SOCIAL AND NUTRITIONAL FACTORS IN ADOLESCENT OSTEOCHONDRITIS OF THE SPINE

BY

F. H. KEMP, DAGMAR C. WILSON, and ELINOR EMRYS-ROBERTS

From the Institute of Social Medicine, Oxford

INTRODUCTION

The association of endemic dental fluorosis with skeletal changes in the native inhabitants of certain villages in the Madras Presidency was first reported by Shortt and others (1937). Similar bone lesions due to an excess of fluorine in drinking water have been recorded in natives in South Africa (Ockerse, 1941) and in aboriginal tribes in China (Lyth, 1946). The evidence that these changes are caused by fluorine is conclusive, for the radiological appearances are identical with those found in industrial workers with fluorine (Møller and Gudjonsson, 1932; Wilkie, 1940) and in the skeletal changes produced experimentally by feeding fluorine to animals (Roholm, 1937). In some cases the clinical features of endemic skeletal fluorosis resemble those seen in the type of ankylosing spondylitis (Marie Strümpell) known in this country as "bamboo spine," which occurs chiefly in young men. Furthermore, fluorosis tends to affect the spine at a later age and it is common to both sexes. The radiological appearances are totally different (Kemp, 1946).

The level of fluorine, about 3 to 4 parts per million (p.p.m.), in the drinking waters associated with bone lesions seen in India and among indigenous populations in other parts of the world, is often no greater than the amount present in certain English waters, for example at Maldon in Essex, but in this country the social environment is never so unfavourable, and severe skeletal deformity is not seen.

As a trace-element, the concentration at which fluorine is effective suggests a catalytic effect and/or an inhibitor action on certain enzyme systems. Epidemiological studies in the United States combined with standardized grading of dental fluorosis showed less dental caries and more teeth of good structure among people who had used drinking water containing fluorine 0.5 to 1.0 p.p.m. for at least the first eight years of life, that is to say before calcification of the dental enamel is complete (*vide* Murray and Wilson, 1946). Observations on fluorosis and nutrition in Morocco have made it likely that the effect of fluorine on the development and structure of the dental enamel depends very much on the state of general nutrition (Murray and Wilson, 1948).

In certain Oxfordshire villages where severe dental fluorosis is seen amongst the inhabitants, no evidence of developed skeletal fluorosis was found (Kemp and others, 1942), but there was a remarkable incidence of changes in the spines of children of the type described by Scheuremann (1921 and 1936) as *kyphosis dorsalis juvenilis*. In one school at least a third of the children were affected. The worst cases were seen in the lower social classes, among the younger members of large families, or in children with a history of defective nutrition in the early years. A group of poor Oxford city children examined at this time—the incidence of dental fluorosis in Oxford city as a whole is negligible—showed no such changes. In general the children showing the radiological changes of juvenile osteochondritis had no complaints, yet many were deformed. The induced changes can, however, give rise to pain under conditions of strain or stress in later life. We have traced the progress of some of these cases and found that further changes have ensued in early adult life. Later we advanced further evidence to show that the occurrence of the disease was related to sustained malnutrition, and that benefit can result from improvements in the diet (Kemp and Wilson, 1947). The changes are not entirely confined to children of the poorer classes, but they certainly occur less frequently in the children of the "well-to-do." Whenever we have seen a case from the higher-income groups, there has been a history of long-continued ill-health or of feeding difficulties (Kemp and Wilson, 1948). Other contributory factors are postural disturbances and the rate at which growth occurs. The original radiographs illustrating the disease have been published elsewhere (*vide* Kemp and Wilson, 1947). The accompanying line drawings taken from a severe case, and from a normal spine for comparison, illustrate the changes observed in this condition.

COMPARATIVE STUDIES

The purpose of the present investigation was to determine whether this form of juvenile osteochondritis can in any way be related to the fluorine intake as well as to poor social and nutritional circumstances. We should have liked to compare two groups of children living under similar social and

nutritional conditions, one having an excess of fluorine in the water supply, the other having none, but such ideal circumstances could not be obtained in this country.

We were able, however, to compare two groups of boys of similar ages (Table I), one from a public

There were 289 public school boys (Group A) and 71 local boys (Group B). On analysis the findings were as follows.

There were no obvious clinical differences in the nutritional standards of the two groups of boys (Table II), although the public school boys as a class appeared fitter. Group A were mostly the sons of middle-class parents and their social circumstances must have obtained for them advantages often denied to the others. The average number of children in each family in Group A was only half of the average number in each family in Group B.

