# Measuring birth weight in developing countries: Does the method of reporting in retrospective surveys matter?

Short Title: Birth weight Data in Retrospective Surveys

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**Abstract**

This study investigates the patterns of recording birth weight data in retrospective surveys and their influence on birth weight estimates in less developed countries. We hypothesise that the method of reporting birth weight in surveys influences the classification of infants in the low birth weight category. Population-level data from Demographic and Health Surveys conducted in six selected countries representing different regions of the world were used. Birth weight data were reported in the survey from either an official health card or from mother's memory. Birth weight distributions were examined in detail and revised low birth weight estimates were calculated accounting for potential heaping and data inconsistencies. There were substantial differences in the distribution of birth weights by method of reporting. The percentage of infants with low birth weight was higher in all six countries for birth weight recalled from memory than when reported from a health card. Health cards displayed less clustering on certain digits than memory recalled weights, but were still highly heaped in certain countries. Heaping of birth weight data on multiples of 500 grams was also observed irrespective of any differences in method of reporting. The study concludes that the method of recording birth weight data can affect birth weight estimates in developing countries. Health systems in poor countries should initiate efforts to systematically monitor the recording of birth weight data ensuring for both quality and comparability at the international levels.

***Keywords***: Birth weight • Demographic and Health Surveys • Measurement errors • Memory recall • Health cards • Heaping

## Introduction

The need for accurate birth weight statistics is acknowledged in population health studies mainly due to the usefulness of low birth weight measurement, a robust biomarker of both short- and long-term health conditions [1-2]. Birth weight data are often difficult to obtain in less-developed countries, especially in countries where most infants are born outside formal health systems. Many infants are never weighed at birth, while those weighed at birth are often not given a formal record of birth weight. Evaluating the accuracy of birth weight data collected through retrospective surveys in resource poor settings is problematic as there are hardly any comparable registration data. Data recorded in small-scale hospital based studies are subject to bias and selection problems [3].

Demographic and Health Surveys (DHS) collect national and regional level data on birth weight retrospectively from mothers of young children under five, although theses data have not been systematically explored in research studies [5-6]. Analyses based on DHS data usually consider infants with a reported birth weight and exclude those with a missing birth weight. However, there are significant differences in the characteristics of infants with a reported birth weight compared to those for which a birth weight is missing [7], which suggests that birth weight indicators estimated from population surveys could be biased. The indicators commonly used to compare birth weight data between populations are the average and the percentage of infants with Low Birth weight (LBW), defined as children born with a birth weight under 2500 grams [8].

There have been a few attempts to assess the accuracy and validity of birth weight data collected from the DHS, accounting for the possible misclassification of reported birth weight and by using other proxy variables, for example the reported size of the

infant at birth [9-11]. Various methods have been proposed to mitigate for the missing birth weight data and to produce representative estimates for the proportion of infants born with LBW [8-9], although these adjustment procedures assume that the birth weight data reported in the surveys (DHS) are accurate.

The DHS record birth weight data from mothers of young children either by using official health records, if they are available, and if not by asking the mother to recall from memory. Those who report birth weight through memory recall were first asked whether an official health card was available, as cards are believed to be more reliable than maternal recall. Entries on cards are generally completed by a physician or a health worker and are usually given to mothers upon discharge from the institution where the birth occurred or during a follow-up health visit at home soon after the birth.

We hypothesise that the method of reporting (memory recall versus card) has an influence on the classification of infants in the low birth weight category. The aims of this paper are two-fold: (i) to investigate the differences in the distribution of birth weights between weights obtained from memory recall and those recorded from health cards and (ii) to examine the effect of the different reporting methods on the estimates of the proportion of infants with LBW. A comparison between the methods of recording is needed as many studies make an explicit assumption that retrospective reports of birth weight are homogenous with respect to bias and accuracy, irrespective of reporting method. Such an assumption has not previously been empirically validated or tested.

## Methods

### Data

We used the DHS data from Bolivia (1998), Cambodia (2000), Gabon (2000), Mali (2001) and Nicaragua (2001) and a DHS equivalent survey from India (1998/99), the National Family Health Survey (NFHS). These countries are seen to have a large range of missing birth weight information, and are also selected to ensure reasonable geographical coverage of less developed regions. Each respondent (mother) interviewed was asked to provide a detailed birth history for all births in the five years preceding the survey. In the case of India, the NFHS obtained only birth histories for the last two births born after January 1995, approximately three years before the survey. The numbers of live births in the five years preceding the survey are shown in Table 1. Details regarding sample design and data collection procedures have been reported elsewhere within the individual country reports [11].

