Comparison of estimates of malnutrition in children aged 0–5 years between clinic-based nutrition surveillance and national surveys

Maria Nnyei, Kesitegile S.M. Gobotswang, Patrick Codjia

Abstract This study documents a marked discrepancy between the nutritional status of children aged 0–5 years in Botswana when measured by national surveys compared to clinic-based surveillance. We compared the average prevalence of underweight (weight-for-age *z*-scores below 2 standard deviations of the mean of the Center for Disease Control (CDC)/WHO reference standards) in children 0–5 years of age. According to clinic surveillance, prevalence of underweight has fallen from 14.6±0.03 to 3.5±0.04 per cent between 1993 and 2010. In national surveys, it had fallen from 14.6±0.01 to 11.5±0.01 per cent between 1993 and 2007. We explored several possibilities to explain this discrepancy, and conclude that it is because of sampling bias in the clinic surveillance. This finding underlines the need for properly conducted surveys to ensure accurate information about the nutritional status of children.
Journal of Public Health Policy (2011) 32, 281–292. doi:10.1057/jphp.2011.32; published online 12 May 2011

Keywords: nutrition surveillance; malnutrition; health information systems; underweight; Botswana

Introduction

Health information systems often rely on surveillance programs to monitor the occurrence of illnesses, malnutrition, risk factors, disease outbreaks, and their correlates. Nutrition Surveillance Systems (NSS) monitor the nutritional status of population groups. They vary from very basic systems that focus on providing the prevalence of the condition(s) of interest, to the more complex ones that cover more conditions, use several indicators for the same condition, and collect data on the correlates of the

conditions or indicators of interest.[1,2] The information generated typically assists in monitoring the nutrition of population groups and in triggering relevant and timely interventions.[3–6] Given their importance in influencing nutrition and health programming, it is important that surveillance information be accurate and reliable. Some surveillance system designs, however, are prone to biases and are likely to generate unreliable observations. Given this limitation, it is important that observations generated by such programs be routinely compared to estimates generated by systems with stronger designs.

To this end, we compared estimates of malnutrition, defined as weight-for-age *z*-scores below 2 standard deviations of the mean of the CDC/WHO growth references, reported by the Botswana National Nutrition Surveillance System (BNNSS, program-based surveillance systems) with estimates reported by nationally representative cross-sectional surveys that target the same population of children.

Background

NSS are health information systems that entail the systematic collection, analysis, and interpretation of children's growth information to monitor nutritional status. These systems usually target children 0–5 years of age. Nutrition surveillance programs were established following a 1974 World Food Conference in Rome, Italy.[7] Participants decided to introduce a global food and nutrition information system to enable United Nations member countries to monitor the food and nutrition situation of their populations, especially children below the age of 5 years.

Three main types of nutrition monitoring systems emerged over time after the conference:

- clinic- or program-based NSS adopted by countries such as Botswana and Malawi;
- community-based surveillance system commonly associated with Tanzania's highly acclaimed Iringa Nutrition Program[8]; and
- more complex population-based nutrition monitoring systems such as the National Health and Nutrition Examinations Survey in the United States of America.

Botswana's surveillance system is based on the country's Growth Monitoring Program, a clinic-based BNNSS established in 1978. It has

run for more than 30 years without interruption. It uses monthly growth monitoring information about children 0–5 years of age from all clinics in the country to estimate the prevalence of underweight in children. Many consultants and scholars have studied the system, often focusing on processes and utilization of information.[3,4,9–15]

Although the BNNSS program is valuable because it provides policymakers with timely and regular estimates of malnutrition, its dependence on data obtained from the Growth Monitoring Program may under-represent children who do not attend clinics regularly. Evidence from other researchers indicates that undernutrition estimates of first-time attenders may be different from those who attend regularly.[16] With this uncertainty, the reliance of policy makers on unweighted BNNSS estimates in making program decisions that affect all the under-fives, seems problematic. We are not aware of any work that has determined whether the BNNSS estimates are comparable to estimates generated by comprehensive, nationally representative surveys. Thus, in this study, we compare estimates of malnutrition generated from national surveys with those reported by the BNNSS.

Methods

We systematically searched for, identified, and reviewed publications and government reports containing estimates of the prevalence of underweight, stunting (height-for-age *z*-scores below 2 standard deviations of the mean of the CDC/WHO growth references) and wasting (weight-for-height *z*-scores below 2 standard deviations of the CDC/WHO growth references) in children 0–5 years of age between 1990 and 2010 in Botswana.

