A Systematic Review of Demographic & Health Surveys: Data Availability, Utilization, & Policy Implications

Madeleine Short Fabic [a]; YoonJoung Choi [a]; Sandra Bird [a]

[a] Bureau for Global Health, United States Agency for International Development (USAID), 1300 Pennsylvania Avenue, NW, Washington, D.C. 20523, United States of America

Correspondence to: Madeleine Short Fabic (email: mshort@usaid.gov)

Funding: The United States Agency for International Development funded the staff time for this study. No other resources were used.

Competing interests: None declared.

Word Count: 2,986 (excluding abstract and tables/figures)

Number of Tables: 3

Number of Figures: 8

ABSTRACT

Objective

To review trends in DHS data availability; to systematically review public health literature to assess trends in analyses using Demographic and Health Survey (DHS) data; and to describe the relationship between data availability and data utilization.

Methods

We searched the MEASURE DHS website to collect information on all completed population-based surveys conducted under the DHS project between 1984 and 2010, including information on country, survey type, survey design, fieldwork period, and special features. We also systematically searched the online biomedical and public health database, PubMed, to identify peer-reviewed articles published through 2010 that analyzed DHS data. We assessed trends in data availability and use in research through descriptive, graphical, and bivariate linear regression analyses.

Findings

In total, 236 household surveys under the DHS project were completed across 84 countries through 2010. The number of surveys per year has remained constant, but the scope of survey questions has expanded. Meanwhile, 1,117 peer-reviewed publications met the inclusion criteria. The number of analyses published has progressively increased with 4.3 (95% CI 3.2-5.3) more publications each year. The trends in analyses using DHS data are highly correlated with worldwide and U.S. Government funding trends for global health.

Conclusion

An increasing number of research articles analyzing DHS data have been published over the last quarter century, making substantial contribution in building public health knowledge. The new knowledge provides for evidence-based policy and program development for health in developing countries.

INTRODUCTION

The Demographic and Health Surveys (DHS) project, funded primarily by United States Agency for International Development (USAID), has conducted over 230 nationally representative and internationally comparable household surveys in more than 80 countries. Since the project's inception in 1984, there have been six DHS phases.[1] The first three phases – DHS I, DHS II, and DHS III – were carried out between 1984 and 1997. In 1997 the DHS project was folded into a family of USAID projects in monitoring and evaluation, and was then renamed MEASURE DHS. MEASURE DHS is currently in its third iteration, which will come to completion in 2013.

Originally focused on fertility, reproductive health, maternal and child health, and nutrition, DHS has evolved to meet national and global health data needs. Today, it covers a wider range of population and health topics in developing countries. Through optional modules—sets of topic-specific questions on subjects such as HIV/AIDS, malaria, and gender-based violence—countries choose to collect data on a variety of health issues. Moreover, through collection of biomarker data, health conditions like anemia, HIV infection, malaria parasitemia, syphilis, and others may also be measured. Figure 1 provides a timeline of key DHS question, module, and biomarker additions.

All surveys under the DHS project are conducted by an in-country implementing agency, typically the national statistics office. The implementing agency receives technical assistance and support from the DHS project to ensure data quality and international comparability, and to build in-country survey capacity.

With few exceptions, all DHS data files and final reports are available to the public for free through the MEASURE DHS website at www.measuredhs.com.[1] Data files follow a standardized format to maximize comparability across surveys and improve ease of use for analysis. Final reports provide summary of the data, description of survey design, and copy of questionnaires used. The MEASURE DHS website also provides in-depth information such as data collection and processing procedures to help users understand the data and to facilitate data analysis.[2-5] The transparency of the DHS, including the free availability of data files, survey

methods descriptions and metrics, allows for external review and feedback beyond the internal quality assurance and control procedures in place.

A key aim of DHS is to provide quality data for policy development and program planning, monitoring, and evaluation. In order to build the policy and programmatic evidence base, DHS data must first be transformed into information, which must then be made accessible to decision makers.[6-8] Robust analyses of the data, beyond that which the DHS project publishes in survey reports, are essential for transforming data into information. These analyses, typically conducted by the research community, are necessary towards meeting the aforementioned DHS key programmatic aim. Research alone, however, will not influence policies and programs. The results of such analyses must be accessed, understood, and embraced by policy makers and program managers.

While DHS is a widely acknowledged data source among researchers, no study has methodically reviewed how DHS data have been utilized by researchers, and the degree to which researchers' analyses have been made available to policy and programmatic decision makers. The purpose of this study is to assess levels and trends of peer-reviewed research publications using DHS data. Findings from the study will contribute to a better understanding how DHS data have been transformed into information, and made available for policy and programmatic use.

DATA AND METHODS

Data

We obtained data from the MEASURE DHS website on all completed population-based surveys conducted under the DHS project between 1984 and 2010. Information collected included country, survey type, brief description of survey design, survey fieldwork period, and special features (i.e., inclusion of biomarker(s) and/or optional module(s)).[1]

We identified peer-reviewed publications analyzing DHS data through PubMed, an online, free, and publicly available biomedical and public health database that provides an important information access point for researchers, particularly in developing countries.[9] We restricted our

search to articles that use data from any population-based household survey conducted under the DHS program, including standard DHS, interim or special DHS, AIDS indicator surveys (AIS), and malaria indicator surveys (MIS). Keyword search terms used include "demographic and health survey"; "demographic AND "health survey"; "DHS"; "AIDS indicator survey"; "AIS"; "malaria indicator survey"; and "MIS". We conducted additional searches on non-standard official survey names used in specific countries such as "National Family Health Survey" in India. In all, 61 unique survey names were included in the search strategy. Based on this initial literature search, we found 1,326 publications as of December 31, 2010.

We then identified publications that met the following eligibility criteria: 1) publications that involved an analysis of DHS data (i.e. data derived from surveys conducted with technical assistance under the DHS project supported by USAID); and 2) publications with an English-language abstract. We excluded publications that only referenced DHS in the background or discussion.

Of the 1,326 publications, 1,160 were initially considered for further review based on the eligibility criteria. All 1,160 publication citations were downloaded to EndNote version X2.1, a bibliographic reference database (Thomson Reuters, Carlsbad, CA, USA). During the subsequent review process described below, we determined that an additional 43 publications did not meet the eligibility criteria, resulting in a final total of 1,117 articles published across 232 journals. Figure 2 presents a flowchart of included and excluded studies.

