7 *Seasonality of reproductive performance in rural Gambia*

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Introduction

There are a number of ways in which the reproductive performance of women can be assessed. These include measures of fertility, pregnancy outcome (one expression of which is birthweight), lactational performance, and child mortality. Ultimately, the survival to reproductive age of as many children as possible is the most direct measure of successful reproductive performance, the other variables, including pregnancy outcome and lactational performance, being proximate factors.

Although it is acknowledged that social factors can influence fertility, these will not be addressed in this chapter. Rather, the focus is on seasonal variation in a number of factors that can cause physiological stress in women and young children. Such factors are linked to seasonality in the natural human-created agricultural environment, and for analytical purposes, can be reduced to the following: 1. food availability and intake of dietary energy; 2. energy expenditure (and also how these two factors affect energy balance); and 3. infectious disease, as it influences pregnancy outcome and child survivorship. Although it might be argued that energy balance (that is, the difference between intake and expenditure) is of prime consideration with respect to energy nutritional stress, a good case has been put forward to suggest that energy intake, expenditure (insofar as this is an expression of heavy physical activity) and balance should be considered separately in at least one aspect of reproductive performance, fertility (Rosetta, 1990). The relative importance for reproductive performance of seasonal variation in these three factors will be considered for one rural agricultural system in the Gambia.

Types of seasonality

In populations living in tropical regions, infectious disease, and energy intake, expenditure and balance may vary seasonally, but may not all vary in the same way, or at the same time. There are societies in which individual seasonal stresses operate, for example in urban Mexico, where the major seasonal stress is infection (Sepulveda *et al.*, 1988), and there are societies in which multiple stresses operate. Urban Third-World communities are more likely to fall into the first category, while rural communities are more likely to fall into the second. Of societies where multiple stresses have been shown to operate, these may or may not be coincidental. In general, agricultural communities are more likely to experience multiple, coincidental seasonal stress than are other types of community. The populations of rural Gambia experience this type of seasonal stress.

The rural Gambian population

Seasonal effects on reproductive performance are considered using published data for one seasonal agricultural system in West Africa, as represented by three villages, Keneba, Kanton Kunda, and Manduar (Fig. 7.1). These villages are set in the West Kiang Administrative District, an area of savannah scrub and farm land, roughly 40 by 20 kilometres, bounded on three sides by brackish tidal rivers (Lewis, in press). The villages are linked to each other by dirt roads, and to urban centres by a laterite road.

People in these villages have been the subjects of extensive medical, demographic and nutritional research, which began with the work of Dr (later Sir) Ian McGregor in 1949, and which continues to the present day. The area and the particular villages were chosen because they were in what was then regarded as an isolated and backward part of the Gambia (Lewis, in press). The British Medical Research Council supported McGregor's work, and that of the Dunn Nutrition Unit (DNU), which in 1974 took over and developed the field research centre that McGregor had established in one of the villages, Keneba. By the mid-1980s, these villages could no longer be considered poor and backward relative to the rest of the Gambia. The availability of jobs and money from the DNU to the local communities served to reduce reliance on the subsistence economy, while a very high standard of primary health care, and numerous health and nutrition interventions provided by the DNU staff (Lewis, in press), were responsible for halving neonatal mortality rates, and reducing infant mortality rates between 1974 and 1982–3 from 149 to 25 per 1000 live births (Lamb *et al.*, 1984). These and other factors, such as seasonal migration for paid labour and dietary supplementation of pregnant women in the third trimester of pregnancy, may have served to reduce these communities' biological experience of seasonality. An illustration of this is given in Fig. 7.2, which shows a decline in overall seasonal weight change in women between 1978 and 1985.

