SOME BIOCHEMICAL EFFECTS OF A MAINLY FRUIT DIET IN MAN*

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SUMMARY

The effect of a nut-supplemented fruit diet on glucose tolerance, insulin secretion, plasma proteins and plasma lipids of human volunteers was investigated. The results suggest that, at least for the period covered by the experiment and under the prevailing conditions, the diet was adequate with respect to the parameters investigated, and may even have something to commend it.

In a previous paper some physiological effects of a nut-supplemented fruit diet on human volunteers were described. The impact of the diet on a variety of biochemical parameters in these subjects was also investigated. The results of this investigation are now reported.

METHODOLOGY

The biochemical parameters investigated included plasma electrolytes (K⁺, Na⁺, Cl⁻, HCO₃⁻), potassium per kg body-weight, liver functions, plasma proteins, α- and β-lipoproteins, blood lipids (a complete lipogram was done in 5 cases), thyroid function (PIH and 131-I-uptake) glucose-tolerance curve, insulin curve and renal function (in some cases).

The total potassium content of the body was determined by measuring the "K content by means of a single crystal whole-body counter. The total plasma protein was determined by the method of Weichselbaum, while the protein fractions were determined electrophoretically on cellulose acetate strips using the Beckman microzone apparatus and technique. Electrograms were stained after fixing with Ponceau S solution.

Cholesterol levels were determined in the auto-analysier (Technicon) using a modification of the method described by Levine and Zak. The micromethod of Young and Eastman was used to determine the triglycerides. The α- and β-lipoproteins were determined by the paper electrophoresis method of Fredrickson et al. The protein-bound iodine and 24-hour 131-I-uptake were employed as criteria of thyroid function. Fifty grams of glucose, taken by mouth, was used to determine glucose tolerance. The glucose level was determined in the auto-analysier (Technicon) utilizing the potassium ferricyanide-potassium ferrocyanide oxidation-reduction reaction. This method is a modification of the method proposed by Hoffman. Insulin levels were determined by the procedure of method C of the double antibody method of Hales and Randle. The other biochemical parameters were determined by means of standard laboratory methods.

RESULTS

The various biochemical parameters for the subject forming group C were determined at three 20-week intervals and the values given in the tables represent the mean.

Glucose tolerance. The tolerance to 50 g of glucose per os was determined for each subject before the project began and subsequently at 6- or 12-weekly intervals. The results are presented in Tables I and II. According to Brown et al. schizophrenia does not affect tolerance to glucose. On the other hand Conn reported that diet does affect tolerance to glucose, and the results obtained for the Bantu subjects (group A) and the White subjects (group B) are therefore presented separately (Tables I and II).

<table>
<thead>
<tr>
<th>Patient No.</th>
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<tr>
<td></td>
<td>At zero time</td>
</tr>
<tr>
<td>1</td>
<td>82</td>
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<td>2</td>
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<td>9</td>
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<td>Mean</td>
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As is clear from Table I, the fasting blood sugar level of the subjects of group A was raised after 12 and 24 weeks on the diet. This change was statistically significant at the 5% level of reliability (P<0:05). The subjects from group B showed no statistically significant change in the fasting glucose level. The subject in group C showed a sharp increase in her blood sugar level which returned to more or less the fasting level after 2 hours (Table II). Glycosuria was present after 30 minutes but had almost disappeared after 1½ hours.

Insulin secretion. Some of the blood drawn to determine glucose tolerance was stored at -20°C until the experiment was completed and the final insulin levels of all the blood samples collected from individual subjects were then determined simultaneously. The results are presented in Tables III and IV.

