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THE NUTRITIONAL IMPLICATIONS OF LACTOSE MALABSORPTION

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THE NUTRITIONAL IMPLICATIONS OF LACTOSE MALABSORPTION

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THE NUTRITIONAL IMPLICATIONS OF LACTOSE MALABSORPTION

Increased recognition of low intestinal lactase activity in major population groups has focused attention on the nutritional implications of these findings in children who are offered milk as a major source of nutrients. While current evidence demonstrates that the hydrolysis of lactose is incomplete, resulting in carbohydrate loss and a spectrum of lactose-induced symptoms, little is known about additional physiological effects in lactose intolerant children who do consume lactose containing products. It is the purpose of this paper to report on changes in the stool, urine, and blood with the consumption of a lactose diet in children who have demonstrated intolerance to a lactose load.

<u>In the first slide, it may be seen that:</u>

Balance studies were carried out on six Peruvian Mestizo subjects ranging in age from 1 year 11 months to 6 years 10 months. Four children were lactose intolerant; with none having a maximum blood sugar rise of greater than 4 mg% with a lactose tolerance test utilizing 2 g of lactose/kg body weight. Two had been previously rehabilitated from marasmus or kwashiorkor; the other

two had never exhibited overt malnutrition. The two lactose tolerant children were 1 year 11 months and 3 years 5 months, respectively. Their maximum blood sugar rises during the lactose tolerance test were 34 and 36 mg%, and both were being rehabilitated from marasmus or kwashiorkor.

In the next slide, it is seen that:

The diet consisted of 2.0 g of protein as casein, 8.0 g of carbohydrate as sucrose or lactose, and 4.0 g of fat as cottonseed oil per kilogram body weight per 24 hours. This was given in six equally divided feedings.

After an initial stabilizing period of 6 days on the sucrose-casein diet, the subjects were placed on a metabolic bed. The balance study was of 21 days duration. In the first stage, the subjects were given a sucrose-casein diet for 2 periods of three days each. This was followed in the second stage by lactose replacing sucrose in the diet and the subjects studied for 3 periods of three days each. In the final stage, sucrose replaced lactose and the subjects again studied for 2 periods of three days.

In the next slide, it may be seen that:

The study is divided into the first two periods on sucrose followed by 3 individually represented periods on lactose, followed by the third stage, again on sucrose.

The total stool weight in the intolerant subjects on a sucrose-casein diet was approximately 50 g per day. This is followed in the first lactose period by a marked rise in stool weight, averaging 310 g per 24 hours. Less marked elevations in the second and third lactose periods are noted. Upon reintroduction of sucrose, the stool weight returned to pre-lactose levels.

Accompanying the increase in total stool weight was an increase in dry weight. The greatest increase, to approximately 25 g per 24 hours, occurred in the first lactose period and paralleled the maximum increase in stool weight. Significant but less marked elevations, to approximately 15 g per 24 hours, were noted in the two subsequent lactose periods, with a return to baseline levels in the following sucrose stage. The change in stool fat during lactose intake was not significant. Little difference was noted in the stool weight, dry weight, and fat in the two lactose tolerant subjects, with no increases over initial sucrose levels noted.

In the next slide: 4

The three stages of sucrose, lactose, and sucrose are represented in a similar manner and changes in stool water, nitrogen, potassium, and sodium are demonstrated.

It may be seen that stool water was the major factor in the increase in stool weight. This is most evident in the first lactose period, with the stool water averaging 282 g per 24 hours, with significant but smaller increases in the subsequent two lactose periods. Baseline levels of approximately 40 g per day are seen on the sucrose diet both before and after lactose intake. The two normal subjects showed no significant change in stool water irrespective of the diet.

Stool nitrogen in the intolerant subjects was approximately 20 mg/kg/24 hours on the sucrose diet. This was followed by a rise to 60 mg/kg/24 hours on the first lactose period with a sustained increase in stool nitrogen in the two additional lactose periods. A return to pre-lactose levels is seen in the subsequent sucrose period. In the tolerant subjects, no increase in stool nitrogen over initial sucrose levels is noted.