The estimates of undernutrition obtained from these reports and publications were compared with BNNSS estimates. We used these terms in our literature search: underweight, malnutrition, stunting, and under-fives. We then screened the search results to find Botswana and reference to –1990–2010. This exercise uncovered only four journal articles. We excluded three because they focused on children 0–3 years[17,18] (and not 0–5 years as desired) or on children born to HIV-positive mothers.[19] We also looked for government reports of surveys containing data on undernourished children from the Nutrition and Food Control Division, the Central Statistics Office (CSO), Government printers, and Government archives. Here, we uncovered

five reports from government and other stakeholders. We excluded documents restricted to a specific group of the under-fives, as before. Estimates of stunting, underweight, and wasting reported by these surveys were then compared with the corresponding years' BNNSS reports for the same coverage area. Thus, for nationally representative estimates, the corresponding BNNS estimates were the national averages for that particular year. For documents that covered only one health district, the corresponding estimates were BNNSS estimates for that particular district and year. These are displayed in Table 1.

Results

Figure 1 shows malnutrition trends reported by four different nationally representative surveys conducted between 1993 and 2007. Two of these were data sets for Botswana's Demographic Health Surveys of 1996 and 2007. Overall, there is a downward trend in all forms of malnutrition. But the prevalence of malnutrition edged upward between 2000 and 2007.

This increase was more pronounced for stunting, which rose by 3 percentage points between 2000 and 2007. The prevalence of stunting in 2007 was as high as it had been in 1993. Of the three indicators of malnutrition, stunting reflects chronic malnutrition, a much more common form of malnutrition in children. Stunting in Botswana has ranged between 23 and 30 per cent in the past 14 years.

We present a graphic comparison of the prevalence of underweight generated by nationally representative surveys and the BNNSS in Figure 2. The figure indicates similarities in the underweight trend patterns between 1993 and 2007. BNNSS observations suggest steady improvements in underweight prevalence since 1993. In fact, current estimates of underweight are about a third of the estimates reported in 1993. Although observations reported by the cross-sectional surveys also show a downward trend, the improvement is not as dramatic as that reported by the BNNSS. The differences between estimates reported by the cross-sectional surveys and the BNNSS are large. First, BNNSS shows a faster rate of improvement over the period covered. Second, prevalence of underweight reported by BNNSS is far less. In 2007, for example, the prevalence of underweight reported by the Demographic Health Survey IV is three times higher than that reported by BNNSS for the same year. Similar conflicts between estimates of

Table 1: Source of child nutrition data used in this article

Data collection year	*Population-based surveys*				*Clinic-based nutrition surveillance system*		
	Scope of the survey			*Author*	*Scope of the surveillance*		*Author details*
	National	*Regional*	*Sample size*		*National*	*Regional*	
1993	✓	—	672	MFDP [20]	✓	—	Nutrition Surveillance
1996	✓	—	2317	CSO [21]	✓	—	reports are generated
2000	✓	—	2870	CSO [22]	✓	—	by the Nutrition and
2007	✓	—	2627	CSO [23]	✓	—	Food Control Division,
2002	—	✓	522	Nnyepi [24]	—	✓	Ministry of Health,
2009	—	✓	471 (Bobirwa) 426 (Mabutsane)	UNICEF Botswana [25]	—	✓	Botswana

