Diameter and Amino Acid Changes in Hair of Negro Children with Protein-Calorie Malnutrition.* (31537)

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(Introduced by R. W. Engel)
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In estimating the nutritional status of large population groups, as in the nationwide surveys of the Interdepartmental Committee on Nutrition for National Defense, protein status is particularly difficult to define. In the absense of a single direct indicator of protein nutriture, the information is inferred from a number of relatively non-specific indices such as total serum protein, serum albumin, hemoglobin, stature, pigmentation of the hair, and estimates of food intake. Even with these multiple observations the protein status remains uncertain because each of the individual observations is influenced by many factors quite unrelated to protein nutriture. Recently Reinhold *et al*(1) found hair to serve as an index of zinc but not of copper nutritional status.

Because hair is an easily accessible, continuously growing, high protein tissue, its use as a possible indicator of protein status has been probed on several occasions. Depigmentation (2,3) loss of curl(3), reduced diameter(3), and reduced cystine content(2,3,4) have been claimed to be associated with kwashiorkor, but contradictory reports exist particularly where different racial groups have been studied(3,5). Age, sex, and race have been shown to influence the cystine content of hair(6,7).

We have reexamined the potential usefulness of hair as an index of protein status in negro children and find that the simplest of the quantitative measurements, diameter, holds promise as an indicator of protein status provided the position on the head from which the sample is taken is controlled. In previous reports, the area of the head from which the hair came has not been stated, and this omission appears, now, to have been a serious one.

The samples were obtained in Haiti from 36 negro children ranging in age from 3 to 72 months. Their nutritional status on admission was recorded as normal, marasmus, or kwashiorkor on the basis of the usual clinical impressions. Three samples of anterior peripheral hair along the hair line and either 2 or 3 samples from the crown and back of the head were taken from each subject yielding a total of 185 specimens. The samples were either cut from the head at the scalp line or plucked.

These were extracted exhaustively with petroleum ether, dried for 10 minutes at 90° C, cleaned under a hand lens to remove dirt, and stored *in vacuo* over P_2O_5. Pigmentation was recorded as normal, or depigmented, and curliness as either the normal tight negro curl as shown in the photograph of Close(3) or straight. Diameter was measured using a calibrated ocular micrometer taking 2 measurements (one at the proximal and one at the distal end of the hair) on each of 5 randomly selected hairs from each sample.

Amino acid analyses(10) were carried out on 1.0 to 2.5 mg samples of anterior peripheral hair hydrolyzed for 24 hours at 121°C in 6 N HCl in an atmosphere of N_2. From analysis of samples hydrolyzed for 24, 48, and 72 hours, the losses during hydrolysis were adjusted to their zero-time values. Total sulfur was determined as described by Jones and Letham(8) and total nitrogen as described by Johnson(9). All quantitative analyses were carried out in duplicate.

Results in terms of average values are shown in Table I. Because of the conspicuous normal changes in diameter, cystine content, and pigmentation during early infancy, statistical analyses were only carried out on data from the 32 children 12 months of age or older.

In comparing the characteristics of hair from the front hair line with that of hair from the crown or back of the head, however, differences which appear to have nutritional as

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TABLE I. Characteristics of Human Hair as Influenced by Nutritional Status.

Parameter	Health status and head position					
	Normal		Kwashiorkor		Marasmus	
	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
% Straight	24.4	16.7	51.9	35.0	57.6	47.8
% Depigmented	39.0	26.4	66.7	47.6	84.9	60.9
Diameter, mm $\times 10^{-2}$	3.91	3.85	3.74*	4.30	3.52	3.69
% Nitrogen	15.1	15.6	15.1	15.6	15.3	15.0
% Sulfur	4.4	4.4	4.0	4.3	4.4	4.4
Amino acids, %, by wt						
Lysine	4.60		4.09		3.90	
Histidine	1.37		1.27		1.14	
Ammonia	2.76		2.27		2.39	
Arginine	9.97		8.73		9.03	
Aspartic acid	6.24		6.25		6.19	
Threonine	5.87		6.03		6.45	
Serine	7.02		7.19		7.41	
Glutamic acid	14.78		15.37		15.67	
Proline	7.07		6.88		7.39	
Glycine	3.66		3.92		3.81	
Alanine	3.30		3.51		3.47	
Valine	5.38		5.55		5.66	
Cysteine	12.01		12.25		13.28	
Methionine	0.55		0.58		0.56	
Isoleucine	3.79		3.80		3.78	
Leucine	6.77		7.11		7.14	
Tyrosine	2.73		2.89		2.40	
Phenylalanine	2.33		2.55		2.37	

