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MEASURING EDUCATIONAL PARTICIPATION:
Analysis of Data Quality and Methodology Based on Ten Studies

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UNESCO

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1. Introduction

Universal primary education (UPE) is a common target set out in the Education for All (EFA) and Millennium Development Goals (MDGs). To track progress toward this goal, it is necessary to use universal methods to measure participation in primary education and count the number of children out of school.

Based on differing data sources, the UNESCO Institute for Statistics (UIS) and UNICEF currently produce different estimates for the proportion of out-of-school children. To track ‘in school’ rates, the UIS uses data on enrolment from administrative sources collected annually from all countries of the world, combined with population census data collected by the United Nations Population Division. In contrast, UNICEF uses attendance rates from two household surveys, which are conducted in about 80 countries roughly every five years: the Demographic and Health Survey (DHS), sponsored by USAID and administered by Macro International, and the Multiple Indicator Cluster Survey (MICS), sponsored and administered by UNICEF. UNICEF also supplements attendance data with enrolment figures from the UIS and data from other surveys.

The discrepancy between the figures published by the UIS and UNICEF has been significant, clearly indicating a need for a unified approach. As a preliminary effort, the two agencies worked together to develop a single estimate based on both sources of data but only reflecting single points in time when both sources were available (UNESCO-UIS, 2005). Since the user community is interested in change in trends over time, there was an obvious need for an estimate based on the two sources of data but consistent over all available time points, including those when survey data are not available. The UIS outsourced the development of such a methodology, which has been delivered and reviewed but needs substantial empirical validation before it can be implemented to produce estimates of out-of-school children *(see Singh, 2006).*

This report addresses some of the issues of the original single-point-in-time methodology. In particular, it aims to meet the need for a better understanding of the various data quality aspects related to the two sources of data – the UIS administrative data and the household survey data used by UNICEF. Thus, the authors of this report have undertaken ten studies in order to investigate the extent to which the discrepancy between estimates derived from the two different sources is due to potential data quality issues (rather than conceptual differences). The outcome of these studies constitutes the basis of this report. The problem of devising a methodology for combining the two data sources to provide a single estimate of out-of-school children will be put aside for the time being, since improving basic data quality is an essential step before development of improved estimation methods.

Before delving into the details of the studies themselves, a short discussion is in order on the definition of ‘educational participation’, which is at the heart of the UIS and UNICEF efforts to track out-of-school children. One of the difficulties with tracking educational participation (or its complement – the lack of participation) is that there is no international agreement at present on what is meant by this concept. Measuring a quantity that has not been carefully defined is difficult to do and poses a variety of problems. Furthermore, there are no existing national or international measurement instruments (administrative, survey or otherwise) expressly designed to capture and measure educational participation. As a result, international agencies are limited to using data from existing measurement instruments that seem the most appropriate for capturing the concept of educational participation.

For instance, the UIS tracks out-of-school children using the complement of enrolment (as measured by administrative sources), despite the fact that educational participation occurs on a continuum and enrolment is a discrete event. Furthermore, enrolment captures the "intent to participate" rather than participation itself. There are also limitations to the measurement instruments used to capture enrolment. For example, the UIS requests countries to report an aggregated figure for enrolment by age and grade. They also need to provide a definition of the various levels of education (i.e. primary, secondary) by indicating the starting age and duration of national programmes. From this information, the UIS can construct enrolment rates for primary school.

However, many countries do not have one education system or one definition of the primary level that holds true for the entire country. Indeed, there can be stark differences within a country. In such cases, countries are requested to report in accordance with the most prevalent definition. The extent to which this 'compromise reporting' distorts international indicators, such as net enrolment rates (NERs), has been largely unexplored. The UIS, however, is not in a position to solicit data that comply with the varying within-country definitions, given that national administrative data are often not available at a more disaggregated level.

In contrast, UNICEF uses the complement of attendance (as measured by household surveys) to track out-of-school children. This is in some ways more appealing heuristically since attendance occurs on a continuum and seems intuitively closer to the notion of participation. Nevertheless, the survey instruments that set out to capture attendance are fraught with measurement problems. For instance, shortcomings in coverage of the population can be a handicap in capturing the notion of participation. By design, DHS does not cover the homeless population and so clearly underestimates the out-of-school population since only children residing in households who do not attend school are deemed out of school. In some countries, this may concern only a very small number of children, but in others (particularly in developing countries), a substantial proportion of out-of-school children may come from the homeless population but are not covered by the surveys.

This is an important limitation. Moreover, it may be that some children living in institutions (e.g. orphanages or charitable hostels) have higher levels of educational participation than the general household population. In addition, for countries with a large population of homeless children (assuming they do not attend school), the estimates of attendance are likely to be upwardly biased since the 'attending population' for the numerator would be less biased than the primary-age population for the denominator, as the latter excludes the homeless children component. When interpreting the studies that follow, it should be kept in mind that the use of household surveys has serious limitations in countries where a significant proportion of primary-age children are homeless, unless some crude correction is possible.

Recommendation 1: *When using household survey data to generate estimates of educational non-participation, an allowance should be made for homeless children wherever this population represents an important factor.*

The use of DHS raises another measurement issue, in particular with regard to the questions about "current attendance at school" and "past attendance (for one or more days) in the previous academic year". The latter is intended to capture students who have temporarily not attended school due to illnesses or other reasons. But there are obvious issues with this exaggerated notion that attending only one day of school during the past academic year is an indication of educational participation. Yet, what would be a reasonable minimum quantum of school attendance in order to consider that a child is in effect participating in education? There should be some international consensus,. One way to define a reasonable definition for educational participation may be by investigating school attendance registers across countries and analysing the various trends in frequencies and distributions of attendance.

On a related note, there seems to be little understanding of the patterns of partial or non-participation and its extent throughout the world. Some children may be enrolled and never attend, children may attend for some time (either with or without formal enrolment), or children may attend on a regular and continuous basis. Non-attendance may be predictable (e.g. during harvest times) or sporadic, and may be extensive or slight (both in time and in numbers of non-attendees). The accuracy of the measurement of educational participation depends on these patterns and any modifications to data collection or questionnaires need to take into account these patterns of non-attendance. Hence, it is essential not only to work on the concept of participation but also to obtain empirical evidence of the actual patterns of participation. It should be noted, however, that there are great differences across countries with regard to the quality of information sources (e.g. well-maintained attendance registers), functioning of the educational system and patterns of participation. Nonetheless, any information – including small-scale studies using records from a number of schools or detailed survey inquiries – can be useful.

Recommendation 2: *International agencies should reach a consensus on the definition of educational participation/non-participation and provide guidelines and standards for measuring out-of-school populations. Obtaining empirical information on the patterns of partial and non-participation would help in the development of the concept and measures of educational participation. Also, since existing instruments used for measuring school enrolment and attendance have various limitations, international agencies should consider using alternate sources of data. For instance, using national registers of attendance (which exist in many countries) could be a possibility. The extent to which this information is available in a comprehensive, timely and accurate fashion is an area of possible investigation.*

The remainder of this paper will present the findings of the ten studies related to various aspects of data quality from administrative, household survey and population census sources. It is unlikely that one single source of data will be appropriate for a range of disparate countries. Thus, this series of quality studies proposes recommendations for strengthening data sources so as to render the widest application. If a general quality improvement is to be achieved, the recommendations need to be universal rather than country-specific.

Section 2 provides an overall comparison of the two estimators, the Adjusted Net Enrolment Rate (NER+) and the Adjusted Net Attendance Rate (NAR+). This is followed by a series of studies focusing on specific issues concerning population data from the United Nations Population Division (Section 3), enrolment data from administrative sources (Section 4) and attendance data from household survey sources (Section 5). The results of a special investigation on age reporting are given in Section 6, followed by some conclusions in Section 7.

2. Overall comparison and decomposition of the two estimators

Initially some 40 countries were proposed for the study, each having more than 1 million out-of-primary school children and/or an NER of less than 75%. According to the Education for All (EFA) *Global Monitoring Report* (2002), these selected countries faced the greatest challenges for achieving EFA goals with respect to access to and participation in primary education. The set of 40 countries was then pared down to a final set of 19, given data availability constraints. Countries were considered only if data on attendance rates could be obtained through either DHS or MICS, and corresponding UIS post-1999 administrative data on enrolment were available for the same year.

Of the 19 countries, 16 had DHS and 3 had MICS as their survey data sources. In a discussion with UNICEF close to the finalisation of this report, it was discovered that there was a coding issue with some of the critical variables for the three MICS countries (Chad, Niger and Senegal), giving the impression that there were many more missing values than in reality. Given the timing of the discovery, it was not possible to redo the empirical work for these three countries and unfortunately they could not be included in this report. The final list of 16 DHS countries which were included in the analysis is included in Table 1.

Study 1. Overall comparison of NER+ and NAR+

In order to get an overall sense of the differences between the Adjusted Net Enrolment Rate (NER+) gathered from administrative and census sources and the Adjusted Net Attendance Rate (NAR+) obtained from household survey sources, a comparison of these two estimators is essential.

NER+ is defined as:

$$\text{NER+} = 100\,\frac{\textit{Number of primary school-aged children enrolled in primary or secondary school}}{\textit{Number of primary school-aged children}}$$

This is somewhat modified from the usual definition of the net enrolment rate (NER), which includes only primary school-aged children enrolled in primary school in the numerator (excluding primary school-aged children enrolled in secondary school). *(See UNESCO-UIS, 2007 for more details on the NER.)* National administrative sources (i.e. ministries of education or national statistical offices) supply data for the numerator to the UIS annually. For the denominator, the UIS uses figures supplied by the UN Population Division, which are taken from United Nations Statistics Division (UNSD) census data. The UN Population Division then produces estimates for inter-census years where there are no data available.

Similarly, NAR+ is defined as:

$$\text{NAR+} = 100\,\frac{\textit{Number of primary school-aged children attending primary or secondary school}}{\textit{Number of primary school-aged children}}$$

As with NER+, it should be noted that this definition differs from the standard definition of net attendance rate (NAR) in that it includes children of primary school age attending secondary school in the numerator. *(See UNICEF, 2008 for more details on NAR.)* For NAR+, both the numerator and denominator are estimated from DHS or MICS surveys with the estimates that integrate survey weights in both the numerator and denominator.

Prior to the development of the joint UIS/UNICEF methodology, the estimate for the proportion of out-of-school children used by the UIS was 100-NER, whereas UNICEF used 100-NAR. More recently, the UIS has used 100-NER+. The rationale for no longer using NER and NAR in estimations is that they exclude primary school-aged children enrolled in or attending secondary school, thus artificially inflating the actual number of out-of-school children.

For the DHS and MICS surveys, the collection periods often spanned two or more (partial) calendar years and, at the same time, one or more primary school academic years *(see **Table 1** for the survey periods and **Table 2** for definitions of academic years by country).* In order to make the NAR+ comparable with the NER+, the latter was calculated using blended rates based on pro-rated values from multiple academic years corresponding as closely as possible to the survey collection period. For example, in Bangladesh, the academic year runs from January to December. The DHS in that country was conducted from November 1999 to April 2000. Thus, a blended enrolment rate using both 1999 and 2000 values was calculated by taking a pro-rated amount of each component proportional to the sample size falling in the last two survey months in 1999 (two-sixths) versus the first four survey months in 2000 (four-sixths). It should be noted that a separate analysis was done to investigate the extent to which the component individual year values on which the blended rates for NER+ were based (1999 and 2000) were not dramatically different from one another, to ensure that the blended rate was itself not introducing a potential bias. In eight of the nine countries where blending was used, the individual year values were very close to each other. In Mozambique, the values were significantly far apart for the two years (62.82% versus 71.04%), but only a very small fraction of the larger figure was used, resulting in a blended rate very close to the lower figure (62.91%).