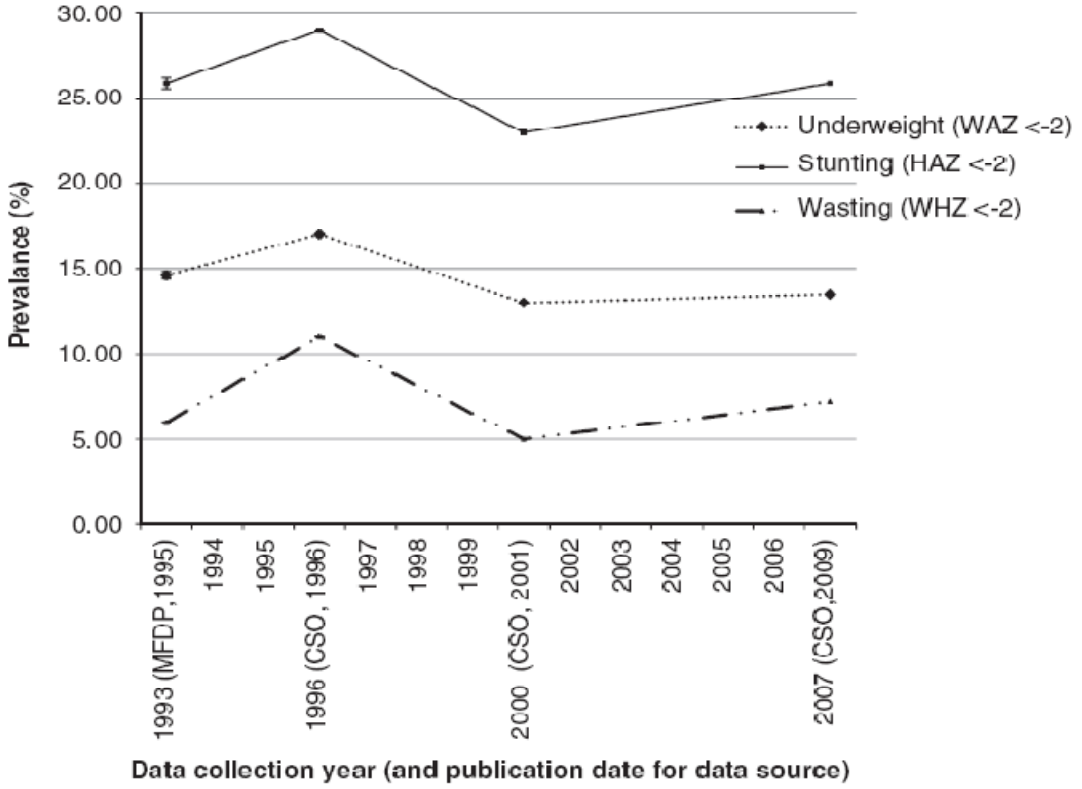

Figure 1: National malnutrition trends among children (0–5 years) in Botswana.

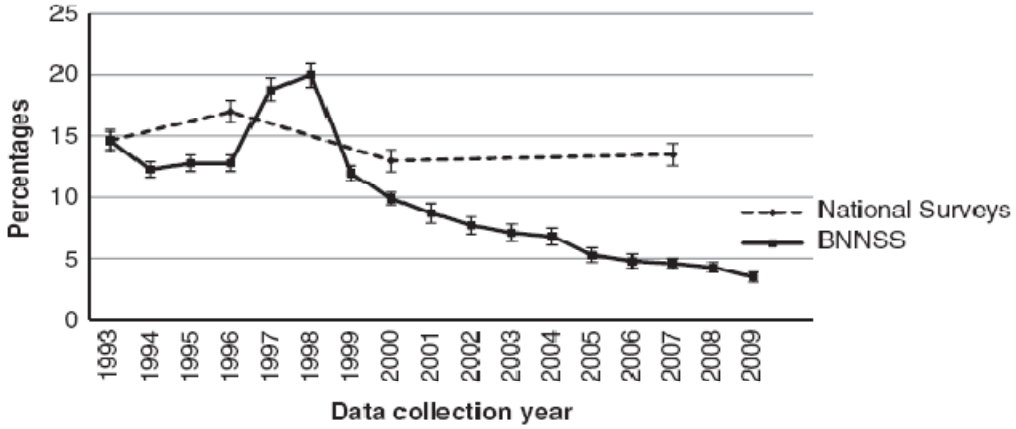

Figure 2: The prevalence of underweight (Weight-for-Age Z-scores (WAZ) < −2) in children (0–5 years) as reported by BNNSS and national surveys.

underweight prevalence generated by surveys and those reported by the BNNSS were observed at the health district level.

