



Adolescence is a phase of life experienced by everyone, which involves fundamental physical, sexual, behavioural and emotional changes, yet the knowledge and memory of the events of many adult individuals is surprisingly limited. Parents and teachers view adolescence with apprehension anticipating aggression, bad temper, moodiness, lack of cooperation, negativism, rebellion etc., yet these are usually transient and not inevitable. This publication is an attempt to elucidate the happenings through these years in simple terms, which will be appropriate for children and adolescents themselves, but also for their families, teachers, social workers, psychologists and medical practitioners. The initial text is an overview, many aspects of which will be described more fully in the pictures and comments section (as indicated).

The processes, which transform a sexually immature child into a mature responsible adult, span about 6 years and vary greatly from one individual to another in their characteristics. Most of these variations are benign with no ultimate long-term adverse implications, yet at the time atypical patterns of development may be a cause of concern and, of course, occasionally they are of clinical significance and warrant investigation.

Much of the stress and anxiety experienced by teenagers and those associated with them may be avoided by an awareness of what to expect, and of the diverse patterns in which puberty can be manifested. Fundamentally this publication is designed to provide this information. Much is unequivocally factual and non-controversial, but the authors' opinion with regard to what is optimal in the family and social setting may not be universally accepted in these days of changing standards and attitudes.

John Buckler Alessandro Sartorio
Leeds and Milan, May 2005

Istituto Auxologico Italiano
Istituto di ricovero e cura a carattere scientifico

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The adolescent years

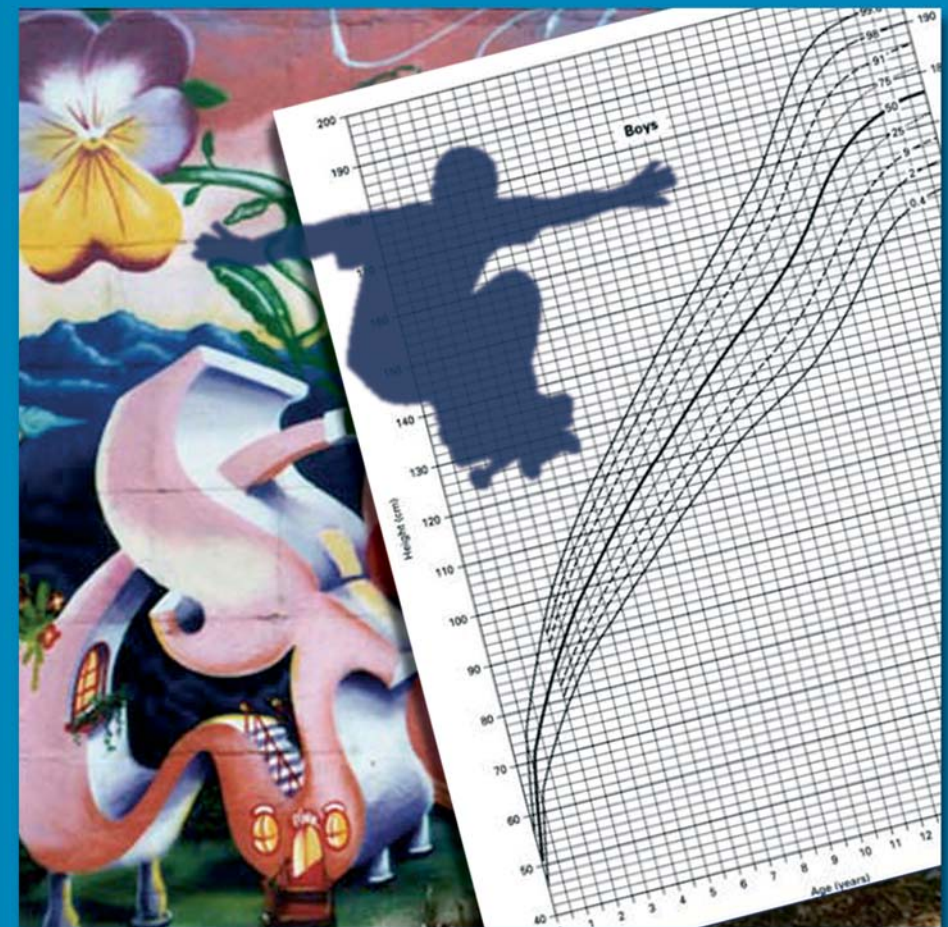
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The adolescent years

A clinical manual of growth and development



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The adolescent years

NOTE

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Introduction

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Much of the stress and anxiety experienced by teenagers and those associated with them may be avoided by an awareness of what to expect, and of the diverse patterns in which puberty can be manifested. Fundamentally this publication is designed to provide this information. Much is unequivocally factual and non-controversial, but the authors' opinion with regard to what is optimal in the family and social setting may not be universally accepted in these days of changing standards and attitudes.

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The range of normality

It is impossible to define rigidly what is ‘normal’ or ‘abnormal’ in adolescent development and certainly average is not synonymous with ideal. Patterns of development, which are outside a certain arbitrary range, may well be normal in a strictly medical sense. Atypical features which are of no long term consequence may be a cause of concern at the time, requiring understanding, reassurance, support and encouragement by many of those linked with these individuals. To determine what constitutes a real ‘abnormality’ requires knowledge and experience.

The hormonal changes at puberty

The fundamental underlying process of puberty is hormonal. Hormones are chemical substances, released into the blood from specific glands, which have widespread effects on tissues and organs throughout the body. Though other hormones do change their levels of production at puberty, the crucial ones are the sex hormones, male hormones – androgens, and female hormones – estrogens. The primary androgen in boys is testosterone derived from the testis (or testicle). In girls estradiol is the major estrogen and comes from the ovary. In both sexes androgens are also secreted from the adrenal glands so there are some ‘masculine’ features in normal female puberty (**20, 21, 23**)*.

Prior to puberty the levels of production of these sex hormones is minimal but at the onset of puberty and throughout its course these sites of sex hormone production are stimulated to activity by other hormones – gonadotropins. These are luteinising and follicle-stimulating hormones secreted by the pituitary gland at the base of the brain. The mechanisms responsible for the gradual spontaneous production of gonadotrophins to initiate puberty are complex and poorly understood, and are influenced in normal healthy children, notably in the timing of their activity, by many factors.

() the numbers in brackets throughout this text refer to the pictures and comments*

The physical changes at puberty

There is a spectrum of changes in boys and girls almost all dependent directly or indirectly on the increasing levels of androgens and estrogens following stimulation of the sex glands by gonadotrophins. These changes are, therefore, interrelated and include growth of sex glands, the internal and external genital organs, sex hair, growth of the body as a whole and its components, voice changes in boys, development of sexual function, orientation and ultimately fertility. Throughout the sequence of these changes there are major behavioural and emotional adjustments which ultimately transform a fully dependent child to an independent, self-reliant, sexually functional adult. These processes are described subsequently (41).

There is a marked gender difference in the age at which puberty with all its components starts and progresses. Girls develop approximately 2 years before boys, in all aspects i.e. in the appearance of first signs of puberty, the age of most rapid growth, of achieving full adult stature and of becoming sexually mature and fertile (34, 39, 41).

The sequence of events in puberty

The first change, which portends the onset of the more familiar and obvious changes, is growth of the sex glands. This is hardly surprising, as the other changes are the result of the hormone production from these growing glands. In boys, this is apparent by observation that the testicles are enlarging. In girls ovaries are enlarging too, but these cannot be seen by external observation (5, 12).

