Remarks

ON

THE ETIOLOGY OF DIABETES MELLITUS

AND THE DIET AND CONDITIONS OF LIFE
DURING THE WAR.By R. T. WILLIAMSON, M.D.LOND., F.R.C.P.,
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WHATEVER may be the exact pathology of diabetes mellitus, certain etiological relations are of much interest and of some importance with respect to the prevention of the disease in England during this period of overstrain through the war.

Diabetes mellitus has been steadily becoming more frequent for many years. The death-rate from the disease has increased in England and Wales from 59 per million living in 1886, to 97 in 1906, and to 130 in 1915. The larger portion of the increased mortality rate may be clearly attributed to the increased frequency of the disease.

In 1908 I collected all the information I could obtain respecting the frequency of diabetes in various countries, and obtained information from all quarters of the world. Some was reliable, some unsatisfactory.¹ My conclusions were:

The mortality from diabetes is much greater than in England and London, in the following towns and countries: In Malta, in many of the large towns of the United States (Worcester, Syracuse, Rochester, New York, Boston, Washington), in Bordeaux (France), in Berlin, Paris, Frankfurt (am Main). Also experience indicates that diabetes is especially common in Bengal, Ceylon, Siam, and Tunis. Certain races are especially liable to suffer: Jews, Hindus, and Maltese. In 1907, the year when my statistics were collected, the mortality for diabetes per 100,000 living in Malta and Gozo was four times that in England and Wales. In New York, Washington, and Boston (United States), and in Paris it was twice that in London. In Worcester (United States) and Syracuse (United States) and in Bordeaux (France) it was three times that in London.

Is more sugar and sweet food taken in these countries and by these races than in England? In many of the towns of the United States, and in Malta and Tunis, I understand that this is the case. May this be a predisposing cause and account for a portion of the greater frequency of the disease in these countries and races?

If we take the history of a large series of cases of diabetes we find the disease has very frequently followed certain conditions. We cannot say that these conditions were the cause of the disease, but the history of such conditions before the disease has been detected has been so frequent that they cannot be regarded as coincidents. Whatever other cause or causes there may be, they may very fairly be considered as at least extremely probable predisposing causes. If the patients had not been exposed to these conditions they would not have suffered from the disease until a much later period, or possibly not at all. In other words, the onset of the disease has been at least accelerated by these conditions of life or habits.

The etiology of diabetes is discussed in detail in textbooks and monographs, and in this article I desire to draw attention to three predisposing causes only. In 1898² I published an analysis of the etiology in one hundred consecutive cases. Since that time I have taken notes on the etiology in most cases I have seen, and my results respecting the frequency of certain predisposing causes have been much the same. More recently I have inquired very carefully in another series, of 300 cases, respecting the frequency of (1) great and prolonged excess of sweet food and drinks, chocolate, etc.; (2) very great and prolonged mental anxiety, worry, and overstrain, or sudden shock; (3) family history of the disease. Other points in the etiology were also noted. I have asked questions on ten points, and collected the answers on separate slips of paper. (Most of these cases were seen before the war.) Though the answers varied much, the most striking points in the history in these cases were (1) the frequency of great excess of sweet food or drink for a long period before the onset of the disease; (2) the frequency of prolonged mental anxiety, worry, or sudden shock just before the onset of the disease; (3) the frequency of a family history

of diabetes. This is shown by the following results respecting the etiology in 300 cases:

History of prolonged great excess of sugar, sweet food, or sweet drinks (alone or combined with other predisposing causes) in 93 (= 31 per cent.).

History of prolonged and intense mental anxiety, worry, overstrain, or sudden mental shock (alone or combined with other predisposing causes), in 120 (= 40 per cent.).

Family history of diabetes (alone or combined) in 76 (= 25 per cent.).

No definite predisposing cause in 59 (= 19 per cent.).

The following are the results in detail, especially with respect to these three questions.

I. Very Great Excess of Sugar, Sweet Food, and Sweet Drinks.

A previous history of prolonged great excess of sugar, sweet food, chocolate or sweet drinks, alone or combined with other predisposing causes, was obtained in 93 out of 300 cases (31 per cent.). If we consider these cases in detail we have the following groups:

(a) Great excess of sugar, sweet food, chocolate, or sweet drinks	40 cases.
(b) Ditto, plus great mental worry, anxiety, strain, or sudden mental shock	19 "
(c) Ditto, plus great overstrain in work	4 "
(d) Ditto, plus mental overstrain, anxiety, etc., and great overstrain in work	6 "
(e) Ditto, plus family history of diabetes	13 "
(f) Ditto, plus family history, plus mental or physical overstrain or shock	9 "
(g) Ditto, plus severe injury	2 "

93 cases.

