CENTRE D'ETUDES
ET DE RECHERCHES
SUR LE DEVELOPPEMENT
INTERNATIONAL

SÉRIE ÉTUDES ET DOCUMENTS

Subsidized antimalarial drugs in Dakar (Senegal): Do the poor benefit?

Georges Karna Kone
Martine Audibert
Richard Lalou
Hervé Lafarge
Jean-Yves Le Hesran

Études et Documents n° 11

June 2017

To cite this document:

Kone G. K., Audibert M., Lalou R., Lafarge H., Le Hesran J.-Y. (2017) "Subsidized antimalarial drugs in Dakar (Senegal): Do the poor benefit?", *Études et Documents,* n° 11, CERDI. http://cerdi.org/production/show/id/1880/type_production_id/1

CERDI
65 BD. F. MITTERRAND
63000 CLERMONT FERRAND – FRANCE
TEL. + 33 4 73 17 74 00
FAX + 33 4 73 17 74 28
www.cerdi.org

The authors

Georges Karna Kone, Health Financing Advisor, Abt Associates, Health finance and government (HFG) Project, Haiti.
E-mail : karnageorges@gmail.com ; georges_kone@abtassoc.com

Martine Audibert**,** Director of Research at CNRS, École d'économie et Cerdi, Université Clermont Auvergne - CNRS, Clermont-Ferrand, France.
E-mail : martine.audibert@uca.fr

Richard Lalou, Director of Research, IRD, UMR 151 IRD/AMU, Laboratoire Population–Environnement–Développement, Aix-Marseille Université, Marseille, France.
E-mail : richard.lalou@univ-amu.fr

Hervé Lafarge, Consultant, Paris, France.
E-mail : lafargeh@yahoo.fr

Jean-Yves Le Hesran, Directeur of Research, IRD, UMR 216, Laboratoire de parasitologie, Paris, France.
E-mail : Jean-Yves.Lehesran@ird.fr

Corresponding author: Georges Karna Kone

This work was supported by the LABEX IDGM+ (ANR-10-LABX-14-01) within the program "Investissements d'Avenir" operated by the French National Research Agency (ANR).

Études et Documents are available online at: http://www.cerdi.org/ed

Director of Publication: Grégoire Rota-Graziosi
Editor: Catherine Araujo Bonjean
Publisher: Mariannick Cornec
ISSN: 2114 - 7957

Disclaimer:

Études et Documents is a working papers series. Working Papers are not refereed, they constitute research in progress. Responsibility for the contents and opinions expressed in the working papers rests solely with the authors. Comments and suggestions are welcome and should be addressed to the authors.

Abstract

Senegal opted for an antimalarial drug policy (artemisinin-based combination therapy) of partial and then full exemption from health care costs for the whole population respectively in 2008 and 2010. Has this policy reduced access inequalities in children's health care between rich and poor households?
Data were collected in Dakar between 2008 and 2009 as part of a research program on urban malaria. A survey was conducted among the population of the Dakar metropolitan area. The sample was based on a two-stage sampling. The three questionnaires used for the survey were based on validated data collection tools. Indicators were built to characterize individuals, households and neighborhoods.
Bivariate analysis (chi2 test) revealed social gradients within the Dakar agglomeration and characterized health care behaviors of the poorest and richest households. Data have therefore been adjusted by a double zero-inflated Poisson model.
Results show that the policy of subsidizing antimalarial drugs in Senegal has reduced health care costs, including for the poor, but without improving its distributive equity. In contrast, this policy has benefited more the richest than the poorest, without mitigating social and financial inequalities. In light of the lessons learnt by the subsidy policy for antimalarial drugs, our study recommends that universal health coverage, currently implemented in Senegal, should seek to mitigate economic inequalities in access to health care for the poorest as well as to improve the health outcomes for the whole population.

Keywords:
Equity, Poverty, Universal health coverage, Health financing, Malaria, Urban area, Dakar.

JEL Codes:
I14, I18

Authors' contributions:
GK, MA and RL designed the study. GK acquired data, led the analyses and drafted the manuscript in consultation with other authors. All authors interpreted the results, reviewed the article. GK, RL and MA critically reviewed improved and approved the final version of the manuscript.

Acknowledgments:
This study was funded by the national agency of research of the French government (ANR 07-SEST-001).

1 Introduction

Although equitable health care access has been a long-standing principle in health policies developed by African states and supported by development partners (Guideline for Primary Health Care, 1978, Bamako Initiative, 1987, MDG 2000, Primary health care: Now more than ever), it was only in the early 21st century that both politicians and scientists acknowledged that improving health in low-income countries depends on financial access to care, including for the most vulnerable groups. Moreover, public measures were taken to this end at that time. While the health knowledge level of the population and the therapeutic efficacy of treatments are steadily increasing, attendance at health facilities remains low (between 0.15 and 0.60 consultations per person per year[1] (Ridde & Queuille 2010), with growing gaps between rich and poor (WHO 2010).

Since the implementation of the Bamako Initiative (IB), the relevance of care funding (medical acts, examinations and drugs) by a pricing policy has once again arisen. For many authors, pricing is a barrier to health care access that must be partially or completely removed. James et al. estimated that full exemption of health care costs for children under five in 20 sub-Saharan African countries would save 150,000 to 300,000 lives per year (James et al. 2005). In Uganda, the removal of the financial barrier had led to a rapid increase in the use of health services by the poorest (Xu et al. 2006). In Burkina Faso, removing out-of-pocket payments at the point of service for children under five has reduced infant and child mortality by 11% in two health districts where this policy had been implemented (Johri et al. 2014).

Only few studies focus on fee exemption policies for health services. Moreover, they analyze the implementation process more than they estimate their financial viability or measure their impact on health facility activities (Ridde & Morestin 2011; Yates 2009). In concerned countries, the full exemption of fees for specific health care services was justified by the adverse effects of pricing policy on health service use and individual health status (Creese 1997; Haddad & Fournier 1995; James et al. 2005; Xu et al. 2003), and by its inability to improve health care quality.

Several studies showed that the exemption of direct payment has led to an increase in the use of health services, at least shortly after the implementation of this policy (Jouquet et al. 2011; Koné et al. 2011; Masiye et al. 2010; Meessen et al. 2011; Nabyonga et al. 2005; Xu et al. 2006). Jouquet et al. (2011) showed that, in Mali, free health care for children under five resulted in an increase in primary health care use (0.34 new contacts per person and per year in 2004 before policy, 2.86 in 2007, after the policy implementation). Koné et al. (2011) also found that health facilities use in Mali had increased by 17% in the case of partial exemption and 300% in the case of full exemption of health care costs. Moreover, two studies, conducted in Mali and Burkina Faso on free maternal care, showed that the abolition of fees favored access to care for both rich

[1] The average for OECD countries is 6.5 consultations per person per year (Health at a Glance 2011: OECD Indicators; http://www.oecd-ilibrary.org/sites/health_glance-2011-fr/04/01/index.html?itemId=/content/chapter/health_glance-2011-29-fr).

and poor alike (Fournier et al. 2011). Two points emerge from these studies: (i) a higher (but not always) increase in health service use for poor households (Meessen et al. 2011; Nabyonga et al. 2005; Nabyonga Orem et al. 2011; Ridde & Queuille 2010) than for rich ones; (ii) higher health service attendance when there is full exemption (consultation and medicines for children) rather than partial or targeted exemption. In the latter case, there might be no observed effects on access to care (Nabyonga Orem et al. 2011).