The sequence of subsequent changes is very variable within the healthy population, but some characteristics do bear a more consistent time relationship within the overall pattern. Thus the timing of most rapid growth in girls is relatively early in the sequence of events, long before the age of full breast or pubic hair development and invariably precedes the onset of menstruation (menarche). On average the menarche occurs about a year after the age of most rapid growth when there is little residual growth to be expected. In contrast, the

most rapid growth of boys is later in the sequence of events, when genital and pubic hair development are well advanced, though the growth of facial hair is late in the sequence when there is little residual growth in stature. Other changes are less consistent in their timing. In about 65% of girls breast budding is the first observable feature, but in the remaining third it is preceded by or concurrent with the appearance of pubic hair. In boys, following testicular growth, genital growth (penis and scrotum) is the commonest subsequent feature but pubic hair can precede this. The timing of appearance of axillary hair and in boys voice changes are very variable (9-11, 17-19, 41).

The onset of menstruation does not mean that a girl has reached an age at which she is fertile. The process of release of an egg from an ovary is termed ovulation. This rarely occurs before menarche and usually the early menstrual cycles are not associated with ovulation and no egg is available for fertilisation (12).

Growth in stature at puberty

Though the actual age at which growth in stature progresses is variable – in parallel with the overall pubertal process of which it is an important component – the shape of the growth curve is similar between individuals.

Before puberty, there is only a slight difference between the height and weight measurements of boys and girls. Throughout prepubertal childhood, height velocity gradually declines reaching its slowest rate just before the first signs of puberty. This is 2 years earlier in girls, averaging an age of 10 years, than boys, averaging 12 years. Growth rapidly accelerates then to reach its maximal velocity about 2 years later – averaging 12 years of age in girls and 14 years in boys. Because of this, for a short period between the ages of about 11 and 13 years girls are slightly heavier and taller than boys. The actual peak velocity value is greater in boys than girls and that, combined with the 2 years longer overall duration of growth, accounts for the fact that the average fully grown man is about 13 cm taller than the average woman. Growth rate rapidly declines following peak velocity and is almost complete 3 years after the age of peak height velocity. The age of effectively achieving full adult stature averages 15 years in girls (with an average age for the menarche of 13 years) and 17 years in boys. Careful

measurements would show that there is, in fact, a slight though insignificant increase for several years after this (**24, 25, 28, 34, 38, 41**).

It is important to realise that at the end of this sequence of growth events, no further growth is possible. In long bones, growth has taken place at what is called the epiphysial cartilage where the new bone is laid down, between the shaft of the bone and its end or epiphysis at the joint. At the completion of growth this epiphysial plate of cartilage disappears with fusion of the epiphysis and shaft (**24**).

The increased growth rate at puberty is due largely to the increase in androgen levels – directly and indirectly – for they (and estrogens) are also responsible for increasing the circulating levels of growth hormone at this time. Androgens, in the early phase of their rise in concentration at the start of puberty increase the growth rate in bones. However, further increase in the circulating androgen levels (and estrogen levels in girls) is also what accounts for the ultimate stoppage of bone growth by causing epiphysial fusion when these concentrations become sufficiently high (**22, 23**).

It is of interest that the growth in the arms and legs progresses more rapidly than that of the trunk in the first half of puberty and trunk growth is the predominant component in the later stages. At mid-puberty (around the age of overall peak height velocity) adolescents – particularly boys – appear to have long arms and legs compared with their appearance earlier on and when fully grown.

About 16% of ultimate height is achieved through the years of puberty (i.e. after an average age of 10 years in girls or 12 years in boys).

Weight changes at puberty

Proportionate weight gain is much greater than that of height, and boys and girls nearly double their weights (an actual average increase of 90%) over these years of puberty (**34, 38**).

In contrast to the steady decline in height velocity through prepubertal childhood, weight velocity is at its slowest between the ages of 2 years and 4 years in boys and girls and then slowly increases. The marked acceleration, however, coincides with the timing of increase in height velocity, as do the ages of the peak velocities and the subsequent decline in velocity (**32, 33**).

In contrast to height, weight does not reach a fixed maximum at the end of adolescence and is liable to continue to creep up subsequently (31).

The massive weight gain is to be expected and is normal – and certainly not a cause for concern. The weight increase is predominantly ‘lean body mass’ (muscle and bone), – everything other than fat, though this is more striking in boys than girls. Lean body mass comprises 82% of the weight of an average young man at the end of puberty – and fat 18% – corresponding figures for the female being about 70% and 30% (40).

Weight/height relationships

These are often reported in terms of body mass index (BMI) (weight/height squared or kg/m squared). In adults – who are fully-grown – increases in this index usually represent increases in fatness. This is not, so, however, through the years of puberty due to the proportionately much greater increase in weight (not due to fat) compared to height (35).

BMI increases from an average value of 16.5 at the onset of puberty in boys and girls to 21.5 at maturity in girls and 22.0 in boys with no proportionate increase in fatness in boys and little in girls. The use of this index as an indication of fatness in these years can be misleading unless linked to the precise stage of puberty (36-40).

Other physical changes

The body is also growing in girth, i.e. across the shoulders and the hips as well as in stature over these years. Shoulder width increases more in males than females, but the hip width of women increases as much if not slightly more than men reflecting the growth of the pelvis.

With the increase in muscle bulk, there is a great increase in muscle strength through puberty, which is much more marked and continues for longer in boys than girls, though girls throughout are more supple, agile and better coordinated.

Psychological and emotional development

As boys and girls grow up physically in adolescence, there are also important changes in attitude and orientation. These are essential in order to achieve a breaking away from the dependent state of earlier childhood, to establish unique adult personalities leading independent lives. Adolescents have to develop abstract thinking abilities, personal identity, self-esteem and their own ideology (65).

These developments may be difficult and challenging for parents to accept but they may actually be beneficial to parents if they cause them to review their own entrenched attitudes. The separation from parents in the home (or whoever has had the caring responsibility up to that time) does not necessarily have to be physical – and close links can be maintained – but is essentially emotional and psychological. At the same time new relationships outside the family will be developed and the knowledge and skills required for future employment and financial independence. It is also a time of developing sexual orientation leading ultimately for the majority to a long-term stable relationship (65).

The implications of all these concurrent physical and psychological ‘metamorphoses’ are enormous, imposing great demands on the individuals (and their families) for which usually they are unprepared and the implications of which they do not understand. Inevitably there are marked changes in behaviour but the manifestations vary greatly, and for some the process is much smoother than for others, often for no very obvious reasons and it does not have to be problematic! (66)

Progress in behaviour

Behaviour progresses in stages, which vary greatly between individuals in their duration and emphasis and have implications in relation to life at home, with their peers and at school. The stages roughly relate to the stages of physical development, and are therefore appropriate and relate to that rather than to actual (chronological) age. Interpretation of behaviour in these years requires an awareness and insight into what is happening physically (or in some cases what is not happening when puberty is delayed) and recognising whether this

behaviour is ‘normal’ and to be expected (even though it is unlikely to be welcomed and valued as in theory it should be) (66).

The most difficult phase is in early adolescence when the child is freeing himself or herself from the emotional attachment to the parents but not yet fully able to do so – still being dependent in financial and many other ways – and is emotionally ‘torn’. This is the phase of negativism in which the child finds difficulty in behaving rationally in the home, becoming argumentative, moody, critical, uncooperative, angry, rebellious and selfish (68).

After a variable period, these difficulties are replaced by happier times with the development of friendships outside the home but with the consequent peer group pressures and the need to conform. Gradually dependence on the group is usually replaced by the acquisition of individual identity, independence and maturity. Initially sexual attractions are commonly with individuals of the same sex but replaced in time by relationships with the other sex. A homosexual attitude thus commonly precedes the ultimate long-term heterosexual orientation (69).

It is almost inevitable that in achieving the goals of adolescence, there will be problems and difficulties, but these can be lessened by an awareness of what is happening and the stresses involved by all concerned – particularly the family. Attitudes of understanding and tolerance can be invaluable, and the insight to recognise when is the right time to express interest and to offer advice and support (70, 71).