Paralleling the increase in stool water and nitrogen in the intolerant subjects were significant increases in stool potassium and sodium on the lactose diet. Again the greatest increase was noted during the first three-day lactose period with less marked elevations in the subsequent lactose periods. During the control stage,

approximately 4 meq of potassium and 2 meq of sodium were measured in the stool per 24 hours. This was followed by greater than a three-fold increase in the potassium and sodium when the intolerant subjects were placed on a lactose diet. In the tolerant subjects, no significant changes from initial sucrose levels were noted in potassium and sodium.

In the next slide, it may be seen that: 5

Urine sodium, potassium, and phosphorus are plotted for the sucrose stages and the three lactose periods.

Urine sodium and potassium in the intolerant subjects showed a decrease while on the lactose diet, which is reciprocal to the increases in the stool sodium and potassium. A marked increase in urine phosphorus over pre-lactose levels was demonstrated when the subjects were started on lactose. These values returned to previous levels when sucrose was restarted. While some fluctuation in the sodium, potassium, and phosphorus in the two control subjects was noted, no significant changes were noted over initial sucrose levels.

In the next slide: 6[1,2]

A representative nitrogen balance study in one lactose tolerant subject is demonstrated. Shown on the

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ordinate is the 320 mg of nitrogen, representing a constant intake of 2 g of protein/kg/24 hours. The balance period is divided into 2 periods on sucrose, 3 periods on lactose, followed by 2 periods on sucrose. Stool nitrogen and urine nitrogen are outlined, and positive and negative nitrogen balance would be demonstrated above and below the zero line.

In this lactose tolerant subject, there is no untoward effect on apparent nitrogen absorption and retention during the lactose period, and the subject remains in positive nitrogen balance throughout the study.

In the next slide, following the same design:[145]

A nitrogen balance study in one representative intolerant 2-year-old subject demonstrates his balance during the initial sucrose stage; with increased nitrogen loss in the stool and urine in the lactose period resulting in decreased apparent nitrogen absorption and retention and negative nitrogen balance. This does not appear to be entirely due to increased nitrogen in the stool, but due to increased nitrogen in the urine as well, which would seem to imply a more generalized physiological readjustment. This is followed in the next sucrose stage

with improvement in apparent nitrogen absorption and recovery in nitrogen balance.

In the next slide, it may be seen that:

Nitrogen balance data on all four intolerant subjects supports the above observations. The intolerant subjects have an increase in stool nitrogen during the three lactose periods. In addition, there is an elevation in urine nitrogen over initial sucrose levels while on lactose. This is reflected by a significant decrease in apparent nitrogen absorption on lactose followed by a return to anticipated levels of apparent nitrogen absorption when restarted on sucrose. In addition, apparent nitrogen retention is decreased in the lactose period, particularly noted during the first 2 three-day periods. A negative nitrogen balance is seen in the initial lactose period in all four intolerant subjects.

Blood values are demonstrated in the next slide: 9

The most significant change is noted in the alkaline phosphatase values in the lactose intolerant children. A sharp decrease from approximately 7 B.u. to less than 4 is noted in the lactose period, with no recovery to pre-lactose levels seen in the subsequent sucrose period.

No change from levels of approximately 7 B.u. in the two tolerant subjects was noted. Serum calcium and phosphorus levels plotted along with alkaline phosphatase show no significant changes in either group of children.

Slide off. Lights, please.

These results suggest nutritional implications above and beyond the inability to effectively utilize lactose in the intolerant children studied. An increase in stool weight due to a marked increase in stool water is seen. This is accompanied by a three-fold increase in stool nitrogen, potassium, and sodium in the intolerant children with no significant deviations over sucrose levels seen in the tolerant subjects. In addition to the decrease in apparent nitrogen absorption in the intolerant children on a lactose-casein diet, there was evident a decrease in apparent nitrogen retention. These changes, which result in varying degrees of negative nitrogen balance in all intolerant children during the initial lactose period, appear to result not only from the increase in stool nitrogen but also from an increase in urine nitrogen, suggesting endogenous nitrogen losses.

A tendency toward moderation of these changes during the second and third balance periods on lactose is, however, observed.

These changes take place despite ready acceptance and consumption of a lactose-containing diet by lactose intolerant children.