Table 1 presents the results of the NER+/NAR+ comparison for the 16 DHS countries. For Bangladesh, the absolute value of the difference between NAR+ and NER+ was greater than 10%. Further investigation is necessary to shed light on why this difference exists. A plausible explanation is given in Study 9, which concludes that NER+ may be a more credible estimator than NAR+ in Bangladesh. For three other DHS countries (Burkina Faso, Indonesia and Tanzania), the absolute values of the differences were hovering just above 5%, whereas for Egypt it was about 8%.

Table 1. Overall comparison of NER+ and NAR+

Country	Academic years on which blended NER+ based	Blended NER+	Survey	Survey period	NAR+	Percent difference between blended NER+ and NAR+	2 * standard error (Jackknife) of NAR+ (as given in Table 13)
Bangladesh	1999, 2000	93.05	DHS	11/99-04/00	79.59	13.46	1.644
Burkina Faso	2003, 2004	38.60	DHS	06/03-12/03	32.33	6.27	3.122
Côte d'Ivoire	1998, 1999	53.67	DHS	09/98-03/99	52.15	1.52	5.396
Egypt	2000	93.50	DHS	02/00-04/00	85.50	8.00	1.134
Ghana	2003, 2004	59.80	DHS	07/03-11/03	61.22	-1.42	2.480
Guinea	1999	43.16	DHS	04/99-08/99	39.95	3.21	*
India	1999, 2000, 2001	82.34	DHS	11/98-07/00	82.33	0.01	0.702
Indonesia	2002, 2003	100.86	DHS	01/02-04/03	95.25	5.61	0.690
Kenya	2003	77.36	DHS	04/03-09/03	74.99	2.37	2.044
Mali	2001	42.98	DHS	01/01-06/01	39.03	3.95	2.842
Mozambique	2003, 2004	62.91	DHS	08/03-01/04	59.85	3.06	2.060
Namibia	2000	74.23	DHS	09/00-12/00	78.60	-4.37	1.860
Nigeria	2003	62.09	DHS	03/03-08/03	61.99	0.10	3.386
Rwanda	2000, 2001	71.10	DHS	06/00-12/00	71.94	-0.84	1.448
Tanzania	1999	47.70	DHS	09/99-11/99	53.83	-6.13	3.410
Viet Nam	2002	96.06	DHS	09/02-12/02	96.27	-0.21	1.254

Table 2. Definition of academic year for primary level by country

Country	Start month	End month
Bangladesh	1	12
Burkina Faso	10	6
Côte d'Ivoire	10	6
Egypt	9	6
Ghana	9	7
Guinea	10	6
India	4	3
Indonesia	7	6
Kenya	1	12
Mali	10	6
Mozambique	1	12
Namibia	1	12
Nigeria	9	7
Rwanda	9	6
Tanzania	1	12
Viet Nam	9	5

The standard error of the survey-based estimator of NAR+ is calculated in Table 13 using the Jackknife technique; in Table 1, two times this value is reported in the last column. It can be seen that the absolute value of the percent difference between NAR+ and NER+ (absolute value of the second to last column) is often higher (for 9 of 15 countries) than two standard errors of NAR+ (last column), emphasising that the apparent differences are not simply the result of sampling errors from the survey-based estimate but an underlying problem of non-sampling bias in one or both sources. This seems to be generally the case, even for many countries where the differences are modest.

Study 2. Decomposing NER+ (from administrative and population census sources) and NAR+ (from household survey sources) into component parts

To further investigate the differences between NER+ and NAR+ for the 16 DHS countries, the numerator and denominator values were decomposed.

First, it should be noted that DHS provides micro-data files containing "scaled survey weights" rather than the "original survey design weights". Scaled survey weights are formed by modifying the original survey design weights so that their sum totals the overall sample size rather than the population size. The use of scaled weights is standard practise for analyses of data sets derived from complex survey designs, particularly for micro-data release files. The advantage is that when estimates based on these are plugged into off-the-shelf statistical packages that do not have special standard error formulae appropriate for complex survey designs, a standard error estimate is provided that at least partially takes into account the various aspects of the complex survey design. Thus, in providing scaled survey weights, the designers of DHS likely wanted to protect against a naïve use of original survey weights in off-the-shelf statistical packages, which would result in false standard errors.

Furthermore, the use of scaled weights results in point estimators that are identical to those produced when original survey design weights are used – *provided the estimates are for ratios or rates*. The problem is that estimates of totals cannot be correctly made using scaled weights, despite the fact that these are sometimes of interest to analysts (e.g. total number of children attending primary or secondary school). Nonetheless, through special request, the UIS was able to obtain the original survey design weights from Macro International (the agency responsible for administering DHS surveys) for 11 of the 16 DHS countries. This made it possible to do an analysis of numerator and denominator separately for these countries *(see Tables 3, 4, 5 and 6).*

The survey design weights provided for the 11 countries were not adjusted for non-response, and the file provided contained insufficient information to be able to perform the non-response adjustment. For all participating countries, survey response rates at the household and individual levels were high (>95%). It is, therefore, likely that with an appropriate adjustment for non-response, the differences in the point estimates of NAR+ (ratio) would be modest compared to the unadjusted figure. Yet, it should be noted that there would likely be a downward bias due to the non-response for estimates of totals and that an underestimate of a few percentage points matters in comparing the survey-based estimate of the population total with an estimate from an alternative source such as the UN Population Division *(as shown in Table 4).*

Recommendation 3: *Future rounds of DHS and MICS surveys should provide both original survey design weights (adjusted for non-response) and scaled weights for the public use micro-data files to enable analysts to produce estimates of totals. The reason provided by Macro International for withholding original survey design weights for some countries that participated in these surveys is that certain modules of the questionnaire procure information for which estimates of totals are deemed too sensitive (e.g. on HIV/AIDS). It is difficult to understand this policy since an estimate of a population total is no more likely to breach confidentiality than an estimate of a rate. Nevertheless, if some items were considered highly sensitive, a better strategy for such countries would be to suppress the release of these sensitive items, rather than to limit the full use of the data set by suppressing the release of the original survey design weights.*

Table 3 gives the relative percent difference of the numerators (number of children enrolled contrasted with number of children attending primary or secondary school), whereas **Table 4** gives the relative percent difference of the denominators (number of primary school-aged children as estimated by the UN Population Division via census estimates contrasted with DHS-based estimates). It should be noted that the enrolment estimates in Table 3 are based on blended figures as in Table 1.

For the comparison of the total number of primary school-age children enrolled versus attending (Table 3), the difference in the figures is not surprising, given that enrolment and attendance are conceptually different. Although both numerators are used to track educational participation (the complement of which is non-participation or out of school), neither is expressly designed to do so. For example, in Bangladesh, roughly 15 million children were enrolled in school but only 12.5 million attended in 1999/2000. How can we explain the difference of 2.5 million? Does this figure accurately represent children who enrolled but did not attend? If so, both figures might be unbiased for what they are setting out to measure (enrolment and attendance respectively), but what does this mean in terms of participation? In this analysis, we will limit ourselves to investigating how well the estimates from the two sources track each other (for both numerator and denominator) and what this means in relation to the estimates of rates given in Table 1. First, we start with an analysis of Tables 3 and 4 separately, and then, we consider them together and investigate the results.

In Table 3, eight countries (Bangladesh, Côte d'Ivoire, Egypt, Indonesia, Mozambique, Namibia, Rwanda and Tanzania) have values highlighted where the relative percent differences (in absolute numbers) are greater than 10% but less than 25%. For all countries except Indonesia and Tanzania, the values are positive, indicating that the enrolment figures are substantially higher than the attendance figures. In Indonesia and Tanzania, the inverse is true.

There is one country where the discrepancy exceeds 25% – Viet Nam (47.2%). The reason for this will be discussed in more detail below. Although original survey weights were available for Guinea, it was excluded from the analysis in this table (and from the analysis of Tables 6, 10, 13, 17 and 18) due to a computational error that was discovered just prior to publication.

Table 3. Comparison of numerators (for primary school-age children)

Country	Total number enrolled (administrative figure from UIS based on blended number)	Total number attending (DHS estimate)	Percent difference (relative to enrolled pupils)	Absolute value of difference between A and B	2 * standard error of DHS estimate	D<E?
	A	B	C	D	E	F
Bangladesh	15,020,499	12,467,164	-17.00	2,553,334	493,828	FALSE
Côte d'Ivoire	1,473,852	1,313,722	-10.86	160,130	202,888	TRUE
Egypt	7,340,000	6,530,655	-11.03	809,345	313,856	FALSE
Indonesia	25,184,874	29,526,814	17.24	4,341,939	1,630,718	TRUE
Mozambique	2,317,869	1,842,006	-20.53	475,863	98,438	FALSE
Namibia	283,802	225,569	-20.52	58,232	26,404	FALSE
Nigeria	13,211,302	12,030,214	-8.94	1,181,088	1,247,614	TRUE
Rwanda	1,046,634	910,074	-13.05	136,559	35,414	FALSE
Tanzania	3,105,435	3,443,945	10.90	338,510	386,822	TRUE
Viet Nam	8,498,039	4,487,110	-47.20	4,010,929	362,864	FALSE

Table 4. Comparison of denominators

Country	Total number of children of primary school age (census figure from UN Population Division)	Total number of children of primary school age (DHS estimate)	Percent relative difference (relative to UN Population Division)	Absolute value of difference between A and B	2 * standard error of DHS estimate	D<E?
	A	B	C	D	E	F
Bangladesh	16,141,818	15,671,789	-2.91	470,028	596,678	TRUE
Côte d'Ivoire	2,746,155	2,522,098	-8.16	224,056	287,116	TRUE
Egypt	7,850,375	7,638,398	-2.70	211,976	363,804	TRUE
Guinea	1,312,388	1,390,773	5.97	78,385	59,226	FALSE
Indonesia	24,970,629	30,999,584	24.14	6,028,955	1,691,758	FALSE
Mozambique	3,684,618	3,082,436	-16.34	602,181	164,236	FALSE
Namibia	382,332	286,563	-25.05	95,768	32,236	FALSE
Nigeria	21,276,574	19,549,112	-8.12	1,727,462	1,625,202	FALSE
Rwanda	1,471,994	1,264,968	-14.06	207,026	42,588	FALSE
Tanzania	6,510,555	6,477,654	-0.51	32,900	619,628	TRUE
Viet Nam	8,846,251	4,662,966	-47.29	4,183,285	388,504	FALSE

Table 4 compares denominators. Near coincidence is expected between the UN Population Division and DHS figures (at least conceptually) since both are intended to estimate the number of children of primary school age. However, for Viet Nam the relative difference is extremely high (47%). This is most likely due to a problem with the sampling weights from DHS: across Tables 3 and 4, there are three independent sources of data (UIS administrative, UN Population Division census and DHS) but the common factor is DHS, so it is likely that the problem stems from this data source. Given that both Tables 3 and 4 give identical values (47%) for Viet Nam, it seems that Viet Nam has weights that are off by a factor of 2; that is, the weights would need to be doubled in order to correctly represent the population. While consulting with Macro International, we were informed that the Viet Nam DHS for 2002 was based on the previous DHS in 1997, which in turn was a sub-sample of the 1996 Multi-Round Demographic Survey. Nevertheless, Macro International made the decision not to boost the final weights for DHS 2002 by the inverse of the sub-sampling rate since their main interest was to produce ratio estimates and omitting this step would not matter. To illustrate this point, although the discrepancies between both the numerator and denominator components of NAR+ and NER+ for Viet Nam are high, the actual ratios are very close, with a difference of less than 1% *(see Table 1).*

If the weights had been boosted by the inverse of the sub-sampling rates for Viet Nam, this would have generated survey-based estimates of totals in both Tables 3 and 4, which would have been close to the estimate from the corresponding alternate source (number enrolled in Table 3 and number of primary-age children in Table 4).