*Date received: 9 November 1970.
The serum lipid level of the single subject in group C was even lower than that of groups A and B. This was the case because the subject of group C had a very low serum cholesterol level. As will be noticed, the insulin responses were high in 4 of the Bantu subjects when the project began. The reason for these high values is not clear. The average maximum insulin level for the corresponding control group was 121 μU insulin/ml serum, and for control persons without medication 220 μU insulin/ml serum. After 12 and 24 weeks on the fruit diet most of the Bantu subjects showed a drop in insulin levels (Table III). This drop was significant at the level of reliability. Only 2 of the 8 normal White subjects showed a slight drop in their insulin levels, while the maximum insulin level increased in 4 of the subjects after 6 and 12 weeks. This might be ascribed to an excessive acid content by some of the subjects. The subject in group C had a very low serum cholesterol level. As will be noticed, the insulin responses were high in 4 of the Bantu subjects when the project began. The reason for these high values is not clear. The average maximum insulin level for the corresponding control group was 121 μU insulin/ml serum, and for control persons without medication 220 μU insulin/ml serum. After 12 and 24 weeks on the fruit diet most of the Bantu subjects showed a drop in insulin levels (Table III). This drop was significant at the level of reliability. Only 2 of the 8 normal White subjects showed a slight drop in their insulin levels, while the maximum insulin level increased in 4 of the subjects after 6 and 12 weeks. This might be ascribed to an excessive acid content by some of the subjects. The subject in group C had a very low serum cholesterol level. The serum triglyceride levels of the subjects of both groups had decreased significantly (P<0.01) after 12 weeks on the diet, and the reduced lipid levels were maintained in group A throughout the 24 weeks that the experiment lasted (Tables V and VI and Fig. 1). The serum lipid level of the single subject in group C was even lower than that of groups A and B. This was the case notwithstanding the fact that fat supplied 45% of her total calorie intake and 36.7% and 27.6% of the total calorie intake of groups A and B respectively.

**Cholesterol.** The mean serum cholesterol of group A decreased during the first 12 weeks of the experiment and the decrease was significant (P<0.05) after 24 weeks. In group B the cholesterol level had decreased significantly (P<0.01) after 6 weeks on the diet. After 12 weeks the mean cholesterol level was still below the control values, but the decrease was no longer statistically significant. This can be ascribed at least in part to an excessive consumption of nuts with a relatively high saturated fatty acid content by some of the subjects. The subject in group C had a very low serum cholesterol level.

**Triglycerides.** The mean serum triglyceride levels of group A had decreased significantly after 12 weeks on the diet (P<0.01) and the reduced values were maintained except in 4 subjects in whom the triglyceride levels tended to rise again after 12 weeks. This might be ascribed partly to a reduction in avocado intake to 100 g instead of 200 to 400 g/day. The reduction was due to a short supply of avocados during the 3 weeks before the follow-up tests.

The control mean serum triglyceride level of group B was considerably lower than that of group A, and unlike group A, no statistically significant changes in the triglyceride levels occurred in group B. The serum triglyceride level of the subject of group C was low.
TABLE VI. PLASMA LIPID LEVELS OF GROUPS B AND C

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>0 weeks</th>
<th>6 weeks</th>
<th>12 weeks</th>
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<th>6 weeks</th>
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<tbody>
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<td>Triglycerides</td>
<td>Phospholipids</td>
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</tr>
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<td>299</td>
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<td>298</td>
</tr>
</tbody>
</table>

**Fig. 1. Changes in the plasma lipid levels of the three groups**

- **Group A** and **Group B** (b) were not statistically different from each other.
- **Group C** had significantly lower levels than **Group A** and **Group B**.

**Table V. Plasma Lipid Levels of Groups A, B, and C**

- **Group A** had significantly lower levels than **Group B** and **Group C**.
- **Group B** and **Group C** were not statistically different from each other.

**Table IV. Insulin Response of Groups A, B, and C**

- **Group A** had the highest insulin response, **Group B** was intermediate, and **Group C** had the lowest response.

**Note:** The mean plasma levels of cholesterol and triglycerides were calculated for each group. The results were obtained from a group of 10 patients in each group. The statistical significance of the differences was determined using the Student's t-test. The p-values are indicated below each graph.

**Legend:**
- **A**: Mean plasma levels of cholesterol and triglycerides for groups A and B.
- **B**: Mean plasma levels of cholesterol and triglycerides for group C.
- **C**: Mean plasma levels of cholesterol and triglycerides for group D.
while it increased significantly in group B (P<0.05). The results are presented in Tables V and VI.

**Plasma proteins.** The values obtained for the total plasma protein, albumin, globulin and different globulin fractions at different time periods of the experiment are summarized in Tables VII and VIII. The changes which occurred are presented graphically in Figs. 2 and 3.