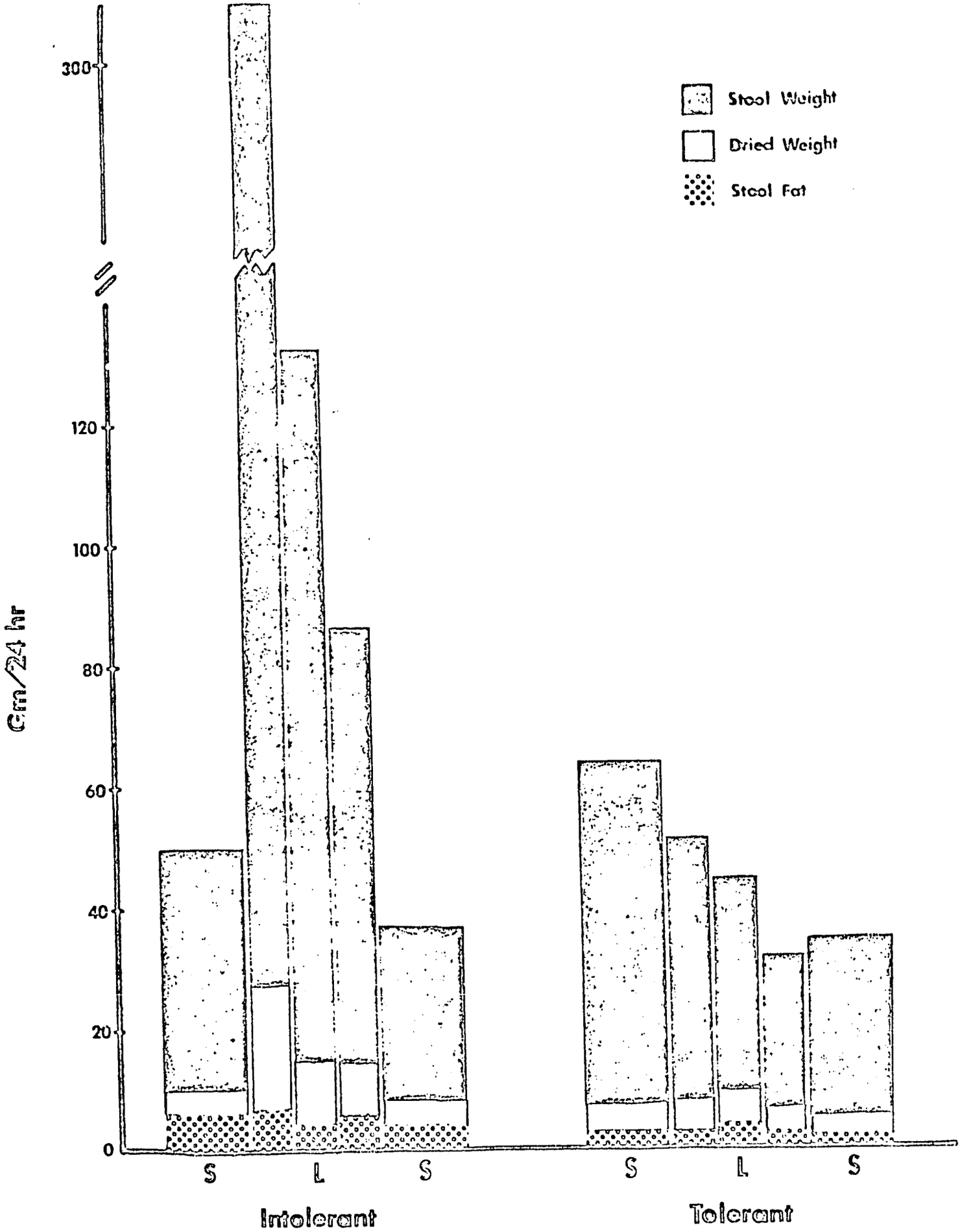
POPULATION STUDIED

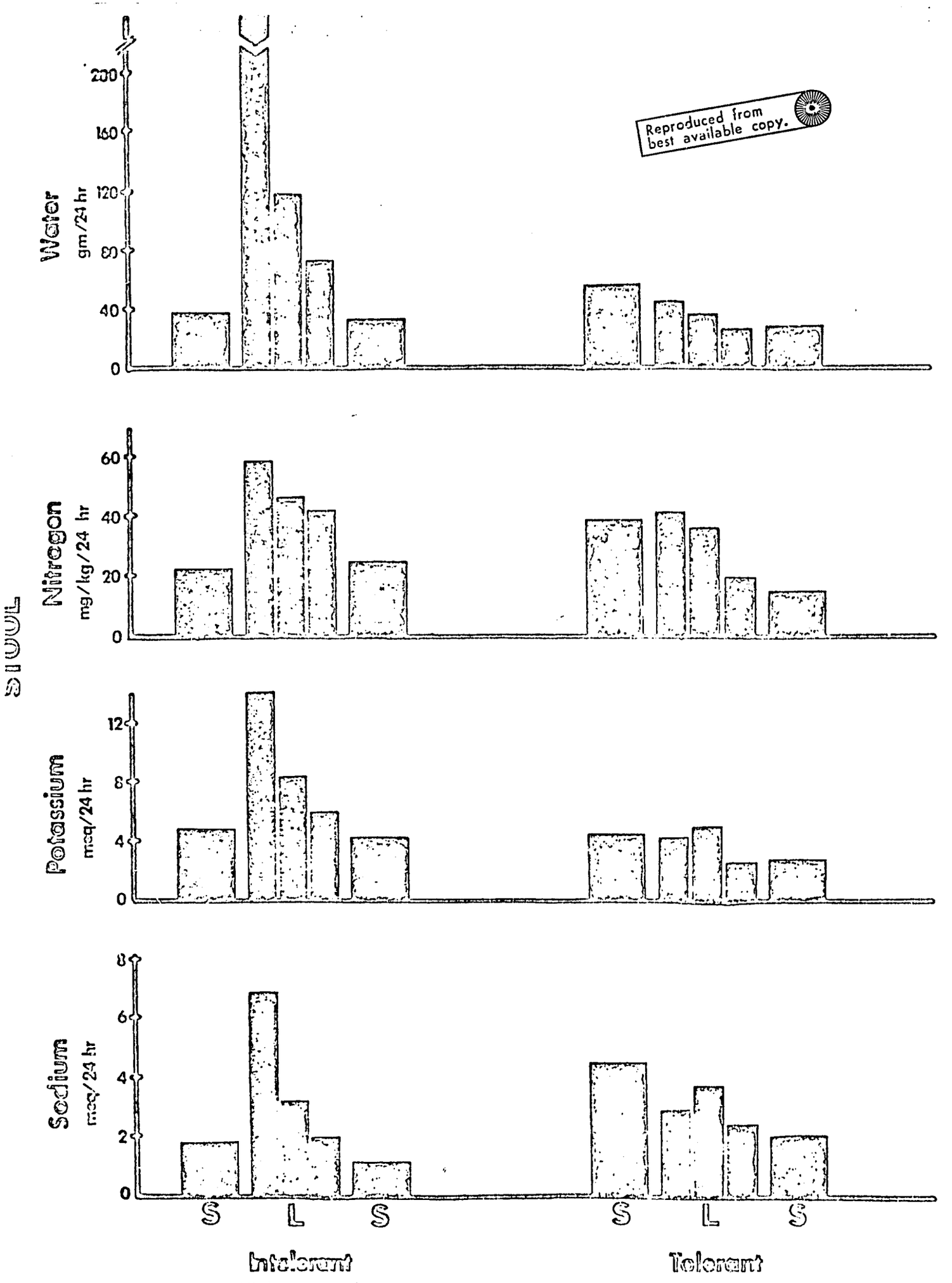
Subject	Age	Weight (kg)	Maximum Blood Sugar Rise (LTT) (mg%)	Previous Nutritional History*
140	5 yr. 8 mo.	17.0	2.0	N
166	5 yr. 10 mo.	18.0	4.0	MK, K
257	4 yr. 7 mo.	15.8	0	MK
310	6 yr. 10 mo.	20.8	2.0	N
288	1 yr. 11 mo.	10.3	36.0	MK
242	3 yr. 5 mo.	12.0	34.0	M, K

* N - Normal
M - Marasmus
K - Kwashiorkor
MK - Marasmic kwashiorkor

DIET

	Gm/Kg/24 hr	Gm/Kg/Feeding
Protein (Casein)	2.0	0.33
Carbohydrate (Sucrose, Lactose)	8.0	1.32
Fat (Cottonseed Oil)	4.0	0.67


