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Physical Activity Patterns and Anthropometric Changes in Senegalese Women Observed Over a Complete Seasonal Cycle

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ABSTRACT This study describes the habitual physical activity of a group of women in Northern Senegal who are involved in a hydroagricultural development program and assesses its consequences for their nutritional status. A group of 30 women was followed on three occasions during a complete agricultural cycle. At each visit, activities were observed and timed over periods of 3 and 2 consecutive days. Anthropometric dimensions were taken at each visit, with a follow-up 1 year later. The women were divided into three groups according to reproductive status: pregnant (P), lactating (L), and nonpregnant, nonlactating (NPNL). The P group showed a gain in weight and body mass index only starting with the second trimester of pregnancy. During the postpartum stage, indices of arm muscle mass were lower than those measured prior to pregnancy. The L and NPNL groups did not show any changes in anthropometric indices during the cycle. Activity intensity levels among the women did not change from one visit to another. The levels could be classified as moderate to heavy intensity according to the FAO/WHO/UNU criteria. Overall the NPNL group was more active than the P group, with the latter increasing rest time and light activity at the onset of pregnancy. The time spent on subsistence activities outside of the household varied from one visit to the next according to the demand for agricultural labor. Estimated energy expenditure of the women was compatible with their physiological state; however, increased participation of P and L women in agricultural work, especially work related to rice cultivation, could have a negative impact on their nutritional status.

Women play a major role in household maintenance in developing countries. Their roles are biological: reproduction and lactation, health maintenance of the family; economic: food production, income generation; and social and cultural: education, religion, social rules (McGuire and Popkin, 1989). The different roles may conflict, for example, biological and economic roles during gestation and lactation. In West African countries such as Senegal, women are pregnant or lactating during about 45% of their active reproductive years (McGuire and Popkin, 1989). In 112 of 202 societies described as traditional, 45% of the women remained active almost until the onset of labor, and about one half of 195 resumed their activities at the end of the second week postpartum (Jimenez and Newton, 1979). Yet, excessive physical activity can have a negative effect on the outcome of pregnancy, that is, low birth weight, failure to grow in utero, and higher risks of placental infarct (Naeye and Peters, 1982). Low birth weight, of course, in an important problem of public health in developing countries because it is a major determinant of infant neonatal mortality (Martorell and Gonzalez-Cossio, 1987). In West Africa, the condition of pregnant and

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breastfeeding mothers may be further aggravated during the rainy season because of greater labor demands in the fields, and this, together with relative shortage of food, may result in a negative energy balance (Singh et al., 1989).

Patterns of physical activity are also modified by external factors such as major agricultural projects in developing areas. This is the case in the Senegal river valley, where dams and other structures along the river could permit the irrigation of 250,000 ha with complete control of plain submersion (Afrique-Agriculture, 1990). In the area studied, modern irrigation started in June 1989, with the first rice harvest in December 1989. Such an irrigation system implies the mobilization of a large amount of cheap labor at certain periods and the redistribution of agricultural tasks throughout the year. This may trigger important changes in activity patterns and in the distribution of tasks at the household level. In this area of Senegal, women are not ordinarily involved in strenuous agricultural tasks, but they help watch the crops to avoid damage by predators and they also help to harvest sorghum. The implementation of a modern irrigation system, in addition to massive emigration of young people to the city, which created a gap in the labour force, favor a new division of labor in which women are more responsible for cereal cultivation and men for monetary revenues (Diemer and Van der Laan, 1987). During a recent time-budget survey in the same area, it was estimated that the daily level of energy expenditure of women corresponded to the "heavy" category of the 1985 FAO/WHO/UNU criteria (Benefice and Simondon, 1993). Such a workload can bring about a nutritional imbalance if energy food intake is not sufficient. This must be taken into account when evaluating improvement of household nutritional status (Leslie, 1991).

The purpose of this study is (1) to describe the pattern of physical activity of Senegalese women and its possible effect on their nutritional status; and (2) to examine the physical activities in relation to the women's reproductive status. This will permit the evaluation of the possibility of specific nutritional risk related to agricultural development.

METHODS

The study was conducted in three villages in the Podor district at the northernmost point of the Senegal bend. The climate is extremely arid, with rainfalls occurring during the annual rainy season from July to October. During the period of the study, total rainfall ranged between 97 and 200 mm. Physical, cultural, and agricultural practices in this region have been described previously (Benefice and Simondon, 1993). The people comprise two ethnic groups: the Fulani, who are seminomadic pastoralists, and the Tokolors, who are sedentary agriculturalists and fisherman. They share the same language, Haalpullar. This study was done only on sedentary Tokolor women. Since 1989, the villages had the advantage of the installation of a modern "irrigated perimeter," which allows the practice of rice cultivation with controlled flooding and some production of sideline crops, such as tomatoes and onions, in the interval between two harvests.

