THE DIET OF A GROUP OF DURHAM MINERS FREE FROM NYSTAGMUS

By C. E. KELLETT, M.D., M.R.C.P.
Assistant Physician, The Hospital for Sick Children, Newcastle-upon-Tyne

Introduction

The "duplex theory" of vision suggests that there is a scotopic mechanism, working with a low threshold stimulus intensity, evident in conditions of dark adaptation, and a photopic mechanism, concerned with form and colour vision, working with a relatively high threshold stimulus. Sharpley (1936) concluded that in order to bring about a change from scotopic to photopic vision at the coal face it was necessary to provide a brightness of at least 0·01 candle per sq. ft. on the surface. To so illuminate an area of 6 ft. in diameter on the coal face would necessitate a 14 candle-power lamp placed 4 ft. 6 in. away. No modern electric safety lamp gives over 4 candle-power.

Miners' nystagmus probably originates as a derangement of the scotopic system, but probably over half the men working underground never suffer from nystagmus; this implies that there are other factors operative in addition to poor illumination. In 1932, I thought that a relative deficiency in vitamin A intake with a consequent impairment in dark adaptation might constitute such a factor, but was unable to obtain sufficient data either to prove or disprove such a suggestion. The recent work, however, of Sir John Orr (1936) and Crawford & Broadley (1938), suggests that such a deficiency exists in the diet of the majority of the families in this country. This opened up a fresh approach to the problem and it became of interest to determine whether or not such a deficiency was present in the diet of miners entirely free from nystagmus.

As a contribution to this subject the vitamin A intake of a small group of Durham miners, who, despite many years of underground work, have never suffered from nystagmus, has been investigated.

Methods and material

Forty volunteers were examined. Their vision was tested by means of Snellen's type; their dark adaptation by means of the apparatus devised by Mutch & Griffith (1937), using Edmund's cards, Tscherning glasses and 60 W. lamps. The actual illumination of the cards being in our apparatus 1380 m.-candles as opposed to the 1000 m.-candles used by Edmund and the 1620 m.-candles by Mutch & Griffith.

Details of their diets were ascertained and the vitamin A content estimated. The effects of adding known quantities of vitamin A were also determined.

Of the forty volunteers, thirty-two worked in the same pit. All these volunteers were working underground and the majority had been doing so for over 20 years. Twenty-five of them were hewers and the rest deputies, stonemen and other types of underground workers. Their average age was 42, which corresponds closely to the age 42·3, at which the maximum number of cases of nystagmus are found to occur (M.R.C. 1922).

Observations

Table 1 summarizes the amounts of vitamin A-containing foods taken by these miners in the spring of 1939. Undoubtedly many of them, who had gardens and small greenhouses, would take far more vegetables, including tomatoes of their own growing, during the latter months of the year. With one

Table 1. *Weekly intake of vitamin A-containing foods*

Initials of men volunteers	Greens (250 I.U. per oz.) oz.	Eggs (600 I.U. per egg)	Butter (2000 I.U. per oz.) oz.	Milk (2000 I.U. per pint) pints	Cheese (1000 I.U. per oz.) oz.	Liver (3000 I.U. per oz.) oz.
G. A.	3	3	16	6	1	4
N. F.	1	7	16	½	8	4
W. M.	2	6	16	2	—	3
G. W.	3	1	16	3½	3½	4
J. B.	2	7	8	—	1	2
C. Q.	2	6	8	—	—	2
W. F.	3	10	16	1	—	6
W. R.	2	2	8	1	1	4
H. S.	3	4	8	1½	1	4
A. F.	7	7	16	1	½	8
A. C.	3	4	8	1	—	4
N. C.	2	7	8	1	1	4
E. W.	3	7	12	7	—	4
W. I.	2	7	10	1	—	4
A. G.	2	7	8	3½	—	6
W. M.	3	12	24	3½	16	—
I. B.	2	12	16	1	1	1
S. S.	1	4	10	—	4	4
S. M.	2	4	12	7	½	2
J. G.	7	12	16	—	4	—
G. C.	2	3	8	2	—	Cod-liver il
H. O.	3	7	8	1	4	4
S. E.	3	12	12	2	2	—
J. L.	2	10	16	—	1	1
J. R.	3	10	12	3	1	—
G. H.	6	10	16	—	1	—
G. C.	3	7	16	3	—	4
J. P.	—	6	16	1	½	5
A. P.	3	12	20	2	16	4
A. I.	3	6	16	—	12	16
J. S.	7	6	12	1	—	2
J. M.	3	6	14	2	—	2
R. D.	2	6	14	1	—	1
J. McA.	1	4	12	2	—	2
H. S.	2	7	16	2	2	1
E. B.	7	2	4	4	—	8
T. L.	2	10	16	1	2	2
J. J.	1	2	12	1	1	1
J. R.	1	12	12	1	1	1
W. T.	1	7	16	—	2	—
Totals 40	110	274	520	70½	88	124
Average diet per man	3	6·9	13	1·75	2·2	3·1