Measurement and Analysis

Prior to reviewing the publications, three reviewers, who are also this study's authors, drafted an initial list of research topics reflecting major survey themes. To refine the list, reviewers independently examined a subset of 25 abstracts, categorizing the abstracts based on the main outcome and independent variables. Reviewers then compared the topic areas each had assigned and resolved any discrepancies. Ultimately, reviewers identified 13 research topics for the classification of publications (Table 1). Topic categories were intentionally made broad to minimize misclassification and inter-reviewer variation.

Thereafter, all eligible publications were systematically divided into three subsets that were randomly assigned to each reviewer. Reviewers assigned up to three research topics per publication, and noted when the research topic of a given publication did not clearly fall within any of the 13 pre-defined topics. Those papers (n=134) were discussed by two reviewers and categorized based on reviewer consensus. Then, reviewers constructed two broad categories constituting the two major themes of DHS data: population and reproductive health (PRH) and maternal and child health and nutrition (MCHN) (Figure 3). The two categories were non-mutually exclusive, since publications frequently included both PRH and MCHN outcome and/or independent variables. The PRH category includes papers examining one or more of the following three topics: fertility and family planning; sexual behavior and knowledge; and/or sexually transmitted diseases, including HIV/AIDS. The MCHN category includes papers examining one or more of the following three topics: maternal health and/or mortality; child health and/or mortality; and/or nutrition, excluding studies on adult obesity. Both categories were assigned to summary papers on DHS results.

In addition, reviewers identified the year of publication and the country and region of each study's population. The five regional classifications were: Asia; Europe and Eurasia; Latin America & Caribbean; Middle East; and Sub-Saharan Africa. Study populations that included more than one country were identified as "Multi-Country" publications and study populations that included more than one region were identified as "Multi-Region" publications. Publications that used data from multiple DHS surveys for a given country to examine time trends were identified as "Trend" publications. Reviewers also noted select special study populations of neonates, youth, couples, and men.

Thereafter, we conducted descriptive analyses, calculating the number of publications per year, country, region, research topic, and the number of publications using data from multiple surveys for cross-country comparison and/or trend analyses. We also calculated the total number of completed surveys per year and per country and further assessed the association between the number of surveys and the number of publications. We conducted graphical and bivariate linear regression analyses using STATA 11.0 statistical software (Stata Corporation, College Station, TX, USA).

RESULTS

Survey Data

A total of 236 household surveys were completed across 84 countries between 1985 and 2010, including 197 standard DHS. The annual number of standard DHS remained constant, while the annual number of all DHS surveys slightly increased due to the introduction of AIS and MIS in the mid-2000s (results not shown).

By region, 49% of surveys were conducted in Sub-Saharan Africa (116/236), followed by Asia (20%) and Latin America & Caribbean (18%) (Table 2). On average, 2.8 surveys were conducted per country (n=84, SD: 2.1, Median: 2). Thirty countries conducted only one survey, and 54 countries conducted two or more surveys, with Egypt having conducted the highest number of surveys at ten.

Although the annual number of standard DHS remained constant, the amount and scope of data collected in a standard DHS increased over time, both through revisions to the household and women's core questionnaires, and through the addition of new optional modules (Figure 1). For example, the household core questionnaire began with 25 questions in the first phase of the DHS project. In the current phase, Phase Six, the household questionnaire contains 131 questions, down from a peak in Phase Five of 226 questions.[10] Much of the increase in the number of questions is attributable to a handful of topics, including HIV/AIDS, malaria, and maternal and child health.[1] As a result, 155 standard DHS collected data on knowledge and/or behaviors related to HIV/AIDS, with 36 having also collected HIV biomarker data; 62 collected data on behaviors related to malaria, with 6 having also collected malaria biomarker data; 97 collected data on gender related issues; and 76 collected data on adult health.

Publications Using DHS Data

[1] Compared to question counts in DHS Phase Four, in DHS Phase Five, 49 questions were added on HIV/AIDS for a total of 69 HIV/AIDS questions, 55 questions were added on maternal and child health for a total of 159 MCH questions, and 20 questions were added on other health issues (adult health) for a total of 20 other health questions.

Analyses using DHS data have been published in over 200 journals. About 40% of articles were published in 6 journals, including *Studies in Family Planning* (n=179), *Journal of Biosocial Science* (n=103), *Social Science and Medicine* (n=56), and *Demography* (n=28). As Figure 3 shows, the annual number of publications has increased substantially, with 4.3 (95% CI 3.2-5.3) more publications each year. Of the 1,117 total publications, we classified 566 (51%) as PRH and 605 (54%) as MCHN– the two non-mutually exclusive categories. Some publications examined topics related to neither PRH nor MCHN (n=145, 13%). While the annual number of publications increased over time in both PRH and MCHN publications, the MCHN topics represent the larger increase (2.09 per year, 95%CI 1.48-2.70) compared to the PRH topics (1.37 per year, 95%CI 1.02-1.72) (Table 3). The recent increase in publications outside PRH or MCHN topics is primarily due to increased number of publications in adult health (n=21), as well as studies on survey methodologies, including data quality (n=70) (results not shown).

Within the PRH category, publications related to HIV/AIDS have increased substantially during the last decade – on average 1.9 additional publications per year between 2001 and 2010 (p-value= 0.007, bivariate linear regression, results not shown). The annual number of publications in fertility and family planning, however, peaked in 1996 and has not changed significantly since then (Figure 4).

Within the MCHN category, publications related to child health represented the largest change over time (Figure 4, Table 3). Similar to HIV/AIDS publications but with a greater magnitude, child health publications increased substantially during the last decade—on average 3.6 additional publications per year between 2001 and 2010 (p-value = 0.007, bivariate linear regression, results not shown).

The number of country-specific publications is statistically significantly associated with the number of surveys conducted in that country, even including the two outliers, Bangladesh and India (Figure 5). Bivariate linear regression analysis suggests that each additional survey yields 3.5 more country-specific publications (p-value $\leq$0.001, n=84). Among the publications that analyzed multiple surveys either within or across countries, representing 34% of all studies reviewed, the annual number of these publications increased dramatically over time (Figure 6).

