Abstract: Barriers Associated with Misuse of Laboratory in Antenatal Care in Senegal: A Quantitative Approach Maternal mortality remains high in developing countries; however laboratory can help to fight against this problematic situation. In Senegal, six (6) tests are recommended by the national program, for antenatal screening. This study aimed to identify barriers regarding utilization of laboratory, by pregnant women, during antenatal care (ANC), in Senegal. A cross-sectional study was conducted in 16 peripheral health facilities, 12 health centers and 4 hospitals (EPS1). Data were collected, amongst 1692 pregnant women, 61 midwives, 99 laboratory staffs and 16 administrators, from February 2013 to July 2014. Pregnancy age, gestity, parity, pregnant age, ANC location were variables studied from pregnant women. From the laboratory, timely accessibility, concordance of opening hours with ANC services, availability of reagents and equipments, skilled laboratory staff, acceptability of results delivery, tests prices visibility, confidentiality and adequacy of infrastructures, were investigated. From ANC, waiting time, availability of skilled midwives and guidelines, adequacy of waiting rooms and infrastructures, were studied. Data were entered in Microsoft Excel version 2013 and Open Clinica 3.1.3, then exploited and analyzed in SPSS version 20. Laboratory misuse was 87.88% among 1692 pregnant women who went to the facilities for the first ANC visit. The whole population had 25.25 ±6.19years [20-29 years] (55%), first pregnancy trimester (54%), multigest (66%), multiparous (42%), had frequented health centers (75%). In the multivariate model, variables independently associated with laboratory use were: gestity, parity (more than 3), confidentiality, affordability of tests prices, availability of guidelines and health center level. Most of the barriers are supply-health systems. It is then important to take into account these results, to sensitize pregnant women, health personnel and authorities for a better use of the laboratory during antenatal care.

Keywords: Laboratory Use, Barriers, Antenatal Care, Maternal Mortality, Senegal

1. Introduction

According to WHO, women must be able to have access to the right care, at the right time. This right care includes antenatal services during pregnancy, assistance by a skilled manpower, during antenatal care (ANC) visits, the delivery period and the support during weeks after [1]. Despite this declaration, and all efforts provided by governments, access to care remains challengeable. Indeed, access is facing several barriers, worldwide, in Africa [2; 3] Asia [4], Europe
Barriers have been defined as challenges that people are facing, in accessing health services [7]. Laboratory, as integral part of antenatal services, might suffer specific barriers to be investigated. Laboratory screening tests from the first trimester of pregnancy is part of the package for appropriate prevention and care continuum and diagnosis of diseases that may affect mother’s health and her child [1]. Studies have already qualified laboratories as barriers to effective health care [8], and paradoxically, the laboratory was also considered as The “Achilles Heel” of Global Efforts to fight Infectious Diseases, like HIV, tuberculosis, malaria and antimicrobial resistance, since 2005, as barriers.

Most studies about barriers focused on individual tests, linked to vertical (mother-child) transmission of syphilis [10; 11], HIV [12; 13] and hepatitis B [14]. Others are related to anemia screening [15]. Cost of tests [9], lack of knowledge about screening in health benefits [9], poor communication between pregnant women, laboratory and ANC providers [10;11], low level of qualification of the health staff, lack of training and motivation of the health personnel [15, 16], equipment and reagents supplies and storage [9;10;16], poor accessibility to clinics (geographical and functional), late enrollment of pregnant women in ANC, fear of social stigma and discrimination [10; 14], delay in seeking treatment have also been reported, as barriers.

Laboratory, as important part of health services, plays a central role, in the diagnosis and prevention of diseases [8; 17]. Appropriate laboratory use may contribute to decrease or alleviate maternal morbidity and mortality. For that, strong and well organized health systems, built around fundamental dimensions defined as accessibility, availability, affordability, acceptability, adequacy and awareness [18] are required.

In Senegal, maternal mortality rate is still high (315/100 000) [19]. A national program of reproductive health, to prevent maternal mortality has been implemented since 2005, and laboratory has been involved in this process. A minimum of six (6) screening tests is required during the first ANC visit: Blood Group and Rhesus Factor, Hemogram, Emmel Test to screen for sickle cell anemia HIV serology, Protein urine test and Syphilitic serology [20]. In the context of fighting against maternal mortality, this study was conducted to identify barriers associated with the use of the laboratory, by pregnant women in Senegal, for antenatal screening.

