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OPERATION EVEREST II: EFFECTS OF A SIMULATED ASCENT TO 29,000 FEET ON NUTRITION AND BODY COMPOSITION

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Progressive body weight loss occurs during high mountain expeditions, but whether it is due to hypoxia, inadequate diet, malabsorption, or to the multiple stresses of the harsh environment is unknown. To determine whether hypoxia alone causes such body weight loss, six men were studied during progressive decompression to 240 torr for 40 days in a hypobaric chamber where hypoxia was the major variable. The subjects were provided a platable *ad libitum* diet that was modified for individual preferences. Complete food consumption data were available for only 38 of the 40 days. Mean caloric intake for 38 days at altitude was 2639±848 kcal/day (Mean±SD). Caloric intake decreased 42.3% from 3136 kcal during the first 7 days of exposure to altitude to 1789 kcal during the last 3 days at 282-240 Torr. During the same time periods the carbohydrate (CHO) intake decreased from 62.1% to 53.2% ($p < 0.001$). All subjects lost body weight with a mean loss of 7.44±2.24 kg (8.90% of the initial body weight) Loss of body weight was greater than could be accounted for by comparing calculated energy expenditures to actual caloric intake. Fluid balance data showed no evidence of hypohydratin

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HUMAN RESEARCH and DISCLAIMER STATEMENTS

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation.

OPERATION EVEREST II:

EFFECTS OF A SIMULATED ASCENT TO 29,000 FEET

ON NUTRITION AND BODY COMPOSITION

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ABSTRACT

Progressive body weight loss occurs during high mountain expeditions, but whether it is due to hypoxia, inadequate diet, malabsorption, or to the multiple stresses of the harsh environment is unknown. To determine whether hypoxia alone causes such body weight loss, six men were studied during progressive decompression to 240 torr for 40 days in a hypobaric chamber where hypoxia was the major variable. The subjects were provided a palatable ad libitum diet that was modified for individual preferences. Complete food consumption data were available for only 38 of the 40 days. Mean caloric intake for 38 days at altitude was 2639$\pm$848 kcal/day (Mean$\pm$SD). Caloric intake decreased 42.3% from 3136 kcal during the first 7 days of exposure to altitude to 1789 kcal during the last 3 days at 282-240 Torr. During the same time periods the carbohydrate (CHO) intake decreased from 62.1% to 53.2% ($p < 0.001$). All subjects lost body weight with a mean loss of 7.44$\pm$2.24 kg (8.90% of the initial body weight). Loss of body weight was greater than could be accounted for by comparing calculated energy expenditures to actual caloric intake. Fluid balance data showed no evidence of hypohydration. Pre- to post-exposure hydrostatic weighing indicated that 4 subjects lost 2.7% body fat whereas two subjects gained 0.65%. Computed Tomography scans indicated that most of the body weight loss was from muscle mass. The data indicate that prolonged exposure to increasing hypoxia does not increase CHO preference and that body weight could not be maintained despite provision of a highly palatable ad libitum diet.

INTRODUCTION

CALORIC INTAKE AND BODY WEIGHT

Loss of body weight is common during exposure to high altitude (1-13). Acute mountain sickness (AMS) frequently occurs after rapid ascent to moderate altitude and may cause body weight loss due to anorexia, nausea, vomiting, and dehydration, or it may cause weight gain due to fluid retention. Headache, weakness, and disordered sleep are other symptoms of AMS which interfere with normal activity. Altitude sickness is dependent on elevation, rate of ascent, and acclimation but usually decreases after the first three days (14-22). However appetite suppression and decreased caloric intake can persist for as long as several weeks (1,5,8,9,11). As exposure continues for weeks, normal values for food and water intake have been approached (1,9,18,23). Acclimatization can lessen the severity of AMS at altitude to lead to a lessening of anorexia (1,4,15,20-22) and of weight loss. However, even after the symptoms of AMS have lessened, body weight can remain reduced. Appetite suppression may decrease caloric and protein intake by as much as 30% and 40% respectively (1,5,8,9,11,24) and thus may explain the body weight loss which persists after AMS symptoms have subsided.

Studies of sustained body weight loss are numerous and contradictory and have attributed this loss to reduced dietary intake resulting from anorexia (1,5-13); loss of stored body fat (5,7,11,25,26); loss of body fluid (1-5,11,25,27-30); malabsorption of ingested fat and/or carbohydrate especially at altitudes in excess of 4300 m (4,31,32); and an elevated rate of energy expenditure under basal, resting, and mild to moderate exercise conditions (4,17,18,20,33-39). Body weight loss ranging from 3-5.4% (5,11,40,41) with rates of 145-330 g/day have been reported (11,23,42).

On an actual climb, it is difficult to determine whether body weight loss is due to increased energy expended in hard physical work, the cold environment, the limited availability or palatability of food, dehydration, malabsorption, or combinations of these stresses. Furthermore, lack of time, space, equipment, and interest make precise intake/output measurements very difficult. As a result, expeditions usually only estimate food intake (23,40).

CARBOHYDRATE PREFERENCE

There are a paucity of reports and a conflict of views regarding food preference at altitude (9,13,23,24,29,37,40). Anecdotal evidence from climbers suggests that they prefer sweets at altitude (9,13,23,24,29,40). However, researchers have suggested that the preference for carbohydrate was really due to a greater availability and ease of preparation (23,24). Few studies have determined dietary preferences for carbohydrate at high altitudes when subjects are given (9,37) palatable foods _ad libitum_.

FOOD RATING

Researchers have not studied food ratings to determine whether the problem is that food does not taste good or whether AMS causes the subject to reduce his food intake no matter how good the food tastes.

BODY COMPOSITION

Although loss in body weight at altitude is common, the composition of the weight loss is unclear. Some investigations show a reduction in body fat (5,11,17,23,25,43,44) while others show a loss in lean body weight (1,45).

The purpose of the present study was to determine if dietary preferences changed and if body weight could be maintained by offering palatable foods _ad libitum_ during a simulated ascent of Mount Everest (240 torr).

METHODS

Nine subjects in excellent physical condition were selected to participate in this study. One subject was excluded at the beginning of the study because of an upper respiratory infection and 2 subjects (#7 & #5) were withdrawn at 18,000 and 25,000 feet, respectively. All of the subjects are described by Houston (46). The subjects were confined in a hypobaric chamber for 40 days during progressive decompression to 240 Torr to simulate previously successful ascents of Mount Everest. Complete dietary data were available on only 6 subjects for 38 days due to incomplete data on the first and last days of confinement.

The subjects were allowed access to any quantity and variety of palatable food. The menus and food preparation were under the supervision of a registered dietitian. The subjects selected three meals per day from menus consisting of approximately 3000 kcal/day (60% CHO, 15% PRO, 25% FAT). The menus included a full breakfast selection, soup and/or sandwich lunches, commercially prepared dinners, simple home-cooked dinners, and food accompaniments to balance meals (Appendix 1). Foods were weighed before being served to the subjects. The returned foods were measured and subtracted from the amount served to accurately measure food intake. Any discrepancies between the menu and food items on the tray were resolved.

A variety of foods were available in the chamber for between meal snacking. Assorted fluids were available ad libitum and subjects were encouraged to drink to prevent dehydration. The subjects recorded any foods and fluids that were ingested between the three meals. The food and fluid intakes were analyzed using the University of Massachusetts Nutrient Data Bank program.

Food ratings were obtained as the subjects consumed the food. They were asked to rate each food item on a hedonic rating scale from 0 to 9 with 9 being "Like Extremely", 1 was "Dislike Extremely", and 0 was "Didn't Try".

The subjects were weighed daily on a physician's scale calibrated to the nearest 1/4 pound. Body heights (cm) were taken at the beginning of the study.

Energy expenditure could not be measured exactly; therefore, the Harris Benedict formula (47) was used to estimate basal energy expenditure (BEE). Because the subjects were confined in a small space, only 20% of BEE was added for daily living activities. The subjects kept a daily log of their voluntary exercises on the treadmill, stationary ladder ergometer, and cycle ergometer. The subjects were encouraged to exercise to a level comparable to that of an actual mountain climbing expedition. The calories expended from these exercises were added to the BEE + 20%BEE value. Since so many of the tests required exercise, they also were included in the log book of exercise activity. Some of the tests that included extensive exercise regimens were: VO_2max (MAX), Inert Gas (GAS), Muscle Biopsy (MUSCLE), and Swan-Ganz Catheterizations (SG). The energy expenditure calculations were not adjusted for possible changes in rate of energy expenditure due to altitude.

Body composition information was collected at sea level pre- and post-altitude exposure. Body weight, whole body density (hydrostatic weighing), residual lung volume, and anthropometric measurements were obtained preprandial 3 to 6 days prior to and within 20 hours after the chamber confinement. During the hydrostatic weighings, a minimum of six practice trials were performed before three actual readings were recorded to assure a true baseline. Residual volumes were obtained while the subjects were underwater during the each of the last three readings. Body density was converted to percent body fat (%BF) using the Siri formula (48).

Anthropometric measurements were obtained before noon on each of the measurement days by the same investigator throughout the entire study. Exercise was not permitted 1 hour prior to the anthropometric measurements. This assessment consisted of seven skinfold and 10 soft tissue circumference measurements obtained while subjects were standing. Two non-consecutive measurements were obtained at each site. A third measurement was taken if the difference between the first two was greater than 1%. The mean of the two or three measurements was used in the statistical analysis. Skinfolds were obtained at seven sites on the right side of the body (triceps, scapula, chest, midaxillary, suprailiac, abdomen, and thigh) using a Harpenden skinfold caliper with a caliper pressure of 10 g/mm^2. Circumferences of the neck, shoulders, chest, hips, thigh, calf, upper arm, forearm, and two abdominal sites were measured using a Gulick spring-loaded tape. The measurement sites were located using standard landmarks.

To quantitatively assess the pattern of fat and muscle distribution (49), computed tomographic (CT) scans were taken of the upper arms and thighs at sea level, pre- and post-altitude exposure. Five 1 cm thick slices were scanned in each limb. In the thigh the center slice was positioned on a mark at mid-point between the tibial tubercle and the anterior superior iliac crest; i.e. mid thigh. In the arm the center slice was positioned on a mark 60% of the distance down from the acromium to the medial condyle of the ulnar. This sampled the thickest part of the upper arm. The area of the bone, muscle, and fat on each slice was measured with a planimeter interfaced to an IBM personal computer. To allow for possible changes in the CT scanner magnification between the pre and post hypoxia images the fat and muscle content of each slice was expressed as a ratio of fat/bone and muscle/bone. It was assumed that there would be no significant change in the diameter of the ulna or femur in the 42 days between measurements. The data from the 10 slices in both limbs were pooled in each individual. The data presented represent the means of these pooled slices in all individuals.

STATISTICS

Descriptive statistics were run on the 6 subjects that completed the 38 days of the study. Mean $\pm$ SD were calculated for each descriptive measurement. Data for the 2 subjects (#5 & #7) that were withdrawn from the study were included in the charts but were not included in the calculations of the means. Analysis of variance was used to test for significant differences between time periods. The Student Newman Keuls post hoc tests were used to determine where the significant differences occurred.

RESULTS

CALORIC INTAKE AND BODY WEIGHT

The physical characteristics of the subjects on day 2 of the study are described in Table 1. The 38 days for which complete dietary data were available were divided into 7-day periods except for the last period which only included 3 days (Table 2). Grouping the data into 6 periods made it easier to interpret overall trends.

Caloric intake decreased over the 38 days at altitude. Caloric intake during period 1 averaged 3136±557 kcal (Mean±SD) and gradually decreased to 1789±682 kcal during period 6 (Table 3). Mean caloric intake averaged 2639±848 kcal/day. The percent decrease in energy intake between Periods 1 and 6 was 42.3% ranging from 23.3 to 62.7% (Table 4). Two subjects (#4 & #6) were able to limit the percent decrease in calories to 28.2 and 23.3%, respectively.

The number of calories expended, time, and number of times per day that the subjects engaged in exercise varied widely (Table 5). The subjects expended more calories exercising during the first half of the study (Figures 1-8). The amount of time spent exercising was higher at the lower altitudes or at the beginning of the study (Figures 9-16).

Average energy requirements ranged from 2372 to 4391 kcal/day (Table 6). Comparing the calculated energy requirements to the energy intake showed that the actual weight loss was greater than expected (Table 7) by as much as 8.2 kg. The mean caloric intake for 4 subjects was less than their calculated energy requirements but the other 2 subjects ingested more calories than were needed to meet their energy requirements (Table 7).

Mean body weight loss for the 38 days was 7.44 ± 2.24 kg ($p<0.01$) ranging from 4.2 to 9.9 kg (Table 8). The subjects lost $8.9 \pm 2.0\%$ of their sea level body weights. The weight loss ranged from 4.2% to 11.6% of original body weights in 38 days. Body weight was lost at a mean rate of 196 g/day (range 110.5 - 260.5 g/day). Body weight and caloric intake (Figures 17-24) followed the same general downward trend. Overall fluid balance was positive to discount fluid loss as a reason for weight loss (Table 9).

Comparing the value of the highest caloric intake to the lowest value for each subject (Table 10) showed a mean difference of 3268 kcal which could cause a 0.45 kg weight loss/day if continued. The difference between the highest and lowest caloric intakes was significant ($p<0.01$). The highest values occurred before the minimum values during the course of the study.

Five of the subjects had mean protein intakes that exceeded the RDA of 0.8 g/kg body weight (BW) (Table 11). The protein intake for these 5 subjects fell below the RDA on several days but there were surrounding days with more than adequate protein intakes. For these subjects the days of low protein intakes occurred more frequently in the last two periods of the study. The sixth subject (#1) had a mean protein intake of 83.7 g which was 83.0% of his sea level protein needs. The subject's protein intake was deficient 63.2% or 24 of the 38 days of the study and started occurring in the first period. The mean protein intakes for the six subjects showed a significant decrease ($p<0.001$) during the second half of the study (Table 11). As the caloric intake decreased, the protein intake also decreased ($r=0.77$, $p<0.001$). The percent of calories from protein (%PRO) did not differ significantly except for period 2 which was significantly greater

($p<0.01$) than the other periods (Table 12). The mean protein intake for all 38 days was $15.4 \pm 3.8\%$ of the total calories.

The mean nutrient intake of the 6 subjects met the Recommended Dietary Allowances (RDA) (50) for all vitamins and minerals (Table 13). However two subjects (#4 & #6) were ingesting vitamin and mineral supplements which artificially increased the mean intake. Excluding the vitamin/mineral supplement from the data showed that the food intake provided enough nutrients to meet the RDA for energy and all vitamins and minerals except for vitamin B_6, folacin, magnesium, and zinc.

CARBOHYDRATE PREFERENCE

The subjects started the study consuming a higher percentage of total calories as carbohydrate (%CHO) in their diets (62.1% CHO); but the %CHO dropped to 54.5% in the second period and remained in that general range for the remainder of the study (Table 14). There was a significant difference ($p<0.001$) between period 1 and the following periods. As the %CHO decreased, the percent of calories as fat (%FAT) increased ($r=-0.90$, $p<0.001$) (Table 15, Figure 25).

FOOD RATING

The overall rating of the food showed that the subjects liked the foods very much. The mean rating was very high at 8.4 on the hedonic rating scale. The mean rating for the first half of the study was 8.4 (range 3-10) compared to 8.7 for the second half (range 4-10). The mean ratings showed a slight increase during the second half of the study; however, the amount of food that the subjects ate decreased.

BODY COMPOSITION

According to the hydrostatic weighing measurements, there was an overall 1.6% decrease in %BF pre- to post-exposure to altitude but the difference was not significant (Figure 26). Four of the 6 subjects lost an average of 2.7%BF whereas the other 2 subjects (#8 & #9) gained an average of 0.65%BF. Mean energy expenditure was greater than the energy intake for the 4 subjects whose %BF decreased (Table 7). The 2 subjects that gained %BF were consuming sufficient calories so that they should have gained instead of losing body weight. Calculations of body fat weight (kg) showed a consistent decrease in body fat (Figure 27) for all subjects. Circumference measurements significantly decreased ($p<0.05$) in the arms and thighs of all subjects (Figures 28-29). Skinfold measurements, which are an indication of subcutaneous fat, decreased in the triceps and thighs except for the 2 subjects (#8 & #9) whose %BF increased according to hydrostatic weighing measurements (Table 16). The sum of all 7 skinfold measurements followed the same trend as hydrostatic weighing with skinfolds decreasing for 4 subjects and increasing for 2 subjects. The CT scan fat/bone data confirmed the trends of the hydrostatic weighing and skinfold data (Figures 30-31). Circumference, %BF, skinfold, and CT scan data showed that body fat decreased except for the 2 subjects (#8 & #9) who had increases in %BF.

Muscle mass decreased (Figures 32-33) in all subjects. CT scan muscle/bone measurements showed that the difference was not significant in the arm ($p<0.073$) but was significant ($p<0.002$) in the thigh measurement. Since bone measurements were not expected to change during the 40-day period of the study, change in the ratio was attributed to changes in muscle mass.

DISCUSSION

CALORIC INTAKE AND BODY WEIGHT

Averaging the data into 7-day periods showed that there was a definite downward trend in caloric intake over the six periods. The largest decreases in caloric intake occurred at the higher altitudes. The average decrease in caloric intake of 42.3% from period 1 to period 6 (Table 3) was comparable to the 20-40% range found in the literature for sojourns of up to 26-days duration (5,8,9,24). Two subjects (#4 & #6) were able to maintain their caloric intake at 71.8 and 76.7% of their beginning values. The small decrease in calories for the 2 subjects (#4 & #6) could be due to the fact that they ate less than their energy requirements in the beginning of the study. The body weight losses for the 2 subjects (#4 & #6) were among the higher values with percent body weight loss being equal to 11.6 and 9.7% (Table 8). Since their energy expenditures due to exercise were greater than those of the other subjects, the large body weight losses are to be expected (Figures 1-8). Energy requirements have been shown to be relatively higher for heavy exercise at altitude compared to that at sea level (36). Since these subjects were heavy exercisers, it is possible that the energy expenditure was increased above that predicted by the Harris Benedict equation. Increased energy expenditure coupled with their decreased energy intake could lead to large energy deficits which would lead to the catabolism of body protein and/or fat (1,5,9,11,24,25,38,43). The decrease in caloric intake was less than 50% for four of the subjects. The 4 subjects started the study eating more than their energy requirements. Boyer and Blume (23) had reported that some climbers ate excess amounts of food before starting to climb a mountain in anticipation of anorexia and body weight loss. The 4 subjects may have been attempting to eat as much as possible at the beginning of the study to increase their body stores and to prevent the debilitating effects of a major weight loss. Their plans seemed to have worked since these subjects lost less weight in comparison to subjects #4 and #6 even though they suffered more from AMS.

Altitude sickness is affected by altitude, speed of ascent, and length of stay. Mild AMS subsides in a few days; high altitude pulmonary edema and high altitude cerebral edema either subside or grow worse and require descent. The longer the stay at altitudes up to 18-20,000 feet, the more complete the acclimatization. However, caloric intake and body weight tend to fall during long stays at altitudes higher than 20,000 feet (4).

The subjects were allowed to acclimate for 3-day periods at 15,000, 18,000, 20,000, and 25,000 feet. The subjects in the present study tended to feel better after each of the three day acclimation periods (46), but nevertheless all subjects lost body weight continuously throughout the study. This suggests that hypobaric hypoxia rather than the combined stresses of the mountain environment may be responsible for a major portion of the deterioration of food intakes during mountain expeditions. Due to the nature of this study, body weight loss was not due to increased climbing activity or to limited food availability. The amount of voluntary exercise decreased drastically for most of the subjects after reaching 23,000 feet on day 26. These results suggested that deterioration in physical condition could override the effects of acclimatization as Pugh (4) and Blume (24) had suggested as early as 1962.

The 8.9% body weight loss in the present study was greater than previously reported. Previous studies have shown weight loss of 3-3.49% in 8 days (5,41); 5.4% in 12 days (11); and 5% in 5 weeks (40) during exposure to altitude. The caloric intake and rate of weight loss for the present study were similar to those of previous studies (11,23,40,42). If the duration of those other studies were extended, the percent body weight loss would be similar to the present study.

All subjects continuously lost body weight during the 38 days at altitude. The mean energy intake for 4 subjects was less than their calculated energy requirements so weight loss was expected. However the other 2 subjects (#8 & #9) ingested more calories than were needed to meet their energy expenditure and should have gained body weight (Table 7). The weight loss for all subjects was greater than would be expected from the energy intake and expenditure figures. The reason for the disparity in body weight losses may simply be a question of the accuracy of the estimation of energy expenditure since energy intake was accurately determined. The subjects with caloric intakes greater than their energy requirements did tend to have smaller body weight losses. Other researchers have suggested that body weight loss may be due to water loss, increased metabolic rates, and fat and/or carbohydrate malabsorption (4,23). Hypohydration may be due to decreased fluid intake (1); increased water loss (2,3,4,11,27); or loss of fluid from the lungs due to hyperventilation (28,29). However, other studies have shown that normal body hydration can be maintained (5,25,30). The fluid data for the present study showed that the subjects were in a slightly positive balance (Table 9). Fluid intake exceeded the output by several hundred milliliters. However losses of fluid from hyperventilation and sweating were not taken into account and would probably decrease the positive fluid balance to euhydration. Body fluid losses were probably minimized because the relative humidity in the hypobaric chamber ranged from 60 to 80% depending on the altitude. In general the fluid balance was negative during the last two periods of the study (Table 17, Appendix 2). The negative fluid balance could account for the continued weight loss of subjects #8 and #9 who should have gained weight according to energy balance calculations. Several researchers have suggested that energy expenditure increases at altitude (17,18,39). The effects of altitude on basal (4,17,33), resting (34,35,39), and mild to moderate exercise (35,36) conditions have been studied and show an increase of 7-11% of energy expenditure at altitude. The increase in energy expenditure has been attributed to the increased work of breathing or the decreased efficiency of work performance. However data from other studies show that the increase in basal energy expenditure is transient and returns to normal after about a week of acclimatization (4,20,37,38).

The possibility that malabsorption due to hypoxia was an important cause of body weight loss has been debated (4,23,31,32) but was not investigated in this study. On mountain expeditions food intake and energy output have only been estimated (23,24) and not at altitudes as high as attained in the present study. Rai et al. (32) and Sridharan (31) showed no disturbance in digestibility and utilization of dietary fat and/or carbohydrate up to 4700 m. Other studies have reported malabsorption of fat and/or xylose (4,23) at higher altitudes. Increased energy expenditure/metabolic rates and/or malabsorption could account for the body weight losses but neither were studied.

The confinement of the 8 subjects in a hypobaric chamber in the present study could have affected body weight loss. Loss of appetite, body weight, and strength could be attributed to confinement in the hypobaric chamber, isolation from the real world, limited physical activity, and boredom. However evidence was not available on the interaction of these factors with body weight and appetite loss. A study of 245 crew members confined to 4 submarines showed that 67% of the personnel lost weight, 25% gained weight, and 8% maintained their weight during long sea voyages even though the food was considered very palatable and exercise decreased (51). The authors attributed the weight loss of a third of the crew members to active dieting but the psychological and physical stresses of confinement may have contributed to the weight loss of the remainder of the crew members (51).

Negative nitrogen balances have been reported in humans exposed to high altitudes (1,41). Under normal conditions, the RDA for protein of 0.8 g/body weight (50) is more than adequate for maintaining nitrogen balance. When energy intakes were less than 2000 kcal/day, nitrogen balance studies on protein intakes of greater than 50-60 g/day were negative during altitude exposure (1,8,38,41). Negative nitrogen balances during caloric deficiency were probably due to protein being used to meet the energy needs of the body (45). Studies have shown that whenever men consumed adequate calories and protein during altitude exposure, positive nitrogen balances were possible (37,42). However decreased appetite usually leads to a decrease in dietary caloric and protein levels (5,8,9,24,41). Nitrogen balance studies were not conducted but five subjects received more than the RDA for protein while one subject (#1) ingested less than the RDA for protein. In the present study the mean caloric intakes for 2 subjects (#8 & #9) were adequate to meet energy requirements but the levels were inadequate for the other 4 subjects (Table 7). The subjects were able to ingest an average of 2152-3022 kcal but their energy requirements ranged from 2314 to 2901 kcal. Four subjects in the present study were probably in negative nitrogen balance because of their caloric deficits. The 2 subjects receiving adequate calorie and protein intakes were probably in positive nitrogen balance (42).

Hannon (52) has concluded that extended periods of low protein intakes are unlikely to present serious nutritional problems since the protein intakes during the most pronounced stages of hypophagia usually exceeded the RDA of 0.8 g/kg BW. This conclusion was not supported by the results of the present study. Protein intake averaged 0.86 g/kg BW for the last period of the study but 2 subjects (#1 & #3) had protein intakes as low as 0.52-0.67 g/kg BW for the last 2 periods of the study. These 2 subjects were probably in negative nitrogen balance. Protein intake decreased on one day to 26.2 g for one of those subjects (#1) whose protein intake for the entire study was deficient 63.2% of the time.

Hypophagia can last from 8-28 days (1,5,8,23,38) at altitude although clinical evidence of nutritional deficiency other than a negative nitrogen balance has not been reported. It has been suggested that subjects starting in a good nutritional state would not develop vitamin and mineral deficiency problems for several months (52). However the duration of the hypophagia and anorexia of AMS may indicate a need for vitamin/mineral supplementation for subjects on lengthy expeditions who are exercising heavily and whose diets are unbalanced.

CARBOHYDRATE PREFERENCE

Several studies have shown that subjects prefer carbohydrate at high altitude, usually at the expense of fat (4,18,37). Consolazio et al. (37) showed that this was true during the first week at altitude but a similar pattern was not apparent during prolonged exposure. The present study confirmed these findings. Though a high carbohydrate (60%) diet was offered throughout the study, the subjects started at 62.1% and then decreased their carbohydrate intake to 53.2%, although the menu choices were adequate to have maintained or even increased carbohydrate intakes. Others (14,23) have found intakes of carbohydrate to increase from 42-55% at sea level to 52-63% at altitude. In the present study, a wide variety of appetizing foods were readily available to the subjects and they consumed a more balanced diet than usually available to mountaineers. The composition of the diet for the entire study was 54.5% CHO, 15.2% PRO, and 31.4% FAT. In 1969, Kryzwicki et al. (11) observed similar body weight losses whether the subjects consumed a high carbohydrate (68%) or a low (42%) carbohydrate diet during 12 days at 4300 m. Increased dietary carbohydrate intake did not decrease body weight loss. Consolazio et al. (18) found a difference in work performance for the heaviest work levels with a high carbohydrate diet at high altitude. Carbohydrate may increase the blood oxygen transport capacity and improve metabolic efficiency (53,54). This may effectively decrease the physiological altitude by 1-2000 feet (55) and make physiological exertion relatively easier. The subjects in the present study did not increase or maintain their intake of carbohydrate.