The data used in this article come from a variety of published sources,

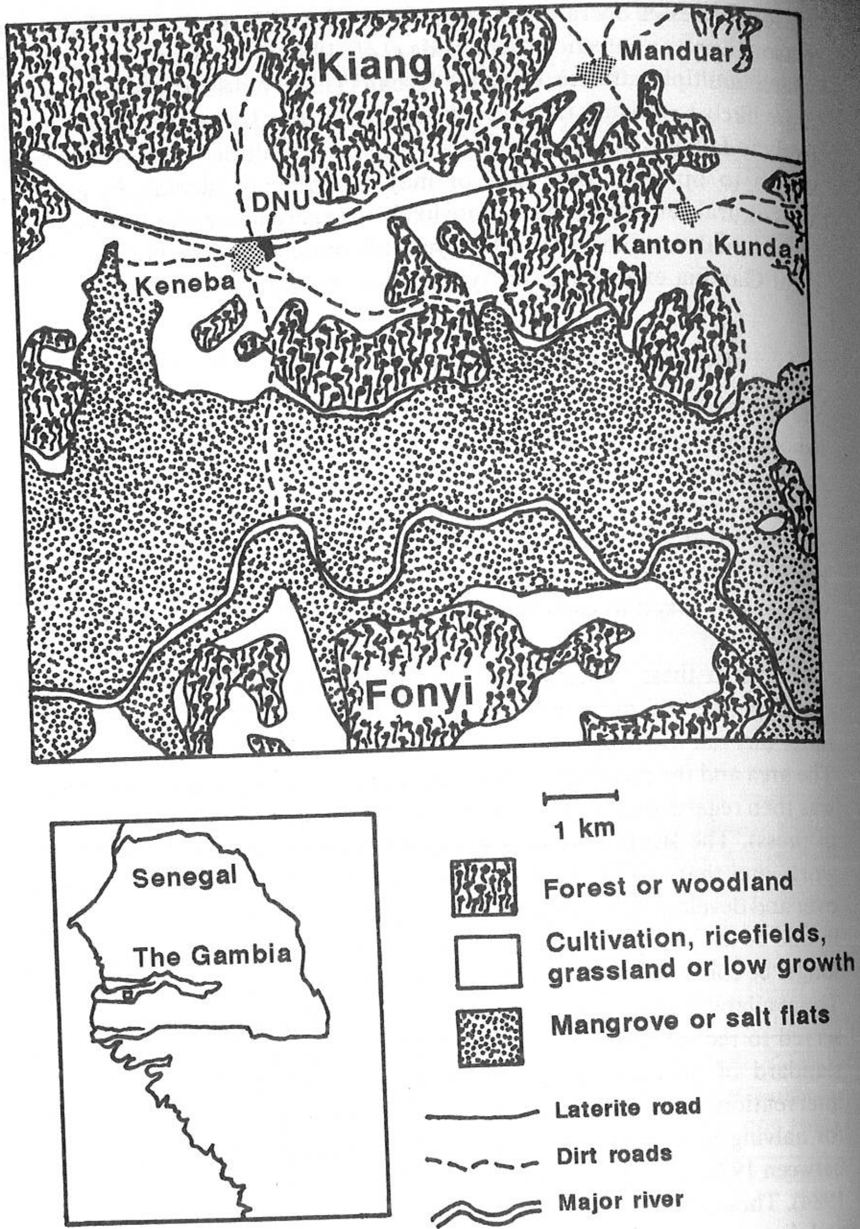

Fig. 7.1. Map of the Gambia, and the three villages studied.

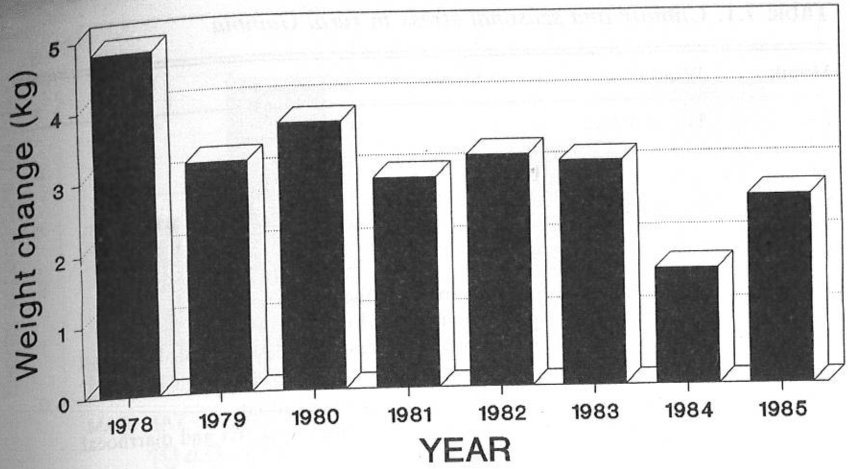

Fig. 7.2. Seasonal weight change in rural Gambian women, 1978–85. From Singh *et al.* (1989).

and were collected at different times between 1949 and 1985. Much of the published data report seasonal effects, which are statistically corrected for differences due to pregnancy and lactation (e.g. Lawrence & Whitehead, 1988; Lawrence *et al.*, 1989), and it is this type of data that is used here. Since the experience of seasonality has probably declined across time, the interpretations offered here are of necessity cautious ones.

