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Impact of malaria control on infant mortality in Senegal

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ABSTRACT

In this study I analyze the impact of recent and major improvements in malaria control policies on infant mortality in Senegal. Though there exist many randomized studies, the potential health gains associated with universal access to malaria treatment remains unresolved. I address potential correlation in health interventions as well as possibilities of mean reversion in measuring the impact of recent malaria intervention on mortality. Our study finds that malaria control policies reduces neonatal and infant mortality by 28.6% and 14.88% respectively while the impact on post-natal mortality is inconclusive. Our study reveals that malaria control policy may have differential effect depending on early or late infancy. Involvement of local communities and civil society organization in the implementation of health programs is crucial. Most importantly our study shed lights on the potential health gains associated with universal access to treatment as clamored by WHO. As many African countries are contemplating implementing a policy of universal access to treatment, this study hopes to serve as a guide to policy makers in gauging the likely health gains associated with such policy.

1. Introduction

Unarguably one of the greatest achievements of the last decade has been the marked reduction in malaria prevalence notably in endemic developing countries. Since the year 2000, malaria prevalence has dropped by 47% globally and 54% in Africa (World malaria report, 2014). However the same report reveals that 278 million out of the 840 million persons at risk in Africa still live in households without a single insecticide treated net (hereafter ITN). Out of the 580,000 malaria deaths registered in 2013, 78% occurred in children aged under five with over 90% occurring in Africa.

Beyond mortality, childhood malaria burden is known to have long lasting adverse socio-economic effects on individuals and economies (Sachs & Malaney, 2002). In a cross country analysis, (Gallup and Sachs, 2001) associate malaria to a 1.3% decrease in economic growth rate in malaria endemic countries. Their study equally indicates that a 10% reduction in malaria prevalence is associated to a 0.3% increase in growth rate. Malaria is equally associated to educational attainment, (Lucas, 2010) reveals that the mid-20th century malaria eradication campaign led to substantial gains in educational attainment and literacy in Paraguay and Sri-lanka.

There has been a sustained increase in funding for malaria control as well as a diversification in donors. Annual funding for malaria control for the year 2013 stood at US$ 2.7 billion representing a three fold increase from 2005. 82% of malaria funds for 2013 came from international donor agencies and organizations. Between 2005 and 2013 international funding for malaria destined to Africa grew on average by 22% per year compared to 15% in other WHO regions. Interestingly domestic funding in Africa has been growing by approximately 4% per year. Though the resources committed to malaria has been on a rise, it still fall short of annual required amounts for a more effective control and elimination. For example out of 5.1 billion US$ required in 2013, only 2.7 billion was effectively disbursed representing a close to 50% gap in funding for that year.

Senegal an all year round malaria endemic West African country has been hailed for the relative success it has achieved in rolling back malaria. Though Senegal only adopted a national malaria control strategy in 2005, it has however organized a number of free mosquitoes bed net distribution campaigns prior to 2005 notably in 1998. Since 2005 the country has been using a battery of policy interventions to roll back malaria. These interventions range from indoor residual spraying (IRS), free ITN nation-wide distributions, rapid diagnostic tests (RDT) and Artemisinin based Combination Therapy (ACT). By 2010 treatment of malaria was declared free in all public health institutions. The fallout from these policies has been perceptible and impressive. The number of malaria episodes reported per 1000 inhabitants has dropped from 130 cases in 2006 to around 10 cases in 2013. Reported cases for children aged under 5 has decreased from 408.588 cases in 2006 to less

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than 30 cases in 2009. With regards to pregnant women, the number of reported cases has dropped from 48 in 2006 to 5 cases in 2013. Following DHS 2008 report, the proportion of pregnant women who received at least two doses of intermittent preventive treatment (IPT) rose from 11% in 2005 to 50% in 2008. While the number of women who slept under ITN two nights before the survey rose from 7% in 2005 to 30% in 2008. On a whole the prevalence of malaria parasite[1] has dropped from 6% in 2008 to 2.3% in 2013. It is however worth noting that there are huge variations in prevalence rates across geographical zones. The South zone has the highest prevalence estimated at close to 10%, while the Center and West-north regions have a prevalence of 2.2% and 0.7% respectively.

Fig 1 shows that funding for malaria control rose as from 2005 though unstable over the years.[2] It appears that prior to the formulation of a national strategy in 2005, funding for malaria control was quite low and was essentially provided by the Global Fund to Fight AIDS, Tuberculosis and Malaria (hereafter "Global Fund"). However as from 2005 Senegal has been receiving substantial funding from an array of international donors notably USAID and President Malaria Initiative (hereafter "PMI"). Funding for malaria control peaked in 2009 estimated at over 30 million US$ (see Fig. 2).