The subjects did not eat pure fat such as butter but they did eat foods containing large amounts of fat such as ice cream, cream soup, whole milk, meat, and french fries. Although they asked for high carbohydrate snacks such as candy, granola bars, etc, these food also contain large amounts of fat. The preference may not be for pure carbohydrate but a desire for palatability resulting from the combination of carbohydrate and fat.

FOOD RATINGS

The high hedonic ratings indicted that the subjects liked the foods. The food was palatable but at higher altitudes the subjects' appetites were diminished compared to their appetites at lower altitudes (Table 18). Toward the end of the study the subjects ate less food but the foods selected were more calorically dense. The low calorie vegetables and salads were not requested as often. Caloric intake was greater than energy requirements on some days indicating that the subjects were attempting to increase their caloric intake (Figures 17-24). Some subjects were able to consume enough food to keep their caloric intake above their energy requirements right up to the 36th day of the study. It was possible to encourage the subjects to ingest more calories but they could not sustain the high intake. Sore throats, feeling full, not hungry, and the problem of eating while struggling to breathe were reasons given by the subjects for their reduced food consumption. Many foods which were favorites at sea level were not tolerated at higher altitudes.

The mean ratings for the different food groups generally increased (Table 19) as the study progressed. The fruit and juice, potato, bread, vegetable, and meat groups had more food items whose rating increased toward the end of the study (Table 19). The ratings for potatoes increased for all subjects. However the potatoes were usually combined with cheese and other high protein and high fat additives and many variations were possible. The ratings decreased for the foods that were available throughout the study. The subjects were offered the foods at least five times during the course of the study. They were provided other foods as requested. The decrease was more likely due to boredom rather than an inability to tolerate the foods.

The food ratings of one subject (#9) increased for all foods during the study (Table 19). This subject also was able to minimize his weight loss (Figure 24). His mean caloric intake was greater than his energy requirements so his ability to keep his weight loss minimized was probably due to the high food intake rather than water retention especially since his fluid balance was negative during the last period of the study.

BODY COMPOSITION

There was a mean decrease in body weight, %BF, body fat weight, and LBM. Percent body fat measurements by hydrostatic weighing, skinfold measurements, and CT scanning increased in 2 subjects (#8 & #9). The fact that these 2 subjects (#8 & #9) ate more calories than they needed for energy expenditure and reduced their exercise provided support for the possibility that subcutaneous fat was maintained or increased slightly. In general the present study confirmed the results of previous studies (25,43) that showed losses in skinfold thickness and %BF (5,11,17,44). Although there was an mean decrease in skinfold thickness and %BF in the present study, there was a wide range from 2 subjects (#8 & #9) who showed increases in skinfold measurements and %BF to subjects who showed losses up to 33% in skinfold thickness. Fulco (56) reported an increase in the %BF determined by hydrostatic weighing after an 18-day exposure to 14,100 ft in a hypobaric chamber. However, the increase in %BF may be misleading. The 1.1% increase in %BF in the Fulco (56) study may have occurred because the amount of fat did not change even though the subjects lost 1.5 kg body weight. The subjects in the present study lost body weight also. Analyzing the body fat weight of the subjects in the present study showed that all subjects lost body fat but the loss was very small for 2 subjects (#8 & #9). Skinfold measurements increased verifying the increase in subcutaneous fat (Table 16). Mountain climbing expeditions have never reported increases in %BF. This difference is probably due to the fact that the subjects in the hypobaric chamber were not exercising as much or in the same manner as would occur during an actual assault on a mountain.

About 25.8% of the 7.44 kg of weight lost by the subjects was from fat and 74.2% from the LBM. The most common percentage of fat loss was approximately 40% but adding the values of the 2 subjects (#8 & #9) who gained %BF lowered the percent attributed to fat considerably. Since the subjects were not dehydrated and bone was not expected to change, the 74.2% loss from LBM was from muscle mass. The CT scans confirmed the decreases in muscle mass.

The CT scans and the measurements of %BF, skinfold, and circumference presented an integrated picture of the changes in body composition. The overall trend was of decreasing muscle mass and body fat except for 2 subjects (#8 & #9) who actually gained fat.

CONCLUSIONS

Conclusions from this study were: (1) energy output decreased as altitude increased; (2) food intake decreased as altitude increased; (3) fluid balance indicated little or no dehydration or edema in most subjects most of the time; (4) essential vitamins and minerals and protein were not deficient except for protein for one subject; (5) lack of oxygen, lack of adequate exercise, and confinement may have caused anorexia which contributed to body weight loss; (6) the amount of body weight loss can not be accounted for by balance of caloric intake vs energy expenditure indicating that there might have been malabsorption or increased energy expenditure that has not been taken into account; (7) %BF decreased in 4 subjects but increased in 2 subjects whose caloric intake indicated that they should have gained weight; (8) body fat weight decreased in all subjects; and (9) LBM decreased.

The data indicate that prolonged exposure to increasing hypoxia does not increase carbohydrate preference and that body weight could not be maintained despite provision of a highly palatable *ad libitum* diet.

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TABLES

Table 1
Physical Characteristics of Subjects *

	Mean + SD	Range
Age, years	27.5 + 2.2	25.0 - 31.0
Height, cm	184.0 + 10.3	171.4 - 196.8
Weight, kg (7 Oct)	82.97 + 9.78	74.09 - 100.91

*Excluding subjects 5 & 7

Table 2

OPERATION EVEREST II PERIODS

PERIOD	DAY OF STUDY
1	2 - 8
2	9 - 15
3	16 - 22
4	23 - 29
5	30 - 36
6	37 - 39

Table 3

Energy Intake (Kcal/Day)

Subject Number	Period (Study Days) 1 (2–8)	2 (9–15)	3 (16–22)	4 (23–29)	5 (30–36)	6 (37–39)	Mean
1	3570	2874	2658	2450	1643	1332	2536
3	2864	2662	2447	1934	1289	1137	2152
4	2650	2833	2712	2658	2634	1903	2635
5	3252	2867	2499	2516	1868		2695
6	3107	3108	3112	2136	2471	2383	2755
7	2672	2024					2373
8	3447	3533	3353	2615	2695	1773	3022
9	3178	2935	2861	2191	2742	2206	2736
Mean*	3136[b]	2991[b]	2857[b]	2331	2246	1789[a]	2639
Std Dev*	557	664	788	804	874	682	847.6

* Excluding Subjects 5 & 7

[a] Significantly different from other periods

[b] Significantly different from periods 4 & 5
$p < 0.001$

Table 4

Percent Decrease in Energy Intake

Subject Number	% Decrease in Kcalories
1	62.7[a]
3	60.3[a]
4	28.2[a]
5	42.6[b]
6	23.3[a]
7	24.3[c]
8	48.6[a]
9	30.6[a]
Mean*	42.3[a]
SD	17.2

* Excluding subjects 5 & 7

[a] Difference between Period 1 & 6
[b] Difference between Period 1 & 5
[c] Difference between Period 1 & 2

Table 5

Operation Everest II

Daily Energy Expenditure from Exercise
(Study Day 4 to 39)

Subject Number	Calories		Exercise Time		Frequency of Exercise
	Mean	SD	Mean	SD	
1	315	325	32.0	31.2	0.92
3	206	218	23.6	27.1	0.72
4	1986	1045	211.5	96.5	2.53
5	466	323	47.6	25.7	1.55
6	1053	509	118.1	50.8	2.17
7	889	654	91.5	48.8	1.25
8	638	699	69.2	63.7	2.00
9	236	234	28.2	27.5	1.00
Mean*	715	807	76.5	81.2	2.11

* excluding subjects 5 & 7

Table 6

OPERATION EVEREST II

AVERAGE ENERGY REQUIREMENTS

SUBJECT NUMBER	BEE	BEE + 20% ACTIVITY	EXTRA ACTIVITY	BEE + 20% ACTIVITY + EXTRA ACTIVITY
1	2232	2678	315	2993
3	1846	2215	206	2421
4	2004	2405	1986	4391
5	1600	1920	466	2386
6	1918	2302	1053	3355
7	1773	2128	889	3017
8	1781	2137	638	2775
9	1781	2137	235	2372

Table 7

Energy Balance and Weight Change in 38 Days

Subject Number	Energy Requirement (Kcal)	Energy Intake (Kcal)	Change in Body Weight (kg)	
			Expected	Actual
1*	2993	2536	−2.3	−9.9
3*	2421	2152	−1.3	−6.1
4*	4391	2635	−8.7	−9.8
5**	2386	2695	+2.7	−1.7
6*	3355	2755	−3.0	−8.2
7***	3017	2373	−2.4	−2.9
8*	2775	3022	+1.2	−6.5
9*	2372	2736	+4.0	−4.2

* October 7 to November 13, 1985
** October 7 to November 7, 1985
*** October 7 to October 19, 1985

Table 8

Operation Everest II

Weight Loss in 38 Days

Subject Number	Initial Weight Oct 7, 1985 (kg)	Final Weight Nov 13, 1985 (kg)	Difference (kg)	Weight Loss (%)
1	100.91	91.02	9.89	9.8
3	76.70	70.57	6.14	8.0
4	84.43	74.66	9.77	11.6
5	59.43	57.73[a]	1.70	2.4
6	84.55	76.36	8.18	9.7
7	72.73	69.77[b]	2.96	4.1
8	77.16	70.68	6.48	8.4
9	74.09	69.89	4.20	5.7
Mean[*]	82.97	75.53	7.44[c]	8.9
SD	9.78	8.02	2.24	2.0

[a] Nov 7,1985
[b] Oct 19, 1985
[c] Significantly different, $p < 0.01$
[*] Excluding Subjects 5 & 7

TABLE 9

OPERATION EVEREST II

FLUID BALANCE

Subject Number	Fluid Intake (ml/day)	Fluid Output (ml/day)	Balance
1	2464.4	1881.3	583.1
3	1906.8	1835.3	71.5
4	3854.1	3540.4	313.7
6	5448.5	5252.5	196.0
8	3928.3	3432.1	496.2
9	2199.2	2078.3	120.9
Mean	3278.5	3074.6	203.9
SD	1618.2	1527.3	1220.7

Table 10

Operation Everest II

Extremes of Energy Intake

Subject	Maximum (Kcal)	Minimum (Kcal)	Difference
1	4331	988	3343
3	3551	558	2993
4	5580	1611	3969
5	3916	1670	2246
6	4450	1269	3181
7	3600	1394	2206
8	4485	884	3601
9	4001	1483	2518
Mean*	4399.7	1132.2	3267.5
SD	±676.3	±395.8	±500.7

* excluding subjects 5 & 7

Table 11

Protein Intake (Grams/Day)

Subject Number	Period (Study Days) 1 (2–8)	2 (9–15)	3 (16–22)	4 (23–29)	5 (30–36)	6 (37–39)	Mean
1	115.0	108.6	90.0	66.6	54.0	47.5	83.7
3	111.2	114.0	91.7	80.1	47.4	47.4	85.6
4	127.5	150.8	127.5	126.4	106.1	66.6	122.9
5	116.6	102.7	75.5	73.9	65.4		89.6
6	93.4	126.8	121.3	90.4	92.7	71.6	102.3
7	101.6	87.4					95.0
8	108.5	135.8	106.9	98.5	103.2	66.1	107.1
9	102.7	121.9	102.9	83.2	95.3	84.6	99.9
Mean*	109.7[b]	126.3[b]	106.7[b]	90.9	83.1	64.0[a]	100.[illegible]
Std Dev	19.9	35.2	33.8	33.5	36.0	26.3	36.3

* Excluding subjects 5 & 7
[a] Significantly different from other periods
[b] Significantly different from periods 4 & 5
$p < 0.001$

Table 12

Operation Everest II

Percent Calories from Protein

Subject Number	Period (Study Days) 1 (2–8)	2 (9–15)	3 (16–22)	4 (23–29)	5 (30–36)	6 (37–39)	Mean
1	12.9	14.8	13.1	10.9	13.2	14.7	13.1
3	15.6	17.2	15.6	17.0	14.7	16.1	16.0
4	19.3	22.0	19.1	20.3	16.9	13.9	19.1
5	14.3	14.2	12.0	11.9	14.0		13.2
6	12.1	16.3	15.8	18.1	14.9	11.5	15.1
7	15.8	17.2					16.4
8	12.7	15.4	12.7	15.1	15.9	14.6	14.4
9	12.9	16.3	14.6	15.0	13.8	15.4	14.6
Mean*	14.3	17.0**	15.1	16.0	14.9	14.3	15.4
Std Dev	3.1	3.6	3.7	4.8	3.9	2.6	3.8

* Excluding subjects 5 & 7
** Significantly different, $p < 0.01$

TABLE 13

OPERATION EVEREST II

MEAN NUTRIENT INTAKE FOR 38 DAYS

	RDA	MEAN INTAKE
Energy (kcal)		2639±848
Protein (gm)	56	100±36.3
(%)		15.4±3.9
Total Fat (gm)		92.3±44.7
(%)		31.1±9.5
Fat, saturated (gm)		36.2±20.7
Fat, monounsat (gm)		30.9±17.3
Fat, polyunsat (gm)		13.7±9.6
Cholesterol (mg)		380±272
Carbohydrate (gm)		359±127
(%)		54.5±9.6
Vitamin A (mcg RE)	1000	2877±1951
Thiamin (mg)	1.4	6.58±9.2
Riboflavin (mg)	1.6	7.20±9.29
Niacin (mg NE)	18	35.5±17.9
Vitamin B_6 (mg)	2.2	6.25±9.1
Vitamin B_{12} (mcg)	3.0	10.2±10.1
Vitamin C (mg)	60	505±457
Folacin (mcg)	400	67109±149319
Sodium (mg)		3645±1387
Potassium (mg)		4001±1657
Iron (mg)	10	26.5±16.0
Calcium (mg)	800	1444±691
Phosphorus (mg)	800	1654±622
Magnesium (mg)	350	378±190
Zinc (mg)	15	20.3±14.9

Table 14

Percent Calories from Carbohydrates

Subject Number	Period (Study Days) 1 (2–8)	2 (9–15)	3 (16–22)	4 (23–29)	5 (30–36)	6 (37–39)	Mean
1	61.8	50.8	54.5	55.7	51.6	54.3	54.9
3	62.6	54.4	54.5	52.8	56.4	54.5	56.1
4	67.5	64.6	55.4	57.2	59.0	50.6	59.9
5	63.3	58.0	59.1	60.4	61.1		60.3
6	68.0	54.3	55.4	52.3	54.4	51.2	57.0
7	59.7	51.2					55.8
8	54.0	47.9	47.4	43.5	37.3	55.0	46.8
9	58.5	49.9	56.2	53.6	45.0	53.4	52.5
Mean*	62.1**	54.5	53.2	52.9	50.6	53.2	54.5
SD	7.1	9.0	9.1	9.6	10.5	7.0	9.6

* Excluding subjects 5 & 7
** Significantly different, $p < 0.001$

Table 15

Operation Everest II

Percent Calories from Fat

Subject Number	Period (Study Days) 1 (2–8)	2 (9–15)	3 (16–22)	4 (23–29)	5 (30–36)	6 (37–39)	Mean
1	24.4	31.3	36.7	32.0	34.9	30.4	31.7
3	23.9	27.8	31.4	32.7	29.3	30.3	29.1
4	15.9	17.9	29.0	23.1	26.4	36.7	23.6
5	23.4	28.3	31.5	28.5	25.8		27.7
6	23.1	28.8	31.8	30.6	30.7	39.4	30.0
7	25.2	30.9					27.9
8	34.1	36.3	42.1	42.5	46.9	30.7	39.6
9	29.2	32.1	31.3	31.2	40.8	30.3	32.7
Mean*	25.1**	29.2	33.7	32.0	34.8	33.0	31.1
Std Dev*	7.5	8.5	9.7	9.0	10.5	7.9	9.5

* Excluding subjects 5 & 7

** Significantly different, $p < 0.001$

TABLE 16

SKINFOLD MEASUREMENTS (mm) Pre- and Post-exposure to 40 Days of Progressive Decompression to 240 Torr

Site	Time	#1	#3	#4	#5[a]	#6	#7[b]	#8	#9
Triceps	Pre	9.8	9.9	9.7	7.9	7.0	7.9	8.6	8.8
	Post	9.1	9.2	7.9	7.3	5.7	-	8.8	8.2
Subscapular	Pre	11.7	13.8	7.7	6.3	11.0	7.9	7.5	8.7
	Post	11.1	12.8	6.5	6.3	9.3	-	7.8	11.2
Chest	Pre	6.3	6.3	4.2	3.8	4.4	4.9	4.4	5.9
	Post	6.1	6.5	4.2	4.4	3.9	-	5.9	5.7
Midaxillary	Pre	9.3	12.8	5.1	4.7	6.1	5.0	8.2	10.1
	Post	7.5	9.5	3.8	4.6	4.6	-	7.4	10.2
Suprailiac	Pre	13.9	22.7	12.2	5.9	8.5	12.7	8.4	14.3
	Post	12.5	18.4	6.1	6.5	6.9	-	12.9	13.8
Abdominal	Pre	22.9	21.1	10.5	7.1	8.7	11.5	8.0	20.7
	Post	19.8	17.4	9.4	8.2	6.4	-	13.5	23.1
Thigh	Pre	12.5	18.0	15.5	7.3	9.6	8.0	12.4	12.4
	Post	12.3	16.1	11.1	9.0	7.3	-	14.1	12.7
TOTAL	Pre	86.4	104.6	64.9	43.0	55.3	57.9	57.5	80.9
	Post	78.4	89.9	49.0	46.3	44.1	-	70.4	84.9

[a] Withdrawn on 33rd day.
[b] Withdrawn on 16th day.

Table 17

Operation Everest II

Average Fluid Balance (ml/day)

Subject Number	Period (Study Days) 1 (2–8)	2 (9–15)	3 (16–22)	4 (23–29)	5 (30–36)	6 (37–39)	Mean
1	1090.8	820.0	825.0	1035.0	47.9	−903.3	583.1
3	713.3	22.1	67.9	−21.0	37.5	−866.7	71.5
4	2125.0	−24.2	−217.1	292.0	−5.7	−613.3	313.7
5	1092.5	727.9	77.9	−724.0	−516.7		250.9
6	814.0	876.4	762.1	−734.0	−357.9	−900.0	196.0
7	419.0	−26.7					251.9
8	2471.7	1149.3	−266.4	−129.0	−202.1	−528.3	496.1
9	984.2	−26.4	402.1	359.2	323.6	−2868.3	120.8
Mean*	1382.3**	481.6	262.3	111.2	−27.7	−1113.3**	296.1
SD	1188.6	1049.7	1031.9	870.0	993.4	1641.0	1259.5

* excluding subjects 5 & 7

** Significantly different from other groups $p < 0.05$

TABLE 18

TRENDS IN FOOD RATINGS AND NUMBER OF FOOD GROUPS CONSUMED

SUBJECT CONSUMED	MEAN RATING	NUMBER OF FOODS
1	+	-
3	=	-
4	+	-
6	+	-
8	+	-
9	+	-

+Measurement increased from the first half of the study to the second half.

=Measurement remained the same.

-Measurement decreased from the first half of the study.

TABLE 19

TRENDS IN RATINGS OF DIFFERENT FOOD GROUPS

SUBJECT	VEGETABLE	SALAD	MEAT	BREAD	SWEETS	DESSERTS	POTATOES	CHICKEN
1		-	+	-	+		+	
3	--	+	+	+	+	-	+	
4	++	+	-	+	=		+	
6		+	+	-	+		+	+
8	++	+	-	+	-	+	+	+
9		+	+	+		+	+	

[+]Measurement increased from the first half of the study to the second half.

[=]Measurement remained the same.

[-]Measurement decreased from the first half of the study.

FIGURES

FIGURE LEGENDS

Figure 1. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 1.

Figure 2. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 3.

Figure 3. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 4.

Figure 4. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 5.

Figure 5. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 6.

Figure 6. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 7.

Figure 7. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 8.

Figure 8. Energy (kcal) expended in ladder ergometer, treadmill walking, and biking exercises from information in the daily log book of exercise activity. Value included in energy expenditure calculations for Subject 9.

Figure 9. Time spent exercising each day for Subject 1.

Figure 10. Time spent exercising each day for Subject 3.

Figure 11. Time spent exercising each day for Subject 4.

Figure 12. Time spent exercising each day for Subject 5.

Figure 13. Time spent exercising each day for Subject 6.

Figure 24. Subject 9: Comparison of daily energy intake, energy expenditure, and body weight changes. Arrows indicate exercise bouts during testing that may have interfered with eating ie: Muscle Biopsy (MUSCLE), VO_2max (MAX), Inert Gas (GAS), and Swan-Ganz Catheterization (SG).

Figure 25. Composition of diet.

Figure 26. Percent body fat changes pre- to post-exposure to 29,000 feet as determined by hydrostatic weighing.

Figure 27. Body fat weight (kg) changes pre- to post-exposure to 29,000 feet calculated from body weight and percent body fat.

Figure 28. Circumference measurements of the arm to determine girth changes pre- to post-exposure to high altitude.

Figure 29. Circumference measurements of the thigh to determine girth changes pre- to post-exposure to high altitude.

Figure 30. Computed tomographic (CT) scans of the arm to determine changes in fat due to exposure to high altitude.

Figure 31. Computed tomographic (CT) scans of the thigh to determine changes in fat due to exposure to high altitude.

Figure 32. Computed tomographic (CT) scans of the arm to determine changes in muscle mass due to exposure to high altitude.

Figure 33. Computed tomographic (CT) scans of the arm to determine changes in muscle mass due to exposure to high altitude.