As is clear from Table VII, the mean total plasma protein level of group A decreased initially, but then increased again to reach a mean value which was only slightly below the initial value. The decrease was mainly due to a decrease in globulins from 3.7 to 3.4 g/100 ml. This decrease was not statistically significant, unlike the decrease in α1 and α2-globulin. After 24 weeks the mean albumin level was 0.319 g/100 ml higher than the mean initial value. The changes in total protein, albumin and globulin fractions are illustrated in Fig. 3.

The total plasma protein of normal White volunteers increased significantly (P<0.01) over the first 6 weeks of the experiment, but returned to almost normal after 12 weeks. Similar changes occurred in the albumin levels. The total globulin levels also increased in this group during the first 12 weeks and the increase was statistically significant (P<0.05 after 6 weeks and <0.01 after 12 weeks). The increase in total globulin was mainly due to an increase of α1-globulin during the first 6 weeks (P<0.01) and to an increase of β-globulin during the second 6 weeks (P<0.01).

The total plasma protein and albumin levels of the one subject constituting group C did not differ significantly from those of the normal volunteers (Table VIII).

**Bantu control persons.** No indication was found that medication or the type of psychoses from which the patient suffered significantly affected any of the biochemical parameters evaluated.

**Glucose Tolerance**

Different methods are used to assess the tolerance of subjects to glucose. According to Notelovitz the specificity and sensitivity of subjects to the standard method of 50 g of glucose per os give results which compare very well with the results obtained when the glucose is administered by the intravenous route. Apparently the standard method also gives superior results as far as insulin secretion is concerned. Consequently the standard method was employed in the present experiment. With this method only the Bantu subjects showed a statistically significant increase in fasting blood glucose levels after 12 and 24 weeks respectively. Dalderup et al. noticed a similar tendency towards raised fasting blood sugar levels in rats maintained on a high intake of refined monosaccharides and disaccharides.

Bantu are habituated to a low-fat, high-carbohydrate diet while the present diet was a high-sugar, relatively high-fat diet. Several authors have demonstrated that the amounts of circulating glucose in rats increased if they were put on a high-fat diet. The present diet also contained large quantities of fructose and impaired glucose utilization had been observed in the livers of human subjects who consumed considerable amounts of fructose as well as in rats fed on fructose. This might be due to a decrease in the glucokinase activity of the liver or to an interference with the mechanism responsible for trans-
porting glucose to the site of glucokinase activity in the cell. This is, however, still a subject of much controversy.

The relatively high potassium intake of the subjects is apparently not responsible for their higher fasting blood glucose levels, for according to Conn a large body of experimental evidence indicates that potassium deficiency leads to deterioration of carbohydrate tolerance, but the mechanisms involved are not clear. The potassium is now known to be an essential activator of many intracellular enzymatic reactions and especially those involved with the transfer of high energy phosphate in carbohydrate metabolism. Seedat, likewise, noticed an inverse relationship between the plasma potassium and the blood sugar in his patients.

The fasting blood glucose levels of the normal White volunteers were not affected by the fruit diet. This could perhaps have been expected, for these subjects were used to high sugar and fat intakes before their collaboration in this project and their fruit consumption was likewise considerable.

The fruit diet did not produce a statistically significant change in the tolerance of glucose of Bantu and Whites. Persson et al. reported a reduced tolerance to glucose in human subjects who consumed a low-carbohydrate diet. Conn made similar observations.

**Insulin Secretion**

The fruit diet produced a statistically significant reduction in the plasma insulin response after glucose intake in some Bantu while in some Whites there was an inexplicably high insulin secretion at some stage during the experiment. Blazquez and Lopez reported an increase in plasma glucose and hepatic glycogen together with a simultaneous marked decrease in the concentration of plasma insulin and in the utilization of glucose by the tissues of rats fed on foods with a high fat content. The sugar intake in the present diet was high, but so was the fat intake. It has also been reported that adrenaline inhibits insulin secretion in the presence of high glucose levels and mental patients apparently often have elevated adrenaline secretions.

In the presence of a relatively high potassium intake, as was the case in the present experiment, one would have expected an increased insulin secretion by the pancreas, for according to Conn a low plasma potassium level prevents the release of insulin from the pancreas and according to Hales and Milner an increase in potassium stimulates insulin secretion. The fruit diet produced a considerable change in the insulin response to oral glucose but the time required to produce these responses differed from subject to subject.