Discussion

Given that the population of interest was the same in both the BNNSS and the cross-sectional surveys, prevalence of underweight estimated by either of these studies is expected to be comparable. We are troubled because BNNSS estimates of malnutrition and those reported by national surveys are different. BNNSS reports lower estimates of malnutrition during a 14-year period (1993–2007) when known correlates of child malnutrition, such as the prevalence of HIV-infected pregnant mothers,[26,27] the number of HIV-infected children, and the infant mortality rate, show either an opposite trend or less dramatic decline.[23] Under-five mortality rate (U5MR) rose from 25 deaths to 75 deaths of children under-5 years of age per 1000 live births between 1996 and 2000.[21,22] Botswana Demographic Health Survey estimated U5MR to be 76 deaths of children under-5 years of age per 1000 live births in 2007.[23] We generated Figure 3 from observations reported by the Botswana Demographic Survey 2006, Botswana Family Health Survey

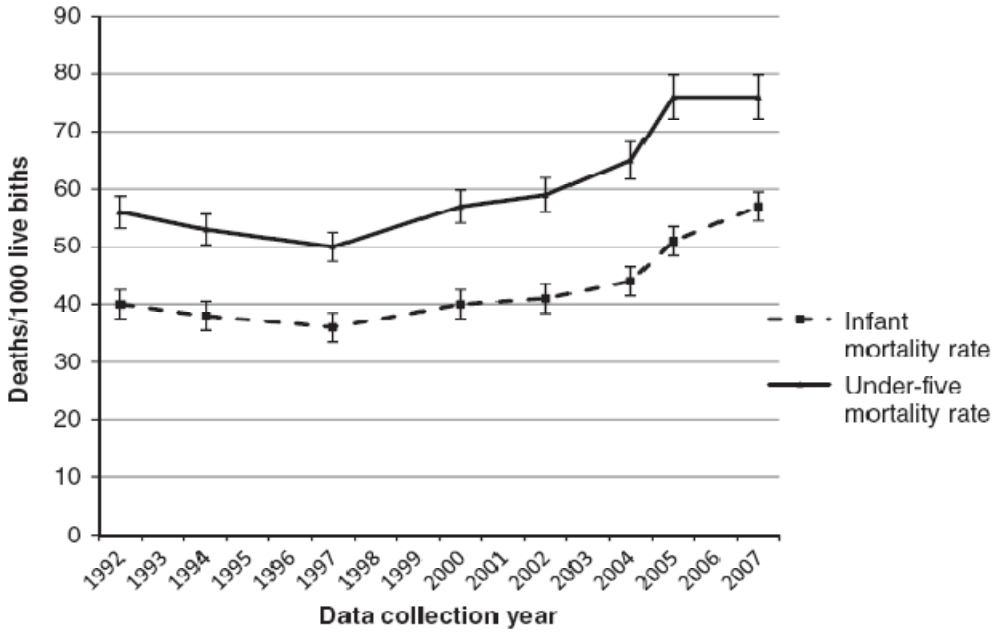

Figure 3: Infant and under-five mortality rate trends.

series,[21,23,28,29] and program data. It presents a picture starkly different from the BNNSS estimates.

The reported decline in child nutritional status is difficult to explain given the trends in these important determinants, particularly because undernutrition in children is known to explain over 50 per cent of the child morbidity.[30]

The observed differences in the estimated prevalence of underweight as reported by BNNSS and cross-sectional studies suggest problems with sampling, data collection (measurements errors), or differences in the reference standards used. For reference standards, however, BNNSS used the same references (CDC/National Center for Health Statistics (NCHS) standards) until 2008, when BNNSS changed to the WHO Reference Standards.[31] The differences cannot be attributed to differences in the reference standards.

Similarly, it is unlikely that the differences are because of technical details in the collection of anthropometric measurements because the Department of Public Health, which houses BNNSS, works closely with the CSO, that coordinates the Demographic and Health surveys and the Multiple Indicator Survey of 2000. In fact, as indicated in the demographic health survey reports, the CSO[22] performed these cross-sectional surveys on behalf of the Department of Public Health. It is, however, plausible that differences in the estimates could be explained by other factors including lapses in the quality of the data collection caused by failure to calibrate weighing scales regularly, less than adequate competency of the health workers taking measurements, and flaws in capturing information.[9]

Perhaps, the major difference between the BNNSS and the cross-sectional surveys resides in the methods of sampling children in the studies. Children in the surveys were selected randomly. The sample is nationally representative, while the BNNSS used a convenience sample. In the former, children 0–5 years in Botswana have an equal and known probability of being sampled, whereas in the latter, only children who attend clinics have a chance of being sampled.

If children who attend the growth monitoring program regularly are different in some ways from children who do not attend, it is plausible that estimates of BNNSS will differ from those generated by the cross-sectional surveys. In view of the reported high coverage rate in children attending child wellness clinics, how would a relatively small proportion of children not attending these clinics carry

most of the malnutrition burden of the country? This question remains unanswered.

