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The Causes of Obesity

Uptodate: Clinical Nutrition

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Produced by Trevor A Scott.

Black-and-white

Duration: 00:36:40:03

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<Opening titles>

<James to camera>

When discussing the causes of obesity, it is usual to list a whole series of endocrinological abnormalities which are associated with the development of obesity. I'm not, in fact, going to discuss these causes as they are extremely rare and I'm going to deal with the simple, everyday type of obesity that affects so many in our community.

The first problem, before we actually look at some of the causes, is one of definition.

<James narrates over series of slides showing obesity definition and statistics, interspersed with talk to camera>

In this first picture, we have a simple definition of obesity which is based on an individual's weight for height, and the definition, as currently accepted, is to define an obese person if their weight for height is more than 120% of a series of values

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derived from Metropolitan Life Insurance statistics. These, in fact, have been obtained over a series of years by looking at the optimal life expectancy of many millions of people living in the United States.

<Next slide> In this next picture, one can see a list of weights for women of different heights, and you'll see that at 5 foot 5, one might expect a woman with a good life expectancy to weigh somewhere between 111 and 119 pounds, whereas somebody who's taller will obviously weigh rather more. Now, notice that one has three frame sizes. These have, in fact, been listed by the Metropolitan Life Insurance Company, but, in fact, we have no objective definition of frame size, so the natural tendency, of course, is for people who don't want to think of themselves as obese to automatically assume that they are large frame size. On the whole, it is becoming accepted that one should take the upper limit of the large frame size for all the heights and then use this as the base line from which one then calculates at 20% above that value. At this point, then, one has a definition of somebody as an obese individual.

Well, one could, in fact, have much more specific measures of an excess of body fat, which is, after all, what we're trying to get at when we think about the problem of obesity. But, for the moment, we have information which relates mainly, if not entirely, to weight in terms of height. <Next slide> So, let us now look at this next picture, which gives us some indication of the problem of obesity in Britain. This is taken from a general practice survey in a suburb of London – in fact, Richmond – and it shows that as one looks at adults of different ages from young men and women through to the elderly, then one finds an increasing problem of obesity. Notice that at almost every age range, men have less of a problem than women, but women, in particular, in the postmenopausal age group have a tremendous problem of obesity and about a third of these women, in the general population, are very overweight.

Now, if we look at the prevalence of obesity in different social classes, we may perhaps begin to gain some information about the reasons for obesity occurring <next slide>. Here, on this picture, we have, albeit a slightly different definition of obesity – you notice it's 30% overweight not 20%, at 30% overweight one can see a

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quite clear social-class trend in women, with those in the lower social class, classes 4 and 5, having a very much higher prevalence of obesity than social class 1 or 2.

Now, one could – this, in fact, is a very common finding and applies to most of the Western world; elsewhere, for example, in India, it's not true. In India one finds social class 1 and 2 women and men who are much more obese, but there, of course, we have a problem of general availability of food.

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<Next slide> Now, if we go to the next picture, we can perhaps begin to see our way to thinking about the causes of obesity. Here are some figures derived from those attending a hospital in Glasgow. And this series of histograms describes how men and women have recorded the time of onset of their obesity. These are individuals who've come to a hospital physician with a medical problem and had their heights and weights measured. Note that nearly half the women say that their obesity has started in childhood. A good proportion, nearly a third, find that their obesity has developed after pregnancy, and a much smaller proportion of women find that their obesity has developed in adult life. Notice that there are, in fact, differences for men: the problem in infancy is still present but the majority of men seem to become obese in adult life.

Well, this obviously focuses one's attention on the childhood period, and this whole question of childhood obesity and whether or not it affects the development of adult obesity was emphasised by a study from Sheffield. In this next picture, we will see that in Sheffield <next slide>, it was found that if one looked at children aged 6 to 8, and looked back to their clinic records to see whether they gained weight slowly or rapidly in the first few weeks and months of life, then one found that the slow weight gainers in the first 6 months of life had very little problem with obesity when they were looked at again between the ages of 6 and 8. In contrast, those children who gained extremely rapidly had a much higher percentage of obesity and, indeed, if you add these two columns together, a third of the children who had been gaining weight rapidly in the first 6 months of life were either overweight or obese at the age of 6, 7

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or 8. So this tended to focus attention on, perhaps, infant rearing practices as a real problem in the development of obesity in the population as a whole.