Recommendation 4: *If the original survey design weights are added to the public use micro-data file as suggested in Recommendation 3, then any sub-sampling that is performed between DHS rounds (as in the case of Viet Nam in 2002) should be reflected by boosting the weights by the inverse of the sub-sampling rate. If not, estimates of totals may be substantially inaccurate. Even if original survey design weights are not released to the public micro-data file, this should be done since sub-sampling rates might be different sub-nationally and may affect estimates of ratios.*

Table 4 shows four countries (Indonesia, Mozambique, Namibia and Rwanda) with differences in absolute values ranging between 10% and 25%. Large discrepancies for these same four countries can also be observed in Table 3. Since the survey-based estimates are common to both the numerator and denominator for these countries, one could conclude that the discrepancies are due to these estimators. This issue is further explored in Study 6 and in Tables 5 and 6.

The survey data give fairly precise estimates of NAR+ (i.e. with low standard errors - see Table 13) but tend to be much less exact for estimating the totals for the numerator and denominator components of Tables 3 and 4 (i.e. containing higher standard errors). The ratio of the two survey-based estimates has better statistical properties than either of the component parts because of the correlation between the numerator and denominator. Hence, the issue is not whether the NAR+ numerators or denominators are well or poorly estimated, since the ratio will have good statistical properties. Rather, the issue is whether the NAR+ numerators and denominators, however poor, throw any light on the corresponding comparisons with the NER+ values.

In both Tables 3 and 4, a comparison is made between the absolute differences of the estimates (column D) and twice the standard error of the survey estimate (column E). Since the survey and UN Population Division estimates in Table 4 track the same quantity, one can identify cases where the survey estimate seems “on track”. Column F shows that the survey estimate tracks the UN Population Division estimate well in four countries (Bangladesh, Côte d’Ivoire, Egypt and Tanzania). Looking at the same four countries in Table 3 reveals that the percent differences (column C) are a little higher or in a few cases much higher than in Table 4. Hence, the numerators seem to be more problematic than the denominators. The tentative conclusion is that, even for countries where, in the denominator, the survey estimates of population seem similar to the UN Population Division estimates, there is some evidence that, in the numerator, enrolment data seem slightly higher than attendance data (and much higher in a few cases). In any event, there may be issues with enrolment data in Côte d’Ivoire, Egypt and Tanzania (the issue with Bangladesh having been resolved earlier) since the survey-based estimates for the denominator seem credible and, thus, are likely to be credible for the numerator as well.

In Table 4 (column C), four countries (Indonesia, Mozambique, Namibia and Rwanda) show large discrepancies between the survey estimate of population and the UN Population Division estimate (the issue with Viet Nam having been resolved earlier). To further investigate this, data from Table 4 were decomposed by single year of age in **Table 5** to illustrate that the discrepancies between the DHS and UN Population Division may be driven by a few problematic ages. In Table 5, figures with a relative difference of greater than 10% in absolute value are highlighted. In Mozambique, the difference of 16% in Table 4 is largely dominated by children aged 7, 9, 10 and 11 years, although all age groups are somewhat problematic. In Rwanda, the difference is dominated by components coming from those aged 7, 8, 9 and 11 years. In contrast, data for almost all ages seem to present a problem in Indonesia and Namibia. A possible solution for dealing with this population by age discrepancy is explored in Study 6.

It should be noted that each country has a different starting age and duration for primary education, as defined by the International Standard Classification of Education (ISCED) *(see Table 17)*. In Bangladesh, for example, the primary school age is considered to be 6 to 10 years, whereas in Tanzania it is 7 to 13 years. In Table 5, the age ranges given are in accordance with the national definition of primary school age and, thus, differ for each country.

Table 5. Comparison of primary school age distribution as estimated by DHS and UN Population Division

Country	Age	Total number of children of primary school age (census figure from UN Population Division)	Total number of children of primary school age (DHS estimate)	Percent relative difference (relative to UN Population Division)
Bangladesh (1999-2000)	6	3,334,029	2,814,202	-15.6
	7	3,288,537	3,366,785	2.4
	8	3,235,003	3,129,013	-3.3
	9	3,175,721	2,738,539	-13.8
	10	3,108,528	3,623,251	16.6
Côte d'Ivoire (1998-1999)	6	476,930	472,725	-0.9
	7	468,646	405,808	-13.4
	8	460,945	438,656	-4.8
	9	453,556	381,788	-15.8
	10	446,455	475,167	6.4
	11	439,624	347,952	-20.9
Egypt (2000)	6	1,540,452	1,541,170	0.0
	7	1,549,989	1,263,143	-18.5
	8	1,565,857	1,405,853	-10.2
	9	1,585,313	1,648,261	4.0
	10	1,608,764	1,779,971	10.6
Guinea (1999)	7	241,080	289,759	20.2
	8	231,923	242,976	4.8
	9	222,924	209,458	-6.0
	10	214,041	270,279	26.3
	11	205,230	153,673	-25.1
	12	197,190	220,815	12.0
Indonesia (2002-2003)	7	4,135,876	5,233,917	26.5
	8	4,140,363	5,065,541	22.3
	9	4,150,236	5,048,195	21.6
	10	4,164,050	5,285,793	26.9
	11	4,180,357	4,918,402	17.7
	12	4,199,747	5,447,736	29.7
Mozambique (2003-2004)	6	569,625	518,388	-9.0
	7	554,210	477,398	-13.9
	8	539,480	494,896	-8.3
	9	525,284	396,095	-24.6
	10	511,722	443,627	-13.3
	11	498,902	314,347	-37.0
	12	485,396	437,681	-9.8
Namibia (2000)	6	60,183	44,777	-25.6
	7	58,897	39,886	-32.3
	8	57,192	43,388	-24.1
	9	55,167	39,627	-28.2
	10	52,843	45,104	-14.6
	11	50,244	34,126	-32.1
	12	47,806	39,650	-17.1
Nigeria (2003)	6	3,774,781	3,596,905	-4.7
	7	3,673,137	3,673,261	-0.0
	8	3,580,089	3,630,518	1.4
	9	3,493,793	2,807,832	-19.6
	10	3,414,063	3,560,902	4.3
	11	3,340,711	2,279,695	-31.8

Country	Age	Total number of children of primary school age (census figure from UN Population Division)	Total number of children of primary school age (DHS estimate)	Percent relative difference (relative to UN Population Division)
Rwanda (2000)	7	240,582	202,526	-15.8
	8	241,668	208,473	-13.7
	9	243,399	180,457	-25.9
	10	246,133	233,757	-5.0
	11	250,234	188,092	-24.8
	12	249,978	251,659	0.7
Tanzania (1999)	7	990,390	1,014,001	2.4
	8	969,267	1,029,554	6.2
	9	949,085	966,626	1.8
	10	930,143	862,876	-7.2
	11	912,748	778,281	-14.7
	12	892,293	925,771	3.8
	13	866,629	900,543	3.9
Viet Nam (2002)	6	1,681,211	771,614	-54.1
	7	1,726,794	893,587	-48.3
	8	1,771,494	963,124	-45.6
	9	1,813,072	997,762	-45.0
	10	1,853,680	1,089,947	-41.2

The population totals in Table 4 for Bangladesh, Côte d'Ivoire, Egypt and Tanzania are relatively similar, but their participation estimates in Table 3 differ. Hence, it is worthwhile to look at the single-year estimates for participation and population, which are provided in **Table 6**. Data with relative differences greater than 10% in absolute value are highlighted. A recurrence of the issues encountered in Table 3 are shown for Côte d'Ivoire, Egypt and Tanzania for several ages.

Issues concerning Bangladesh and Viet Nam will not be discussed here since they were addressed previously.

Large discrepancies were seen earlier for Indonesia and Namibia between both the numerator and denominator estimates. In Table 6, almost all age groups in these countries have significant discrepancies. Single-year-of-age breakdowns were not possible for Mozambique and Rwanda.

The overall conclusion from Study 2 is that, for countries where the survey estimates of the primary school-age population are relatively consistent with the UN Population Division census-based estimates in the denominators (Bangladesh, Côte d'Ivoire, Egypt and Tanzania), there is some evidence that enrolment figures in the numerators are slightly inflated compared to attendance estimates (except for Tanzania), which would imply that there might be a concern with enrolment data in those countries. Countries showing primary school-age population estimates that are not consistent across the two data sources (Indonesia, Mozambique, Namibia and Rwanda) are reassessed later in this report.

Table 6. Comparison of the number of primary school-age children enrolled to number of children attending by age, as estimated by UIS and DHS respectively

Country	Age	Total number enrolled (administrative figure from UIS based on blended number)	Total number attending (DHS estimate)	Percent relative difference (relative to enrolled pupils)
Bangladesh (1999-2000)	6	3,224,841	1,886,921	-41.5
	7	3,161,639	2,624,373	-17.0
	8	3,128,934	2,612,193	-16.5
	9	2,795,148	2,354,709	-15.8
	10	2,517,674	2,988,968	18.7
Côte d'Ivoire (1998-1999)	6	235,547	142,488	-39.5
	7	262,165	192,786	-26.5
	8	268,773	262,687	-2.3
	9	252,798	230,769	-8.7
	10	226,445	265,072	17.1
	11	227,395	219,917	-3.3
Egypt (2000)	6	1,389,717	873,638	-37.1
	7	1,435,446	1,171,219	-18.4
	8	1,523,739	1,316,824	-13.6
	9	1,590,642	1,540,590	-3.1
	10	1,400,456	1,628,383	16.3
Indonesia (2002-2003)	7	4,238,414	4,804,825	13.4
	8	4,541,099	4,899,029	7.9
	9	4,436,898	4,928,233	11.1
	10	4,338,569	5,135,989	18.4
	11	4,250,128	4,755,739	11.9
	12	3,379,767	5,002,998	48.0
Namibia (2000)	6	19,247	11,542	-40.0
	7	40,503	31,312	-22.7
	8	46,080	37,401	-18.8
	9	46,084	36,292	-21.2
	10	49,378	40,776	-17.4
	11	41,912	31,290	-25.3
	12	40,598	36,952	-9.0
Nigeria (2003)	6	1,658,828	1,312,456	-20.9
	7	2,014,657	1,983,363	-1.6
	8	2,212,151	2,386,253	7.9
	9	2,354,664	2,041,766	-13.3
	10	2,197,043	2,437,929	11.0
	11	2,773,959	1,868,448	-32.6
Tanzania (1999)	7	145,636	218,459	50.0
	8	315,083	399,400	26.8
	9	443,522	439,165	-1.0
	10	538,700	498,130	-7.5
	11	564,750	556,280	-1.5
	12	558,051	694,798	24.5
	13	539,693	637,711	18.2
Viet Nam (2002)	6	1,539,876	688,859	-55.3
	7	1,630,674	872,795	-46.5
	8	1,780,672	935,560	-47.5
	9	1,752,685	979,612	-44.1
	10	1,793,994	1,063,458	-40.7

3. Investigations relating to population data from the UN Population Division

Study 3. The effects of using Sprague interpolation on UN Population Division data

For the denominator of the NER+ indicator, the UIS obtains from the UN Population Division an aggregated population figure for the age groups that cover primary school for the country in question. Normally, the UN Population Division has access to single-year-of-age data for approximately one-third of the countries of the world, while the remaining two-thirds are covered by data in traditional five-year age groups (0-4 years, 5-9 years, 10-14 years, etc).