Only some of the subjects showed a significant correlation between plasma glucose and plasma insulin levels. Buchanan and McKiddle and Abrams et al. reported similar inconsistent results, while Seymore and De Bruin found that 50% of their cases showed a significant correlation.

Another factor to consider in connection with the plasma insulin response of the subjects in the present experiment is their high avocado intake, for according to Viktora et al. avocado suppresses insulin secretion. This effect of avocado has been ascribed to its high content of a 7-carbon sugar, namely D-mannoheptulose which con-
stutters approximately 1.3% of the pulp of avocado. In 5 of the 8 human subjects studied by Viktora et al. mannoheptulose reduced insulin secretion. No effect was apparent in the other 3 subjects. In some of these subjects the depression of the plasma insulin resulted in benign melituria. According to these workers, feeding of mannoheptulose to animals produced a low steady blood mannoheptulose level which was maintained for extended periods. Mannoheptulose accumulates in the liver and Viktora et al. suggested that the maintenance of a steady mannoheptulose blood level for a considerable number of hours is due to slow absorption of this sugar from the intestines, and later the slow release of the sugar from the liver. Our subjects consumed a minimum of 225 g of avocado per day, so that their minimum intake of mannoheptulose was about 2.7 g per day. It is, however, doubtful whether the D-mannoheptulose played any part in the reduced insulin response to oral glucose in the present study, for the glucose-tolerance test was performed 12 hours after the last meal and the reduced insulin response was only noticed in the Bantu subjects.

When this experiment commenced the subject of group C had eaten considerable amounts of avocado daily for the past 12 years. Although she developed glycosuria during the glucose-tolerance test, she had no symptoms or signs of diabetes mellitus, and her glucose-tolerance curve was not of the diabetic type. Her melituria was therefore apparently benign.

**Lipids**

To some extent the plasma levels of cholesterol, triglycerides and phospholipids are interrelated. Hence conditions affecting the level of one often also affect the levels of the other two. Fat intake is the most important single factor affecting the plasma lipid level, but carbohydrate intake also affects the plasma lipid levels. In this respect it should be pointed out that not only is the total quantity of dietary carbohydrate important, but also the nature of the carbohydrate which is consumed. This is of special importance in a fruit diet for most fruits contain considerable quantities of fructose, glucose and sucrose.

In the present experiment the subjects from groups A, B and C received 36.7, 37.6 and 45% respectively of their calories from fat and 64.8, 64.7 and 52% respectively from carbohydrate.

Numerous factors affect the plasma cholesterol level, but the level is surprisingly constant in any one person. However, although the plasma cholesterol level is unaffected by minor day-to-day variations in diet or routine, it is changed gradually over several weeks by a change in the nature of the diet. According to Davidson et al. the full effect of a change in diet on the plasma cholesterol level is usually apparent only after 2 weeks, and persists for at least 8 weeks. Whether these changes are permanent when a new dietary habit is maintained, is not yet known. The general pattern of the cholesterol changes noticed in the subjects of group A seems to point in this direction.

While the initial mean cholesterol level of 224 mg/100 ml for our White subjects (group B) is comparable to the mean value of 234 mg/100 ml reported for White males in Cape Town by Brönte-Stewart et al., the initial mean value of 214 mg/100 ml for our Bantu subjects (group A) was considerably higher than the mean value of 166 mg/100 ml for Cape Town Bantu obtained by Brönte-Stewart et al. This difference might be due to the fact that our Bantu subjects were on a balanced hospital diet for about 3 months before their participation in the experiment. In man the cholesterol content of the diet has apparently only a negligible effect on the plasma cholesterol level, while the fat content of the diet will gradually alter the plasma cholesterol level. According to Hegstedt et al. controlled variations in the quantity and quality of dietary fats produce rather well-described and predictable changes in plasma cholesterol levels in man, while several workers have concluded that the type of dietary carbohydrate may participate in the control of the plasma cholesterol level.

In general, sucrose is thought to have a hypercholesterolaemic effect as compared to starch—or at least when an isocaloric substitution of sucrose is compared with complex carbohydrate from various plant sources, e.g. fruits, leafy vegetables and legumes.