2. Patients and Methods

2.1. Context of the Study

This study is part of SOCIALAB project– Addressing Social, Cultural and Historical, Factors Limiting the Contribution of Medical Laboratory services to antenatal care in West Africa -, funded by Amsterdam Institute for Global Health and Development (AIGHD) and The Netherlands Organization for Scientific Research (NWO/WOTRO), based at the Direction of Laboratories of Senegal.

2.2. Study Population and Sites

Senegal's health system is pyramidal, with three main levels, administratively: a central, regional and a peripheral level. The central level contains the minister's office, branches, and related services. The regional level is known as the "medical region", an administrative region that addresses healthcare services within a given region. The peripheral level is known as the "health district", with each district having at least one health center and a network of smaller centers. The technical organization is divided into five levels: national hospitals, regional hospitals, districts health centers, health posts and health huts.

The study was conducted in 10 regions (out of 14 in the country), precisely in 16 peripheral structures, including 12 Health Centers (HC) and 4 Hospitals (HOSP). These are the HC of Cambereone (CA), Dagana (DA), Diamniadio (DI), Gaspard Kamara (GK), Gossas (GO), HLM (HLM), Kasnack (KA), Khombole (KH), Kedougou (KE), Mbacké (MBA), Gaspard Kamara (GK), Gossas (GO), HLM (HLM), Kasnack (KA), Khombole (KH), Kedougou (KE), Mbacké (MBA), Tambacounda (TA), Ziguinchor (ZI), HOSP of Mbour (MOB), Roa Baudouin (RB), Richard Toll (RT) and Sedhiou (SE). Facilities were randomly selected.

All health facilities had a functional laboratory service. Additionally, the study covered a sample of 61 midwives, 99 laboratory health workers, 16 administrators and 1692 pregnant women visiting health facilities, during their first ANC visit (ANC1).

2.3. Type of Research

It was a quantitative research through cross-sectional study, where data were collected in a standardized way.

2.4. Data Collection

2.4.1. Tools

Five tools, previously tested, in a pilot study, in two structures, in the Region of Dakar (a health center and a hospital), corrected and then validated, were used, as collection tools. Each tool was especially developed for the purpose of the study, for each target. The ANC1 tool, composed by 48 questions, allowed to appreciate both, the demand and use of services, was applied to midwives working in ANC centers. The ANC2 tool, composed by 60 questions, measured the level of knowledge of midwives regarding tests recommended, was applied to midwives working in ANC services. Laboratory tool, composed by 63 questions, gave information about laboratory productivity, compared with others resources, human resources, internal organization, logistics (Infrastructures, equipments and reagents), were applied to laboratory staff. Finances toll, with 45 questions, allowed to evaluate financial laboratory resources compared to others services, was applied to administrators and health committees. Study card tool, composed by 52 questions, was the simulation of the health record. It traces pregnant women circuit, tests requested, laboratory use by tests results, appropriate care, based on biological results. For all tools, questions were closed, opened, or observational.
2.4.2. Data Collection Process
Before data collection, all selected structures received, from the Direction of Laboratories, an information letter about their participation, the objectives of the study and the program of activities. In each structure, before the beginning of the activities, an opening meeting was organized with the study population (ANC, laboratory, administrators), by the senior researcher. The presentation of the study, the objectives, the tools, the data collection process and all information regarding study duration and expectations, were done. Midwives were also trained, on the way to fill out the tools, particularly the study card, by the senior researcher (AMS). During 5 opening days, midwives were supervised to fill out the study card, at the arrival of pregnant women, and after informed consent.

The study card design has 4 columns. The first one, filled by midwives, informs about demographic characteristics and obstetric past history of the pregnant woman. A list of tests was included. Midwives are required to only tick tests usually requested, in a faithful way (First column). After that, pregnant women brought the study card filled, to the laboratory, for screening tests. In the laboratory, the responsible confirmed the availability or not, of tests and ticked them (2nd column). Available laboratory results were then notified above (3rd column). After that, the study card was sent again to midwives, waiting for the arrival of pregnant, for appropriate care, based on biological results, or dietary advice, etc. (4th column). However, these steps required pregnant women presence in the laboratory and ANC services. All pregnant women had two identification numbers, internal (facility) and external (study). As soon as the quota of 100 cards per structure was reached, the midwives sent them to the research team. A total of 1692 pregnant women were recruited, from February 2013 to July 2014. The others tools, ANC, laboratory and finances, were directly applied to the targets, with closed questions and observations. Appropriate information was collected by research assistants, during five (5) opening days. The quality control and the validation of collected data were daily carried out by the researcher.