Figure 1
Operation Everest II

Energy Expenditure from Exercise
Subject 1

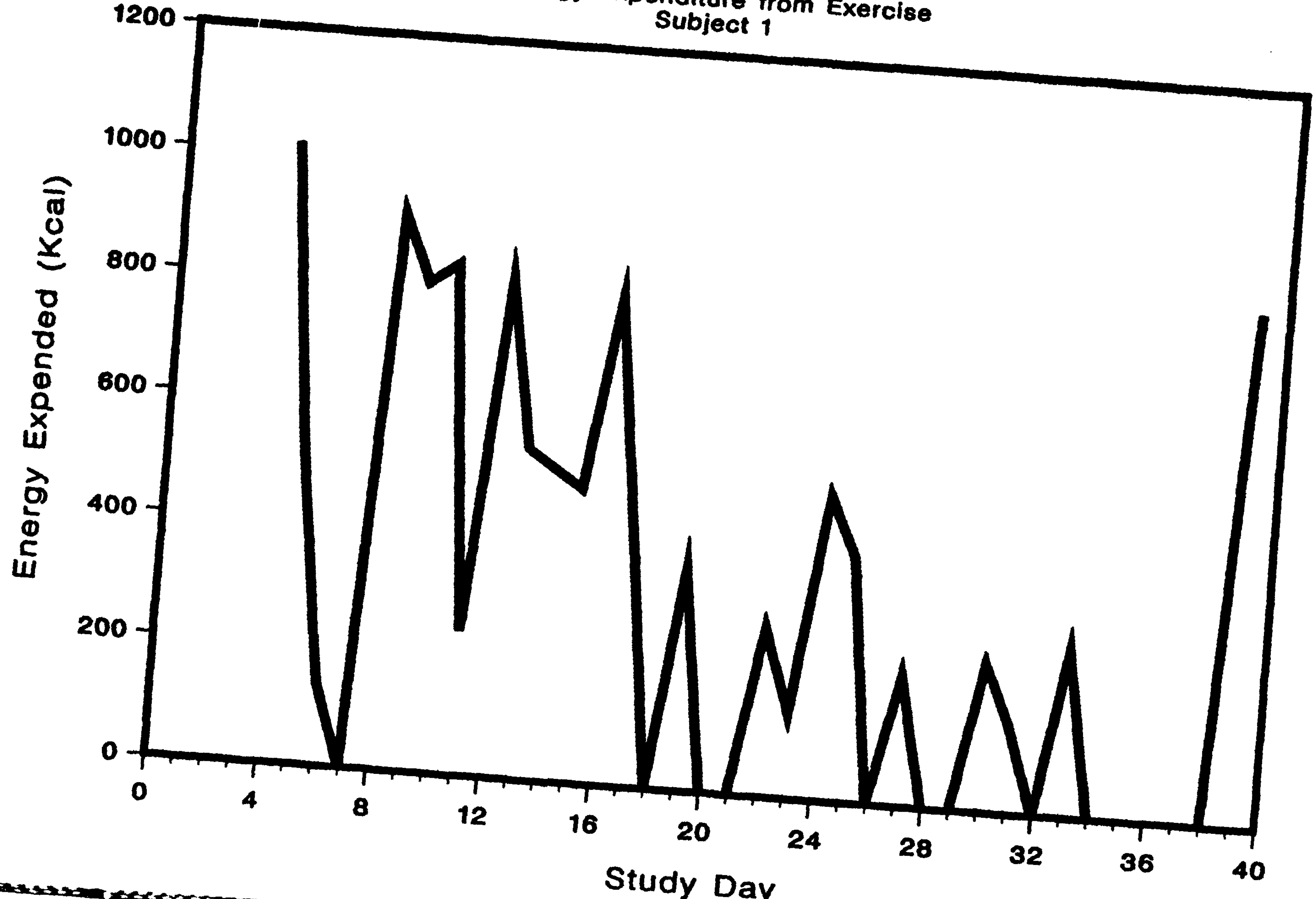


Figure 2
Operation Everest II
Energy Expenditure from Exercise
Subject 3

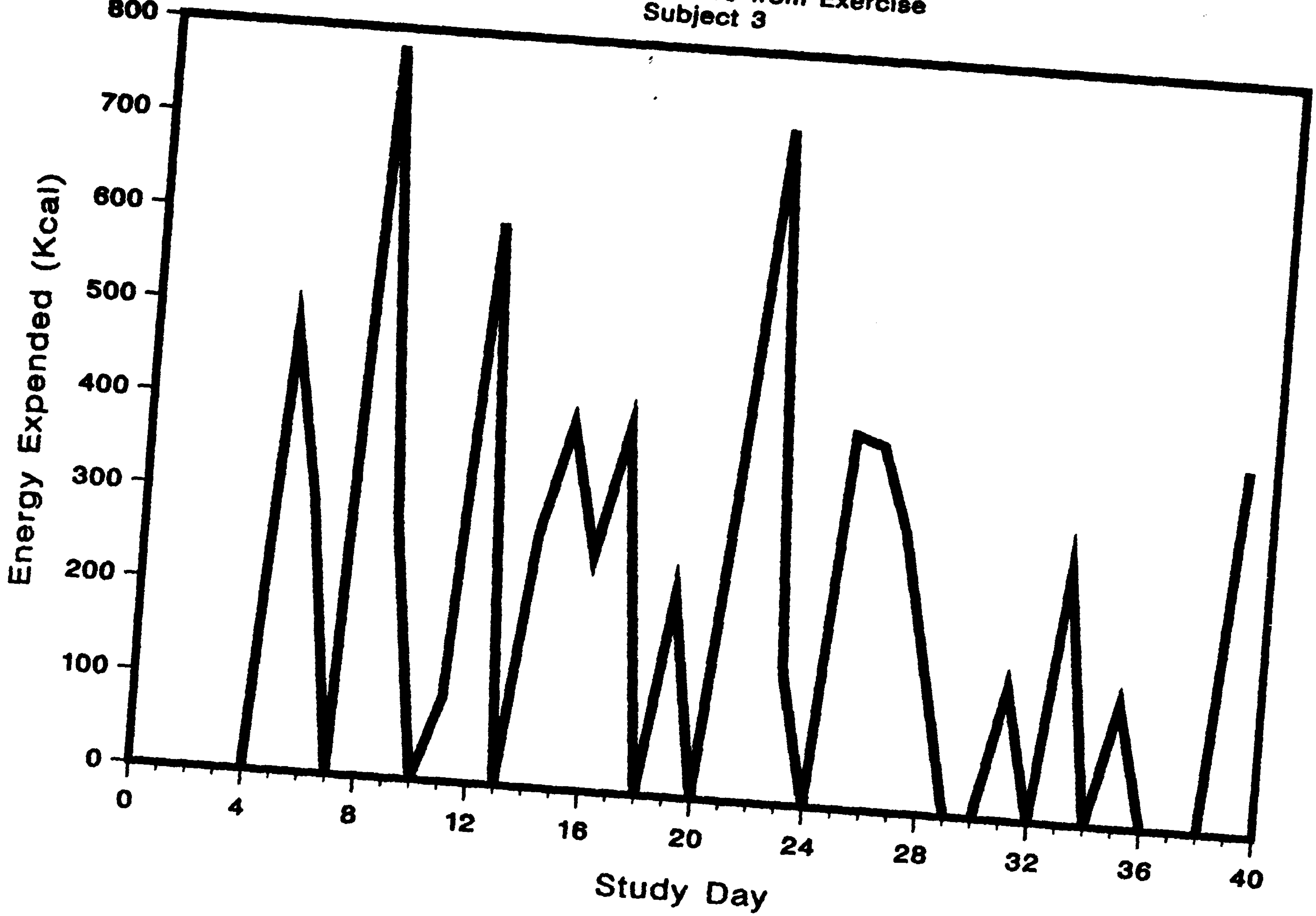


Figure 3
Operation Everest II
Energy Expenditure from Exercise
Subject 4

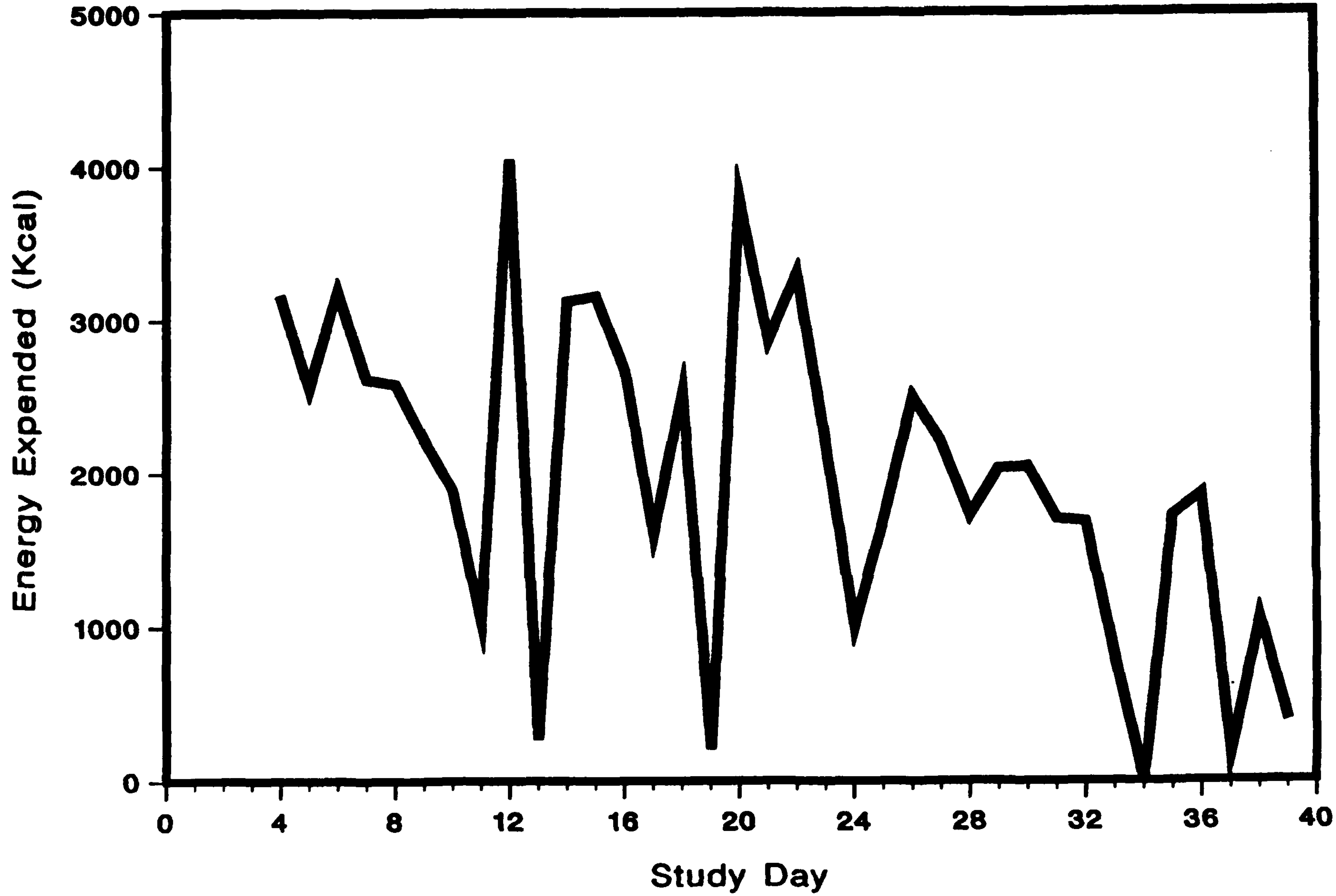


Figure 4
Operation Everest II
Energy Expenditure from Exercise
Subject 5

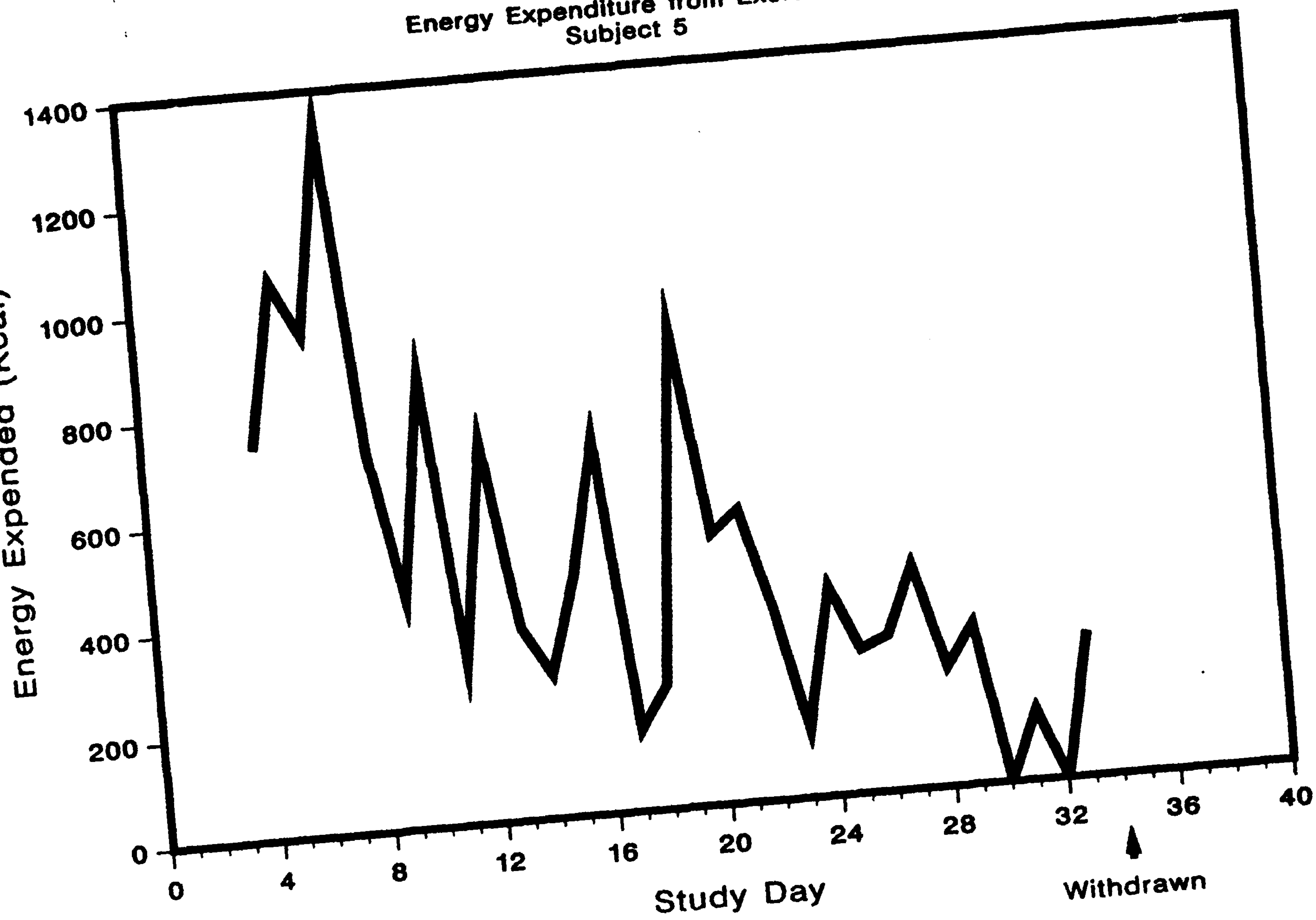


Figure 5
Operation Everest II
Energy Expenditure from Exercise
Subject 6

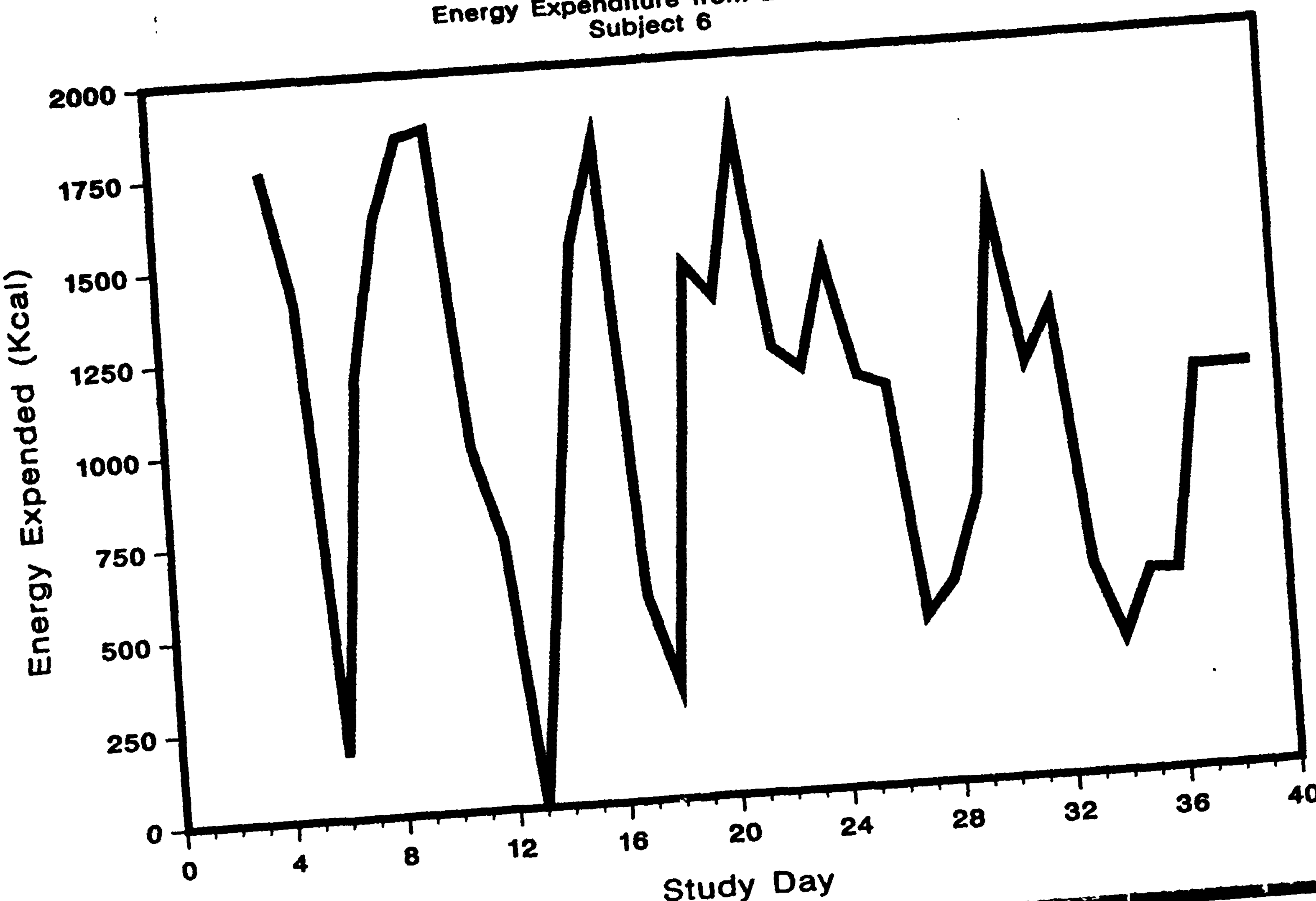


Figure 6
Operation Everest II
Energy Expenditure from Exercise
Subject 7

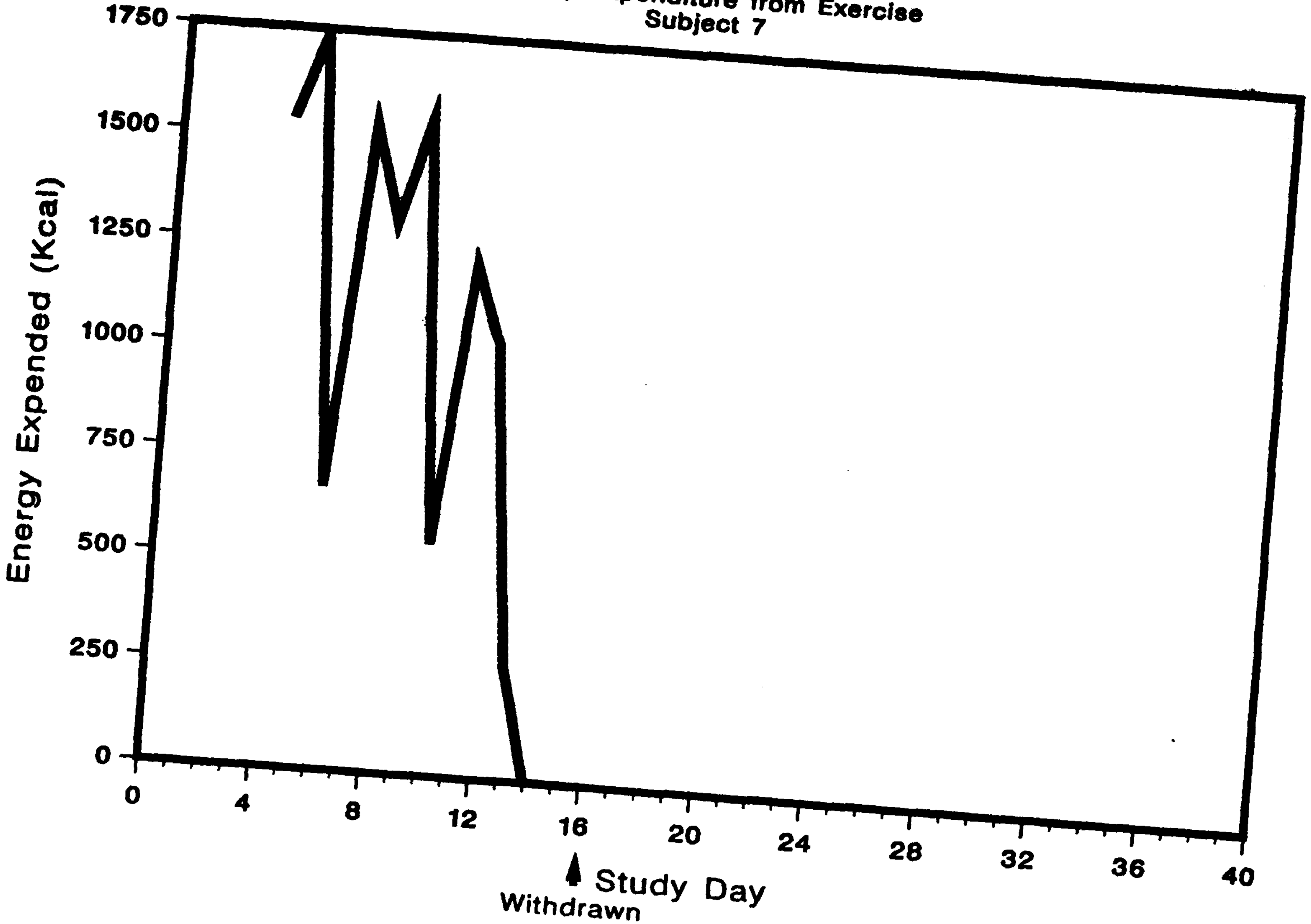


Figure 7
Operation Everest II
Energy Expenditure from Exercise
Subject 8

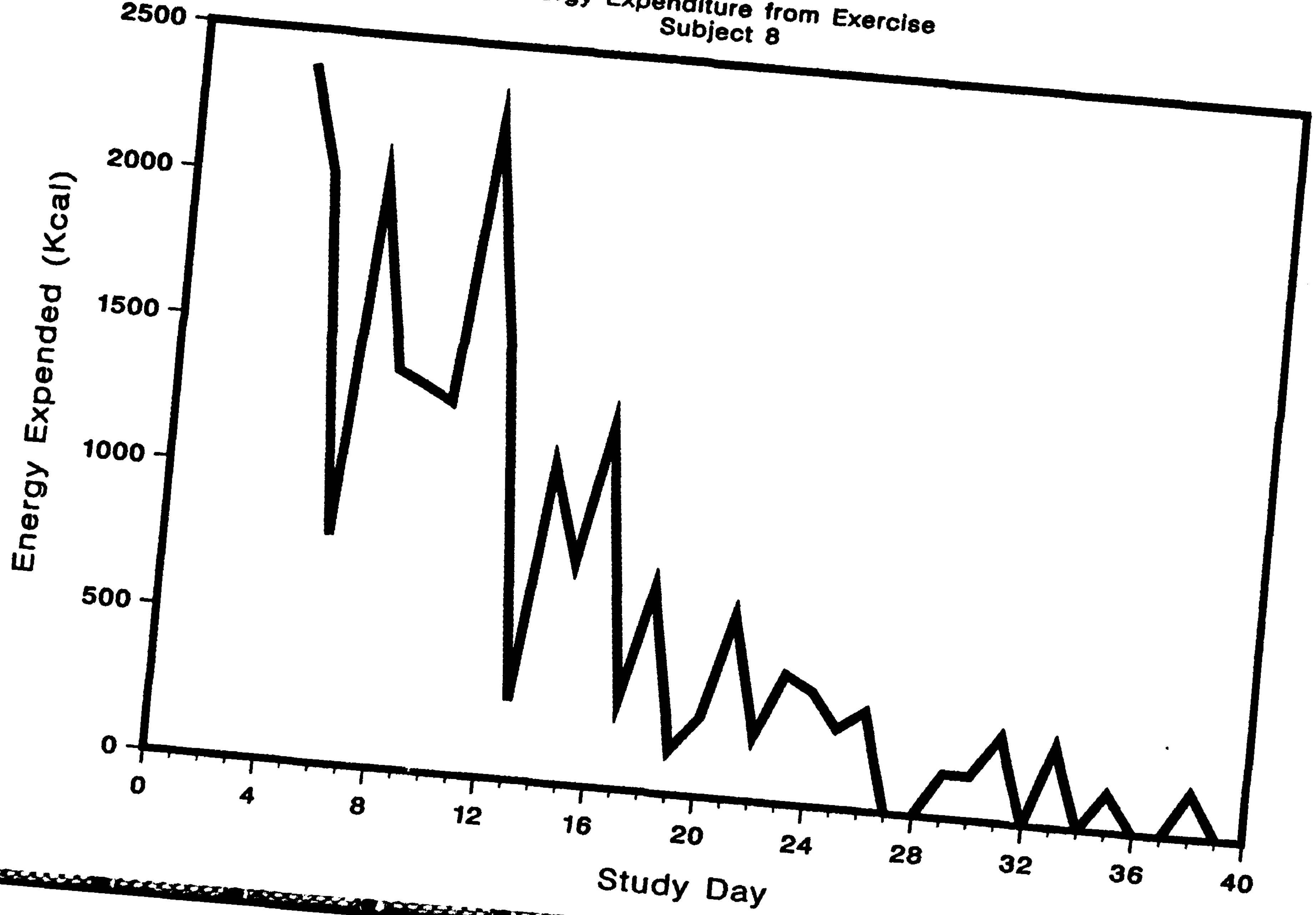


Figure 8
Operation Everest II
Energy Expenditure from Exercise
Subject 9

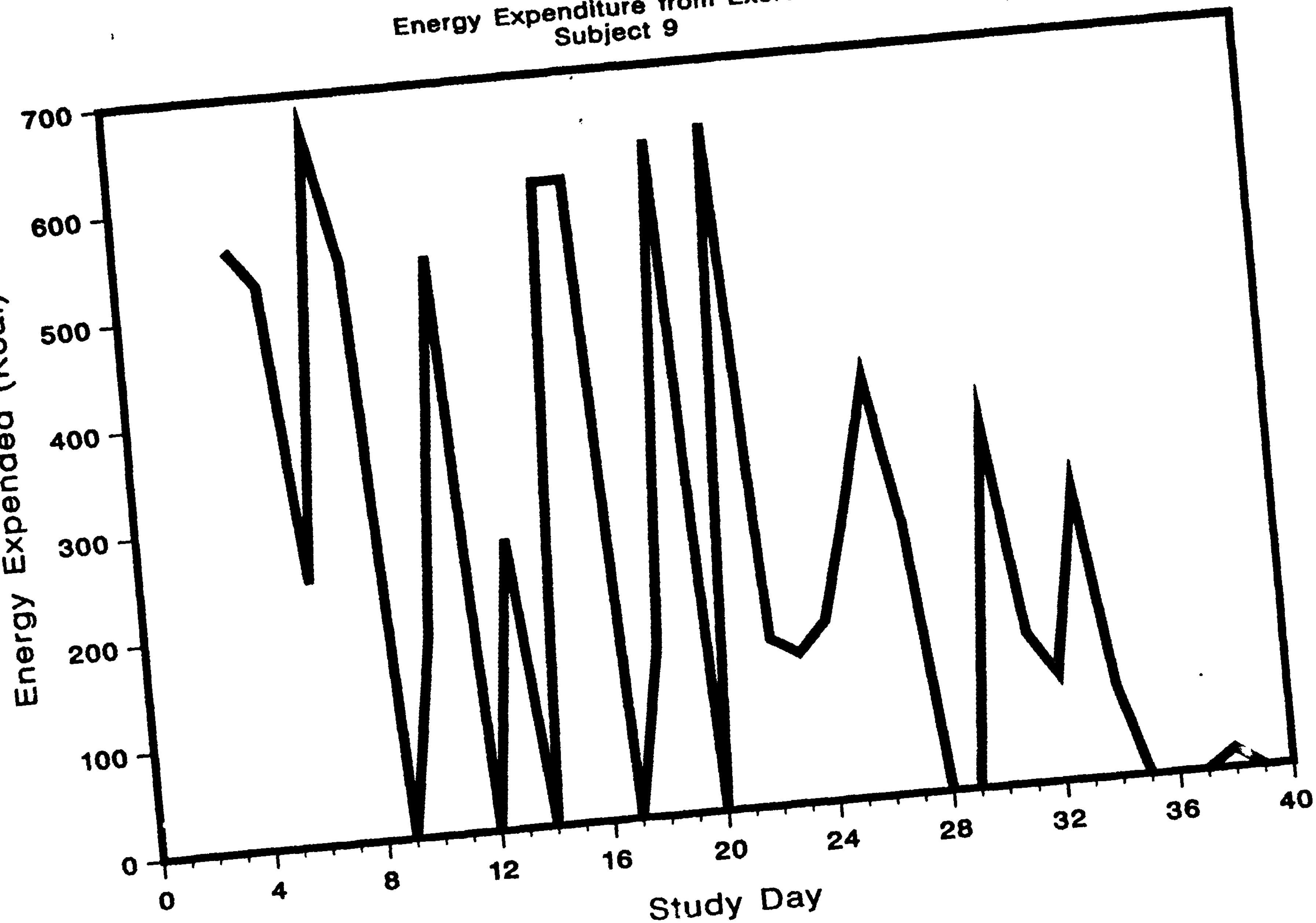


Figure 9
Operation Everest II
Duration of Exercise
Subject 1

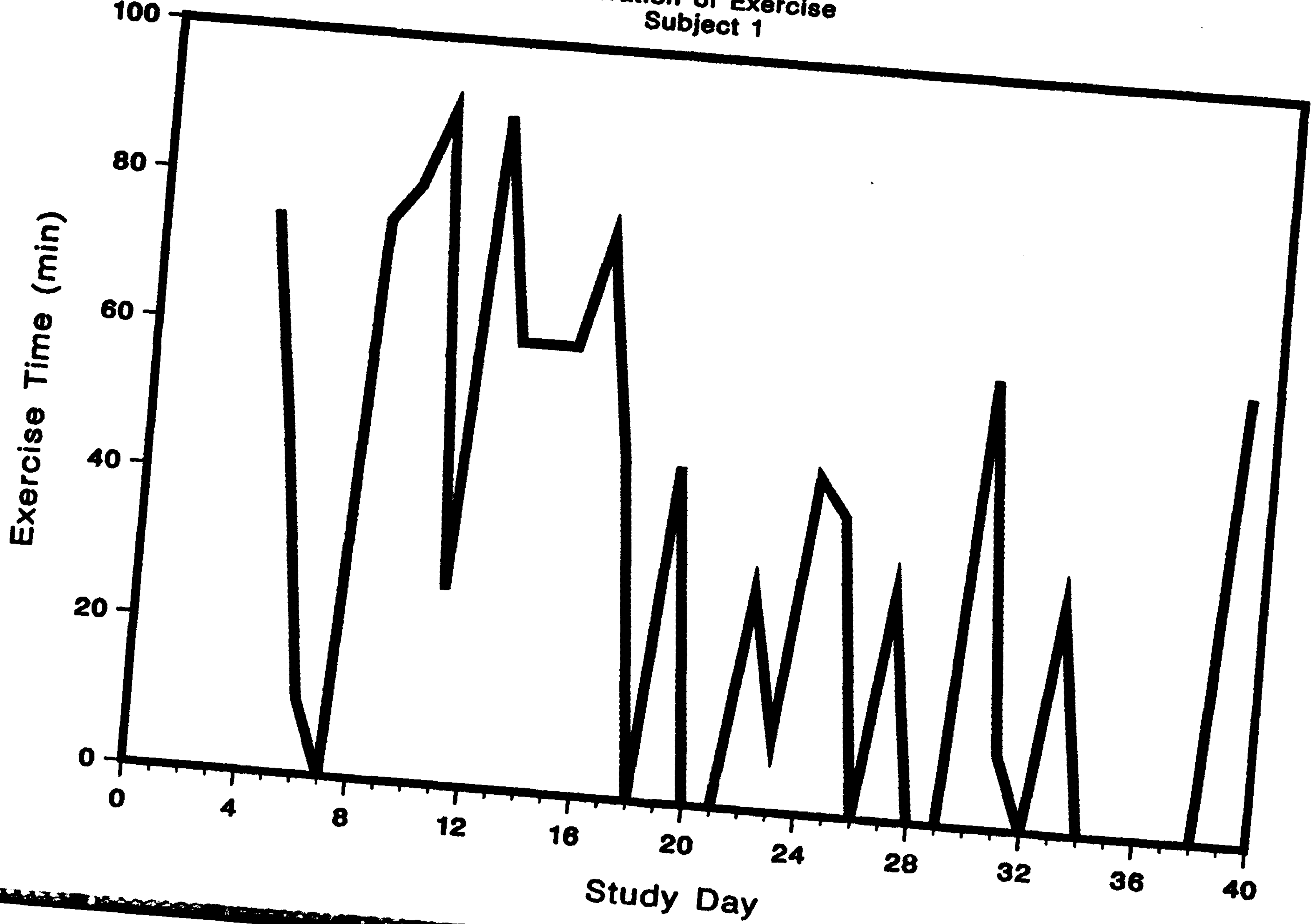


Figure 10

Operation Everest II

Duration of Exercise
Subject 3

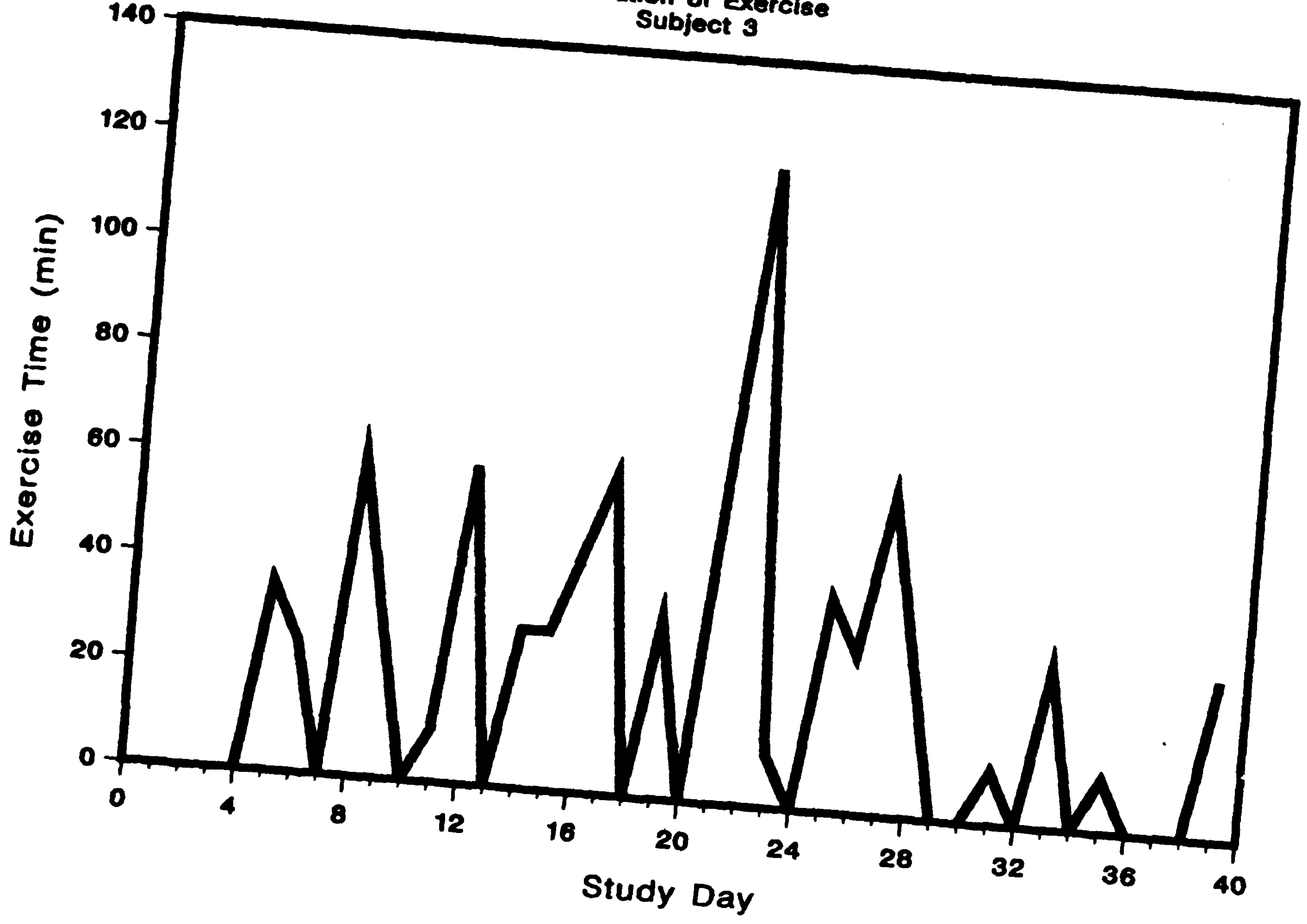


Figure 11

Operation Everest II

Duration of Exercise
Subject 4

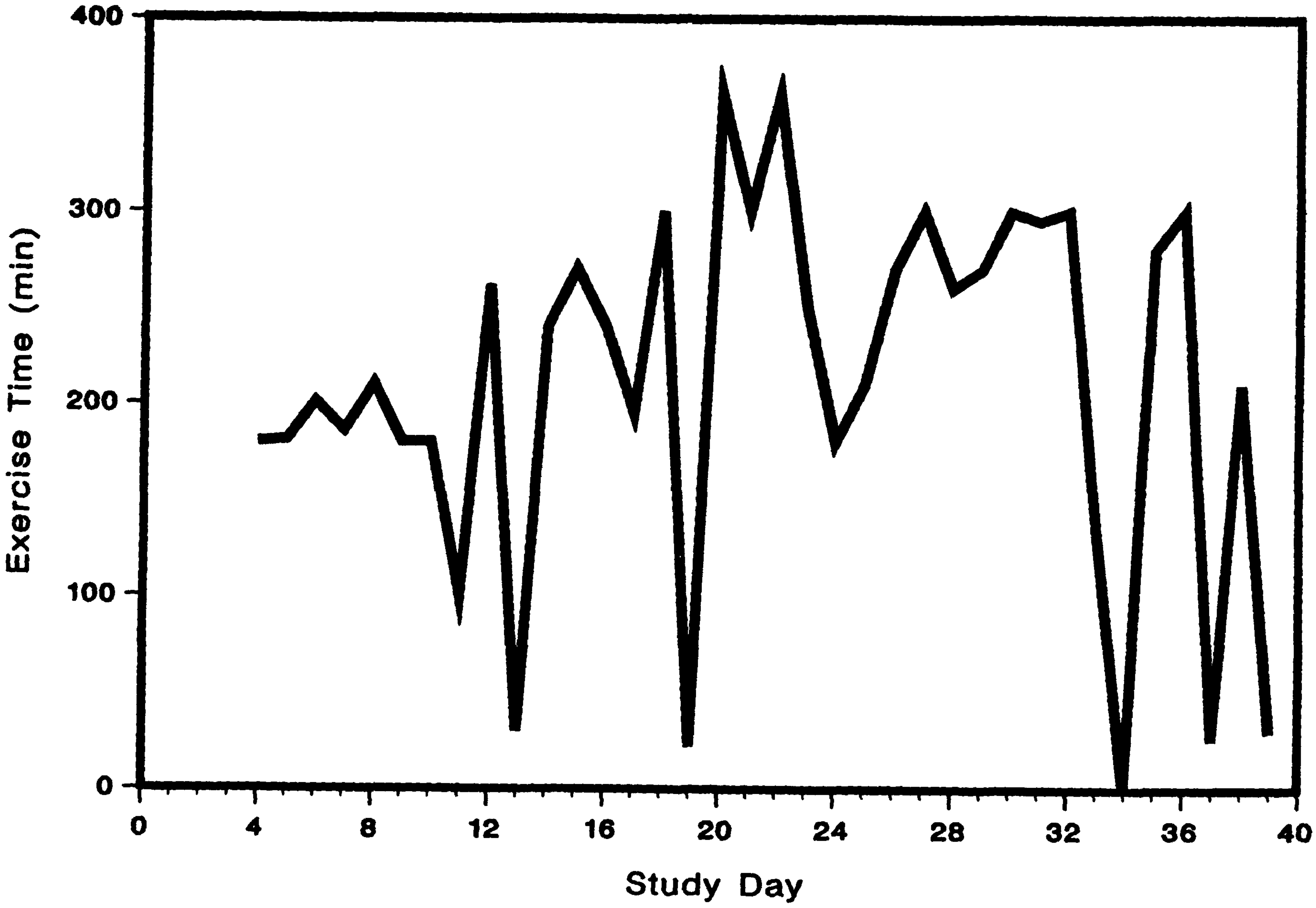


Figure 12

Operation Everest II

Duration of Exercise
Subject 5

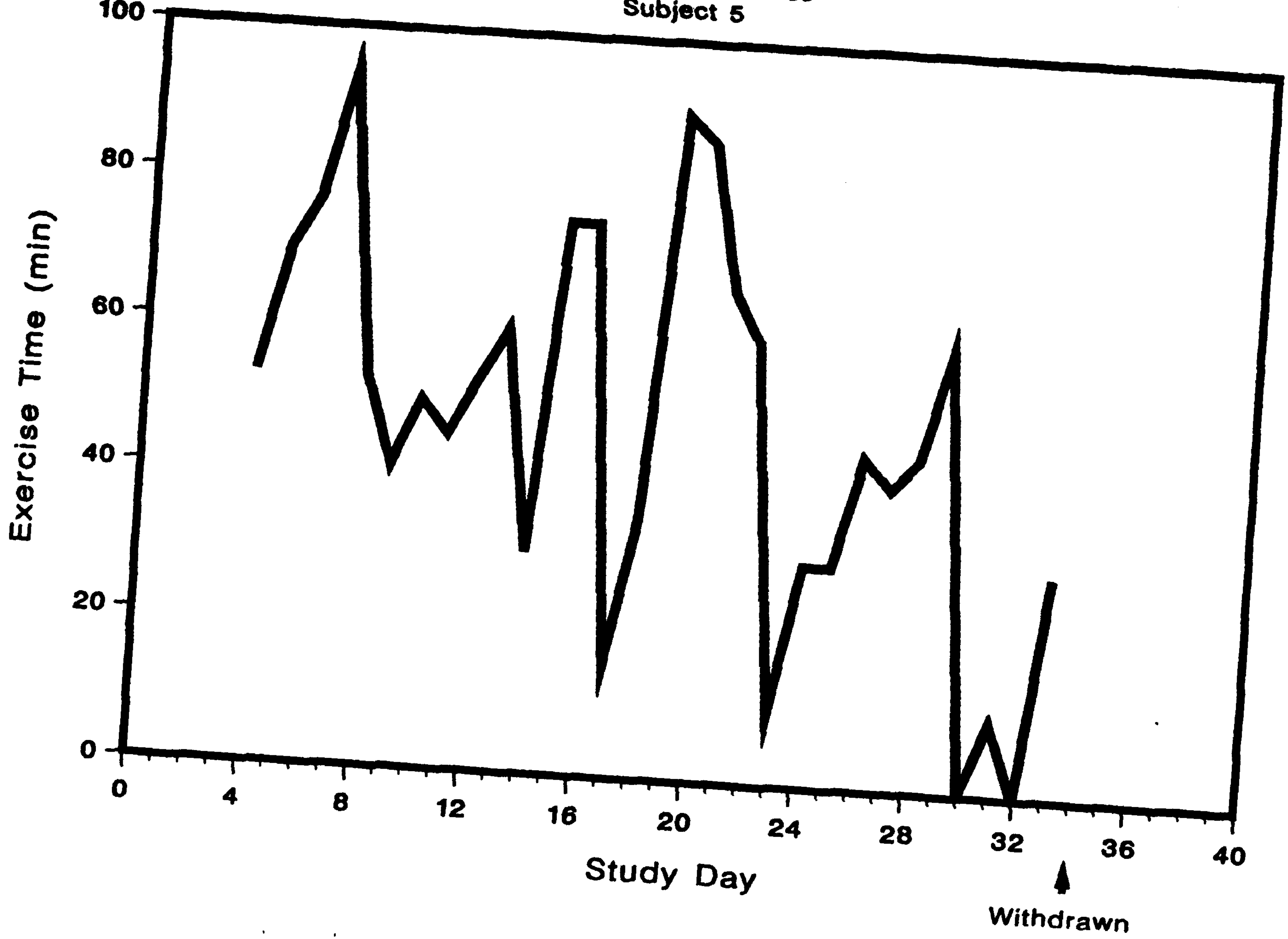


Figure 13

Operation Everest II

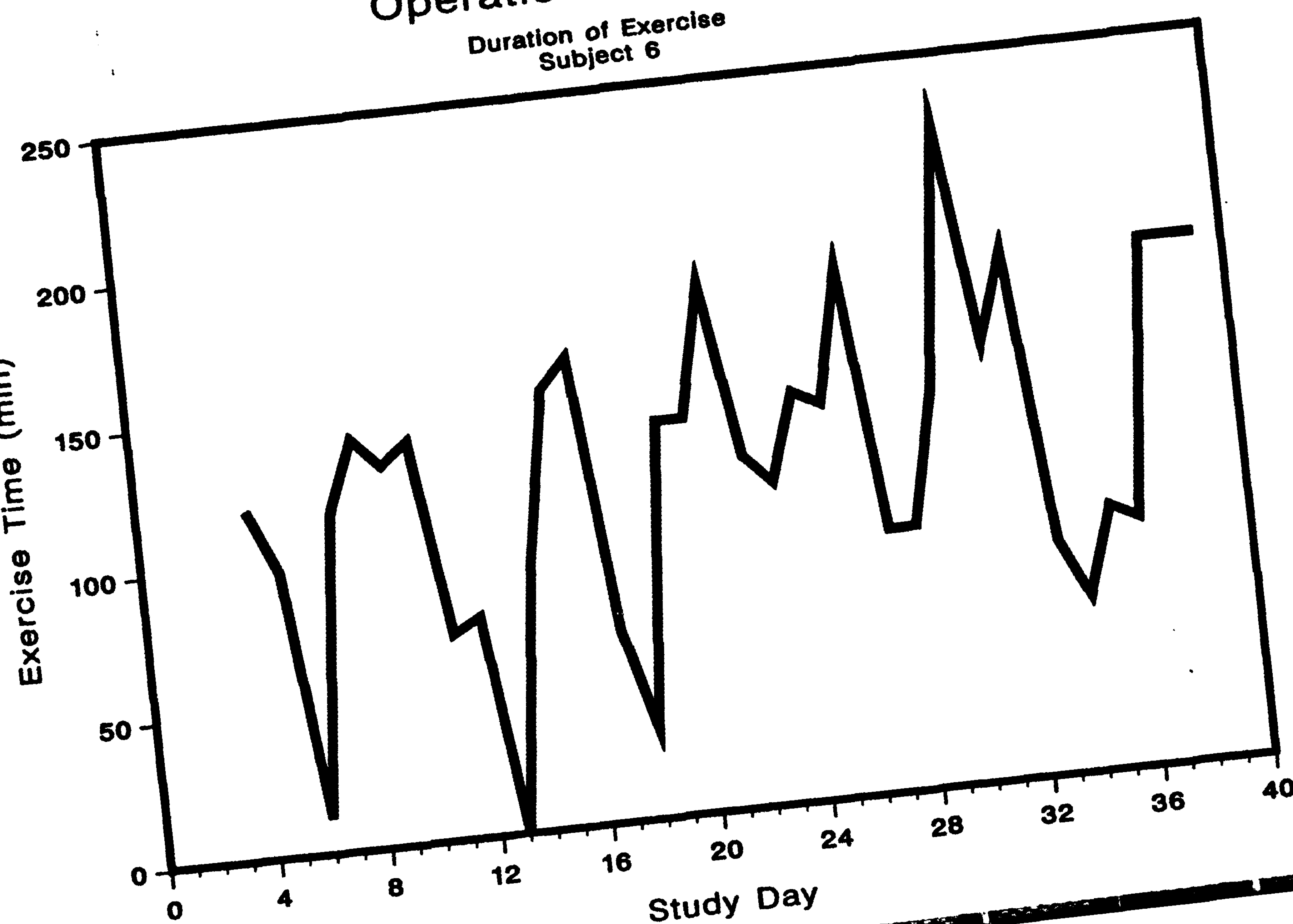


Figure 14

Operation Everest II

Duration of Exercise
Subject 7

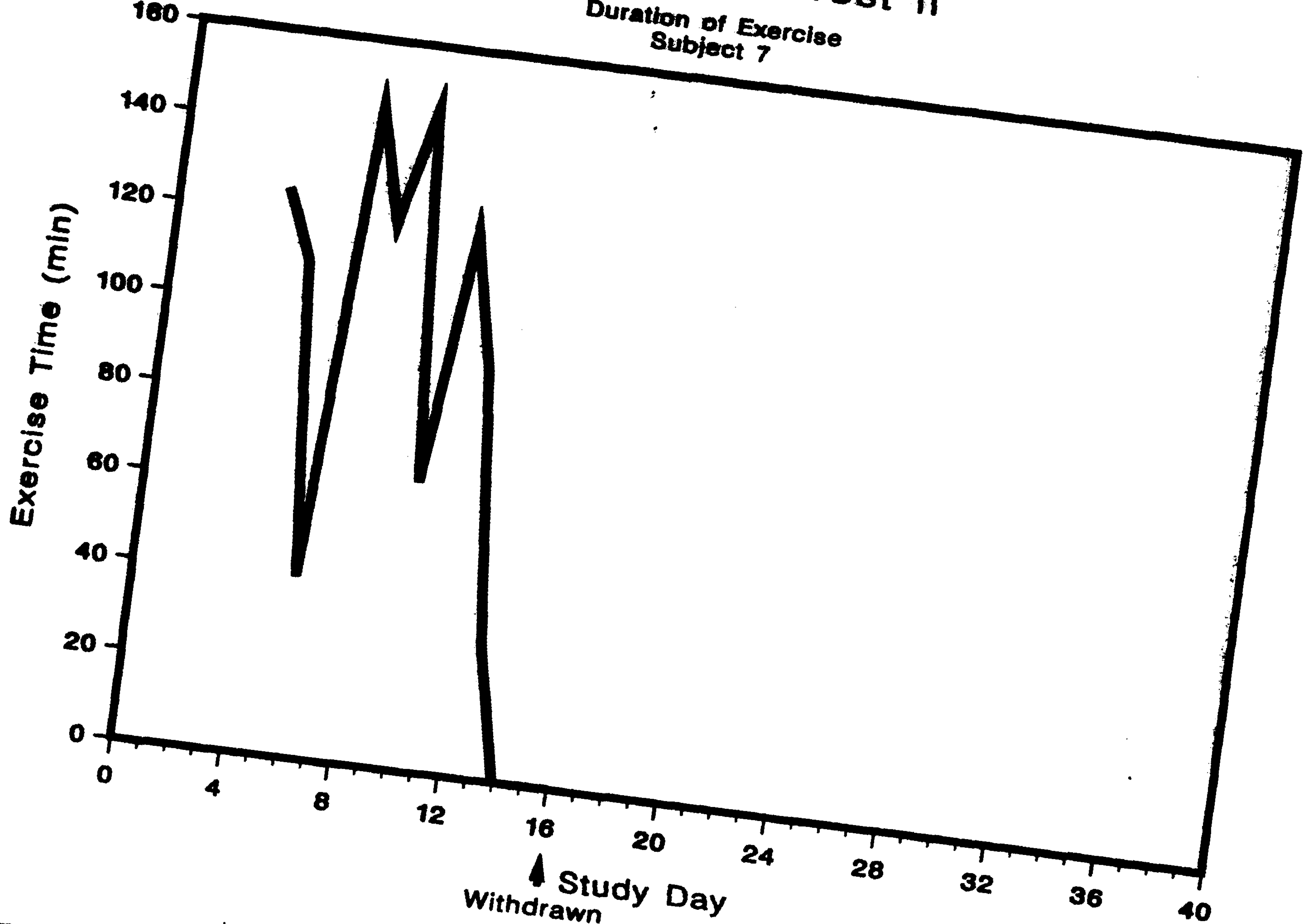


Figure 15

Operation Everest II

Duration of Exercise
Subject 8

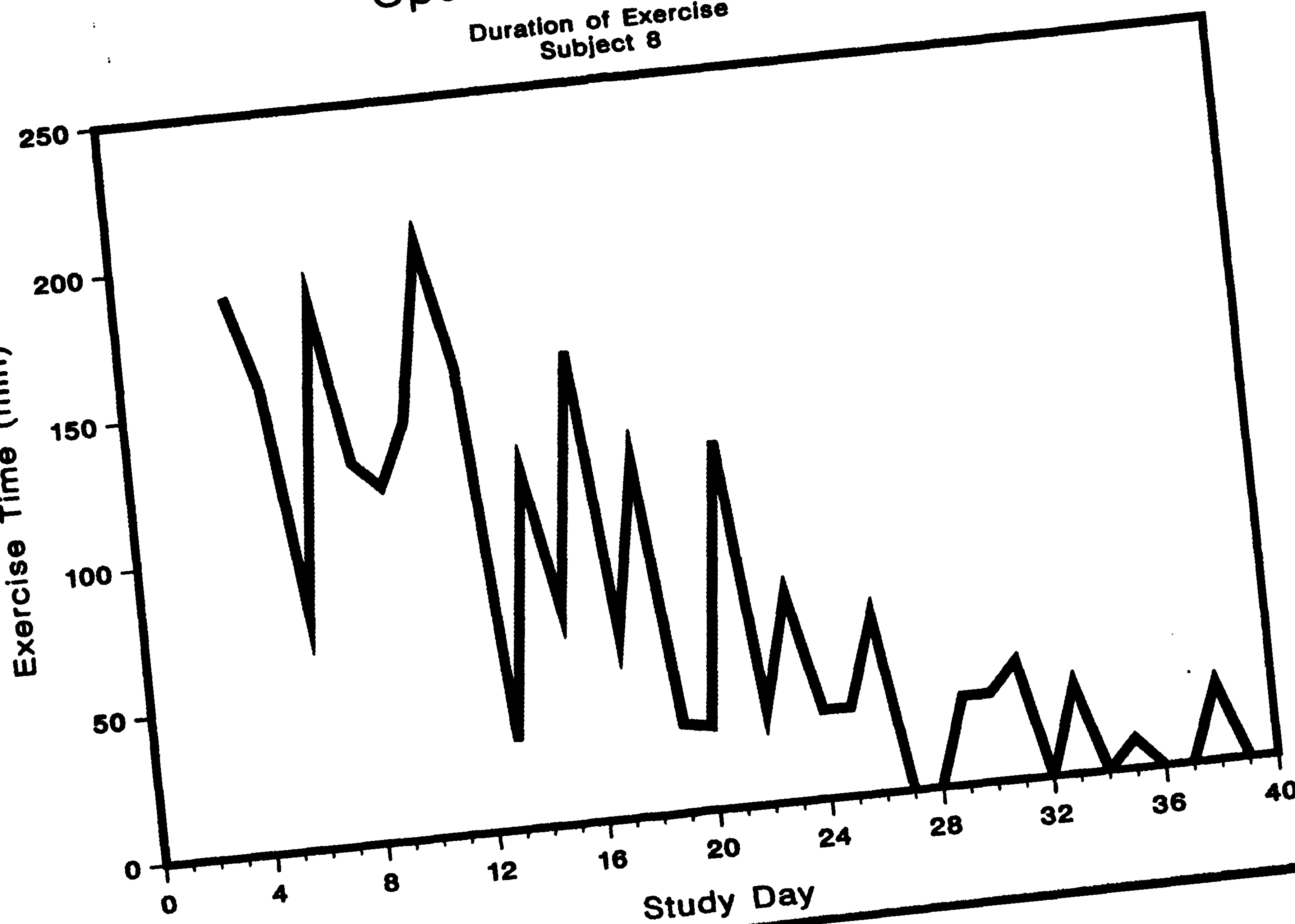


Figure 16
Operation Everest II

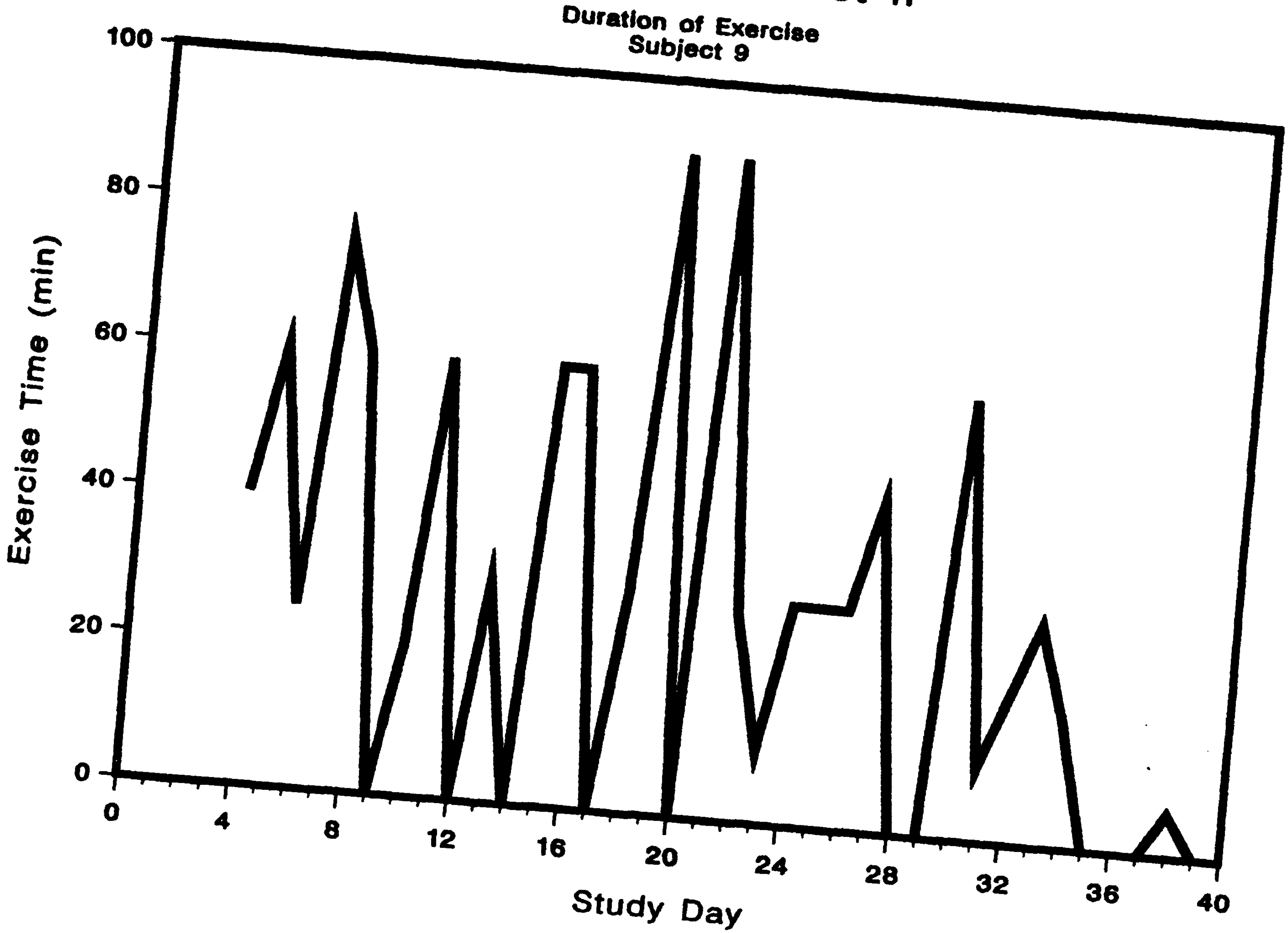


Figure 17

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 1

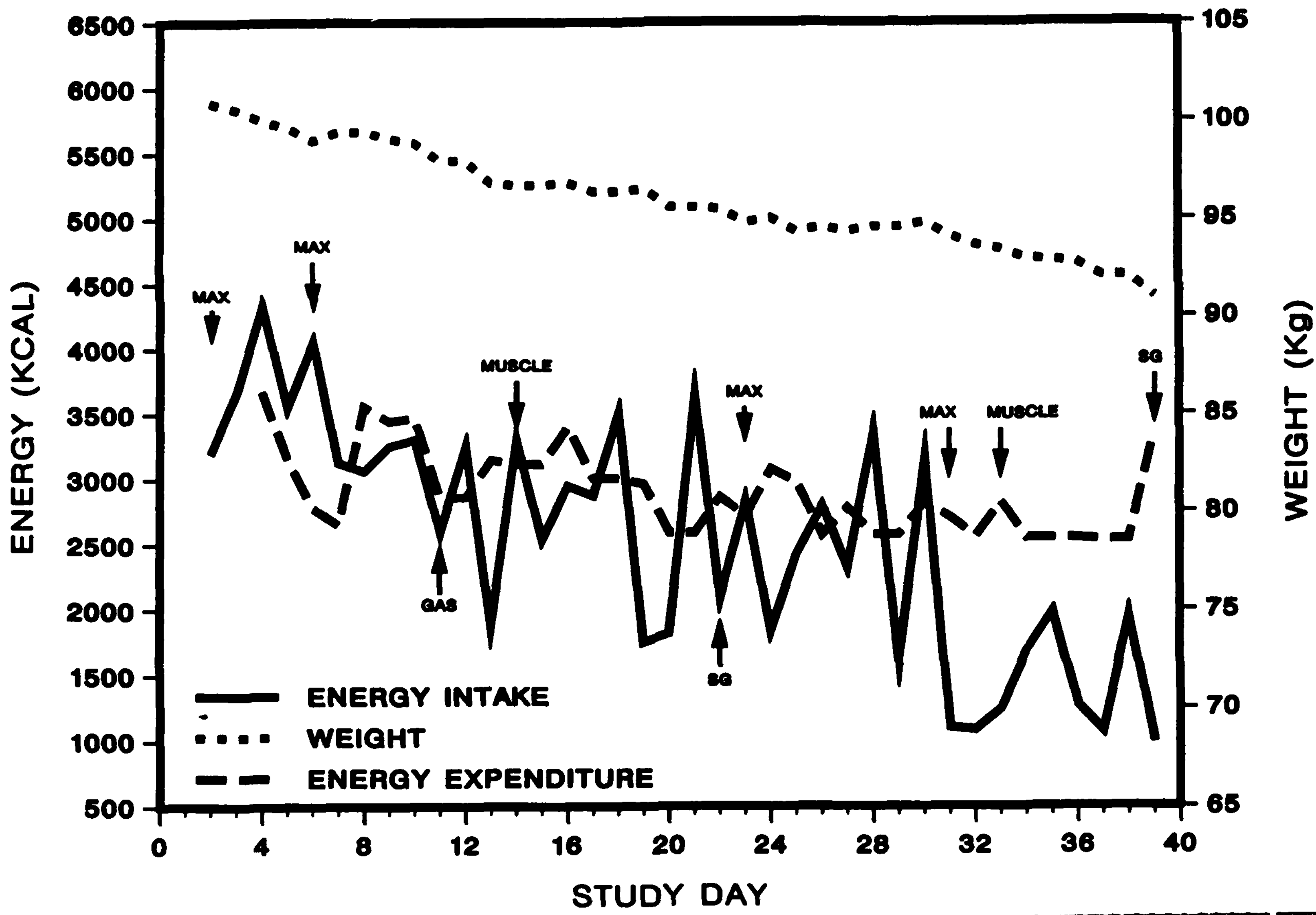


Figure 18

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 3

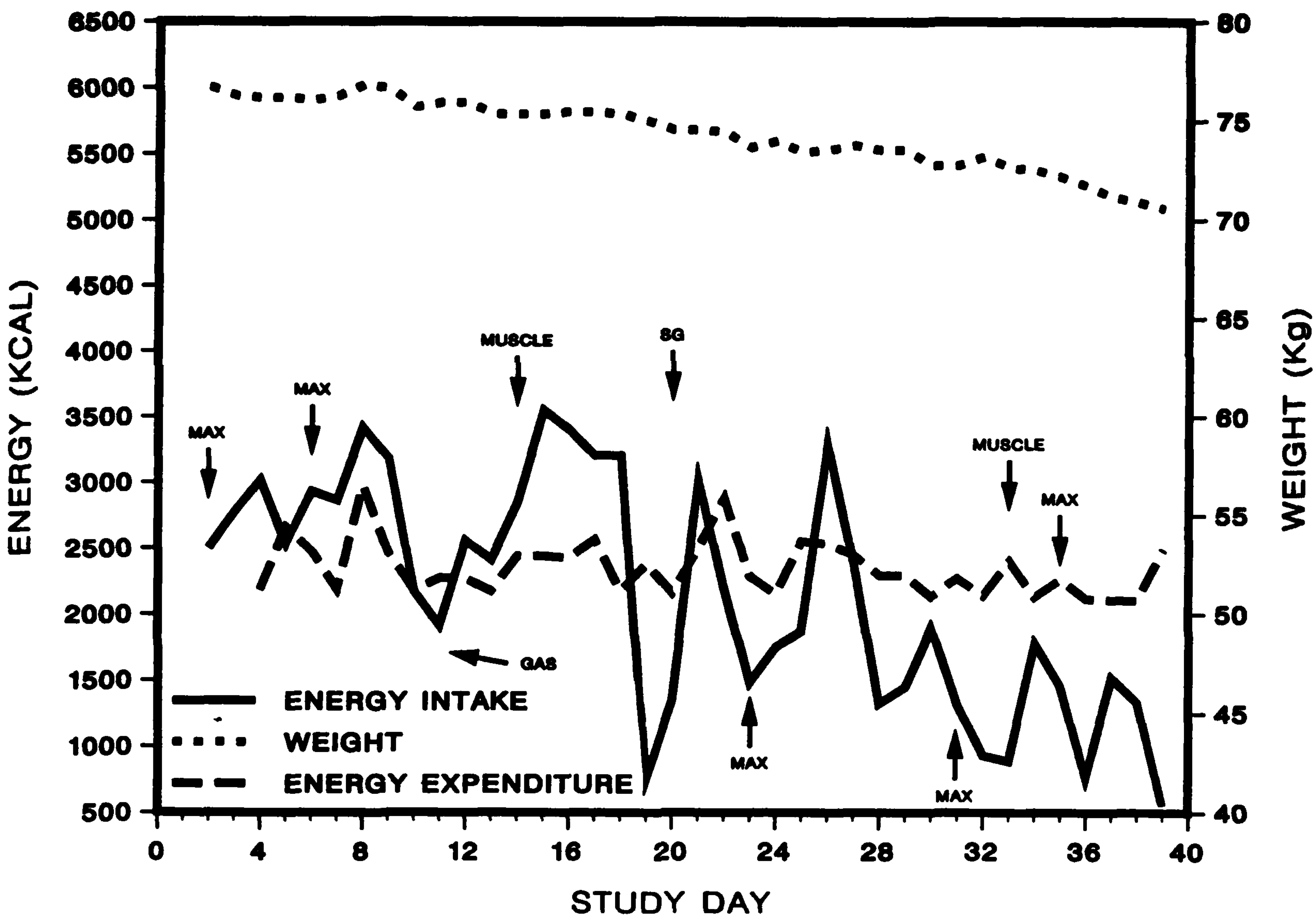


Figure 19

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 4

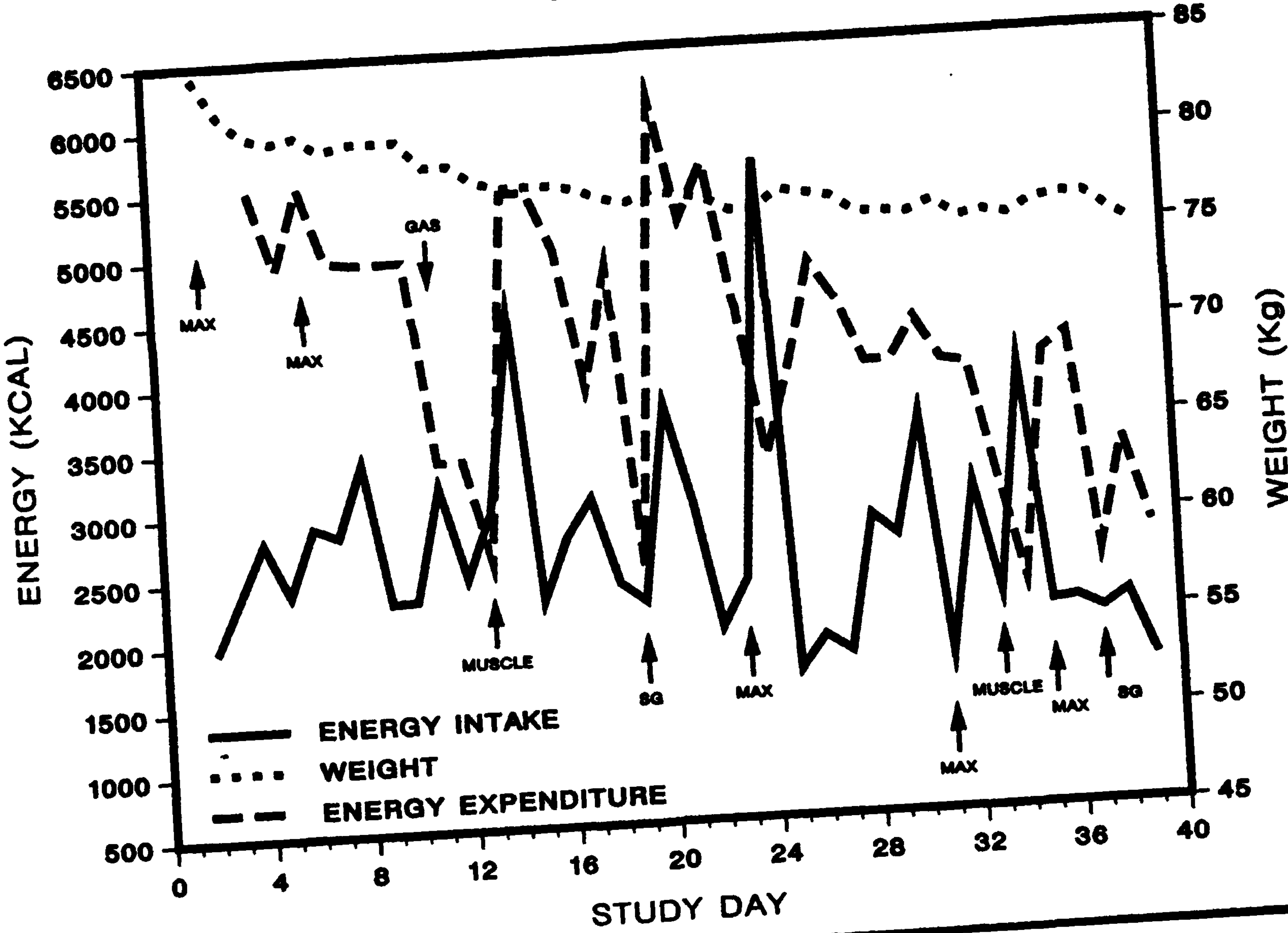


Figure 20

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 5

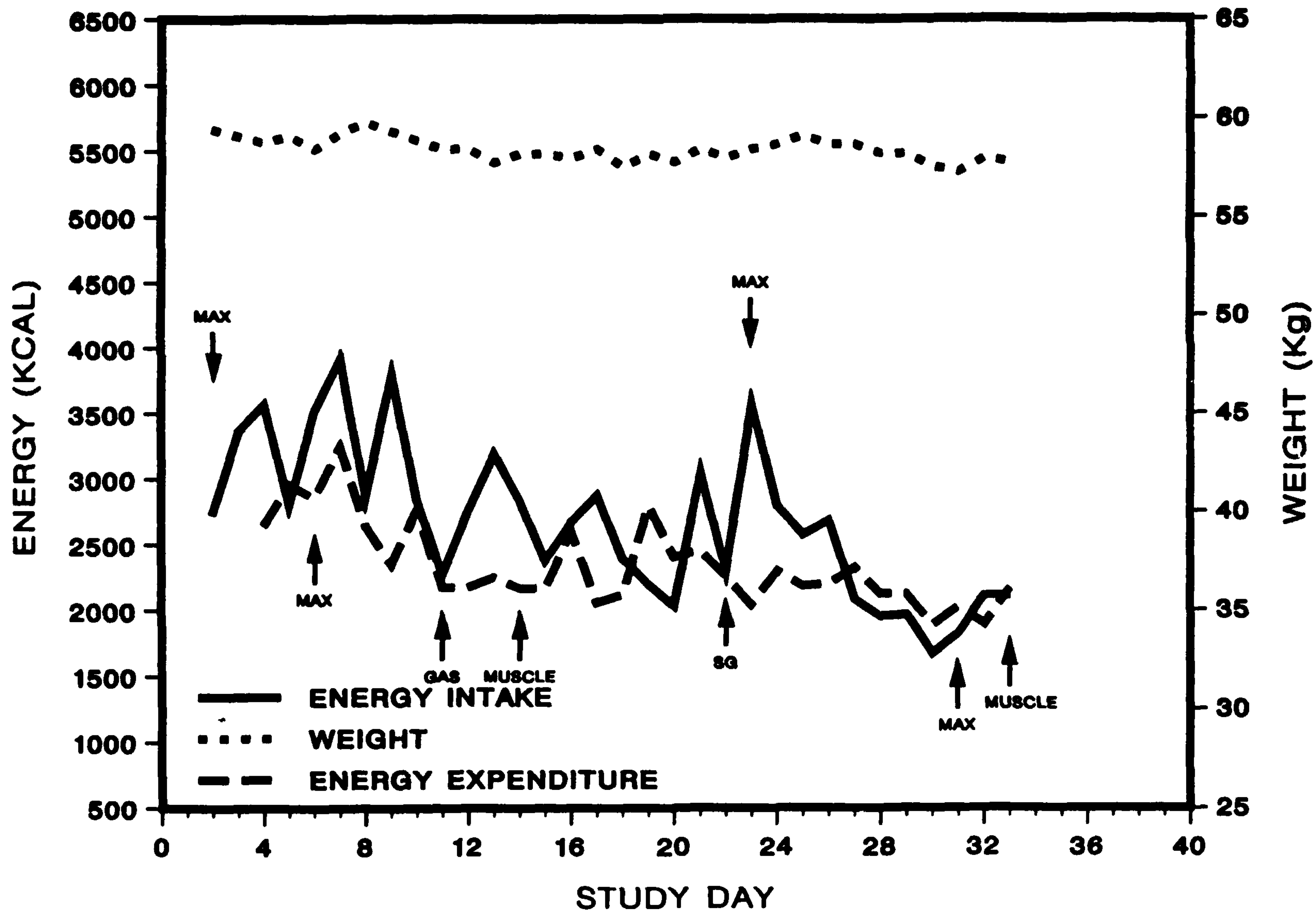


Figure 21

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 6

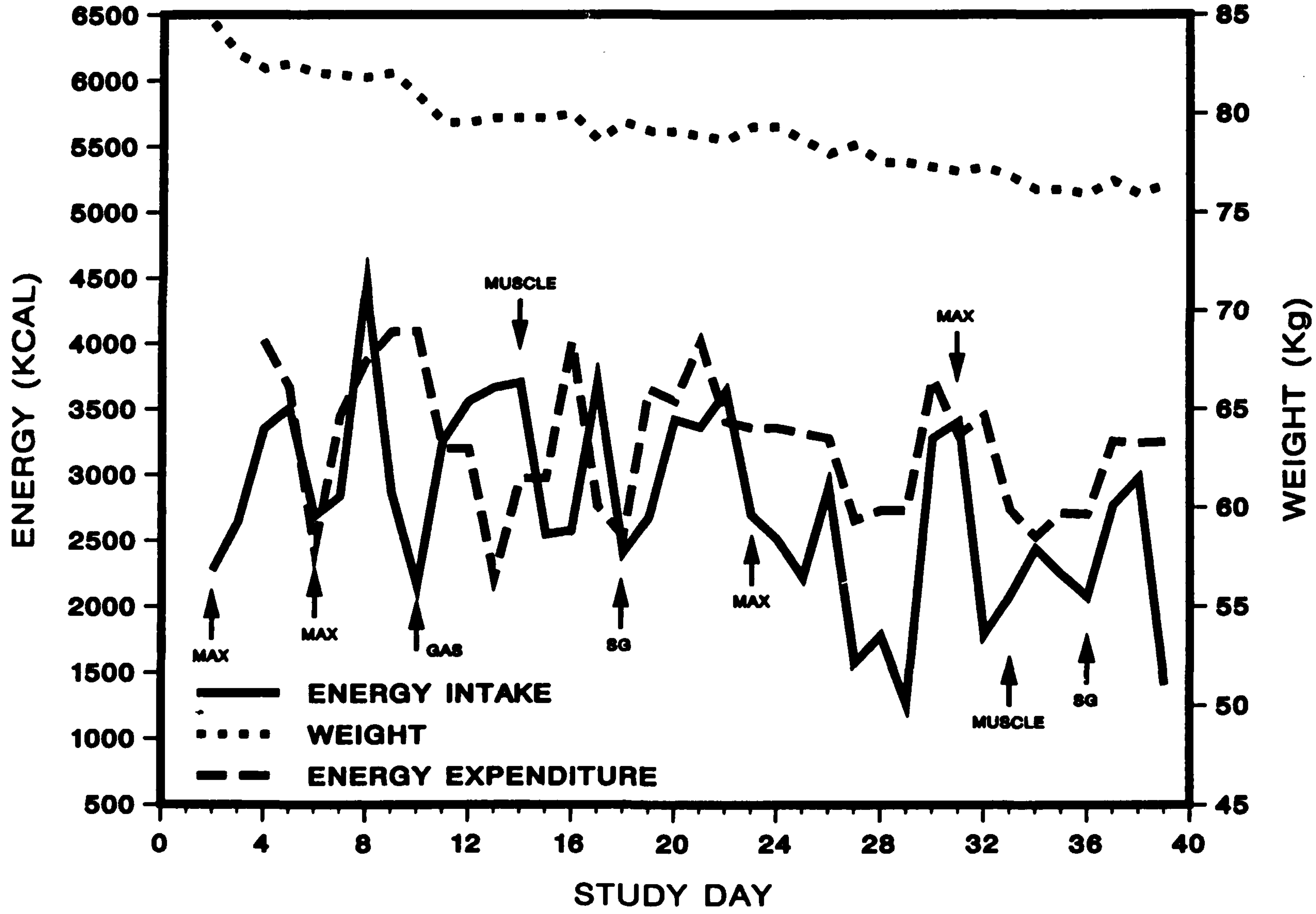


Figure 22