There are many ways in which the broad spectrum of manifestations of the pubertal process can vary and still, unquestionably be considered as ‘normal’. Extremes may be a real cause for concern but these are rare.

That is not to say, of course, that deviations from the average (and with behaviour even the average) will not present problems – particularly emotional ones and notably when an individual appears different from the group.

Variations in the pattern and timing of pubertal growth

Variations are commonly seen in the sequence of the physical events in puberty, their duration and their magnitude. But the most obvious and concerning is the variation in the timing of puberty. As indicated already, the average age for

boys to enter puberty is about 12 years, to grow at their fastest 14 years, and to be almost fully grown 17 years. For girls these ages are 2 years younger at each stage with an average age for the onset of menstruation of 13 years. But the spread of ages is so great that over 3% of the normal healthy population develops at ages 2 years or more earlier and over 3% at ages 2 years or more older than these averages. There is thus a difference of over 4 years for over 6% of the population. It is highly likely that in the same year group of 12 year old girls at school, there will be some who are fully grown, developed and menstruating and others who are not yet showing the first signs of puberty or any growth spurt. The mature girl will be likely to be about 16 cm taller than her undeveloped counterpart at that age, physically stronger and more confident. Boys show a similar range though with corresponding ages 2 years older. Delayed puberty is much commoner in boys than girls, and early development commoner in girls than boys (**43-47, 54**).

These deviations will have emotional and psychological implications, though the effects can be alleviated by the reassurance (when this is appropriate) that the ultimate outcome will be acceptable. The late developing boys and girls (assuming they are not part of the small rare group where there is an underlying pathology) will grow and develop in due time and reach a stature as tall as their precocious counterparts and be in every way functionally normal. However, excessive emotional strain at the time through anxiety, teasing and bullying etc. can cause long term psychological upsets and every effort should be made to avoid or counteract these developments – particularly by the informed attitude and support of the family and schoolteachers (**48-50**).

Even though doctors may be able with confidence to predict a good outcome without intervention, sometimes the stress for the child may be so great that treatment is justified to initiate puberty in those in whom it is delayed, or delay it when it is excessively early. But such interventions must be carefully assessed, considering the precise age and stature of the child, the family history and attitude, the severity of the emotional stress to the child and the confidence that the condition is benign (**50**).

Other atypical occurrences

These are not uncommon and usually have no long-term *sequelae*. Isolated features of puberty appearing early – such as breast development, the appearance of pubic or axillary hair without any acceleration in growth rate are seldom due to underlying pathology and are often transient and regress before the onset of true puberty (59-61).

In girls the two breasts may not develop at the same time, yet end up the same. Menstrual periods in the early stages may vary in their frequency, regularity and volume, and are seldom ovulatory for the first 3 to 12 months (61, 62).

Breasts commonly develop transiently in boys during the course of puberty and usually regress with time. Developing testes are frequently not the same size and the right testis usually hangs higher in the scrotum than the left. Boys experience erections of the penis, nocturnal emissions and masturbate as part of the natural outlet for their sexual development and powerful sexual drive (13, 21).

Reasons for concern about puberty

Fundamental questions to be answered by the clinician are:

- To what extent the concerns are justified?
- What are the reasons for the concerns?
- When is the situation really reflecting abnormality (pathology)?
- When is reassurance justified?

Though the problems are fundamentally those of the adolescents themselves, they may be instilled in them or increased by the feelings or comments of others notably parents, other pupils at school, school teachers or a host of friends, relatives or acquaintances (47, 54).

Lack of knowledge of the norm and its variations may be reflected in comments about weight, height, rates of growth etc. implying an abnormality, which does not exist.

There may be a fear that there is some underlying serious disease process, that in delayed puberty it will never happen, that as an adult there will be some permanent defect or abnormality. In practice, there is seldom any residual difference from others, as an adult, in appearance or function and in time the fact

that there is normality will become evident. The only residual that can occur is that if puberty is markedly early there is a risk that adult stature will be shorter than it should be due to the early age at which growth stops (47, 54).

Factors that influence the timing of puberty

In most cases no explanation can be found to explain the variation in the timing of puberty, but there are several factors which are known to influence it (44).

There is a definite family pattern so that parents who were early or late in their development are likely to have children with similar timing. However, there can be wide variation within a sibship! (44, 46, 48, 49)

Nutritional status is a powerful influence. Undernourished children are late entering and progressing through puberty. Healthy thin children, notably those who are active and very athletic tend to be late developers. Severe weight loss during the course of puberty whether due to illness or deliberate food restriction or dieting delays progress in puberty and in girls menstruation (44, 52, 82, 84).

Overweight children – particularly girls – tend to be younger and taller at the time of entering puberty (though not tall ultimately) (75, 78).

Through the course of the last 100 years puberty has been getting progressively earlier in most countries of the world, though there appears to be a slowing down or stopping in this trend recently. This is reflected in the age of menarche in girls. The explanation for this is not clear though at a certain stage improved nutrition was clearly an important factor.

In a pathological situation, chronic ill health of whatever kind often but not always associated with undernutrition retards growth and delays puberty .

It is usually appropriate to offer reassurance in these situations but this needs to be well founded and there is a need for guidelines to indicate when referral for medical evaluation is appropriate.

Reasons for investigation

When puberty occurs at an early age, signs developing before 8 years in girls or 9 years in boys are arbitrarily considered to justify referral for assessment.

Delay of puberty in which there is no evidence of it being imminent at an age or 14 years in girls or 16 years in boys likewise justifies referral. A family history of similar precocity or delay is however reassuring and may warrant wider age limits (55).

In boys the first sign of puberty is testicular growth, a sign seldom noticed or looked for, but if that is observed, it is a good indication that puberty in the usually accepted sense will follow soon. The presence of early pubic hair (with or without axillary hair), as the sole evidence of puberty in girls, does not necessarily imply that true puberty is imminent – as this may be due to androgenic activity derived from the adrenal glands, and not indicating ovarian development (19, 20, 60).

When isolated pubic hair is accompanied by rapid speed up of statural growth this always warrants investigation in girls. In a similar way, in boys, precocious masculinisation and accelerated growth without enlargement of the testicles is a potentially serious finding as this is not the picture of true puberty but implying that the androgenic stimulus is derived not from the testicles but from an abnormal site, most likely the adrenals (20, 60, 64).

When concern is expressed about delay in the onset of menstruation, it is fundamental to know whether this delay is linked with a delay in the whole process of puberty (in which case menarche would not be expected in the absence of an appropriate pubertal stage). Such delay would be evaluated in terms of overall puberty. If, however, the pubertal process has progressed normally but without menstruation when it would be expected, the causes are quite different most likely a structural or anatomical abnormality warranting gynaecological assessment (62, 63).

Relationships of adolescents within the family

The commonest problems related to both precocious and delayed puberty are emotional and psychological due to being different, particularly in view of the associated marked difference from others in stature – excessively tall or short. Precociously developing girls have the added embarrassment and vulnerability of early onset of menstruation. Teasing, taunting and bullying and a feeling of

isolation can have serious implications and children exposed to these need strong support, encouragement and reassurance (47, 49, 54).

The attitude of the family – parents and siblings – is fundamental, and they need to understand the situation, its cause and the nature of the problems and their likely outcome. This applies to the family relationships with all adolescents anyway. Those homes where parents – mother and father – have provided a secure, consistent, loving and disciplined setting in which the children have grown up through their childhood will cope incomparably better when it comes to adolescence (71).