Based on a file of 260 women in a small market gardening project, which included almost of all the women in the villages, a preliminary survey of 60 women who met the following criteria was conducted: 17–40 years of age, married with children under 5 years, nonpregnant at the first visit, and in good health, according to a medical examination done during the preparation of the survey. The purpose, methods, and duration of the survey were explained to the women and their spouses. Participation was voluntary. The final sample included 30 women averaging 27 ± 6 years of age (range 17–41), who were nonpregnant at the beginning of the survey. The study involved clinical and anthropometric examination, and monitoring of activities at three different periods in 1992: April to May, the dry hot season with limited agricultural activities (vegetable gardening on the edge of the river and clearing lots); September, the second half of the rainy season, with rice cultivation activities in the "irrigated perimeter"; December, beginning of the cool dry season, which is the harvest period. One year later, in December 1993, a final clinical and anthropometric survey was done. All women were examined during these visits. The surveys were scheduled for times that did not coincide with religious holidays and family celebrations.

At each visit, the women were weighed while wearing light clothing and no jewels, and barefoot, using an electronic scale precise to 100 grams. Stature was measured with a Harpenden anthropometer. The triceps skinfold (TSF) was measured on the

TABLE 1. Categories of activities with their intensity score and metabolic cost

Score	Multiples of BMR (METS)[1]	Example of activities
1	1.0	Sleeping, lying in the bed
2	1.5	Light activity while sitting: eating, plaiting hair
3	2.3	Light activity while standing: bathing, preparing food, cooking
4	2.8	Walking, light activity in movement: dressing, cutting straw, weaving, dish washing, care of children
5	3.3	Light manual work: cleaning, sweeping, gathering wood, washing clothes, winnowing, sowing, carrying light load
6	4.8	Manual work at a moderate pace: fetching water, cutting wood, loading a cart, stirring a big pot of millet porridge, harvesting sorghum
7	5.6	Manual work at a sustained pace: grinding grain, pounding, hoeing, carrying heavy loads, harvesting peanuts, football
8	6.0	Physical activity of high intensity: digging earth, uprooting manioc, land clearing, walking steeply, dancing
9	7.0	Physical activity of very high intensity: wrestling, very fast dancing, running, jogging

[1]Compiled from published values of Brun et al. (1981), Bleiberg et al. (1980), Torún et al. (1982), and FAO/WHO/UNU (1985).
BMR = basal metabolic rate; METS = for multiples of BMR.

left arm using a Holtain caliper, and arm circumference (AC) was measured at the same level with a nonstretchable tape. The TSF and AC measurements were combined to estimate the total area of the upper arm muscle (UMA) and fat (UFA) areas based on the formulae of Gurney and Jelliffe (1973). Children under 5 years were also examined, but the results are not reported here. All of the anthropometric dimensions were taken by the same observer.

Physical activity was recorded in two ways: the intensity of different activities, and the nature and location of the specific tasks. Physical activity levels were monitored by direct observation every minute for a total of 12 hours per day divided in two periods of 6 hours with a 1 hour break: 7 a.m. to 1 p.m. and 2 p.m. to 8 p.m. These observations were carried out during three consecutive days at the first visit and two consecutive days during the other two visits. This resulted in an aggregate amount of 2,520 hours of direct minute-by-minute observations. Activities were rated according to the level of intensity based on a 9-point scale ranging from lying down to maximum effort following the procedures of Bouchard et al. (1983). Table 1 summarizes the categories of activity and gives several examples.

Data were gathered by women surveyors specifically trained for the task. They had to observe the subject for approximately 50 seconds and during the remaining time record the appropriate code for the dominant activity. The observers were regularly controlled by a supervisor, and when in doubt they called upon him to give the proper code for an activity. Before the survey, a training period was organized during which code conformity was tested, with different surveyors coding activities of the same subjects. Interobserver agreement of the same subject was in excess of 90%. During the first visit, different subjects were systematically assigned to the surveyors on each of the 3 days; no significant difference was observed in the coding of activities from one day to the next. In the course of the next visits, the same surveyor was assigned to the same individual. To avoid fatigue, a rest period was observed at the end of every week of the survey. To simplify the presentation of results, activities were grouped into four levels of intensity (lying down, rest or light activity while seated, light activity while standing and moving, moderate to heavy activity while moving). In order to have a simple index for intensity of activity, an indicator of activity equal to the mean of the different scores recorded each minute (mean score activity, MSA), was created.