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 7

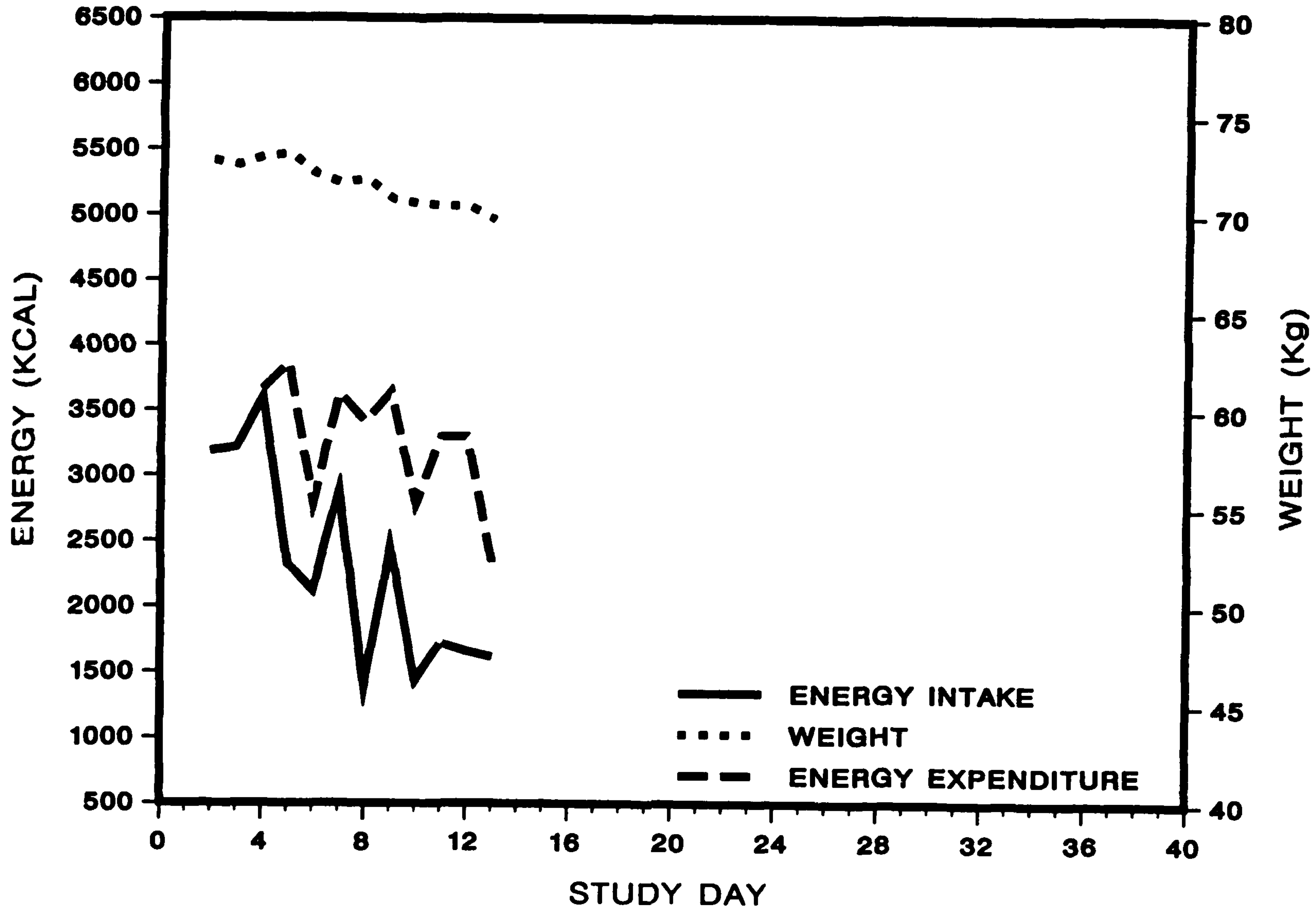


Figure 23

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 8

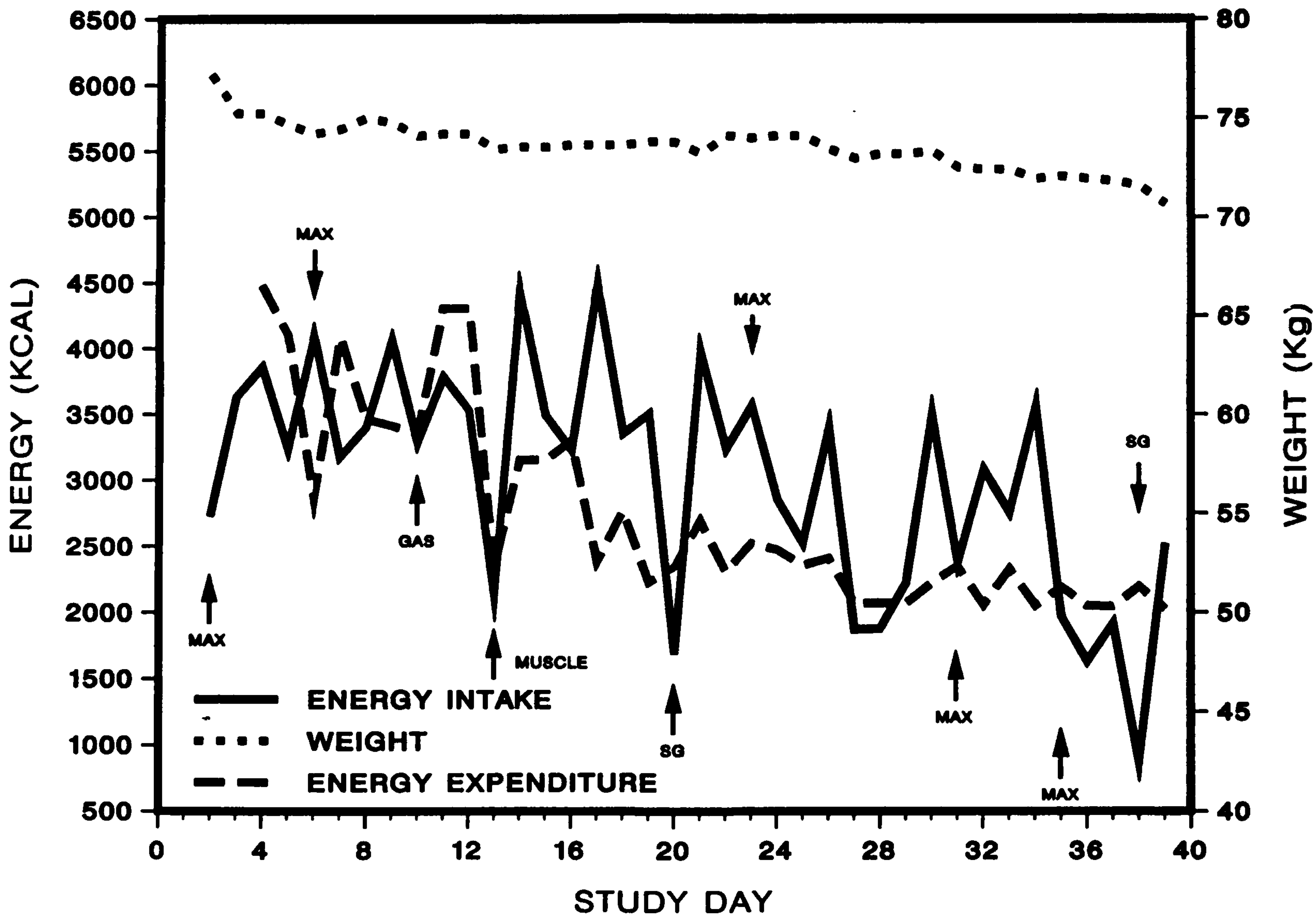


Figure 24

ENERGY and WEIGHT MEASUREMENTS

SUBJECT 9

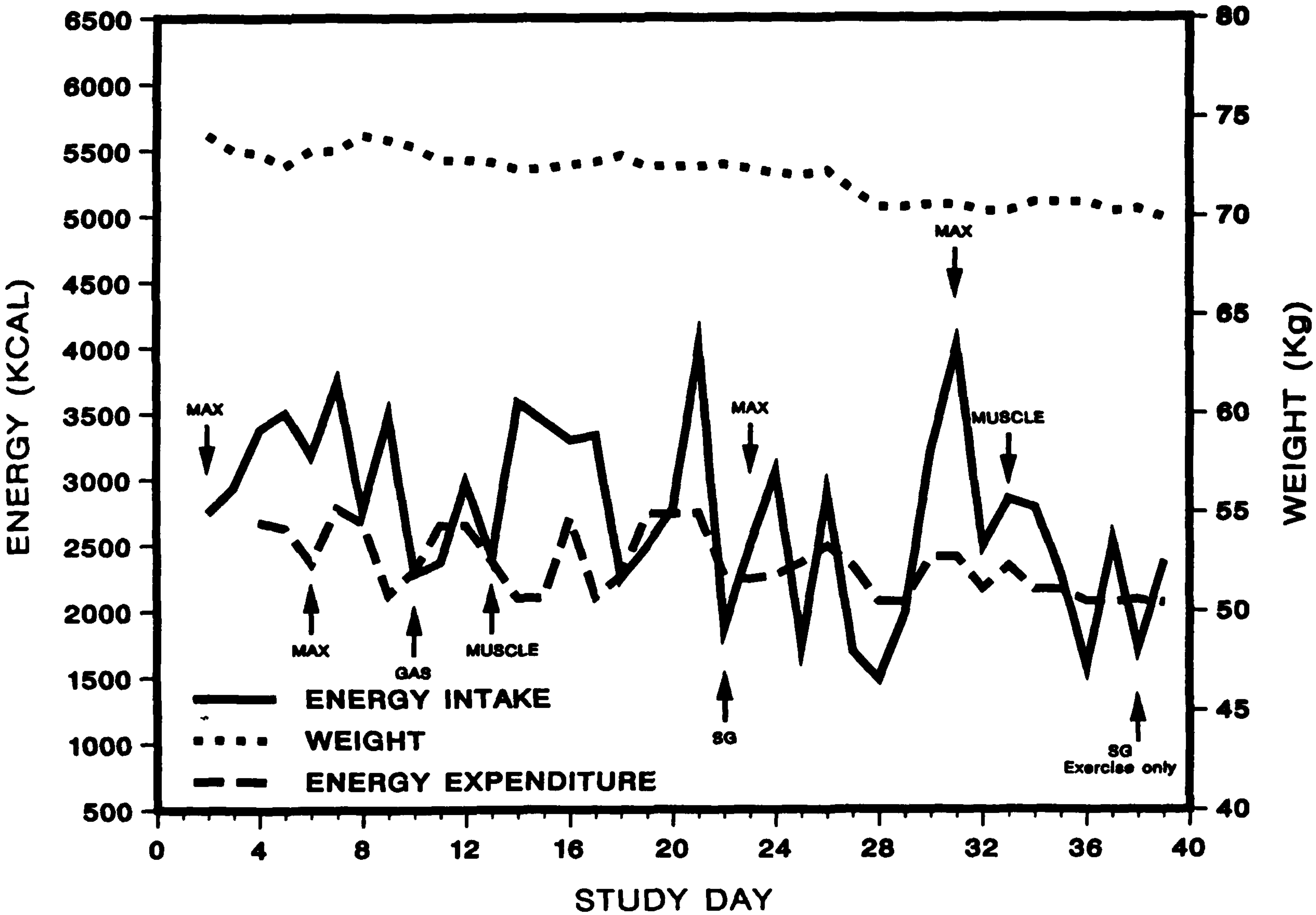


Figure 25

OPERATION EVEREST II

COMPOSITION of DIET

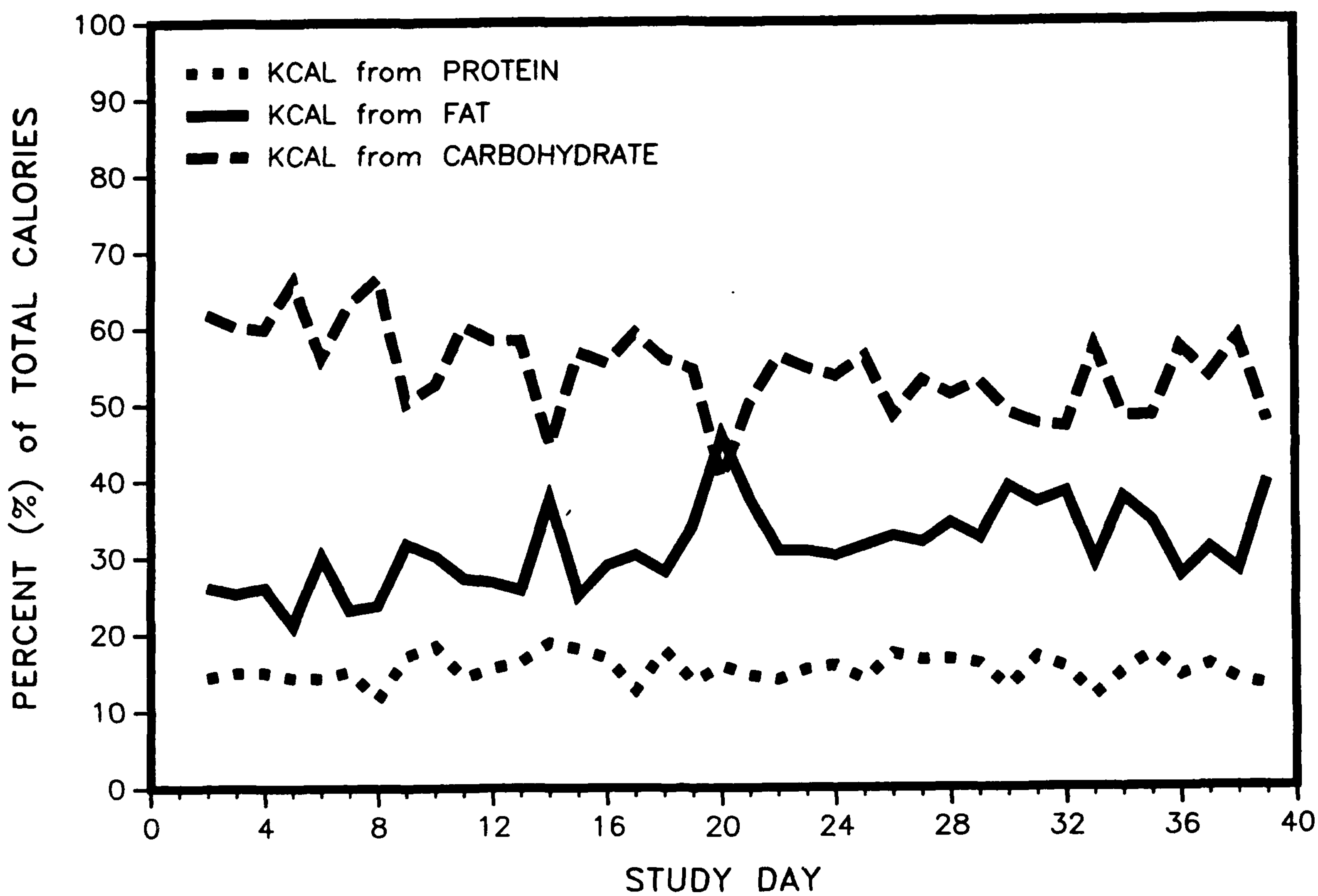


Figure 26
BODY COMPOSITION CHANGES
PERCENT BODY FAT BY HYDROSTATIC WEIGHING

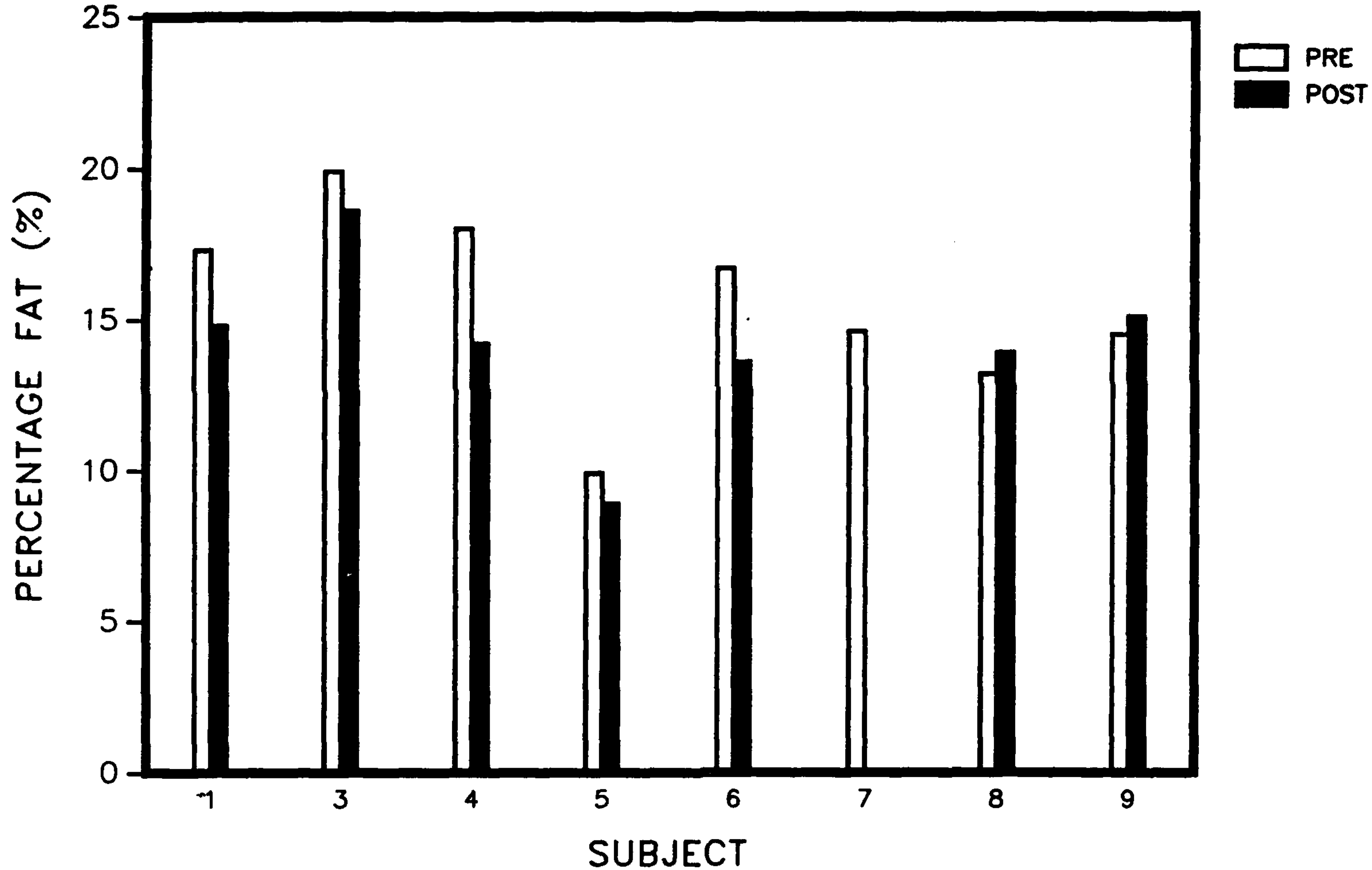


Figure 27

BODY COMPOSITION CHANGES

BODY FAT WEIGHT AS DETERMINED BY HYDROSTATIC WEIGHING

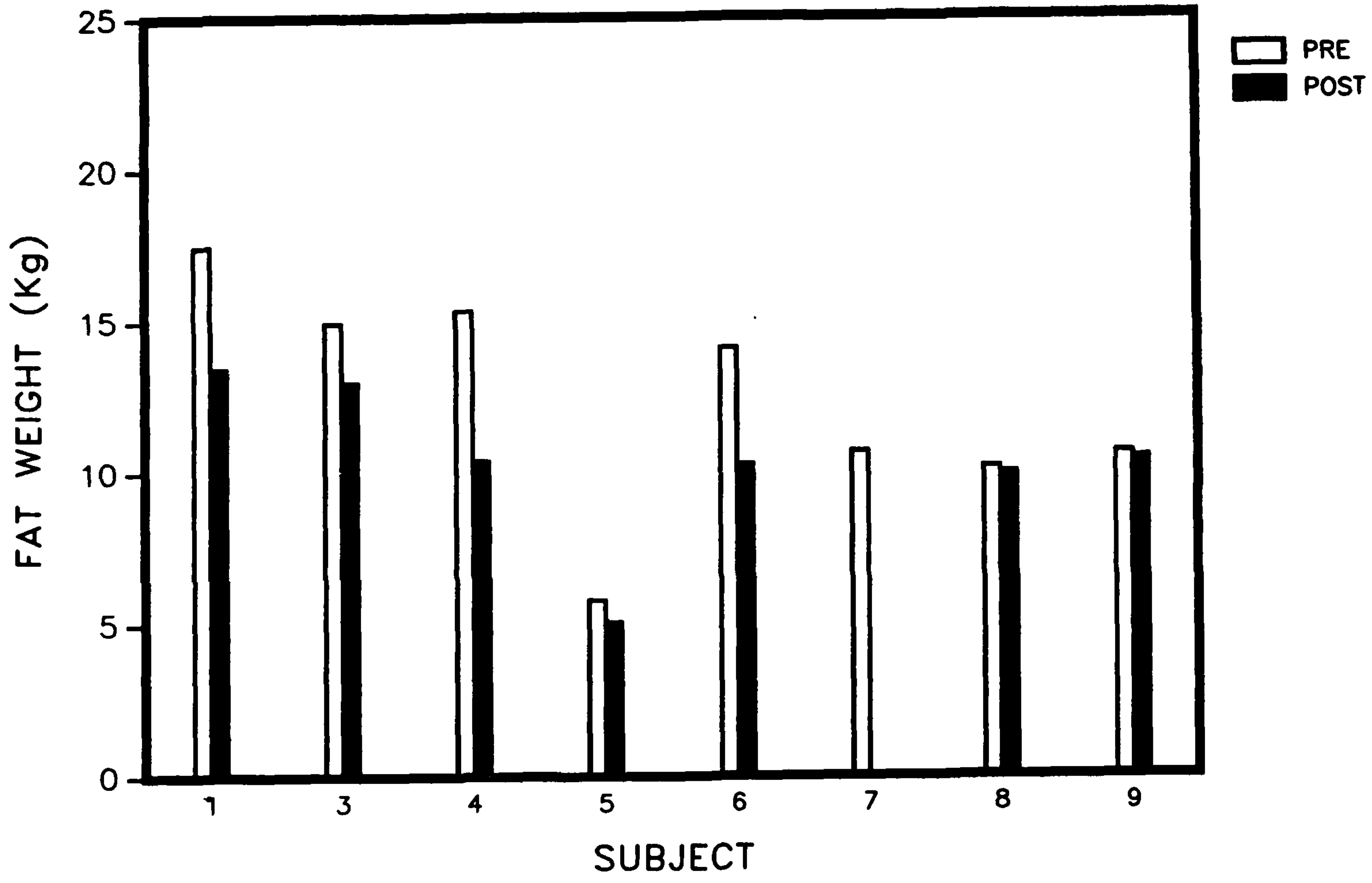


Figure 28
BODY COMPOSITION CHANGES
CIRCUMFERENCE MEASUREMENT OF ARM

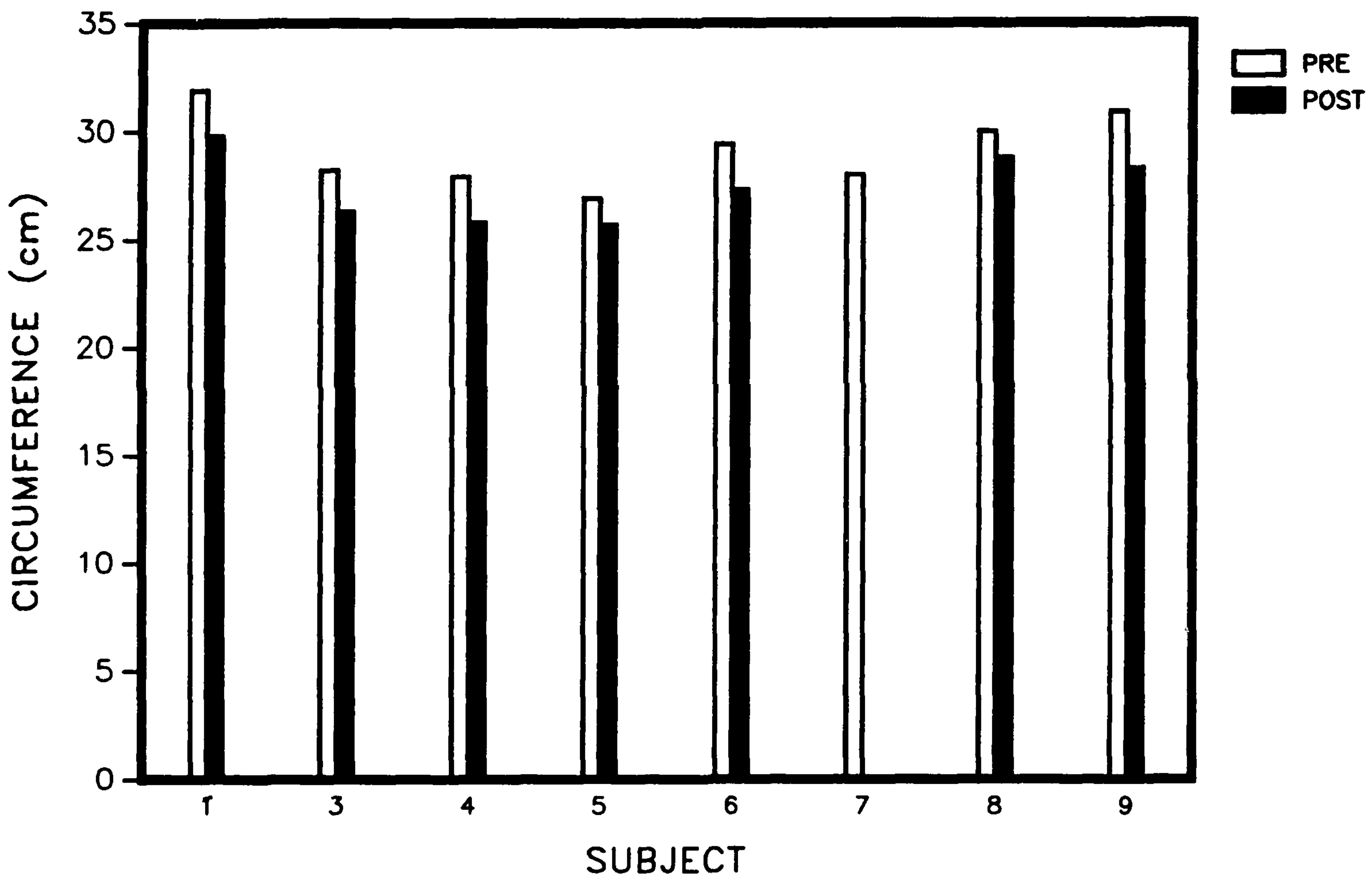


Figure 29

BODY COMPOSITION CHANGES

CIRCUMFERENCE MEASUREMENT OF THIGH

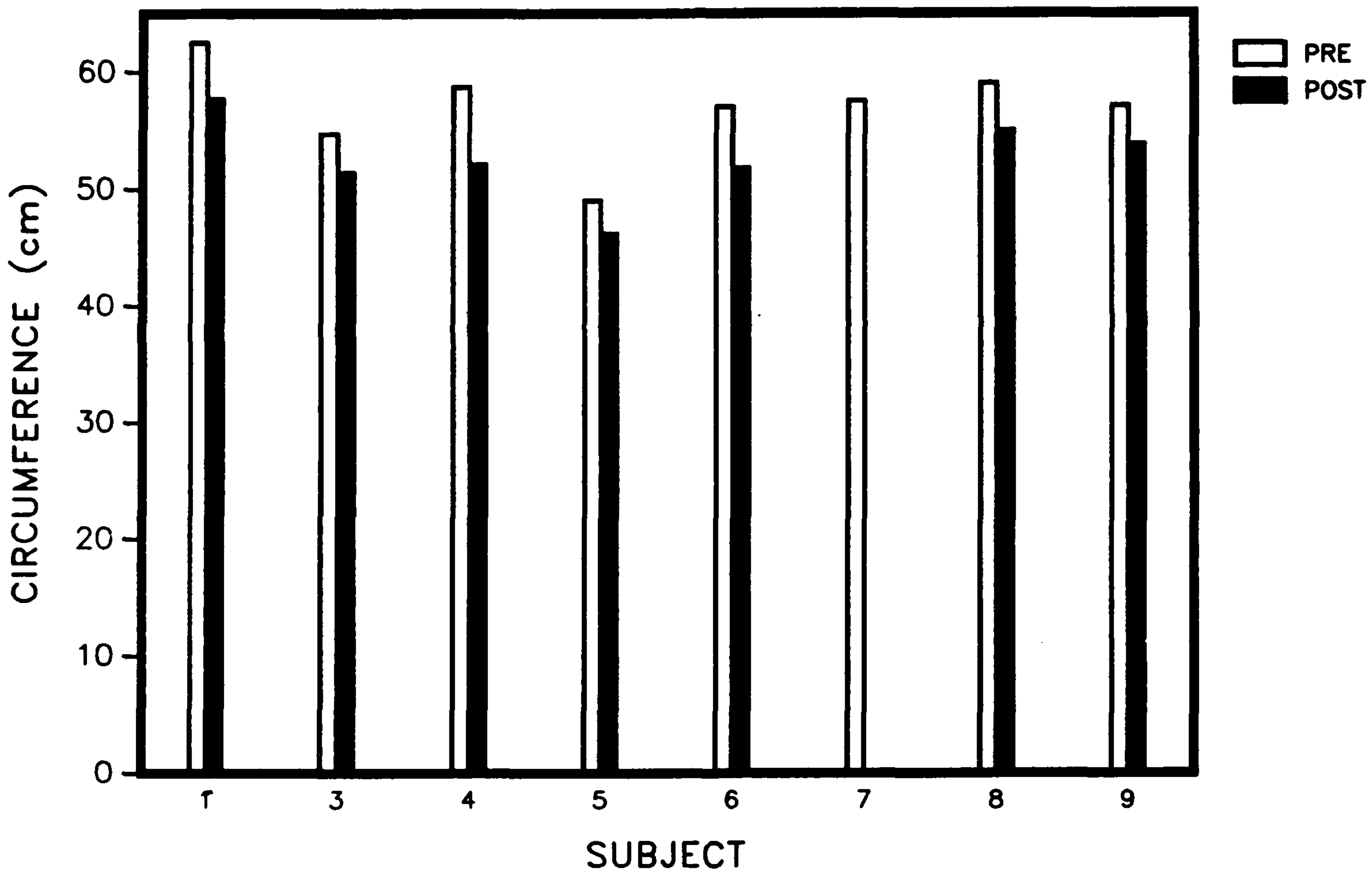


Figure 30

OPERATION EVEREST II
BODY COMPOSITION CHANGES

CT SCAN OF ARM

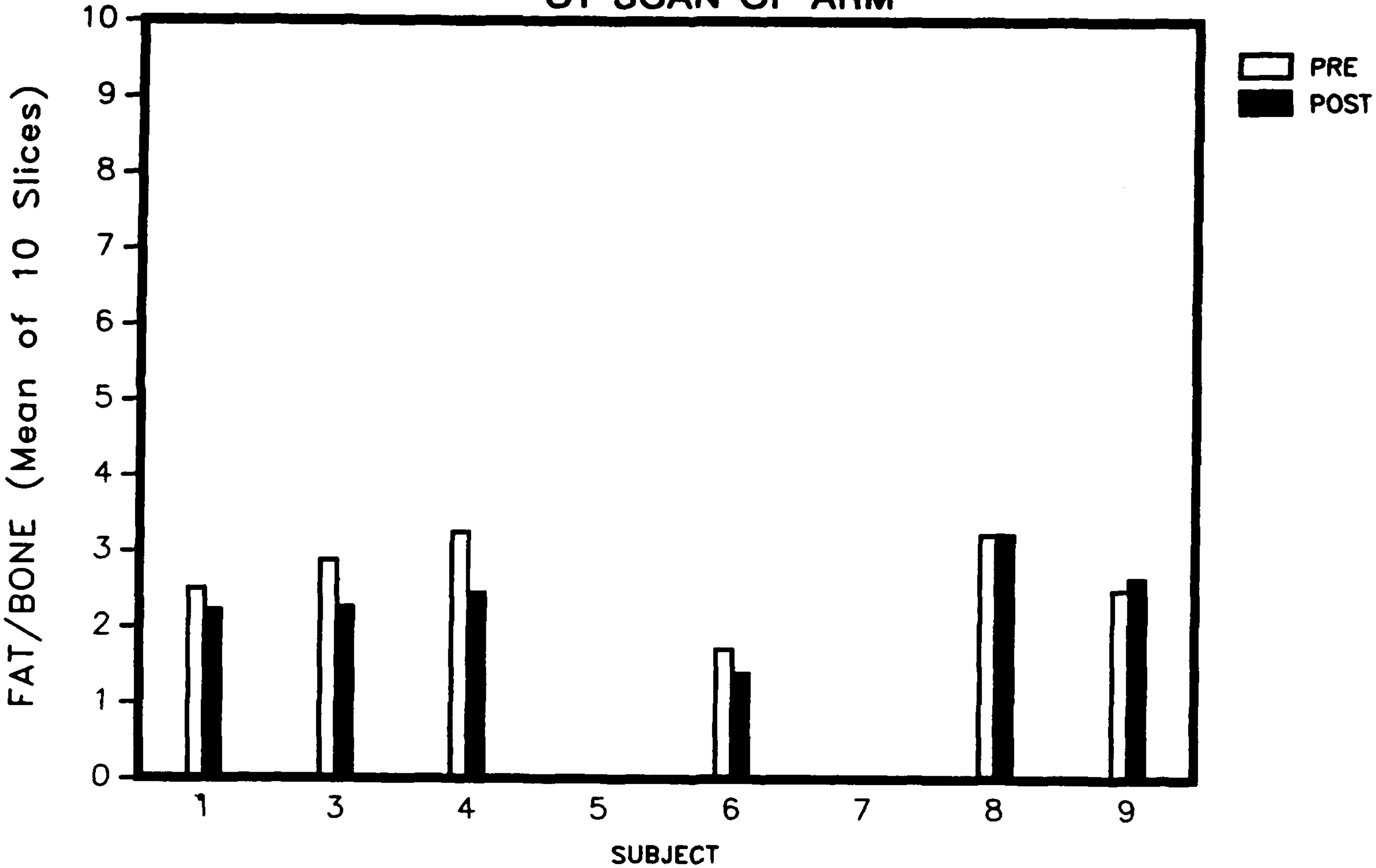


Figure 31

OPERATION EVEREST II
BODY COMPOSITION CHANGES

CT SCAN OF THIGH

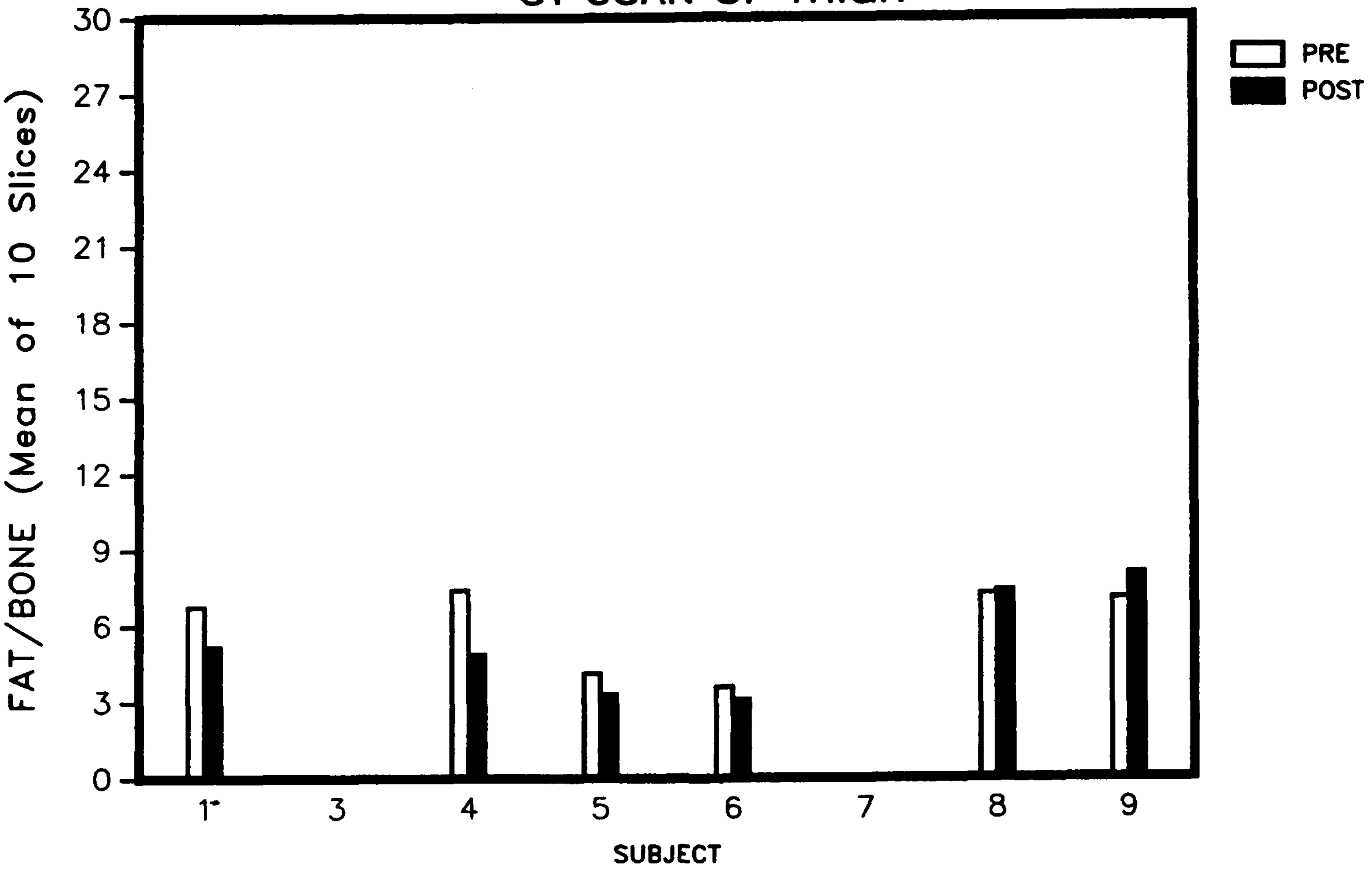


Figure 32
OPERATION EVEREST II
BODY COMPOSITION CHANGES

CT SCAN OF ARM

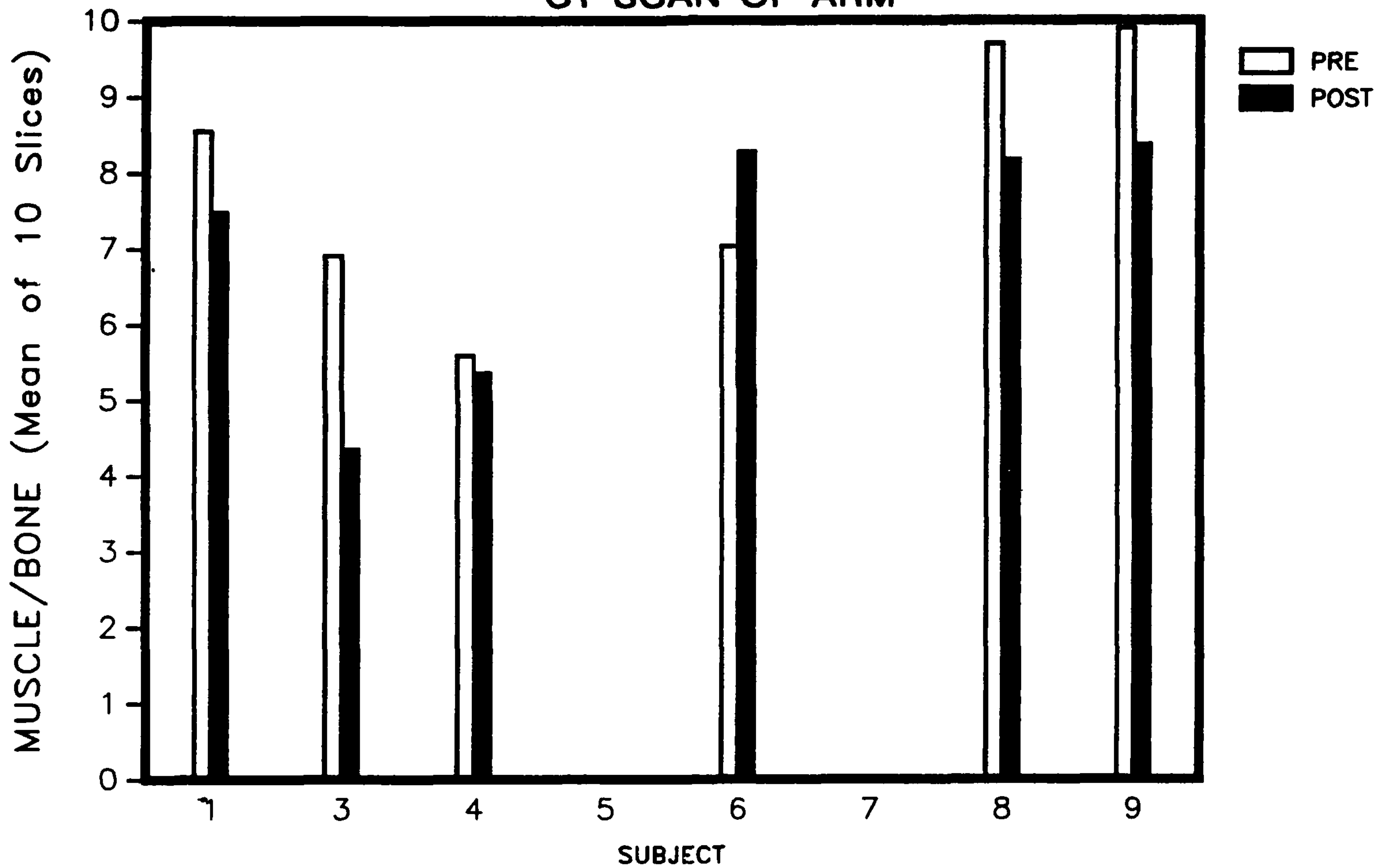
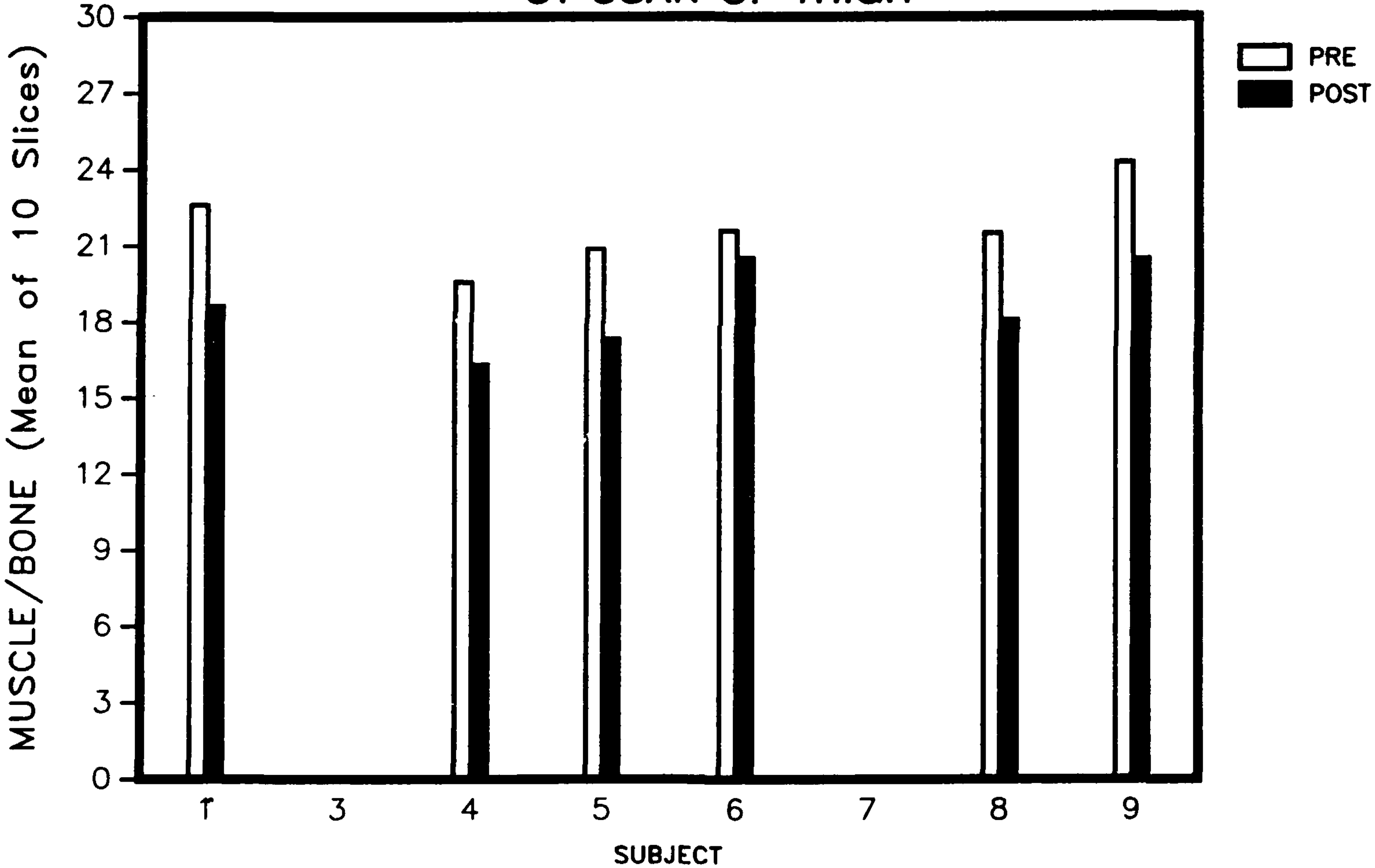


Figure 33

OPERATION EVEREST II
BODY COMPOSITION CHANGES

CT SCAN OF THIGH



APPENDICES

APPENDIX 1

Breakfast (1)

Subject Name______________________

Date______________________

Amount	Unit	Food Item
8	oz.	Orange Juice
2	each	Hard boiled eggs
1	cup	raisin bran
1	cup	lowfat milk
2	slices	toast
1	T.	Margarine
1	T.	Jelly
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Lunch (1)

Subject Name______________________

Date______________________

Amount	Unit	Food Item
4	slices	whole wheat bread
3	oz.	Roast Beef Lean
2	leaves	lettuce
2	T.	mayonnaise
1	cup	Potato Sld
1	each	Fresh banana
1	pkg	sugar
8	oz	coffee
8	oz	hot tea

Dinner (1)

Subject Name______________________

Date______________________

Amount	Unit	Food Item
10 1/2	oz	Spaghetti w/meatsauce
1/2	cup	corn
1	cup	tossed salad
1	T.	Italian Dressing
2	slices	french bread
1	T.	margarine
1	serving	Chocolate Cake
1	pkg	sugar
8	oz	coffee
8	oz	hot tea

Snack (1)

Subject Name______________________

Date______________________

Amount	Unit	Food Item
1	cup	lowfat yogurt w/fruit

Breakfast (2)