<Next slide> On the next picture, we see, however, that we must be a little cautious because these are a series of studies done in a different part of the United Kingdom – in Dudley, Blackwell, Exeter and Sheffield. And there have been slightly different criteria used for obesity, but I don't think this really matters. Note, however, that there is quite a marked decline in the prevalence of obesity as one studies the older age groups. So immediately we have a cautionary tale: we cannot automatically assume that because a child appears to be obese in infancy, below the age of 1, that child will automatically be an obese infant between the ages of 6 or 8.

<Next slide> Well this, of course, is cross-sectional evidence; let's go to the next picture which actually involves a study on a set group of children who are measured in infancy and then 4 or 5 years later – the same children were looked at. And here we find that although 26% of the infants were overweight, by the time they were 4 or 5, less than half of this group were overweight. A study in Newcastle has also shown that if you look at children who are obese between the ages of 5 and 10, then one finds that only half of the obese children have developed their obesity in infancy. So, we are not yet in a position to say absolutely that overweight children automatically become overweight adults, and indeed we are now gaining evidence which shows that that is just not true. There may be an increased likelihood for an obese infant to become an obese adult, but we cannot automatically say that this is inevitable.

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<To camera> Let us now go to the question of why babies become fat. <Next slide> It is often thought that this really results from the problem of bottle feeding rather than breastfeeding and here is a good illustration of this from a study which was undertaken in Dublin. In this particular community, they found that if a child was breastfed then none of those of those children became overweight, whereas of all those children who were bottle fed, and this in fact comprised the majority of the population, then 12% of these children were, in fact, overweight and progressing to

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the state of obesity. So one could argue, on this basis, that the breastfed child is not, as it were, being stuffed by the mother; the mother has very little idea how much food that child actually receives or indeed needs and so the baby is able to monitor its own intake and adjust the food intake to meet its individual needs.

<Next slide> However, we have to recognise that obesity does run in families and so one could say, is it true that if obesity runs in families that this is merely the result of abnormal eating patterns in families or could there be a genetic component? Well, first of all, let's look at this diagram which shows that in a study in Massachusetts that if neither parent is obese then only 7% of their children are obese, whereas if one parent is obviously obese then nearly half, 40%, of their children are fat, however, once both parents are fat then there's a very high chance indeed of the children being obese as well.

Twin studies have been undertaken to try to disentangle the environmental from the genetic factors in this type of study. And there is a lot of contradiction, but there is a general feel that perhaps 30 or 40% of the variability in weight amongst children is, in fact, related to genetics and the rest of it is in some way geared to environmental influences. However, we should not automatically assume that these environmental influences relate solely to food intake.

<Next slide> Here is a study conducted in Glasgow, where Dr Durnin was looking at a large number of adolescent boys and girls and observing what they actually eat over the course of the week. Here, he has divided the energy intake, calculated in megajoules per day, calculated it for the thinnest and the fattest boys, and for the thinnest and the fattest girls. Now, you might expect that you would find that the fat boys were taking more than the thin boys – this was just not true. This figure of 10.8 megajoules amounts to about 2500 calories per day and the fat boys were certainly not, during this study, eating more than the thin boys. In fact, when one goes to the girls, look what a marked difference there is with the fattest girls eating less than the thinnest. Now, you might argue that this is simply the consequence of the study being undertaken, nevertheless, a whole series of studies on adults and children

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suggest and support the idea that it's not simply a question of a high food intake which leads to the development of obesity.

<James narrates over diagrammatic slide illustrating flow of energy in the body>

Well, now let's think about the problem of energy balance. Here we have a flow of energy coming into the body, each day, as food. And we are able to get rid of energy through, obviously, external work and activity. Even if we lie in bed then we are, in fact, having to expend energy maintaining the body's synthesis of proteins and the turnover of cellular constituents and just for the simple transfer of nutrients around the body. This is measured simply in terms of the basal metabolic rate. So, if one lies in bed, one's getting rid of energy. Obviously, if one undertakes physical activity, further energy is dissipated, but the question always is brought up as to whether, in fact, there is a heat-dissipating system so that, for example, the thinnies in this world are able to perhaps blow off heat, whereas the poor old fatties, as they take a similar amount of food, they cannot generate this heat and so the food energy that comes in at the top simply has to be stored.