The nature of activities and their location were recorded every 15 minutes, that is, "kitchen, sifting millet" or "goes to market to buy fish." Table 2 gives a list of the various tasks, which are divided into four location categories: production tasks outside of the household; household chores; social activities, rest, recreation, and attendance at the health center; and travel.

BMDP software (Dixon, 1985) was used for the statistical analysis. For the anthropometric variables, variance analysis for re-

TABLE 2. List of activities performed by women in the Senegal river valley

Group 1: Productive tasks outside
Agriculture
1 Planting, harvesting, clearing, watering.
2 Sowing, watching fields
3 Hoeing, watering
4 Caring for animals
5 Carrying loads, loading/unloading carts
6 Cutting wood for fences, digging
Handicraft, small trading
7 Preparing food for sale
8 Handicraft: weaving, sewing, plaiting
9 Selling (nonedible things)
Group 2: Tasks at home
Light to moderate activities
10 Washing and dressing
11 Caring for children
12 Washing, drying the linen
13 Dish washing
14 Preparing meals
15 Cooking
Tedious tasks
15 Gathering and cutting wood
16 Pounding millet or rice
17 Fetching water
18 Carrying water
19 Carrying loads
Group 3: Leisure, rest, social activities
20 Religious or social events outside
21 Talking, drinking tea, praying
22 Lying in bed
23 Vaccination, going to the health center for illness
Group 4: Travelling
24 Walking for domestic purpose
25 Walking to the market or for work outside

peated measurements and paired t-tests were performed along with covariance analysis. Nonparametrical testing was used to analyze the time spent on different activities because of the large intergroup variability. The Kruskal-Wallis one-way analysis of variance test was used to compare the time allocation in different activities at each visit. Friedman's two-way analysis of variance and the Wilcoxon signed-ranked test on pair samples were used to compare the levels of activity in the three groups of mothers during the three visits (Schwartz, 1977).

RESULTS

The sample was initially selected to have no pregnant women at the onset of the study so that by its completion, 6–7 months later, no woman would be in the last trimester of pregnancy. Thus, it was expected that the pregnancy status of some women would not interfere much with habitual physical activities. It was retrospectively possible to approximate the stage of pregnancy of the women at the time of the visit on the basis of questioning and clinical inspection, and on knowledge of the exact birth date of the infants, assuming a mean duration of pregnancy of 40 weeks. In this way, it appeared that 2 women were at the beginning of their pregnancy during the first visit (1–2 weeks); 12 became pregnant between the first and second visits, and finally 2 became pregnant between the second and third visits. The mean duration of pregnancy at the time of the visits was then estimated to be 0 (range 0–2) during the first visit; 14 weeks (range 1–26) during the second visit, and 24 weeks (range 5–36) during the third visit.

During the 9 months of the survey, only seven women had not been pregnant or breastfeeding. Thus, the women were divided into three groups: women who were pregnant (P) during the second and third visits (n = 16), women who were lactating (L) during all three visits (n = 7), and women who were neither pregnant nor lactating (NPNL) during all three visits (n = 7). Unfortunately, for practical reasons it was not possible to record the weight of the P women at the end of their pregnancy. During the last visit in December 1993, it was noted that the pregnancy outcome was successful for 15 women and one had a miscarriage.

From the data of a random study study of 110 households carried out in January 1990 in the same three villages, it was possible to have an indication of the mean number of live births for women <45 years: <20 years, parity was 0.7 (range 0–2); 20–24 years, parity was 1.3 (range 0–4); 25–35 year, parity was 3.6 (range 1–7); and 36–45 years, parity was 4.7 (1–9). It was also observed that 95% of the children between 15 and 18 months were breastfed. In the Northeast part of Senegal, the medium of the interval between births is 31 months (range 7–47) and the median duration of breastfeeding is 19.7 months (Ndiaye et al., 1994).