These data are sourced from national census figures collected by the United Nations Statistics Division (UNSD). Since the UN Population Division adopts a common methodology for all countries, the data received by single-year-of-age are aggregated into the traditional five-year age groups in accordance with the data received from two-thirds of the countries. Then, estimation methods are applied using external information on fertility, mortality and migration rates for inter-census years for which there are no estimates.

However, the UIS requires these figures not by standard five-year age groups but rather by age groupings in accordance with the definition of primary school age for each country. Therefore, the data traditionally disseminated by the UN Population Division cannot be used in the calculation of NER+. A bilateral arrangement exists whereby the UN Population Division adds one additional step to its final estimates to accommodate the special needs of the UIS. That is, it uses a special interpolation algorithm, using a fifth-difference osculatory formula due to Sprague, 1881, to decompose the final estimates from the traditional five-year age groups back into single-year-of-age estimates. The UIS can then re-aggregate the figures according to the groupings required in order to produce estimates of NER+. These single-year-of-age estimates are also publically available for 196 countries and territories (UN Population Division, 2008).

Because of this additional step of applying Sprague interpolation, extra variation is added onto the population estimates used by the UIS in the denominator of NER+. This study sets out to investigate the extent to which this is a concern and contributes to the differences between UIS estimates and survey-based estimates of the denominators of NER+ and NAR+ respectively.

It should be noted that the investigation was only possible for a special set of countries, forming part of a UIS/OECD joint initiative called the World Education Indicators (WEI) programme. The programme includes 19 middle-income countries (and generally the most populous) from which OECD and the UIS collect single-year-of-age data directly, i.e. these data are not obtained from the UN Population Division. Of these 19 countries, only two (Egypt and Indonesia) are also included in the 16 countries on which this report is focused. This particular study mimics the UN Population Division process used for WEI countries by aggregating the data into standard five-year groupings and then applying the Sprague interpolation algorithm to see how closely the resulting single-year-of-age figures (second column of **Table 7**) correspond to the original WEI estimates (third column of Table 7). The percent relative difference is given in the fourth column. Figures greater than 10% are highlighted in dark grey, and those between 5% and 10% are highlighted in light grey.

Table 7. The effects of Sprague interpolation on single-year-of-age estimates of primary school-age populations

Primary school ages within countries	Population estimates, Sprague interpolation	Population estimates, WEI (original data)	Percent relative difference Sprague interpolation (relative to WEI original data)
Argentina, 2003			
6	670,227	687,086	-2.45
7	700,874	684,015	2.46
8	714,684	680,966	4.95
9	715,039	677,948	5.47
10	702,068	675,093	4
11	675,903	672,531	0.5
Brazil, 2003			
7	3,551,001	3,636,128	-2.34
8	3,654,123	3,620,271	0.94
9	3,689,362	3,590,516	2.75
10	3,657,055	3,561,225	2.69
Chile, 2003			
6	281,962	288,738	-2.35
7	296,843	290,067	2.34
8	304,727	291,175	4.65
9	306,869	291,962	5.11
10	303,330	292,488	3.71
11	294,170	292,815	0.46
China, 2002			
7	18,232,357	17,914,756	1.77
8	20,304,834	18,752,106	8.28
9	22,123,665	20,082,026	10.17
10	23,803,276	26,210,044	-9.18
11	25,458,094	25,137,678	1.27
Egypt, 2003			
6	1,348,216	1,457,444	-7.49
7	1,421,328	1,374,873	3.38
8	1,465,463	1,317,026	11.27
9	1,486,589	1,294,569	14.83
10	1,482,575	1,329,439	11.52
India, 2004			
6	24,979,127	26,412,941	-5.43
7	26,317,098	23,045,028	14.2
8	27,001,328	31,031,074	-12.99
9	27,128,710	20,868,238	30
10	26,755,786	33,855,378	-20.97
Indonesia, 2003			
7	4,316,952	4,221,700	2.26
8	4,438,881	4,248,200	4.49
9	4,479,827	4,269,900	4.92
10	4,440,173	4,287,700	3.56
11	4,320,303	4,301,300	0.44
12	4,231,518	4,307,500	-1.76
Jamaica, 2003			
6	56,169	56,823	-1.15
7	59,086	56,494	4.59
8	60,476	59,735	1.24
9	60,609	59,310	2.19
10	59,530	58,010	2.62
11	57,287	55,250	3.69

Primary school ages within countries	Population estimates, Sprague interpolation	Population estimates, WEI (original data)	Percent relative difference Sprague interpolation (relative to WEI original data)
Jordan, 2003			
6	125,604	125,721	-0.09
7	131,030	124,461	5.28
8	133,172	133,817	-0.48
9	132,658	131,298	1.04
10	129,565	131,544	-1.5
11	123,970	124,707	-0.59
Malaysia, 2003			
6	542,338	555,700	-2.4
7	564,049	548,500	2.83
8	571,751	543,100	5.28
9	568,287	538,300	5.57
10	553,476	531,300	4.17
11	527,138	526,200	0.18
Paraguay, 2003			
6	126,892	129,127	-1.73
7	134,424	131,747	2.03
8	138,791	133,880	3.67
9	140,540	135,402	3.79
10	139,660	136,228	2.52
11	136,147	136,281	-0.1
Peru, 2003			
6	594,479	609,018	-2.39
7	622,368	607,829	2.39
8	634,963	605,885	4.8
9	635,138	603,153	5.3
10	623,106	599,843	3.88
11	599,073	596,166	0.49
Philippines, 2003			
6	2,007,719	2,022,815	-0.75
7	2,083,165	2,064,351	0.91
8	2,103,902	1,993,364	5.55
9	2,081,351	2,017,126	3.18
10	2,012,074	2,052,869	-1.99
11	1,892,630	1,848,693	2.38
Russian Fed., 2003			
7	1,395,548	1,403,952	-0.6
8	1,550,111	1,447,971	7.05
9	1,697,062	1,473,846	15.15
Sri Lanka, 2003			
5	271,821	302,422	-10.12
6	297,298	304,584	-2.39
7	314,745	307,459	2.37
8	325,505	310,933	4.69
9	330,921	314,892	5.09
Thailand, 2003			
6	943,256	960,276	-1.77
7	988,693	960,151	2.97
8	1,011,494	965,974	4.71
9	1,016,236	973,765	4.36
10	1,003,878	979,490	2.49
11	975,380	980,118	-0.48

Primary school ages within countries	Population estimates, Sprague interpolation	Population estimates, WEI (original data)	Percent relative difference Sprague interpolation (relative to WEI original data)
Tunisia, 2004			
6	174,858	180,860	-3.32
7	180,778	180,860	-0.05
8	186,780	180,860	3.27
9	192,703	180,860	6.55
10	198,485	207,660	-4.42
11	204,063	207,660	-1.73
Uruguay, 2003			
6	54,988	56,346	-2.41
7	57,531	56,174	2.42
8	58,672	55,956	4.85
9	58,681	55,694	5.36
10	57,592	55,419	3.92
11	55,436	55,165	0.49
Zimbabwe, 2002			
6	314,464	332,470	-5.42
7	326,149	315,889	3.25
8	330,751	302,544	9.32
9	330,025	294,592	12.03
10	322,931	295,864	9.15
11	308,428	315,334	-2.19
12	302,260	316,210	-4.41

In general, it seems that the Sprague interpolation process does not cause excessive variation. Nonetheless, issues are detected across most age groups for China, Egypt, India, the Russian Federation and Zimbabwe, while only certain age groups present a problem in other countries (e.g. age 5 in Sri Lanka). Three of the countries in the first group are among the most populous in the world (China, India and the Russian Federation), and thus, the discrepancies seen for these countries could have a substantial impact not only on country-level estimates of NER+ but also on regional estimates of NER+ for which they contribute a dominant part. Given that 5 of the these 19 highly-influential countries have substantial relative differences with a significant additional variation, which is entirely due to Sprague interpolation, the UIS should perhaps consider alternative ways of producing single-year-of-age population estimates.

It should be noted that while the impact of Sprague interpolation on single-year-of-age estimates is significant in some cases, NER+ is typically calculated for the aggregated age group that comprises primary school age, and therefore, the effect of Sprague interpolation is likely to be more moderate for the aggregated group than for single year ages. To show this, an analysis (similar to Table 7) was done on the aggregated age groups and the results are presented in **Table 8**. It can be seen that while the impact of Sprague interpolation is diminished for most countries relative to Table 7, the effects are still significant for Egypt and the Russian Federation – slightly greater than 5%. Therefore, the notion of using the Sprague interpolation method should be reconsidered by the UIS.

Table 8. The effects of Sprague interpolation on estimating totals for primary school-age populations (aggregated)

Country	Population estimates, Sprague interpolation	Population estimates, WEI (original data)	Percent relative difference Sprague interpolation (relative to WEI original data)
Argentina, 2003	4,178,795	4,077,639	2.48
Brazil, 2003	17,915,795	17,648,719	1.51
Chile, 2003	1,787,901	1,747,244	2.33
China, 2002	109,922,226	108,096,610	1.69
Egypt, 2003	7,204,171	6,773,351	6.36
India, 2004	132,182,049	135,212,659	-2.24
Indonesia, 2003	26,227,654	25,636,300	2.31
Jamaica, 2003	353,157	345,622	2.18
Jordan, 2003	775,999	771,548	0.58
Malaysia, 2003	3,327,039	3,243,100	2.59
Paraguay, 2003	816,454	802,665	1.72
Peru, 2003	3,709,127	3,621,894	2.41
Philippines, 2003	12,180,841	11,999,218	1.51
Russian Fed., 2003	4,642,721	4,325,769	7.33
Sri Lanka, 2003	1,540,290	1,540,290	0.00
Thailand, 2003	5,938,937	5,819,774	2.05
Tunisia, 2004	1,137,667	1,138,760	-0.10
Uruguay, 2003	342,900	334,754	2.43
Zimbabwe, 2002	2,235,008	2,172,903	2.86

In the past, the UIS has considered the possibility of collecting nationally-produced inter-census population data for single-year-of-age estimates directly from countries via its annual education survey, eliminating the need for UN Population Division estimates and the Sprague interpolation technique. However, this would place the UIS in the untenable position of becoming the arbitrator of what constitutes acceptable country-sourced estimates of population, an area definitely outside of the UIS mandate. In fact, countries themselves are at times not in agreement – neither internally across different ministries nor with the UN Population Division – when it comes to determining which figure is the official one.

Instead of using the traditional five-year groupings for all countries, the UN Population Division could consider producing estimates for single-year-of-age data, even for countries that do not provide this kind of data initially. This change in strategy would have the double benefit of preventing the loss of information (due to aggregation) for countries that do provide data at this level and helping the UIS meet its specific data needs.