DISCUSSION AND CONCLUSION

As DHS data proliferate, so does peer-reviewed research analyzing DHS data. With this expansion comes increased availability of information, which provides the basis of evidence-based policy and program development. Our analyses reveal several important trends in the use of DHS data for research publication, as well as several gaps in data utilization.

First, although the number of publications per year has increased in all health topics, it is more pronounced in MCHN areas compared to PRH areas. One possible explanation of this difference is that it may be attributable to recent additions of MCHN questions to the core questionnaire and additions of MCHN-related modules. The difference may also be related to funding trends, which are further discussed below.

Second, the data show that the increased number of studies in certain topics followed the introduction of related questions and modules to the DHS, suggesting that DHS modifications are meeting emerging data needs. For example, HIV/AIDS publications using DHS data proliferated in the years following the 2001 introduction of HIV testing and 2006 introduction of AIS. Similarly, gender-related publications using DHS data increased in number following the introduction in 1995 of the women's status module and in 1998 of the domestic violence module.

Third, recent increases in adult health publications using DHS data following the introduction of data collection related to adult health (e.g., tobacco use questions, diabetes testing), also confirm that DHS is meeting emerging health data needs. Moreover, additions of such questions indicate that DHS is responsive to the data needs of host countries, not just those of USAID and other international donors for whom adult health issues are typically of lesser priority.

These trends demonstrate that DHS adaptations are meeting data needs, and researchers are utilizing DHS data to build the knowledge base. However, even though data is available, is being transformed by the research community into information, and is being made available

through peer-reviewed publications, it is difficult to measure the uptake of such information by decision makers.

One way to measure the degree of importance decision makers place on a given issue is to review trends in funding for that issue. We collected data on yearly U.S. Government funding for specific international health issues—family planning,[11] HIV/AIDS,[12,13] and maternal, child health and nutrition[14]—and compared those funding trends to trends in DHS publications on those issues. Our analysis reveals that trends in DHS research are highly correlated with trends in U.S. Government funding for global health (Figure 7). For example, HIV/AIDS publications using DHS data are highly correlated with U.S. Government funding for global HIV/AIDS programming. To confirm our findings, we also collected data on yearly worldwide development assistance funding for health[15] and compared this data with the total number of DHS publications on all topics per year. Again, the trends in funding and publications are highly correlated (Figure 8). Our findings do not, however, imply causality— the correlation may reflect the relationship of increased number of publications using DHS data leading to increased funding; alternatively, it may reflect a relationship of increased funding leading to increased publications; it may reflect a bidirectional relationship where increased publications lead to increased funding that in turn leads to increased publications; it may reflect a larger, sector-wide consensus between researchers and the donor community on health priorities; or the correlation may be spurious. Nevertheless, the strength of the correlation does lend weight to the notion that research using DHS data likely provides relevant information for program and policy decision makers.

Despite the many published analyses using DHS data, research gaps remain. For example, we found very few publications on water and sanitation (n=6) despite the large amount of related data that DHS provides, including household core module questions related to drinking source and toilet type. Published research using data from special surveys is also limited. Although Peru has been implementing the DHS Continuous Survey every year since 2004, our search discovered only one publication using that data. For family planning analyses, DHS is one of the few sources that provide data on unmet need for family planning. We, however, found only 13 publications that examined unmet need or included it as a covariate in fertility and family

planning analysis. These examples highlight not only the need for more published research in a given area like water and sanitation and unmet need for family planning, but also the need for DHS to increase researcher awareness of non-traditional data sources, like special surveys.

Our study is not without limitation. First, we did not conduct a more comprehensive search of studies analyzing DHS data in both the peer-reviewed and grey literature. Further, our reliance on PubMed may have overly limited our results given PubMed's omission or limited indexing of some non-biomedical and health oriented journals known to publish research using DHS data such as *Population and Development Review*, *Population Research and Policy Review, and Economic and Political Weekly*. Second, we likely underestimated researchers' use of DHS data for trend and cross-country analyses. This is in part due to our limited definition of "trend analysis", which excluded trend analyses using one DHS dataset in comparison with one or more non-DHS nationally-representative datasets (e.g. UNICEF's Multiple Indicator Cluster Survey). It is also due to the limitations of our search terms, which did not find several well-known global systematic analyses which employed DHS data.[16-20] Finally, we did not conduct any formal statistical test to assess inter-rater variation among the three reviewers. Nevertheless, we believe misclassification was minimal since our publication classifications were broad and non-mutually exclusive.

Despite these limitations, study results show that researchers are increasingly using DHS data, and that vital health information is more accessible to health policy and program decision makers. DHS is well positioned to achieve its aim to provide quality data for policy development and program planning, monitoring, and evaluation in global health.