Children and particularly adolescents need people on whom they can rely, whom they can respect and trust and with whom they can share their problems and talk (when it suits them!). Though in one sense it is right that they are 'breaking away' in seeking independence, in another the values of a secure loving family are never lost. Society, nowadays, tends not to rate the value of the family highly, accepting almost as the norm, perhaps encouraged by the media, a fragmented setting with a lack of communication partaking few activities (including meals) together. Reliance for entertainment is found in the television and videos and computer games, etc. – provision which is for the individual not the family or group (65, 71).

Relationships of adolescents with their siblings

Problems in relationships of adolescents within the family may well arise with brothers and sisters as well as with parents. After years of involvement with younger siblings in games and many pastimes, the adolescent now grows away seeking new company of the same age, no longer finding satisfaction in these activities. This separation can be hurtful to the younger children, particularly if the adolescent behaves in a superior, derogatory way looking upon his younger siblings as 'juvenile' and a nuisance. Elder siblings, despite having gone through the adolescent process themselves probably quite recently, have little sympathy for what they consider the obnoxious, irrational behaviour or their younger teenagers in the family. In a stable family setting, good relationships are readily resumed as the adolescent matures.

Groups at special risk for problems at adolescence

Single parents face increased burdens with their adolescent children. One-parent families comprise an increasing proportion of the population as the years go by due to family breakdown (divorce or separation), or unmarried mothers being on their own. The lack of support of a spouse or partner of the opposite sex presents greatly increased psychological and emotional burdens for the single parent who is likely to have difficulty in determining the best attitude and in providing appropriate authority and discipline and consistency. Remarriage or acquisition of a new partner is not necessarily a satisfactory answer, for the adolescent may not be accepted or welcomed by the new step-parent and the adolescent in turn may resent this encroachment on the household – particularly if this involves the introduction of a set of step-siblings.

Adolescents in such settings and those in care show more frequent and more severely disruptive behaviour, and poverty is commonly an added burden. Children who have been in care and therefore lacking an ideal family show much higher prevalence of mental health disorders, teenage pregnancy and involvement in crime. Problems surfacing in adolescence have often been present in the earlier childhood years though not evident or recognised (71).

When there is no family or in the extreme circumstance of abuse, the stresses and disruption will greatly increase for the adolescent. Recourse will often be by withdrawal or to other sources of company within the peer group, which may or may not provide what is needed. Conformity with peers may lead to such practices as smoking, drug and alcohol abuse, promiscuous sexual activity with the high incidence of sexually transmitted disease and pregnancy.

Adolescence in twins

Twin teenagers may face particular problems, the nature and significance of which is variable. Identical (monozygotic, MZ) twins are likely to be closer to each other in all respects than non-identical (dizygotic, DZ) or mixed sex pairs. MZ twins are likely to go through the stages of puberty at very similar ages. MZ twins who have been brought up as a 'pair' and very dependent on each other, rather than as individuals, and are looked upon as a pair by the family, school, society

etc. may find separation from each other and the family particularly difficult, with continuing interdependence. The more MZ twins have been allowed to be individuals and not just one of a pair through early childhood, the easier will be the breakaway process of adolescence.

In contrast to the similar pattern and timing of puberty shown by MZ twins, DZ twins will have no greater similarity to each other than brothers or sisters in general. The girl of a mixed set twin pair is likely to develop 2 years or so earlier than her brother with the obvious implications. It is not uncommon in DZ pairs for one to develop and grow earlier than the other. If the reason for this is not recognised, it is likely to cause concern for the parents and the twins themselves who may think that something is wrong with one of them. They may assume that being twins, they ought to progress in a similar way at similar ages whereas this is in fact unlikely. A marked difference in the ages of development of twins will exaggerate the problems of early and late developers within the overall population already described.

Of course, apart from these particular circumstances, having 2 adolescents within a family entering and progressing in puberty at ages close together (if MZ twins) or relatively close (if DZ twins) might be expected to double the 'normal' difficulties for the family. This should not otherwise produce unique problems if the twins have always been able to consider themselves 'individuals'. In the optimal setting, however, twins can be supportive to each other achieving the right balance between the breakaway and yet retaining a link with each other and the family. In such circumstances, the burdens of caring for 2 adolescents are certainly not doubled.

Concerns about physical appearance and weight

Many of the concerns of teenagers depend on relations with peers and their reactions to real or inferred 'differences' from them. These include their appearance, including concern about acne and other skin problems, appropriateness of their weight and their physical (or sexual) prowess, or lack of it (71).

Many individuals consider themselves incorrectly to be over- or under-weight, though boys and girls differ in the way they do this. Over half of adolescent girls consider themselves to be too fat, whereas in reality less than a quarter really are.

Conversely over half of the boys would prefer to be heavier, taller and more muscular. Less than a quarter are actually underendowed with fat (84).

Many adolescents undertake programmes to alter their weight, girls to reduce it by dieting – seldom by increasing their exercise and boys to increase it largely by exercise programmes rather than by altering their food intake. Their concern is often unnecessary and exaggerated.

Most teenagers who look thin are in fact healthy. The potentially dangerous condition of anorexia nervosa is associated with a basic complex psychological upset and results in very severe weight loss (81, 82).

It is difficult to define ‘abnormal’ weight and this depends on many factors. Extremes of under- and over- weight are usually obvious and these may be due to a significant pathological problem. This is not the case, however in the majority of cases, though concern may nevertheless arise and occasionally be appropriate, especially if it has resulted in severe emotional or psychological reaction.

Weight should always be related to height, and is only likely to be a problem where there is a big difference between weight and height centiles. Excess weight, though usually due to fat, is not always so but may be the result of a different physique with broad build and more muscle and bone (42, 74).

Overweight and obesity at puberty

Though overweight is not really as common as many adolescents consider, nevertheless obesity in many countries is becoming an increasing problem. It is probable that 5 – 10% of children really are overweight, about 15% of teenagers and 30% of adults. Most obese teenagers become obese adults.

In less than 10% of obese children and adolescents is there an underlying disease that is responsible. These individuals can invariably be identified by the observation that they are of short stature and it is important that they are investigated and treated for the underlying condition. Such obesity is termed endogenous and with treatment is likely to resolve (75, 76).

In contrast, the majority of obese young people are taller than one would expect but though remaining obese as adults they are no longer inappropriately tall. This is exogenous obesity and such individuals have few medical consequences from their obesity during their growing years, though frequently

emotional and psychological ones. However, in adults obesity is associated with many illnesses and adverse effects (**75, 78**).

Exogenous obesity commonly runs in families. If one parent is obese 40-50% of their children will also be obese and if both parents are obese 70-80% of the children. Though undoubtedly there is an inherited component, there is also an environmental factor resulting from common eating practices and preferences (**77**).

Growth at puberty is dramatic and food requirements increase in consequence. Inappropriate and rigid dieting is detrimental and should be avoided even in obese individuals as it causes growth to be slower than it should be (**72, 73**).

Management of obesity

An obese subject should aim to reduce fatness while increasing muscle and bone and probably overall weight. Weight control should be carefully supervised and weight changes monitored and evaluated. Inappropriate weight loss from muscle and bone and fluid also results in deficiencies in minerals and vitamins, often resulting in general malaise, reduced concentration and depression.

Family support with regard to food is very helpful. A common policy for the whole family with explanation and avoiding conflict and stress has the greatest chance of success. Diets can be simple, avoiding excess sweet and fatty food and snacks, the same food for the whole family who eat it together (**79**).

Obesity is essentially the result of an excess of food taken in over what is required for growth and activity. Present day culture shows a marked reduction in physical activity at all ages, but particularly children and adolescents. Far less do children make their own entertainment nowadays which used to involve enjoyable exercise in some form or another. With the advent of television, computer games, transport by vehicles and lifts rather than walking or cycling etc. many teenagers undertake hardly any activity (**77, 79**).