The extent to which clinic-based surveillance is representative of all children 0–5 years in the population is generally unknown.[5] Reports in some other countries suggest variations between the prevalence of underweight in first-time attendees versus repeated attendees.[15]

More recently, a survey report by UNICEF – Botswana reported age-associated differences in the immunization coverage of the under-fives. Older children whose immunizations (mostly boosters) were spaced further apart had lower immunization rates than younger (0–12 months) children. As children receive immunizations while attending the growth monitoring program, this observation suggest that older children's representation in the BNNSS data may be lower than previously assumed. Consistent with this observation, younger children generally have better growth indicators.[32] If they are over-represented in the BNNSS than older children, then the estimates of malnutrition generated by BNNSS would be lower. While this is a possible explanation, other plausible explanations exist. It is urgent that we ascertain factors related to the differences in these estimates, so that the accuracy of the estimates may be improved.

Sampling challenges in surveillance programs are not unique to Botswana. An overview of nutrition surveillance programs points out some of these challenges in detail.[33] As we base policies on trend studies, they may not provide information sufficiently frequently, but have fewer methodological challenges than program-based surveillance systems.[34] To continue benefitting from the readily available BNNSS data, BNNSS observations should be validated regularly. If no action is taken, the consequences of relying on BNNSS data alone may be detrimental to child survival. Surely so, if national survey estimates truly reflect reality. If, on the other hand, malnutrition rates in children are not as bad as reported by national surveys, then reliance on survey estimates may negatively affect budget allocation.

In conclusion, we suggest that nutrition information systems, such as the nutrition surveillance, should have built-in data quality control mechanisms to improve data collection and analysis in monitoring undernutrition 'trends'. Whether nutrition surveillance data are generated from clinic programs or repeated cross-sectional surveys, these mechanisms are important. Where possible, however, repeated cross-sectional surveys should be used to monitor the prevalence or incidence

of undernutrition. These are population-based surveys and therefore more likely to provide reliable estimates.

About the authors

Maria Nnyepi, PhD (Human Nutrition), is a senior lecturer, Human Nutrition and Head of Department of Family and Consumer Sciences at the Universty of Botswana. Her research work focuses on maternal and child nutrition issues.

Kesitegile S.M. Gobotswang, PhD, is a senior lecturer of nutrition affiliated to the University of Botswana, Gaborone. His research interests are in the area of nutrition and food policy analysis.

Patrick Codjia is a nutrition specialist, based at UNICEF Botswana – Gaborone Office.

References

1. Babu, S.C. and Quinn, V.J. (1994) Food security and nutrition monitoring in Africa: Introduction and historical background. *Food Policy* 19(3): 211–217.
2. Quinn, V.J. and Kennedy, E. (1994) Food security and nutrition monitoring systems in Africa: A review of country experiences and lessons learned. *Food Policy* 19(3): 234–254.
3. Morgan, R. (1985) The development and applications of a drought early warning system in Botswana. *Disasters* 9(1): 44–50.
4. Ismail, S.J. (1991) Nutrition surveillance: Experience from developing countries. *Proceedings of the Nutrition Society* 50: 673–679.
5. Belbase, K. and Morgan, R. (1994) Food security and nutrition monitoring for drought relief management: The case for Botswana. *Food Policy* 19(3): 285–300.
6. Kachale, M.P. (2009) Establishment of the Botswana Vulnerability Assessment and Analysis System for National Food Security. Report submitted to the Ministry of Finance and development planning and SADC RVAC-PMU., http://www.sadc.int/fanr/aims/rvaa/Documents/Botswana/2009%20Botswana%20VAA%20Synthesis%20Report.pdf, accessed 4 November 2010.
7. Mason, J.B. and Mitchel, J.T. (1983) Nutritional surveillance. *Bulletin of the World Health Organization* 61(5): 745–755.
8. Pelletier, D.L. and Johnson, U. (1994) The use of information in the Iringa Nutrition Program: Some global lessons for nutrition surveillance. *Food Policy* 19(3): 211–217.
9. Bailes, A. (2006) National nutrition surveillance system: A review and recommendations report supported by UNICEF Botswana. Unpublished consultancy report.
10. Boonstra, E., Lindbaek, M., Fidzani, B. and Bruusgaard, D. (2001) Cattle eradication and malnutrition in under-fives: A natural experiment in Botswana. *Public Health Nutrition* 4(4): 877–882.