Figure 1. DHS Timeline: Key survey question, module, and biomarker milestones

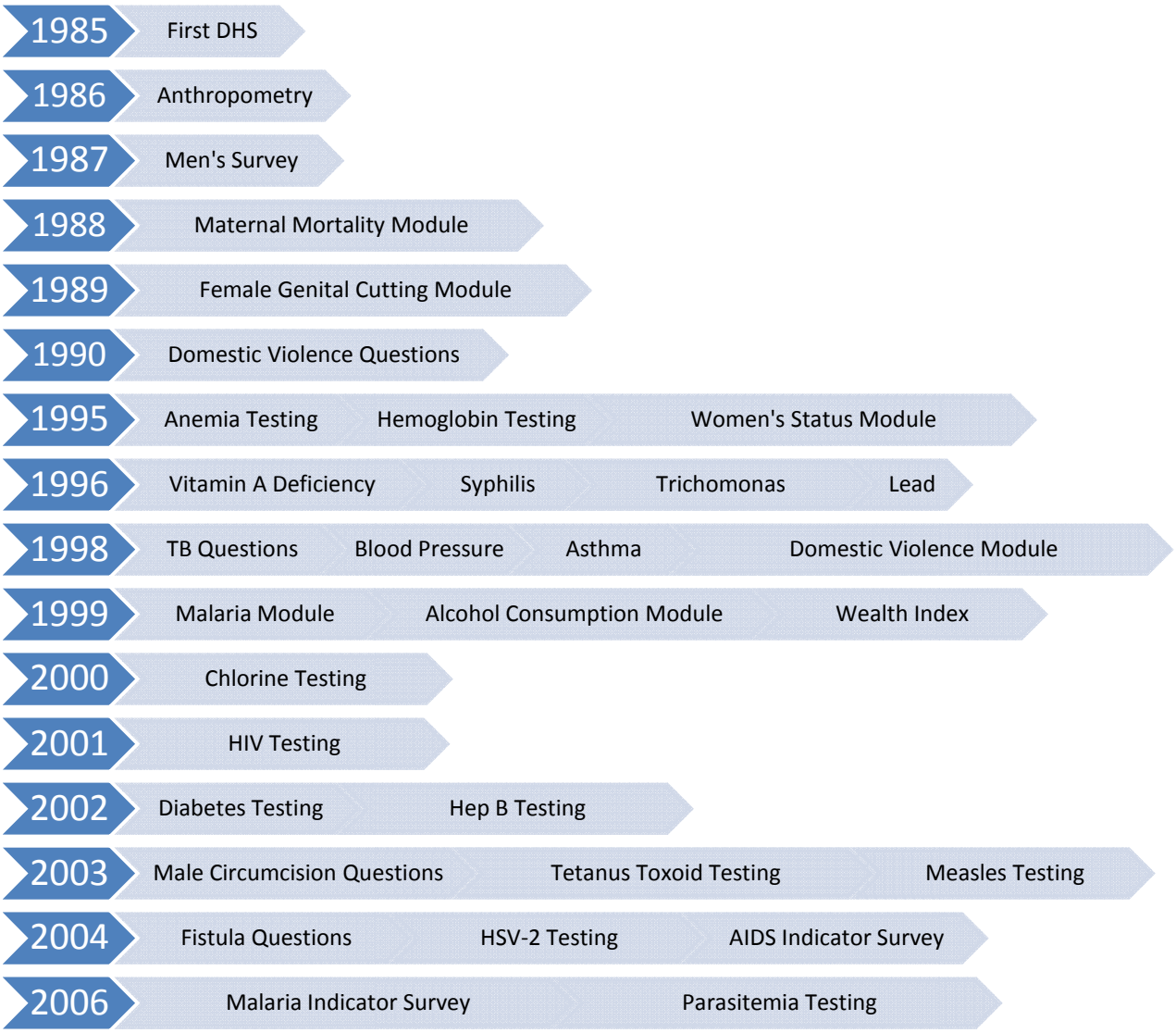


Table 1. Number of publications using DHS data by research topic and special study population

	All (n=1117)
Research topic	
Fertility and family planning	289
Sexual behavior and knowledge	81
HIV/AIDS	88
Maternal health and mortality	123
Child health and mortality	305
Nutrition	141
Malaria	24
Gender	107
Poverty and equity	69
Adult health and mortality	45
Water and Sanitation	6
Summary of single DHS survey	151
Survey and statistical methods	70
Special study population	
Couples	19
Men	21
Youth	32

* Categories are non-mutually exclusive.

Table 2. Completed population-level surveys conducted under the DHS project: 1985-2010

	n	(%)
Type		
Standard DHS	197	(83.5)
Continuous DHS *	1	(0.4)
AIDS Indicator Survey	7	(3.0)
Malaria Indicator Survey	5	(2.1)
Interim surveys **	8	(3.4)
Experimental surveys†	2	(0.9)
Special surveys ‡	16	(6.8)
Region		
Asia	46	(19.5)
Europe & Eurasia	9	(3.8)
Latin America & Caribbean	43	(18.2)
Middle East	22	(9.3)
Sub-Saharan Africa	116	(49.2)