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<James narrates over further slides of graphs and statistics on obesity>

<Next slide> Well, let's look at the question of physical exercise in, and the general activity, of the same adolescent boys studied by Dr Durnin. Here, we have divided the time of day up into various activities. Note that here we have both thin and fat boys, fat boys being defined in this instance as having more than 21% body fat. Both of them seem to stay for about the same time in bed, 8 to 9 hours as all good Glaswegians should. Now, if we look at the low activity, you can see that a high proportion of the day is spent in low activity. It's a myth to think that we spend a great deal of our time rushing about the place. In fact, if one accumulates the amount of time standing and actually doing physical exercise, then this is a very small part of

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the total 24 hours. Anyway, it's quite clear from this that the fatter boys are not doing any less than the thinner boys.

<Next slide> Now, what about those girls where we found that the fat girls were, if anything, eating rather less than the thin girls? Here, again, we have a similar pattern to that which we've just seen in the boys with the girls spending a fair time in bed as usual, a lot of time on low activity, and a small amount of time in light and heavy activity. There is, in fact, a slight decrease in heavy activity amongst the fat girls, but really the overall difference is not very striking.

<James narrates over earlier diagrammatic slide illustrating flow of energy in body>

So, we have the rather unusual situation, apparently, where fat and thin boys and girls seem to be eating just about the same amount of food; they seem to be indulging in pretty well the same amount of exercise, so the question then arises, is there, in fact, a difference between thinnies and fatties in these strange processes which make up the basal metabolic rate and perhaps these additional components of energy expenditure, which may be all important in distinguishing between these two types of individual?

<James narrates over slide of graph comparing basal metabolic rates in children of different weights>

Well, let's look at the amount of each of these components in terms of its contribution to the total amount of energy expended in a day. Note here *<indicates normal weight>*, as we saw on the activity charts, that in fact physical activity accounts for, in this case, 20% of one's total energy output, by no means a large component, although obviously an important one. Note that the basal metabolic rate amounts to about half of one's total energy expenditure and this is the energy that you spend just lying in bed, and this would be the amount of energy that you would expend if you just lay quietly in bed throughout a 24 hour period.

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Now, the question is what about these additional components? They comprise a whole series of small activities and metabolic processes, just an increase in muscle tone will put up your energy expenditure; if you eat a meal, there will be a 10 to 20% increase in metabolism; if, in fact, one overfeeds individuals, there will be an increase not only in basal metabolic rate but also in the specific dynamic action. Now, recently, it has been suggested and, in fact, found in a small group of children that if you look at normal-looking children of fat and thin parents that the normal-looking children of fat parents are, in fact, expending 20% less than the children of thin parents doing the same amount of physical energy, so, in fact, it's obvious that they are in some way expending less energy for these two processes *<indicates maintenance and basal metabolic rates of energy expenditure>* and they are able to maintain energy balances at this stage of their lives because in some way they either learn or they have mechanisms which match energy intake to energy output.

Now, we don't yet know whether their true basal metabolic rates are any different, although these can vary between individuals by 30 or even 40%. But, then, an interesting suggestion now comes, and there is some evidence in the literature that these additional increments are, in fact, the most important difference between the fatty and the thinny. We have found that these increments seem to depend upon catecholamine secretion by nerve endings and that thinnies characteristically have a much higher increase in catecholamine output after odd movements, after, for example, just standing up, after a drink of coffee even – the thinny, in fact, has a much bigger surge in metabolism and in catecholamines than the fatty.

So, one hypothesis is that the pre-obese children of constitutionally fat parents are, in fact, as it were, programmed for obesity and they will have to live permanently on a reduced energy intake if they are not to get fat. If they do get fat, then their basal metabolic rate rises and finally compensates for their excess energy intake. In adults, the basal metabolic rate is not low; if you express it in absolute units, it is high and this is an important feature to remember.

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<James narrates over slides of effects of ovulation on body temperature>

Now, we have to ask ourselves are there any other environmental effects, other than physical activity, which will affect the energy expenditure. Well, let's take a young woman, who on a daily basis shows a cycle in her body temperature: after ovulation in mid-cycle there is an increase, well recognised, in temperature. Now, this is shown, this increase in body temperature will, in fact, cause a surge in metabolism. If one abolishes ovulation by giving a contraceptive pill then, in fact, the normal or the pre-ovulatory cycle will continue and, in fact, there will be no elevation in body temperature.