All mothers were first asked whether their child was weighed at birth, and for those that were the mother was then asked to report the birth weight. Stillbirths were excluded since the DHS records birth weight only for live births. For each infant the method of reporting birth weight was obtained (memory versus health card). Birth weight was recorded in grams in all countries, even if the mother had reported the weight in pounds and ounces (using the Imperial scale). In Nicaragua there was a third response option to identify whether the mother had reported birth weight in the Imperial scale. It should be noted that hospitals in Nicaragua use the metric scale and not the Imperial scale. The birth weight data pertains to births in the five years preceding the surveys. Evidence from developed settings show that mothers are likely to recall and report birth weight accurately even for children born many years preceding the survey date [12-13].

--- Table 1 about here ---

**Statistical analysis**

One of the methodological issues when analysing birth weight data is heaping of reported birth weights. Heaping or spikiness is a phenomenon inherent in population surveys and censuses where respondents tend to report certain information, for example their ages, dates or measurement quantities, in numbers ending with 0, 5 or any other preferred digits [14]. Heaping of birth weight data was evident in the DHS data where mothers show a tendency to round birth weight information to the nearest digit, for example 2500 grams instead of 2485 grams [9, 15]. To analyse the scale of heaping on birth weight for each recall method, the proportion of weights heaped on multiples of 100g and 500g were calculated separately.

Low birth weight in this study is defined as a weight of less than 2500g as recommended by the WHO [7]. The amount of heaping on 2500g could potentially have a substantial effect on the LBW estimation. Some infants whose birth weights were rounded to exactly 2500g may actually have been lighter and hence these infants should actually be classified in the LBW category. The effect of this misclassification is seen to be substantial in determining the prevalence of LBW infants [8-9]. In this study, LBW is defined in three different ways to highlight how the classification of infants weighing 2500g affects the percentage of infants with LBW. The first definition is the standard one, which classifies only those weighing less than 2500g as LBW. The second includes all those weighing 2500g as LBW. The last definition apportions a percentage of infants recorded as weighing exactly 2500g as LBW. The percentage apportioned varies for each country, and is determined by obtaining the total number of babies weighing 2000g to 3000g, excluding those weighing exactly

2500g. The percentage of infants weighing 2000g-2499g out of the total weighing 2000g-3000g (excluding those weighing exactly 2500g) was calculated. Assuming that the distribution of birth weights between 2000g and 3000g is linear, this percentage was then used to reclassify the same percentage of those infants weighing exactly 2500g into the LBW category (referred hereafter as the ratio method).

For each country, the percentage of infants with LBW was calculated separately by the method of recall of the birth weight. The purpose of this analysis is to determine the extent of differences in birth weight distributions by reporting method and not per se produce definitive estimates of the percentage of infants with LBW. Furthermore, the aim is not to propose a method to more accurately re-distribute the birth weights heaped on 2500g, but to demonstrate the effect of heaping on LBW estimates. All multiple births were excluded from the analysis. Sample weights were applied on the raw data in order to adjust for potential differences in the probability of selection of households and respondents in the survey.

## Results

### Memory versus health card reporting

The percentage of missing birth weights in each of the countries is shown in Table 1. The percentage ranges from 11.4% in Gabon to 84.1% in Cambodia. Blanc and Wardlaw [9] reported that infants with a birth weight are more likely to be born in a hospital, live in an urban area, have educated parents and are alive at the time of survey. Similar results were obtained from our investigations into these six countries (results not shown). The characteristics noted have been seen to be associated with a higher birth weight [16]. In four of the six countries, the majority of weights were recalled from the mother's memory (Table 1). In India, about half of the reported birth

weights are recalled from memory and half transcribed from a health card. Cambodia is the only country with a clear excess of birth weights reported from a health card.

There are significant differences in the mean birth weight by recall method in Cambodia, Gabon, Mali and Nicaragua, where birth weights recalled from memory are, on average, significantly higher than those from a card (Table 2). The largest difference is seen in Nicaragua, where memory recalled birth weights are, on average, 181g heavier than card recalled weights.

*--- Tables 1 and 2 about here ---*

**Heaping of reported birth weight**

The analysis of DHS data show considerable heaping of reported birth weights, irrespective of the method of reporting. The percentage of weights recorded on multiples of 100g range from 12.6% in Nicaragua to 99.2% in Cambodia, whilst the heaping on 500g/½lb multiples range from 19.0% in Gabon to 69.6% in Nicaragua (Table 3). The high level of heaping seen in Nicaragua is mainly due to rounding of birth weight in pound and half-pound units. If only 500g multiples are considered, then heaping in this country occurs in just 3.5% of cases (results not shown).