In this study, I estimate the impact of the intensification in malaria control on early and late infant mortality in Senegal. I exploit the quasi-natural variation in malaria prevalence across geographic zones coupled with the sharp escalation in malaria control policy to estimate the impact of the policy on neonatal, post natal and infant mortality. Senegal provides a unique context for this study in several regards. Firstly there are significant climatic variations across different geographical zones, thereby creating important discontinuities in malaria prevalence. For example in 2013, malaria prevalence in the North-west zone was as low as 0.7% while prevalence in the South zone was as high as 10%. Secondly the timing of DHS surveys in Senegal enables us to have sufficient information before and after the escalation in malaria control policy. I use three waves of DHS Senegal (2005, 2010 & 2014). I equally extract information on pre-intervention Malaria and HIV prevalence rates from Multiple Indicator Cluster Survey (hereafter "MICS-2000"). Another justification for studying Senegal is that Senegal appears to have made huge strides in rolling back malaria. Senegal prides itself as a success story in the fight against malaria in sub-Saharan Africa. Senegal was one the first countries in sub-Saharan Africa to institute universal access to malaria treatment.

Table 1 summarizes my estimation strategy. Firstly I use information on birth to categorize my sample into pre-intervention i.e. births prior to 2005 and post intervention i.e. births after 2004. Secondly using information on pre-intervention malaria prevalence rate,[3] I categorize the sample into endemic (high) and non-endemic (low) regions. High region comprises of children born in the South zone comprising the regions of Zuiguichor, Tamba, Sedihou, Kolda and Kedougou. These regions have the highest prevalence rate as reported in the MICS-2000 survey report. Children born in the remaining 6 regions are classified as low. Given this categorization I then take differences in the mean value of the different mortality indicators across cohorts and across high and low regions. This descriptive but informative exercise reveals that neonatal, post natal and infant mortality has declined significantly among younger cohorts born in endemic regions.

Beyond the above descriptive results, more formally I control for a number of potential confounders inherent in such an estimation strategy. Firstly we provide evidence that our estimates are robust to contemporaneous health campaigns such as the HIV/AIDS control policy. Secondly we provide evidence that our results are not driven by pre-existing differences in mortality trends. Our estimates are robust to region specific time trends. Lastly improvements in maternal health care delivery in treatment regions might confound our results. We find no statistical association between the policy intervention and changes in maternal health care. We equally out rule any possibility of mean reversion. Our analyses indicates that rapid intensification in malaria control was effective in saving the lives of 1032 and 1412 neonates and infants respectively in the endemic regions annually. This represents 28.6% and 14.88% reduction in neonatal and infant mortality respectively in the malaria endemic regions during 2005–2014.

This paper is part of a broad literature on the impact of malaria on socio-economic out comes. However this paper makes a number of contributions. Firstly unlike previous studies, we analyze the impact of malaria control in the context of ITN's, RDT's and universal access to treatment. Previous studies have looked at the impact of malaria control in the context of DDT spraying. This approach to malaria control is old and no longer recommended. Our study estimates the impact of malaria control at a time when maiden methods are used to combat malaria such as rapid diagnostics test (RDT), large scale distribution of ITN's, advanced ACT treatment methods etc. Most importantly our study shed lights on the potential health gains associated with universal access to treatment[4] as clamored by WHO. As many African countries are contemplating implementing a policy of universal access to treatment, this study hopes to serve as a guide to policy makers in gauging the likely health gains associated with such policy.

2. Malaria control in Senegal

Senegal an all year round malaria endemic West African country with a population of approximately 14 million has a long history of malaria control. Just like many other African countries, attempts to control malaria dates as far back as the colonial period. It is however only in 1995 that the first malaria control strategy[5] was elaborated. This document laid emphasis on the distribution and utilization of ITN's as a viable strategy in rolling back malaria in the country. In line with this document and following support from WHO, Senegal implemented its first free ITN's distribution in 1998. This maiden ITN's distribution campaign was however limited to 12 districts with alarming malaria prevalence rates. In 1999 Senegal was enlisted for the *Roll back malaria* campaign jointly financed by WHO, PNUD, UNICEF and the World Bank. Following the ratification of the Abuja declaration,[6] Senegal was among beneficiaries of the first round of funding provided by the Global fund in 2003. Senegal adopted intermittent preventive treatment (IPT) and indoors residual spraying (IRS) in 2003 and 2005 respectively.

These early initiatives to contain malaria however remained weak and ineffective largely due to inadequate technical human resource, socio-cultural resistance as well as resource mismanagement. DHS survey report (2005) revealed that less than 27% of households owned a mosquito bed net. Only 10% of children sampled in the survey slept under a bed net two nights prior to the interview. Malaria was responsible for over 30% of mortality in health facilities. Over 30% of children sampled in the survey had

[1] *Plasmodium falciparum* accounts for more than 90% of all reported cases.

[2] There was a significant drop in funding in 2008 following the global economic recession.

[3] We use malaria prevalence rate at regional level for the year 2000 as reported in the MICS report following MICS survey conducted in the year 2000.

[4] Senegal instituted universal access to treatment of malaria in 2010.

[5] The implementation of the national strategy was crippled by resource constraints given the economic crises of the mid 1990's. This is why the 2005 national strategy is widely considered as the first major strategic document for malaria control.

[6] In April 2000, African head states and governments gathered in Abuja to renew their commitment to roll back malaria. It was agreed that at least 15% of national budget be allocated to health.