The history showed that these patients had taken very large quantities of sugar in tea and foods, or very large quantities of jam, or sweets, or chocolate, or very sweet fruits and other very sweet foods. In many cases the patient had taken tea in very large quantities, containing much sugar, three times a day.

Chocolate had been taken in very large quantities by 21 of the 93 patients, either alone or with other sweet food or drinks. In some of these cases a history was also obtained of mental overstrain or shock, physical overstrain or a family history of diabetes.

Apart from the excess of very sweet tea already mentioned, in 17 of the 93 cases great excess of other sweet drinks had been taken for a long period before the onset of diabetes—herb beer containing much sugar or treacle, ginger beer, whisky with much sugar, sweet wines, gin and ginger beer, cider, sugar and milk. In some of these cases often other sweet food had been taken freely, or a history of mental overstrain, shock, or physical overstrain, or a family history of diabetes was obtained. Great excess of jam (jam at nearly every meal), great excess of chocolate, great excess of tea containing much sugar (in one case thirty-six lumps of sugar in the tea daily), and great excess of herb beer containing much sugar or treacle (in one case 8 pints daily), were striking points in the histories of certain cases.

The following are a few examples of the continued excess of sugar and sweet foods or drinks taken for long periods before the onset of diabetic symptoms:

1. Female; stated that she had "lived on sweet food"; great excess taken; jam taken freely "at nearly every meal." Excess of sweet drinks, including herb beer containing sugar.

2. Female; stated that she had "lived on sweet food": had taken sweet food at every meal; sweet fruit, jam, sweet cake, and chocolate, all taken in excess. Sweet lemonade taken freely.

3. Male; great excess of sweet food; half a pound of jam daily ($\frac{1}{2}$ lb. for breakfast and $\frac{1}{2}$ lb. for tea); tea three times a day, with 18 teaspoonfuls of sugar (about $\frac{1}{2}$ oz. of sugar daily); beer four or five glasses daily; whisky twice a day; wine occasionally. Overwork; great mental strain and worry.

4. Male; excess of sweet food; half a pound of jam daily ($\frac{1}{2}$ lb. for breakfast, $\frac{1}{2}$ lb. for tea); sweet food at dinner; 4 to 6 oz. of cream chocolate daily; sweet tea three times a day (containing nearly 2 oz. of sugar); herb beer and sweet lemonade freely.

5. Male; great excess of sweet food and sugar; 3 lb. of chocolate weekly; 20 lumps of sugar (nearly 4 oz.) in tea daily. Great mental strain and overwork.

6. Female; excess of sweet food; about 25 lumps or more of sugar (about 4 to 5 $\frac{1}{2}$ oz. of sugar) in tea daily; herb beer 1 pint daily; bitter beer also taken daily.

7. Female; 36 lumps of sugar in tea alone daily (about 6 $\frac{1}{2}$ oz. of sugar). Great mental worry.

8. Male; great excess of sweet food and sugar (about 4 oz. of sugar in a pint of tea); about 6 oz. of sugar daily; 4 oz. of "sweets" daily; half a pound of sweet cake daily; beer taken freely.

9. Male; excess of sweet food; 4 oz. of chocolate daily; tea three or four times a day, well sweetened ($3\frac{1}{2}$ to 4 oz. of sugar in tea alone daily). Great mental overstrain.

10. Male; 18 teaspoonfuls of sugar (about 4 oz.) daily in addition to other sweet food.

11. Male; medical man with heavy practice in Scotland. Breakfast early, dinner very late in evening; "lived on chocolate" between these hours; no midday meals very frequently except chocolate. Great excess of chocolate daily.

12. Male; sweet food in excess; half a pound of sugar daily: great mental strain and worry.

13. Male; great excess of sweet food; tea very sweet; herb beer containing much sugar (8 pints) daily in summer (4 in winter). Great mental strain and hard work.