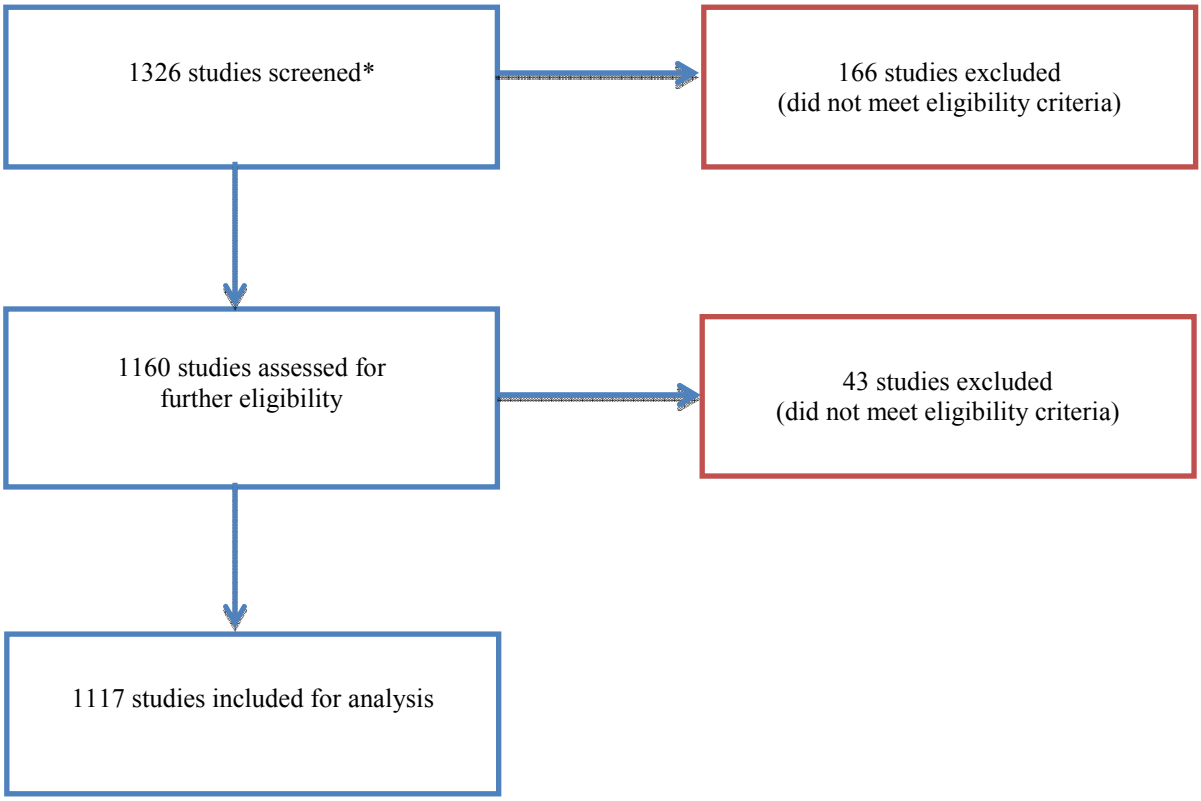
* Peru continuous DHS 2004-2008

** Interim DHS and Knowledge, Attitudes, Practices (KAP) surveys

† Two experimental surveys on methodologies in the beginning of the DHS project

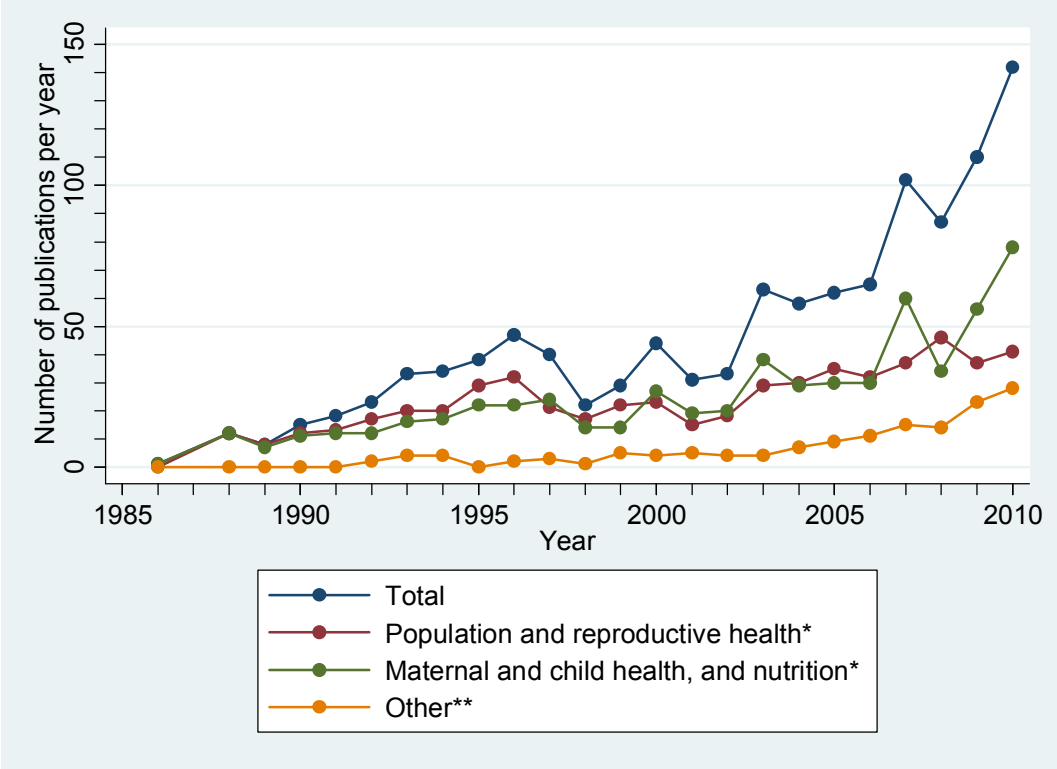
‡In-depth surveys on specific topics

Figure 2. Flowchart for bibliographic search of studies analyzing DHS data in PubMed



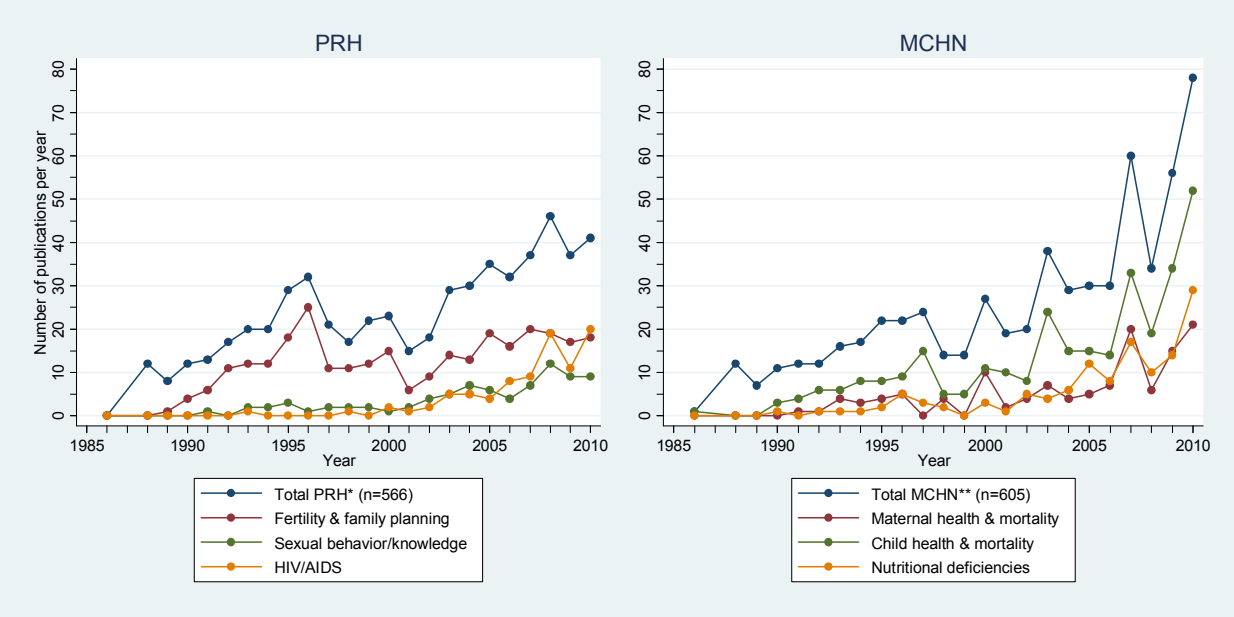
*Duplicates were automatically removed during the process of identification in EndNote bibliographic reference database

Figure 3. Annual number of publications by research topic among all 1117 publications



* Population and reproductive health category includes papers examining fertility, family planning, sexual behavior and knowledge, and/or sexually transmitted diseases including HIV/AIDS; Maternal and child health, and nutrition category includes papers examining maternal health and mortality, child health and mortality, and nutrition, excluding studies focused on adult obesity; The two categories are not mutually exclusive. Both categories include DHS summary papers.
** Neither PRH nor MCHN papers.