The methodological approach also included an exhaustive review of the documents published in PubMed, Scholar and Public Health, and the gray literature, including various national policy documents, standards and national strategy procedures, followed by an active analysis.

2.4.3. Variables of Study
Variables studied from pregnant women, were ANC location, demographic characteristics and obstetric past history: pregnant age, gestity, parity, pregnancy age.

Variables studied from laboratory services were: opening days, opening hours, same-day results; availability of reagents and equipments, skilled laboratory technician, infrastructures (waiting, sampling and technical rooms); confidentiality during results delivery; affordability and visibility of test prices. Data collected regarding antenatal care were: waiting time; availability of skilled ANC attendant, national guidelines, antenatal consultation rooms; adequacy of ANC reception in terms of logistics and comfort.

The test prices was dichotomized in two categories, for the purpose of the statistical analyses in less than and superior to 18 USD (<10,000 FCA). Only official prices, validated, by health facilities, were considered.

Availability of skilled human resources was compared with national norms. At peripheral level, the standard requires at least one laboratory technician with university level, and at least 4 skilled midwives for health centers and 6 for hospitals [21].

Waiting times for antenatal visit were determined, based on the time spent by a pregnant woman, since her arrival at the facility, until she finished the visit. The arrival time was mentioned electronically on the payment receipt; the departure time was collected by the research assistant after the ANC visit. This variable was categorized to less than 60 minutes and more than 60 minutes for the analysis. More than 60 minutes were considered as long waiting time.

Laboratory use is normal when all 6 tests have been made in the laboratory, otherwise it is considered as misuse.

2.4.4. Data Entry and Analysis
Data were entered into Open Clinica version 3.1. After the entry, quality control was carried on a random sample of 10%. Univariate, bivariate and multivariate stepwise regression analyses were realized. P-values of less than 0.05 were considered to be statistically significant. The odd ratios were computed with 95% Confidence Interval (CI).

2.4.5. Ethical Considerations
The protocol was approved by the National Ethics Committee of Senegal (CNES) (SEN13/09).

3. Results

3.1. Characteristics of the Population and Sites
The women had a mean age of 25.25 ± 6.19 years. They were mostly in their first trimester (54%), multigest (66%) and multiparous (42%) (Table 1).

| Variable                  | n  | %   |
|---------------------------|----|-----|
| Pregnant women            | 1692|     |
| Mean age ±SD, years       | 25.25 ±6.19 |     |
| Extreme ages, years       | 15-47|     |
| Age ranges:               |    |     |
| <20                       | 305 | 19  |
| 20-29                     | 890 | 55  |
| 30-39                     | 387 | 24  |
| 40-49                     | 38  | 2   |
| Period of first ANC visit |     |     |
| First trimester           | 906 | 54  |
| Second trimester          | 619 | 37  |
| Third trimester           | 124 | 7   |
| >Third trimester          | 30  | 2   |
| Gestity                   |     |     |
| Primigest                 | 583 | 35  |
| Multigest                 | 1109| 66  |
| Parity                    |     |     |
| None                      | 629 | 38  |
| 1                         | 349 | 21  |
| 2                         | 279 | 17  |
| ≥3                        | 407 | 25  |

Table 1. Demographic characteristics of the pregnant women.
The majority of pregnant women had their first ANC visit in health centers (75%). The ANC health personnel were mainly composed by skilled midwives (51%). Waiting time was higher in health centers (123.58 ± 60.56 min) compared to Hospitals (69.25 ± 23.94 min). Laboratory services were composed by skilled laboratory technicians (31%) of laboratory staff. Tests prices were higher in hospitals (19.77±4.48 USD) compared to Health (17.20±5.32 USD). (Table 2).