14. Male; great excess of a mixture of gin and ginger beer daily.

15. Male; three pints of herb beer daily; port wine rather freely. Great mental strain in work.

16. Male; five bottles of herb beer (containing much sugar) daily. History of a fall followed by neurasthenic symptoms.

17. Male; ten glasses of whisky daily well sweetened with sugar.

18. Female; great excess of whisky very well sweetened with sugar.

In a number of cases in young children a history was obtained of great excess of sweet food, with a large quantity of chocolate daily or a large quantity of sweets.

19. Baby 14 months old; had been fed on milk to which the mother added large quantities of sugar. Severe diabetes; death in two weeks.

II. *Prolonged and Intense Mental Anxiety, Worry, Overstrain, and Sudden Shock.*

Willis (the English physician who first discovered that the urine in diabetes had a sweet taste) 240 years ago attributed the disease to sadness and long sorrow, and from that date numerous writers have pointed out that the disease sometimes follows prolonged and intense mental anxiety, overstrain, worry, or severe mental shock. Such a history I have obtained in a large percentage of the cases of which I have notes during the last thirty years.

The following are the statistics in the series of 300 cases on which this article is based.

The disease followed directly after a period of intense and prolonged mental overstrain, anxiety, or worry, or after a sudden very severe shock in 120 out of 300 cases (= 40 per cent.).

In these 120 cases we had a history of mental overstrain, anxiety, or shock alone in 61; along with a family history of diabetes in 25; along with a history of great excess of sugar or sweet food or drinks in 25; along with a history of excess of sugar and a family history of the disease in 9.

Often associated with the mental overstrain, anxiety, or shock we have a history of physical overwork and overstrain and long hours of work, or occasionally a history of acute illness or alcoholic excess or other predisposing causes.

A history of sudden mental shock immediately before the onset of the disease is occasionally obtained (13 out of the 120 cases). Often the disease directly followed the mental overstrain and anxiety caused by the death of a relative, or by the prolonged illness of a relative, or by nursing a relative through a long or critical or fatal illness (12 out of the 120 cases). Very often we had in these cases a history of great loss of sleep and of physical overstrain.

Often we had a history of great anxiety and mental overstrain through losses in business, frequently associated with overwork, and frequently with loss of sleep, and occasionally with excess of alcohol. Occasionally a history was obtained of excessive mental work in preparing for examinations and prolonged hours of close study just before the onset of the disease (5 of the 120 cases).

The loss of sleep, so often associated with sorrow and anxiety caused by the death or illness of a relative, by sudden mental shock, or business losses, in the cases just mentioned, is probably a very important point.

The two following cases are of interest with respect to sudden mental shock:

20. A lady who had just been confined developed diabetes directly after a sudden mental shock. The nurse was warming the baby before the fire. The nurse dozed, or fell asleep, for a short time, and held the baby too close to the fire, and the

baby's legs were severely scorched. This caused the greatest shock to the mother; she was never well afterwards. In a few days symptoms of diabetes were noted. Previous to the shock the lady had been quite well, and the urine had been tested towards the end of pregnancy and found free from sugar.

21. In a man aged 57 symptoms of diabetes followed rapidly after a sudden mental shock. Four months previous to the shock he had passed a medical examination for life assurance, at which his urine had been tested. Whilst playing cards, the friend with whom he was playing died quite suddenly at the table. This caused the patient the greatest shock; he was never well afterwards. Within one week of the shock thirst and symptoms of diabetes were first noted.

III. *Family History.*

A family history of diabetes was obtained in 76 of the 300 cases = 25 per cent. Many striking instances were noted.

A history of great excess of alcohol was obtained in only a small proportion of the cases, much less frequently than a history of excess of sugar, or of mental anxiety or shock, or a family history of diabetes. In the statistics published in 1898 (chiefly hospital patients) I found a history of great alcoholic excess in 17 per cent. Amongst the private diabetic patients such a history was much less frequently obtained.

It is interesting to note that glycosuria occurs in some cases of Graves's disease. Occasionally the symptoms of Graves's disease diminish markedly, or cease, and symptoms of severe diabetes develop.

In many cases of acromegaly glycosuria or well-marked diabetes develops.

Diabetes sometimes follows directly after an acute illness, and the history often shows many other interesting etiological relations, but it is only to the three predisposing causes just considered that I desire to draw attention in this article.

In some cases no predisposing or exciting cause can be found (in 59 of my last series of 300 cases).