Climatic seasonality and seasonal stress

Table 7.1 summarises the major climatic types across the year in the Gambia, and the immunological and physiological stresses associated with them. During the period December to May of each year, there is little stress, since work output is low, food is available from the previous year's harvest, and exposure to infectious disease is low. June to August sees the start and the peak of the rainy season, a time in which food shortages are experienced, and high physical work output is required to clear and plant the fields. The transmission of malaria and diarrhoeal diseases is high at this time. During the months September to November, the rains decline then cease. Transmission of infection remains high, work output, particularly in harvesting, is high, although food becomes increasingly available with the first harvest.

Fig. 7.3 shows the proportion of time spent ill by children in Keneba village in 1974–5, illustrating the seasonality in infectious disease to be found there. Diarrhoea, lower respiratory tract infection and malaria all

Table 7.1. *Climate and seasonal stress in rural Gambia*

Month	Weather	Stresses
Dec. Jan. Feb.	Dry and cool	
Mar. Apr. May	Increasingly hot	
Jun. Jul. Aug.	Start and peak of rains	Shortage of food High physical work output High transmission of malaria and diarrhoeal diseases
Sep. Oct. Nov.	Decline and cessation of rains	High physical work output High transmission of malaria and diarrhoeal diseases

After Rowland *et al.* (1981).

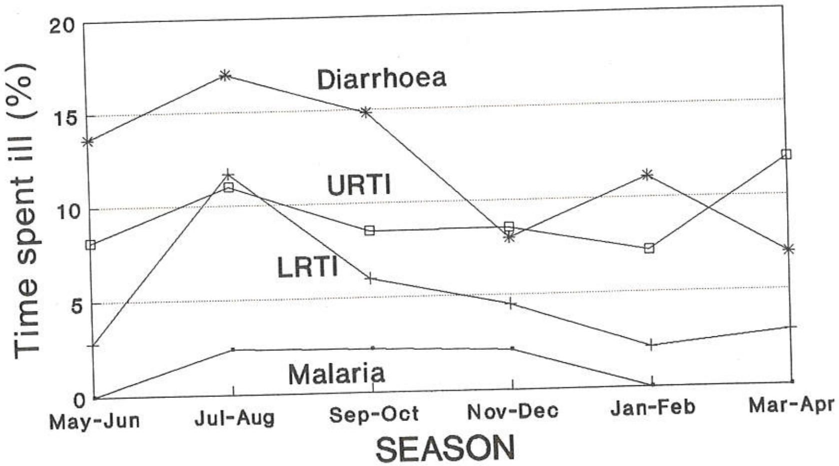

Fig. 7.3. Proportion of time spent ill by children in Keneba village, 1974–5. URTI = upper respiratory tract infections; LRTI = lower respiratory tract infections. From Rowland *et al.* (1981).

show marked seasonal prevalences, although children spend 13 times as long being ill with diarrhoea than with malaria (Rowland *et al.*, 1981).

A comparison of seasonality in energy expenditure in physical activity of women in 1949–50, and 1982–5 is given in Fig. 7.4. The data for 1949–50 come from a region of the Gambia different from that of 1982–5, so the comparison can only be suggestive. It would appear, however, that there has been a decline in seasonal variation in activity levels, mainly due to