https://doi.org/10.1017/S0022172400027935 Published online by Cambridge University Press

exception, E.B., who had a glass of orange juice each day before going to work, they eat very little fruit throughout the year. One man only, G.C., took additional vitamin A in the winter in the form of two to three pounds of cod-liver oil and malt.

In the items each individual diet does not differ materially from another. It seems legitimate therefore to construct an average weekly diet, which is shown at the foot of this table. If the values of the vitamin A content, expressed in international units and indicated in brackets in this table, are accepted this diet has the high weekly value of 46,000 I.U., or a daily average of 6600 units. In order to compare this average weekly diet with those of Sir John Orr it is necessary to know approximately both the weekly earnings and the size of the miner's family:

The average wages for the period were: hewers 11*s*. a shift, say 55*s*. a week, less offtakes of 4*s*. 6*d*., but in addition house and coals; deputies 10*s*. 3*d*. a shift with probably six or seven shifts a week; stonemen much the same wages as hewers. The sizes of twenty-six families were ascertained. There was one single man, three families of two, eleven with one child, ten of two children, one family with three children; the average family being 3·3. This average family is in striking contrast with the average Durham miner's family of 7·14 in the M.R.C. report of 1924 on the Nutrition of Miners and their Families, but is probably little below the present average size for the county which in 1931 was 4·04 with a rate of decline that had risen to 12·4 %.

In Table 2 the average diet is compared with the intake of similar foods by different groups as determined by Orr (1936) and by Crawford & Broadley (1938) and with the ideal B.M.A. diet no. 2 (1933).

Table 2. *Weekly intake of vitamin A-containing foods at different income levels*

	Greens oz. per week	Eggs per week	Butter oz. per week	Milk pints per week	Cheese oz. per week	Liver oz. per week
Orr (1936, from Table 1, Appendix VI)						
Group 1, up to 10*s*.	—	1·9	2·7	1·1	1·5	—
Group 2, 10*s*. to 15*s*.	—	2·8	5·7	2·1	2·1	—
Group 3, 15*s*. to 20*s*.	—	3·7	7·4	2·6	2·8	—
Group 4, 20*s*. to 30*s*.	—	4·8	8·8	2·9	3·2	—
Group 5, 30*s*. to 45*s*.	—	4·7	8·9	4·5	2·9	—
Group 6, +	—	5·2	9·7	5·4	2·5	—
Crawford & Broadley (1938, Caps. XV and XVII, *pass.*)						
Class AA, £1000 p.a. +	—	6·6	11·6	5·3	3·3	—
Class A, £500 to £999	—	6·2	11·3	5·01	3·3	—
Class B, £250 to £499	—	5·5	10·3	4·38	3·0	—
Class C, £125 to £249	—	3·8	7·2	2·62	2·7	—
Class D, under £125	—	2·6	4·5	1·57	2·1	—
B.M.A. diet 2; Supp. *Brit. med. J.* 25 Nov. 1933	16	1	4	1·75	8	4
Miners, 1939	3	6·9	13	1·75	2·2	3·1

Coal miners are classed by Crawford in class D. On the assumption that the average earning is slightly under £3 a week the average family (3·3) would come just into group 3 as defined by Orr.

It is apparent that the diet of these miners compares favourably with any of those given in Table 2.

The high daily intake of vitamin A is remarkable, miners being probably the only body of men making continuous demands on their scotopic vision.

The high level is due to a butter intake which is substantially larger than any in Table 2. At first we were inclined to doubt the large intake of butter, but after, and in order to confirm this conclusion, an investigation was made into the butter consumption of a small group of miners in another colliery village by a reliable independent observer who personally knew the families concerned. This group was not an altogether random sample because he was anxious to include families of different sizes. The results of this investigation, which included 55 persons in families consisting of two to ten individuals, is given in Table 3. The weekly incomes per head ranged from 8*s*. to 30*s*. per week, equal to 2·7–8·8 oz. of butter in Orr's figures.