Sugar intake was not restricted in our subjects. Being on a fruit diet they occasionally developed a craving for salt rather than for sugar. Hence their intake of refined sugar was quite low, their main source of carbohydrate being the various fruits.

Reaven et al. suggested that the ability of a high-carbohydrate diet to stimulate hepatic triglyceride production and secretion may be directly related to the insulin response produced by the diet. The acute effect of glucose or insulin in the postabsorptive state is to lower the blood glucose level, probably by facilitating peripheral clearance of glycerides through an increase in lipoprotein lipase activity. However, there is some experimental evidence that insulin may increase hepatic triglyceride production. Insulin may therefore have a dual role with the blood glucose level being an important balancing factor. According to Lees and Fredrickson a high-carbohydrate diet containing a minimum of 7 g carbohydrate per kg body-weight per day resulted in a progressive rise in the serum triglycerides in normal people reaching peak levels after 7-14 days, but then gradually returned towards normal despite a continued high-carbohydrate intake.

In the present study the subjects of group A ingested about 7 g carbohydrate/kg body-weight/day and the results obtained for the 5 subjects agree with the results reported by Reaven et al. in that their triglyceride levels and insulin response decreased significantly. However, none of our groups showed a close correlation between triglyceride levels and the sum of the insulin response. The triglyceride levels of group B were much lower than those of group A, and showed no specific trend. The higher control triglyceride levels in the Bantu than in the White subjects are unexpected, for it is generally assumed that serum triglyceride levels are lower in Bantu and Coloureds than in Whites. The high values of our Bantu subjects can probably be ascribed to their 3 months of hospital diet, their physical inactivity during hospitalization and perhaps their medication.

According to Ford et al. there may also be a separate correlation between glucose and triglyceride concentra-
tions, being relatively independent of body-weight and insulin levels. These workers inferred that triglyceride levels were dependent upon blood glucose as well as insulin levels. In the present study no significant correlation between glucose response and triglyceride levels was, however, noticed. The decrease in the serum triglyceride levels of the subjects in group A in the present study may in part be due to the high intake of unsaturated fatty acids. The avocado and nuts consumed supplied about 100 g of fat per day and approximately 63% of this fat consisted of unsaturated fatty acids. In the case of group B the intake of unsaturated fatty acids varied considerably from subject to subject. The consumption of high-fat diets rich in unsaturated fatty acids apparently maintains low plasma triglyceride levels, and lowers the lipid content. 5,6 The absence of significant changes in the triglyceride levels of the subjects in group B may be due to their low initial triglyceride levels and the relatively short period covered by the present experiment. According to Antonis and Bersohn triglyceride levels are not significantly affected by the composition of the diet consumed over short periods.

The limited phospholipid studies carried out in the present experiment confirm the observations of Antonis and Bersohn that a high-calorie, high-unsaturated-fatty-acid diet which lowers the serum cholesterol level, lowers the phospholipid level even more.

**Plasma Proteins**

The average protein intake of about 50 g per day, supplying 7.5% of the total calorie intake, was relatively low, and all the protein consumed was of plant origin. Yet the total serum protein did not decrease significantly in the Bantu subjects while a significant (P<0.01) temporary increase was noticed in White subjects. This raises the question as to what may be regarded as an adequate protein intake. The observations of Darling et al. and Hegstedt et al. suggest that the protein requirements of man are less than is generally accepted, and according to Best and Taylor there is no accepted norm for protein intake. Since significant underweights (perhaps 10-15% less than the weight/height tables indicate) and hypoproteinaemia did not develop in our subjects, gross protein intake, in the main, could not have been seriously low.

On the other hand Louw et al. found hardly any correlation between serum protein levels and dietetic factors, and these workers regard the total serum protein levels as a poor criterion of the nutritional status of a human subject. However, they did find a positive correlation between serum albumin levels and the intake of protein from animal origin. This correlation did not exist between serum albumin levels and the intake of plant protein.

Our subjects consumed only plant protein, yet the albumin levels increased significantly and in Bantu subjects the increase was maintained. Similarly the subject forming group C had a normal albumin level. This suggests that the supply of essential amino acids was also adequate. About 35% of the protein consumed was of nut origin and nut protein is regarded as first-class protein.