Subject Name ____________________

Date ____________________

Amount	Unit	Food Item
8	oz	Orange Juice
1	each	Banana
1	cup	oatmeal
1	cup	milk, lowfat
1	each	English Muffin
2	T.	margarine
1	T.	jam
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Lunch (2)

Subject Name ____________________

Date ____________________

Amount	Unit	Food Item
4	slices	Whole Wheat Bread
1/2	cup	Tuna, water packed
2	T.	Mayonnaise
2	leaves	lettuce
1/2	each	tomato slices
1/2	cup	celery sticks
1	large	carrot stick
1	each	pear
1	cup	milk, lowfat
1	cup	apple juice

Dinner (2)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
6 3/4	oz	Southern Fried Chicken Patty w/Vegetable Medley
1/2	cup	mashed potatoes
1/4	cup	gravy
1	cup	carrot raisin sld
1	each	hard roll
1	T.	margarine
1	cup	ice cream
1	pkg	sugar
8	oz	coffee
8	oz	hot tea

Snack (2)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
3	cups	popcorn, plain

Breakfast (3)

Subject Name____________________

Date____________________

Amount	Unit	Food Item
8	oz	apple juice
1/2	each	grapefruit
1	cup	shredded wheat
1	cup	milk, lowfat
1	each	bagel
1	oz	cream cheese
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Lunch (3)

Subject name____________________

Date____________________

Amount	Unit	Food item
4	slices	whole wheat bread
3	oz	turkey breast
2	leaves	lettuce
2	T.	mayonnaise
5	each	radishes
1	large	carrot stick
1	cup	fruit salad
2	each	cookies
1	cup	milk, lowfat

Dinner (3)

Subject Name______________________

Date______________________

Amount	Unit	Food Item
9 1/4	oz	beef steak w/carrots
1	each	baked potato
1/4	cup	sour cream
1	cup	tossed salad
1	T.	1000 island dressing
2	each	dinner roll
2	T.	margarine
8	oz	grape juice
1	serving	surprise pie
1	pkg	sugar
8	oz	coffee
8	oz	tea

Snack (3)

Subject Name______________________

Date______________________

Amount	Unit	Food Item
3/4	cup	raisin, unsalted nut, coconut mix

Breakfast (4)

Subject name____________________________

Date________________________________

Amount	Unit	Food Item
8	oz	orange juice
1	each	fresh banana
1/2	cup	grapenuts
1	cup	milk, lowfat
2	slices	toast
1	T.	margarine
1	T.	jelly
2	pkg.	sugar
8	oz	coffee
8	oz	hot tea

Lunch (4)

Subject name____________________________

Date________________________________

Amount	Unit	Food Item
10	each	crackers, unsalted
1	bowl	Chef's salad