Unfortunately team and individual sports and activities are not encouraged in many schools and clubs. A concept of partaking in regular exercise for enjoyment is seldom achieved or even attempted. In parallel with sensible 'dieting' such exercise should be a permanent component of a young person's life

style, with benefits to general wellbeing and health as well as the effect on weight and body composition. Attitudes to eating, physical activity and the tendency to obesity developed in adolescence are likely to persist through life (79).

Short and tall stature in the teenage years

These are most commonly explicable on the basis of parental stature and atypical timing of puberty and the outcome is likely to be acceptable. Except in circumstances of severe psychological upset treatment is seldom required in such cases. However, in the minority in whom observations indicate extremes of stature (originating before puberty) which are progressive, and atypical for the family, clinical evaluation is important. If a cause is identified, appropriate treatment should be instituted straight away though the problem should have been recognised before puberty – and continued through the adolescent years, often in increased dosage. Children with glandular dysfunction, such as deficiencies of thyroid or growth hormone are good examples (48).

Adolescents with chronic illnesses or disabilities

The problems and difficulties of adolescents are compounded in those who have had chronic illness or disability through childhood or who develop it in teenage. The illness which has severely affected their life now causes increasing fears and uncertainties for a boy or girl who recognises the implications with regard to their physical appearance, and their expectations for social wellbeing and acceptance and their prospects of sexual function in addition to their health prognosis.

In childhood the parents (or carers) have managed the health care. They have now themselves to accept that it is appropriate for their child to take charge of his or her life if independence is to be achieved. Many adolescents recognise this need yet may fail to realise the long-term implications of this responsibility and its seriousness for their future health.

This is most likely if their attitude is uncooperative and rebellious. Parents need encouragement and support through this difficult phase as well as the

teenagers themselves. The parents must avoid being overprotective and creating excessive dependence on themselves. The children need appropriate professional input to provide health advice and information and the opportunity to discuss confidentially their lifestyle, their problems and their practical difficulties. These young people need someone to explain to them how to obtain information and how to use the facilities theoretically available to them.

It is important that such young people consider themselves and are treated as fundamentally 'normal' in all ways other than their illness or disability. They will, of course, experience the changes and difficulties of this stage of life in the same way as healthy adolescents, and these developments should be recognised as normal to all and not dependent on their disorder (71).

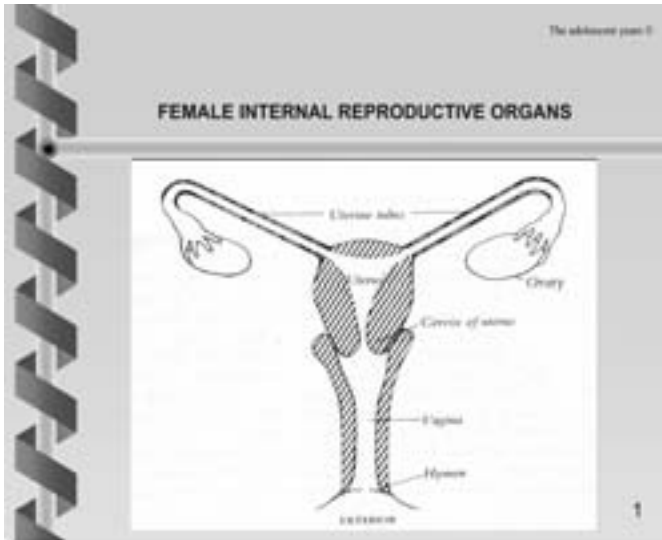
The take-over of the management of such severe chronic disorders as epilepsy and diabetes is particularly critical for teenagers. Correct treatment and monitoring is essential with potentially life threatening implications from mismanagement. The balance between disease control and free independent life style is very difficult to achieve. Diabetic control is poorer at adolescence than at any other age for many reasons. In addition to the effects resulting from growth and development (with all the related hormonal changes) and altered life style, those linked to the transfer of management to themselves are critical. There may be lack of knowledge with poor education, and sometimes a tendency to rebel or to use the condition to manipulate or even attempt to deny it to avoid the implications of peer reaction. In addition the peak age for the first development of insulin dependent diabetes is adolescence.

Immigrants and other disadvantaged groups

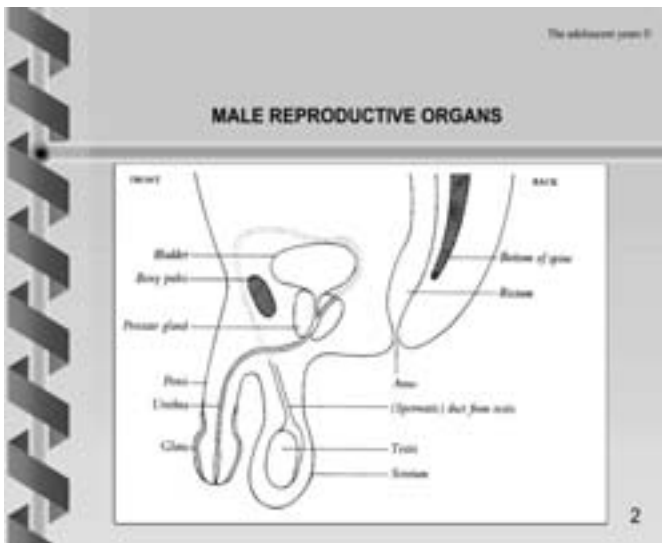
Adolescents are not a homogeneous group. Among them are those with disadvantages, social and educational, family breakdown, but in particular due to being immigrants. Ethnic minorities have increased numerically greatly in recent years in many European countries. They have special health needs linked with specific disorders (partly associated with the high incidence in some cultures of inherited disorders due to consanguinity) and because they suffer socio-economic disadvantages, problems with language and

poverty. Their difficulties may be highlighted at adolescence. They often stem from prejudice and intolerance, associated with differences of culture and religion and difficulty in integrating. Such individuals may be less inclined or able to obtain health services or know about them and these people include those with the greatest needs (71).

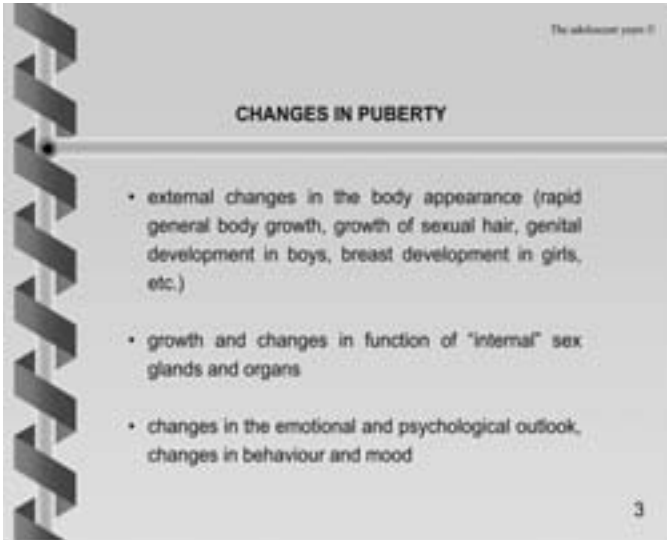
Mortality in the adolescent age group has not fallen in recent years, the main causes being accidents and self harm. Chronic illnesses and mental health problems are common, a cause for great concern and illustrated by the increased risk of suicide in young men. These observations emphasise the fundamental relationship between physical, mental and social well being and the need to address all aspects if the well being of adolescents and society as a whole is to be improved.