Anthropometry

Women of the NPNL group were the oldest (31.3 ± 6.5 years), followed by the L group (28.1 ± 5.9 years) and the P group (24.6 ± 4.8 years). The difference was significant ($F = 3.52$; $P < 0.04$). Anthropometric indices of the three groups at the beginning of the study are shown in Table 3. Stature was the same, but the other indices differed significantly. NPNL women were heavier, and had larger AC, TSF, UMA, and UFA than P

TABLE 3. Comparison of anthropometric indices between reproductive groups during the first visit (April 1992)

Parameter	Reproductive group	Mean	SD	F	Significance of t-test
Height (cm)	P (n = 16)	163.9	4.1	1.7	ns
	L (n = 7)	162.4	4.1		
	NPNL (n = 7)	164.8	4.1		
Weight (kg)	P	58.2	8.8	4.5**	NPNL > P**
	L	57.0	5.5		NPNL > L**
	NPNL	69.7	12.3		
BMI kg/m^2	P	21.6	5.0	5.0**	NPNL > P**
	L	21.6	1.9		NPNL > L**
	NPNL	25.6	4.1		
AC (cm)	P	26.5	2.8	5.0**	NPNL > P**
	L	25.9	2.2		NPNL > L**
	NPNL	30.3	3.7		
TSF (mm)	P	12.7	3.8	3.3*	NPNL > P*
	L	11.9	3.2		NPNL > L*
	NPNL	18.7	9.8		
UMA (cm^2)	P	40.7	6.8	3.3*	NPNL > P*
	L	39.2	5.3		NPNL > L*
	NPNL	47.8	8.1		
UFA (cm^2)	P	15.9	5.7	4.1**	NPNL > P**
	L	14.6	4.8		NPNL > L**
	NPNL	26.2	15.5		

P, pregnant; L, lactating; NPNL, nonpregnant, nonlactating; BMI, body mass index; AC, arm circumference; TSF, triceps skinfold; UMA, upper arm muscle area; UFA, upper arm fat area.
ns, not significant; *$P < 0.05$; **$P < 0.01$.

and L women. P and L women in the latter two groups did not differ in anthropometric indices. However, part of the observed differences may be explained by age; after adjusting for age by covariance analysis, only differences in AC and UFA remained significant ($P < 0.05$).

Anthropometric indices did not change over time for L and NPNL women during the first three visits but changed for P women. In this case, the December 1993 visit allowed a comparison before and after pregnancy (Fig. 1). Between the first and the second visits, which corresponded to a mean duration of 14 weeks of pregnancy, AC and UMA decreased significantly. Between the second and third visits, corresponding to a mean duration of 24 weeks of pregnancy, these indices and weight and the BMI increased, while those related to fat mass, triceps skinfold, and UFA decreased. After delivery in December 1993, the P women, who were then lactating, recovered their prepregnancy weight and BMI, but still had a lower AC and UMA.

Nature of activities

The nature of activities varied from one visit to another. Table 4 shows the time spent (min/day) in seven categories of activity. Agricultural tasks had the highest seasonal variation; they consumed more time during rice harvest in December and the least time in April. Variation among women was important, especially for productive tasks: 13 women had no agricultural activities and 21 had no craft activities. On the other hand, rest times were shorter in September. Ten women did not take any rest during the day. There was a trend toward decreasing time spent on moderate domestic chores and time spent travelling during December.

At each visit, the time spent in activity categories by women of different reproductive status was compared. P and L women spent the same amount of time in agricultural tasks and strenuous domestic chores. The only significant difference was observed for rest time, which was significantly increased among P women in December (Kruskal-Wallis test, $P < 0.02$).

Levels of physical activities

Results of comparisons of activity levels among the different reproductive status groups by visit are presented in Table 5. The P group spent more time lying down for rest than the other groups in September and December. The L and NPNL groups spent more time doing light to moderate activities than the P group in September. There was a nonsignificant trend for P and L women to in-