According to James and Hay a decrease in protein intake is immediately followed by a reduction in the rate of albumin synthesis. However, the body tries to preserve its blood albumin level and this is done by transferring albumin from the extravascular to the intravascular compartment, and reducing the rate of albumin catabolism. The observations of James and Hay have been confirmed by Kirsch et al. Although from a nutritional point of view one is probably not justified in applying results obtained on plasma albumin pari passu to body proteins in general, the circulating albumin mass reflects at least to some extent the quality and quantity of protein consumed in the present experiment.

According to Waterlow if albumin constancy is not achieved, then one may suppose that the physiological range of adaptation has been exceeded. By contrast, the finding of a normal intravascular albumin mass with a reduced rate of catabolism would suggest a successful adaptation. In the present study the albumin level was not only adequately maintained in Whites, but very efficiently raised and maintained in Bantu. As the circulating albumin mass in the normal White volunteers was most probably optimal when the experiment began, the explanation of their transient increase in circulating albumin is not clear. Our results are at variance with those of Louw et al. who associate high circulating plasma albumin levels with a high animal-protein intake and a high plant-protein intake with low serum albumin levels. The total circulating plasma globulin and β-globulin levels did not increase significantly in the Bantu subjects, but showed a statistically significant increase in the White subjects over the first 12 weeks of the experiment. Mack reported a positive correlation between total circulating globulin mass and plant-protein intake. The absence of a significant increase in circulating total and β-globulin in Bantu subjects must probably be ascribed to the already high circulating mass of total and β-globulin in Bantu, for obviously there is a limit to which the different plasma protein fractions can increase. Once this limit has been reached no additional protein intake of whatever composition will induce further rise.

Scrimshaw recently emphasized the importance of an adequate intake of essential amino acids together with an adequate intake of utilizable nitrogen for the synthesis of non-essential amino acids. For obvious reasons the amino-acid composition of animal protein corresponds more closely to the amino-acid composition of the human body than plant protein. Most plant proteins are deficient in one or more essential amino acids. The deficient amino acids can be supplied by other plant proteins supplying complementary amino acids; taking the deficient amino acids in synthetic form; animal protein; or consuming excessive amounts of plant protein so as to make up for the low levels in which some of the amino acids are present. According to Scrimshaw the average young man who is leading a fairly active life requires a daily protein intake of less than 30 g. This amount of protein is even adequate for young men who are physically very active provided that the total calorie intake is such that part of the protein is not required for calorific purposes and the protein is of good quality.

In the present experiment the nut supplementation of the fruit diet supplied amino acids on a complementary basis. In addition a great variety of fruit and a few
types of vegetables could be eaten ad libitum. This probably explains why the subjects did so remarkably well on the diet.

Looking at the plasma proteins from a different point of view also suggests that the nut-supplemented fruit diet supplied protein, adequate in quantity and in quality. The plasma protein pattern of black Africans often differs from that of healthy white Africans, the main difference being a tendency to lower circulating plasma albumin and higher total globulin, especially of $\gamma$-globulin, in Blacks than in Whites. The total plasma protein is often reduced in African subjects, but sometimes the rise in globulins is enough to compensate for the low albumin. These racial differences appear after the first year of life. Suggestions put forward to account for these racial differences include inadequate protein intake, chronic liver disease and true genetic differences.

In Bantu children suffering from malnourishment from nutritional or from nutritional oedema the total serum protein level is far below normal, mainly because the albumin level is greatly reduced; $\alpha$- and $\beta$-globulin levels are usually normal, while $\gamma$-globulin is both absolutely and relatively normal or higher than normal. The serum albumin level rises rapidly on protein repletion. In malarious adults Stanier and Holmes noticed a rise in serum albumin after a period, when these subjects were fed on foods with a high-protein content. However, the high $\gamma$-globulin level did not fall invariably. Schofield studied West African residents in Britain and concluded that with time the protein pattern approaches that of healthy Europeans.

When the present study began the Bantu subjects had normal total protein levels, but the albumin level was low and the globulin level, especially the $\gamma$-globulin, was high. The A/G ratio was less than unity. Although the fruit diet did not alter the mean total protein level of the Bantu substantially, their mean albumin level did not fall invariably. Schofield studied West African residents in Britain and concluded that with time the diet supplied protein, adequate in quantity and in quality.

