DO HEALTH AND DEMOGRAPHIC SURVEILLANCE SYSTEMS (HDSS) CONTRIBUTE TO THE HEALTH OF THE AFRICAN COMMUNITY?

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Date

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Abstract (English)

Objective To demonstrate the achievements and opportunities presented by longitudinal Health and Demographic Surveillance Systems (HDSS) in the developing world in relation to their contribution towards improvement of the health of the African community.

Methods A detailed literature research was conducted. The INDEPTH network’s website was used, leading to individual HDSS websites and lists of their health implications, relating these realizations to the matching publications.

Results An enumeration is given of several studies and their impact on public health, ranging from primary health care interventions to disease specific treatment and nutritional measures. Advantages and disadvantages of this kind of data gathering are discussed and suggestions are made towards improvement of such surveillance systems.

Conclusion Although various constraints are related to longitudinal surveillance, such as conducted at the HDSS sites, the impact on the health of the African community by INDEPTH and its HDSS member sites is clearly demonstrated in the literature.

Abstract (Nederlands)

Doel Het aantonen van de verwezenlijkingen en de mogelijkheden naar de toekomst toe van langdurige data vergaring van een specifieke populatie zoals uitgevoerd door Health and Demographic Surveillance Systems (HDSS) in Afrika. De invloed van deze systemen op de gezondheidszorg in Afrika wordt gevalueerd.

Methodologie Een gedetailleerde literatuurstudie werd uitgevoerd. Ook de website van het INDEPTH netwerk werd veelvuldig gebruikt, leidend tot websites van hun individuele HDSS sites waarop lijsten met hun verwezenlijkingen te vinden zijn, gekoppeld aan publicaties in de literatuur.

Resultaten Een opsomming van de verwezenlijkingen van deze HDSSs leidend tot een verbeterde gezondheid van de Afrikaanse gemeenschap wordt gegeven. Ook worden de voor- en nadelen van deze manier van data vergaring in het daglicht gehouden, zo worden suggesties geformuleerd ter bevordering van deze systemen.

Conclusie Desondanks de beperkingen verbonden aan dit type van data verzameling, kan de bijdrage tot de gezondheid van de Afrikaanse gemeenschap door deze systemen niet worden ontkend. De literatuur toont duidelijk aan dat deze systemen reeds vele malen hun belang hebben bewezen door het bijsturen en creëren van aanbevelingen voor de gezondheidszorg in Afrika.
Introduction

Many, if not all African countries face a lack of accurate data reflecting their rural population which is not covered by the rudimentary civil registration systems associated with the developing world. Only the people who live in urban areas are likely to be integrated by these vital registration systems. Hence people living in rural areas are unregistered and therefore not taken into account by the data collected in these systems.

When vital registration data is nonexistent, hospital statistics are used as a public health information resource. The validity of this kind of information is widely questioned when talking about the developing world as hospital populations are highly selective (Cooper et al., 1998; Reniers et al., 2005). The available health data, which is a reflection of the health facility utilization, is biased by a number of factors: the restricted accessibility of these facilities in developing countries where roads are in poor shape or even absent and motorized vehicles are not widely distributed; low utilization of hospital services exists especially during terminal illness; gender based discrimination: i.e. lower accessibility to medical facilities for women is still present; and so on.

Health policies based on data from these dysfunctional vital registration systems are most likely not the best way to address the need of the rural population in these resource-constrained countries in the developing world. Moreover, these national figures don’t reflect the whole population since they largely neglect the rural populations. This is especially true when these figures are based on defective registration systems. Determining health profiles from this limited available data is a bridge too far as the lack of population based data constitutes major constraints on the formation of effective policies and programs aimed at improving the health of the African population.

Accurate long-term data is needed in order to develop a good health policy which will eventually improve health itself in the African community. Most of the international health research is conducted on a short term base due to research career and funding structures. Yet, many health issues take several years to detect, understand, and find a solution. That is why one of the key advantages of longitudinal studies such as conducted at Health and Demographic Surveillance Systems (HDSS) is that they gather information from their populations for a longer period of time which facilitates finding solutions for the numerous existing health issues faced by the African continent.

Data gathered by the World Health Organization (WHO) demonstrates that only five African countries have vital registration systems covering more than 25% of their population.¹ Byass et al (2002) state

¹ World Health Organization (2010) WHO statistical information system database (WHOSIS).
Source: http://www.who.int/whosis/en/
Accessed on 18 January 2010
that in the absence of civil registration, such Health and Demographic Surveillance Systems have to start by identifying individuals in the communities covered and include basic demographic surveillance (births, deaths, migration and other vital events), before covering specific health parameters.

**(H)DSS**

A (Health) and Demographic Surveillance System is a set of field and computing operations to handle the longitudinal follow-up of well-defined entities or primary subjects (individuals, households, and residential units) and all related demographic and health outcomes within a clearly circumscribed geographic area called the Demographic Surveillance Area (DSA). Unlike a cohort study, a (H)DSS follows up the entire population of such a geographic area (INDEPTH Network, 2002).

Health and Demographic Surveillance Systems are set up in a specific order (figure 1); first there is a complete census of the population living in the Demographic Surveillance Area (DSA), an area determined by natural borders. Then there are regular update rounds. Depending on the site, the time interval between these update rounds varies from once a week to once a year. This generates a geographically-defined population under continuous demographic monitoring with timely production of data on all births, deaths and migration events plus site specific health or demographic indicators depending on the sites’ interest. The only way to get excluded out of a HDSS is by death or out-migration, just as the only two ways to get included in such a HDSS is by birth or in-migration.

![Figure 1 (H)DSS Setup, adapted from INDEPTH](image)

HDSSs are typically structured around three main subjects (residential unit, household and individual) within the DSA. The reasons to distinguish between these subjects are multiple. Evidently it is not feasible to interview all individuals directly, and also not all people are able to give the information
needed. Therefore HDSSs work with key informants, whom are chosen by their intellectual ability and other characteristics in order to maximize the correctness of the information. These key informants fill in a register whenever an event has occurred and get token fees for reporting such events, when they are confirmed by the system. Ideally, key informants are part of the community so that no effort should be done on their behalf to gather the vital events in their community. Key informants are often senior or respected members of the community within the DSA.

In the last 40 years, many of such Health and Demographic Surveillance Systems have been established in various developing countries throughout the African continent where routine vital-registration systems were poorly developed or nonexistent. Although initial objectives of these HDSSs differ according to the specific interest of the researchers and the major health issues in the area, similar approaches to define key variables and their relationships are used.

The detailed data derived from small sentinel areas such as the Demographic Surveillance Area (DSA) can often be generalized to larger areas, which can reduce the costs and thus have a positive influence on the cost effectiveness of such HDSSs. Governments without the necessary resources to do nationwide censuses, and donors trying to invest in development effectively, can really use this data in order to get a detailed picture of the health and economic status of their population, they can use this information to plan and budget health care services more strategically.

In the beginning of the acquisition of independence by the African countries, in the late 1950’s and the early 1960’s the limited demographic data was based on censuses and vital registration of the European population living in Africa. At best there was some reliable data based on the African population from local vital registration systems in cities or parish registers in rural areas (Garenne and Cantrelle, 1991). The demographic surveillance methodology evolved from the need for accurate information describing the population living in rural areas in the developing world where vital registration systems were insufficient to provide this kind of information.

Among the first (H)DSS sites in Africa are the Pholela DSS in South Africa initiated in 1940, the Niakhar DSS in Senegal initiated in 1962, the Bandafassi DSS in Senegal initiated in 1970 and the Bandim DSS in Guinea-Bissau initiated in 1978 (see figure 2).