Recommendation 5: *The UIS should invest resources to work closely with the UN Population Division to formulate an alternate strategy that could replace the use of Sprague interpolation. Given the critical importance of population estimates to UIS indicators, funding a staff member dedicated to the area should be seriously considered.*

Overall, one of the main barriers to obtaining sufficiently high-quality population data is that many countries do not conduct population censuses frequently enough. It is recommended that countries do so at least every ten years. In the last census round of 2000, more than 25 countries did not conduct censuses at all; 17 of these were in sub-Saharan Africa. Furthermore, even when censuses were conducted, in many cases the quality of the data produced was low.

Typical problems that plague such data sets include significant under-coverage (either for specific geographic regions or particular population groups), as well as lack of disaggregation by age, sex or other characteristics. National capacity building efforts are essential to achieving high-quality census results, particularly in developing countries where: i) censuses have not been conducted for several decades; ii) recent social and political conflicts have decimated the national infrastructure; iii) financial, infrastructure and human resources are limited; or iv) political will is simply lacking.

To this end, UNFPA (United Nations Funds for Population) works closely with developing countries to help build strategies for advocating census-taking. UNFPA also helps countries to raise external funds for censuses and assists them in the development of master plans and implementation of census-taking efforts. In addition, through thematic workshops, guidelines and manuals on various technical topics and direct country technical cooperation, the 2010 World Programme of the United Nations Statistics Division (UNSD) seeks to encourage all countries of the world to conduct a census in the current round and comply with the UN Principles and Recommendations for Population and Housing Censuses (UNSD, 2008) regarding the content and processes for census taking to ensure quality outputs.

Study 4. The impact of *World Population Prospects* revisions on NER+

The UN Population Division uses census and household survey data to obtain population figures. Many countries conduct censuses every ten years, while some provide updated population figures from household surveys, such as DHS and MICS. For the years in between censuses or household surveys, the UN Population Division produces updated estimates using external information on fertility, mortality and migration. Every two years, the UN Population Division releases revisions to the most recent population data in *World Population Prospects*. These affect the denominator of the UIS indicators.

The revisions take into account any new data received from countries. Even if there has not been a new census or household survey conducted since the previous revision, there may be updated information on mortality related to HIV/AIDS that can improve estimates for inter-census years, for example. Thus, The UN Population Division revises the estimates even for the years for which it does not have any updated census figures. However, if a new census or household survey has been conducted since the last UN Population Division revision, then the data are added and estimates for the years between that census (e.g. year 2000) and the previous census (e.g. year 1990) are revised. Most often this results in better estimates compared with those from the previous revision, since the update comprises a “backwards revision” between two fixed points (years 1990 and 2000) and not a forward projection based on one fixed point (year 1990). Clearly, as one moves farther away from a census year, estimates become less accurate, particularly in the case of forward projections.

The UIS updates many of its indicators (including NER+) based on the revised population data. It should be noted that the UIS updates the denominator of NER and NER+ only, so any observed changes in NER and NER+ result from the population revisions and not from revisions to enrolment data.

This study compares the difference between NER+ figures based on two rounds of revisions (2002 and 2004) from *World Population Prospects*. The relative percent differences between these data are provided in **Table 9**; differences of more than 5% in absolute value are highlighted. It should be noted that although the estimates of NER+ from Table 1 are based on the 2004 round of revisions, they are different from those in Table 9 because they are blended rates from multiple academic years. It should be further noted that Table 9 includes the MICS countries Chad, Niger and Senegal since the investigation here only involves census data.

It can be seen that in some cases there are substantial differences between estimates from the two census rounds, for example Bangladesh at 9%. In this case, the NER+ estimate for 2000 based on the 2002 census revision probably did not take into account the most recent data from the census taken in 2001, since it often takes a few years for census data to be processed and sent to the UN Population Division. The figure of 84.55% was most likely a forward projection based on the census taken in 1991, nine years previous to 2000. Thus, it is not surprising that there was a substantial change in the figure based on the 2004 revision (93.09%), given that this figure most likely *did* take into account the census of 2001 and a backwards revision was made for the year 2000, a clear improvement given that this was only one year previous to the census.

A similar situation probably occurred in Niger and Senegal. It should also be noted that in the case of Bangladesh, the revision between 2002 and 2004 has substantially increased the difference between the figures for NER+ and NAR+ (the latter of which is 79.59%). Nonetheless, the revised population figure is probably an improvement.

Recommendation 6: *While little can be done to remedy this situation, analysts should be cautious with NER+ estimates if the denominators are based on UN Population Division census information that dates back several years. It has been acknowledged that estimates based on censuses that are substantially distanced in time from the given academic year are likely to be less accurate and may be a source of error, accounting for the discrepancies between NER+ and NAR+ figures.*

Table 9. The effects of census revisions on NER+

Country	Year of most recent census	Year of enrolment data	NER+ (census 2002 revision)	NER+ (census 2004 revision)	Percent relative difference (relative to 2004)
Bangladesh	2001	2000	84.55	93.09	-9.17
Burkina Faso	1996	2003	35.48	37.28	-4.83
Chad	1993	2000	54.94	51.87	5.92
Côte d'Ivoire	1998	1999	56.18	53.34	5.32
Egypt	1996	2000	90.29	93.50	-3.43
Ghana	2000	2003	63.40	62.19	1.95
Guinea	1996	1999	45.05	43.16	4.38
India	2001	2000	81.31	80.90	0.51
Indonesia	2000	2003	97.08	101.08	-3.96
Kenya	1999	2003	78.69	77.36	1.72
Mali	1998	2001	.	.	.
Mozambique	1997	2004	72.64	71.04	2.25
Namibia	2001	2000	77.80	74.23	4.81
Niger	2001	2000	26.27	24.49	7.27
Nigeria	1991	2003	62.78	62.09	1.11
Rwanda	2002	2000	.	.	.
Senegal	2002	2000	59.68	53.46	11.63
Tanzania	2002	1999	46.37	47.70	-2.79
Viet Nam	1999	2002	97.13	96.06	1.11

Note: NER+ for Indonesia for 2003 based on the 2004 round of census revisions is greater than 100%. This is discussed further in Section 4

4. Investigations relating to combining enrolment data from administrative sources with population data from censuses

Study 5. The impact of using two separate data sources to construct NER+

As discussed earlier, the UIS uses two sources of data to construct NER+. Data for the numerator are obtained from national administrative sources via ministries of education or national statistical offices, and supplied to the UIS through its annual data collection on education. Aggregate figures on students, teachers and finance are obtained from each country of the world. In particular, aggregated enrolment data by age and grade are obtained and used as an input for the numerator of the NER+ indicator. Input for the denominator is supplied to the UIS by the UN Population Division. Although theoretically the NER+ indicator should not exceed 100%, in practice it sometimes does because the numerator and denominator are obtained from different data sources and errors can result.

An analysis of the entire database between 1999 and 2004 (spanning five years) for approximately 200 countries for which the UIS collects data shows that there are close to 250 values of NER+ that exceed 100% (roughly 25% of the 1,000 values) across 65 countries. The UIS treats the cases of NER+ (and NER) exceeding 100% by constructing "capped" values of less than 100% via a formula that pro-rates the figure downward using both the male and female rates. The method is as follows: if either NER or NER+ exceed 100% but do not exceed 105%, both the original NER and NER+ figures are simultaneously divided by the maximum of the following six figures: NER, NER (female), NER (male), NER+, NER+ (female) and NER+ (male). If either of the original NER or NER+ values exceed 105%, then capping does not occur since the figures are considered too unreliable and the original values are suppressed. However, it seems that before adopting this solution, it might be sensible to investigate the underlying reasons for the occurrence and to see if there are more deep-seated issues with one or both sources of the data that may need to be addressed.

It should be noted that NER+ exceeding 100% may not be cause for alarm in and of itself. In fact, it is to be expected that there will be errors (both biases and uncertainty/variability) in both the numerator and denominator of NER+. It may be that both numbers are unbiased but contain some random error or variability in their measurement. In cases where educational participation is virtually universal, and thus the true value for NER+ is almost 100%, both the numerator and denominator will be independent estimates of the same value. If there is random error, then one would expect that half of the time the enrolment estimate would exceed the population estimate (resulting in NER+ greater than 100%) and half of the time the opposite would be true. Thus, if there are only small deviations above 100%, particularly in cases where participation is thought to be virtually universal, then the impact on regional or global participation rates will be insignificant. Under these circumstances, this issue may not merit much attention and capping may be an acceptable solution.

To illustrate this point, let us consider the case of NER+ for Indonesia for 2003. Table 9 shows that the value based on the 2002 round of census revisions is 97.08%, whereas the value based on the 2004 round of revisions is 101.08%. Given that the UIS does not update the numerator value for the indicator NER+ from one census revision to the next, it is clear that, when a figure of less than 100% increases to over 100% during this period, the change is due entirely to the update of the census data reflected in the denominator – and it is clear that the estimated population figure diminished between the consecutive census revisions. However, this does not necessarily mean that the updated census figure (2004 revision) was flawed – later revisions are often improved values over those from earlier revisions. Indeed, it is likely that the 2004 revision figure was based on the 2000 census in Indonesia, whereas the 2002 revision figure was based on the previous census, taken some 12 years earlier in 1990. Thus, it is likely that the NER+ figure based on the 2004 revision exceeds 100% (and only slightly) because of random measurement errors in either the numerator or the denominator.

Returning to the analysis of the database between 1999 and 2004, many of the 250 values that exceed 100% only do so by a small amount – i.e. by less than 5%. It mostly occurs in countries where educational participation is virtually universal (e.g. Belgium, Bermuda, Canada, Denmark, Finland, France, Hong Kong Special Administrative Region of China, Iceland, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland and the United Kingdom) and, therefore, these cases are not of great concern.

However, a value which significantly exceeds 100% is a cause for concern, since the variation in the numerator and denominator cannot plausibly explain the excess, and in instances when there is reason to doubt that educational participation is virtually universal. In these cases, the figure >100% may indicate a serious underlying data problem that needs further investigation. Moreover, if there are such data problems, they may concern not only countries where NER+ exceeds 100% but also other countries where NER+ may be falsely inflated, but not to such an extent that the value exceeds 100%.

Approximately 50 of the 250 cases have an NER+ exceeding 105%, spanning across 16 countries. For many of these countries, it is not likely that educational participation would be very close to 100%. Furthermore, 13 of these 16 countries have very small populations (Anguilla, Belize, Grenada, Guyana, Kiribati, Montserrat, Netherlands Antilles, Niue, Saint Kitts and Nevis, Seychelles, Tokelau, Tonga and Tuvalu) and the UN Population Division does not supply data for countries with populations of less than 100,000 – which is the case for 7 of these 13 countries. Therefore, the UIS either collects population data directly from them or makes estimates using various means.

UIS population estimates, however, are not considered to be as reliable as UN Population Division data for larger countries. Yet, even in cases where the population is not so small (less than 200,000 but greater than 100,000), and UN Population Division does provide population figures (4 of the 13 countries), these are often not considered to be reliable either. For instance, some of these countries do not provide disaggregated data by age, which would allow verification of age distributions as an overall quality measure of the total population figure. In these cases, potentially underestimated denominator figures may account for the large NER+ values. Perhaps further efforts should be made in order to improve population figures for these smaller countries.