Table 3. *Weekly income and intake of butter in a second group of miners*

Husband	Wife	Boys	Girls	Men working	Total income	Income per head	Butter	
							Per family lb.	Per head oz.
1	1	2	4	2	80*s*.	10*s*.	6	12
1	1	—	—	1	60*s*.	30*s*.	2	16
1	1	1	1	1	60*s*.	15*s*.	3½	14
1	1	2	2	1	60*s*.	10*s*.	4½	12
1	1	6	2	5	140*s*.	14*s*.	9	14½
1	1	—	1	1	60*s*.	20*s*.	2½	13½
1	1	2	1	3	100*s*.	20*s*.	4	12¾
1	1	1	—	1	60*s*.	20*s*.	2½	13½
1	1	—	2	1	60*s*.	15*s*.	3	12
1	1	—	—	1	60*s*.	30*s*.	2	16
—	1	3	—	3	70*s*.	17*s*. 6*d*.	3	12
—	1	1	2	1	?30*s*.	?7*s*. 6*d*.	3	12

Average weekly income per head approximately 15*s*. 6*d*. with house and coals. Average weekly intake of butter 13·7 oz. per head.

Despite this the weekly consumption only varied from 12 to 16 oz. per head; the average for the whole group being 13·7 oz. per head, a figure which does not differ very greatly from that obtained in our first group.

From 1927 to 1934 a considerable increase in the consumption of butter, from 15·9 to 25·2 lb. per head per annum occurred (League of Nations, 1936), which could be closely correlated with the price; a rise or fall of 1*d*. per lb. decreasing or increasing consumption during that period by the same absolute amount—39,000 cwt. (League of Nations, 1937). In general the consumption of butter appears therefore to be very dependent on the standard of living (see Table 2). On the other hand the actual consumption of butter in the miner's family is only slightly affected, if at all, by variations in the family income per head, and is probably conditioned by the nature of the men's work, which also influences their habits with regard to smoking and drinking.

Some 8½ or possibly 9 hr., inclusive of travelling, is spent at work, much of which is heavy. During this period weak tea is generally drunk and thick slices of bread and butter often sprinkled with sugar, eaten. The bread is generally home-made. Breakfast is taken before work, or in the case of the later shifts a light meal of a similar nature, and a supper or high tea on return, and in these the frying pan is apt to play an important role, as is further bread and butter, eggs and in certain instances, liver. The butter purchased is usually the best and margarine is hardly ever substituted. Certain miners prefer dripping, which was probably more commonly used formerly than at present: E.B. alone in our group had this preference. He alone in our series had only 4 oz. of butter a week, on the other hand, he had 1 lb. of beef dripping made for him at home each week, and amply compensated for the deficiency in vitamin A by having ½ lb. of liver each week as well as 4 pints of milk, in addition starting each day with a glass of orange juice.

The main source of vitamin A is then an expensive one, liable to restriction in times of dearth, but less vulnerable than might have been anticipated. It remained to be seen whether, large though it is, it is adequate for their particular type of work.

Though there is, according to McCollum *et al.* (1939), a "widespread skepticism as to the reliability of the dark adaptation technic as a measure of vitamin A deficiency", we used it because it seemed not only a superior method to blood estimations but more suitable for our investigation (Ungley, 1938).

Improvement with practice is said not to occur, but Ungley suggests that repeated readings should in each case be taken until they become constant, and that low readings cannot be accepted as evidence of vitamin A deficiency unless definite improvement should ensue following the administration of vitamin A. Every care was taken to obtain accurate readings, and not more than six miners investigated in the usual morning session. It was not possible for us to take repeated readings before starting the test.

Table 4 gives, in addition to other information, the daily vitamin A intake, and the power of distinction, expressed as Ungley has suggested, in terms of the total number of test cards visible through Tscherning glasses 1–8, before and after the administration of known quantities of vitamin A. In our machine the actual illumination was less than in Ungley's and the normal range 35–42, as opposed to his normal range of 43–51. It is apparent that there was definite improvement in the results obtained on the second reading, for the range was less wide and approximated more closely to that of the small group of ten students (Table 5) used as a control. On the other hand, there was no apparent relationship either between the daily intake of vitamin A and the initial reading or between the subsequent reading and the dose of vitamin A administered. The three persons taking the control old adexolin, which had been prepared for the 1932 investigation and which was known to be inert, did as well as those receiving the old adexolin, which, however, seemed to have lost most of its potency. There was no obvious difference between the improvement shown by this group of ten persons, which may be regarded as a control, and that shown by other groups receiving large known quantities of vitamin A.