In the late 1990s it became clear that the need for a reliable information base to support health development could best be met by population and community based data of all population groups being collected prospectively and continuously. The existing Health and Demographic Surveillance Systems together with new ones were found ideal to accomplish this goal (INDEPTH, 2002, p6).
INDEPTH (International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries)

The INDEPTH network was founded in Dar es Salaam in November 1998 with the intention to present an international platform of demographic field sites which provides health and demographic data and research. As such this way they want to enable developing countries to set health priorities and policies based on longitudinal data. Furthermore they want their data to guide cost effective measures to ensure and observe progress towards national and international goals such as the Millennium Development Goals. Their primary objective is to address the urgent need for correct population-based data to inform health policies throughout the developing world. The founding paper states that ‘this great void constitutes a major long-standing constraint on the articulation of effective policies and programs aimed at improving the health of the poor and as such perpetuates profound inequities in the health of the poor’ (INDEPTH, 1998, p1).

The networks aim is to facilitate the sharing of knowledge between its member sites by organizing multi-site research projects and workshops. In addition, they expand the research capacity in resource-poor settings and strengthen the interface between research and policy. INDEPTH also provides practical tools concerning data processing and analysis and quality control. Their ultimate goal is to draw a blueprint on how the ideal HDSS should be constructed, organized and maintained.

The INDEPTH Network is currently constituted of 37 member sites in 19 countries. Twenty five of these sites are situated in 12 African countries (Burkina Faso, Ethiopia, Gambia, Ghana, Guinea-Bissau, Kenya, Malawi, Mozambique, Senegal, South Africa, Tanzania and Uganda) with a covered African population of 1.675.765 (figure 2). Only the African Demographic Surveillance Systems will be mentioned in this thesis because, as stated in the title, the health of the African community is the subject of this present paper. The average population under registration of an African Demographic Surveillance System is 67.000 and varies between 4.492 at the Ouagadougou HDSS in Burkina Faso and approximately 300.000 in the Ifakara HDSS in the Republic of Tanzania.

These Health and Demographic Surveillance Systems serve as platforms for a wide range of research activities within a specific geographic area. The main focus for INDEPTH has been the field testing of primary health care strategies (Shamebo et al., 1992; Binka et al., 1995; Krause et al., 1998), and the study of appropriate health technologies to address the diseases and conditions endemic in developing countries. The several studies conducted at HDSS sites are elaborately described in the results of this paper.
Figure 2. African INDEPTH member sites, adapted from INDEPTH

<table>
<thead>
<tr>
<th>SITE</th>
<th>COUNTRY</th>
<th>Pop under surveillance</th>
<th>Established</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nouna</td>
<td>Burkina Faso</td>
<td>75,847</td>
<td>1992</td>
</tr>
<tr>
<td>Sapone</td>
<td>Burkina Faso</td>
<td>19,904</td>
<td>2005</td>
</tr>
<tr>
<td>Ouagadougou</td>
<td>Burkina Faso</td>
<td>4,492</td>
<td>2002</td>
</tr>
<tr>
<td>Butajira</td>
<td>Ethiopia</td>
<td>40,000</td>
<td>1987</td>
</tr>
<tr>
<td>West Kiang</td>
<td>Gambia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farafenni</td>
<td>Gambia</td>
<td>16,883</td>
<td>1981</td>
</tr>
<tr>
<td>Dodowa</td>
<td>Ghana</td>
<td>101,000</td>
<td>2003</td>
</tr>
<tr>
<td>Kintampo</td>
<td>Ghana</td>
<td>145,000</td>
<td>1994</td>
</tr>
<tr>
<td>Navrongo</td>
<td>Ghana</td>
<td>140,000</td>
<td>1993</td>
</tr>
<tr>
<td>Bandim</td>
<td>Guinea Bissau</td>
<td>101,000</td>
<td>1978</td>
</tr>
<tr>
<td>Kilifi</td>
<td>Kenya</td>
<td>220,000</td>
<td>1992</td>
</tr>
<tr>
<td>Kisumu</td>
<td>Kenya</td>
<td>135,000</td>
<td>1992</td>
</tr>
<tr>
<td>MBITA</td>
<td>Kenya</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nyeri</td>
<td>Kenya</td>
<td>68,598</td>
<td>2000</td>
</tr>
<tr>
<td>Karonga</td>
<td>Malawi</td>
<td>40,000</td>
<td>2002</td>
</tr>
<tr>
<td>Mlanje</td>
<td>Mozambique</td>
<td>80,000</td>
<td>1980</td>
</tr>
<tr>
<td>Bandafassi</td>
<td>Senegal</td>
<td>11,200</td>
<td>1970</td>
</tr>
<tr>
<td>Mlop</td>
<td>Senegal</td>
<td>7,500</td>
<td>1985</td>
</tr>
<tr>
<td>Mnikhar</td>
<td>Senegal</td>
<td>35,000</td>
<td>1992</td>
</tr>
<tr>
<td>ACDS</td>
<td>South Africa</td>
<td>85,263</td>
<td>1999</td>
</tr>
<tr>
<td>Agincourt</td>
<td>South Africa</td>
<td>70,000</td>
<td>1992</td>
</tr>
<tr>
<td>Dikgale</td>
<td>South Africa</td>
<td>8,071</td>
<td>1995</td>
</tr>
<tr>
<td>Magu</td>
<td>Tanzania</td>
<td>28,000</td>
<td>1994</td>
</tr>
<tr>
<td>Rufiji</td>
<td>Tanzania</td>
<td>90,000</td>
<td>1998</td>
</tr>
<tr>
<td>Ifakara</td>
<td>Tanzania</td>
<td>90,000</td>
<td>1995</td>
</tr>
<tr>
<td>Iganga</td>
<td>Uganda</td>
<td>67,000</td>
<td>2004</td>
</tr>
<tr>
<td>Rakai</td>
<td>Uganda</td>
<td>12,000</td>
<td>1988</td>
</tr>
</tbody>
</table>

African Countries with Health and Demographic Surveillance System (HDSS) Field Sites participating in the INDEPTH Network.
The main objective of this present thesis is to reflect the current situation of all African Health and Demographic Surveillance Systems (HDSS) by mentioning the achievements from the past and what can be expected in the near and distant future. The methods used to gather HDSS-data and the obstacles being faced in this kind of longitudinal research are examined.

The intention is not to be complete, but rather give a nuanced picture of the advantages and disadvantages of this kind of longitudinal population surveillance in all of its aspects starting with the collection and ending with the implementation of its data in health policies throughout Africa.
Methods

Initial research was carried out by using several search engines such as PubMed, ISI Web of Knowledge and Google Scholar. Keywords used were: “demographic surveillance system”, “Africa”, “HDSS”, “INDEPTH network” and many others depending on the specific topic relevant to the subject on which this paper elaborates. Articles were preferably chosen when they were cited several times and when published in medical or non-medical journals with a high impact factor which implies a higher relevance of the scientific journal.

Since this paper attempts to synthesize the contributions of the Health and Demographic Surveillance Systems (HDSS) (under the wings of the INDEPTH network) to the health of the African community, Dr. Osman Sankoh, the executive director of the INDEPTH network, was contacted. Given that a list of achievements of the member sites of the INDEPTH network was absent, a structured questionnaire was made in collaboration with Dr. Osman Sankoh. This questionnaire was constructed in such a way that it would serve as an extension of the information available on the INDEPTH network website. Hence the outcome of this survey would provide further insight in the implementation of relevant study results by local, national or international governments and organizations such as the World Health Organization (WHO).

1) Which health policy changes were the result of studies conducted at your HDSS?

2) Can you give an estimation of the time span between publishing your results and achieving health policy adjustment to your findings?

3) How did the process of implementation occur?

4) What difficulties did you face to get your results implemented by the government?

5) Are the improvements suggested by the study achieved, to which extent?

6) After implementation have there been studies to confirm the effects of these health policy adjustments?

7) What are the results of these studies?