This is shown in more detail on the next picture where we find that if one looks at the pre-ovulatory period *<next slide>* then, in fact, again there is a natural cycle throughout the day and, of course, during the night in the rectal temperature. The whole temperature is set at a higher level after ovulation so if one, in fact, abolishes this with a pill, down will come the daily normal cycle of temperature to the pre-ovulatory rate. *<Next slide>* And this is accompanied by a difference in oxygen uptake and therefore, of course, in energy expenditure. By, in fact, taking the contraceptive pill, one will automatically reduce energy expenditure, and so these women will be pushed a little further towards the obesity spectrum. We don't yet know how much, but they will either have to learn to eat slightly less or they will have to call on other processes for compensating and for blowing off heat and these processes, of course, may well depend, as we believe anyway, on catecholamine secretion.

<James narrates over animated slide showing energy intake and energy output recorded over time>

So, we have a strange situation where we are having to look at obese people over a prolonged period of time because quite small differences in energy balance will make an appreciable difference as the months go by. Now, obesity doesn't develop just because energy intake is always very high; in fact, energy intake goes up and down not only on a daily basis but indeed from week to week. Now, if you compare this

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with the energy output, you will see that they don't follow at all, and at some stages, for example, here, energy intake is above energy output, but it's the combined effect that determines whether or not one is in balance. And, in fact, when one is marginally in excess in terms of energy output, one will start going into negative balance; when one is, in fact, with a higher energy intake, then one will be in positive energy balance. And so you see it's the accumulative shape and nature of this which determines on a month long or, indeed, on a year long basis whether or not somebody becomes obese.

Now, you might say that this is all very well but do we have any evidence that there are individuals who, in fact, tend to become fatter more easily than others?

<James narrates over further slides of graphs and statistics on obesity>

Well, there is some evidence now beginning to accumulate from some very interesting studies on prisoners in Vermont. Look at this young man who, in fact, was in energy balance eating an exactly regulated amount of food and maintaining body weight at a constant value. He was asked to continue exercising normally, but his energy intake was increased very substantially and, in fact, amounted at this stage to nearly 4000 kilocalories per metre squared. His body weight did go up, but by this stage it had re-stabilised and yet he was consuming very much more energy than before. His energy expenditure without exercising had therefore gone up and this involved an increase in basal metabolic rate and an increase in the specific dynamic action of food, in other words, the thermogenic increment that we have suggested may be linked to catecholamines. Well, that man is, in fact, a thinny who had great difficulty in becoming obese even though he may have had prison remission if he had managed to get himself obese.

<Next slide> Let's look at another chap who, in fact, was put through pretty well the same system. In this case, again, he was in energy balance. There was a short-lived high increase in food intake and a pretty rapid increase in weight, but by this stage he was really having very little more than the resting early state of the study and yet his weight continued to climb, and it was only at this stage that he began to come back

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into balance once more with only a small increase. So this man is perhaps unfortunate in that he tends to put on weight very readily, whereas the first man that we looked at, he seems to have the capacity to blow off heat whenever he eats a little too much.

<James to camera>

So a story seems to be emerging, then, of an individual susceptibility to obesity and we're suggesting that this is in some way related to metabolic processes, which do not, incidentally, involve an excess number of fat cells. The story about fat cells has, I think, been somewhat exaggerated, and a more detailed look at fat cell numbers in adult obesity suggests that there is, in fact, very little evidence for a programming of the number of fat cells from infancy, and there's very little evidence that this, in fact, is therefore geared to infant feeding practices. We find no evidence that hypercellular obesity is particularly applicable to obesity of childhood onset. And, indeed, hypercellularity only occurs in the very extreme forms of obesity, but also major technical problems with the accurate measurement of fat cell number and I don't think that story is going to last very much longer.

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Well, even though there is an individual susceptibility to obesity, we still have to recognise that these can be overwhelmed – one's capacity to remain thin can be overwhelmed by social pressures which we started the discussion with.

<James narrates over strip cartoon>

Now, here we have a strip cartoon to illustrate some of the points which one could make about the social pressures in our society which maximise our tendency to obesity. Take, first of all, our young friend, Esmé Fawcett, the young girl who is encouraged by her mother to eat a good solid breakfast. Now, there are two good points about this story: first of all that she is in fact eating at a table and that, of course, is becoming increasingly unusual, an unusual feature of the upbringing of

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children. The other thing is that she is in fact being encouraged to eat breakfast before school, but, aah, several things: one suspects that that young lad has a much better appreciation of the very high fat content of his typical British eggs and bacon and, in fact, could well do without this form of forced feeding.