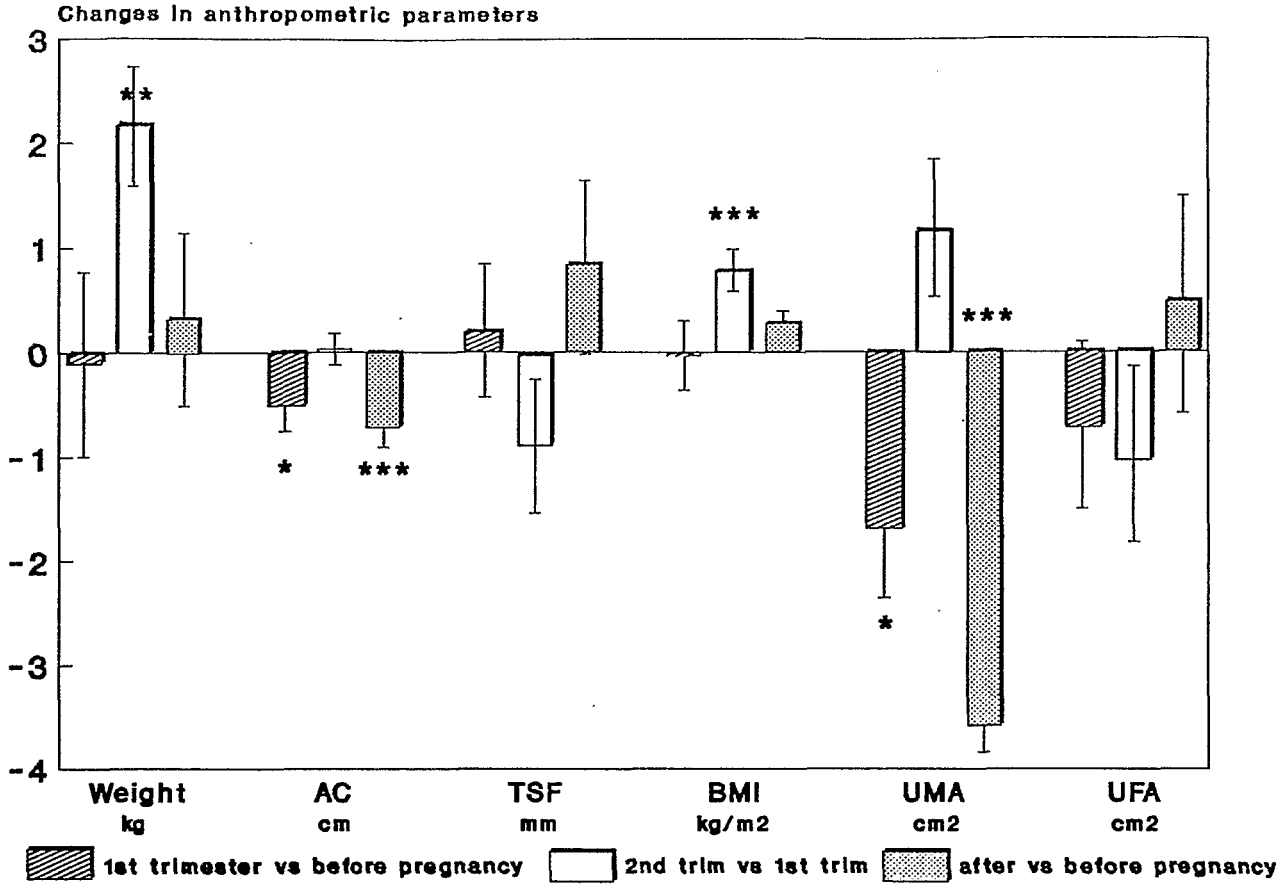

Fig. 1. Changes in absolute dimension of anthropometric indices of Senegalese pregnant women (mean ± 1 standard error). ns: not significant; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. See text for abbreviations.

crease moderate to heavy activities in September. Variation in the time spent in activities of different intensity from one visit to the next was not significant for L and NPNL women, but there was significant variation among P women (Fig. 2). During the second visit, P women significantly increased time at rest and reduced time in light activity. This trend was reversed between the second and third visits. P women reduced time at rest time slightly, increased time spent in light activities, and reduced time at moderate to heavy activities.

The mean score of activity (MSA) did not show any significant variation between visit (3.02 ± 0.29). However, after adjustment for visit by covariance analysis, the MSA of NPNL women (3.1 ± 0.27) was significantly higher ($P < 0.02$) than that of P women (2.9 ± 0.27). The MSA of L women was identical to that of NPNL women.

DISCUSSION

It was hypothesized that the nutritional status of a group of women in the Senegal river valley would be jeopardized because of their involvement in rice cultivation, which could lead to higher energy expenditure and energy deficit during the peak of field work. Among nonpregnant women, there were no changes in anthropometric indices during the harvest period, and the level of physical activity remained relatively stable over a complete agricultural cycle. However, pregnant women showed a variation in anthropometric indices and their pattern of physical activity, and have been exposed to a nutritional risk related to agricultural development. Two reasons may explain these observations: Only healthy women were selected for study, and there was low involvement in agricultural activities because the "irrigated

TABLE 4. Time allocation (min/day) for different activities at three periods of the year

	April	September	December	p[1]
Farming	0.0[2]	11.2	18.7	**
	0.0[3]	0.0	0.0	
	5.0[4]	105.0	105.0	
Handicrafts	0.0	0.0	0.0	
	0.0	0.0	0.0	
	11.2	15.0	20.6	
Moderate housework	352.5	292.5	337.5	*
	297.5	253.1	268.1	
	391.2	345.0	382.5	
Heavy Housework	95.0	71.2	93.7	
	53.7	52.5	58.1	
	133.7	127.5	128.3	
Rest	42.5	52.5	15.0	**
	15.0	20.6	0.0	
	56.2	71.2	39.3	
Leisure, health & social time	155.0	150.0	150.0	
	133.7	112.5	103.1	
	236.2	205.5	189.3	
Walking	35.0	45.0	48.7	
	23.7	20.6	30.0	
	50.0	69.3	60.0	

Kruskal-Wallis test (one-way analysis of variance). Differences between seasons are significant at $*P < 0.05$; $**P < 0.01$.
[2]Median.
[3]25th percentile.
[4]75th percentile.

perimeter" was not in full production at the time of the study.

