing countries who disproportionately suffer from anemia, pre-eclampsia and eclampsia. This paper adopts a realist systematic approach to investigate the maternal outcome of anemia and eclampsia in relation to seasonality. A review of 23 published studies shows a statistically significant link between these maternal disorders and seasonality in developing countries in Sub-Saharan Africa and Central and South Asia. Anemia and eclampsia tend to decrease during the dry season, only to increase with greater rainfall, low and cold temperatures. Numerous studies suggest that the seasonality of anemia and eclampsia is associated with changes in malaria transmission. This was observed during the rainy season, suggesting a potential seasonal relationship with malaria as a driver of these disorders in Sub-Saharan Africa. Anemia and eclampsia were principally exacerbated among primigravidae and young women. Food insecurity, access to antenatal care, poverty, and environmental factors may also play a crucial role in the predisposition to these disorders. More research is required to identify the seasonal link between malaria and eclampsia particularly as climate change may exacerbate the rate of the disorders in tropical and sub-tropical areas.

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1. Introduction

Millennium Development Goal number five, as advanced by the United Nations (2015), strives to improve maternal health by reducing maternal mortality and enhancing access to reproductive health and family planning. In the global south, some of the principle causes of adverse maternal health include anemia, pre-eclampsia, eclampsia, and malaria during pregnancy. Both anemia and eclampsia are multi-factorial disorders with uncertain etiologies (Brabin et al., 2001; Immink et al., 2008; Buurma et al., 2013). Pre-eclampsia is a

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pregnancy-specific malady often accompanied by hypertension (high blood pressure), proteinuria (Roberts and Cooper, 2001), reduced blood flow and the accompanying inadequacy of oxygen and nutritional transmission to the fetus. This enigmatic illness is the harbinger for eclampsia as comas and seizures often ensue when left untreated (NIH, 2013). Anemia, another common maternal ailment, is a result of iron deficiency, which like pre-eclampsia and eclampsia results in adverse maternal outcomes. When present, it is possible that malaria, a perilous mosquito-borne disease manifested through chills, fever, and flu-like symptoms, may exacerbate these conditions (Messina et al., 2013).

Anemia, eclampsia and pre-eclampsia are ubiquitous in the global south. The World Health Organization (WHO) estimates that more than 40% of pregnant women in Sub-Saharan Africa, India, Iran and Bangladesh are anemic compared to 5–19% of women in the West (World Health Organization, 2006). The number of women suffering from pre-eclampsia and eclampsia in developing countries is not as easily ascertainable but is substantial compared to the rate of 15–20% in developed countries like the United States (Sibai et al., 2005). These ailments merit further exploration, as malaria has resurged since the end of the Global Malaria Eradication Programme in 1969 (Cohen et al., 2012). This revival has principally affected Sub-Saharan Africa, where 25 million pregnant women are affected each year (WHO, 2004). Malaria results in adverse health consequences for gestating women, specifically those with lower immunity, birth parity and age (Ter Kuile et al., 2003).

In conjunction with climate change, malaria is anticipated to aggravate maternal health. Studies have indicated that long-term seasonal variation will increase malaria susceptibility by 5–7% in Africa, due to the intensification of the vector-borne disease in higher altitudes (McMichael et al., 2004). This indicates that highland regions of Sub-Saharan Africa will become hospitable environments for the malaria vector, with favourable transmission conditions peaking by 2080 (Pascual et al., 2006; Boko et al., 2007). India and regions of Pakistan are also estimated to suffer the brunt of climate change and increased malarial transmission (Martins and Hall, 2000; Bouma et al., 1996). As anemia and eclampsia exhibit seasonal trends in tropical and temperate regions of the world, it is important to investigate the seasonality of these conditions with regard to maternal outcomes, so as to better prepare and mitigate the effects of climate change.

Expectant women of the global south are therefore the most vulnerable population given pre-existing barriers (e.g. gender inequality, lack of family planning and healthcare, poverty etc.) and the general incapacity to effectively combat these illnesses. Vulnerability will therefore compound the effects of seasonal variation on maternal outcomes as a result of poor acclimatization to seasonal change (Bodnar et al., 2006). To date, there have been a handful of studies documenting the relationship between adverse maternal health (e.g. anemia, eclampsia and malaria) and seasonality, with the majority stemming from the global south (Magnus and Eskild, 2001; Bodnar et al., 2006).

Accordingly, the primary intention of this realist systematic review (Pawson et al., 2005) is to investigate what causes anemia and eclampsia in pregnant women in developing countries under seasonal circumstances and how. A realist approach is adopted to provide an interpretive understanding of seasonality in anemia, pre-eclampsia, and eclampsia among pregnant women in the developing world (Pawson et al., 2005). I will delve into this question by broadly determining whether general seasonality impacts maternal outcome with regard to anemia, pre-eclampsia and eclampsia in Sub-Saharan Africa, Central and South Asia. I investigate why these illnesses are climate sensitive for women of child-bearing age and how the illnesses may have common etiologies. This review will therefore investigate the connection between climatic variation or seasonality and maternal outcomes through the examination of existing literature.

2. Materials and methods

2.1. Systematic literature review search strategy

A systematic literature review of the relevant epidemiological literature was conducted to examine the influence of seasonality on maternal outcomes, namely: anemia, pre-eclampsia, and eclampsia in developing countries. The review was conducted in accordance with an adapted version of the Heller Checklist and the PRISMA guidelines (Heller et al., 2008; Moher et al., 2009). I searched for articles which were published by academic and peer-reviewed journals, to the exclusion of all government reports and grey literature. I conducted a search using the PubMed and Google Scholar databases in October 2013. My first PubMed search comprised of inserting the [MESH TERMS] "maternal mortality" and "climate" in the Boonlean field. This resulted in 36 abstracts, of which 10 met the final inclusion criteria (see Table 1) and were published between 1994 and 2010. I supplemented my search using the Google Scholar database (Gehanno et al., 2013; Osungbade and Ige, 2011) to obtain studies in the French language, as the PubMed database rendered no relevant French publications. I used the search term "variation saisonnière prevalence maternelle *mortalité*." I sifted through the first 50 articles and found one relevant article on seasonality. An additional twelve articles, published between 1970 and 2010, were found through snowballing of the PubMed results (see Fig. 1).

2.2. Screening and review process

Given the large geographic scale of Sub-Saharan Africa and Central and South Asia, the searches were conducted in English and French and were evaluated in accordance with specific inclusion/exclusion criteria (see Table 1). Sources were categorized based on their geographic region, to ascertain whether regional

Table 1
The inclusion and exclusion criteria utilized in the systematic literature review.

Inclusion	Exclusion
English, French	Languages other than English, French
Maternal mortality	Population mortality, infant mortality
Maternal outcome	Population outcome, infant outcome
Climate change, seasonal variation, rainfall, rainy season, winter	Topography and biomes (e.g. deserts, mountainous areas, jungles etc.)
Developing countries (Sub-Saharan Africa and South Asia)	Developed/westernized countries with low rates of maternal mortality and good maternal outcomes
Women of reproductive age, including female adolescents, primigravidae and multigravidae	Pre-pubescent girls, older/elderly women
Malaria, pre-eclampsia, eclampsia, anemia, antenatal care and food security	Hemorrhage, ebola
Published up to 2010	Prior to 1970
Peer-reviewed	Non-peer-reviewed or grey literature