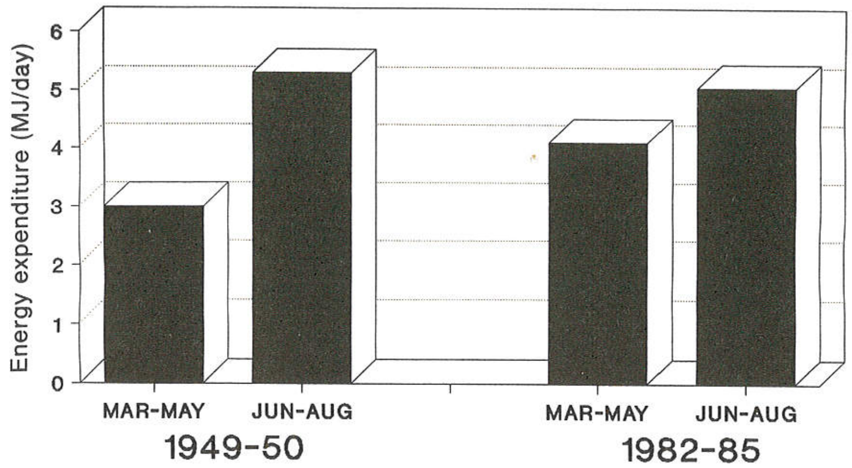

Fig. 7.4. Estimated energy expended in physical activity by rural Gambian women, 1949–50 and 1982–5. From Haswell (1953) and Lawrence & Whitehead (1988).

greater dry season energy expenditure in 1982–5 compared with 1949–50. There is little difference in wet season activity level between these two times of measurement. The difference in dry season energy expenditure at activity is in the order of 1 MJ per day, and can be attributed largely to increases in the time spent performing household maintenance activities, including food preparation, drawing and carrying water, washing clothes and dishes, and so on. In 1949–50, women would spend an average of 3.5 hours per day in such tasks (Haswell, 1953), while in 1982–5, the value reported was 4.8 hours per day (Lawrence & Whitehead, 1988). Time spent in agricultural activities showed little difference across time, for either time of year.

Other seasonal stresses coinciding in the wet season in the Gambia have been reported to be low food intake (Prentice *et al.*, 1981) and low levels of breastmilk production (Prentice *et al.*, 1983). The relative contribution of these factors to reproductive performance will be considered in the next section.

Reproductive performance

Billewicz & McGregor (1981) demonstrated clear seasonality of birthrates, the lowest number of births taking place at the beginning of the wet season (Fig. 7.5). Although lower frequency of coitus in the second half of the wet season is possible (although not reported) it cannot explain this pattern of birth rates. If coital frequency is reduced because of tiredness due to heavy physical work, and birth rate is a function of coital frequency, then lower

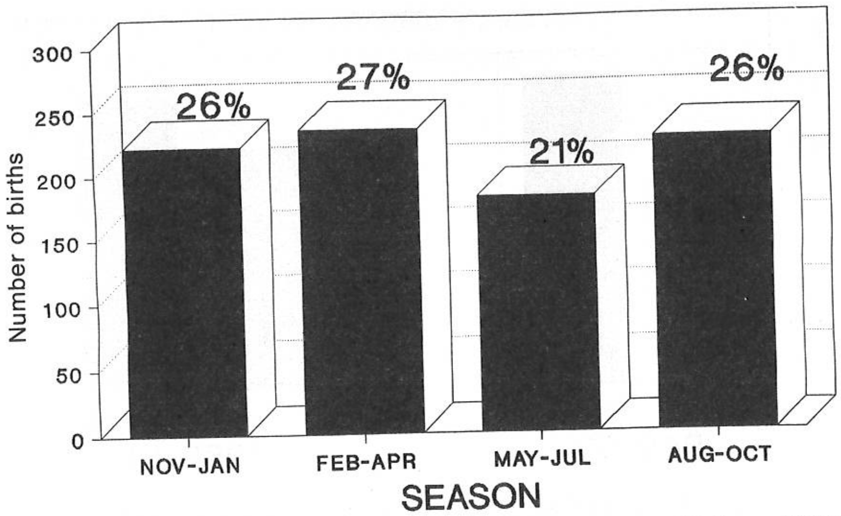

Fig. 7.5. Seasonality of births in Keneba. From Billewicz & McGregor (1981).