While many studies have acknowledged that free health care policy has improved the access to care (increased health facility attendance and better access to effective drugs), there continues to be a controversy regarding the redistributive effects of this policy: do the poor benefit more than the rich from free health care? Has this policy allowed households to escape the poverty trap by reducing catastrophic costs (Xu et al. 2006)? In Uganda, despite the policy of free health care, health care spending remained high, particularly among the poorest quintiles of the population (Nabyonga Orem et al. 2011). The geographical barrier, additional medical costs (rarely covered by targeted free policies), transport and opportunity costs are limiting factors that mitigate the positive impact of free health care, especially among the poorest. While several studies observe that the abolition of payment at the point of service has a positive effect on health service use, they do not have been able to check the sustainability of this impact nor to measure its consequences on household health expenditures.

In the 2000s, Senegal opted for a targeted exemption policy: free childbirth and Caesarean sections (2005), exemption from health care payment for the 60 and over (2006), subsidies (2008) followed by full exemption (2010) for payment for the entire population of an antimalarial drug: the artemisinin-based combination therapy[2] (ACT) whose trade name is Falcimon®. The introduction of the malaria subsidy policy provided an opportunity to evaluate its impact on health care use among children from the poorest households and on expenditures incurred for suspected malaria cases within these families. Our study addresses the following issue: Has this policy reduced disparities in access to health care between children of rich households and poor households?

We assume that a subsidy or free health care policy that changes health care access conditions for the whole population does not improve access to health care for the poorest, as these have less capacity to transform this financial opportunity into a health outcome, compared to wealthy households.

2 Method

2.1 Study area

It was agreed, until recently, that the process of urbanization led to a reduction in malaria transmission: Anopheles, vector of malaria, were considered not to adapt to cities. The urban malaria facies has been significantly revised over the last decade. The adaptation of the anopheles

[2] Falcimon was the only subsidized ACT in Senegal.

to the urban environment (in particular An. Gambiae s.s. of molecular form M or An. Coluzzii) (Klinkenberg et al., 2008; Mireji et al., 2008; Awolola et al., 2007; de Sylva and Marshall, 2012) and rapid urbanization (with poor drainage of surface water) have contributed to increasing vector density in cities, multiplying breeding sites in artificial areas, and changing the intra-urban and inter-annual distribution of risks of transmission. If gametocytocidal treatments have been more effective in eliminating the parasite, some situations common in urban areas have probably reduced their performance. Man-mosquito transmission is thus facilitated by (i) frequent rural-urban and urban-rural moves; (ii) the non-use or misuse of antimalarial drugs: self-medication, delayed or sub-curative treatment, monotherapy, and (iii) a pluralistic health care supply (public, private, r, occupational medicine, traditional healers) which does not always follow the Ministry of Health guidelines.

Malaria in the Dakar region has not escaped these epidemiological changes. During the last major dry period in Senegal (1970-2000), urban malaria was considered essentially an import disease (Diallo et al. 2000; Diallo et al. 1998; Prothero 1977; Trape et al. 1992; Vercruysse et al. 1983). With the exception of a very weak local and seasonal transmission concentrated around urban market gardens (Diallo et al. 2012; Trape et al. 1992), urban malaria was the result of infections in rural areas. However, since 2005, with the return of more abundant rainfall (Bodian, 2014), the transmission has become more endogenous, with the main vectors *An. arabiensis* (97.8% of Anopheles caught in the city of Dakar) and *An. gambiae*, (Pages et al. 2008). This transmission is unstable and exhibits strong inter-annual and spatial variations (Drame et al. 2012; Machault *et al.* 2010; Pages et al. 2008). In Dakar, parasite prevalence, measured by the polymerase chain reaction (PCR), was relatively high in 2012 (16.5%), again with strong disparities between neighborhoods (Diallo et al. 2012).

Public health services were in keen competition with the private sector, which counted one confessional hospital, 32 clinics, 70 maternity hospitals, 131 medical practices, 77 health posts and 843 pharmacies (MSPHP/Sénégal 2008). In 2008, public supply of health services in the Dakar metropolitan area included 8 hospitals, 19 health centers and 109 health posts (MSPHP/Sénégal 2008). The national supply of private health care was predominantly concentrated in Dakar (83% of private doctors in the agglomeration of Dakar). In addition, these services coexisted with an informal health care supply, made up of traditional healers and illegal drug sellers.

According to the Ministry of Health, health expenditures in Senegal was 247.5 billion CFA francs in 2005 and was mainly financed by households through direct payments (54%). The State contributed 22% and the donors 15%. The share borne by social protection agencies relative to health care [IPM (sickness insurance institutions), Ministry of Finance for civil servants, commercial insurance, mutual insurance] accounted for 9% of those expenses (MSPHP & CAFSP 2005)[3]. In addition, drug purchases accounted for almost half

[3] Health national accounts of Senegal.

(48.8%) of household health expenditures. The high share of direct health payments contributed to unequal access to care. For example, in 2005, the percentage of children who received antimalarial drugs in the two days following the onset of fever was 7% in the poorest households and 16% and 17% in the two richest quintiles (Ndiaye & Ayad 2006). Excluding medicines, household health expenditures concentrated in public hospitals (70%) (MSPHP & CAFSP 2005).

In 2008, the subsidized ACT was available at a very low price (300 CFA francs for children and infants, 600 CFA francs for adults) in public health centers and private pharmacies. This initiative was intended to increase the affordability of health care in case of fever for the poorest households. However, a study carried out in private pharmacies on the availability of ACTs showed that this treatment was not the only one offered: more than sixty trademarks of antimalarial drugs, that covered all the molecules and all their combinations, were available (Koné et al. 2007).

2.2 Data Collection

Data were collected in Dakar between September 15 and December 22, 2008, during the period of high malaria transmission. It was part of a research project on urban malaria (Actu-Palu) that aimed at two objectives: 1) to highlight and describe the urban context that has contributed to the resurgence and development of malaria in Dakar; and 2) to assess the capacity of the residential location to mitigate or increase people's vulnerabilities impeding access to health care. A survey was conducted among the population of the Dakar metropolitan area. The sample was based on a two-stage sampling (for more details, see (Koné et al. 2015).

The survey covered the four communes of Dakar, estimated at 1,983,093 inhabitants (270,669 households) in 2002 (ANSD 2006), including about 2000 census districts (CDs), each of them comprising an average population of 1037 inhabitants (141 households and 86 compounds per CD). In total, 50 clusters (neighborhood or equivalent CDs) and 3000 households were selected from the entire Dakar metropolitan area (Koné et al. 2015).

The three questionnaires used for the survey were based on validated data collection tools (Chauvin & Parizot 2009; Franckel et al. 2008; Roubaud & Razafindrakoto 2005; Souares et al. 2009). The household questionnaire addressed characteristics of household members, housing, household environment and economic status. The women's questionnaire concerned mothers/guardians and documented in particular their knowledge and attitudes about malaria and health in general, perceptions of medicines, the neighborhood's health-care facilities, and their health care-seeking behavior during the last fever episode for children aged less than 10 (Koné et al. 2015).

2.3 Variables

The cost of health care use includes all expenses incurred by the household during the child's fever episode: *cost of transportation* and *cost of care* (consultation and prescription costs). The cost of health care was assessed for children between two and ten years suffering from isolated

fever for the following treatments: modern medicine (public or private sectors), traditional medicine and self-medication. Children under-two were excluded from the study to eliminate various fevers associated with very young age. Fevers for children over age two are usually equated with an uncomplicated malaria crisis, when they occurred during the high transmission season.