The incidence of obvious dental caries in both groups was comparatively high (Table III). In Group A there were some 46 boys who showed definite signs of dental fluorosis; the rest had either very mild changes or none at all. In Group B signs of dental fluorosis were entirely absent. It will be seen that there is a marked difference in respect of caries between the two groups, but this cannot be taken as a measure of the relative levels of general nutrition, as the boys in Group B having the higher caries rate had not the benefit of fluorine in the water supply. The fact that some 46 boys in Group A had definite signs of dental fluorosis is, on the other hand, evidence that these boys have in the past incurred some degree of malnutrition, for it has been shown that characteristic mottling of the teeth is due to a high fluorine intake accompanied by malnutrition; in a fluorine area the well-nourished children do not show such changes (Murray and Wilson, 1948).

There was some difficulty in the interpretation of the dorsal x-ray films, for in neither group were spinal changes conspicuous. There were none with lesions so severe as those which we had seen elsewhere in certain Oxfordshire villages. Many cases showed minor disturbances of ossification, some definitely due to osteochondritis, but in others the

TABLE I
SHOWING THE NUMBER OF CHILDREN IN EACH AGE GROUP

	Age in years			
	14	15	16	17
Public school Group A ..	26	85	75	103
Oxford City Group B ..	10	21	15	25

school (Group A), and the other composed of boys collected from the poorest quarters of Oxford (Group B). The former came from homes in different parts of the country and had consequently derived their drinking water from different sources (fluorine content unknown). The latter had all received the same water supply (fluorine content less than 0.1 p.p.m.). A rough assessment of the levels of fluorine intake and absorption, which could not be measured directly, was based upon clinical observations of the degree of the dental changes (Dean, 1942; Murray and Wilson, 1948). Characteristic changes in the teeth are irrefutable evidence of absorption of fluorine in excess. In addition, the examination included a note on the boy's age, his previous health, the number of children in the family, and his father's occupation, together with measurements of the height and weight and a count of the number of teeth described as decayed, missing, or filled (D.M.F.). The radiographic examination comprised a lateral film of the dorsal spine.

TABLE II
RELATION OF HEIGHT AND WEIGHT TO AGE

		Age in years			
		14	15	16	17
(a) Height to age relations					
Group A	Mean height (inches)	62.77	65.87	67.13	69.82
Group B	„ „	59.40	62.67	67.07	65.44
(b) Weight to age relations					
Group A	Mean weight in lb.	108.23	114.98	126.08	149.89
Group B	„ „	93.00	109.48	128.13	131.44

FIG. 1.—Considerable irregularity of the structure of the vertebral bodies. Some deformity of the back has occurred.

FIG. 2.—The regular formation of the upper and lower borders of the vertebral bodies, i.e. the end plates. The accessory centres of bone development (epiphyseal nuclei) are visible as thin interrupted lines, one for the upper and one for the lower surface of each vertebral body.

lesions were not sufficiently developed for us to be certain of their nature. It was impossible to pick out all the minor cases of osteochondritis without introducing errors in diagnosis, and we therefore decided to divide the cases into two categories, those showing regular spinal ossification and those in which it was deformed. From the latter we subtracted those which had radiographic appearances corresponding to nuclear expansions and Schmorl's nodes, and we considered all other cases with irregularities of ossification as one entity, which we classified as non-specific irregularities of the end plates. We were satisfied that by this means it was possible to make a fair comparison of the incidence of the disturbances of ossification in the two groups of boys, A and B. The findings, which are indicated in Table III, show that there were no significant differences in the two groups. When we came to consider individual cases we found that there were some in which there were slight but definite indications of osteochondritis in which no definite fluorosis (mottling) was noted, but the cases were too few in number to allow a detailed analysis.

COMMENTARY

When this investigation was planned we expected that a number of the boys in Group A would show well-developed spinal lesions, for our previous

experience with nurses and medical students had led us to suppose that many young adults showed these changes. The discrepancy may be partly due to the fact that we were in this instance dealing with a younger age group and that, in many cases, the lesions had not had time to develop, or it may be that there were other factors, such as differences in diet, for the original investigation was conducted between six and seven years ago. On the other hand, dental changes occurred just as frequently as we had expected.