2	T.	italian dressing
1	each	fresh apple
1	cup	milk, lowfat

Dinner (4)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
10	oz	Chicken cacciatore w/spaghetti
1/2	cup	green beans
1	cup	tossed salad
1	T	Blue cheese dressing
2	slices	french bread
1	T.	margarine
1	serving	Carrot Cake
8	oz	cranberry juice cocktail
1	pkg	sugar
8	oz	coffee
8	oz	hot tea

Snack (4)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
3	cups	popcorn, plain

Breakfast (5)

Subject Name______________________________

Date______________________________

Amount	Unit	Food Item
8	oz	grape juice
1	each	fresh orange
1	cup	wheat flakes
1	cup	milk, lowfat
2	each	doughnut, cake type
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Lunch (5)

Subject Name______________________________

Date______________________________

Amount	Unit	Food Item
4	slices	whole wheat bread
3	oz	roast beef, lean
2	leaves	lettuce
2	T.	Mayonnaise
1	cup	tossed salad
1	T.	french dressing
1	each	fresh fruit
1	cup	milk, lowfat

Dinner (5)

Subject Name____________________________

Date____________________________

Amount	Unit	Food Item
15 1/4	oz	sliced turkey w/gravy & stuffing w/broccoli and carrots
1/8	cup	cranberry sauce
2	each	dinner roll
1	T.	margarine
1/2	cup	coleslaw
1	serving	Surprise Cake
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Snack (5)

Subject Name____________________________

Date____________________________

Amount	Unit	Food Item
2	T.	peanut butter
4	each	graham crackers

Breakfast (6)

Subject name________________________

Date________________________

Amount	Unit	Food Item
8	oz	orange juice
1/2	each	grapefruit
1/2	cup	grapenuts
1	cup	milk, lowfat
1	each	toasted bagel
1	oz	cream cheese
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Lunch (6)

Subject name________________________

Date________________________

Amount	Unit	Food Item
1	each	hamburger bun
3	oz	hamburger
1	T.	mayonnaise
1/2	each	tomato slices
2	leaves	lettuce
1	slice	onion
2	T.	catsup
1/2	cup	cottage fries
1	cup	milk, lowfat
1	each	apple

Dinner (6)

Subject Name________________

Date________________

Amount	Unit	Food Item
8	oz	New England Clam Chowder
5	each	crackers, unsalted
11	oz	Lasagna
1/2	cup	peas
1	cup	tossed salad
1	T.	italian dressing
2	slices	Boston Brown Bread
1	T.	margarine
1	serving	Cheesecake
1	pkg	sugar
8	oz	coffee
8	oz	hot tea