The estimation of *the household standard of living* is a much debated topic in the literature. Income is considered as partially reflecting the economic and financial status of households and individuals: income reflects cash (immediate resources) while assets refer to the potentialities of the economic status (Koné et al. 2015). Therefore, we needed to use several indicators. In line with several authors (Filmer & Scott 2008; Sahn & Stifel 2000), we built indices using a principal component analysis including four household standard of living dimensions: income, expenditure, housing and assets (types of dwelling and property owned) (Bradshaw 2001; Bradshaw & Finch 2001; Delhausse 2002; Diagne et al. 2005; Roubaud & Razafindrakoto 2005). Very poor households belonged to the first quintile of all four dimensions. They accounted for 8% of studied households (N=257). Very rich households belonged to the last quintile of both income and expenditure dimensions because none of the studied households were in the last quintile for all standard of living dimensions. Ten percent of the studied households were identified as the richest (N=322). More details concerning this classification are available in our previous published article (Koné et al. 2015).

The neighborhood's standard of living—poor, heterogeneous and rich—was estimated using the percentage of poor and rich households for each neighborhood. If the percentage of poor (quintiles 1 and 2) or rich (quintiles 4 and 5) households in a neighborhood was equal or higher than 45%, the neighborhood was classified as poor (or rich). For the other cases, the neighborhood was considered as heterogeneous (neither poor nor rich). Among the 50 neighborhoods, 18 were poor, 10 rich and 22 heterogeneous (Koné et al. 2015; Sen 1993; Sen 1999).

2.4 Data Analysis

We constructed indicators to characterize individuals, households and neighborhoods. Synthetic indices (see above key concepts) were calculated, based on the score method, using a principal component analysis for quantitative variables and a factor analysis for discrete variables. Indices concerned housing and assets, social capital, knowledge of maternal and child health, and neighborhood environment identified by two indicators (risk of flooding and level of facilities).

Bivariate analysis (chi2 test) revealed the social gradients within Dakar and characterized the health-seeking itineraries of the poorest and richest households. For each socioeconomic group, we describe the treatment paths and estimate the differences in care costs and financial gains generated by subsidies of antimalarial drugs.

The modeling of health care cost is based on non-negative data, with a heavy-tailed asymmetrical distribution (see Annex 1), due to the mass of zeros produced by non-users of health services

(self-medication). Given the non-normal distribution of the variable of interest (see Annex 2), the inflation of zeros and the presence of heteroscedasticity (Breusch-Pagen test), the linear regression model (such as OLS) is not appropriate (Santos Sylva and Tenreyro, 2006). Data have been adjusted by a double zero-inflated model: a Poisson model to explain the cost of health care and a logit model to predict excess zeros. Data over-dispersion is corrected by the linear Huber/White/Sandwich estimator (Chatterjee & Hadi 2015; Hilbe 1999; Raciborski 2011; Selvin 2004) ; Gould, 2011).

The covariates considered in the model are: the use of Falcimon® (the only subsidized ACT), the use of a public health facility, social network, health knowledge level, mother's education, mother's perception of the child's frailty, and neighborhood economic status. Based on this model, we estimated the marginal effect (Graubard & Korn 1999; Greene 2012; Searle et al. 1980) reduction in costs due to the use of Falcimon® for each household socioeconomic category. This analysis helped to address the key question: has the antimalarial drug subsidy benefited the poorest?

3 Results

3.1 Patterns of health-seeking behavior for fever among children

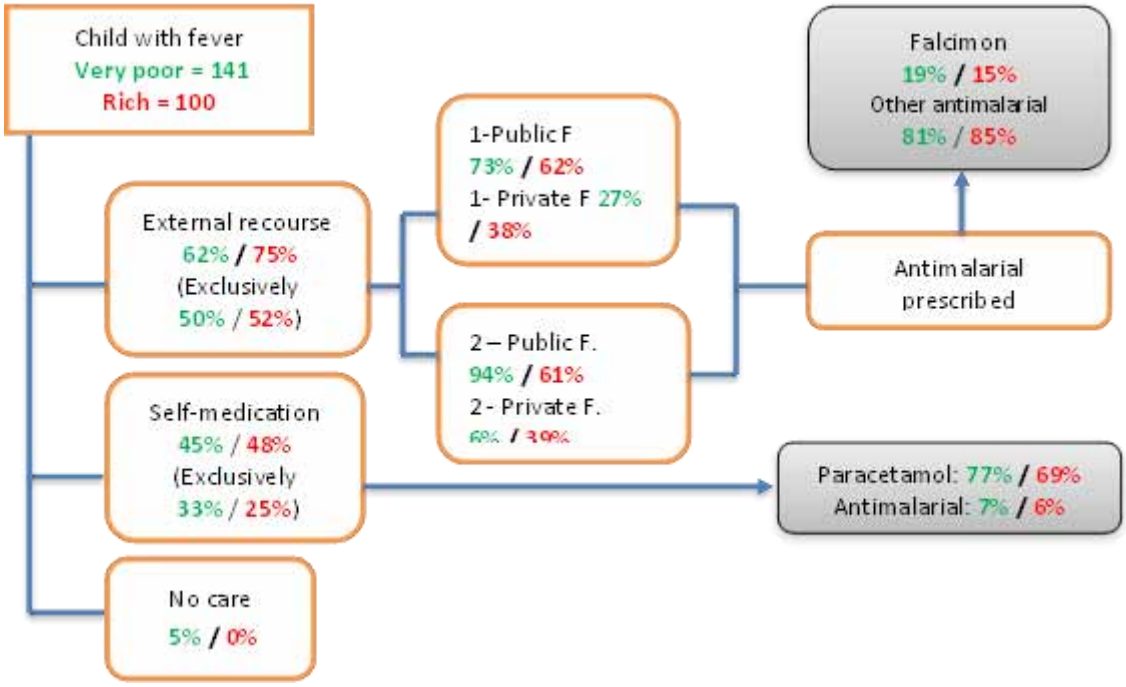
Does subsidized malaria treatment remove barriers related to monetary poverty and help in overcoming other obstacles faced by households and neighborhoods? To address this question, our study aimed to compare health-seeking behaviors between the poorest and richest households.

The first result appears counterintuitive given that the percentage of households that used self-medication was similar among the poorest and the richest (45% *vs* 48%, respectively; no significant difference) in 2008 in Dakar. But deeper analysis suggests that the poorest were more likely to have no treatment than the richest (5% vs 0%) or to use self-medication only (33% vs. 25%) in case of a child's fever episode. Overall, the poorest households were 1.5 more likely than richest households not to see a doctor (38%[4] vs 25%; $p<0.05$).

Paracetamol was the most commonly used medication for self-medication, by both the poorest and the richest (77% and 69%, respectively, Figure 1), while antimalarial consumption remained very low (7% and 6%, respectively). When they opted for an external health care use, richest households were more likely to use private health facilities (38% in first use, 39% in second use) compared to very poor households (27% in first use and 6% in second use, $p <0.05$).

[4] e.g.: 33% for exclusive self-medication and 5% for no treatment, resulting in 38% for the poorest.

Figure 1: Pattern of health-seeking behavior for a child's fever episode among poorest and rich households (percent estimated on the total resorts observed) [5]



1 = First resort; 2 = Second resort ;(Source: Actu-Palu, 2008)

The number of drugs, whether prescribed in a public or a private health facility, varied for all households between one and nine, with a median of three. The poorest households had, on average, more prescribed drugs than the richest households. Thus, they were twice as likely to have to buy five drugs and more than wealthy households (chi2 = 0.019). Some 70% of prescriptions included at least one antimalarial drug (62% for the very poor households, 70% for the richest households). If ACTs accounted for 71% of prescribed antimalarials, the subsidized ACT (Falcimon®) represented only 31% of the prescribed ACTs. In other words, Falcimon® was very little prescribed to both rich and poor households: it was prescribed to 16% of the poorest patients and 22% of the richest patients. The difference is not statistically significant.