As expected, in all countries except Nicaragua, the amount of heaping on multiples of 100g and 500g/½lb was higher if the mother recalled the birth weight from her memory than if the weight was transcribed directly from a health card (Table 3). In both Gabon and Mali, the card reported weights have much less heaping than those from memory recall. However, in the other countries which use metric measurements of weight there are only small differences in the percentage heaped between the two methods of reporting, contrary to those reported by the Blanc and

Wardlaw study [9]. In Nicaragua, heaping was seen more on multiples of 100g for card reported data. This is due to the discrepancy in recording birth weight between health cards (in metric units) and memory recall (Imperial scale).

*--- Table 3 about here ---*

The observed heaping patterns are graphically illustrated in the form of birth weight pyramids (Figure 1), which are analogous to population pyramids. These pyramids clearly show that for most countries heaping is common for memory recalled birth weights. The distribution of card reported birth weights in Gabon, although not perfectly normally distributed, is very close to the unimodal bell shaped distribution of weights. Card reported birth weights from Bolivia, Mali and Nicaragua are also approximately symmetrical, although there is evidence of heaping on certain weights. However, the weights recorded from health cards in Cambodia and India are highly heaped and do not show much of a difference when compared to those from memory recall. The pyramids also indicate that there is usually a larger proportion of infants in the extremes of the birth weight distribution (below 2500g and above 4500g) when the birth weight was recalled from memory. This is clearly obvious in the case of Nicaragua, but the same pattern holds for all other countries in the analysis.

*--- Figure 1 about here ---*

**Percentage of infants with LBW**

The estimation of the percentage of infants with LBW is sensitive to how those infants who have a reported birth weight of exactly 2500g are treated, with many of the infants heaped at 2500g probably weighing less than this amount and who should be classified as LBW. The percentage of infants weighing exactly 2500g ranges from

0.4% in Nicaragua to 18.7% in India, with little difference in heaping between memory recalled and card reported birth weights.

The impact of the heaping at 2500g on the LBW proportion is assessed through three different approaches as explained previously. The ratio method apportioned 9.1% of infants weighing exactly 2500g in Cambodia and 31.1% for infants born in Mali into the LBW category. The percentage of infants with LBW is estimated for birth weights by method of recall (Table 4). It must be noted that the estimates for Nicaragua may actually overestimate the percentage with LBW, as some weights are heaped at 5lb 8oz (equivalent to 2495g), just below the LBW threshold.

*--- Table 4 about here ---*

The method of recall affects the classification of LBW infants, with a higher proportion classified as LBW if the birth weights are recalled from memory than from a health card. The results from the ratio method show that there are differences in the LBW estimates by the method of recall, for example by 1.2 point difference between memory and card recall in Nicaragua to 4.7 point difference in Gabon. This contrasts with the mean birth weight which is consistently higher for infants with birth weights recalled from memory. This apparent contradiction can be explained by the greater numbers of birth weights reported from memory recall which fall in the extremes of the distribution. The mean birth weights are shifted upwards due to the large proportion of infants being classified in the high birth weight category based on memory recall, while the proportion of LBW infants also increased due to the heaping of infants weighing exactly 2000g at birth.

**Discussion**

Cross-sectional estimates of birth weight data are subject to recall bias and measurement errors [8-9]. An inherent problem in using birth weight from most population-based retrospective surveys, including the DHS, is the heaping of the weights as people tend to round digits, irrespective of the unit of measurement. Although heaping of birth weight is found common in both developing [8] and developed countries which rely on registration data [5, 15, 17], it is expected that weights reported from a health card show less heaping than those recalled from memory. However, this study shows that this is not necessarily the case. In Bolivia, Cambodia and India the difference in the heaping of birth weight by method of recall is only trivial. Other countries, such as Gabon and Mali display the expected trend with more heaping if birth weights are recalled from memory than if read from a card. Thus it cannot be assumed that birth weights reported from health cards are of better quality than those recorded from a mother's memory.

This analysis demonstrates evidence that heaping on card recalled birth weight data exist, although the variations between countries investigated are difficult to explain. It is likely that there are no formal standards in recording birth weight within the health systems and hence the tendency to rounding birth weight on health cards. The relationship between the amount of heaping and the performance of health systems seems an obvious link. However, this is surprisingly not seen in Mali which shows less heaping on card recalled birth weight data. Mali ranks the lowest in terms of institutionalisation of health care systems when compared to other five countries included in the analysis [18].