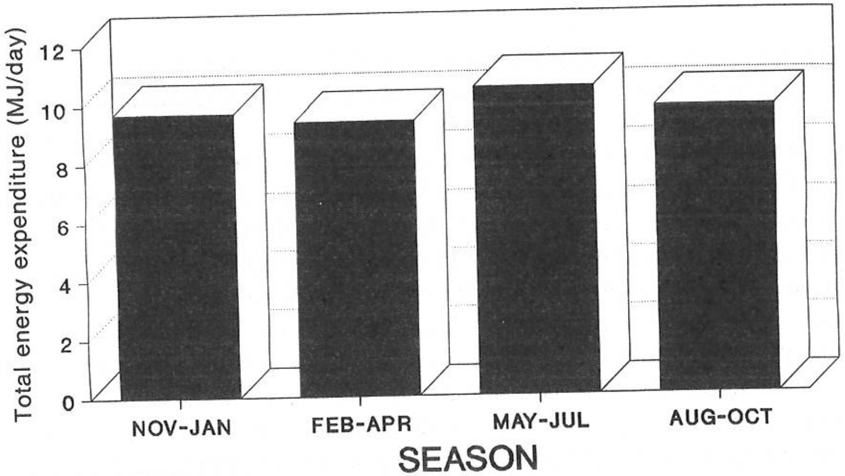

Fig. 7.6. Total daily energy expenditure of rural Gambian women by season, 1982–5. From Lawrence & Whitehead (1988).

birth rates would be expected between February and April as well as May to July, since the heaviest agricultural period comes in the early wet season, and not in the late wet season. It is more likely that the effect shown in Fig. 7.5 is due to the cumulative effects of heavy work load and negative energy balance across the wet season.

Total daily energy expenditure for pregnant and lactating women in the early wet season (May to July) is higher than at any other time of year, including the late wet season, August to October (Fig. 7.6). Energy balance

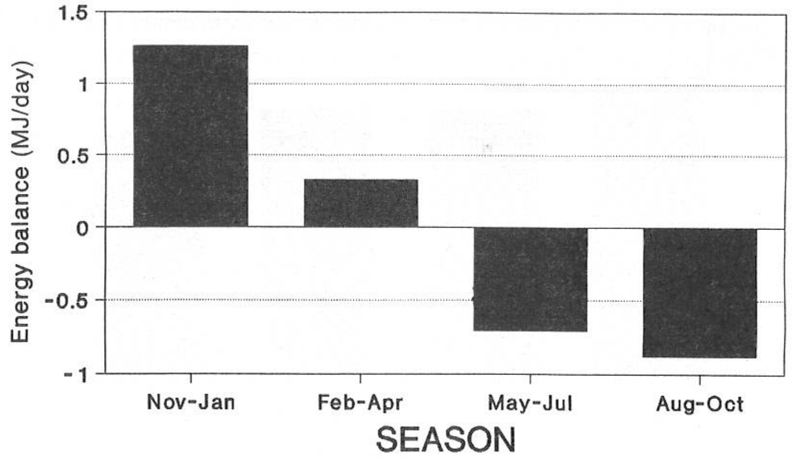

Fig. 7.7. Energy balance (estimated from body weight and skinfold thickness measures) of rural Gambian women by season. From Lawrence *et al.* (1989).

(estimated from changes in body weight and skinfold thicknesses) is positive in the dry season, negative in the wet (Fig. 7.7). The greatest positive energy balance comes in November to January (after the harvest) and the greatest negative energy balance comes between August and October, before the harvest, but not at the period of greatest energy expenditure. In this analysis, energy intake is estimated from energy balance and expenditure, and not from direct measurement of intake, since Singh *et al.* (1989) have shown that for Gambian women, accurate measures of average total energy expenditure exceed estimates of energy intake by over 50%. Using this estimate, energy intake is greatest between November and January, and lowest between August and October (Fig. 7.8). It would appear that the period of greatest negative energy balance is more closely related to low food intake than to seasonally higher energy expenditure.

When the output of breastmilk is examined, there is a steady decline with the duration of lactation, with some seasonal variation, 12-hour breastmilk output being lowest in the August to October period (Fig. 7.9). With respect to protection from ovulation by mechanisms associated with lactation, it is unlikely that these are particularly important during the wet season, if Prentice *et al.* (1986) are to be believed. They suggest that there is a strong drive towards milk synthesis in Gambian women, milk output being not limited by food intake, but controlled by the characteristics of the mother–infant pair. This view contradicts evidence from Bangladesh, where the amount of time spent suckling during the times of high work output and throughout the wet season is higher than during the dry season