When these observations together with those of the other workers referred to are considered, one is justified in concluding that the present diet was neither inadequate in total protein nor deficient in individual amino acids— in fact it tended to “westernize” the plasma protein pattern of the Bantu. Support of this conclusion is the slight change in the mean albumin level of Whites (Table VIII).

In conclusion it should be pointed out that under different nutritional circumstances the biochemical effects of a fruit diet would not necessarily be comparable to those found in this study, for it has been well established that the effects of a change in diet would depend on the degree of change (quantitative and qualitative), the duration, and on the individual concerned.

This investigation was supported by the University of Pretoria, the Medical Research Council of South Africa and the Atomic Energy Board.

**REFERENCES**

EMOTIONAL HANDICAPS TO LEARNING IN TWO CULTURES*

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SUMMARY

Deteriorating academic performance in schoolchildren may be due to emotional rather than intellectual causes, but these are not always recognized. The problem is likely to be of increasing importance in African children in Rhodesia as the general level of education rises.

Emotional problems in 11 European and 16 African schoolchildren are compared. Although no firm conclusions can be drawn, the evidence suggests that the same conceptual framework may be used for both groups; that physical symptoms may present more often in African children; and that 'over-driving' and peer group rejection may be more common psychopathological factors in African children.

The incidence of psychiatric problems in children is not accurately known, partly because there are no generally acceptable criteria of abnormality; the most frequent 'abnormalities' of child behaviour are, in fact, normal stages of development which have been extended in time or significance. Nevertheless, problems are very common. A recent study by New York University of 1034 Manhattan children selected at random indicated that 12% showed marked to severe psychiatric impairment. Planning for psychiatric services in Britain is based on the estimate that about 2% of all schoolchildren will need psychiatric treatment every year, but recent reports have called for greatly increased investment in physical and professional resources for dealing with disturbed children.

Although emotional problems frequently give rise to disturbed behaviour both at home and within the classroom, the continual monitoring of the child's school career may sometimes bring to light deteriorating academic or social performances before other symptoms become obtrusive. Parents often fail to recognize the true nature of their child's disability and it is frequently assumed that the child is 'not trying'. On the contrary, the child may be well aware that he is not functioning as usual and bewildered as to why this should be so despite his increased effort. Exasperated parents often resort to increased discipline and extra lessons in attempts to drive the child harder. Further deterioration results until—as a last resort and without much hope—the help of the doctor is enlisted.

With the increasing educational opportunities for African children who form more than half the African population, it is inevitable that educational problems of this kind will be seen with increasing frequency.

The purpose of this paper is to compare groups of African and European children and, although the groups are too small for any firm conclusions, to suggest tentatively that the same conceptual framework is valid for both, despite important clinical differences.

CLINICAL GUIDELINES

The picture which confronts the doctor is very variable but the following broad diagnostic categories were used in the present study:

1. Psychological Discomfort
   (a) School phobia. This is manifested as truancy, refusal to attend school or repeated absences because of minor ailments. Acute and chronic forms can be differentiated.
   (b) Depressive states. These are often difficult to diagnose as the presenting symptoms may be entirely misleading, e.g. vague abdominal pain, and the assessment of depressed mood on interview is not very reliable.
   (c) Anxiety states. Children's fears are commonly related to a distinct object with subsequent stimulus generalization. Abnormal fears may be derived from other children or adults and, if unrelied, lead to hysterical features which complicate the picture. Emphasis on the somatic components is common, particularly in girls.
   (d) School inadequacy. This is manifested as lack of interest in school, a disinclination to study, lack of application and compensatory identification with other children with educational problems. Alternatively, the child may react by acting out aggression and expressing it as defiance, rudeness or general negativism.

2. Cognitive Inefficiency
   This is manifested as an inability to think clearly or use occupational or social skills.

3. Disturbance of Bodily Function
   There may be loss of weight, headache, persistent diarrhoea, etc.

4. Deviation from Social Norms
   Statistical correlations of behaviour patterns with situational factors have revealed three broad categories of

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*Date received: 16 November 1970.