### Table 2. Characteristics of health facilities.

| Variable                                           | n    | %   |
|----------------------------------------------------|------|-----|
| Health level                                       | 1280 | 75  |
| Health Center                                      |      |     |
| Hospital                                           | 412  | 25  |
| Characteristics of ANC services                    |      |     |
| ANC attendant                                      | 61   |     |
| Midwives - mean ±SD: 3.81±0.95                     |      |     |
| Skilled midwives                                   | 31   | 51  |
| Waiting time                                       |      |     |
| Mean ±SD =110 ±58.27                              |      |     |
| < 60 min                                           | 1269 | 75  |
| > 60 min                                           | 423  | 25  |
| Health Center (Mean ±SD)=123.58± 60.56             |      |     |
| Hospital (Mean ±SD)= 69.25 23 94                   |      |     |
| Characteristics of Laboratory services             |      |     |
| Laboratory staff                                   | 99   |     |
| Mean ±SD: 2.58±2.64                                |      |     |
| Skilled laboratory staff                           | 31   | 31  |
| Tests prices                                       |      |     |
| <18 USD (10 000 FCA)                               | 950  | 56  |
| ≥18 USD (10 000 FCA)                               | 742  | 43  |
| Overall (Mean ±SD) USD:17.85 ± 3.91 (9000 ±2189 FCFA) |      |     |
| Health center (Mean ±SD)USD:17.20 ± 5.32 (9600 ± 2926 FCFA) |      |     |
| Hospital (Mean ±SD) USD 19.77±4.48 (11 000 ±2508 FCFA) |      |     |

### Table 3. Results of bivariate analyses.

| Characteristics of pregnant women                  | Laboratory use | p-value |
|----------------------------------------------------|----------------|---------|
| Pregnant age                                        |                | 0.793   |
| <20                                                | 36             | 17      |
| 20-29                                              | 107            | 16      |
| 30-39                                              | 49             | 18      |
| ≥40                                                | 3              | 12      |
| Period of first ANC visit                          |                | 0.226   |
| First trimester                                    | 107            | 16      |
| Second trimester                                   | 70             | 15      |
| Third trimester                                    | 21             | 23      |
| >Third trimester                                   | 04             | 21      |
| Gestity                                            |                | 0.002   |
| Primigest                                          | 99             | 21      |
| Multigest                                          | 105            | 14      |
| Parity                                             |                | 0.018   |
| 0                                                  | 58             | 12      |
| 1                                                  | 47             | 18      |
| 2                                                  | 39             | 20      |
| ≥3                                                 | 59             | 20      |
| Type of structure                                  |                | 0.006   |
| Hospital                                           | 56             | 05      |
| Health center                                      | 149            | 15      |
| Laboratory services                                |                |         |
| Timely laboratory access                           | 35             | 14      |
| Same day result                                    | 180            | 19      |
| Concordance laboratory and ANC services            | 153            | 18      |
| Reagents                                           | 157            | 17      |
| Appropriate Technical and sampling rooms           | 03             | 03      |
| Skilled laboratory staff                           | 133            | 17      |
| Equipment                                          | 49             | 27      |
| Visibility of tests fees                           | 107            | 17      |
| Confidentiality                                    | 177            | 18      |
| Price of the tests                                 | 125            | 21      |
| Antenatal services                                 |                | 0.001   |
| Adequacy of ANC infrastructures                    | 77             | 14      |
| Waiting time                                       | 35             | 14      |
| Availability of guidelines                         | 03             | 03      |
| Skilled ANC attendant                              | 34             | 8       |

3.2. Laboratory Misuse

Globally, among the whole population of women, the frequency of laboratory utilization varied according to the tests: Blood Group (64%), Hemogram/Blood Count (59%), Emmel Test to screen for sickle cell anemia (64%), Syphilitic serology (70%), HIV serology (39%) and Protein urine test (7%) (data not shown).

Laboratory misuse was observed among 1487 women regarding the 6 tests requested with a frequency of 87.88%. In the bivariate analysis, variables independently associated with laboratory use were: gestity, parity, type of structure, same day results, coordinated ANC and laboratory opening hours, availability of equipments, appropriate technical and sampling rooms, confidentiality, tests fees, adequacy of ANC infrastructures, availability of guidelines and skilled ANC attendant (Table 3).