In statistics of a previous series of cases (1908) I obtained a history of great mental anxiety, shock, and overstrain in 35 per cent.; history of very great excess of sugar, sweet food or sweet drinks in 37 per cent.

This consideration of the etiology of diabetes shows the frequency, and I think the importance, of three predisposing causes: (1) Prolonged mental worry, anxiety, great mental strain, or sudden great mental shock, sometimes associated with overwork; (2) excess of sugar in the diet—sweet food or drinks, and excess of chocolate; (3) family history of the disease. Often we find a history in the same case of a combination of two or all three of these.

From my own experience in Manchester I think we shall find that diabetes has increased in frequency amongst the civil population of England since the war commenced. Amongst those who are doing military service I think we shall find that diabetes has not been much more frequent than amongst men of the same age in civil life before the war, but this is an impression, and not based on definite statistics. If correct, possibly the increased exercise and better regulated diet, in which great excess of sugar and sweet food is not allowed, may account for diabetes not being more frequent amongst those engaged in military work. Possibly also they have less time for brooding and worrying than people in civil life. We may find, however, that many who are now suffering from shell shock, neurasthenia, and functional nervous diseases will develop diabetes later.

Prevention of the Disease.

We cannot alter our family history, but we can all avoid excess of sweet food, sweet drinks, sugar, chocolate, and sweet jam during the war; and though we cannot avoid mental worry, anxiety, and shocks, we can often do something to diminish their effects.

It is important for all to avoid excess of sweet food, jam, chocolate, sugar, and drinks containing much sugar; but more so for those who have great mental strain, anxiety, and overwork, and especially for those who, in addition, have a family history of diabetes. The sugar restrictions will do much to check the excess of sugar in tea and coffee and in cooking, but we have as yet no restriction directly as to jam, chocolate, and many articles of sweet food. Those who have great mental anxiety and overstrain, and especially if they have also a family history of diabetes, would do well to discontinue the addition of sugar in tea, coffee, and in food entirely, and to limit to the minimum the use of

jam, sweet foods, chocolate, and drinks containing much sugar, such as herb beer, sweet wines, and combinations of sugar and alcohol. They would thereby be helping the Food Controller, as well as doing something to diminish their own risk of diabetes.

Alcohol, and especially combinations of alcohol and sugar, if they can still be obtained, should be very limited in the case of those who have much mental strain, anxiety, or worry. The regulations now in force will check any excess for most people.

Through the war, we are now all suffering, more or less, from mental overstrain, worry, anxiety, or sudden mental shocks, which will tend to increase the risk of diabetes. We cannot avoid them, but we can do something (and this is especially desirable in those who are suffering severely) to diminish their effects by directing our attention, whenever possible, to subjects not directly associated with the particular anxiety or worry, and especially by close occupation. Most people have now to work very hard, and occupation and close attention to work are useful in diminishing the effect of mental shock and anxiety; but when the overwork is excessive something may be done to diminish the injurious effects by putting aside any work not absolutely necessary, if this is possible.

Sleep is very important. When insomnia is associated with the great mental strains already named prompt treatment is desirable, and, if it cannot be checked, drugs such as chloralamide, trional, adalin, etc., taken under the direction of a physician for a short time, may be of much service.

Summary.

It is desirable for all to cut down sweet foods and drinks, chocolate, jam, sugar, and alcohol to a minimum during the war, and especially for those who have a family history of diabetes, and are suffering from great mental strain or shock; they will thereby help the Food Controller and also diminish the risk of diabetes. Occupation and close attention to work are useful in diminishing the effects of mental worry and shock, and thereby the risk of diabetes, but in certain cases of excessive overwork it is desirable to cut off work not absolutely necessary, if this is possible; sleep is very important.

The recent food restrictions, as already mentioned, will check for most people any excess of sugar and alcohol, and will thus tend to diminish the risk of diabetes. Those who have been obliged through these restrictions to discontinue excess of alcohol or sugar should, however, not replace these by excess of non-alcoholic drinks containing much sugar, and excess of jam, chocolate, and other sweet foods which may be still obtainable.

REFERENCES.

- ¹ The details were published in the *Medical Chronicle*, July, 1908.
- ² *Diabetes Mellitus and its Treatment*, London, 1898.

THE EFFECT OF INTERMITTENT STRETCHING ON MUSCLES AND NERVES AFTER NERVE SEVERANCE.