[5] Overall, traditional self-medication accounts for less than 5% of use of health care: 4.3% for very poor households and 2% for the richest. No consultation with a traditional healer has been reported.

3.2 Economic cost of treating fever for children aged 2 to 10 years

The average cost of self-medication for fever was estimated at 259 CFA francs for all economic groups in the sample (very poor, poor, middle and rich). This cost was 280 CFA francs for the poorest and 363 CFA francs for the richest (Table 1). Nevertheless, more than half of the households had spent nothing for fever regardless of the economic level (with a median cost of zero). Indeed, 60% of all households had medicines at home (57% among the poorest vs 70% among the richest, p <0.01).

Table 1: **Economic cost of treating fever in children for poor and rich households, CFA francs**

	Median	Mean	95%CI	Prob (T-Test)
Cost of self-medication				
Total (N=627)	0	259	[198 – 320]	
Poorest (n_p=63)	0	280	[80 – 480]	0.6319
Richest (n_r=48)	0	363	[66 – 660]	
Cost of transport in case of external recourse				
Total (N=889)	0	273	[153 – 229]	
Poorest (n_p=95)	0	229	[29 – 279]	0.0022
Richest (n_r=75)	0	809	[339 – 875]	
Cost of health care in case of external recourse				
Total (N=775)	4 300	5 743	[5 301 – 6 184]	
Prescription				
with antimalarials (n_p=525)	4 710	6 018	[5 467 – 6 569]	0.0795
without antimalarials (n_r=250)	3 682	5 165	[4 435 – 5 894]	
Cost of health care when antimalarials other than Falcimon® were prescribed				
Total (N=524)	4 500	5 900	[5 334 – 6 465]	
Poorest (n_p=57)	2 500	5 475	[3 159 – 7 925]	0,0258
Richest (n_r=47)	7 000	9 548	[6 908 – 12 188]	
Cost of health care when Falcimon® was prescribed				
Total (N=115)	2 300	3 649	[2 722 – 4 540]	
Poorest (n_p=9)	1 650	1 805	[647– 2 964]	0.2308
Richest (n_r=7)	2 200	7 057	[4 583 – 8 697]	
Cost of health care for all types of care				
Total (N=1272)	1 700	3 946	[3 616 – 4 277]	
Very poor (n_p=141)	1 000	3 547	[2 448 – 4 651]	0.0017
Rich (n_r=100)	3 550	7 242	[5 293 – 9191]	

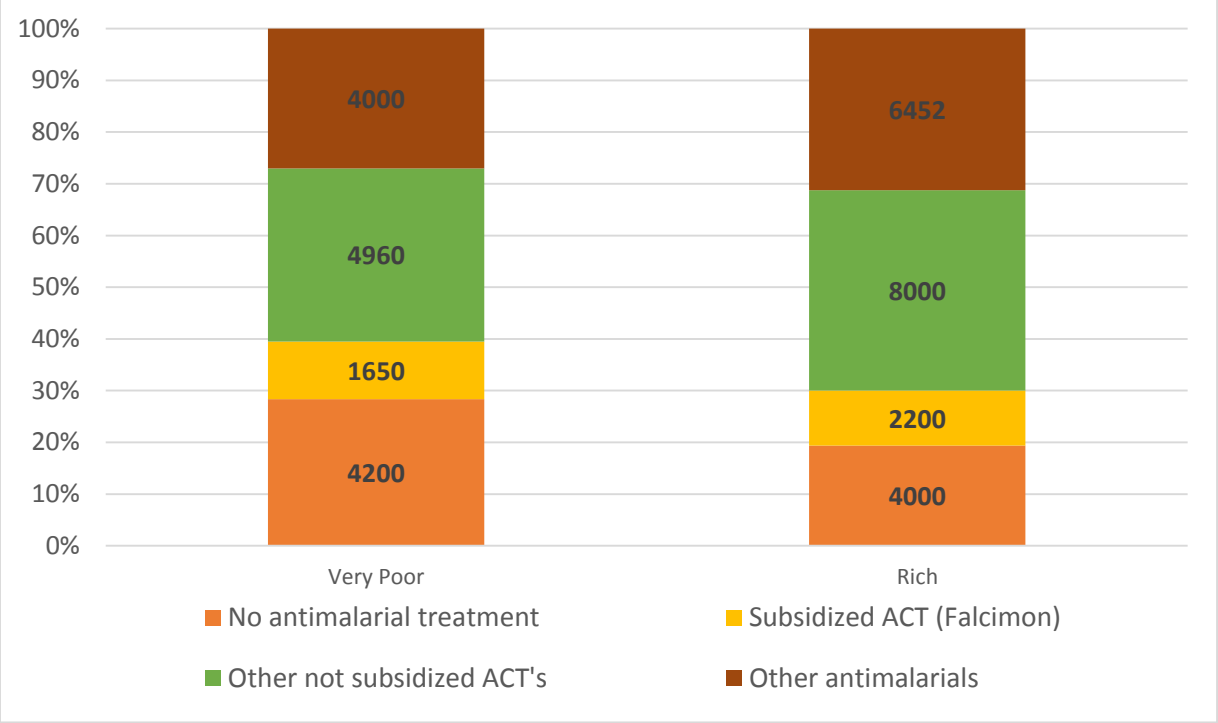
[1] Euro = 655.956 CFA francs in fixed parity.

Transport costs remained relatively low: 273 CFA francs on average for the entire sample. It accounted for 5% of the cost of care when external services were used and over half of resorts produce no extra expenses as patients and their accompanying persons go there on foot. Wealthy households spent more than three times for transport compared to very poor households (809 CFA francs vs 229 CFA francs, p <0.01).

In 2008, the average cost of care (consulting fees + prescription fees) was estimated at 5,743 CFA francs with a median of 4,300 CFA francs (Table 1). The cost of care was higher for households that were prescribed antimalarials (6,018 CFA francs vs 5,165 CFA francs, p <0.08). It was lower for households that were prescribed a subsidized antimalarial drug (Falcimon®) compared with those with a prescription of unsubsidized antimalarials (3,649 CFA francs vs 5,900 CFA francs, p <0.001 for the mean and 4,500 CFA francs vs 2 300 CFA francs for the median). Of the total households that received an antimalarial drug (68%), the proportion of Falcimon® was low (22%), given the subsidy policy. This proportion was 19% for the poor and 15% for the rich.

In the case of fever in children 2 to 10 years of age, the richest households spent on average a total (all cases included) of twice as much (7000 CFA francs) as the very poor households (3500 CFA francs). The median total cost is 3550 CFA francs vs 1000 CFA francs, respectively. When we compare the treatment cost with and without Falcimon®, the median cost was for the richest 2200 and 7000 CFA francs, respectively, and for the poorest 1650 and 2500 CFA francs, respectively (Figure 2 and Table 1). The analysis of the median values shows that prescribing a subsidized antimalarial drug results in a 49% reduction in the cost of care, regardless of the household economic level. This reduction is twice as high for the richest households as for the poorest households (-68% vs -34%).

Figure 2: Median treatment cost in CFA francs, by types of antimalarials prescribed, Dakar, 2008



3.3 Estimating the financial benefit of drug subsidies for households

Based on the health-seeking patterns of the poorest and richest households and the median cost for each type of health care use (Figure 2), we estimated the amount of money saved by buying subsidized drugs. The prescription of the subsidized antimalarial drug resulted in an average reduction of 62% in malaria care costs for a poor household (a gain of 2950 CFA francs) and a 69% reduction for a wealthy household (a gain of 4800 CFA francs). Only 6% of very poor households and 9% of richest households, however, received a prescription of Falcimon®. Using data from all malaria-treated patients, the average patient's gain from subsidized drugs was 506 CFA francs per malaria episode for the very poor and 1080 CFA francs for the richest. In sum, the average cost-saving amount for the richest was twice as high as for the poorest.