Figure 4. Annual number of publications by topic in PRH and MCHN



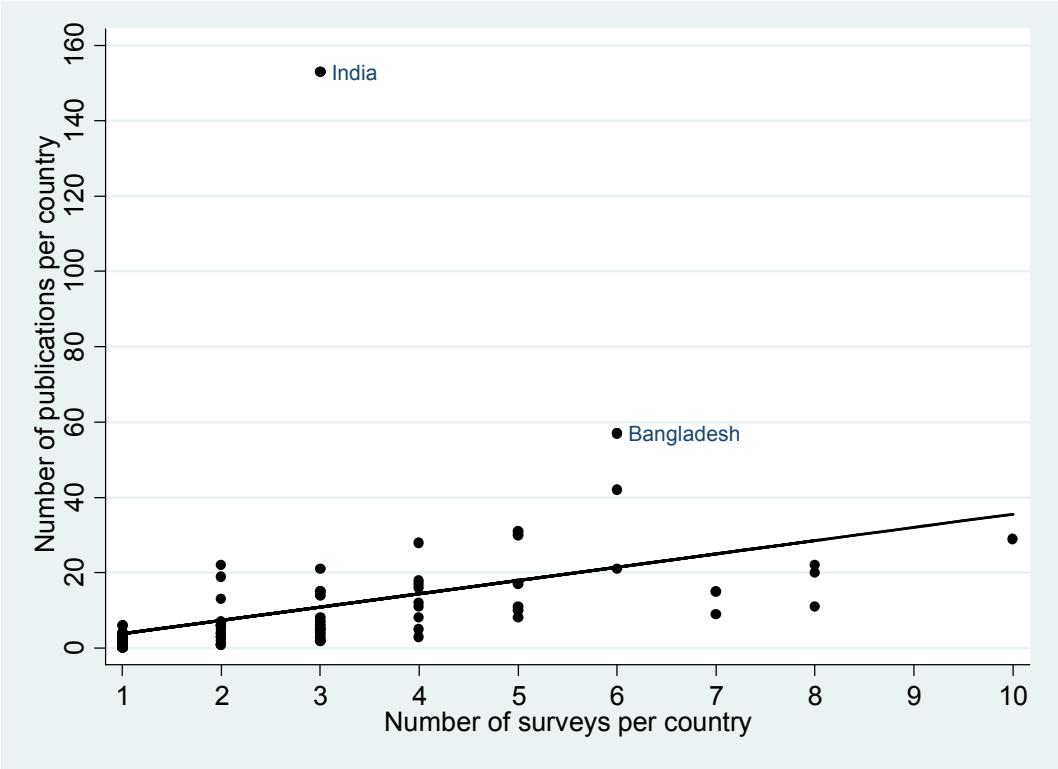
PRH: Population and reproductive health; MCHN: Maternal and child health and nutrition
* PRH has three non-mutually exclusive topics: fertility and family planning, sexual behavior and knowledge, HIV/AIDS
** MCHN has three non-mutually exclusive topics: maternal health and mortality, child health and mortality, and nutritional deficiencies.

Table 3. Association between the total and research-topic specific number of publications and calendar year, 1985-2010: bivariate linear regression analyses (n=24)

The number of publications by research topic	Coefficient per year	(95% CI)	Adjusted R-squared
All	4.27	(3.24-5.30)	0.76
Population and reproductive health	1.37	(1.02-1.72)	0.74
Fertility and family planning	0.66	(0.37-0.95)	0.48
Sexual behavior and knowledge	0.41	(0.31-0.51)	0.75
HIV/AIDS	0.64	(0.41-0.86)	0.59
Maternal and child health and nutrition	2.09	(1.48-2.70)	0.68
Maternal	0.62	(0.37-0.87)	0.53
Child	1.40	(0.95-1.85)	0.64
Nutritional deficiencies*	0.76	(0.49-1.03)	0.58
Other**	0.85	(0.59-1.11)	0.66

*Nutritional deficiencies: Publications focused on nutrition, excluding studies on adult obesity
**Other: Publications neither focused on PRH nor MCHN topics.
Each row represents an individual regression analysis

Figure 5. Association between the number of surveys and publications at the country-level (n=84)*



Solid line is the fitted line based on the bivariate linear regression of the number of publications on the number of surveys at the country-level (n=84; coefficient: 3.5; p-value<0.00; adjusted R-square: 0.14).

*This calculation includes only publications that use data from a single country (n=898), and excludes all publications that use data from multiple countries (n=216). In making this calculation, we assume that single country studies are more likely to generate country-specific policy implications and that multi-country studies are randomly distributed across countries and regions.