This analyses confirmed our hypothesis that the method of reporting has an impact on the classification of infants in the low birth weight categories. The large

percentage of infants with birth weights recalled from memory that are in the extremes of the distribution (<2500g and >4500g) in each of the countries indicate that there is considerable inaccuracy in birth weight data reported through memory recall. Birth weight analysis based on memory recall should be handled with caution and it is important that reporting method should be controlled in regression analyses aimed at predicting birth weight outcomes.

The difference that the heaping and the method of reporting have on the classification of LBW is considerable. In India, the LBW estimates range from 21.2% to 41.9%, and even in Gabon with the smallest amount of heaping the LBW estimates range from 10.1% to 18.8%. However, these are conditional estimates representative of infants with a reported birth weight in the survey, and cannot be generalised to the entire infant population in each country. The methods developed by Boerma *et al.* [8] and Blanc and Wardlaw [9] are useful and should be considered to produce population based estimates in less developed countries. But these estimation procedures are sensitive to heaping and the way in which the data are recorded (memory versus card recall). Further research is needed to develop a consistent methodology that takes into account potential misclassification of birth weight data arising from heaping and the method of recording. Health systems in poor countries should initiate efforts to systematically monitor the recording of birth weight data ensuring for both quality and comparability at the international levels.

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**Table 1** Number of children born in five years before survey and distribution of reported birth weight by method of recall[1]

| Country | Number of children in survey | Missing birth weight data (%) | Reported birth weight (%) | |
|---|---|---|---|---|
| | | | Health card | Memory |
| Gabon | 4405 | 11.4 | 44.1 | 55.9 |
| Nicaragua | 6986 | 29.6 | 16.5 | 83.5 |
| Bolivia | 7304 | 41.7 | 15.1 | 84.9 |
| India | 33026 | 75.1 | 50.2 | 49.8 |
| Mali | 13097 | 79.4 | 38.7 | 61.3 |
| Cambodia | 8834 | 84.1 | 68.3 | 31.7 |

[1] In India only the last two children born in the three years preceding the survey were considered.

**Table 2** Mean birth weight by method of recall (in grams)

| Country | Overall | Health card | Memory |
|---|---|---|---|
| India | 2793 | 2801 | 2785 |
| Gabon | 3152 | 3115 | 3181* |
| Mali | 3190 | 3144 | 3219* |
| Cambodia | 3202 | 3179 | 3251* |
| Nicaragua | 3281 | 3130 | 3311* |
| Bolivia | 3379 | 3369 | 3381 |

* Significant difference between mean weights by method of recall ($p<0.05$)

**Table 3** Heaping in reported birth weight data (%)

| | Multiples of birth weight | | | | | |
|---|---|---|---|---|---|---|
| | 100 grams | | | 500g & ½ lb | | |
| Country | Overall | Health card | Memory | Overall | Health card | Memory |
| Nicaragua[1] | 12.6 | 51.0 | 5.0 | 69.6 | 12.6 | 80.8 |
| Gabon | 61.6 | 42.6 | 76.7 | 19.0 | 9.7 | 26.4 |
| India | 85.5 | 83.8 | 87.1 | 66.5 | 63.7 | 71.1 |
| Bolivia | 87.8 | 76.6 | 89.9 | 32.6 | 25.5 | 33.8 |
| Mali | 90.4 | 82.3 | 95.5 | 50.4 | 33.4 | 61.1 |
| Cambodia | 99.2 | 99.1 | 99.5 | 45.9 | 42.5 | 53.2 |

[1]Imperial measurements used by some mothers

**Table 4** Estimates of LBW by method of reporting

| | All* | | | Health Card | | | Memory | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | <2500g | Ratio | ≤2500g | <2500g+ | Ratio+ | ≤2500g+ | <2500g+ | Ratio+ | ≤2500+g |
| Cambodia | 5.6 | 6.2 | 12.6 | 5.1 | 5.7 | 12.5 | 6.6 | 7.2 | 12.7 |
| Bolivia | 6.9 | 7.5 | 9.9 | 4.5 | 4.6 | 6.5 | 7.6 | 8.0 | 11.2 |
| Nicaragua | 9.6 | 9.7 | 10.0 | 8.6 | 8.7 | 10.1 | 9.8 | 9.9 | 9.9 |
| Gabon | 12.0 | 13.0 | 15.6 | 10.1 | 10.5 | 11.7 | 13.6 | 15.2 | 18.8 |
| Mali | 14.2 | 16.5 | 21.6 | 13.2 | 15.2 | 20.1 | 14.8 | 17.3 | 22.5 |
| India | 21.9 | 27.7 | 40.5 | 21.2 | 26.8 | 39.2 | 22.5 | 28.6 | 41.9 |

*All infants with a recorded birth weight in the survey

Notes:

<2500g – the percentage of infants classified as having LBW if only those with a recorded birth weight under 2500g are included as having LBW;

Ratio – the percentage of infants classified as having LBW if those weighing 2500g are apportioned to the LBW in the same ratio as those weighing 2000g-2499g to 2501g-3000g;

>2500g – the percentage of infants classified as having LBW if all those with a recorded birth weight of 2500g are included as having LBW.