A zero-inflated Poisson regression model was used to validate this first result (Table 2). The prescription of Falcimon® decreases the treatment cost (IRR = 0.634; p = 0.001) by almost 60% compared to any other antimalarial drug. Similarly, the cost of care is for the richest households 30% higher than for the very poor households (IRR = 1.296; p = 0.003). The marginal effect of the use of Falcimon® on the cost of fever treatment (Figure 2) shows again that the richest benefited more from the ACT subsidy policy than the very poor. According to model estimates, the average cost reduction for treatment of malaria with Falcimon® is 3058 [8362 - 5304] CFA francs for the rich compared to 2449 [6697 - 4248] CFA francs for the poor (Figure 2 and Table 2). Finally, these two estimates converge and show that the subsidy policy on antimalarials has benefited somewhat more to rich households than to poor households.

We also show that the cost of treating fever is higher if the mother has good knowledge about health (Table 2). This situation is probably due to the fact that these mothers practice self-medication as their first option to treat their children's fever and then consult a health facility. They also come from a well-off background where more money is spent on health (see Table 2, IRR richest households = 1.30, p = 0.003). Conversely, a mother from a poor household with little health knowledge and less access to a family pharmacy will consult directly and more often a doctor if her child has fever.

Table 2: Cost of treating fever (zero-inflated Poisson regression model with robust standard errors)

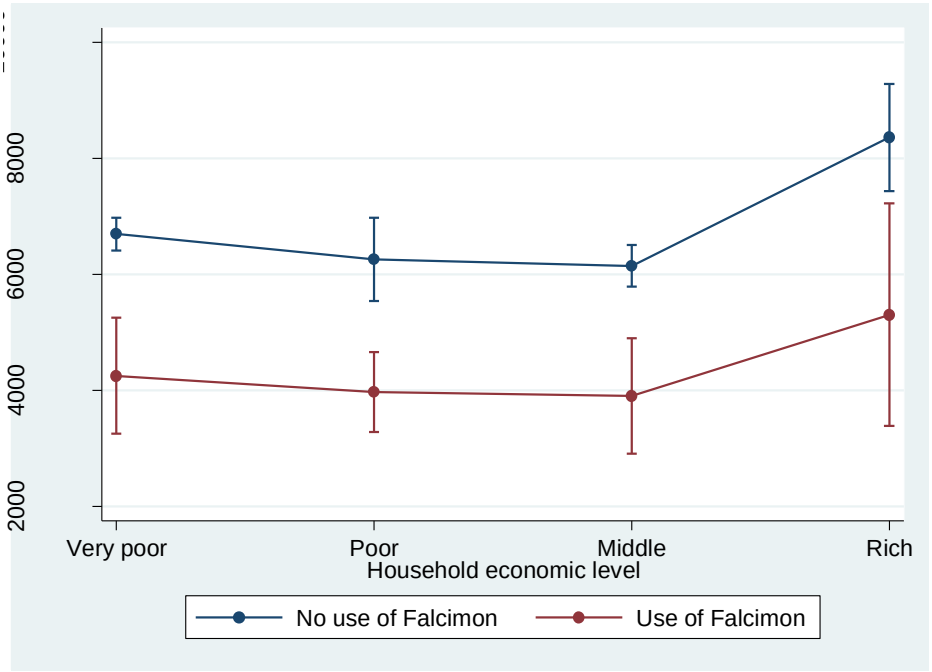
Cost of treating fever (N=444)		**Cost of treating fever**		
Variables		IRR	(95%CI)	Prob
Household economic level				
	Very poor	Ref		
	Poor	1.02	(0.93 – 1.12)	0.655
	Middle	0.98	(0.95 -1.02)	0.318
	Rich**	**1.30**	(1,10- 1.54)	0.003
Recipients of *Falcimon* (Yes vs No)* **		0.634	(0.49 – 0.82)	0.001
Use of public health facilities (Yes vs No)		1.16	(0.97 – 1.38)	0.107
Health knowledge				
	Poor	Ref		
	Fair**	1.16	(1.00 - 1.34)	0.040
	High*	1.16	(0.99 – 1.36)	0.062
Mother's education level				
	No education	Ref		
	Primary	1.07	(0.96 – 1.20)	0.203
	Secondary	1.18	(0.87 – 1.59)	0.287
Perceived frailty of sick child				
	Poor	Ref		
	Fair**	1.29	(1.03 – 1.58)	0.027
	High*	1.39	(0.95 – 2.03)	0.086
Neighborhood economic level				
	Poor	Ref		
	Rich***	1.29	(1.20 – 1.38)	0.000
	Heterogeneous***	1.07	(1.04 – 1.10)	0.000
No cost (Zeros inflation, N=77)			**No cost**	
Household economic level				
	Very poor	Ref		
	Poor*	0.74	(-0.05 – 1.53)	0.066
	Middle**	0.60	(0.06 – 1.14)	0.028
	Rich	0.37	(-1.36 – 2.10)	0.673
Health seeking behavior				
	No recourse to external services	Ref		
	Recourse to public health facilities*	0.37	(-0.05 – 1.53)	0.066
	Recourse to private health facilities**	0.75	(0.17 – 1.32)	0.011
Perceived frailty of the sick child				
	Poor	Ref		
	Fair**	-0.66	(-1.20 - -0.11)	0.018
	High	-0.03	(-0.13 – 0.07)	0.517

***P=0.001; ** Prob= 0.005; * P=0.010.

Table 3: Marginal effects (also see below Figure 3)

	Marginal effects		
By households' standard of living	Values	(95%CI)	Prob.
Poorest X without Falcimon®	6696.58	(6413,37 - 6979,79)	0.000
Poorest X with Falcimon ®	4247.86	(3247,72 -5247,99)	0.000
Poor X without Falcimon®	6261.19	(5544,14 - 6978,23)	0.000
Poor X with Falcimon®	3971.67	(3283,32 - 4660,02)	0.000
Middle X without Falcimon®	6144.75	(5784,58 -6504,93)	0.000
Middle X with Falcimon®	3897.82	(2902,28 -4893,36)	0.000
Rich X without Falcimon®	8361.71	(7438,34 -9285,09)	0.000
Rich X with Falcimon®	5304.10	(3383,38 -7224,83)	0.000

Figure 3: Effects of Falcimon use on the average treatment cost by household economic level



Model A: Marginal effects estimated from the Poisson regression on the cost (excluding transportation costs) of the fever episode and adjusted by Falcimon use, public health facility use, social networks, health knowledge, mother's level of education and the fact that households benefit from health insurance or mutual (see Table 3, results of the regression).

4 Discussion

Our results show that Senegal's policy of subsidizing antimalarial drugs has lowered health care costs, including for the poor, without improving equity. Instead, this policy has benefited the wealthiest more than the poorest households, without even partially alleviating social and financial inequalities.

4.1 Subsidizing antimalarial drugs: a policy to address malaria rather than to reduce health inequalities

Due to the lack of universal health coverage, households can rapidly fall into poverty following catastrophic health expenditures (Xu et al. 2003). A number of countries have responded by implementing subsidized or exempted health care fees at service points. In 2006 Senegal decided to subsidize ACTs, as recommended by the national malaria control program. This paper aims to study the effect of this policy on health expenditures in case of fever and discusses whether this policy turned out to be pro-poor.