Table 1 Questionnaire

Unfortunately, only one of the 25 sites situated in Africa responded to this questionnaire, making it impossible to gather the necessary information. In most cases the implementation of study results and the long-term impact on the health of the African population obtained by these health care changes is not mentioned in any kind of literature. Moreover given that every country and even every region is organized differently, implementations of health reforms are hard to compare.
The Bandim Health Project is the only Health and Demographic Surveillance System which answered the questionnaire by sending two books (Sodemann and Aaby, 2003; Sodemann et al., 2008) which give a rundown of studies conducted at their HDSS site in Guinea-Bissau and their public health implications. These books were intensively studied and helped to find the relevant articles that published study results which are of interest to this thesis.

The INDEPTH network website provided a valuable source of information with links to several available HDSS-websites. However, the website was not always up to date and even contained conflicting data. Some of the HDSS-websites include a list of health policy changes realized by studies conducted at their own surveillance system and connect these achievements with the publications of their study results in medical journals. The HDSS-websites differ significantly in usability, clarity and accessibility of their data. Chandramohan et al. state in 2008 that INDEPTH and its member sites still do not have a collective policy on access to HDSS data. Also no links to HDSS databases are given.

In a next step the World Health Organization’s website was checked to verify whether recently recommendation changes were made by the WHO based on results released in recent times by the HDSSs.
Results

In the following an overview of studies and projects conducted at HDSS sites, that have significantly contributed to health policy changes in Africa and elsewhere, will be presented. These studies can be divided in projects regarding primary health care strategies and studies trying to address diseases and conditions prevalent in the area where the HDSS is located.

The goal of each of these studies and projects is to use the longitudinal data and existing favorable setup, available at these HDSS sites, in combination with the necessary study-specific data to improve the overall health of the sites’ population. In a next step these results are brought to a higher level where not only the people living in the Demographic Surveillance Area (DSA) benefit from these health interventions but whole nations may profit by incorporating the findings from these studies and projects in their health policy.

Community-Orientated Primary Health Care (COPC)

Pioneering work in demographic surveillance has been done by the Pholela Health Centre in South Africa. In 1940, the Pholela Health Center was set up to address the need for prevention and treatment of diseases present in the Natal area, informing health policies based on their 15 years of data gathering covering a population of approximately 10,000 individuals. The roots of Community Orientated Primary Health Care (COPC) (Kark, 1981) were introduced and developed here by Sidney and Emily Kark. They integrated preventive and curative care with community participation creating multidisciplinary teams, promoting the collaboration between health educators, doctors, nurses, social workers, laboratory technicians and others. Results from their work outlined by Susser (1999) show that it was a credible expression of the effects of COPC, decades before the WHO and UNICEF endorsed the policy of Community-Orientated Primary Health Care (COPC) at Alma-Ata in 1978.

Although this approach of addressing health problems was not completely identical to the definition of primary health care given at the declaration of Alma Ata in 1978, it is considered to be an expression of the same spirit (Gofin and Gofin, 2005).

Research capacity strengthening in Africa and tackling the brain drain

As mentioned before, Africa suffers from a shortage of technical and human capacity to use existing knowledge and generate new knowledge to surmount the diseases and health problems that are being faced. A major cause for this scarcity is the outflow of medical professionals from the developing world, the so called brain drain. Statistics from South African medical schools suggest that a third to a half of all graduates leave their country to work in the developed world (Weiner et al., 1998). This
brain drain enlarges the already big gap in health inequities between the developing world and the developed world by aggravating the already impoverished healthcare resources in Africa. Pang et al. (2002) point out the need for international collaboration to protect the value of Africa’s “intellectual property”. Efforts are needed that concentrate on a long-term base and thus preserve the intellectual property embodied in a nation’s health professionals.

As one of its four strategic objectives INDEPTH puts research capability strengthening on its agenda. Through several programs and platforms they try to accomplish this objective and in that way help to build research capacity in the countries where HDSS sites, part of the INDEPTH network, are active. INDEPTH works together with the WHO’s TDR Research Capability Strengthening (RCS) which is the Special Programme for Research & Training in Tropical Diseases. Their common goal is to foster self-reliance in biomedical and social science research in disease-endemic developing countries by building a critical mass of human resources, institution capacity, and a conducive environment able to respond to public health research needs (RCS Workplan, 2004).

In 2002 Nchinda summarized a list of factors associated with success of research capacity strengthening.

- Capable and committed scientific leadership
- Continuity of funding for research
- Ability to attract a core of dedicated young scientists and providing them with independent research funding
- Adequate and appropriate infrastructure for research (building and premises)
- Adequate equipment and supplies including modern communication facilities and scientific literature
- Scientific linkage to another (stronger) institution particularly in the North
- Stable conditions of service with adequate remuneration

Using these “indicators for success”, the contribution of INDEPTH and its member sites will be evaluated regarding research capacity strengthening in Africa.

In 2005, INDEPTH started its leadership programme in collaboration with the University of Witwatersrand in South Africa. The objective of this programme was to train the next generation of scientists in the developing world. The two year course focuses on five areas: epidemiology; biostatistics and data management; demography and other social sciences; information technologies for demographic and health surveillance; and leadership. This programme is unique as it combines practical on-the-job training at several of its HDSS sites with courses on all five of the areas previously mentioned. Considering the fact that many scientists have stated that combining important principles and elements from all relevant disciplines, in an advance towards problem solving in the
broadest possible context, is needed to strengthen evidence-based public health (Rosenfield, 1992; Pappaioanou et al., 2003), it is plausible that the INDEPTH approach is correct.

Furthermore, INDEPTH distributes grants to individuals and member sites. Grants for individuals are the so-called re-entry grants for scientists who benefited from the leadership programme. They get rewarded when returning to their respective sites of origin, this kind of remuneration is known to have a positive effect on research capacity strengthening (Nchinda, 2002) by opposing brain drain. Grants for sites are distributed by INDEPTH through their Cross-Site Capacity Development Grants Programme. The objective is to promote research collaboration and research training between INDEPTH sites in the developing world by providing seed grants to member sites participating in a cross-site activity.

Another programme created to absorb the deficit of manpower experienced in some INDEPTH member sites is the fellowship programme. The justification of this programme is that young scientists are sent to INDEPTH member sites and might develop a special interest in these sites and perhaps want to work there on a more permanent basis.

Recently, INDEPTH also started a new initiative to strengthen the communication skills of young scientists from non-English-speaking countries. In that way they want to overcome the language barrier and increase contributions from the HDSSs situated in these countries which in turn strengthens the research capacity since most INDEPTH’s communication is in English. Two young scientists have already benefited from this program by residing approximately one month at an English-speaking HDSS.

All in all, these efforts are probably leading towards a higher retention of a new generation of highly-skilled and locally-trained African scholars in research and academic positions within their continent and thus tackling brain drain effectively.

The role of Health and Demographic Surveillance systems in the progress towards the Millennium Development Goals (MDGs)

The Millennium Development Goals were set up in 2000 by the UN. They agreed on eight development goals to be achieved by the year 2015. Three of these goals are aimed directly at health issues: reduce child mortality, improvement in maternal health and reduction in prevalence of HIV/AIDS, malaria and other diseases; respectively goal 4, 5 and 6 (table 2). Below, these three goals will be discussed in detail.
<table>
<thead>
<tr>
<th>Goal 1 Eradicate extreme poverty and hunger</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Reduce by half the proportion of people living on less than a dollar a day</td>
</tr>
<tr>
<td>b) Achieve full and productive employment and decent work for all including women and young people</td>
</tr>
<tr>
<td>c) Reduce by half the proportion of people who suffer from hunger</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 2 Achieve universal primary education</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Ensure that all boys and girls complete a full course of primary schooling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 3 Promote gender equality and empower women</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 4 Reduce child mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Reduce by two thirds the mortality rate among children under five</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 5 Improve maternal health</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Reduce by three quarters the maternal mortality ratio</td>
</tr>
<tr>
<td>b) Achieve, by 2015, universal access to reproductive health</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 6 Combat HIV/AIDS, malaria and other diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Halt and begin to reverse the spread of HIV/AIDS</td>
</tr>
<tr>
<td>b) Achieve by 2010, universal access to treatment for HIV/AIDS for all those who need it</td>
</tr>
<tr>
<td>c) Halt and begin to reserve the incidence of malaria and other major diseases</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 7 Ensure environmental sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources</td>
</tr>
<tr>
<td>b) Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss</td>
</tr>
<tr>
<td>c) Reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation</td>
</tr>
<tr>
<td>d) Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 8 Develop a global partnership for development</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Develop further an open, rule-based, predictable, non-discriminatory trading and financial system</td>
</tr>
<tr>
<td>b) Address the special needs of the least developed countries</td>
</tr>
<tr>
<td>c) Address the special needs of landlocked developing countries and small island developing States (through the Programme of Action for the Sustainable Development of Small Island Developing States and the outcome of the twenty-second special session of the General Assembly)</td>
</tr>
<tr>
<td>d) Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term</td>
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</table>