With NER+ values which lie in the 105.5% to 109% range, Argentina, Portugal and Syria have large populations (approximately 41 million, 11 million and 22 million respectively). With regard to Argentina and Portugal, one might expect enrolment to be close to 100%. However, for both of these countries, there is some evidence that there is double-counting of some students in the numerator enrolment figure. This may be due to the fact that the national figures on enrolment are collected at different times of the year for different schools within the country, and some students may have moved schools in the meantime and thus be counted twice. In the case of Syria, NER is very close to 100% (less than 102%), but the NER+ figure is in the 107% to 109% range. The fact that NER exceeds 100% may simply be due to random errors as suggested earlier. However, the additional 5% to 7% inflation of NER+ over NER is likely due to the fact that a substantial number of under-age children are enrolled in secondary school (a comparison of the definitions of NER and NER+ will show this).

Recommendation 7: *Between 1999 and 2004, 25% of NER+ values were greater than 100%. The majority of these values, however, exceeded 100% by very little, and chiefly concerned countries where educational participation is likely to be close to universal (100%). For these values, the figure >100% may be simply due to random errors occurring because the numerators and denominators stem from different data sources. In these instances, the UIS methodology of capping the figures so that they do not exceed 100% seems reasonable.*

However, there are a substantial number of small-population countries (less than 200,000 inhabitants) where NER+ values are greater than 105% but where participation is not likely to be close to 100%. For these countries, it is probable that the denominator figures for the population may be problematic. In these cases, the UIS should invest substantial resources and work closely with the UN Population Division and the countries themselves in order to identify the source of the problem. Indeed, many UIS indicators depend on coherence between UIS administrative data and UN Population Division population data. As mentioned in Recommendation 5, population issues are of such paramount importance to the UIS that consideration should be given to funding a dedicated UIS post to address these issues.

5. Investigations relating to attendance data from household survey sources

Study 6. How post-stratification of household survey weights affects estimates of totals

Ideally, the relative percent difference between census and DHS estimates of the number of children of primary school age should be reasonably close to 0 *(see Table 4)*. As DHS and UN Population Division figures essentially indicate the same thing, they should be very similar. But if the survey sample was drawn in such a way that representativeness of age distribution (or other attributes) is not respected, then differences will arise.

Table 4 shows that four countries (Indonesia, Mozambique, Namibia and Rwanda) have relative percent differences between 10% and 25% in absolute value, which suggests that there might be a problem with sample representativeness (the case of Viet Nam was dealt with in Study 2.) One way to correct for this is to use a technique called post-stratification, or benchmarking, where an adjustment is made to the sampling weights so that they add up to external census totals by age. Although post-stratification will have virtually no effect on the NAR+ estimates because they are ratios, it will affect the estimates of the NAR+ numerators (which are estimates of totals) for two reasons. First, it will force the survey data to reflect the overall age distribution implicit in the external census figures. Second, it will force the survey data to reflect the total population of primary school-age children from the external census figures. The second reason is likely to have the biggest effect on the estimates of the NAR+ numerator.

Although we were informed that DHS countries do perform empirical checks to ensure that there is coherence in age distributions between surveys and national population sources, and that post-stratification takes place when it is deemed necessary (i.e. when there is a lack of coherence), none of the DHS countries considered in this report have used post-stratification. We have done so, however, and this study shows the results. We adjusted the original sampling weights using single-year-of-age population figures from the UN Population Division in order to present a set of adjusted “post-stratified” weights. These weights were then used to recalculate the survey estimates and ensure that there was exact coincidence between the DHS and UN Population Division denominator entries given in Table 4. The post-stratified weights were then used to recalculate the survey-based estimates in Table 3 in order to see if there would be an improvement relative to the enrolment figure. The results of these recalculations are given in the last three columns of **Table 10**.

There is little difference when the estimate of the original NAR+ from Table 1 (calculated using the scaled weights) is compared to the estimate of NAR+ (calculated using the post-stratified weights). This is to be expected, since estimates of ratios are not greatly affected by post-stratification.

Table 10. The impact of post-stratification on estimates

Country	NAR+ (original from Table 1)	NAR+ (using post-stratified weights)	Total number enrolled of primary school age (original administrative figure from UIS based on blended number)	Total number attending of primary school age (DHS estimate using post-stratified weights)	Relative percent difference (relative to enrolled pupils)
Bangladesh	79.59	79.34	15,020,499	12,727,738	-15.26
Côte d'Ivoire	52.15	52.63	1,473,852	1,420,720	-3.60
Egypt	85.50	85.73	7,340,000	6,730,628	-8.30
Indonesia	95.25	95.31	25,184,874	23,588,450	-6.34
Mozambique	59.85	61.03	2,317,869	2,242,635	-3.25
Namibia	78.60	78.30	283,802	297,963	4.99
Nigeria	61.99	63.09	13,211,302	13,299,210	0.67
Rwanda	71.94	71.97	1,046,634	1,057,650	1.05
Tanzania	53.83	53.70	3,105,435	3,491,601	12.44
Viet Nam	96.27	96.05	8,498,039	8,494,682	-0.04

However, the estimates of totals (as shown in the last three columns of Table 10) are greatly affected. The relative percent difference for all countries is significantly reduced in comparison with those in Table 3, with only Bangladesh (-15.26%) and Tanzania (12.44%) with figures greater than 10% in absolute value. For the last case, post-stratification seems to have worsened the situation in comparison to Table 3. As mentioned before, the discrepancy for Bangladesh is most likely related to the way the question on attendance was asked *(see Study 9),* so it is expected that post-stratification does not improve the situation. For Côte d'Ivoire, Egypt, Indonesia, Mozambique, Namibia, Nigeria and Rwanda, however, the high relative percent differences in Table 3 have been radically reduced.

Ideally, survey estimates should be post-stratified to census "benchmark" figures provided by countries (i.e. national figures) and not to UN Population Division figures. UN Population Division figures are used in this report mainly to illustrate the potential improvement to estimates of totals and due to lack of access to national census benchmark figures. Forcing survey data to conform to UN Population Division benchmarks is to be avoided because this will distort the UN Population Division figures as an independent source compared to the administrative measure of NER+ that uses the UN Population Division figures. If the NAR+ figure is distorted, it becomes much more difficult to know when the NER+ figure is reliable and when it is not.

Recommendation 8: *Along with making original weights (Recommendation 3) available, both DHS and MICS should consider post-stratifying their original weights for all countries by single year of age (and perhaps other attributes as well). They should use national sources for the benchmarks before releasing them in public use micro-data files. This will improve estimates of totals, since the weights will bring the estimates in line with external census controls from national sources. This will, thus, correct any deficiencies with respect to the representativeness of the sample drawn in relation to the attributes benchmarked. Post-stratifying to UN Population Division figures is not recommended. For more details on post-stratification, see Sarndal et al., 1992.*

Study 7. Non-sampling errors: A look at household non-response in DHS

There are many potential sources of non-sampling error with household surveys, including: non-response errors, survey frame coverage errors, instrument (questionnaire) errors, interviewer errors, respondent errors, processing errors, estimation errors and analysis errors. Although undue attention is often given to tracking sampling errors within surveys, errors due to non-sampling are frequently overlooked, even though these can be greater than the former. In most cases the sponsors of surveys do not invest sufficient resources into tracking and controlling non-sampling sources of error because it is both expensive and difficult to do so. For instance, one way of determining bias due to household non-response is to implement a non-response follow-up study, where a sub-sample of non-respondents to a survey are re-contacted and an attempt is made to interview them after the main survey has been completed to see if their responses to the survey are systematically different from those of the respondents to the main survey. This is clearly an expensive task and is rarely done.

However, for one of the sources of non-sampling error – non-response – it is easy to track by investigating overall response rates at the household and individual item levels. This is the focus in Study 7. Failing to address high non-response rates can contribute to data quality issues. If the non-response rate is modest, a possible solution is re-weighting respondents by boosting their sampling weights to represent the non-respondents who are missing in the sample. This method implicitly assumes that, if the non-respondents had replied to the survey, they would have provided data similar to the respondents (denoted as the "missing completely at random" or MCAR assumption). While it is known that this is often not the case and that some bias is introduced by resorting to the MCAR assumption, little else can be done to remedy the situation without knowing more about the actual extent of the bias. Improved methods often weight-adjust within response classes (e.g. geographic regions) where it is assumed that non-respondents and respondents are more likely to give similar responses (denoted as the "missing at random" or MAR assumption, which is milder than the MCAR assumption).

The reported household-level response rates for DHS are very high (>95%) for all 16 countries *(see **Table 11**)* and, thus, are not considered to be problematic.

Table 11. Household response rates for DHS

Country	Household response rate
Bangladesh	99.3
Burkina Faso	99.4
Côte d'Ivoire	97.9
Egypt	99.1
Ghana	98.7
Guinea	97.3
India	-
Indonesia	98.9
Kenya	96.3
Mali	98.0
Mozambique	-
Namibia	96.9
Nigeria	98.6
Rwanda	99.5
Tanzania	98.3
Viet Nam	99.9

It is equally important to check the item response rate – that is, the rate of response to the specific variable used to measure attendance. The item non-response rate can be defined as:

$$100\,\frac{\textit{Number of sampled children of primary school age (unweighted) who responded to attendance question}}{\textit{Number of sampled children of primary school age (unweighted) who were asked attendance question}}$$

The results of this analysis are given in **Table 12**, which indicates that item response rates are also very high (>97%) for all 16 countries and, thus, these are not considered to be problematic either.

Table 12. Response rates for attendance item (attended school during current school year/still in school) in DHS

Country	Item response rate
Bangladesh	99.43
Burkina Faso	99.89
Côte d'Ivoire	97.72
Egypt	100.00
Ghana	99.85
Guinea	99.77
India	99.60
Indonesia	99.48
Kenya	99.92
Mali	99.84
Mozambique	99.89
Namibia	99.44
Nigeria	99.75
Rwanda	99.83
Tanzania	99.90
Viet Nam	99.97

Study 8. Sampling errors: A look at standard errors and coefficients of variation for DHS

High sampling errors are a potential source of problems for data quality. Sampling error refers to the difference between the estimate derived from a sample survey and the true value that would result if a census of the entire population was taken under the same conditions. One way of measuring the extent of the sampling error is by calculating the standard error of the estimate. A variety of techniques can be used to do this, including Taylor Linearization and Jackknifing *(see Wolter, 1995).* The percent coefficient of variation (CV) is commonly used, which involves dividing the standard error by the estimate multiplied by 100. Often, the CV is reported instead of the standard error. This is because the CV is a scale-less quantity that permits comparisons, both among estimates of similar types (such as NAR+ across countries) and estimates having different units of measure (not the case for this study).

In **Table 13**, the standard error of NAR+ was calculated using both the Taylor Linearization method (via the SAS software package) and the Jackknife method (via WesVar, a free software package downloadable from Westat). These two methods should give similar results and they do in all cases. It should be noted that NAR+ and the corresponding standard errors in Table 13 were calculated using scaled weights *(see Study 2 for a description of scaled weights).* A similar calculation was also done using post-stratified weights, but there was very little difference in either the point estimates or the standard errors from what was reported in Table 13.

CVs are also given in Table 13. These are all less than 7% (and often well under 7%), indicating very accurate estimates for NAR+. Generally, if CVs are less than 16%, the corresponding point estimates are considered publishable; while point estimates having CVs between 16% and 33% should be published with caution and point estimates having CVs greater than 33% should be suppressed. According to this standard, all the estimates for NAR+ in Table 13 are publishable, and sampling errors are clearly not a major issue for these countries.