Figure 6. Annual number of publications analyzing multiple surveys

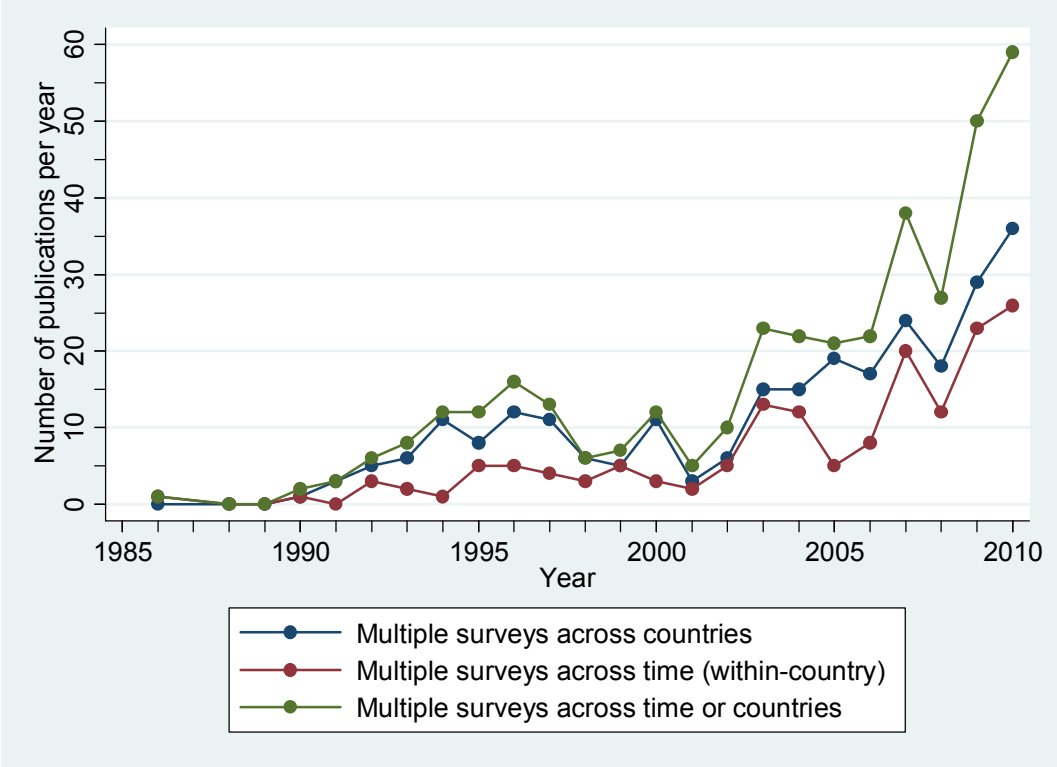
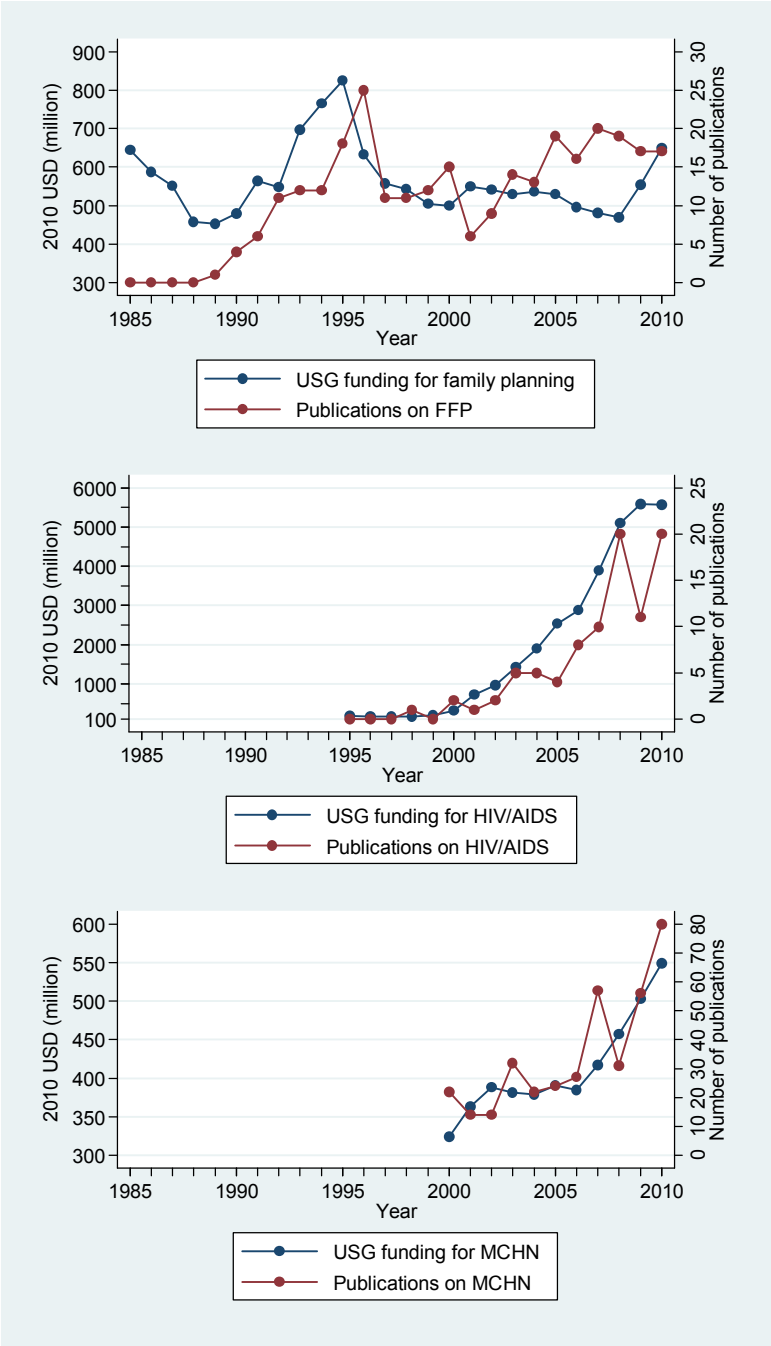
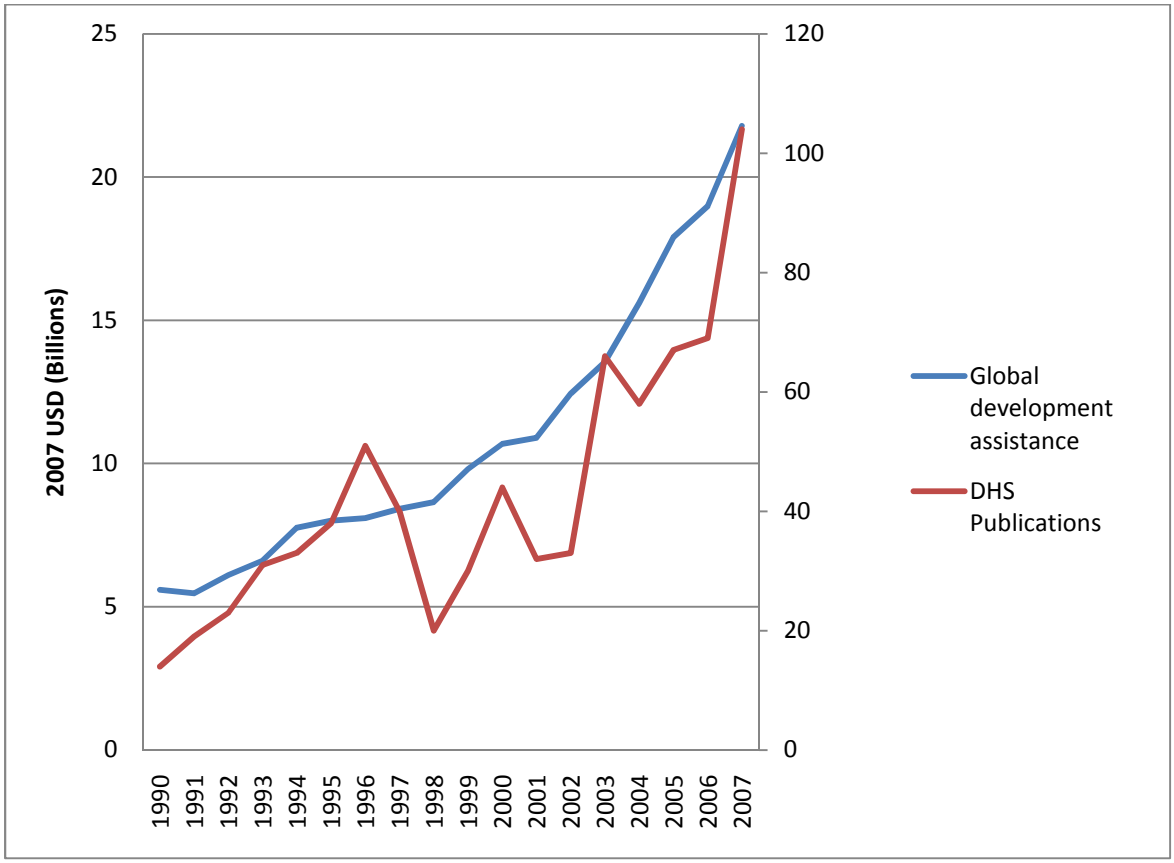