Stool Weight
Dried Weight
Stool Fat
Gm/24 hr
300
120
100
80
60
40
20
0
S
L
S
S
L
S
Intolerant
Tolerant



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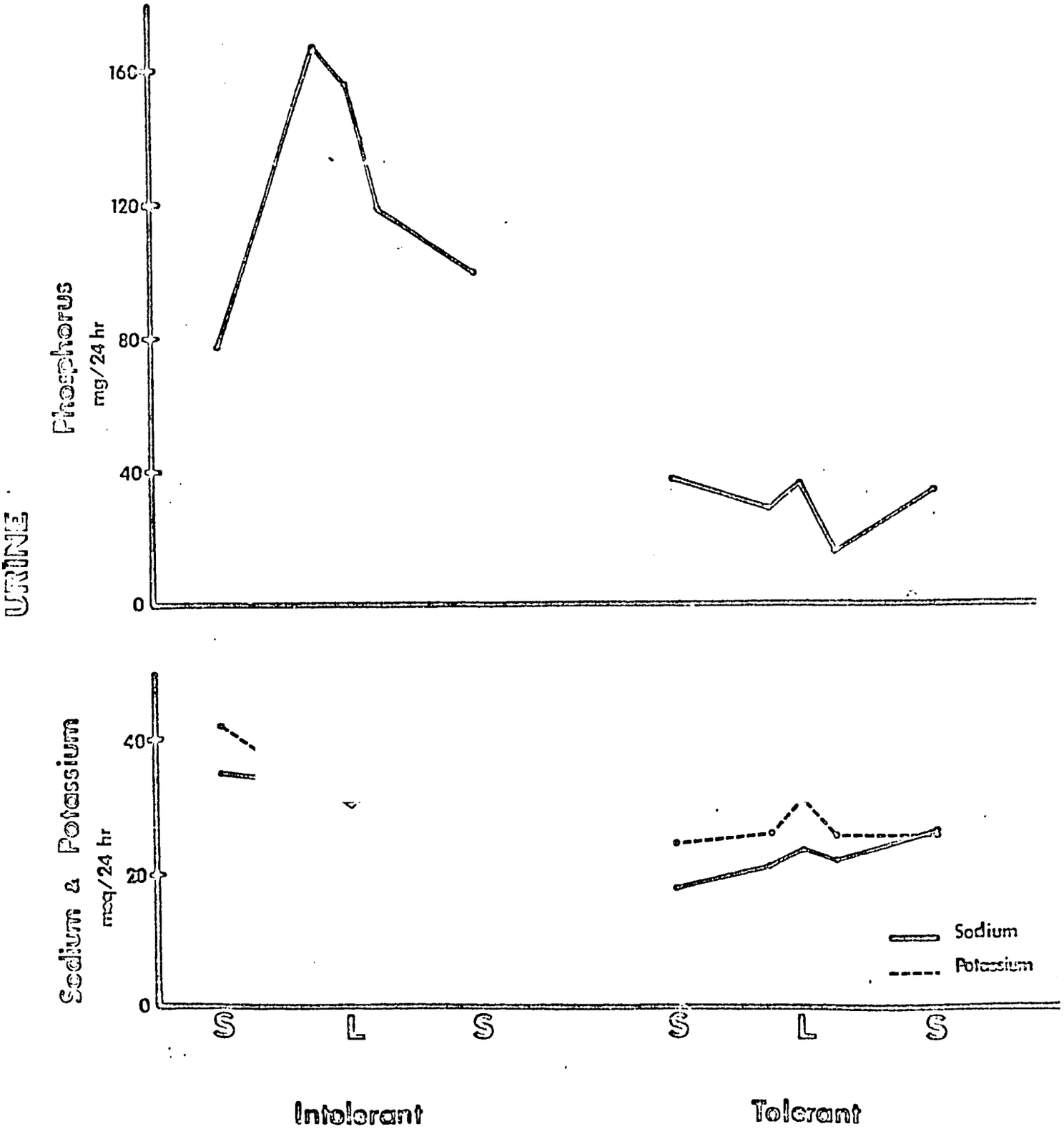
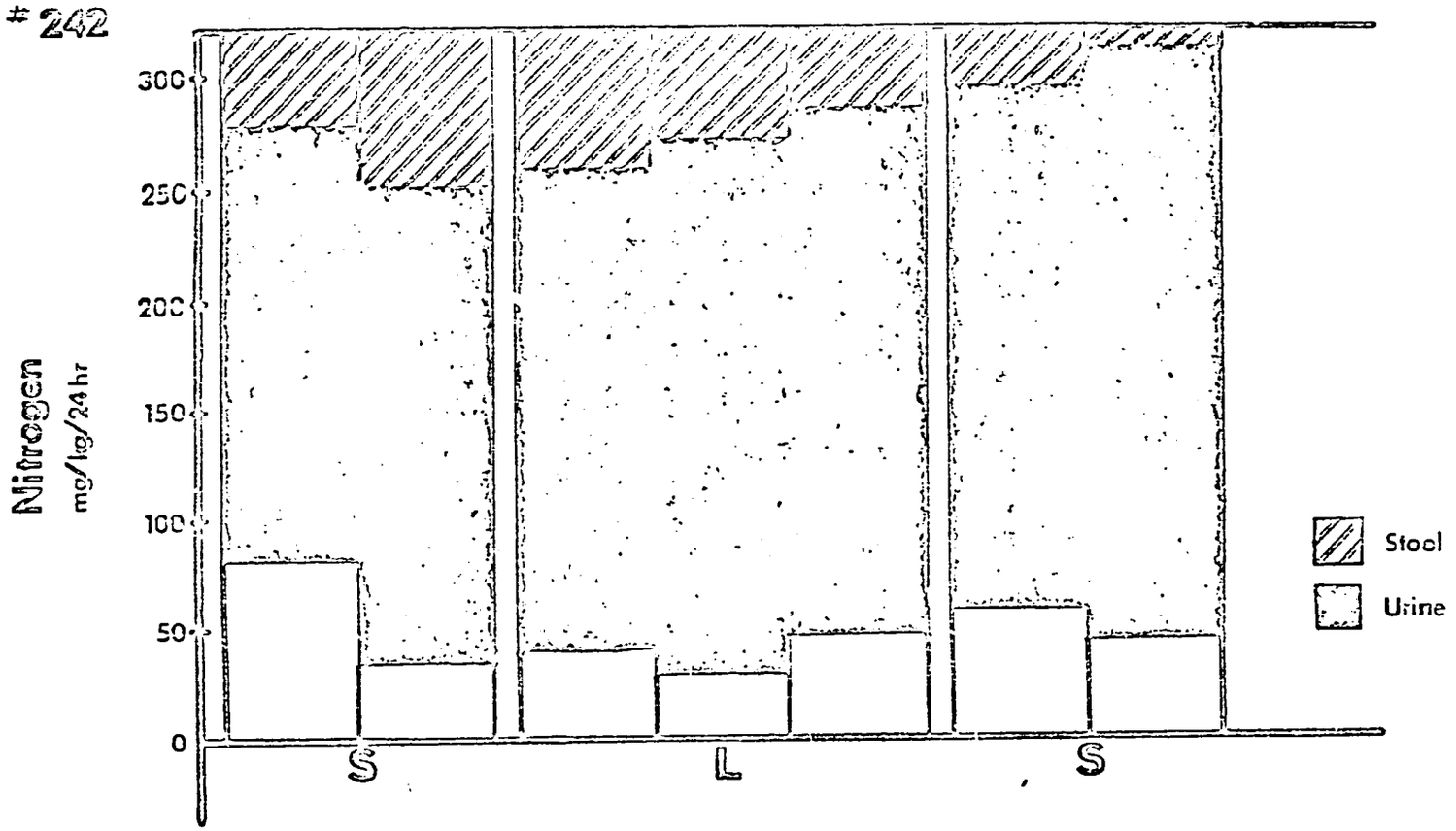