Snack (6)

Subject Name________________

Date________________

Amount	Unit	Food Item
3/4	cup	raisin, unsalted nut, chocolate chip mix

Breakfast (7)

Subject Name____________________

Date____________________

Amount	Unit	Food Item
8	oz	apple juice
1	each	fresh banana
1	cup	40% Bran flakes
1	cup	milk, lowfat
1	each	English Muffin
1	T	Margarine
1	T.	Jelly
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Lunch (7)

Subject name____________________

Date____________________

Amount	Unit	Food Item
4	slices	whole wheat bread
2	egg	egg salad
2	leaves	lettuce
1/2	each	tomato wedges
1/2	cup	cauliflower, raw
1	large	carrot stick
1	cup	fruit salad
2	each	oatmeal cookies
1	cup	milk, lowfat
8	oz	orange juice

Dinner (7)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
9	oz	Sweet & Sour chicken w/veg. Oriental
1/2	cup	rice
1	cup	tossed salad
1	T.	1000 dressing
1	serving	apple pie
1	each	hard roll
1	T.	margarine
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Snack (7)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
2	T.	peanut butter
10	each	soda crackers

Dinner (8)

Name_______________________________

Date_______________________________

Amount	Unit	Food Item
8	oz	grilled pork chops
1/4	cup	gravy
1	ea	baked potato
1/4	cup	sour cream
1/2	ea	baked acorn squash w/brown sugar and butter
1	cup	tossed salad
1	T	french dressing
2	ea	dinner rolls
1	T.	Margarine
1	cup	ice cream
8	oz	coffee
8	oz	hot tea

SPECIAL MENUS

Special Breakfast

Subject Name____________________

Date 19 Oct 85

Amount	Unit	Food Item
1	cup	orange juice
1	each	banana
1	cup	Fruit and Fiber Cereal
1	each	muffin
1	T.	margarine
1	cup	milk, lowfat
2	pkgs	sugar
1	cup	coffee
1	cup	hot tea

Special Lunch

Subject Name____________________

Date 19 Oct 85

Amount	Unit	Food Item
1	each	hard roll
4	oz	roast chicken
2	T.	mayonnaise
2	leaves	lettuce
1	stalk	celery stick stuffed w/peanut butter
5	each	radishes
2	each	cookies
2	cups	apple juice
1	cup	milk, lowfat

Special Dinner

Subject Name ______________________

Date ______ 19 Oct 85 ______

Amount	Unit	Food Item
	slice	Pizza (Pans will be sent into chamber.
		List amounts after you eat the pizza).
		cheese
		hamburger
		green peppers, onions, mushrooms, and jalapenos
1	cup	tossed salad
1	T.	1,000 island dressing
1	cup	sherbert
1	pkg	sugar
1	cup	coffee
1	cup	hot tea