Our results showed that this policy had little effect both on health service use and on health spending reduction for the poorest households. Health seeking behaviors by household economic status indicate that the richest people always used more health facilities despite incentives to medical care produced by antimalarial drug subsidizing. Although self-medication is used by nearly half of richest households, it is not an alternative but rather a complement to external health care services, unlike the poorest households for whom self-medication is often the sole care. The rich tend to seek care several times and spend more in case of a fever episode, in particular owing to the diversity of health care providers. A similar result was found in Uganda by Nabyonga (Nabyonga Orem et al. 2011). Our study thus confirms the hypothesis that policies of partial subsidization of health costs and exemption targeted at a disease do not improve health facilities attendance for the poorest.

Partial health financing policies do not fundamentally affect the economic factor which influences the health care decision-making process. Given the inability to diagnose malaria in a child at home, households do not know whether they will benefit from the subsidy until the time of the consultation. Only rich households are better able to take the financial risk of a medical consultation, as they can afford care or have better health coverage (member of a mutual health insurance). Thus they may have the opportunity to benefit from partial financing of care (subsidy or partial exemption). Other studies on several sub-Saharan African countries (McKinnon and coll. 2015; Ponsar and coll. 2011) found similar results.

The antimalarial drug subsidy policy was intended for the whole Senegalese population, without targeting vulnerable groups in particular. It sought to improve access to health care for the overall population (and thus for the poorest) rather than curbing health inequalities (Rose, 1992). However, this population-based approach does not take into account that rich households are more capable to convert redistributed resources provided through public health interventions into health outcomes by actually resorting more to health facilities (Frohlich and Potvin, 2008 and 2010). Our previous analyzes on Dakar showed that social health inequalities can be reduced by strengthening the capabilities of the poor. This may occur by increasing the opportunities of their living environment and their ability to access medical facilities and effectively use them, due to removal of financial barriers and through human and social networking (Koné et al. 2015). Vertical equity (funding of the patients' medical care according to their means) could be improved if subsidy or fee exemption policies were only aimed at benefiting the poorest.

Once the decision is made to go to a health facility, the very poor do not benefit more than the richest from subsidized treatment. Contrary to our expectations, Falcimon® was very little prescribed (less than 22% of households): this is true for both rich and poor alike, even though the prescription of this drug greatly reduces the cost of malaria treatment.

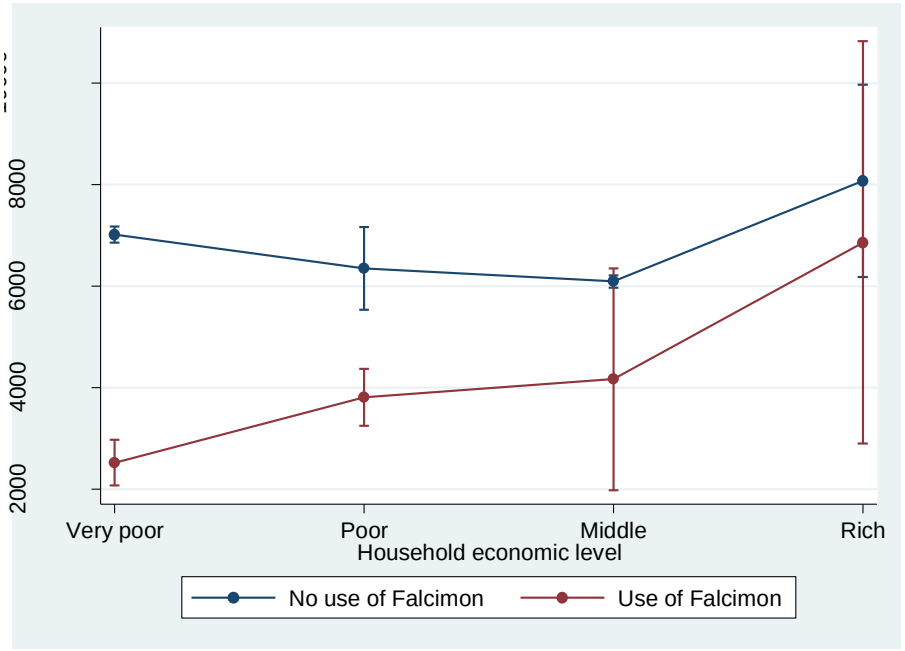
For the wealthiest patients, who were used to consuming expensive medicines, the purchase of Falcimon® led to a very substantial cost reduction (- 4,800 CFA francs versus - 2,950 CFA francs for the poorest). However, these financial gains decrease considerably, once distributed over all the patients treated for malaria, and benefit rich patients (- 1080 CFA francs compared to - 506 CFA francs).

4.2 What would be the financial benefits if the subsidy policy of the antimalarial treatment targeted the poorest?

The impact of the subsidy policy on health behavior is difficult to assess in an urban context where health services are already heavily used and because our household survey took place two years its inception. However, the subsidy policy of an antimalarial treatment probably had little effect on Dakar households' health behavior whether poor or rich. This argument is based on the fact that patients, not knowing about their illness, were also unaware of whether they would be able to benefit from the subsidy at the time they decided to consult a doctor. It is therefore very likely that poor households did not opt for health care use according to the subsidy policy of antimalarials in Dakar in 2008.

However, would subsidies have benefited the poor more if there had been a greater promotion of the subsidized drug and a stronger support of health providers to this policy? We therefore simulated the situation where poor households use health services more. The greater consumption of Falcimon® by households would have led to a greater treatment cost reduction for the poorest (- 4,496 CFA francs), compared to the richest (-1,212 CFA francs), as shown in Figure 4 and Annex 3.

Figure 4: Effect of mass use of Falcimon® on treatment costs



Model B : Model A adjusted by the interactive variable : Household economic level x Recipients of Falcimon®

A study on the availability of Falcimon® in Senegal showed that private pharmacies provided little support in commercializing this drug. They argued that the profit margin was lower compared to margins for other ACTs. Doctors were reluctant about inappropriate dosage forms (tablets) available for infants and young children as well as adverse side effects of amodiaquine (vomiting, dizziness, etc.) (Koné et coll. 2007).

Finally, some households, who were questioned about their perception of Falcimon®, would rather no longer receive this treatment because of the large number of tablets (24) and the risks of vomiting. The reluctance of health staff to give ACTs was not specific to Dakar or Senegal. Same attitudes were reported in Benin (Nahum et al. 2010; Wang et al. 2006).

5 Conclusion

Strong inequalities in health care access persist between rich and poor in urban areas given disparities in the living environment and household socioeconomic status. Contrary to expectations, the subsidy policy of Falcimon® has had only a very limited effect in reducing inequalities in access to effective antimalarial treatment. The policy set up in Senegal in 2006 was designed as an instrument for fighting malaria. However, it benefited more the rich than the poor in Dakar.

The only positive effect of the Falcimon® subsidy policy was to increase access to a very effective malaria treatment for the poorest. This subsidy policy was aimed more at addressing public health issues than reducing poverty. However, we showed that if Falcimon® had been

more prescribed by health care staff, then this policy would have been pro-poor and far more equitable than it actually was.

In recent years, the international community has made more efforts to expand universal health coverage (UHC) for the poorest and most vulnerable populations, given the greater impact of UHC in tackling poverty and disease compared with other ways of financing health. Experiences from Rwanda, Ghana, Egypt, the Philippines and India (State of Andhra Pradesh) seem to have been very successful (Nyandekwe et al. 2014; Peltzer et al. 2014). For the moment, partial and targeted exemption based on health vulnerability criteria remains the second best option for many African countries (Mali, Niger, Burkina Faso, Cote d'Ivoire, Cameroon). Our study shows that when state solidarity, through tax revenues and international aid, financially supports the most vulnerable groups (children, elderly people and pregnant women, …), it may not contribute in reducing financial inequalities in health care access. We therefore recommend that universal health coverage, currently implemented in Senegal, should seek to mitigate economic inequalities in access to health care for the poorest (by vertical solidarity mechanisms) as well as to improve the health outcomes for the whole population.