The women were selected for satisfactory health and nutritional status at the start of the study, and their body mass index (BMI) did not change during the period of agricultural activities. On comparing anthropometric indices observed during the first visit with those of a representative sample of women in the same villages (Simondon et al., 1993), the present sample was of the same stature (163.8 ± 4.2 cm vs. 163.8 ± 5.2 cm for the entire village), but heavier (61.1 ± 10.1 kg vs. 57.8 ± 10.4 kg), and had a higher BMI (22.6 ± 3.2 kg/m^2 vs. 21.5 ± 3.3 kg/m^2). In fact, the habitual nutritional status of these villages was generally satisfactory compared with other regions in Senegal (Simondon et al., 1993). This is confirmed by a recent food consumption survey, which reported a daily per capita intake of 2,438 Kcal (or 111% of the WHO/FAO recommended allowances) and of 65 g of protein, although there were deficiencies in calcium, riboflavin, folate, and zinc (Benefice and Simondon, 1993). Nevertheless, differences

TABLE 5. Time allocation (min/day) in physical activity levels during three periods of the year

Group of women	P	L	NPNL	Friedman's two-way analysis of variance: Effects
Lying				
April	53.1[1] (34.3–74.9)[2]	29.0 (12.6–55.8)	54.3 (16.1–86.1)	Group: $P < 0.001$ Season: $P < 0.05$
September	64.5 (50.5–118.3)	17.0 (0.9–58.9)	63.5 (19.1–78.4)	
December	49.7 (33.9–69.4)	13.5 (5.0–26.7)	15.0 (6.2–42.6)	
Sitting				
April	228.8 (196.7–281.1)	257.0 (236.8–325.4)	175.3 (152.5–229.7)	Group: n.s. Season: n.s.
September	269.5 (226.5–312.5)	260.5 (205.2–305.6)	245.5 (210.2–278.2)	
December	262.2 (215.0–282.4)	250.0 (194.8–336.0)	222.0 (169.9–262.5)	
Light to moderate				
April	398.9 (360.4–434.1)	377.6 (330.5–423.1)	444.6 (376.4–485.2)	Group: $P < 0.05$ Season: $P < 0.006$
September	338.0 (271.6–346.5)	371.5 (332.2–415.6)	380.5 (336.9–443.9)	
December	373.7 (360.1–431.0)	410.5 (337.2–474.8)	435.0 (346.6–511.6)	
Moderate to heavy				
April	23.1 (19.2–38.4)	25.3 (8.0–46.7)	42.3 (24.7–68.8)	Group: n.s. Season: n.s.
September	23.7 (20.1–93.5)	66.5 (41.0–79.4)	29.5 (5.3–67.7)	
December	20.7 (14.2–33.6)	32.5 (16.8–48.5)	33.5 (6.2–94.2)	

[1]Median.
[2]95% confidence interval.