### Table 4. Results of the multivariate analysis.

| Characteristics of pregnant women                  | OR       | IC (95%) |
|----------------------------------------------------|----------|----------|
| Parity                                             | 0.658    | 0.434-0.999 |
| None                                               | 0.982    | 0.627-1.539 |
| 1                                                  | 1.026    | 0.638-1.651 |
| ≥3                                                 | -        | -        |
| Gestity                                            | 0.583    | 0.424-0.802 |
| Primigest                                          | -        | -        |
| Multigest                                          | -        | -        |
| Characteristics of laboratory services             | 0.321    | 0.164-0.667 |
| Confidentiality                                    | 0.608    | 3.714-24.854 |
| Affordability of tests prices                      | 0.062    | 0.016-0.238 |
| Characteristics of antenatal services              | 0.056    | 0.353    |
| Availability of guidelines                         | -        | -        |
| EPS                                                | -        | -        |
| Type of structures                                 | -        | -        |
| CS                                                 | -        | -        |

In the multivariate model, variables independently associated with laboratory use were: multigestity, parity (more than 3), confidentiality, affordability of tests prices, availability of guidelines and health center level (Table 4).
4. Discussion

4.1. Misuse of Laboratory Services

These findings showed clearly the misuse of the laboratory in maternal health in Senegal, with a frequency of 78.88%. The frequency of laboratory misuse is variable worldwide and it can even be different within a country. In Nigeria, 76.8% [22] and 19.2% [23] of misuse have been reported, 15% in Tanzania [15]. In a cross study, Gunn et al [24] found out different frequencies in Uganda (81.5%), Mozambique (69.4%) and Congo (45.4%). It varied also from 27.8% to 80.3% in Canada [25] and from 86% to 36% in Brazil [12]. For all these studies, authors focused on individual tests. In the case of our study, overall use of laboratory in maternal health was studied, regarding the 6 tests recommended.

For a better understanding of barriers able to hamper the laboratory use, the focus has been put on pregnant women characteristics, laboratory and antenatal services.

4.2. Barriers Associated with Pregnant Women

Despite the fact that the whole study population arrived at health facilities for the first ANC visit during the first trimester (54%), laboratory use was associated with gestity and parity. This result was observed in Pakistan, that the inadequate use of antenatal care was associated with high parity [26]. These conditions confirm the necessity to encourage the women and to reinforce the communication regarding the importance of testing, regardless the medical conditions and parity and gestity of the women of childbearing age.

4.3. Barriers Associated with Laboratory Services

Women are sensitive to confidentiality, during antenatal visits. Because they are suggested to sensitive questions [27], so privacy and confidentiality are required. Laboratories have the obligation to ensure that pregnant women confidentiality is protected. Otherwise, if it is not, the right to health is adversely impacted. Consequently, they are more likely to misuse laboratory and in the worst case, to drop out laboratory services. Only 3/16 laboratories respected confidentiality norms regarding results delivery, with a laboratory use of 18% (OR 0.331; 95% CI 0.164-0.667). The lack of confidentiality in result delivery can be a source of stigma [28]. It is also a gap vis-à-vis international norm ISO 15189 requirements [29]. In addition, results notification in private, by a professional, in a responsive and interactive way, seems to be the preference for the majority of pregnant women. Thus, it is important to give a careful listening to pregnant women, regarding their preferences [30]. In all cases, whatever, the means of results delivery adopted by laboratories, confidentiality and security should be preserved [31]. Paying cash is still a popular method of financing in our settings. Test fees were significantly associated with laboratory use in health centers as well in hospitals, with price mean of 17.20±3.68 and 19.77±4.48USD, respectively. In Health Centers, the fees system is autonomous, compared to hospitals. In fact, management of health centers is under the authority of committees, including tests fees. In hospital, the fees system follows national system based on the minima and maxima for each specialty. Tests fees are really a significant barrier to laboratory mainly in sub-Saharan Africa countries, where poverty is major challenge [13; 32]. That is the reason why, mechanisms of health insurance have been adopted and implemented in Senegal, as recommended by WHO [33]. Known as mutuelles de santé, the Community-Based Health Insurance are increasing in Senegal. The assessment of its impact has not yet been done, but the statistics have clearly shown the increase of members [34]. The first results are probant but require more researches. In Ghana, Indonesia and Rwanda the effect of health insurance on maternal health care utilization has been established [35].