Table 4. *Dark adaptation tests in relation to time underground and intake of vitamin A*

Initials of volunteers	Type of work	Age (in brackets length of work underground)	Total family	Daily intake of vitamin A given in I.U.	Visual acuity as tested by Snellen's types	Dark adaptation; 1st reading	Known additional quantity of vitamin A taken in week preceding second test	Second dark adaptation test
G. A.	S	42 (20)	3	7,400	6/9 6/9	35	21 O.A.C.	36
N. F.	H	42 (28)	3	7,000	6/6 6/6	33	69 O.A.C.	35
W. M.	S	40 (26)	5	7,200	6/6 6/6	33	21 O.A.C.	35
G. W.	D	49 (38)	3	8,200	6/6 6/12	28	12 O.A.	35
J. B.	H	42 (26)	?	6,000	6/6 6/6	31	69 O.A.	32
C. Q.	H	38 (25)	4	4,000	6/6 6/6	35	31 O.A.	35
W. F.	H	44 (30)	3	8,000	6/12 6/6	34	70 O.A.	34
W. R.	H	46 (32)	5	4,500	6/6 6/6	30	70 O.A.	35
H. S.	S	45 (31)	2	7,000	6/6 6/6	30	21 O.A.	36
A. F.	H	42 (22)	4	8,700	6/6 6/6	31	43 O.A.	34
A. C.	H	40 (26)	4	8,000	6/6 6/6	33	120,000	38
N. C.	H	37 (23)	2	5,200	6/6 6/6	34	168,000	40
E. W.	H	36 (15)	3	8,500	6/6 6/6	26	168,000	38
W. I.	H	34 (20)	2	5,000	6/6 6/36	33	120,000	34
A. G.	H	39 (24)	?	6,500	6/9 6/12	26	126,000	32
W. M.	H	41 (25)	3	10,000	6/6 6/6	31	126,000	34
T. B.	H	35 (21)	?	6,500	6/12 6/6	35	168,000	34
S. S.	D	49 (36)	?	5,600	6/24 6/36	29	168,000	35
S. M.	D	35 (21)	3	5,500	6/9 6/12	34	168,000	37
J. G.	HK	28 (2)	1	6,200	6/6 6/6	31	168,000	39
G. C.	D	42 (24)	?	4,000	6/6 6/6	38	336,000	40
H. O.	H	40 (26)	?	6,000	6/9 6/9	31	336,000	37
S. E.	D	45 (30)	4	5,000	6/6 6/6	31	336,000	40
J. L.	H	37 (25)	3	6,000	6/6 6/6	33	336,000	34
J. R.	H	42 (27)	4	4,500	6/18 6/12	34	336,000	35
G. H.	H	30 (16)	4	5,500	6/18 6/12	34	336,000	35
C. C.	H	40 (20)	?	7,000	6/36 6/36	27	336,000	33
T. P.	D	54 (40)	4	7,500	6/9 6/18	31	504,000	35
A. P.	H	48 (31)	?	10,000	6/18 6/18	35	504,000	38
A. I.	H	41 (24)	4	10,000	6/6 6/6	28	504,000	38
J. S.	H	50 (36)	3	8,500	6/6 6/6	33	504,000	33
J. M.	H	39 (25)	4	7,000	6/6 6/6	31	504,000	28
R. D.	D	42 (28)	4	6,000	6/6 6/6	34	504,000	38
J. McA.	S	55 (41)	?	5,000	6/6 6/9	23	336,000	28
H. S.	H	42 (28)	?	6,500	6/6 6/6	28	336,000	35
E. B.	D	46 (34)	?	6,500	6/6 6/6	36	336,000	35
T. L.	S	37 (25)	3	6,500	6/6 6/6	35	336,000	39
J. J.	H	42 (28)	?	4,500	6/6 6/6	33	336,000	31
J. R.	H	40 (22)	?	5,100	6/6 6/6	33	336,000	33
W. T.	H	38 (24)	?	6,500	6/24 6/24	26	336,000	26

Abbreviations: D, deputy; H, hewer; HK, horsekeeper; S, stoneman; O.A.C. old adexolin control capsules; O.A. old adexolin capsules.

https://doi.org/10.1017/S0022172400027935 Published online by Cambridge University Press

In Table 5 the average result for each group is given in greater detail which admits of their comparison with the results obtained by Mutch & Griffith (1937); the improvement shown cannot in our view be regarded as constituting evidence of any vitamin A deficiency in these men or that any material improvement could be affected by the administration of vitamin A in large quantities.