The results of this study are, nevertheless, interesting. In both groups, the spinal changes observed were less frequent and less severe than those seen in the Oxfordshire village communities in which dental fluorosis is common and the water fluorine is known to be high (about 1 p.p.m.). From this we infer that the condition has a possible connexion with fluorine, even though fluorine may not be a direct or the sole causal agent. In the hope of obtaining further information we re-examined the x-ray films of the Launton (Oxfordshire) children. This group included 25 children from a village community having a child population of 51 between the ages of 12 and 16 years. In this village the water-supply contains an excess of fluorine and many of the inhabitants show severe dental fluorosis. The village lies in an area which, until the war, was

TABLE III
DENTAL STATE AND RADIOGRAPHIC FINDINGS IN BOYS OF DIFFERENT SOCIAL STATUS

Group	Sex	No. of cases	Social class (a)	Water supply, fluorine contents	Dental state		Radiographic findings		
					Dental fluorosis	Caries: incidence	Nuclear expansions %	Schmorl's nodes %	Non-specific irregularities of the end plates %
Public school (Group A)	Boys	289	1 and 2	Various sources. F unknown	Moderate 5 Mild 41 V. mild or absent 243	D.M.F. (b) 7.4 (mean)	8.2	2.7	20.6
Oxford City (Group B)	Boys	71	4 and 5	Oxford City (R. Thames) F. less than 0.1 p.p.m.	Nil	22.4 (mean)	15.7	1.4	20.0
Launton (Village community)	Boys and Girls	28 (c)	4 and 5	Local wells. F. up to 1.0 p.p.m.	Severe to moderate	Not measured	17.8	Nil	64.2 (c)

(a) Social status estimated according to the Registrar General's classification.

(b) A crude rating, "Decayed, Missing, Filled," based on inspection of the mouth. Dental mirror not used.

(c) The record includes three more cases than those mentioned in the previous paper. The figure of 64.2 per cent. is lower than the previous estimate because on this occasion we excluded all cases in which the predominant lesions were nuclear expansions.

one of the poorest agricultural districts in the county. We had previously (Kemp and Wilson, 1947) recorded osteochondritis of the spine in no less than 20 of these children. On re-examining the films, employing the same criteria as we had used for Groups A and B, we found that there were in these children more than three times as many cases showing disturbances of ossification of the end plates as were present in the control Groups A or B (Table III); moreover, it was obvious that the changes were more severe. It is probable that these village children had in the past sustained a lower level of nutrition than the boys in Group A, but we cannot say with certainty whether they had fared worse than the children from the poor city area in Group B. We have good reason to believe that these findings in Launton are similar to those which would be obtained in other village communities in the Oxfordshire region, for in many of these villages we have previously examined groups of the population, although we have no records of a series of children at comparable ages.

This much we can say, that we have evidence in this condition pointing to the association of some factor closely related to fluorine in geological distribution. The possibility that fluorine is in itself partly responsible cannot be entirely eliminated, since we know that fluorine may interfere with enzyme systems concerned in the calcification of bone.

SUMMARY

This paper summarizes a series of investigations conducted on the distribution and the hitherto obscure aetiology of juvenile osteochondritis of the spine (Scheurmann's disease), and gives an account of its relation with malnutrition and a possible relation with fluorine.

Two groups of boys were compared; the first group taken from a public school and the second from the poorer quarters of the city of Oxford. The incidence of disturbances of ossification of the spine in the two groups were similar, although none had severe changes. Some of the boys in the first, and presumably better nourished group, had evidence of dental fluorosis, whereas none of the second group who were not exposed to a high fluorine intake were thus affected.

Both these groups were compared with another group of children living in a village community where dental fluorosis affects nearly all the inhabitants and considerable poverty had formerly prevailed. In this group spinal changes occurred more than three times as frequently as in the other two groups and the disturbances were, in some instances, more severe. Having regard for the

known association of endemic dental and osseous fluorosis with malnutrition in other countries, the possibility of a similar association in the case of dental fluorosis and juvenile osteochondritis in this country must now be borne in mind.

Whatever the intimate pathology of the condition may be, the practical implications of these findings are quite simple. It has been previously shown that juvenile osteochondritis of the spine is in part at least related to malnutrition, and we have commented on the beneficial effects obtained by improvements in the diet. It is therefore reasonable to suppose that even the most severe cases could be prevented if proper measures were taken to assist the promotion of health and welfare of children, particularly by means of a good dietary, during the years of adolescence. Special attention should be given to children living in rural areas, particularly where dental fluorosis is noted. Although spinal changes are not invariably associated with changes in the teeth, the probability of finding spinal changes can in fact be gauged by the examination of the teeth of a community. Under adverse circumstances spinal changes occur especially when there is a rapid increase in the growth of the child.

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