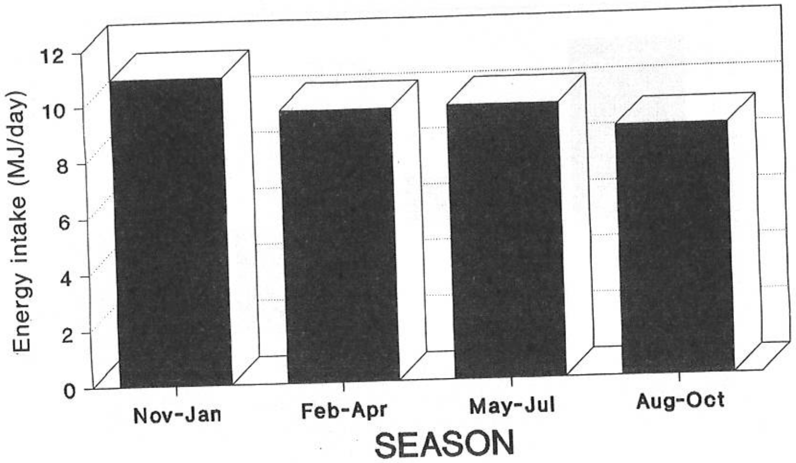

Fig. 7.8. Energy intake (estimated from energy expenditure and balance measures) of rural Gambian women by season.

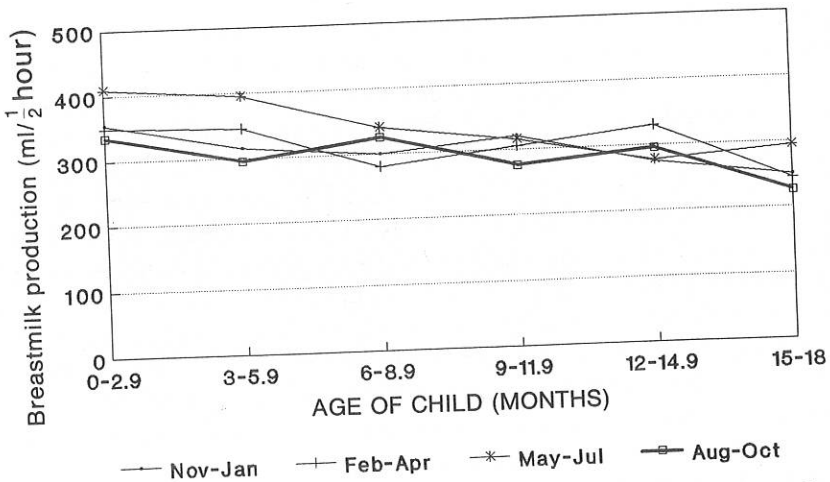

Fig. 7.9. Seasonality of breastmilk production in rural Gambian women. From Prentice *et al.* (1983).

when work output is low (Chowdhury *et al.*, 1981). Wet season–dry season differences in suckling behaviour need to be clarified before the influence of breastfeeding on wet season fertility can be determined with any confidence in the Gambia.

Women in Keneba show differences in energy balance, as estimated from measures of body composition, at all stages of pregnancy, between wet and dry seasons (Table 7.2). One result of this difference in energy balance is that birthweights are about 200–300 g lower in the wet season than in the dry (Prentice *et al.*, 1981).

Table 7.2. *Estimates of energy balance, from changes in body composition*

	Energy balance (MJ/day)	
Months of pregnancy	Dry season	Wet season
0–2.9	+1.16	−0.31
3–5.9	+0.61	−0.22
6–9	+0.84	+0.10

From Prentice *et al.* (1981).

One seasonal difference is that of higher mortality in early infancy, which may be related to low birthweight (less than 2.5 kg). Although the majority of low birthweight births may be attributable to the lower energy intakes experienced by women passing their third trimester of pregnancy during the wet season, infection by malaria is also important, particularly among primiparous women (Watkinson & Rushton, 1983). In Keneba, primips represent 18% of all births, but about 30% of them are affected by malarial infection *in utero*, as assessed by placental pigmentation. First-born infants with pigmented placentas due to malarial infection have mean birthweights of 2.58 kg, compared to 3.15 kg for unaffected babies. This must contribute significantly to neonatal mortality, although the extent of this has not been investigated.