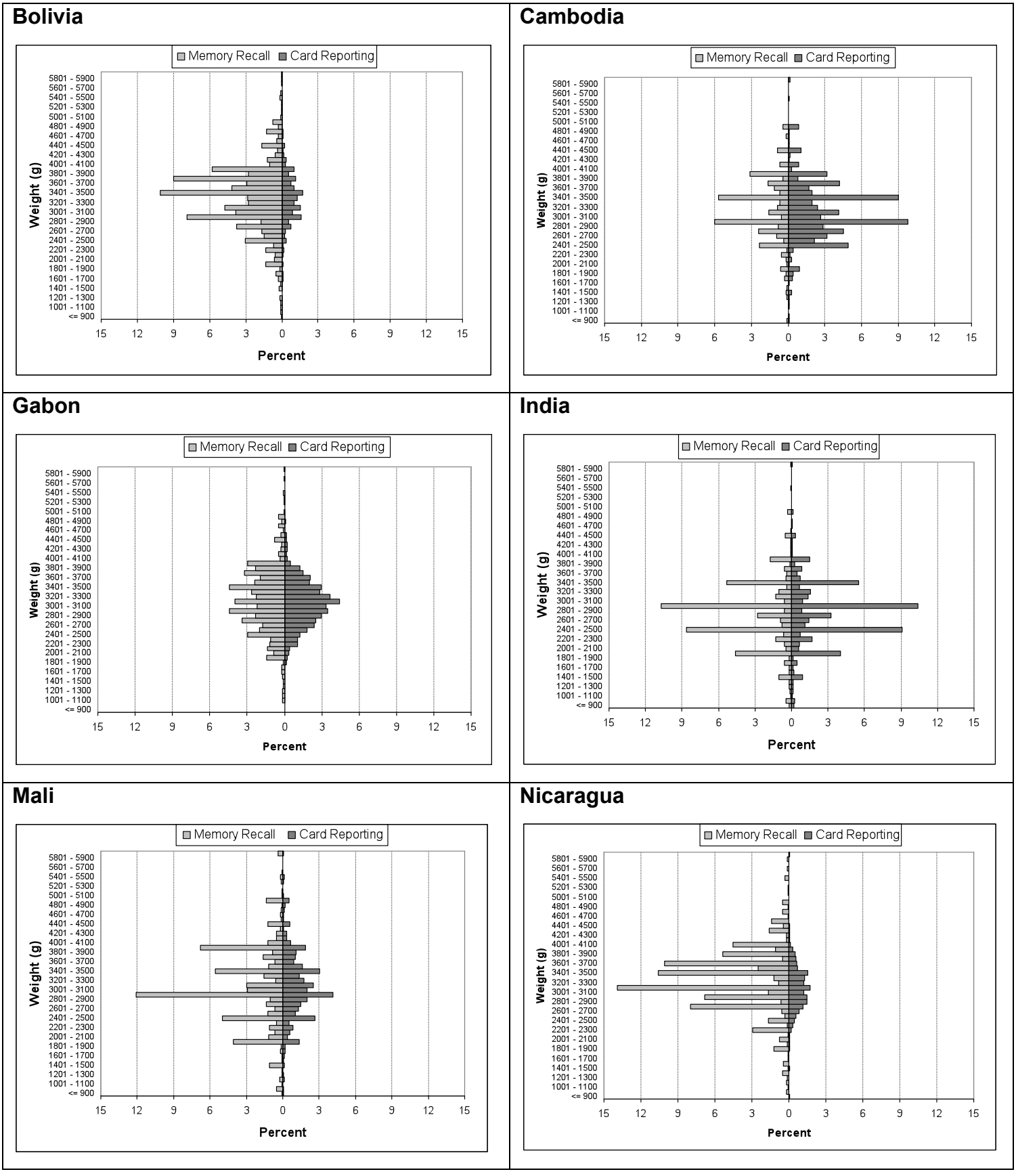


**Figure 1** Birth weight pyramids showing the proportion of weights in each birth weight category by method of recall