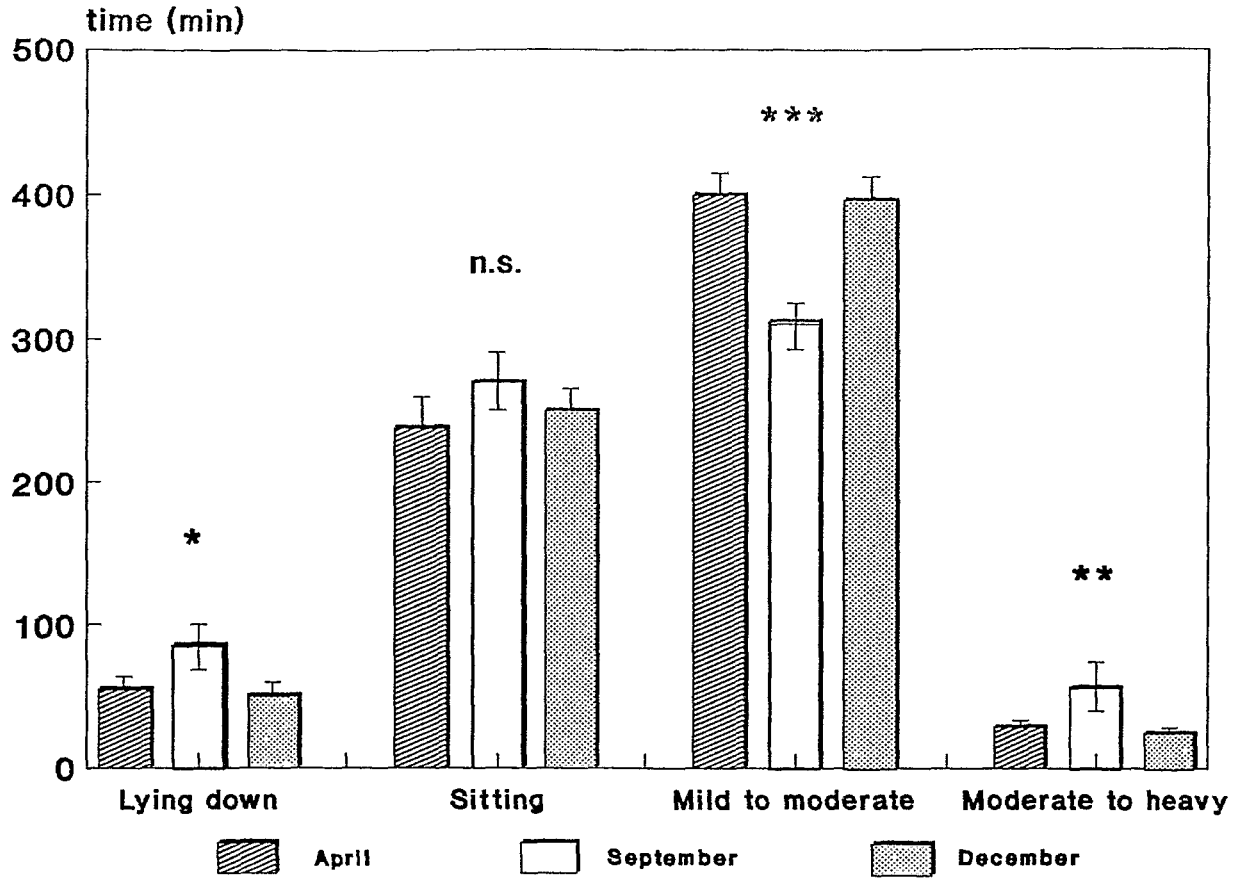

Fig. 2. Seasonal differences in time spent in four categories of activities by pregnant Senegalese women (mean ± 1 standard error). ns, not significant; $*P < 0.05$; $**P < 0.01$; $***P < 0.001$.

were observed between women according to reproductive status. The mean weight of P women decreased slightly in September, which was also the peak of agricultural activity, and then increased in December. In December 1992, the mean estimated pregnancy duration was 24 weeks. Normally, it is the period when the rate of maternal weight gain is maximum, about 0.45 kg per week (Hytten, 1991). By this time, the mothers under study would have gained 4–6 kg instead of the 2 kg recorded. These results may be a cause of concern because weight gain during the 24 first weeks of pregnancy is an important determinant of pregnancy outcome in young mothers and may be an important public health problem in developing countries (Hediger et al., 1989). Changes in UMA and UFA may reflect the participation of the P women in agricultural activities, since they require considerable use of their arms. It appears from Table 5 that P and also L women tended to increase, although not significantly, their moderate to heavy activities during the peak of agricultural work in September.

After delivery, while nursing, the women recovered their prepregnancy anthropometric values, except for UMA. This can be explained by an increase in energy and nutrient needs during breastfeeding. In the Philippines, considerable weight loss was observed during the first months of lactation, but these were not accompanied by noticeable modifications in fat mass (Adair, 1992), which suggests, as is the case in the present study, a decrease of fat-free mass.

The L group did not show significant changes in anthropometric indices during the three visits, and the change in their reproductive status 1 year later (they were either pregnant or had just stopped breastfeeding) makes the results difficult to interpret. Indices of the NPNL group indicated that they were in the best nutritional condition. They were older than the other women and had a higher parity. Obviously, they were not suffering from the so-called mater-

nal depletion syndrome due to cumulative effects of nutritional stress from successive pregnancies and lactation periods aggravated by excessive physical activity (Jelliffe, 1966). This syndrome, which is often questioned has been recently described in nomadic Turkana women (Little et al., 1992) and also in Melanesia, where it has been shown that, even in remote areas, socioeconomic factors were significant determinants of variation in body composition in relation to fertility (Tracer, 1991). However, the existence of a maternal depletion syndrome in the area cannot be completely disregarded; pregnant women did not fully restore their AC and UMA several months after delivery. The small sample size is also a potentially confounding factor.