Table 5. *Average readings before and after known amounts of vitamin A*

Group	Dosage of vitamin A in I.U.	Tscherning glass numbers						
		7	6	5	4	3	2	1
Students (10)	—	0·33	0·60	0·8	1·20	1·45	1·52	1·625
1 (3)	Control O.A.	0·17	0·4	0·83	1·11	1·25	1·5	1·5
		0·25	0·6	1·0	1·11	1·35	1·05	1·5
2 (7)	34 O.A.	0·0	0·3	0·72	1·0	1·22	1·44	1·44
		0·02	0·3	0·75	1·12	1·4	1·50	1·53
3 (10)	150,000	0·1	0·37	0·65	1·0	1·20	1·45	1·425
		0·3	0·52	0·77	1·13	1·43	1·6	1·57
4 (7)	336,000	0·07	0·4	0·72	1·0	1·25	1·43	1·46
		0·14	0·53	0·84	1·13	1·43	1·6	1·57
5 (6)	504,000	0·08	0·42	0·66	0·96	1·21	1·4	1·4
		0·21	0·62	0·79	1·10	1·32	1·46	1·4
6 (7)	336,000	0·1	0·4	0·64	0·98	1·14	1·3	1·4
		0·1	0·46	0·7	1·07	1·3	1·4	1·37

Test cards

The number in brackets indicates the numbers in each group.

SUMMARY

This limited investigation shows that the diet of some miners differs substantially from that of the general population, in that the vitamin A intake is high.

This high intake, which in view of the nature of their work is of considerable theoretical importance, appears to be to some extent conditioned by their manner of working, and therefore less susceptible than might have been anticipated to changes in income.

The largest single source of vitamin A is the butter eaten by the men, which varies from ½ to 1 lb., the higher figure being the more frequent and probably the more representative. The large consumption of butter is associated with a large consumption of bread and, except in certain individuals, probably does not vary greatly from person to person, or from season to season.

The next most important source of vitamin A is liver, but great differences occurred in its intake. Its great value as a food, which could be readily admitted into his dietary, has as yet barely been appreciated by the average miner.

The addition of further quantities of vitamin A to the diet, in the shape of Prepalin, occasioned no discomfort, but produced no material improvement in the miners' power of dark adaptation.

The excellent health of the group of miners investigated and freedom from nystagmus or other defects of vision appears to be good reasons for endeavouring to maintain in the miner a relatively high daily intake of 6000–7000 units of vitamin A.

My thanks are due to the General Committee and Workmen's Governors of the Sunderland Eye Infirmary for the facilities granted me there for carrying out this investigation; to the Medical Research Council for their support; to Messrs Glaxo for their ready co-operation and supply without charge of Adexolin and Prepalin; and to the Washington Coal Company for a grant towards expenses.

REFERENCES

Crawford, W. & Broadley, H. (1938). *The Peoples Food*, p. 13. London.

League of Nations (1936). *The Problem of Nutrition*, **4**, 86.

League of Nations (1937). *Nutrition: Final Report on the Relation of Nutrition to Health, Agriculture and Economic Policy*, p. 194.

McCollum, E. V., Orent-Keiles, E. & Day, H. G. (1939). *The Newer Knowledge of Nutrition*, p. 313. New York.

Medical Research Council (1922). *Spec. Rep. Ser. med. Res. Coun., Lond.*, no. 65. *First Report of the Miners' Nystagmus Committee*, pp. 18, 51.

Medical Research Council (1924). *Spec. Rep. Ser. med. Res. Coun., Lond.*, no. 87. *Report on the Nutrition of Miners and their Families*, p. 54.

Mutch, J. R. & Griffith, H. D. (1937). A study of diet in relation to health. Dark adaptation as an index of adequate vitamin A intake: technique and preliminary results. *Brit. med. Journ.* **2**, 565.

Orr, J. B. (1936). *Food Health and Income*. London.

Sharpley, F. W. (1936). Vision and illumination in coal miners with reference to miners' nystagmus. *Brit. J. Ophthal.* **20**, 129.

Ungley, C. C. (1938). Goulstonian Lectures: On some deficiencies of nutrition and their relation to disease. *Lancet*, **1**, 875.

(*MS. received for publication* 29. I. 40—Ed.)