► This simple diagram shows in section the anatomy of the adult female genital organs



► A sagittal section of the adult male pelvis as a diagram to show the internal and external organs of reproduction and their relationship to neighbouring structures



The adolescent years II

CHANGES IN PUBERTY

- external changes in the body appearance (rapid general body growth, growth of sexual hair, genital development in boys, breast development in girls, etc.)
- growth and changes in function of "internal" sex glands and organs
- changes in the emotional and psychological outlook, changes in behaviour and mood

3

- ▶ Evidence of puberty and its progress usually depends on external changes that can be seen
- ▶ These and the other changes are interrelated
- ▶ All are dependent on the same basic hormonal mechanisms



The adolescent years II

GRADING OF CHANGES OF PUBERTY

Tanner staging of puberty is widely used to describe:

- breast development in girls
- external genital development in boys
- pubic hair development in boys and girls

4

- ▶ The grading is in 5 stages. Stage 1 is completely prepubertal and stage 5 adult
- ▶ These features of puberty are the most consistent in sequence and definition
- ▶ Progress between stages in all these features is gradual and the achievement of each stage cannot be defined precisely

The adolescent years II

THE PHYSICAL CHANGES IN A GIRL AT PUBERTY


- breasts
- body hair (pubic and axillary hair)
- growth (height and weight, bone, muscle, fat, internal body organs)
- onset of menstruation (menarche)

5

- ▶ The first physical change in girls is usually growth of the ovaries
- ▶ Unlike the testes in boys, this gonadal growth is not recognisable by external examination
- ▶ Many of the external features are dependent on hormone secretion from the developing ovaries
- ▶ The menarche is the one incident whose timing can usually be accurately identified
- ▶ Axillary hair usually appears 1-2 years later than pubic hair, though may occasionally precede it

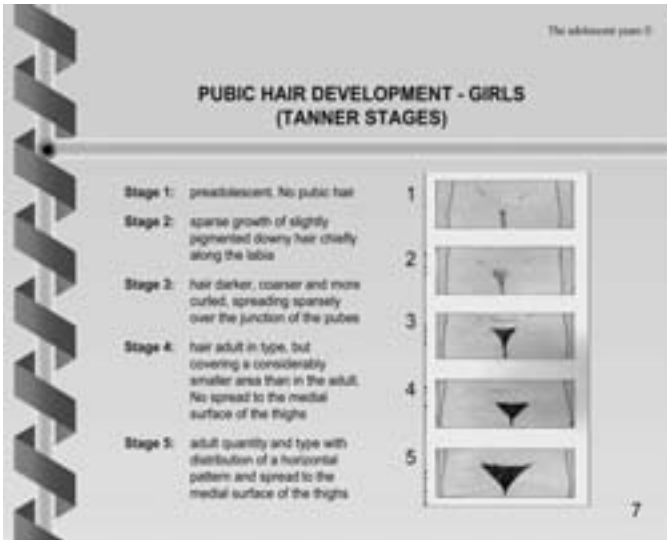
The adolescent years II

BREAST DEVELOPMENT - GIRLS (TANNER STAGES)

<p>Stage 1: prepubescent, elevation of the papilla only</p> <p>Stage 2: breast bud stage. Elevation of the breast and papilla as a small mound. Enlargement of the areola diameter</p> <p>Stage 3: further enlargement and elevation of the breast and areola, with no separation of their contours</p> <p>Stage 4: projection of the areola and papilla above the level of the breast</p> <p>Stage 5: mature stage, projection of the papilla alone due the recession of the areola</p>	<p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p>	
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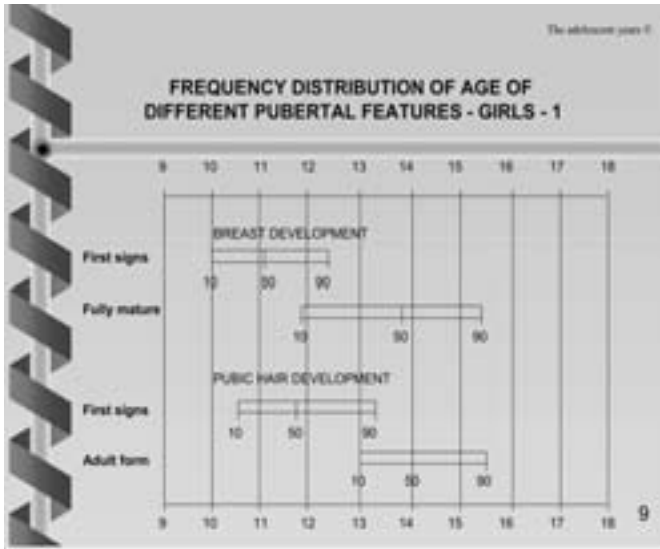
- ▶ The two breasts do not necessarily develop at precisely the same time or grow at the same rate
- ▶ In obese girls, stage 2 is often difficult to distinguish from fat
- ▶ In a few girls stage 4 does not occur and there is a gradual increase in breast size from stage 3 to stage 5



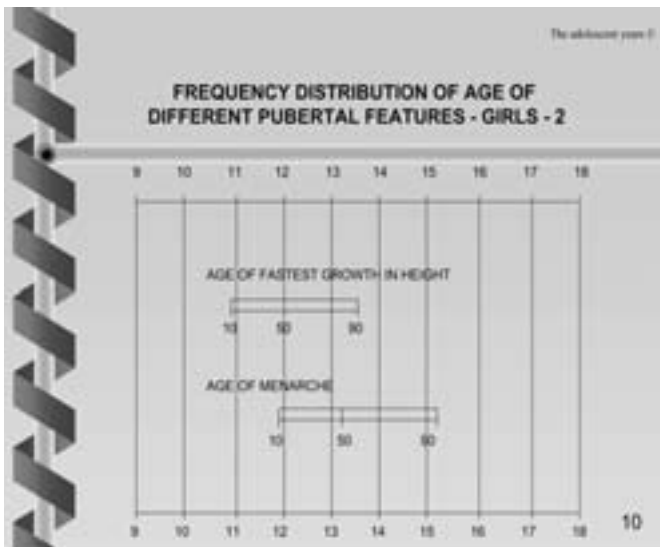
- ▶ Stage 2 hair is inconspicuous and not evident in photographs
- ▶ The quantity and extent of pubic hair varies greatly between individuals



- ▶ The ages shown are averages for a developing girl
- ▶ The average girl grows in stature at her fastest rate at 12 years of age



- ▶ The 10,50,90 figures shown indicate the percentage of girls who have achieved that pubertal stage by that age
- ▶ The frequency distributions shown are derived from longitudinal observations on a group of English girls
- ▶ The ages attributed for achieving maturity or adult form can only be approximate, as these cannot be defined precisely
- ▶ The age range of pubertal events across the normal population is very great



- ▶ The ages for these events can be defined with considerable precision
- ▶ The timing of fastest growth in height can only be assessed retrospectively




The adolescent years II

ORDER OF EVENTS IN PUBERTY - GIRLS

- the onset of breast development precedes the appearance of pubic hair in over 2/3 of girls
- the most rapid growth in stature is about a year after the first signs of puberty
- menarche is invariably after this stage (averaging 1 year later) and is an indication that growth is rapidly slowing down
- the average girl only has about 5 cm of residual growth after the menarche

11

- ▶ The evaluation of the amount of growth still to come depends not on age as such but on how far puberty has progressed
- ▶ Whatever the age, if puberty is not underway or is only in the early stages considerable growth is still to be expected
- ▶ Once menstruation has started growth has slowed and there is little more to come whatever the actual age