Breakfast (1)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
3	oz.	Orange Juice
2	each	Scrambled eggs
1	cup	Hash Browned Potatoes
1	cup	raisin bran
1	cup	lowfat milk
2	slices	toast
1	T.	Margarine
1	T.	Jelly
2	pkg	sugar
8	oz	coffee
8	oz	hot tea
1	pkg	salt

Lunch (1)

Subject Name________________________

Date________________________

Amount	Unit	Food Item
1	cup	Cream of Tomato Soup
2	cups	Beef & Green Bean Casserole
		or
2	cups	Green Bean Casserole
1	each	Fresh banana
1	pkg	sugar
8	oz	coffee
8	oz	hot tea
1	pkg	salt

Dinner (7)

Subject Name____________________

Date____________________

Amount	Unit	Food Item
1/4		Chicken w/Spicy Mushroom Gravy
1	cup	rice
		or
1/4		Roasted Chicken
1	cup	Sweet Potato Casserole
1	cup	tossed salad
1	T.	1000 dressing
1	serving	apple pie
1	each	hard roll
1	T.	margarine
2	pkg	sugar
8	oz	coffee
8	oz	hot tea

Snack (7)

Subject Name____________________

Date____________________

Amount	Unit	Food Item
2	T.	peanut butter
10	each	soda crackers

Breakfast (8)

Name ____________________

Date ____________________

Amount	Unit	Food Item
8	oz	orange juice
2	slices	french toast
2	pats	butter
1/4	cup	syrup
1	oz	ham, grilled
1 /2	cup	100% Granola Cereal
1	cup	milk, lowfat
8	oz	coffee
8	oz	tea
2	t.	sugar
1	pkg	salt

Lunch (8)

Name ____________________

Date ____________________

Amount	Unit	Food Item
2 cups		Lipton's Chicken Noodle Soup
2 cups		Tuna Noodle Casserole
1	stalk	Celery Stuffed w/Peanut Putter
8	oz	cranberry juice
1	ea	fresh orange
1	cup	milk, lowfat
1	pkg	salt

Dinner (8)

Name________________________________

Date________________________________

Amount	Unit	Food Item
1		Broiled Steak w/ Onions & Mushrooms
1	ea	baked potato
1/4	cup	sour cream
1/2	ea	baked acorn squash w/brown sugar and butter
1	cup	tossed salad
1	T	french dressing
2	ea	dinner rolls
1	T.	Margarine
1	cup	ice cream
8	oz	coffee
8	oz	hot tea
1	pkg	salt

Dinner (7)

Name ___________

Date ___________

Amount	Unit	Food Item
1/4		chicken, roasted season w/spices or w/ homemade Shake N Bake
	or	
8	ounce	sliced turkey
	or	
1	cup	tuna
	or	
2	ounces	cheese + 2 oz different cheese
	or	
1/4	pound	tofu
1	ea	baked potato
	or	
1/2	ea	baked squash + 1 T. brown sugar + 2 pats butter
	or	
1	cup	brown rice
1	ea	green apple or 1/4 melon
	or	
1	pint	Ben & Jerry's Ice Cream
	or	
2	cups	mixed fruit
	or	
1/8	serving	pie
	or	
4	ea	cookies
3	slices	Boston Brown Bread
	or	
1	ea	hard roll
	or	
2	ea	rolls

Amount	Unit	Food Item
2	salad leaves	lettuce
	or	
1	cup	spinach
1	leaf	chinese cabbage
	or	
1	wedge	red cabbage
1	each	tomato
1	stalk	celery
1/4	ea	red onion or 2 stalks green onion
1/4	ea	cucumber or green pepper
1/2	ea	zucchini
1	large	carrot
1	cup	parsley or basil or cilantio
1/4	cup	bean sprouts or alfalfa sprouts
1/4	cup	garbanzo beans or kidney beans

APPENDIX 2

APPENDIX 2 LEGENDS

Daily fluid intake and output raw data.
N=Subject Number,
C_Date=Calendar Date,
B_Intake=Fluid intake (oz) at breakfast,
L_Intake=Fluid intake (oz) at lunch,
D_Intake=Fluid intake (oz) at dinner,
ADLIB_6218=Intake (oz) of fluids available ad libitum 0600-1800 hours,
ADLIB_1826=Intake (oz) of fluids available ad libitum 1800-0600 hours,
Urine_6218=Urinary output 0600-1800 hours,
Urine_1826=Urinary output 1800-0600 hours,
T_Intake=Total fluid intake (cc)/24 hr period (B_Intake+L_Intake+D_Intake+ADLIB_6218+ADLIB_1826),
T_Output=Total fluid output (cc) in a 24 hr period (Urine_6218+Urine_1826),
Balance=Fluid balance derived from T_Intake minus T_Output.

N	C_DATE	B_INTAKE	L_INTAKE	ADLIB_0210	ADLIB_1030	URINE_0210	URINE_1030	T_INTAKE	T_OUTPUT	BALANCE
1	07-OCT-85	24	20	8	16	2375	850	2640	3225	-585
3	07-OCT-85	16	0	40	0	1050	650	1680	1700	-20
4	07-OCT-85	24	24	32	52	1600	1650	4560	3250	1310
5	07-OCT-85	24	24	60	60	2450	1600	5280	4050	1230
6	07-OCT-85	16	0	56	90	2625	1150	5080	3775	1305
7	07-OCT-85	32	0	40	20	950	1100	3360	2050	1310
8	07-OCT-85	24	0	20	104	1650	1000	4160	2650	1510
9	07-OCT-85	24	0	24	0	600	550	1440	1150	290
1	08-OCT-85	32	24	32	0	950	650	3240	1600	1640
3	08-OCT-85	16	16	8	0	850	450	1600	1300	300
4	08-OCT-85	24	28	40	52	400	1600	5640	2000	3640
5	08-OCT-85	32	28	44	40	1650	1175	5160	2825	2335
6	08-OCT-85	0	0	96	32	2200		4000		
7	08-OCT-85	24	16	12	0	1300	900	2400	2200	200
8	08-OCT-85	24	16	180	80	450	1800	7920	2250	5670
1	09-OCT-85	32	20	44	24	1750	400	4080	2150	1930
3	09-OCT-85	16	0	8	32	450	1550	2400	2000	400
4	09-OCT-85	24	32	180	12	1000	1900	5200	2900	2300
5	09-OCT-85	24	28	62	16	2000	1900	3900	3900	0
6	09-OCT-85	16	0	90	76	2100	2600	5640	4700	940
7	09-OCT-85	24	16	24	12	2300	700	2520	3000	-480
8	09-OCT-85	16	20	40	56	800	2100	4440	2900	1540
9	09-OCT-85	24	0	20	0	900	200	2040	1100	940
1	10-OCT-85	32	20	24	32		1000	3720		
3	10-OCT-85	16	0	32	0		550	2160		
4	10-OCT-85	24	0	60	36		2050	4600		
5	10-OCT-85	32	12	44	40		1875	4560		
6	10-OCT-85	16	0	72	56		1475	4560		
7	10-OCT-85	24	16	0	24		800	2400		
8	10-OCT-85	24	20	16	100		2125	5520		
9	10-OCT-85	24	20	20	0		550	2040		
1	11-OCT-85	40	20	60	0	1675	725	4320	2400	1920
3	11-OCT-85	16	0	32	16	400	500	2400	900	1500
4	11-OCT-85	56	40	48	42	1100	2200	6420	3300	3120
5	11-OCT-85	32	16	32	40	1500	1650	4320	3150	1170
6	11-OCT-85	8	0	94	30	2450	1700	4200	4150	50
7	11-OCT-85	24	12	24	16	1000	1200	2520	2200	320
8	11-OCT-85	32	20	60	80	650	3200	6600	3850	2750
9	11-OCT-85	24	0	52	0	575	400	2520	975	1545
1	12-OCT-85	24	20	8	12	1150	550	2700	1700	1000
3	12-OCT-85	16	0	0	104	575	2375	4080	2950	1130
4	12-OCT-85	24	20	80	32	1925	1925	5520	3850	1670
5	12-OCT-85	32	0	64	24	975	1600	4440	2575	1865
6	12-OCT-85	16	0	104	40	2950	1700	4980	4650	330
7	12-OCT-85	24	12	48	36	1175	1300	3840	2475	1365
8	12-OCT-85	32	20	72	32	675	1325	5200	2000	3200
9	12-OCT-85	24	0	40	36	800	850	3480	1650	1830
1	13-OCT-85	32	16	0	36	1800	500	2800	2300	500
3	13-OCT-85	24	16	56	32	2000	950	3840	2950	890
4	13-OCT-85	24	16	64	44	1400	2050	4680	3450	1230
5	13-OCT-85	24	16	36	20	2250	1275	3480	3525	-45
6	13-OCT-85	8	0	86	90	2200	2075	5760	4275	1485
7	13-OCT-85	16	0	0	0	1800	500	1200	2300	-1100
8	13-OCT-85	24	16	52	32	2400	1600	4080	4000	80
9	13-OCT-85	24	16	40	0	1800	900	3000	2700	300
1	14-OCT-85	24	16	0	12	875	1125	2340	2000	340
3	14-OCT-85	16	16	0	0	1200	550	1320	1750	-430
4	14-OCT-85	24	16	32	22	1700	1200	3060	2900	160
5	14-OCT-85	16	16	44	16	1300	1875	3360	3175	185
6	14-OCT-85	8	0	78	92	2300	2050	5340	4350	990
7	14-OCT-85	24	16	24	8	575	1100	2940	1675	1265
8	14-OCT-85	24	16	80	32	600	2350	4980	2950	2030
9	14-OCT-85	24	16	24	0	1400	1775	2520	3175	-655

N	C_DATE	B_INTAKE	L_INTAKE	ADLIB_0218	ADLIB_1826	URINE_0218	URINE_1826	T_INTAKE	T_OUTPUT	BALANCE
1	15-OCT-85	32	24	0	20	875	1200	2700	2075	625
3	15-OCT-85	16	8	0	0	550	625	720	1175	-455
4	15-OCT-85	24	16	60	32	1600	2400	4200	4000	200
5	15-OCT-85	24	16	60	24	600	2175	4440	2775	1665
6	15-OCT-85	8	0	70	60	1225	3200	4140	4425	-285
7	15-OCT-85	0	16	24	0	575	1850	1440	2425	-985
8	15-OCT-85	16	16	40	40	1275	2150	4080	3425	655
9	15-OCT-85	24	0	0	0	950	1075	1200	2025	-1625
1	16-OCT-85	32	16	16	0	1800	1050	2640	2850	-210
3	16-OCT-85	16	24	0	0	1100	950	1200	2050	-850
4	16-OCT-85	24	40	36	20	2400	2200	4560	4600	-40
5	16-OCT-85	20	24	20	36	1650	1820	3240	3470	-230
6	16-OCT-85	16	0	54	100	2200	2475	7980	4675	3305
7	16-OCT-85	24	16	32	8	1700	1300	2640	3000	-360
8	16-OCT-85	24	24	40	64	1850	340	4200	2190	2010
9	16-OCT-85	24	16	12	8	1150	540	2040	1690	350
1	17-OCT-85	16	8	36	0	350	700	2520	1050	1470
3	17-OCT-85	24	8	0	16	250	900	1680	1150	530
4	17-OCT-85	24	40	36	28	900	1700	3900	2600	1300
5	17-OCT-85	40	16	24	16	1150	1100	3600	2250	1350
6	17-OCT-85	24	0	40	60	1500	2300	3900	3800	100
7	17-OCT-85	16	0	34	0		200	2220		
8	17-OCT-85	16	8	64	56	1050	2350	4920	3400	1520
9	17-OCT-85	32	8	12	0	525	500	2280	1025	1255
1	18-OCT-85	12	8	12	24	250	800	2400	1050	1350
3	18-OCT-85	16	0	32	8	650	1100	1920	1750	170
4	18-OCT-85	16	8	84	20	2500	3750	4320	6250	-1930
5	18-OCT-85	32	20	16	40	1100	1525	3960	2625	1335
6	18-OCT-85	8	0	70	82	2350	2000	5100	4350	750
7	18-OCT-85	0	8	20	0		1125	1320		
8	18-OCT-85	0	8	16	32	1250	2000	1920	3250	-1330
9	18-OCT-85	0	8	60	0	1000	700	2200	1700	500
1	19-OCT-85	0	24	16	0	525	800	1680	1325	355
3	19-OCT-85	16	24	0	16	300	1250	1920	1550	370
4	19-OCT-85	16	8	42	0		950	1800		
5	19-OCT-85	0	12	24	16	1350	1050	2520	2400	120
6	19-OCT-85	0	0	84	64	3000	975	4440	3975	465
7	19-OCT-85	24	16	0	0	1000		1440		
8	19-OCT-85	16	0	80	64	1750	1500	5160	3250	1910
9	19-OCT-85	24	0	16	16	1500	650	1920	2150	-230
1	20-OCT-85	24	0	20	32	600	650	3000	1250	1750
3	20-OCT-85	16	16	32	0	350	750	1920	1100	820
4	20-OCT-85	16	8	74	32	1450	2525	4140	3975	165
5	20-OCT-85	32	8	48	40	2150	1500	4320	3650	670
6	20-OCT-85	0	0	90	104	3625	1625	6000	5250	750
7	20-OCT-85									
8	20-OCT-85	32	0	64	64	1900	2850	5400	4750	650
9	20-OCT-85	32	8	0	0	600	700	1440	1300	140
1	21-OCT-85	16	8	32	12	800	675	2280	1475	805
3	21-OCT-85	16	8	0	24	300	650	1440	950	490
4	21-OCT-85	16	8	62	44	1400	2775	3900	4175	-275
5	21-OCT-85	0	8	46	52	1250	1000	3240	2950	290
6	21-OCT-85	21	16	40	128	2700	2700	6150	5400	750
8	21-OCT-85	24	8	80	44	2850	2800	4920	5650	-730
9	21-OCT-85	16	8	28	36	1200	1000	2640	2200	440
1	22-OCT-85	8	0	28	12	600	675	1920	1275	645
3	22-OCT-85	24	16	0	32	950	1350	2480	2300	180
4	22-OCT-85	20	16	72	64	1925	2075	5100	4000	500
5	22-OCT-85	40	8	64	32	3800	1800	4800	5600	-800
6	22-OCT-85	0	0	128	46	2575	1200	5220	3775	1445
	22-OCT-85	16	8	60	64	2800	3050	5160	5850	-690
	22-OCT-85	32	16	32	12	1250	1400	3240	2650	590

N	C_DATE	B_INTAKE	L_INTAKE	ADLIB_0210	ADLIB_1020	URINE_0210	URINE_1020	T_INTAKE	T_OUTPUT	BALANCE
1	23-OCT-85	24	12	32	24	700	1800	3240	2500	740
3	23-OCT-85	16	16	20	64	1725	1200	3480	2925	555
4	23-OCT-85	44	16	54	22	1850	3100	4320	4950	-630
5	23-OCT-85	0	12	20	32	1500	2100	2400	3600	-1200
6	23-OCT-85	0	0	140	64	3600	1800	6300	5400	900
8	23-OCT-85	24	8	88	80	1100	1950	6240	3050	3190
9	23-OCT-85	16	16	20	0	1400	650	2040	2050	-10
1	24-OCT-85	16	8	60	16	1800	900	3240	2700	540
3	24-OCT-85	0	0	16	8	1200	1200	960	2400	-1440
4	24-OCT-85	24	0	44	0	3100	1300	2040	4400	-2360
5	24-OCT-85	16	8	60	48	2100	2350	4200	4450	-250
6	24-OCT-85	8	0	88	100	1800	3400	6120	5200	920
8	24-OCT-85	16	8	72	64	1950	3450	5040	5400	-360
9	24-OCT-85	24	0	16	24	650	1500	2160	2150	10
1	25-OCT-85	16	0	0	56	700	450	2640	1150	1490
3	25-OCT-85	16	24	0	32	400	1550	2160	1950	210
4	25-OCT-85	24	0	91	12	1800	1250	4050	3050	1000
5	25-OCT-85	16	16	60	64	1400	1800	5160	3200	1960
6	25-OCT-85	8	0	96	56	3000	2525	4620	5525	-905
8	25-OCT-85	0	0	0	80	1800	2600	2640	4400	-1760
9	25-OCT-85	24	0	8	8	800	525	1200	1325	-125
1	26-OCT-85	12	8	0	48	1025	700	2760	1725	1035
3	26-OCT-85	16	8	0	24	200	750	1680	950	730
4	26-OCT-85	16	32	96	22	3400	2700	5820	6100	-280
5	26-OCT-85	24	12	48	32	1925	2625	4920	4550	370
6	26-OCT-85	8	0	72	68	850	2550	4440	3400	1040
8	26-OCT-85	16	16	64	32	1550	2150	3840	3700	140
9	26-OCT-85	16	22	24	24	300	575	3060	875	2185
1	27-OCT-85	0	0	0	92	2000	1200	3720	3200	520
3	27-OCT-85	16	8	32	32	1400	1650	2880	3050	-170
4	27-OCT-85	32	8	64	32	2250	2325	5040	4575	465
5	27-OCT-85	16	8	76	52	2000	2725	4800	4725	75
6	27-OCT-85	8	0	64	124	2000	3175	6360	5175	1185
8	27-OCT-85	16	8	32	32	2010	2525	2880	4535	-1655
9	27-OCT-85	8	0	20	8	800	1275	1800	2075	-275
1	28-OCT-85	16	8	0	48	200	800	2670	1000	1670
3	28-OCT-85	0	8	0	32	200	600	1200	800	400
4	28-OCT-85	0	64	0	57	1950	1775	4770	3725	1045
5	28-OCT-85	32	8	60	58	2400	2175	4680	4575	105
6	28-OCT-85	8	0	96	100	4600	3000	6360	7600	-1240
8	28-OCT-85	32	8	48	64	2100	2475	4560	4575	-15
9	28-OCT-85	24	8	8	0	650	525	1440	1175	265
1	29-OCT-85	24	0	0	42	800	1300	2220	2100	120
3	29-OCT-85	16	8				800			
4	29-OCT-85	8	20	32	30	1800	850	3360	2650	710
5	29-OCT-85	24	16	48	40	2500	2975	4680	5475	-795
6	29-OCT-85	8	0	64	44	2400	1175	3480	3575	-95
8	29-OCT-85	16	8	48	40	1750	2275	3600	4025	-425
9	29-OCT-85	8	8	50	0	1100	1350	2400	2450	-50
1	30-OCT-85	8	20	0	44	350	1300	3120	1650	1470
3	30-OCT-85	16	16	0	32	350	1250	1920	1600	320
4	30-OCT-85	16	0	32	32	2175	2000	2880	4175	-1295
5	30-OCT-85	32	24	60	60	3200	2975	6000	6175	-175
6	30-OCT-85	8	0	64	144	2325	3200	6480	5525	955
8	30-OCT-85	8	0	48	44	1550	1750	3000	3300	-300
9	30-OCT-85	8	24	32	0	600	975	2520	1575	945
1	31-OCT-85	16	8	0	20		1075	3240		
3	31-OCT-85	16	24	0	24		850	2160		
4	31-OCT-85	20	40	32	32		1400	4440		
5	31-OCT-85	14	8	72	32		2475	4140		
6	31-OCT-85	8	8							
6	31-OCT-86	8	8	16	50		1400	2400		

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9	31-OCT-85	24	10	84	0		2475	3100		
9	31-OCT-85	16	20	40	80		2150	4000		
1	01-NOV-85	20	16	36	0	750		2520		
3	01-NOV-85	16	0	56	40	1725	1950	3840	3675	165
4	01-NOV-85	0	32	0	32	1150	1600	3000	2750	250
5	01-NOV-85	20	16	48	64	2825	3125	4500	5950	-1450
6	01-NOV-85	0	0	96	40	2700	3650	4080	6350	-2270
8	01-NOV-85	16	8	64	32	1750	1950	3600	3700	-100
9	01-NOV-85	16	20	12	0	1500	600	1680	2100	-420
1	02-NOV-85	20	24	40	0		900	3000		
3	02-NOV-85	8	20	16	48	400	2650	3000	3050	-50
4	02-NOV-85	16	0	12	80		1975	2800		
5	02-NOV-85	20	16	52	40		2100	4500		
6	02-NOV-85	0	0	32	48		2525	2400		
8	02-NOV-85	0	24	0	32		1675	1600		
9	02-NOV-85	8	16	80	17	1150	1150	3450	2300	1150
1	03-NOV-85	0	16	0	0	700	700	2200	1400	800
3	03-NOV-85	8	8	16	32	1300	1800	2160	3100	-940
4	03-NOV-85	0	32	20	32	1000	1250	3000	2250	750
5	03-NOV-85	16	8	48	16	1625	2800	3120	4425	-1305
6	03-NOV-85	0	0	80	20	2450	2050	3480	4500	-1020
8	03-NOV-85	8	8	48	48	1200	1725	3120	2925	195
9	03-NOV-85	0	16	44	0	800	975	2040	1775	265
1	04-NOV-85	16	12	0	0	500	900	1600	1400	200
3	04-NOV-85	8	24	32	32	450	1500	3120	1950	1170
4	04-NOV-85	8	44	0	32	1000	1900	3840	2900	940
5	04-NOV-85	20	8	72	32	2000	2350	4320	4350	-30
6	04-NOV-85	8	0	64	120	3750	4000	5760	7750	-1990
8	04-NOV-85	12	8	32	48	1600	1200	3000	2800	200
9	04-NOV-85	8	20	0	0	950	600	1080	1550	-470
1	05-NOV-85	24	0	0	16	425	1000	1680	1425	255
3	05-NOV-85	16	0	0	32	300	1000	1440	1300	140
4	05-NOV-85	20	0	32	52	600	3250	3600	3850	-250
5	05-NOV-85	24	0	32	22	350	3250	2580	3600	-1020
6	05-NOV-85	32	16	120	80	4075	3750	7680	7825	-145
9	05-NOV-85	24	8	52	28	1050	1400	3840	2450	1390
1	06-NOV-85	16	0	0	32	600	940	1680	1540	140
3	06-NOV-85	8	8	32	32	400	1000	2400	1400	1000
4	06-NOV-85	8	16	0	42	950	950	1980	1900	80
5	06-NOV-85	16	8	64	44	2600	2100	4200	4700	-500
6	06-NOV-85	0	24	64	112	4000	2000	5600	6000	-400
8	06-NOV-85	16	24	0	48	1400	1650	2640	3050	-410
9	06-NOV-85	8	8	56	28	600	550	3000	1150	1850
1	07-NOV-85	12	0	0	48	625	1250	2520	1875	645
3	07-NOV-85	8	12	0	0	300	650	360	950	-590
4	07-NOV-85	0	32	0	20	1750	1500	1600	3250	-1650
5	07-NOV-85	16	0	0	0	800		480		
6	07-NOV-85	8	12	96	32	3225	2225	4200	5450	-1250
8	07-NOV-85	8	0	32	32	1150	1675	1920	2825	-905
9	07-NOV-85	8	0	52	28	400	850	2640	1250	1390
1	08-NOV-85	16	20	0	40	600	700	2200	1300	900
3	08-NOV-85	8	24	0	32		1200	1920		
4	08-NOV-85	20	12	0	0	825	875	1200	1700	-500
8	08-NOV-85	8	24	96	80	2675	2550	6240	5225	1015
9	08-NOV-85	8	32	44	0	1750	1375	2760	3125	-365
1	09-NOV-85	16	8	0	0	675	1100	720	1775	-1055
3	09-NOV-85	16	0	0	0	425	1000	480	1425	-945
4	09-NOV-85	8	0	32	40	775	2050	3200	2825	375
6	09-NOV-85	8	0	96	48	2200	3750	4320	5950	-1630
8	09-NOV-85	24	0	32	32	700	1750	2640	2450	190
9	09-NOV-85	0	0	0	0	530	1250	600	1780	-1180
1	10-NOV-85	16	0	0	0	600	1650	1440	2250	-810

N	C_DATE	B_INTAKE	L_INTAKE	ADLIB_0210	ADLIB_1020	URINE_0210	URINE_1020	T_INTAKE	T_OUTPUT	BALANCE
3	10-NOV-85	14	16	0	0	200	1250	900	1450	-550
4	10-NOV-85	16	32	64	64	3350	1525	5880	4875	1005
6	10-NOV-85	0	16	128	112	2750	2575	7680	5325	2355
8	10-NOV-85	0	16	0	32	275	950	1680	1225	455
9	10-NOV-85	24	24	24	0	1100	1650	2400	2750	-350
1	11-NOV-85	8	0	0	0	1000	1150	720	2150	-1430
3	11-NOV-85	11	0	0	0	975	250	570	1225	-655
4	11-NOV-85	0	40	0	32	1350	1725	2400	3075	-675
6	11-NOV-85	16	8	0	64	3100	2575	2640	5675	-3035
8	11-NOV-85	16	8	0	32	1175	1500	1920	2675	-755
9	11-NOV-85	16	8	100	0	1850	3625	4200	5475	-1275
1	12-NOV-85	24	8	0	0	400	900	1800	1300	500
3	12-NOV-85	16	0	0	0	1300	475	720	1775	-1055
4	12-NOV-85	0	0	0	72	1075	600	3600	1675	1925
6	12-NOV-85	16	0	144	120	3100	3375	8580	6475	2105
8	12-NOV-85	0	0	48	32	2200	250	2400	2450	-50
9	12-NOV-85	16	0	0	0	2200	1925	720	4125	-3405
1	13-NOV-85	0	0	0	0	2000	1700	1920	3700	-1780
3	13-NOV-85	0	0	0	32	1600	250	960	1850	-890
4	13-NOV-85	0	0	0	32	2050	2000	960	4050	-3090
6	13-NOV-85	0	0	96	104	4500	3750	6480	8250	-1770
8	13-NOV-85	0	0	32	32	1100	1600	1920	2700	-780
9	13-NOV-85	0	8	0	0	1800	2425	300	4225	-3925
1	14-NOV-85	16	0	0	0	375		480		
3	14-NOV-85	0	0	16	0			480		
4	14-NOV-85	0	8	64	0	1500		2160		
6	14-NOV-85	0	0	64	0	1800		1920		
8	14-NOV-85	8	8	0	0			480		
9	14-NOV-85	16	8	0	0	1075		720		
9	08-OCT-85	16	8	16	20	450	350	1800	800	1000
8	05-NOV-85	16	0	32	45	750	3250	3030	4000	-970
8	08-NOV-85	16	20	32	32	1675	1300	3000	2975	25

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