Esmé, once she's consumed this breakfast, is anxious to get off to school, but the one thing that's not shown here is that her satchel is stuffed full of sweets and toffees and so on, as part of the mother's need to show her affection for her child, so off she goes to school with her sweets which she can consume on her way, only to find the first prize in home economics goes to our young friend for producing her magnificent cake. The amount of education that we put into good nutrition at school is really still abysmal and we are constantly extolling the virtues of such peculiar activities as making cakes rather than teaching sound nutrition.

Once she's got through her school life, young Esmé is now in a position where she feels that she has finally arrived and she has her first job, only, of course, to find that the delights of physical education at school have gone and she can now go off to work in a car, thus reducing that, albeit important, 10 to 20 % of energy expenditure that we talked about. Being a fairly independent young lady, she now probably lives with her friends and goes to a supermarket where she finds an extraordinary range of foods which are pre-packaged, often packaged in quantities which are perhaps inappropriate for her own needs. She's bombarded with advertisements; the only good one here, incidentally, is the one that tells you that bread is really very good. And, in fact, she is able to buy pretty well what she needs because, although we think that food is very expensive in Britain, it really, relative to other European countries, it's comparatively cheap. So she has a whole range of pressures which increase the size of that shopping bag.

Once she's got home, she immediately starts thinking about other things and she probably is trying her best to remain slim in the hope that she'll soon be in the position of getting married. Now, this is slightly unusual in that there is evidence to suggest that fatties and thinnies marry like with like. And here we have Esmé, who's decided that at least her children should be only half way fat by picking on a young

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thin man. The right-hand part of the cartoon is perhaps a little old fashioned in that it's a very late stage of heterosexual activity for young Esmé to start on the contraceptive pill, but, nevertheless, this indeed will reduce her energy expenditure.

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We then find that having gone to work with her new husband, she comes home and collapses at home telling everybody about her hard day's work, although of course, nowadays machinery and so on is reducing the amount of activity that actually has to be involved in one's work. Notice that she, in fact, is watching the television and, in fact, is consuming a variety of nutritionally inappropriate meals in an environment where she is unable to really assess what she's taking in because she, in fact, is concentrating on the television. Her only hope, in fact, of perhaps staying thin is to smoke those terrible cigarettes, which not only help to reduce her appetite but also may increase her energy expenditure by stimulating catecholamine secretion, a well-known property of cigarette smoking and nicotine.

Well, that's Esmé in a state where she's already on the way to getting fat and soon she's thinking about having a so-called 'famby'. And the only point at which public health education seems to have got through is that once you're pregnant you should stop smoking and, of course, this then, again, tends to both increase her appetite and diminishes her energy expenditure, so during here pregnancy, she rapidly puts on weight, and there are very good hormonal reasons why she should lay down an excess amount of fat at this stage. This, in fact, is a process which is geared to retaining energy as body fat in preparation for lactation, but our young Esmé has decided otherwise despite the campaign in favour of breastfeeding. And so she, in fact, is now lumbered with the excess body fat which she's accumulated during pregnancy and she's already started her own child on the slippery slope by forcing the babe to consume the regulation 6 or 8 ounces. Finally, as that child is starting once more on school, she, again, is maintaining that vicious cycle which started with her mother.

<James narrates over slide of table listing causes of obesity>

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Well, these are some of the social pressures that are obvious really and the question arises to how do we get the mix between these social factors and the metabolic considerations which we discussed earlier? Well, undoubtedly, if we look at a list of the causes of obesity, they are legion, and here are summarised a few of them. We're all familiar with a gluttonous individual who is eating enormous quantities of food, but we have to think more of these causes as applying to the whole of society, and the abnormal metabolism and genetic factors – picking out those poor unfortunates who are not able to cope with the everyday commonplace sloth and very small amount of exercise that we do. And then one has individuals, the fatties of this world, who find it very much more difficult, perhaps, to cope with the social pressures and advertising pressures to increase our food consumption.

<James to camera>

These whole pressures on our environment, affecting both childhood and adulthood and indeed the elderly, all impart, press, on the body's natural ability to maintain energy balance.

<End credits>