References

Bradshaw J. Methodologies to Measure Poverty: More than one is best. . *Paper presented at International Symposium Poverty: Concepts and Methodologies,* Mexico City Unpublished Document.

Bradshaw J, Finch N. Core Poverty *Paper presented at Seminar at Centre for the Analysis of Social Exclusion* LSE, London Unpublished Document.

Chatterjee S, Hadi AS. 2015. *Regression analysis by example*. John Wiley & Sons.

Chauvin P, Parizot. 2009. Les inégalités sociales et territoriales de santé dans l'agglomération parisienne: une analyse de la cohorte SIRS. In: DIV Edl (ed). *Les documents de l'ONZUS.* Paris.

Creese A. 1997. *User fees limited success at managing demandProfound effects on access*.

Delhausse B. 2002. Noyau dur de la pauvreté en Wallonie: Une actualisation. *Reflets et perspectives de la vie économique* **4**: 55-63.

Diagne OD, FAYE O, FAYE S. Le Noyau dur de la pauvreté au Sénégal. *Paper presented at 4th PEP Research Network General Meeting,* Clombo, Sri Lanka. Unpublished Document.

Diallo A, Ndam NT, Moussiliou A et al. 2012. Asymptomatic carriage of plasmodium in urban Dakar: the risk of malaria should not be underestimated. *PLoS One* **7**: e31100.

Diallo S, Konate L, Ndir O et al. 2000. Malaria in the central health district of Dakar (Senegal). Entomological, parasitological and clinical data. *Sante* **10**: 221 - 29.

Diallo S, Ndir O, Faye O et al. 1998. Malaria in the southern sanitary district of Dakar (Senegal). 1. Parasitemia and malarial attacks. *Bull Soc Pathol Exot* **91**: 208 - 13.

Drame PM, Machault V, Diallo A et al. 2012. IgG responses to the gSG6-P1 salivary peptide for evaluating human exposure to Anopheles bites in urban areas of Dakar region, Senegal. *Malaria Journal* **11**: 72.

Filmer D, Scott K. 2008. Assessing Asset Indices. World Bank

Fournier P, Haddad S, al. 2011. Qui bénéficie de la gratuité de la césarienne dans les pays à faibles ressources ? Une étude en milieu rural à Kayes (Mali). In: CERDi (ed). *3e Colloque International. Financement de la santé dans les pays en développement et émergents.* Clermont-Ferrand; France.

Franckel A, Arcens F, Lalou R. 2008. Contexte villageois et recours aux soins dans la région de Fatick au Sénégal. *Population (French Edition)* **3**: 531-53.

Graubard BI, Korn EL. 1999. Predictive margins with survey data. *Biometrics* **55**: 652-59.

Greene WH. 2012. Econometric Analysis, 71E. *Stern School of Business, New York University*.

Haddad S, Fournier P. 1995. Quality, cost and utilization of health services in developing countries. A longitudinal study in Zaïre. *Social Science & Medicine* **40**: 743-53.

Hilbe J. 1999. Robust variance estimators for MLE Poisson and negative binomial regression. *Stata Technical Bulletin* **8**.

James C, Morris SS, Keith R, Taylor A. 2005. Impact on child mortality of removing user fees: simulation model. *BMJ* **331**: 747-9.

Johri M, Ridde V, Heinmuller R, Haddad S. 2014. Estimation of maternal and child mortality one year after user-fee elimination: an impact evaluation and modelling study in Burkina Faso. *Bull World Health Organ* **92**: 706-15.

Jouquet G, Frédérique P, Seco G et al. 2011. Analysing cost, outcome and impact of different subvention strategies to improve uptake of malaria treatment in Kangaba, Mali In: CEDI (ed). *3e Colloque international. Financement de la santé dans les pays en développement et émergents.* Clermont-Ferrand, France.

Koné G, Mak G, Haddad S, RIDDE V. 2011. Les coûts des consultations curatives des enfants de moins de 5 ans dans un contexte de gratuité des traitements antipaludiques dans quatre cercles du Mali. In: CERDI (ed). *3e Colloque international. Financement de la santé dans les pays en développement et émergents.* Clermont-Ferrand ; France.

Koné G, Ndonky A, LALOU R, LE HESRAN JY. 2007. ACT subventionnée mise en vente dans les officines privées : expérience du Sénégal. Institut de Recherche pour le Développement (IRD).

Koné GK, Lalou R, Audibert M et al. 2015. Use of health care among febrile children from urban poor households in Senegal: does the neighbourhood have an impact? *Health Policy Plan*.

Machault V, Vignolles C, Pages F et al. 2010. Spatial heterogeneity and temporal evolution of malaria transmission risk in Dakar, Senegal, according to remotely sensed environmental data. *Malar J* **9**: 252.

Masiye F, Chitah BM, McIntyre D. 2010. From targeted exemptions to user fee abolition in health care: experience from rural Zambia. *Soc Sci Med* **71**: 743-50.

Meessen B, Hercot D, Noirhomme M et al. 2011. Removing user fees in the health sector: a review of policy processes in six sub-Saharan African countries. *Health Policy and Planning* **26**: ii16-ii29.

MSPHP, CAFSP. 2005. Comptes Nationaux de la Santé du Sénégal, année 2005. Ministère de la Santé et de la Prévention et de l'Hygiene Publique du Sénégal.

MSPHP/Sénégal. 2008. Carte sanitaire 2008 du Sénégal. Ministère de la Santé et de la Prévention et de l'Hygiene Publique du Sénégal.

Nabyonga J, Desmet M, Karamagi H et al. 2005. Abolition of cost-sharing is pro-poor: evidence from Uganda. *Health Policy and Planning* **20**: 100-08.

Nabyonga Orem J, Mugisha F, Kirunga C, Macq J, Criel B. 2011. Abolition of user fees: the Uganda paradox. *Health Policy and Planning* **26**: ii41-ii51.

Nahum A, Erhart A, Mayé A et al. 2010. Malaria Incidence and Prevalence Among Children Living in a Peri-Urban Area on the Coast of Benin, West Africa: A Longitudinal Study. *The American Journal of Tropical Medicine and Hygiene* **83**: 465-73.

Ndiaye S, Ayad M. 2006. Enquête Démographique et de Santé, Sénégal 2005. Ministère de la Santé et de la Prévention Médicale.

Nyandekwe M, Nzayirambaho M, Baptiste Kakoma J. 2014. Universal health coverage in Rwanda: dream or reality. *Pan Afr Med J* **17**: 232.

Pages F, Texier G, Pradines B et al. 2008. Malaria transmission in Dakar: A two-year survey. *Malaria Journal* **7**: 178.

Peltzer K, Williams JS, Kowal P et al. 2014. Universal health coverage in emerging economies: findings on health care utilization by older adults in China, Ghana, India, Mexico, the Russian Federation, and South Africa. *Glob Health Action* **7**: 25314.

Prothero R. 1977. Disease and mobility: a neglected factor in epidemiology. *Int J Epidemiol* **6**: 259 - 67.

Raciborski R. 2011. Right-censored Poisson regression model. *Stata Journal* **11**: 95.

Ridde V, Morestin F. 2011. Une recension des écrits scientifiques sur l'abolition des frais aux usagers dans les services de santé en Afrique.