11. Ministry of Finance and Development Planning. (1986) Report of the drought assessment tour by the Inter-Ministerial Drought Team, 25 January to 12 February 1986. Ministry of Finance and Development Planning, Gaborone, mimeo.
12. Buchanan-Smith, M. (1990) *Report on the Evaluation of the Drought Relief and Recovery Program, 1982–1990: Drought, Income Transfers, and Rural Household Economy.* Gaborone, Botswana: Government Printer.
13. Cogill, B. (1990) *Report on the Evaluation of the Drought Relief and Recovery Program, 1982–1990: Information System.* Gaborone, Botswana: Government Printer.
14. Chaudhuri, S. (1987) *Growth Monitoring and Promotion in Botswana: Present Status and Future Prospects – Final Report/Consultant.* Gaborone, Botswana: Ministry of Health/ UNICEF.
15. Yambi, O. (1988) Report on the Evaluation of the Botswana National Nutritional Surveillance System. Gaborone, Botswana: Government of Botswana. Report for the Ministry of Health and UNICEF Botswana.
16. Serdula, M.K. *et al* (1987) Validity of clinic-based nutritional surveillance for prevalence estimation of undernutrition. *Bulletin of the World Health Organization* 65(4): 529–533.
17. Mahgoub, S.E.O., Nnyepi, M., and Bandeke, T. (2006) Factors affecting prevalence of malnutrition among children under three years of age in Botswana. *African Journal of Food, Agriculure, and Nutrition Development* 6: 3–15.
18. Nnyepi, M.S., Bond, J., Johnson, N. and Weatherspoon, L. (2004) Influence of complementary foods on the growth indicators of children in Gabane, Botswana. *African Journal of Agriculture, Food, Nutrition and Development* 4(1), http://www.ajol.info/index.php/ajfand/article/view/19149.
19. Shapiro, R.L. *et al* (2010) Antiretroviral regimens in pregnancy and breast-feeding in Botswana. *New England Journal of Medicine* 362: 2282–2294.
20. Ministry of Finance and Development Planning (MFDP) and Food and Nutrition Unit. (1996) Determinants of child nutritional status in Botswana: A national study. Gaborone, Botswana. Unpublished report.
21. CSO. (1996) *Botswana Demographic Health Survey III.* Gaborone, Botswana: Government Printers.
22. CSO. (2001) *Botswana Multiple Indicator Survey.* Gaborone, Botswana: Government Printers.
23. CSO. (2009) *Botswana Demographic Health Survey IV.* Gaborone, Botswana: Government Printers.
24. Nnyepi, M.S. (2007) Household factors are strong indicators of children's nutritional status in children with access to primary health care in the greater Gaborone area. *Scientific Research and Essays* 2(2): 055–061.
25. UNICEF Botswana. (2010) Baseline nutrition economic study in the context of the rising food prices. Unpublished report.
26. NACA. (2003) *Botswana 2003 Second-generation HIV/AIDS Surveillance: A Technical Report.* Gaborone, Botswana: National Aids Coordinating Agency.
27. NACA. (2000) *Botswana AIDS Impact Survey II: Popular Report.* Gaborone, Botswana: National Aids Coordinating Agency.
28. CSO. (1984) *Botswana Family Health Survey I.* Gaborone, Botswana: Government Printers.
29. CSO. (1988) *Botswana Family Health Survey II.* Gaborone, Botswana: Government Printers.
30. Caufield, L.E., De Onis, M., Blossner, M. and Black, R. (2004) Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria and measles. *American Journal of Clinical Nutrition* 80(1): 193–208.

31. WHO Multicenter Growth Reference Study Group. (2006) WHO child growth standards based on length/height, weight and age. *Acta Paediatrica* 95(supplement S450): 76–85.
32. De Onis, M., Garza, C., Onyango, A.W. and Borghi, E. (2007) Comparison of the WHO child growth standards and the CDC 2000 growth charts. *Journal of Nutrition* 137: 144–148.
33. Jerome, N.W. and Ricci, J.A. (1997) Food and nutrition surveillance: An international overview. *American Journal of Clinical Nutrition* 65(4): 1198s–1202s.
34. Mock, N. and Mason, J. (1999) Nutrition information systems for implementing child nutrition programs. *Asian Development Review* 17(1.2): 214–245.