Seasonality of child survivorship

Table 7.3 gives mortality rates by season and age for rural Gambian children. Those children born between August and October, and November and January have the highest mortality rates in the first three months of life. Although three-monthly mortality rates are highest for all birth cohorts when they are in the wet season (Billewicz & McGregor, 1981), the November to January birth cohort has the highest overall mortality rate in the first year of life, while the May to July birth cohort has the lowest mortality rate for the same period. The latter cohort also has the greatest proportion of children surviving to the age of five years. Children born in May to July enter the wet season with higher average birthweights than children born later on in the wet season. Breastfeeding is likely to shield them from excessive exposure to diarrhoeal diseases for most of the wet season, the introduction of weaning foods taking place when the worst of the wet season is over. Most of the infant mortality in rural Gambia is due to the interactive effects of undernutrition and infection; this synergism is greatest in the wet season, but still operates at a lower level in the dry season when the incidences of respiratory tract infection and diarrhoea are lower if not completely absent (Rowland *et al.*, 1981).

Table 7.3. *Young-child mortality in Keneba*

Season of birth	0–3 month mortality rate (per 1000 live births)	Chances of dying (%)	
		By 1 year	By 5 years
Nov.–Jan.	135	32	54
Feb.–Apr.	85	21	49
May–Jul.	88	15	40
Aug.–Oct.	123	25	55

From Billewicz & McGregor (1981).

Comparing the mortality of children by season of birth (Table 7.3) with seasonality of fertility (Fig. 7.5), it is apparent that the birth cohort with greatest young child survivorship, May to July, is the one with the lowest proportion of births, compared with other times of the year. It would appear, therefore, that women who conceive late in the wet season have an advantage in reproductive performance compared with women who conceive at other times of the year. There must be constraints on conception at this time, since it seems logical that all women would seek to maximise their reproductive performance in this way, given the opportunity, giving rise to higher birth rates than average at the beginning of the wet season, rather than the lower rates observed.

An obvious constraint is an energetic one, of low energy intakes and negative energy balance, possibly interacting with lactation; this could lead to an impairment in ovulation by the mechanism postulated by Rosetta (1990), through blockage of the hypothalamic pulsatile generator of gonadotrophin release hormone, thereby reducing conception rates. Another constraint might be reduced coital frequency during the wet season because of physical exhaustion. Yet another could be the effect that high birth rates at the beginning of the wet season might have on work schedules.

It has been shown that in the wet season, late pregnant and early lactating women go to the fields to work for fewer days than do women who are in early pregnancy or late lactation (Lawrence & Whitehead, 1988) (Table 7.4). When the percentage of all days spent in the fields is crudely translated into days per seven-day week, women in late pregnancy or early lactation spend 4.7 and 3.5 days in the fields during the early wet and late wet seasons respectively, compared with 5.7 and 5.4 days for women in early pregnancy or late lactation. In addition, on the days when women in late pregnancy or early lactation go to the fields, they expend less energy at work than their counterparts who are not at either stage of the reproductive cycle. If the energy costs of pregnancy are in large part borne by this type of reduction in physical activity, there may be limits to the amount of accommodation possible. In the early wet season, late pregnant or early lactating women form about 20% of the total work force. Cooperative organisation of work may allow these women, one fifth of the female work force, to spend one day per week less in the fields in the early wet season, if the other 80% of women work one day more per month. If a greater proportion of women were to give birth at the beginning of the wet season, it might not be possible to buffer them and their babies against energetic stress without a reduction in overall agricultural work output. It can be argued that a reduction in work output could lead to a decline in food production, which could affect the nutritional well-being of the entire community. Thus the reproductive advantage of the few would be bought at the cost of nutritional disadvantage to the entire community.

Table 7.4. *Proportion of all days spent in the fields by rural Gambian women, by season*

Season	Days spent in fields (%)	
	28 weeks pregnant – 4 weeks post-partum	Early pregnancy and later lactation
Dry	30	26
Early wet	67	81
Late wet	50	77
Harvest	31	42

From Lawrence & Whitehead (1988).

Conclusions

In this chapter the relationships that exist between birthrate, pregnancy outcome, lactational performance and child mortality are examined in a rural community in the Gambia, where seasonality of food intake, energy expenditure and infectious disease are experienced. Seasonal troughs in birthrate are more closely related to seasonally low intakes of dietary energy, and childhood mortality is lowest in children conceived at the time of year when fertility is lowest.

Acknowledgements

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