4.4. Barriers Associated with Antenatal Services

Availability of appropriate ANC services was independently associated with laboratory use among pregnant women, regarding availability of guidelines in health facilities. The unavailability of national guidelines in health facilities is associated with appropriate use. The first measurable consequence highlighted by our study was, beyond the lack of respect of guidelines, the misuse of laboratories. Laboratory use requires guidelines adherence, because they are intimately linked. In health facilities where guidelines were available and/or respected, pregnant used more likely laboratory services (OR = 0.062; 95% CI: 0.016-0.238). In fact, guidelines do not only focus on tests requests, counseling is also part of antenatal visit. Counseling about issues related to the importance of screening tests is an appropriate way to convince pregnant to use the laboratory service for a safe care, for herself and her baby [36]. Guidelines were available in only one structure. The same situation was found in Tanzania [37]. Association between availability of guidelines and laboratory use [38] confirm the important rule that midwives play in antenatal care services through tests prescription and appropriate delivery of ANC services. Without prescription, there is no laboratory use [39]. Most of the midwives were not aware of the new Senegalese national guidelines referring biological laboratory tests during antenatal care. Midwives should be trained in new guidelines. This is under the responsibility of the Senegalese Reproductive Health Program. Participation of means users during all steps is required, for a better appropriation and use. Midwives are facing another kind of problem. There is the lack of standardization between the national guidelines and the pregnant management tools (register and patient health book). For instance, glycemia test is not part of national guidelines, but exists in management tools. This situation is confusing for midwives. In Senegal, antenatal care services are available in all health facilities levels, depending on pregnant women choice. In this study, almost 75% of pregnant women preferred Health Centers for antenatal visit, compared to Hospitals. Consequently, pregnant women of health center were more likely to use laboratory services. In Uganda, 86% received their care in...
Health Centers [40]. This situation is probably due to the fact that, they are geographically and financially accessible to the population. In addition, Health Centers deliver community cares, reflecting economic, sociocultural conditions and countries health policy [41]. Hospitals have been qualified by some authors as inhospitable [42], with a tendency to amplify social inequalities [43]. This can have an impact on laboratory use.

Limitations
As a cross-sectional study, this study presents some limitations, regarding missed information related to the place of residence of pregnant women. It could help to analyze deeply the rule of socio-economic condition of pregnant women. Also, the limited sample size, which only covered 10% of laboratories, for financial reasons is another limitation. The investigations only focused on pregnant women who used laboratory services during the first ANC visit. It does not consider pregnant ones who went to the laboratory for others investigations. In some structures, rapid tests, as HIV and protein urine tests, were performed by midwives, in ANC rooms, and not in the laboratory. That is the reason why, low frequencies regarding laboratory use, for these tests, were observed. However these results give an idea about main barriers to laboratory use during ANC, in Senegal.

5. Conclusion
Laboratories play a central role in care in maternal health. It allows to prevent diseases that may affect both mother and child. Barriers identified are levers on which it urges to act, for improving laboratory access to pregnant woman. As the first study conducted in Senegal regarding laboratory misuse, particularly in maternal health, it is important to take into account these results, to sensitize pregnant women, health personnel and authorities for a better use of laboratory during antenatal care, contributing to reduce maternal mortality. In health facilities, the focus should be done on the internal organization, to overcome substantially barriers identified. Women should be encouraged to advantages of tests screening for a safe pregnancy. Governments need to develop strategies to tackle with supply and demand-side barriers to laboratory. Lastly, innovative operational researches are needed improve health system responsiveness.

Disclosure Statement
The authors declare that they have no conflicts of interest.

Acknowledgements
This work was supported by the Netherland Organization for Scientific Research, Science for Global Development (NWO/WOTRO), grant W07.4.203.00, in SOCIALAB project.

We are grateful to Anja Van’t Hoog and Mafall Ka for their contribution to statistical analysis, the staff of the Direction des Laboratoires du Sénégal, Senegalese Department of Laboratories, Ministry of Health and Social Affairs, for their active participation to tools reviews and pilot phase.

Authors’ Contributions
AMS: was the scientific senior researcher, in charge of biomedical compound of the project (SOCIALAB). First author, conducted the data collection, analysis and developed the draft manuscript for publication. AIS: (University Cheikh Anta Diop-Dakar, the Director of the Laboratories in Senegal), co-Principal Investigator. PO (Amsterdam Institute of Global Health of Development): was the Principal Investigator. WK (University of Amsterdam): was the scientific senior researcher, in charge of anthropological compound of the project. OD: was an assistant researcher administered financial questionnaire and electronic data entry. AKDF: was an assistant researcher, administered midwives questionnaire and electronic data entry. KT (University of Thies-Senegal), critically revised the draft for important intellectual content, revision and final approval of this article. All authors critically revised the manuscript.

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