There were seasonal differences in the demand for agricultural work, but this pronounced seasonality was not accompanied by variation in the mean score activity (MSA), even for P women. In the latter group, however, the level of intensity of activities was variable from one visit to the next. P women rested more and decreased the amount of light activities during the first trimester; this behavior was reversed during the second trimester. It has been shown that variation in time spent on light activities sustainable through the day can generate differences in total energy expenditure of up to 20% (Dauncey, 1989). The modulation of time spent in light activities may provide a means for P women to reduce energy expenditure.

Estimation of total energy expenditure (TEE) in field conditions is a difficult task, with numerous sources of error (Ulijaszek, 1992). Without caloric measurements of the energy cost of tasks, the TEE values are only considered to be an approximation. TEE was obtained by multiplying time spent in the nine levels of activities with multiples of basal metabolic rate (MET) taken from energy expenditure values published in the literature (FAO/WHO/UNU, 1985; Bleiberg et al., 1980; Brun et al., 1981; Torun et al., 1982). The multiples are indicated in Table 1. It was also assumed that the women slept 8 hours and spent 4 hours doing light activities in the evening (1.2–1.4 METS). Thus, the estimated TEE is 1.68 ± 0.10 METS for the P group, 1.71 ± 0.09 METS for the L group, and 1.74 ± 0.09 METS for the NPNL group. The estimated TEE of NPNL women was significantly higher than that of P women ($P < 0.02$). These figures correspond to a moderate to heavy level of activity (FAO/WHO/UNU, 1985). They are lower than previous estimates of 1.79–2.0 METS for nonpregnant women (Benefice and Simondon, 1993).

The difference can be partly explained by the more precise recording method used in this study. However, the results are consistent with others indicating a high level of activity throughout the year among African women (Bleiberg et al., 1980). In Nepal, Panter-Brick (1992) noted moderate to heavy (1.77 METS) to very heavy (2.0 METS) levels of activity according to season of the year, which were aggravated by the necessity to climb to the plots during peak work times and then to descend; thus pregnant women could not reduce their energy expenditure. In northern Senegal, travelling occurs on flat surfaces and load carrying is facilitated by traction animals. Furthermore, pregnant women, even though they were involved in collective agricultural activities in the morning, used the afternoon to rest. It appears that the stage of gestation was a more important factor in modulating activity levels than external demand; pregnant women resumed the same activities as the other groups from the onset of the second trimester of pregnancy. On the other hand, the lactation period, during which energy demand is high for the mother, was not characterized by a significant reduction of activity levels compared with NPNL women.

It was anticipated that the agricultural development process in the valley, involving greater participation of women in field activities, could have a negative effect on energy balance. Actually, it appears that the daily duration of agricultural tasks, exclusive of travelling and wood cutting tasks, in this region of Senegal, was only moderate, averaging 68.2 min/day during the peak harvest time. Durations of the same order or lower are apparent in the literature: 66 min/day in India and 48 min/day in Ethiopia (Ferro-Luzzi et al., 1992). In Africa, time spent in agricultural activities ranges from 66 min/day in Senegal to 282 min/day in Nigeria, and 162–240 min/day in the Congo, and 162–192 min/day in the Gambia (McGuirre and Popkin, 1989). A study dealing with a traditional ethnic group, the Otammari of northwestern Benin, reveals that women spent an average of 31 min/day in the fields during the intermediate season and 116 min/day

during the preharvest season (Van Liere, 1993). The time spent on agricultural activities in Nepal ranges from 81 min/day in January to 305.9 min/day in July to December, and appears to be exceptionally long (Panter-Brick, 1993). The analysis of activity levels during the day shows that activities corresponding to a high energy expenditure lasted only a short time and were not very frequent (12 minutes, on average, were spent on tasks exceeding 5.5 METS). Most of the time was spent in light tasks.

In conclusion, physical activity levels of the nonpregnant Tokolor women were apparently compatible with their physiological capacity. The nutritional demands of repeated pregnancies and lactation may be aggravated by increased involvement in agricultural production. However, physiological consequences of physical activity are not the only consequences of physical activity are not the only considerations in African women; social and cultural issues are also important to the maintenance of the health of the family and order in the household.

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