Table 13. Standard errors and coefficients of variation (CV) for DHS

Country	NAR+	Standard error of NAR+ (Taylor)	Standard error of NAR+ (Jackknife)	Percent coefficient of variation (using Jackknife)
Bangladesh	79.59	0.82	0.822	1.032
Burkina Faso	32.33	1.56	1.561	4.828
Côte d'Ivoire	52.15	2.70	2.698	5.173
Egypt	85.50	0.57	0.567	0.663
Ghana	61.22	1.24	1.240	2.025
India	82.33	0.35	0.351	0.426
Indonesia	95.25	0.32	0.345	0.362
Kenya	74.99	1.02	1.022	1.362
Mali	39.03	1.42	1.421	3.640
Mozambique	59.85	1.03	1.030	1.720
Namibia	78.60	0.93	0.930	1.183
Nigeria	61.99	1.69	1.693	2.731
Rwanda	71.94	0.72	0.724	1.006
Tanzania	53.83	1.70	1.705	3.203
Viet Nam	96.27	0.59	0.627	0.651

It should be noted that the standard errors and CVs for NAR+ are low because of the high correlation between numerator and denominator, given they are both survey-based estimates. Theoretically speaking, in the absence of any bias, the survey estimate might be preferable to the estimate derived from administrative sources, simply because in the latter case the values used in the numerator and denominator are not correlated. Thus, given the high precision of the estimates exhibited in Table 13, the question of whether or not the survey should be the preferred data source is related to the scope and extent of any potential bias (e.g. non-response, measurement errors, non-coverage from the overall design or from omitted non-household population). The first of these (non-response) has been investigated in Study 7; a complete investigation of the last two (measurement errors and coverage) is, however, beyond the scope of this report.

One final comment will be made regarding the treatment of missing values. The NAR+ values throughout the report were calculated by omitting the missing values in the survey data file; no imputations for missing values were performed. The standard errors were calculated similarly. Although this is not ideal due to potential biasing, the number of missing values for most DHS countries was so low that their omission was likely to have only a negligible impact on the calculated value.

Study 9. The impact of how DHS captures attendance in different countries

In the DHS, primary school attendance is generally captured through two questions: one relating to current attendance and one relating to attendance (for one day or more) at any time in the current academic year (if not presently attending). The latter question attempts to capture children not attending school due to temporary reasons such as illness. In order to estimate the number of out-of-school children, the UIS and UNICEF are working on developing a methodology that uses administrative and survey data jointly. For the survey component, the definition of "in school" is tracked through the notion of attendance. A child is considered to be attending school if he or she has answered yes to either of the two questions that DHS poses. However, while some countries pose both questions *(see **Table 14**)*, others pose only the question on current attendance *(see **Table 15**)*. In most cases, the question on current attendance captures the largest part of school attendance, but this is not always the case.

Table 14. Comparison of NER+ with NAR+ for countries where both current and past attendance questions were asked in DHS

Country	Current attendance	Past attendance	Current + past attendance: NAR+ (B)	Blended NER+ (A)	Difference (A-B)
Burkina Faso	31.85	0.47	32.32	38.6	6.28
Egypt	85.42	0.07	85.49	93.5	8.01
Ghana	61.06	0.14	61.20	59.8	-1.40
Guinea	27.46	12.49	39.95	43.16	3.21
Kenya	74.87	0.11	74.98	77.36	2.38
Mali	38.96	0.07	39.03	42.98	3.95
Mozambique	58.78	1.07	59.85	62.91	3.06
Namibia	78.31	0.29	78.60	74.23	-4.37
Nigeria	61.59	0.40	61.99	62.09	0.10
Rwanda	43.74	28.19	71.93	71.10	-0.83
Tanzania	53.70	0.13	53.83	47.70	-6.13

Table 15. Comparison of NER+ with NAR+ for countries where only current attendance questions were asked in DHS

Country	Current attendance: NAR+ (B)	Blended NER+ (A)	Difference (A-B)
Bangladesh	79.34	93.05	13.71
Côte d'Ivoire	52.63	53.67	1.04
India	82.51	82.34	-0.17
Indonesia	95.31	100.86	5.55
Viet Nam	96.05	96.06	0.01

For instance, Table 14 shows that 28% of Rwanda's total primary school attendance (72%) and 12.5% of Guinea's total (40%) were captured by the second question. Compared to the other countries, these are exceptional figures. It is difficult to know whether these results represent reality in terms of attendance (these results could brought on by a major dislocation of educational services within the year due to drought or civil war) or whether they actually represent some serious difference in the way the survey was conducted in Rwanda and Guinea compared to other countries. In the latter case, the difference is due to a survey artefact rather than a real phenomenon of attendance.

One possible explanation could be the timing of the survey relative to the academic year. In Rwanda, the survey ran from June to December *(see Table 1),* but the academic year ran from September to June *(see Table 2).* When the survey was in the field during the months of July and August (2 of the 7 survey months), children were on break from school. Due to this timing artefact, the question on current attendance asked during those two months may have obtained more negative answers and the question on past attendance may have obtained more positive answers than normally expected. In fact, the difference between total NAR+ (calculated using the scaled weight, column B) and NER+ (column A) is so minimal for Rwanda (<1% in absolute value) that the total NAR+ is very likely to be correct – and, therefore, the above explanation is plausible in the case of Rwanda.

A similar survey timing artefact likely occurred in Guinea where the survey ran from April to August *(see Table 1)*, but the academic year ran from October to June *(see Table 2).* When the survey was in the field during the months of July and August (2 of the 5 survey months), children were on break from school. What is curious is that in three other countries in Table 14 the survey was conducted during holiday months (Burkina Faso for 3 of the 7 survey months, Ghana for 1 of the 5 survey months, and Nigeria for 1 of the 6 survey months), but survey timing did not seem to have the same impact, not even in some small measure, as it did in Rwanda and Guinea. This discrepancy may reflect differences in how the interview was worded in the different countries.

When considering the countries where only the question on current attendance was posed *(see Table 15),* Bangladesh shows a substantial difference between total NAR+ (column B) and NER+ (column A). This difference (13.71%) might be explained by the fact that the data on past attendance were not captured. There was no survey timing artefact in this country as in Rwanda and Guinea; in Bangladesh, the academic year spans all 12 months of the year. Given that the missing information on past attendance may have constituted a significant portion of attendance for this country, the enrolment figure for Bangladesh may be considered more credible than the attendance figure.

It should also be noted that although one can observe a modest difference for Indonesia (5.55%) in Table 15, Tables 3 and 4 reveal that there is a problem with both the numerator and denominator components for this country. The problem observed in Indonesia, therefore, cannot be fully explained by how the attendance question was posed, as this affects only the numerator. It should also be noted that in Study 4 the NER+ based on the 2002 census revision for Indonesia had a value (97.08%), considerably closer to the NAR+ in Table 15 than the value for NER+ in Table 15.

Recommendation 9: *All countries participating in a DHS should consider posing both questions relating to school attendance (current and past) in order to ensure that the full phenomenon of educational participation is captured and to make the indicator NAR+ as comparable to NER+ as possible. Interviewers should be trained to explain to respondents the exact meaning of "current attendance" and "past attendance", particularly when the survey is being conducted during holiday months. Alternatively, the DHS questionnaire could be modified to take holiday months into account.*

6. Investigations relating to age reporting across the three data sources (survey, administrative and census)

Study 10. The impact of how age is captured for attendance versus enrolment

In revisiting Table 1, it is interesting to note that the blended NER+ value is almost always greater than the NAR+ value. One plausible explanation is that some children enrol in school but never attend. However, since the definition of both NER+ and NAR+ includes children of primary school age in the numerator, it is possible that the administrative source (from which NER+ is calculated) systematically attributes more children to be of primary school age (either correctly or incorrectly) than the household survey (from which NAR+ is calculated). Therefore, it is not simply the notion of whether enrolment or attendance is captured correctly that is at issue, but rather how age is captured by both instruments.

In order to investigate this, a study regarding how each of the two sources captures age was performed. Three quantities were calculated:

Percentage of correct age =

$$100\,\frac{Number\ of\ children\ enrolled\ in\ (attending)\ primary\ school\ of\ primary\ school\ age}{Number\ of\ children\ enrolled\ in\ (attending)\ primary\ school\ of\ any\ age}$$

Percentage too old =

$$100\,\frac{Number\ of\ children\ enrolled\ in\ (attending)\ primary\ school\ older\ than\ primary\ school\ age}{Number\ of\ children\ enrolled\ in\ (attending)\ primary\ school\ of\ any\ age}$$

Percentage too young =

$$100\,\frac{Number\ of\ children\ enrolled\ in\ (attending)\ primary\ school\ younger\ than\ primary\ school\ age}{Number\ of\ children\ enrolled\ in\ (attending)\ primary\ school\ of\ any\ age}$$

Table 16 provides both enrolment and attendance data for primary school. It should be noted that the three quantities for enrolment add up to 100%, as they do for attendance. The definition of primary school age is given in **Table 17** for the 16 DHS countries in question.

In Table 16, there is no obvious pattern that emerges for the pupils who are too young to attend or enrol into primary education. However, the "percentage of correct age" is systematically higher for enrolment than attendance (except for Indonesia and Nigeria). Similarly, the category of pupils who are too old for the primary level is systematically lower for enrolment than attendance (except for the same two countries). This means that either the administrative data incorrectly indicate too many children of the correct age in primary school or the household survey source incorrectly counts them as too few. Furthermore, the size of the discrepancy between attendance and enrolment data is rather large (in over one-half of the countries the discrepancy is 9% or more), suggesting that there is some serious inconsistency between the way that age data are collected and used by the survey and administrative sources.

Table 16. Comparison of how age is captured for attendance and enrolment data

Country	Percentage too young		Percentage of correct age		Percentage too old	
	Attendance	Enrolment	Attendance	Enrolment	Attendance	Enrolment
Bangladesh	5.92	7.14	65.99	81.82	28.09	11.04
Burkina Faso	5.42	12.29	74.21	77.59	20.37	10.11
Côte d'Ivoire	.	7.46	69.05	75.91	30.95	16.63
Egypt	0.17	1.17	83.40	92.36	16.43	6.47
Ghana	0.92	2.70	62.75	73.78	36.33	23.52
India	.	9.09	75.14	84.04	24.86	6.87
Indonesia	11.06	10.20	83.60	82.76	5.34	7.04
Kenya	1.29	1.07	50.26	69.39	48.46	29.54
Mali	6.31	.	72.94	.	20.74	.
Mozambique	0.79	0.00	62.34	74.83	36.87	25.17
Namibia	0.48	0.04	70.92	72.81	28.60	27.15
Nigeria	3.47	7.09	65.95	57.15	30.58	35.76
Rwanda	2.53	4.98	68.43	82.30	29.04	12.71
Tanzania	4.54	0.11	69.81	74.07	25.65	25.82
Viet Nam	2.96	0.10	72.28	90.88	24.76	9.02

Table 17. Definition of primary school age by country

Country	Starting age	Ending age	Duration (years)
Bangladesh	6	10	5
Burkina Faso	7	12	6
Côte d'Ivoire	6	11	6
Egypt	6	10	5
Ghana	6	11	6
Guinea	7	12	6
India	6	10	5
Indonesia	7	12	6
Kenya	6	11	6
Mali	7	12	6
Mozambique	6	12	7
Namibia	6	12	7
Nigeria	6	11	6
Rwanda	7	12	6
Tanzania	7	13	7
Viet Nam	6	10	5

A possible explanation for the results presented in Table 16 is that administrative primary school enrolment data include over-age children. One way of testing this is to produce a survey-based facsimile of what the apparent participation rate would look like if over-age children in primary education were wrongly included in the estimate of enrolment. For example, if all children (regardless of age) in primary school are included in the primary school participation rate and this brings the facsimile survey-based participation rate into line with the current NER rate, then this will support the view that the enrolment counts are flawed by wrongful inclusion of over-age children in the primary school count. This can be investigated by comparing NER with the gross attendance rate (GAR) to see if they are similar. This means comparing NER as estimated by the administrative data and given by:

$$\text{NER} = 100\,\frac{\textit{Number of primary school-aged children enrolled in primary school}}{\textit{Number of primary school-aged children}}$$

with the GAR as estimated by the survey data and defined as:

$$\text{GAR} = 100\,\frac{\textit{Number of children attending primary school of any age}}{\textit{Number of primary school-aged children}}$$

By definition, GAR can exceed 100% as witnessed for several countries in **Table 18**. When comparing NER and GAR in Table 18, it is apparent that no country has a NER close to GAR.