Table 2 Millennium Development Goals; Source: http://www.undp.org/mdg/countryreports2.shtml
MDG 4

The forth Millennium Development Goal commits the global community to reduce child deaths below 5 years of age by two-thirds by 2015 from a 1990 baseline. Mason (2005) states that 4 million neonates and more than 6 million older children continue to die each year (Black et al., 2003; Lawn et al., 2005) and that up to 60% of these deaths can be prevented by a small set of interventions which unfortunately do not reach these children in the developing world (Jones et al., 2003; Darmstadt et al., 2005). In the following, an example will be presented from rural Ghana on how to reach this goal by reducing child death and fertility rate, a measure which has been proven to decrease under-five mortality (Cleland and Sathar, 1984; Hunt, 1988).

In Navrongo a Community Health and Family Planning project (CHFP) was set up to test the hypothesis that improved health care delivery, by deploying nurses and volunteers to village locations, might induce a demographic and health alteration in rural Ghana. This study was divided into four cells, testing each cell relative to another (volunteer services vs. deploying nurses to communities vs. the combination of both vs. a control group). The results demonstrated that the nurses, who provided a basic form of curative and preventive care, were able to substantially reduce childhood mortality, so helping the progress towards achievement of the 4th Millennium Development Goal (table 2). Unlike the deployment of nurses, the community volunteers had no impact on child mortality. However this does not mean that they had no effect whatsoever. The community volunteers played an important role in achieving an impact on fertility by mobilizing male support for the use of contraception (Phillips et al., 2006). The availability of contraception alone proved not sufficient to have an impact on the high fertility rates prevalent in Sub-Saharan Africa. These volunteers have proven valuable to counteract the social constraints in adopting contraceptives.

The fact that this project had such a big impact on under five mortality, in an area where initial survival gains for children in the 60’s, 70’s and 80’s were offset by the persistence of endemic childhood diseases and the HIV/AIDS pandemic in the 90’s (Ahmad et al., 2000), meant a big breakthrough in the empirical support of such family planning projects in achieving improved health care delivery. This gives a hopeful prospect of achieving the Millennium Development Goals towards a two-third decrease in the under-five child mortality (Binka et al., 2007).

Several studies showed that it is possible for community-based health services to significantly reduce child mortality/morbidity and fertility (Hill, 1992; Philips et al., 2006; Binka et al., 2007). The latter findings at the Navrongo Health and Demographic Surveillance System resulted in a national health care policy in Ghana that used the results of the CHFP. Despite all these efforts, Africa still remains the continent where the need for family planning is the highest of all continents in the world.
MDG 5

With a shocking average maternal mortality ratio of 900 women/mothers per 100,000 live births, Africa is the continent with the highest number of women dying during child birth (figure 3). This number far exceeds that of every other continent in the world. Hence it is obvious that the efforts for achieving the fifth Millennium Development Goal, striving towards improvement of maternal health and reducing the maternal mortality ratio by three quarters by 2015, should be directed especially to the African continent. In this aspect, the Health and Demographic Surveillance Systems might be of great importance as they help to understand the cause of death, identify risk factors and so direct more efficient health interventions.

Figure 3 shows that Guinea-Bissau has one of the highest maternal mortality ratios in Africa and consequently in the whole world. This explains why the people of the Bandim HDSS have a specific interest in this subject. Statistics from Bandim reveal that 32% of all deaths in women of fertile age are of maternal origin. Since it is well-known that motherless children have a significantly higher mortality risk (Masmas et al., 2004), it is obvious that when a maternal death can be prevented, both mother and child benefit. Reducing the maternal mortality rate is an effective measure for tackling Millennium Development Goals 4 and 5, respectively by reducing child mortality and improving maternal health.

Studies conducted at the Bandim HDSS have identified twins or triplets, increased distance from a hospital and stillborn fetuses to be risk factors for maternal dying (Hoj et al., 2002). Also these studies have demonstrated that postpartum haemorrhage, obstructed labor and puerperal infection are the main causes of maternal death. In Guinea-Bissau postpartum hemorrhage was responsible for no less than 42% of maternal death. In addition it was shown in other studies from low-income countries that atony of the uterus is an important underlying condition leading to postpartum haemorrhage. Therefore, they began a randomized double blind clinical trial to compare misoprostol which is a heat stable prostaglandin E1 analogous and can be administered orally, rectally or even sublingually, to the standard treatment of oxytocin, ergot derivatives and injectable prostaglandins (Hoj et al., 2005). The latter drug requires cool storage and injectable administration and thus sterile conditions. Obviously these needs are not easy to fulfill in a developing country. The advantages of a treatment such as misoprostol are evident in circumstances where sterility and cool storage are not easy to maintain.

Hoj et al. (2005) concluded in their randomized double blind trial that misoprostol administered sublingually reduced the frequency of severe postpartum haemorrhage. This finding was confirmed in other studies in other low-income countries (Derman et al., 2006). Gulmezoglu et al. (2007) reviewed 37 misoprostol trials and compared them to placebo and conventional injectable treatments with oxytocine. They concluded that misoprostol shows promising results compared to placebo, but in comparison to oxytocine misoprostol gives more side-effects. New research should be directed
towards finding the lowest effective dose of misoprostol and the optimal route of administration. Until now, misoprostol is still not included in the WHO Model List of Essential Medicines since the efficacy results are considered not consistent and an increased risk of shivering and fever. There is still an unresolved concern of a possible increase of maternal mortality (WHO., 2009). This emphasizes the need for further investigation of this potential live-saving intervention in a resource-poor situation.

Figure 3 Source: World Health Statistics 2009, p16

**MDG 6**

Over 28 million people infected with HIV are living in Sub-Saharan Africa, which is two-thirds of all HIV-infected persons in the developing world. HIV infection exacerbates the burden of other diseases and is mainly responsible for the recrudescence of tuberculosis as a major disease in Africa (Bloom and Sachs, 1998, p19). Five and a half million HIV-infected individuals live in South Africa making it the country with the highest HIV-prevalence in the world. This explains the special interest of the people working in South African Health and Demographic Surveillance Systems (ACDIS and Agincourt) for this infectious disease.
In the Africa Centre Demographic Information System (ACDIS), which is in fact a HDSS and member of the INDEPTH network, an individual HIV surveillance was started in 2003, from then on several studies were conducted combining the specific HIV surveillance data with the HDSS data. This allowed statistical approaches to investigate community-level risk factors on acquisition of infection.

By its sixth Millennium Development Goal, the UN states that universal access to treatment for HIV/AIDS is to be achieved by 2010, implying that Active Retroviral Therapy (ART) should now be available across the entire African continent. Considering the current situation in Africa and the entire developing world, it is correct to state that this goal is not accomplished. Nevertheless this does not mean that efforts should be ceased, the need for ART treatment has never been higher with more than 15 000 people getting infected every day (WHO, 2003, p57).