URINE
Phosphorus
mg/24 hr
160
120
80
40
0
Sodium & Potassium
meq/24 hr
40
20
0
Sodium
Potassium
S
L
S
S
L
S
Intolerant
Tolerant

242



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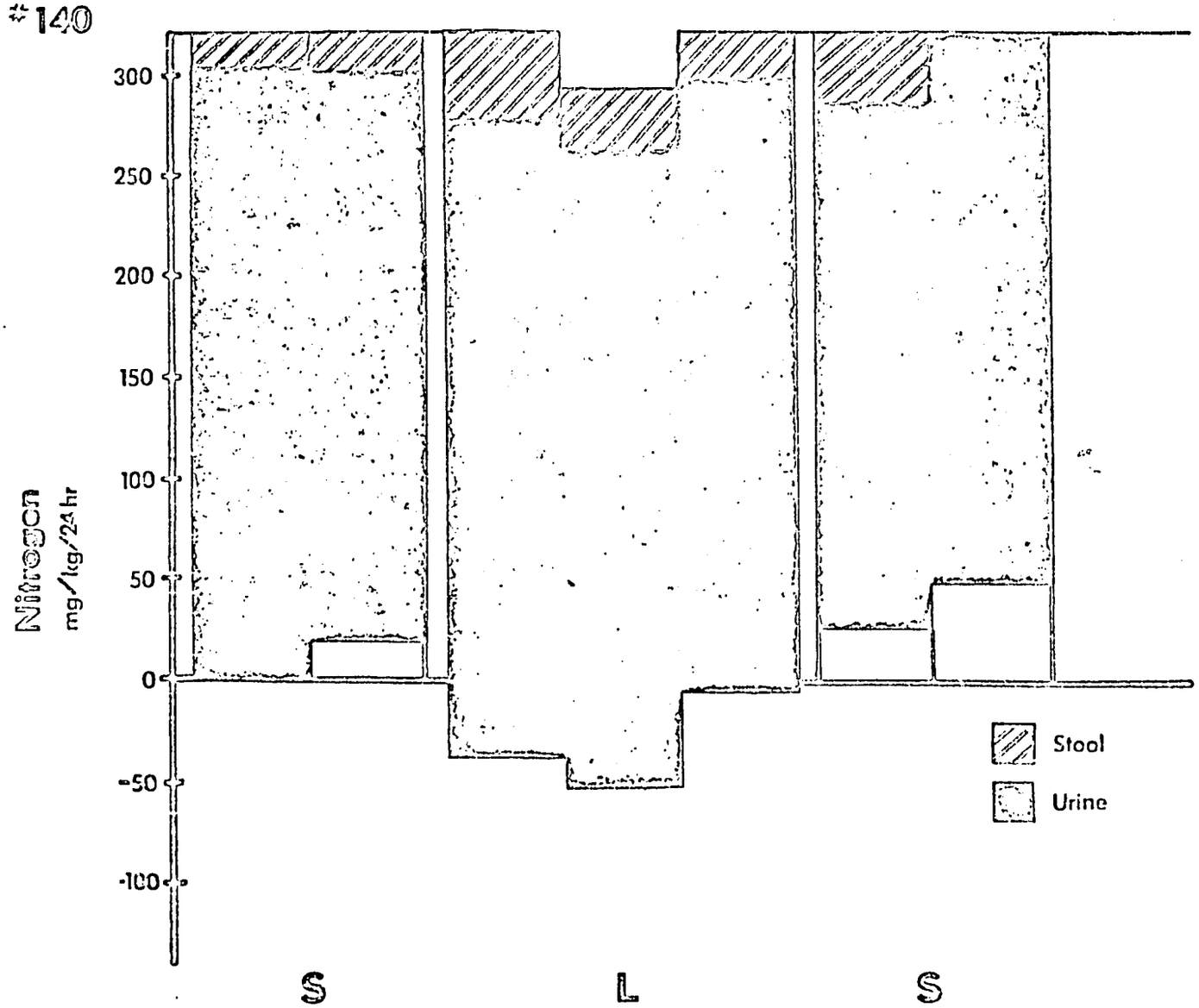

Intolerant

	S	L_1	L_2	L_3	S
Stool Nitrogen (mg)	21.8	57.9	46.3	41.7	24.7
Urine Nitrogen (mg)	243.9	268.1	267.0	257.0	270.5
Nitrogen Absorption (%)	93.2	81.9	85.5	86.9	92.2
Nitrogen Retention (%)	15.4	−1.9	2.0	6.7	7.8

SERUM
Alkaline Phosphatase
B.U.
0
2
4
6
8
Phosphorus
mg %
0
2
4
6
8
Calcium
mg %
0
2
4
6
8
10
S L S
S L S
Intolerant
Tolerant