* Anterior diameters significantly smaller than corresponding posterior diameters at $p = .01$.

well as statistical significance were seen. The mean diameter of anterior hair was significantly lower than that of crown or posterior hair in the kwashiorkor group but not in the marasmic or normal group. The frequency of thinner anterior than crown hair in normal, marasmic, and kwashiorkor subjects was 12.5, 50 and 100%, respectively.

Multiple regression analysis showed no significant differences between the three health groups with regard to any of the measurements. Differences in diameter also lacked statistical significance for the various pigmentation, curliness, head position, sex, and age groups. In cystine content the only significant differences ($p>0.05$) were between pigmented and non-pigmented hair. Here, significantly ($p>0.05$) lower cystine values were found for pigmented hair compared to non-pigmented hair. No significant correlation was found between N- or S-content and health status, sex, age pigmentation, or curliness.

The amino acid composition although similar in general to that reported by Close(3) shows conspicuously higher values for lysine, arginine, glutamic acid, and leucine, somewhat lower values for serine and methionine and much lower values for cystine. The present data represent analyses of samples from 36 subjects from known head locations corrected for losses during hydrolysis while the earlier data represent 10 analyses of samples from unspecified positions on the head of 10 subjects without correction for losses during hydrolysis.

The apparent ability of the diameter of hair from specified positions on the head to reflect the past protein-calorie status of the subject suggests that such data would be useful in assessing the nutritional status of negro populations. Its relevance to other racial groups remains unproven.

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Sympathetic Control of the Dog's Nasal Blood Vessels.* (31538)

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The blood supply of the nose is important not only for the needs of the nasal tissues but also to warm and humidify the inspired air. The very rich vasculature with its large venous plexuses has been referred to as the erectile tissue of the nose(1a). Engorgement of the erectile tissue can hinder movement of air through the nose, for in places the air passages are narrow(1b). Vasoconstriction of the nasal blood vessels could reduce both the blood flow and blood content but not necessarily in the same proportion. The present work is the only one we are aware of, which shows quantitatively the marked constrictor effects of slow rates of nerve stimulation on the nasal blood content.

In his article on peripheral autonomic mechanisms Hillarp(2) reviewed the evidence which now has become very convincing that low frequencies of nerve impulses to the blood vessels are very effective in causing contriction or dilatation. Recent work, particularly that by Celander(3) and Folkow(4) indicate that almost maximal vasoconstriction or vasodilatation can be obtained at discharge rates of about or below 10 per second.

Method. Jackson's method of nasal plethysmography(5) was used on the anesthetized dog (35 mg/kg pentobarbital i.p). The nasal cavity is considered to be surrounded by unyielding bony walls and can be blocked off posteriorly and anteriorly. Any change in the volume of blood (blood content) of the nasal mucosa should result in the movement of air into or out of the nose. The nasal cavity is blocked off posteriorly by a rubber ball pushing the soft palate upward. The rubber ball is on a metal rod, and held in place by the Jackson head holder. The method was modified at the recording end in 2 respects. Electronic recording with a transducer and Physiograph was substituted for a tambour. Also between the nasal cannula, tightly secured in the anterior nares and the transducer was a 2500 cc air-containing reservoir immersed in a water bath at a constant temperature. There were also 2 side tubes leading to the reservoir. Both were closed during the recording. One was connected to a water manometer to check for leaks and the other for the purpose of calibrating aspirating known volumes of air with a syringe. The large reservoir was used to prevent changes in intranasal pressure greater than those occurring in normal, quiet respiration. The femoral arterial blood pressure was measured throughout all procedures. The sympathetic fibers in the cephalic end of the ansa subclavia, after section of the dorsal branch, were stimulated with square wave shocks for 30 seconds. Only the frequency was varied, so that frequencies of 4/min, 12/min, 2, 5, 10, 20 or 25 shocks per second were applied, while the other characteristics of the stimulating current were kept constant (3 volts and a shock duration of 15 msec). The observations were made on large or medium sized dogs.

Results. The cervical sympathetic nerve fibers of 10 dogs were stimulated for a total

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