Table 18. Comparison of GAR with NER to investigate possible misattribution of age by administrative data sources

Country	GAR	NER (2002, revised)
Bangladesh	116.99	89.45
Burkina Faso	42.54	38.22
Côte d'Ivoire	74.29	52.82
Egypt	101.88	93.50
Ghana	95.86	58.96
India	108.70	82.34
Indonesia	105.16	96.28
Kenya	143.36	76.69
Mali	52.30	42.98
Mozambique	90.10	62.89
Namibia	107.43	74.08
Nigeria	89.04	60.26
Rwanda	104.08	71.10
Tanzania	75.04	47.67
Viet Nam	133.35	95.92

Although Table 18 does not shed additional light on this issue, overall, this study is an important one that may offer a plausible explanation for the discrepancies between NER+ and NAR+. Therefore, it is worth pursuing the investigation as far as possible. For one country, a small-scale pilot project to collect both survey and enrolment data and reconcile this at the micro level would be very worthwhile. The selection of a few villages in the catchment area of schools and linking the survey data from these villages to enrolment data (and to children who were not enrolled) would offer tremendous insights.

Recommendation 10: *Age reporting is such an important matter that additional studies need to be conducted to better understand the issue. A small-scale pilot project to collect both survey and administrative data and reconcile this at the micro level would be very worthwhile.*

Another possible explanation for the results in Table 16 is related to attendance data. Within the module that asks about attendance, DHS do not collect date of birth *per se* (to directly calculate age). Rather, the household respondent reports the age of the child at the time of the survey in years only (rather than years and months). This is because DHS was not designed as an education survey with age as a crucial variable needed for analysis. Due to the timing of the survey interview, it may be possible that the child has had a birthday since the beginning of the school year but before the survey interview on school attendance was conducted. For these cases, DHS may show some children to be one year older than they were at the beginning of the school year. Hence, if these children are on the boundary between primary school age and secondary school age, they may be classified as over-age for primary school instead of being classified as being at the correct age level. This may partially explain why the DHS estimates of "percentage too old" are greater than those based on UIS administrative data – although this cannot be the whole explanation since the discrepancies are too large, given that only the last year of primary school is affected.

Recommendation 11: *In future rounds, DHS surveys should consider adding a question to the education module where the age of the child in years and months (or alternately the date of birth) is captured, to enable the production of more accurate NAR+ estimators.*

It is useful to address what is meant by the term "primary school age". Countries individually define this term in a variety of ways. For example, let us suppose that the academic year in a country runs from September to August and covers ages 5 to 10 years inclusive. For some countries, children are allowed entry into primary school, and thus are of primary school age, if they cross the minimum boundary (5 years in the above example) by the first month of the academic year (September in the above example). This definition generally presents no problem since primary school age is in line with the academic year.

However, for other countries, children are allowed entry into primary school if they cross the boundary sometime during the academic year. In this case, some children will be aged 4 years on the first day of school and will reach their fifth birthday sometime during their first year in primary school. Since the UIS requests that countries report how old the child was at the beginning of the academic year, children who are 4 at that time will appear to be enrolled under-age in UIS data, although they are not. The UIS is investigating this issue and starting to collect information on how different countries define primary school age, but so far no adjustment has been made to account for these discrepancies.

It should be noted that the age reporting issue also exists for survey data since they record the age of the child at the time the survey is conducted (and not necessarily in relation to the academic year). Thus, in the above example, if a child is 4 years old when a survey is conducted in September and is currently attending primary school, he or she will appear to be under-age.

Another issue concerning age reporting is associated with the UN Population Division estimates that are used in the denominators of NER+. For these population figures, a single-year cohort represents mid-year estimates of all children having reached a specific birthday by 30 June. Thus the population estimates are not consistent with the enrolment age definition if a school year begins in January, for example. The estimate of the population of primary school age will differ by several percentage points if one simply uses population estimates for ages 5 to 10 years (as in the above example) and compares these to estimates, adding 6 months of age 4, years 5 to 9, and 6 months of age 10. Hence, there may be systematic differences between the population estimates of school age (based on the school year) and those based on whole years. This has the potential to distort NER+ by a few percentage points, but the distortion is expected to be minimal, as the age distribution ought to be relatively stable over a six-month period.

Recommendation 12: *There should be a review of how countries define primary school age and how age reporting affects enrolment data, survey data and the UN Population Division definition. If necessary, further studies should be undertaken to investigate potential ways of either adjusting the reporting process or adjusting the data.*

An additional note on the timing of DHS: Tables 1 and 2 contain the dates of the DHS field operations and the start and finish dates of the academic years respectively. It should be noted that in a number of countries the DHS spans the end of one academic year and the beginning of the next. Furthermore, the question on school attendance is posed retrospectively and concerns the year prior to the survey date, which means that the survey period may in fact span two to three academic years. It would be better if DHS were limited to a single academic year, which would reduce confusion over age and attendance. However, since the DHS was not specifically designed to be an education survey and focuses more on health, it is unlikely that countries will opt to conduct these surveys differently in order to be in line with the academic year. It should be noted that this shortcoming was corrected in this report by using “blended rates” for NER+ whenever it was compared with NAR+. We recommend that analysts who wish to compare enrolment with attendance make such adjustments as well.

A final note on how international agencies determine the reference date for the age data accompanying enrolment data. While the UIS requests that countries report the age of children as of the beginning of the academic year, the OECD and Eurostat (which collect enrolment figures for their member countries) request countries to report the age of children as of 31 December. This can create serious under-estimating of NERs. For example, in Germany (an OECD country), children are admitted to primary school if they turn 6 years old by 1 July (for a 1 September academic year start). Since the 5-year-old cohort is one-half year older by the 31 December reference date, approximately one-half of the children who were 5 on 1 July will be recorded as being age 6 by 31 December, and will be recorded as not having enrolled – resulting in an undercount.

This reporting problem is exacerbated by the fact that Germany has a relatively short duration for primary schooling (ages 6-9 or four years). Indeed, in recent years, the NER figure for Germany has been as low as 85%, which does not seem credible. To remedy the problem, OECD and Eurostat should consider adjusting the reference date for age reporting to be the start of the academic year, thus bringing it in line with UIS practise. As no OECD or EU countries were among the 16 countries analysed in this report, this issue may not seem to be of immediate concern here. More generally, however, it is a concern for the UIS, since it relies on OECD and Eurostat enrolment and corresponding age data.

Recommendation 13: *OECD and Eurostat should consider adjusting the reference date for age reporting to be the start of the academic year in order to bring it in line with the reference date for enrolment information.*

7. Conclusions

Primary school enrolment and attendance data from 16 countries have been examined in this report as a basis for investigating potential sources of error that could contribute to discrepancies between NAR+ and NER+ and, ultimately, to incorrect estimates of out-of-school children. Several of the 10 studies included here reconciled observed differences to some extent. The largest discrepancy occurred for Bangladesh. Study 9 demonstrates that data on past attendance were not being captured and this may be contributing to overall under-reporting on school attendance in this country. Thus, for Bangladesh, administrative data on enrolment may be a more credible source. Study 4 shows, however, that census revisions (2002 versus 2004) had a substantial effect in Bangladesh on successive enrolment estimates.

In Indonesia, Mozambique, Namibia, Rwanda and Viet Nam, differences between NER+ and NAR+ are less than 5% in absolute value (Table 1), but a decomposition showed that there are substantial discrepancies between numerators from the corresponding two data sources (administrative data versus survey data from Table 3) and between denominators from the corresponding two data sources (census data versus survey data from Table 4). In Viet Nam, there is clearly a problem with a missing multiplicative factor for the final weights: both numerator and denominator show differences of almost 50% between the corresponding two sources of data. For the remaining four countries, Study 6 shows that post-stratification of the weights could realign a potential sample representativeness deficiency, given that the common data source for numerators and denominators is survey data.

In Guinea, Study 9 illustrates the issue that survey timing during holiday months may have accounted for some under-reporting of current attendance and over-reporting of past attendance. This is also an issue for Rwanda.

In Côte d'Ivoire, Egypt and Tanzania, there are negligible differences between the denominator estimates (Table 4) but substantial differences between the numerator estimates (Table 3), indicating a possible problem with enrolment data. However, it is not clear why this is so and further investigation might be required on this issue. It should be noted that, although there are negligible differences between denominator estimates (based on census data versus survey data), Study 3 (Table 8) surprisingly shows that for Egypt the Sprague interpolation algorithm generated substantial variation in the census-based estimates (one of the two data sources). In addition, Study 4 demonstrates that there was a modest effect of census revisions (2002 versus 2004) on enrolment estimates in Côte d'Ivoire.

For the remaining countries considered in this report (Burkina Faso, Ghana, India, Kenya, Mali and Nigeria), there appears to be reasonable coherence between the two data sources. For these countries, there seem to be few perceptible data quality issues, at least with regard to the studies undertaken in this report.

In conclusion, this paper attempts to investigate some key data quality issues that arise in the use of household survey data versus administrative data (in combination with census data) to measure educational participation. Although this report is not exhaustive, it highlights many important findings and recommends remedial actions that have implications for both the sponsors and implementing agencies of household surveys (including UNICEF and Macro International), the secondary collectors of administrative data (the UIS) and the UN agency responsible for worldwide population data (UN Population Division).

The recommendations made by the report are not meant to be a criticism of the agencies mentioned, and it is understood that some of the recommendations would require considerable resources to bring about the suggested changes. But these changes would improve their coherence and increase their utility in general.

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The number of out-of-school children is one of the most widely quoted figures used to monitor the achievement of universal primary education (UPE) by 2015. It is, therefore, essential to apply precise methodology when measuring participation in primary education. Traditionally, enrolment data from administrative records are used to calculate these numbers. Yet, over the last decade, statisticians are turning to an alternative source of data for their estimations: attendance data from household surveys.

Technical Paper No. 4 reviews the data sources and methodology used by the UNESCO Institute for Statistics (UIS) to estimate the number of children out of school. The global and regional figures it produces are widely used by national governments and UN agencies to monitor progress towards Education for All (EFA).

This paper describes the adjusted net enrolment rate and adjusted net attendance rate, two indicators for participation in education, and discusses possible sources of error in their application. It also investigates discrepancies between population estimates from different sources and their effect on the measurement of school participation. The authors examine survey weights, sampling and non-sampling errors in household survey data, as well as the impact of survey timing in relation to the school year. The paper concludes by comparing discrepancies in age data from different sources and how they affect the calculations.

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