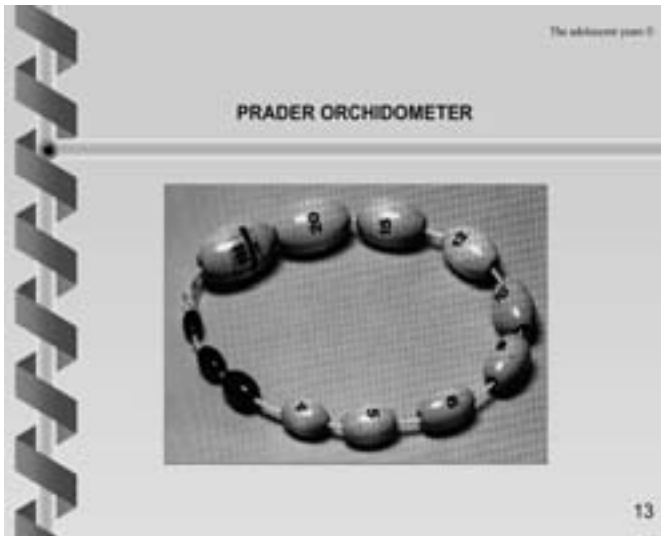
The adolescent years II

THE PHYSICAL CHANGES IN A BOY AT PUBERTY

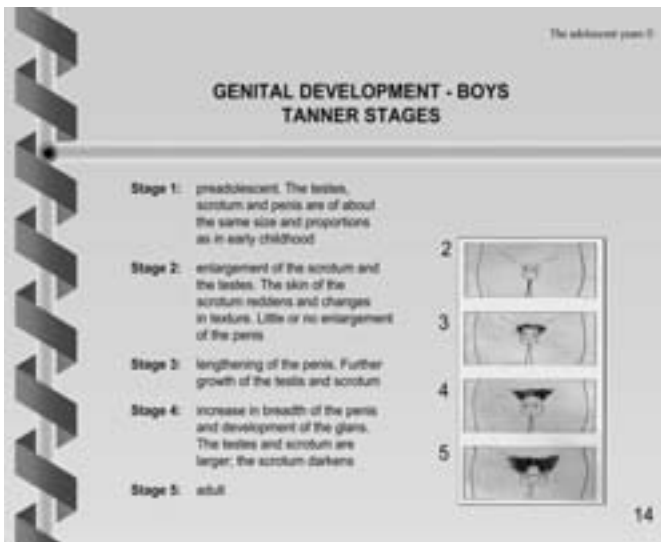
- genital development
- body hair (pubic, axillary and facial hair)
- growth (height and weight, bone, muscle, fat, internal body organs)
- voice

12

- ▶ The first sign of puberty in boys is almost always growth of the testes
- ▶ Most of the observable changes of puberty are due to testosterone secreted by the developing testes
- ▶ As in girls axillary hair usually appears later than pubic hair
- ▶ Voice changes, which are dependent on growth of the larynx, are variable in timing and duration but usually a boy's voice breaks at about the time he is growing at his fastest



- ▶ This is a means of assessing testicular size, the figures indicating the volume of a testis in ml
- ▶ The testes of a preadolescent boy are about 2 ml in volume
- ▶ Growth of the testes to 4 ml or more is the first sign of puberty in most boys (Genital stage 2)
- ▶ This sign of puberty may precede any other by several months but is a reassuring indication that puberty is underway
- ▶ One testis is often larger than the other during the course of normal puberty
- ▶ The right testis usually hangs higher in the scrotum than the left



- ▶ In very fat boys, the penis may be buried in fat and appear underdeveloped. The true size of the penis is evident if the fat is retracted
- ▶ Progressive genital and pubic hair development without enlarging testes suggests this is not true puberty, but due to an abnormal production of excess androgens from another site – most likely the adrenal glands

The adolescent years II

PUBIC HAIR DEVELOPMENT - BOYS (TANNER STAGES)


Stage 1: preadolescent. No pubic hair

Stage 2: sparse growth of slightly pigmented downy hair chiefly at the base of the penis

Stage 3: hair darker, coarser and more curled, spreading sparsely over the junction of the pubes

Stage 4: hair adult in type, but covering a considerably smaller area than in the adult. No spread to the medial surface of the thighs

Stage 5: adult quantity and type with distribution of a horizontal pattern and spread to the medial surface of the thighs. Spread up linea alba occurs late in about 80% of men (stage 6)

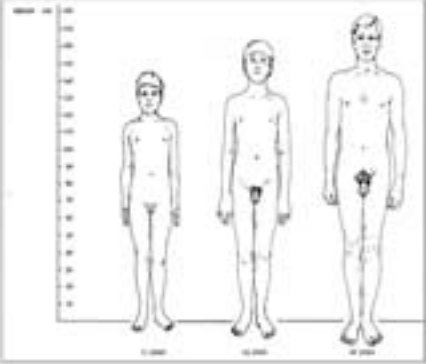


15

- ▶ The description of the stages is similar to that in girls, except for stage 6
- ▶ The quantity and extent varies greatly between individuals

The adolescent years II

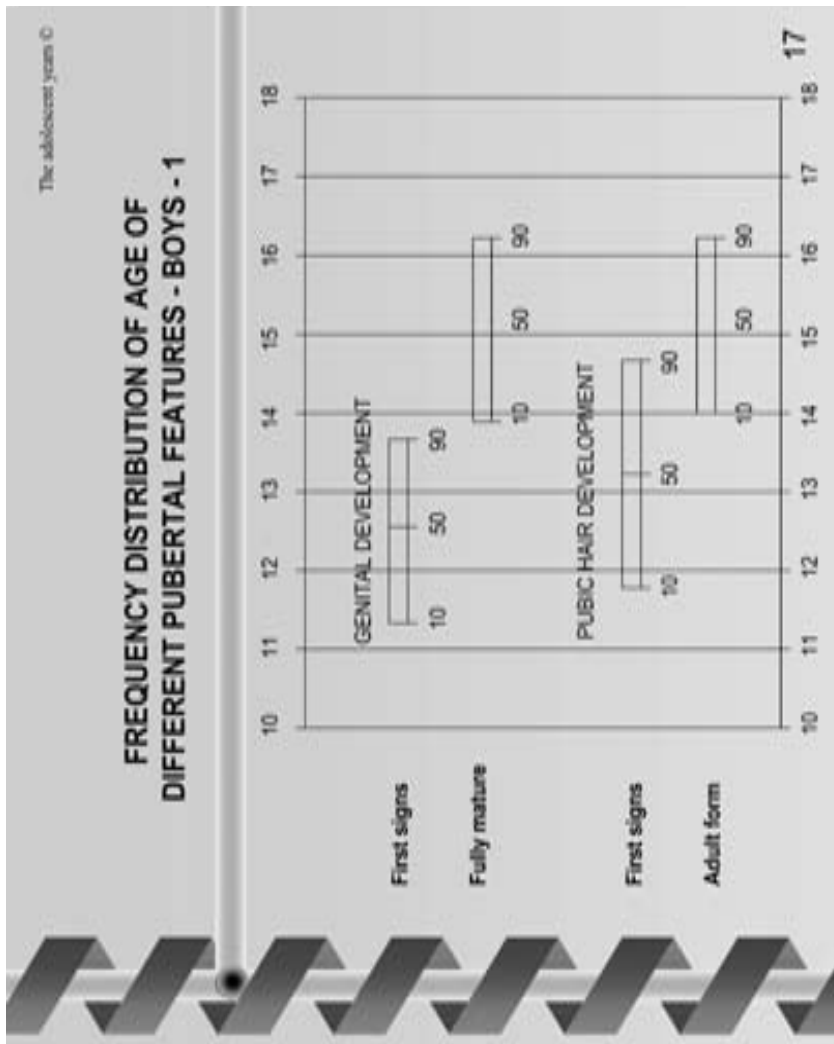
THE PHYSICAL CHANGES IN A BOY THROUGH PUBERTY