Figure 7. Trends of annual funding for global health by US government* and the annual number of publications using DHS data by technical program element



FFP: Fertility and family planning; MCHN: Maternal and child health and nutrition
Pearson's correlation coefficient between funding and publications: 0.18 (FP, n=26, p-value=0.36), 0.93 (HIV/AIDS, n=16, p-value<0.01), and 0.85 (MCHN, n=11, p-value<0.01)
*Sources for funding data: Population Action International 2010 (Family planning), Kaiser Family Foundation 2004 (HIV/AIDS), President's Emergency Plan for AIDS Relief 2011 (HIV/AIDS), and U.S. Agency for International Development 2011 (MCHN)

Figure 8. Trends of annual global development assistance funding for global health* and the annual number of publications using DHS data (1990-2007)



Pearson's correlation coefficient between funding and publications: 0.90 (n=18, p-value<0.01)
*Source: Ravishankar 2009

References

1. MEASURE DHS. Demographic and Health Surveys. http://www.measuredhs.com/. Accessed 7/1/2011.
2. MEASURE DHS. DHS Recode Manual. http://www.measuredhs.com/pubs/pub_details.cfm?ID=739&srchTp=type. Accessed 7/26/2011.
3. MEASURE DHS. DHS Model Questionnaires. Accessed 7/26/2011, 2011.
4. Macro International Inc. *Sampling Manual.* Calverton, Maryland1996.
5. Croft T. DHS Data Editing and Imputation
6. The Policy Project. The policy circle. http://www.policyproject.com/policycircle/content.cfm?a0=2. Accessed 7/1/2011.
7. AbouZahr C, Adjei S, Kanchanachitra C. From data to policy: good practices and cautionary tales. *Lancet.* Mar 24 2007;369(9566):1039-1046.
8. Colebatch H. What work makes policy? *Policy Sciences.* 2006;39.
9. U.S. National Library of Medicine NIoH. PubMed. http://www.ncbi.nlm.nih.gov/pubmed.
10. ICF Macro. DHS Questionnaire Revision Process: Counts of Questions over 25 Years; 6/29/2009, 2009.
11. Population Action International. U.S. Funding for International Family Planning and Reproductive Health, 1965-2010. http://www.populationaction.org/Issues/U.S._Policies_and_Funding/Trends_in_U.S._Population_Assistance.shtml. Accessed 6/22/2011, 2011.
12. Kaiser Family Foundation. Chartpack: Trends in U.S. Government Funding for HIV/AIDS Fiscal Years 1981-2004. 2004; http://www.kff.org/hivaids/7033.cfm.
13. President's Emergency Plan for AIDS Relief. PEPFAR Funding: Investments that Save Lives and Promote Security. 2011; http://www.pepfar.gov/documents/organization/80161.pdf.
14. U.S. Agency for International Development/ Global Health Bureau. Maternal Health Portfolio Review. Washington, DC2011.
15. Ravishankar N, Gubbins P, Cooley RJ, et al. Financing of global health: tracking development assistance for health from 1990 to 2007. *Lancet.* Jun 20 2009;373(9681):2113-2124.
16. Hill K, Thomas K, AbouZahr C, et al. Estimates of maternal mortality worldwide between 1990 and 2005: an assessment of available data. *Lancet.* Oct 13 2007;370(9595):1311-1319.
17. Gakidou E, Cowling K, Lozano R, Murray CJ. Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: a systematic analysis. *Lancet.* Sep 18 2010;376(9745):959-974.
18. Rajaratnam JK, Marcus JR, Flaxman AD, et al. Neonatal, postneonatal, childhood, and under-5 mortality for 187 countries, 1970-2010: a systematic analysis of progress towards Millennium Development Goal 4. *Lancet.* Jun 5 2010;375(9730):1988-2008.
19. Rajaratnam JK, Marcus JR, Levin-Rector A, et al. Worldwide mortality in men and women aged 15-59 years from 1970 to 2010: a systematic analysis. *Lancet.* May 15 2010;375(9727):1704-1720.

20. Hogan MC, Foreman KJ, Naghavi M, et al. Maternal mortality for 181 countries, 1980-2008: a systematic analysis of progress towards Millennium Development Goal 5. *Lancet.* May 8 2010;375(9726):1609-1623.