Ridde V, Queuille L. 2010. User fees exemption: One step on the path toward universal access to healthcare. University of Montreal

Roubaud F, Razafindrakoto M. 2005. Les multiples facettes de la pauvreté dans un pays en développement. Le cas de la capitale malgache. *Economie et statistique*: 131-55.

Sahn DE, Stifel DC. 2000. Poverty Comparisons Over Time and Across Countries in Africa. *World Development* **28**: 2123-55.

Searle SR, Speed FM, Milliken GA. 1980. Population marginal means in the linear model: An alternative to least squares means. *The American Statistician* **34**: 216-21.

Selvin S. 2004. *Statistical analysis of epidemiologic data*. Oxford University Press.

Sen A. 1993. Capability and well-being. *The quality of life* **37**: 30 - 53.

Sen A. 1999. Commodities and capabilities. *OUP Catalogue*.

Souares A, Lalou R, Sene I, Sow D, Le Hesran J-Y. 2009. Factors related to compliance to anti-malarial drug combination: example of amodiaquine/sulphadoxine-pyrimethamine among children in rural Senegal. *Malaria Journal* **8**: 118.

Trape J, Lefebvre-Zante E, Legros F et al. 1992. Vector density gradients and the epidemiology of urban malaria in Dakar, Senegal. *Am J Trop Med Hyg* **47**: 181 - 89.

Vercruysse J, Jancloes M, Velden L. 1983. Epidemiology of seasonal falciparum malaria in an urban area of Senegal. *Bull World Health Organ* **61**: 821 - 31.

Wang SJ, Lengeler C, Smith TA et al. 2006. Rapid Urban Malaria Appraisal (RUMA) IV: epidemiology of urban malaria in Cotonou (Benin). *Malar J* **5**: 45.

WHO. 2010. Le financement des systèmes de santé: Le chemin vers une couverture universelle. Wolrd Health Organization (WHO).

Xu K, Evans DB, Kadama P et al. 2006. Understanding the impact of eliminating user fees: Utilization and catastrophic health expenditures in Uganda. *Social Science & Medicine* **62**: 866-76.

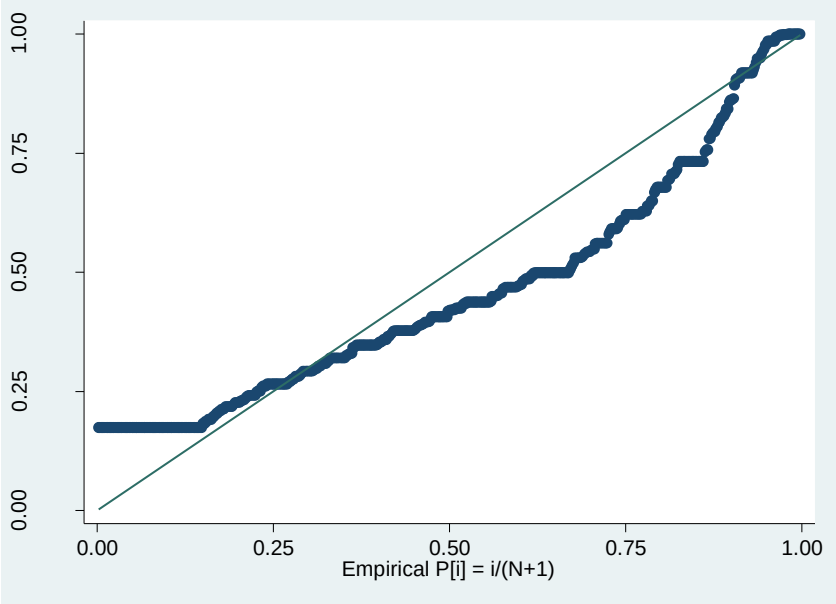
Xu K, Evans DB, Kawabata K et al. 2003. Household catastrophic health expenditure: a multicountry analysis. *The Lancet* **362**: 111-17.

Yates R. 2009. Universal health care and the removal of user fees. *Lancet* **373**: 2078-81.

Annex1: Cost of fever treatment for children 2 to 10 years among very poor and rich households

Annex 2: Normality test of the dependent variable

1-test graph



2- test swik

```
. swilk Cout_Soins_épi_ST  if m126==1 & antipalu!=0

                  Shapiro-Wilk W test for normal data

    Variable |   Obs       W           V         z       Prob>z
-------------+--------------------------------------------------
Cout_Soins~T |   525     0.79733     71.240    10.277     0.00000
```

Annex 3: Zero-inflated Poisson regression with robust standard errors for the cost of fever episode. Marginal effects are shown in Figure 4 - Simulation of a high use of Falcimon® for the very poor

Cost of fever episode (N=444)	IRR	Robust standard-error	P>z	[95%CI]	
Household economic level					
Poor	0,987899	0,038481	0,755	0,915284	1,06628
middle	0,928550	0,011531	0,000	0,906222	0,95143
Rich	1,194775	0,054835	0,000	1,091993	1,30723
Recipients of Falcimon®	0,359308	0,036561	0,000	0,294342	0,43861
Use of public health facility	1,155937	0,100861	0,097	0,974232	1,37153
Health knowledge					
Fair	1,161069	0,078747	0,028	1,016547	1,32614
High	1,152579	0,089248	0,067	0,990283	1,34147
Mother's education level					
Primary	1,065232	0,043000	0,117	0,984202	1,15293
Secondary	1,177897	0,173434	0,266	0,882624	1,57195
Perceived frailty of the sick child					
Fair	1,264595	0,143429	0,038	1,012532	1,57941
High	1,374898	0,264679	0,098	0,942774	2,00509
Neighborhood economic level					
Rich	1,303591	0,066891	0,000	1,178865	1,44151
Heterogeneous	1,069120	0,026584	0,007	1,018265	1,12251
Household economic level X Falcimon®					
Poor X Falcimon®	1,667355	0,296864	0,004	1,176187	2,36363
Middle X Falcimon®	1,902481	0,309706	0,000	1,382780	2,61751
Rich X Falcimon®	2,365179	1,102968	0,065	0,948239	5,89943

_cons	4536,637	625,1441	0,000	3462,895	5943,315
No cost (Zeros inflation, N=77)	IRR	Robust Standard Error	P>z	[95%CI]	
Household economic level					
Poor	0,7385365	0,4018977	0,066	-0,0491687	1,526242
Middle	0,6045456	0,2753351	0,028	0,0648988	1,144192
Rich	0,3729249	0,8832832	0,673	-1,358278	2,104128
Health seeking behavior					
Use of public health facility	0,3684676	0,258165	0,154	-0,1375264	0,8744616
Use of private health facility	0,7482122	0,2935002	0,011	0,1729624	1,323462
Perceived frailty of the sick child					
Fair	-0,6562659	0,2773559	0,018	-1,199873	-0,1126583
High	-0,0326576	0,0504335	0,517	-0,1315055	0,0661902
_cons	-2,455805	0,4164266	0,000	-3,271986	-1,639624
Marginal effects *			Prob	[95%CI]	
Very poor X without Falcimon®	7017,12		6860,57	7173,67	6979,79
Very poor X with Falcimon ®	2521,31		2074,20	2968,41	5247,99
Poor X without Falcimon®	6351,18		5533,09	7169,28	6978,23
Poor X with Falcimon®	3804,95		3243,84	4366,06	4660,02
Middle X without Falcimon®	6091,26		5971,49	6211,03	6504,93
Middle X with Falcimon®	4163,84		1980,77	6346,91	4893,36
Rich X without Falcimon®	8076,38		6184,30	9968,47	9285,09
Rich X with Falcimon®	6863,53		2901,41	10825,64	7224,83