In rural Kwazulu-Natal, located within the ACDIS area, an ART programme began in October 2004, the aim was to deliver safe, effective, efficient, equitable and sustainable ART to all who needed it in this specific region. To date this programme has put more than 6000 patients on ART treatment and approximately 300 new patients are initiated on treatment every month, thus contributing to the health of the South African population with a 22% and 29% reduction in HIV-related mortality in women and men, respectively (Herbst et al., 2009). Earlier work from Malawi, conducted in a different environment at the Karonga HDSS showed a 35% decline in adult mortality shortly after the introduction of free ART therapy in their study population, which was detectable at the population level (Jahn et al., 2008). Moreover, this programme is a good example of how to ensure the continuation of such projects as it is largely overseen, managed and staffed by public sector employees which ensures operational permanence if external support should be stopped.

Linking the HDSS data with the HIV surveillance data created models of need of ART treatment and HIV prevalence which showed large spatial variations in a fairly small area. Studies are now being conducted at the ACDIS that have the purpose to generate understanding in causal pathways of HIV acquisition and transmission; and the impact of ART therapy on HIV epidemic dynamics. The ACDIS team collaborates with colleagues from the Erasmus University, Rotterdam and the WHO which, as mentioned above, improves research capacity.

Other studies have investigated the impact of labor migration and male risk behavior on the spread of HIV/AIDS in rural South Africa (Collinson et al., 2006) and the effect of educational interventions and other factors on the risk of HIV in pregnant South African women (Johnson et al., 2009).
Impregnated bed nets against malaria

Annually there are 881,000 deaths as a cause of malaria in the world, more than 90 % of these deaths take place in Africa.\(^2\) The WHO estimates that 3,000 children under 5 years old die every day from the effects of malaria. Hence malaria is responsible for 85 % of all deaths in children under 5 years old (Greenwood et al., 1987).

In the Rufiji Health and Demographic Surveillance System (HDSS) in rural Tanzania it was observed that the lion share of the hospital attendances were due to malaria. Although malaria was well known as being the number one health problem at health facilities, studies conducted in several Health and Demographic Surveillance Systems showed that severe malaria patients did not come to the health facilities. Moreover, half of the malaria patients who did come to the health facilities still died. This implies that first, prevention on the household level was much more important than previously thought and second, that improvement is needed of the case management at the health facility level (de Savigny et al., 2004).

Until the nineties, Sub-Saharan Africa malaria control relied primarily on antimalarial drugs for treatment and prevention and on the reduction of man-vector contact by using bed nets. Alonso et al. (1991) suggested that insecticide-treated bed nets could be a cheap and acceptable method in order to reduce morbidity and mortality caused by malaria. Nowadays, 20 years later, this theory is widely accepted. Many studies, conducted in several Health and Demographic Surveillance Systems (HDSS) showed that by using these impregnated bed nets a decrease in overall child mortality of 15% to 33% is obtainable (Alonso et al., 1991; Binka et al., 1996; Nevill et al., 1996; Habluetzel et al., 1997; Binka et al., 1998). All of these studies were conducted at one of the INDEPTH network HDSSs in several countries across the African continent: Burkina Faso, Gambia, Ghana and Kenya. The strong effect of insecticide-treated bed nets on mortality is also shown by Alonso et al. (1991). This study was carried out at the Farafenni HDSS in Gambia and implied, due to their study design, that chemoprophylaxis had no additional benefit in preventing deaths. These authors concluded that these insecticide-treated bed nets were simple to introduce into a community that was familiar with using bed nets which was the case for the people present at the Farafenni region. Therefore they warned that caution should be exercised before extrapolating these findings to other areas, considering that several factors can affect efficacy in such an intervention. For example: the importance of malaria as a cause of death in that particular area, the nature and habits of the dominant malaria vector and the acceptance of bed nets.

\(^2\) Source: http://www.rollbackmalaria.org/keyfacts.html
Accessed on 3 February 2010
The study conducted at the Kilifi HDSS in Kenya reveals that these concerns regarding the acceptance of bed nets in areas their use is uncommon is not completely just. In the Kilifi area bed net use was uncommon before the start of the study in 1991. Despite this, the insecticide-treated bed nets were well accepted and no significant adverse effects were seen following the study period (Nevill et al., 1996).

Unlike the other studies Habluetzel et al. (1997) found that the greatest impact on mortality occurred in the dry season. This finding shows that it is important to approach these health interventions individually and although overlapping should be avoided in these kind of studies, it is important to observe these interventions very carefully because, seemingly meaningless, changes in community and/or environment may cause a totally different need of health interventions. In this case the timing of impregnating the bed nets, which is done once a year right before the start of the high prevalence period of malaria, differs depending on region. If the results of one region are extrapolated to other regions without paying attention to the new setting, preventable deaths will occur.

The Ifakara and Rufiji HDSSs, situated in Tanzania have demonstrated that these impregnated bed nets have the potential of preventing 30,000 deaths each year in Tanzania alone (Abdulla et al., 2001). In Tanzania, an 11 fold increase in expenditure for malaria was obtained because the Tanzanian government took these findings seriously and made fundamental policy changes to make insecticide treated nets more accessible to all people (McElroy et al., 2009).

As shown in figure 4, an average of only 14% of all under-five children in Africa sleeps under insecticide-treated bed nets. This result is disappointing as it is more than fifteen years after the introduction of these impregnated bed nets. This is partly due to the initial resistance from the World Health Organization (WHO) as a result of inconsistent results from several studies (Kroeger et al., 1995). The last 7 years, the prevalence of malaria has declined substantially, in all likelihood due to the introduction of these bed nets. If this trend continues over the next five years, the impact on reaching the Millennium Development Goals cannot be overestimated (Sodemann et al., 2008).
Childhood infections

The Bandim HDSS in Guinea-Bissau focuses on maternal and childhood health. This results from an extremely high under-5 mortality rate after independence in 1974 which prompted the Ministry of Health to approach SAREC (Swedish Agency for Research Co-operation with Developing Countries) to conduct a study to define nutritional priorities in preventive health care.

Several studies conducted at the Bandim HDSS concluded that there was no correlation between the state of nutrition and the likelihood of dying of several infectious diseases like measles, poliomyelitis, chickenpox (VZV) and acute lower respiratory tract infection from RSV (Aaby et al., 1984; Aaby et al., 1988). Therefore it was necessary to look for other factors which could explain the high mortality in these infections.
Results of the first registered measles epidemic in Bandim suggested that there was a higher risk for fatality in households with several cases of measles. In retrospective interviews researchers reached the conclusion that intensive exposure (overcrowding, larger family size) increased the fatality.

Other factors influencing the severity of the infection were: the intensity of exposure, the transmissibility of severity (secondary cases were even more severe) and the increasing severity in cross-sex transmissions.

The problem of the high child mortality in combination with the findings that the “weakness” of the children was not a main risk factor for the fatality of a number of infectious diseases strengthened the potential role of disease-specific prevention.

Results from the measles-study led to the immunization of the population in the Bandim surveillance area and beyond.

**Diarrheal diseases research**

Diarrheal diseases are a major cause of mortality and morbidity. This is not only the case in Guinea-Bissau but accounts for the whole African continent. From 1987, the people of the Bandim Health & Demographic Surveillance System conducted a series of longitudinal studies to determine morbidity, mortality, etiology, risk factors and interaction between nutritional status and diarrhea during early childhood.

The following risk factors associated with diarrhea were identified: weaning, male gender, diarrhea in the previous fortnight, being cared for by somebody else than the mother, storage of drinking water in open containers, storage of prepared food for later consumption, keeping pigs and dogs in the household, boiling water, eating with the hand from the same bowl, … (Molbak et al., 1997). Certain of these risk factors are associated with specific pathogens. Therefore they must be seen in their precise context, but since this would lead us too far from the objective of this thesis this will not be discussed any further.