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ONE of the problems of the treatment of cases of nerve severance is the time during which movement of the paralysed muscles can be allowed and the extent to which it can be carried on with safety. In the period before suture the practice is to allow some degree of movement, and Sir Berkeley Moynihan,¹ in a recent paper, says that in order to keep the joints supple the paralysed parts must be freely moved every day, and many times a day. On the other hand, for a certain time after suture, no movement at all is allowed. The necessity of this has been specially insisted on by Sir Robert Jones,² who has had a wide experience of nerve suture cases.

The statement that movement is not permissible for some time after nerve suture is usually given in the form that the muscle during this time must be kept completely relaxed, or that the muscle must not be stretched. Thus Sir Robert Jones² says that "the slightest stretching of a muscle on the point of recovery disables it again," and Sir Berkeley Moynihan¹ that "not for a moment at any time must paralysed muscle be stretched." These are no doubt merely practical directions to avoid delay in recovery,

but the natural inference from them is that any degree of stretching is injurious to the muscle, and that it is this injury which delays the recovery. The inference is strengthened when it is at the same time pointed out that prolonged stretching of a muscle causes permanent elongation. So far as this inference is made it must tend to restrict movement before nerve suture, for if stretching is injurious to a muscle after suture it will be injurious to it for more or less time before suture. In any case it is necessary for satisfactory treatment to know what degree of stretching not only paralysed muscle but also degenerating and regenerating nerves will stand. I venture, then, to offer some remarks on these points, although my experiments are incomplete. Unless otherwise mentioned, I only consider the stretching produced by intermittent ordinary joint movement, and not the protracted stretching caused by the unrestricted action of antagonistic muscles. We may consider separately the effect on muscles and the effect on nerves.

I. STRETCHING OF MUSCLES.

The effect of intermittent stretching on muscles might *a priori* be either advantageous or the reverse, according to the weight which is laid on particular events. On the one hand, it forces lymph from the muscles, and so presumably metabolic products, and this we should expect to be advantageous. Further, it seems not unlikely that it is of advantage in relation to connective tissue formation. In denervated muscles the connective tissue increases—it is said to be visibly increased in microscopic preparations three weeks after nerve section—and part of the late contracture is attributed to the shrinking of the newly formed tissue. The connective tissue when first formed is soft and extensible. Intermittent extension will elongate the developing fibres, so that when they shrink there may be less tendency to contracture. On the other hand, muscles after denervation rapidly lose weight—in cats and rabbits the gastrocnemius loses about 50 per cent. of its weight in about four weeks—and it is practically certain that in this state it cannot stand as great a strain as normal. Whilst a great reduction in its power of withstanding strain might take place without making it liable to be injured by the degree of strain put on it by free joint movement, we cannot offhand say that free movement does not injure it. Observations on man can hardly settle the point, since the effect has to be judged by the rapidity of regeneration, and this is greatly influenced by the events after nerve suture. In animals a more definite result can be obtained by noting the effect of intermittent tension on the appearance of the muscles and on the degree of atrophy.

A short time ago I published an experiment³ on these points. The popliteal nerves in a rabbit were cut on both sides, and the leg and foot on one side rhythmically extended and flexed for an hour morning and evening.

At the end of three weeks the animal was killed and the muscles of each leg weighed. The muscles had no obvious difference to the eye, and no sign of ruptured fibres. On the side on which the paralysed muscles had been rhythmically extended, four of the muscles were rather heavier than on the other side, one was of the same weight, two were somewhat lighter. The differences were not decidedly outside the normal difference of weight on the two sides in normal animals.

The experiment showed that stretching the paralysed muscle a great number of times to about the full normal extent did not in its total effect appreciably affect the atrophy. It must be noticed that, on account of the experimental error, a slight effect would not be appreciable unless a number of experiments of the kind given were made, and that irritability might be altered without an alteration in the loss of weight. Further, the total effect may have been the algebraical sum of + and - effects, but, from the practical point of view, this is unimportant. I have made incidental observations on muscles in later stages of atrophy up to about three months, and have seen no sign that they are injured by moderate intermittent tension, or by the degree of strain exercised by antagonistic muscles provided this is not prolonged.

II. STRETCHING OF NERVES.

Movements of joints and stretching of muscles exerts more or less pull on the nerves. The conditions affecting these are essentially different before and after nerve suture.