As an example for research conducted to countervail diarrheal deaths, a double-blind randomized controlled trial conducted in 1996 is given in which the objective was to find out whether the use of low osmolarity ORS was beneficial in comparison with the use of standard ORS, recommended by WHO and UNICEF. This study was based on the findings from developing and developed countries which suggested a better absorption of water and sodium for these low osmolarity ORS compared with the standard ORS.

The study concluded that low osmolarity ORS were as efficient as the standard ORS, assessed by the duration of diarrheal episode. However among non-breastfed toddlers low osmolarity ORS reduced
the duration of diarrheal episodes significantly. Subsequently it was concluded that these findings could be of great importance as in the developing world early weaning is common (Valentiner-Branth et al., 1999).

After an expert meeting in New York in 2001 the World Health Organization decided to encourage the use of low osmolarity ORS. This measure clearly shows the impact of studies conducted at a Health and Demographic Surveillance System on health care policy.

Currently a study is being conducted to see if the recommendation to use low osmolarity ORS will result in the anticipated advantages on growth.

**Nutrition**

**Breastfeeding**

Most studies focusing on the relationship between breastfeeding and child health are conducted in countries with different breastfeeding patterns and mortality risk compared to African countries. This is not consistent with the thought that health interventions should be evaluated in the settings where they are going to be implemented (Sodemann and Aaby, 2003, p 47). Although breastfeeding is essential to reduce child morbidity and mortality, there is a serious need for appropriate approaches to promote breastfeeding during the first 2 years of the child’s life. Studies conducted in Guinea-Bissau have revealed that health education according to the WHO’s recommendations didn’t have the expected effect on child mortality and morbidity. They conclude that it is necessary to evaluate the WHO recommendations in different settings (Jakobsen et al., 1999) and thus suggest that other studies should be done in order to confirm their findings or reject the conclusions of Jakobsen et al..

An exception to the statement that most studies are not conducted in African countries is a study by Cantrelle and Leridon (1971) conducted at the Niakhar Health and Demographic Surveillance System in Senegal. Their results show a clear and direct negative effect of breast feeding on fertility. This shows that efforts have been done by HDSSs to provide information regarding the influence of breastfeeding in regions that differ significantly from the developing world and thus provide very valuable information for the African continent.

**Vitamin A Supplementation**

Ever since the 1970’s vitamin A deficiency was found to correlate to several diseases and xerophthalmia in particular, the WHO stated that investigations were required to look into the relation of xerophthalmia to mortality and morbidity (WHO, 1976). Later in the 1980’s it became clear that children with xerophthalmia, a sign of vitamin A deficiency, had a higher chance to die compared to children without xerophthalmia. In response to these findings large-scale intervention trials with
vitamin A supplementation were undertaken. It became clear that overall mortality in children above 6 months of age could be reduced with 23 % (Beaton et al., 1994) to 30 % (Fawzi et al., 1993; Glasziou and Mackerras, 1993) just by giving vitamin A supplementation. The World Health Organization then decided to recommend vitamin A supplementation at immunization contacts after the age of 6 months to avoid vitamin A deficiency.

Although it was generally accepted that vitamin A affects the immune system, the potential interactions between vaccines and vitamin A were not studied in those days. Reanalysis of data from vitamin A supplementation and vaccination studies demonstrated that the effect of vitamin A supplementation varied by age group with a beneficial effect at birth and after 6 months of age. A slight negative effect when administered between the age of 1 and 5 months was recorded. Therefore Benn et al. (2009) decided to examine the link between vitamin A supplementation and the vaccination status, which is also age-specific (see Table 3). They concluded that vitamin A supplementation reduced the risk of xerophthalmia in all children but no effect on mortality was observed. Among children who were vaccinated, vitamin A supplementation even increased the mortality of girls who have received a DTP-vaccination (Benn et al., 2009) as their last vaccination. This was found to be a potential problem because vitamin A supplementation was given at random vaccination contacts, based on the policy delineated by the WHO. This policy is based on the first large randomized vitamin A supplementation studies conducted a long time ago. Since no specific studies were taken into account, Benn et al. (2009) conclude that there is an urgent need to reanalyze data from previous studies which include data on the vaccination status.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Birth</th>
<th>6 weeks</th>
<th>10 weeks</th>
<th>14 weeks</th>
<th>9 months</th>
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<td>x</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Oral polio</td>
<td>x*</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
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<td>x</td>
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<td>x</td>
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<tr>
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<td>x</td>
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<tr>
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<td>x</td>
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<td></td>
</tr>
<tr>
<td>Yellow fever</td>
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<td></td>
<td></td>
<td></td>
<td>x**</td>
</tr>
<tr>
<td>Measles</td>
<td></td>
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<td></td>
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<td>x***</td>
</tr>
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</table>

* In endemic counties
** In countries where yellow fever poses a risk.
*** In addition, a second opportunity to receive a dose of measles vaccine should be provided for all children. This may be done either as part of the routine schedule or in a campaign.
* Only a few African countries have been able to introduce the vaccines to date

Table 3 Source: State of the World’s Vaccines and Immunization, p88
Immunization

Measles vaccines

The current World Health Organization’s (WHO) policy of providing measles vaccine at 9 months of age in low-income countries was defined in the early 1980s, some 30 years ago. Because of studies published by Sabin and Whittle (Whittle et al., 1984) that showed that the Edmonston-Zagreb (EZ) vaccine against measles could immunize infants at 4-6 months. This finding could play a major role in preventing measles before the age of 9 months and thus reducing mortality. The earlier vaccination was considered necessary because there was an increase in mothers who did not have had a natural measles infection but were immunized during childhood. These mothers have lower measles antibody levels throughout their pregnancy which implies a reduced transmission of such antibodies to their children and thus an earlier fading out of antibody levels in the newborn. Most children now lose maternal antibody levels around 4 to 5 months of age, whereas 30 years ago, when the current vaccination programme was formulated, protection was lost between 6 and 9 months of age.

Therefore, trials were initiated at the Bandim Health and Demographic Surveillance System (HDSS) in Guinea-Bissau (1985) and the Niakhar HDSS in Senegal (1987). The results of the first trial in Guinea-Bissau using a medium-titre or standard dose (ST) of the EZ vaccine were positive and hinted clinical protection against measles even when already given at 4 months of age (Aaby et al., 1988). After these first results were obtained, the World Health Organization recommended the use of High-titre (HT) measles vaccinations from 6 months of age in developing countries with a high incidence of measles. When the results of the second trial in Bandim and Niakhar with HT vaccines were published around 1990, they both revealed a negative effect on child mortality. This was especially the case for females. A meta-analysis suggested an increase in mortality of 34 percent in these West African studies (Knudsen et al., 1996). A WHO expert panel reviewed these reports in 1991 and recommended the continued use of HT Edmonson Zagreb vaccines because they found the results from Guinea-Bissau and Senegal unplanned and biological implausible. However, when in 1992 results from a study in Haiti confirmed the observations in West Africa, namely an increase in the female mortality rate among HT vaccine recipients (Holt et al., 1993), a new expert panel from the WHO decided to withdraw the recommendations regarding HT measles vaccines (EPI, 1992). Until today, the actual reason for this raise in female mortality is unknown. In 2003, Aaby et al. reviewed 9 studies of high-titre measles vaccines. They concluded by testing two hypotheses that the vaccine itself is unlikely to be the cause of the increased female mortality and further investigations are necessary to unveil the exact reason of this increase in female mortality. In 2003 a randomized clinical trial was started in the Bandim HDSS with the objective to study the efficacy of protection given by measles vaccinations in infants in a low income country before the age of 9 months (Martins et al., 2008). Although not significant, it could be concluded that overall mortality was lower in the early
measles vaccination group in comparison to the group that got vaccinated at the recommended 9 months of age. If other studies confirm these results, this might be an opportunity for the World Health Organization to adjust their policy to the changed conditions mentioned above.

The use of mid-upper arm circumference (MUAC) as a reliable indicator of child health

McDowell and King (1982) stated that arm circumference provides a similar accuracy compared to weight-for-age and to weight-for-height as an indicator of severe acute malnutrition (SAM). Therefore, it presents a viable alternative to these more cumbersome measurements for use in field surveys. Given the correlation to these other indicators, arm circumference is a composite indicator and therefore has a high significance. Garenne and Cantrele (1986) investigated this method in detail in rural Senegal at the Niakhar Health and Demographic Surveillance System (HDSS) and discovered that arm circumference correlates with even more indicators, thereby highlighting the predictive value.

Another study conducted at the Niakhar HDSS by Briend et al. (1989) investigated in a 2-year prospective study the relevance of nutritional indices, derived from comparison with growth standards, in assessing the mortality risk. The 3151 children included in the study were measured twice a year. Briend et al. (1989) found that the mortality rate of children differs more by anthropometric measures related to absolute muscle mass (weight, height or arm circumference) than it differs by nutritional indices (weight-for-age, weight-for-height and height-for-age). These findings questioned the approach used at that time to identify high risk children. In those days screening schemes were based on the comparison with growth curves or weight gain, however the study of Briend et al. (1989) revealed that these predictors were not likely to be predictive for risk of dying. In contrast arm circumference was shown to be substantially better than the classical nutritional indices mentioned above. Due to the long time span necessary to arrange effective international food aid, fast and easily implementable investigations are necessary to estimate the population at risk before food supplies are fatigued. Since measuring weight-for-height on a population basis implies logistic difficulties, arm circumference is recommended.
Discussion

The results mentioned above, clearly demonstrate the potentials of these Health and Demographic Surveillance Systems (HDSS) in providing detailed, longitudinal data about a well-defined population and the possible applications of such high-quality information. A substantial part of the conclusions based on these results could not have been assessed by other approaches and therefore stress the value of this kind of longitudinal information gathering.

Although the substantial contributions made by the INDEPTH network and its member sites have proven valuable, some considerations should be made to address the problems faced by INDEPTH, its member sites and other scientists who use the INDEPTH data to conduct studies concerning the health of the African community. As stated by Clark (2004), Health and Demographic Surveillance Systems are an intensive study technique to produce data with substantial advantages over other data and at the same time significant disadvantages, therefore some will be mentioned below.

Local obstacles

Field work in Africa entails a number of problems. Many African countries are ruled by unstable governments which fail to improve the health of their population. Evidently, this does not account for the entire African continent. Several examples are known where the government takes into account the results of studies conducted at HDSS sites. Nevertheless the fact remains that some countries face political, religious and methodological research issues that impede the process to reach the goals of the present HDSSs.

In this context Garenne and Cantrelle (1991) state that questions may be raised regarding scientific work which is carried out in a traditional society where nothing is fixed by law and even name and age are negotiable. These issues can be solved but require a large effort from the researchers working in these difficult circumstances.

Lack of standardization

As mentioned in the introduction, each HDSS site chooses individually a time interval for their update-rounds. This shortage in a joint, unified approach of all HDSS sites is also evident in other areas. Experiences from Health and Demographic Surveillance sites have shown that a 9 years interval between two complete censuses is too long and too much false information accumulates in such a long interval (Byass et al., 2002). Experiences like these should be assembled by the INDEPTH network in order to provide general guidelines that help the local researchers to optimize their HDSS based on the knowledge gathered by all HDSS member sites.
Currently INDEPTH is working on such a system which is called the INDEPTH Resource Kit for Demographic Surveillance Systems. It collects the best practices and experiences of the existing member sites. The presented ‘guidelines’ are intended for two audiences, the first objective is to take away the unnecessary startup difficulties and delays faced by new sites which don’t have timely access to the expertise and technical know-how needed. The second objective is to help existing sites cope with the increasing challenge to provide additional information to serve the intensified efforts of countries to reduce poverty and improve health.

This resource kit is an example of how well the people of the INDEPTH network correspond to the new demands in order to strengthen their network.

**Data access and sharing**

Tollman and Zwi (2000) state that many sites have a largely untapped potential with respect to contributing substantially to national and sub national health development due to the accumulation of unanalyzed data. Accessibility of this data is complicated by two factors: “possessiveness” on the part of the HDSS site and the complicated structure of HDSS data. These factors are not solely a problem of the HDSSs, but are prominently present in this kind of labor-intensive data gathering.

The problem of accessibility of the data obtained by the different HDSSs has been mentioned by many scientists (Clark, 2004; Chandramohan et al., 2008). This issue has encouraged the people of INDEPTH to work out a solution on this matter. Currently they are working on the INDEPTH Data System (IDS) that will fulfill their commitment in regard to making as much of the network data available, as soon and as widely as possible. Also, this measure fits in the vision of Chandramohan et al. (2008) who state that HDSS data need to be considered as a global public health good. They suggested that there should be a limited period of “private” ownership (18 - 24 months) before the data becomes more widely available to “external” investigators. This would considerably increase the impact of the data gathered by the HDSSs as more analysis could then be done by scientists from outside the INDEPTH network. Moreover this measure would enhance the INDEPTH’s impact on research capacity strengthening.

In 2006 the foundations were laid by a subset of the Asia-Oceania INDEPTH member sites which aimed at developing a protocol for facilitating data sharing between their collaborators and themselves (INDEPTH Annual report 2006, p23). From this first seed the iSHARE project sprouted. This pilot project puts HDSS data from 6 member sites (of which 3 African) online. The iSHARE project will be of great value to INDEPTH because of the know-how that will be gathered for developing a data sharing web interface like the IDS.
In 2007, INDEPTH site leaders agreed on having a minimum of data being submitted by the member sites annually to the INDEPTH Secretariat (INDEPTH Annual report 2007, p3). The required data to be submitted annually contains demographic data (population by age and sex), mortality data (deaths by age and sex), fertility data (number of women between 15 and 49) and cause of death. These statistics will facilitate cross-site comparisons and make it more applicable on a larger scale. Thus the analysis of data of a bigger population will improve INDEPTH’s impact on health knowledge in the developing world.

INDEPTH is also putting effort in producing an INDEPTH data sharing policy which every site should subscribe to so that data sharing will be more easily than it is now, with every site having its own specific data-use agreements.

An example of this kind of data sharing efforts is present at the Agincourt HDSS, which allows access to a 10% sample of their database.³

Also the complicated structure of the HDSS data is being assessed by INDEPTH. In order to simplify this structure, guidelines were drafted in which a fixed way to collect data is proposed, using software developed by INDEPTH in cooperation with an external organization specialized in developing data software. The measures mentioned above, in combination with additional training of population scientists through workshops, will effectively tackle the problem of data accessibility.

Migration issues

As many rural communities comprise individuals who change residence for longer periods of time for their seasonal work, employment, or educational opportunities. A major problem constitutes of tracking these persons.

Two types of migration events are distinguished. In the first case the residence of an individual changes between a residential unit in the Demographic Surveillance Area (DSA) and one outside, this is called “external migration”. In the second case an individual changes his residence from one residential unit to another in the same DSA, this is called “internal migration”. Although only external migration influences the size of the population, the recording of internal migration is equally important to guarantee the accuracy and validity of HDSS data by avoiding double counting of individuals and ensuring that their exposure to the according social and physical environment is taken into account. Migration also influences the registration of births and deaths and can thus create a void in the information regarding these births and deaths.

³ Source: http://www.agincourt.co.za/DataSection/DataDownloads.htm
Accessed on 22 March 2010
This is shown by an example from rural Senegal (Garenne and Cantrelle, 1991) where censuses were conducted during the dry season which never allowed a suitable recording of a part of the population called the pavetanez who are temporary workers, only residing in the Niakhar DSA during the rainy season.

**Ethical questions**

Although Health and Demographic Surveillance data plays an important role in improving health and health equity in the developing world, there are some ethical problems which cannot be ignored in this kind of longitudinal surveillance of a specific population. According to Carrel and Rennie (2008) HDSSs often face ethical conflicts between short- and long-term beneficence, by this they indicate the problem of balancing between providing health care for the population under surveillance while not overly impacting the topic of the study conducted. Moreover, improvement of health in a specific population implies a decrease in events of interest which results in less information on patterns that could be occurring in untreated areas, as the areas surrounding the Demographic Surveillance Area (DSA).

Another ethical problem faced in longitudinal surveillance is the problem of informed consent. First a DSA is chosen by the possibility to obtain a community consent in the site that was in mind. If however no agreement exists on taking part in longitudinal surveillance, another location has to be found. So community consent is the first degree of consent necessary to conduct a longitudinal surveillance system. Until this fase no insurmountable problems are faced. However, the second degree of consent needed, results in a few complications specific to surveillance activities. Which kind of consent is needed? Is it the individual consent as in the developed world, or is a household consent sufficient in developing countries where values of autonomy may be partly or completely absent (Carrel and Rennie, 2008). The duration of consent also raises ethical obstacles specific for surveillance systems. In contrast to research conducted in the developed world which has a specific start and end point, Demographic and Health Surveillance may last for several years or even decades which gives rise to the problem if the consent from the family elder also applies to the younger generations. Hence, when the new generation was not even born at the beginning of the study new consent should be asked to this younger generation.

Another problem was encountered in rural Senegal were it was observed that obtaining an informed consent from the people participating in such surveillance studies was extremely difficult to explain to people who had spent all of their lives in a traditional remote society. This was the case for the Serer people in Senegal (Garenne and Cantrelle, 1991).
A surveillance system might decide, due to funding or other issues, to reduce their study area and thus exclude a part of their study population. However this measure raises the question, what obligations the HDSS still has towards its former population? An analysis of this particular problem was conducted by Merritt and Grady (2006) whose research was particularly related to HIV/AIDS. They concluded that reciprocity for participation as in post-study treatment, does not solve the problem, even though it has an intuitive appeal. This is due to the fact that the people that used to be part of the study population are still unfairly privileged over others.

Although the ethical questions mentioned above are applicable to all HDSSs and can thus be approached by an umbrella organization such as the INDEPTH-network. There are however other ethical questions which depend on local factors and should consequently be approached by the HDSS itself.

**Pursuing the Millennium Development Goals (MDGs)**

![Figure 5 Source: World Health Statistics 2009, p14](image)
Sub-Saharan Africa houses approximately 15% of all under-five children, but an astonishing 50% of all under-five deaths are attributable to this region. Moreover 15% of all newborn children in Africa are likely to die before reaching the age of 5 years (Ahmad et al., 2000). In such a region where child mortality is especially high, pregnant women do not get their hopes up when being pregnant. Most of them give birth in their local village with no attendance of any health care professional (figure 6). In case of death, the child will have no record of birth, no record of death and certainly no indication of what caused the death. This is a dilemma for developing countries trying to plan effective health care programs. The lack of this population based data is the most important reason why Health and Demographic Surveillance Systems (HDSS) are being set up in these rural regions where the absence of vital registration systems is most abundant. The HDSSs provide information that is used by the district health management teams in their plans and to evaluate the cause of death. Also, HDSSs provide the opportunity to evaluate an interventions conducted in the Demographic Surveillance Area (DSA).

Figure 5 shows that the prognosis of a two-third decline in child mortality by 2015 is not realistic if the most recent numbers of the WHO are taken into account. Sodemann (2007) states that many developing countries will not reach the MDG by 2015, due to several reasons. First, the impaired health care systems in the developing world suffer from a seemingly insurmountable low quality of care. Subsequently this results in mistrust of the population in their own health care systems. Donors on the other hand do not seem to be engaged in capacity building of the existing health care systems. In contrast, they rather favor disease oriented vertical programmes that are mainly directed at urgent needs.

A long-term vision to address health care problems is lacking and many of the organizations in Africa work individually rather than teaming up. The reality that the goals of these organizations and their donors change almost every year ignores the fact that if existing interventions coverage would be increased to 99%, a 30-50% reduction of under-five child mortality could be achieved (Sodemann, 2007).

As already mentioned, health care interventions such as vitamin A supplementation and high-titre measles vaccination got implemented extremely fast in the developing countries health care systems. However, it appeared that these interventions have potentially life-threatening side-effects which were not anticipated in the studies conducted in the developed world. This due to the fact that these studies were conducted under completely different circumstances compared to those present in the developing countries. Too often, these circumstantial factors are not taken into account when discussing health care issues in the developing world. Studies conducted at HDSS sites expose these pernicious side effects and therefore play a key-role in reducing the mortality rate of children and adults in the developing world.
AFRICA

Mauritius 59
Botswana 54
Algeria 65
South Africa 91
Congo 86
Gabon 85
Namibia 81
Sao Tome and Principe 81
Cape Verde 78
Benin 78
Swaziland 74
Democratic Republic of the Congo 74
Zimbabwe 69
Equatorial Guinea 63
Cameroon 63
Togo 62
Comoros 62
Mauritania 61
Côte d'Ivoire 57
Cambodia 57
Lesotho 56
Burkina Faso 54
Malawi 54
Central African Republic 54
Kenya 52

Senegal 52
Madagascar 51
China 50
Mali 49
Mozambique 48
Angola 47
Zambia 47
Uganda 46

United Republic of Tanzania 45
Sierra Leone 42
Uganda 42
Kenya 42
Guinea-Bissau 42
Guinea 38
Nigeria 35
Burundi 34
Eritrea 28
Niger 18
Chad 14
Ethiopia 6

No data

Key

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Birth attendance by skilled health personnel (%)
Conclusion

Accurate data on effective health technologies and interventions such as generated by Health and Demographic Surveillance Systems have, as seen in this thesis, made substantial contributions to our knowledge of several important causes of mortality in the developing world. In this present study, it is highlighted that circumstantial differences between studies conducted in the developed world and developing world should be taken into account when evaluating the effectiveness and side effects of health interventions. Health organizations, active in the developing world, should focus on the existing health interventions known for their effectiveness in resource-constraints environments to maximize the benefit of their actions. Moreover, in a society where resources available to address a multitude of problems are limited, it is vital to explore all possibilities that information technology can offer in enabling to use the limited resources in an efficient and sustainable manner.

The results discussed here, stress the role of the INDEPTH network sites in improving our understanding of demographic dynamics, disease profiles and the epidemiology of the major killers in Africa. Given that this kind of detailed, longitudinal information of a specific population has proven to be of great value in providing insight in factors affecting specific health problems, more access is needed to this kind of data. In this way Africa’s policymakers can implement this data to direct their health policy. The World Health Organization states that only a few African health information sources are included in the world’s leading bibliographic databases. Therefore, a wealth of vital information for improving health policy remains untouched. The release of this information would generate awareness of what has already been achieved, avoiding overlap and thus making it possible to build on previous information.

Although specific, this facility-based data may be extrapolated when combined with data from more regional studies such as vital registration systems, demographic health surveys and others. This would spectacularly reduce the costs of the labor-intensive surveillance systems and thus strengthen the research capacity of the entire INDEPTH network. Also, more research should be carried out to confirm the effectiveness of such systems as proposed here. In that way information on health problems faced in one country could be shared with other countries experiencing similar health issues in comparable conditions.

The achievements of the INDEPTH network prove that this network takes well-founded comments made by scientists into account and tries to solve the structural “problems” within their organization. This provides hopeful perspectives on the future of the network and its member sites. Ten years after the foundation of the INDEPTH network, a solid base has been achieved. Moreover, results show the effectiveness of the work done by its member HDSS sites.
The use of the knowledge, derived from these HDSS sites, has proven valuable in properly informing health policies and redirecting health programs which concentrate on the health interventions already proven to be effective in the developing world such as measles vaccination. When these studies are exploited to their full potential, a major step forward will be achieved in reaching the Millennium Development Goals by 2015 and thus improving the health of the African community.
References


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