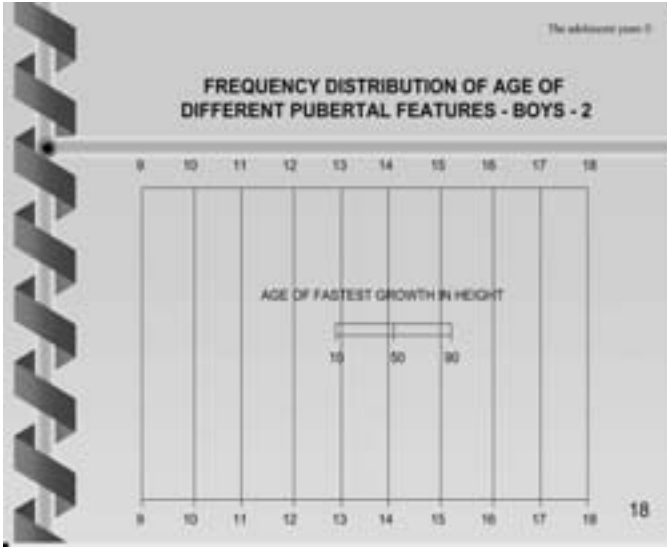


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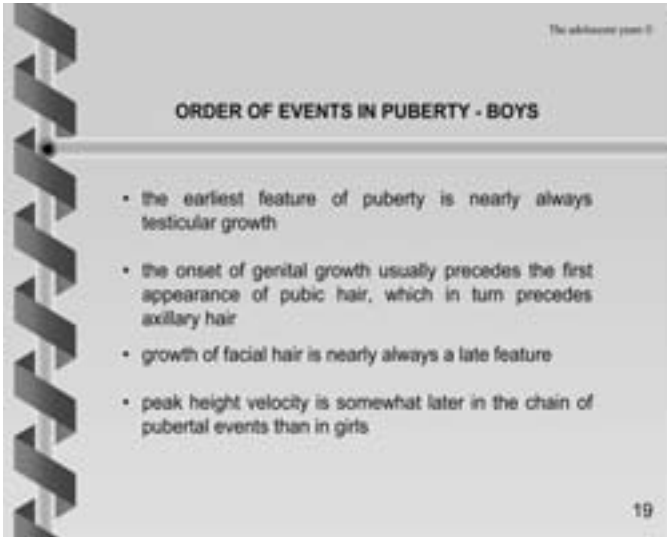
- ▶ These are average representations for age and height
- ▶ The average boy grows at his fastest at 14 years

- ▶ The frequency distribution is derived from longitudinal observations on cohorts of English schoolboys
- ▶ The timing of becoming fully mature or adult cannot be determined precisely





- ▶ The timing of the fastest growth is found retrospectively and its precision depends on the frequency of observations



- ▶ If puberty is delayed, prior to its onset, growth velocity will be slower than average for the actual age, but growth potential will be greater, as long as there is no underlying pathology
- ▶ Considerable growth in stature can still be expected up to the time when genital and pubic hair growth are well advanced, irrespective of the actual age
- ▶ When facial hair is clearly evident and shaving has commenced, little residual growth in stature is to be expected

The adolescent years II

THE SEX HORMONE BASIS FOR PHYSICAL CHANGES IN PUBERTY - GIRLS

- ovarian secretions (estradiol and progesterone) produce the changes in breast development, body fat deposition and vaginal and uterine tissues (as well as the psychological development) that occur during puberty
- the adrenal secretion of androgens is a major cause of the development of axillary and pubic hair growth in females and contributes to the growth spurt

20

- ▶ If there is ovarian failure with absent ovarian hormone production, pubic hair may appear as the result of adrenal androgen production
- ▶ The appearance of pubic hair as the sole feature of sexual development does not therefore necessarily imply that true puberty will follow
- ▶ Premature isolated growth of sexual hair particularly if associated with acceleration of growth raises the possibility of adrenal hyperactivity

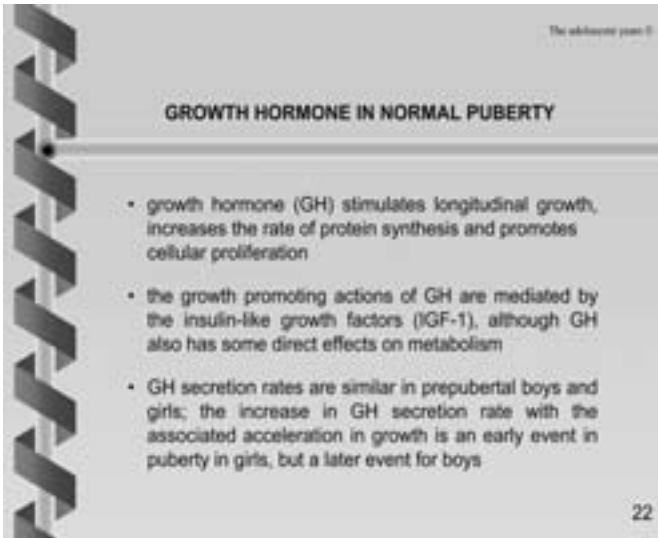
The adolescent years II

THE SEX HORMONE BASIS FOR PHYSICAL CHANGES IN PUBERTY - BOYS

- the changes of puberty are essentially due to the action of androgens primarily from the developing and growing testes (testosterone) and to a lesser extent from the adrenal gland
- the adrenal contribution can become marked in situations of pathological overproduction
- transient estrogen production (by conversion from androgens) commonly occurs during the course of puberty causing development of the mammary glands (termed gynaecomastia)

21

- ▶ Lack of testicular growth is the only clinical feature that distinguishes the sexual development due to adrenal androgen overproduction from that of true puberty
- ▶ Adolescent gynaecomastia usually regresses spontaneously with time though occasionally it is gross and persistent and may require surgical treatment



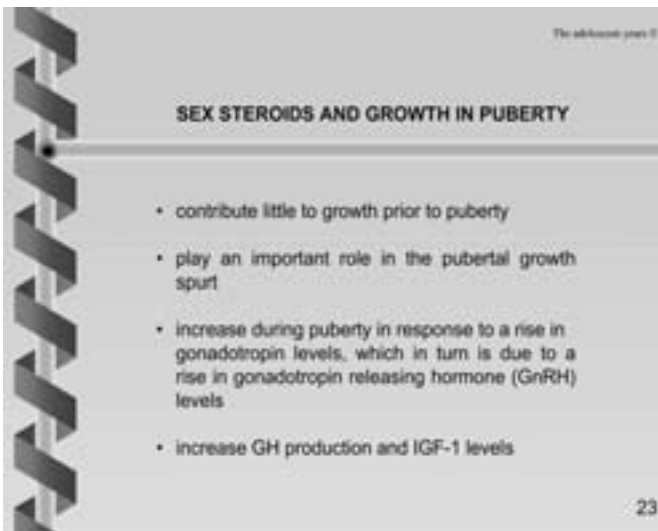
The adolescent years II

GROWTH HORMONE IN NORMAL PUBERTY

- growth hormone (GH) stimulates longitudinal growth, increases the rate of protein synthesis and promotes cellular proliferation
- the growth promoting actions of GH are mediated by the insulin-like growth factors (IGF-1), although GH also has some direct effects on metabolism
- GH secretion rates are similar in prepubertal boys and girls; the increase in GH secretion rate with the associated acceleration in growth is an early event in puberty in girls, but a later event for boys

22

- ▶ The increase in GH output during puberty is largely secondary to rising androgen and oestrogen levels



The adolescent years II

SEX STEROIDS AND GROWTH IN PUBERTY

- contribute little to growth prior to puberty
- play an important role in the pubertal growth spurt
- increase during puberty in response to a rise in gonadotropin levels, which in turn is due to a rise in gonadotropin releasing hormone (GnRH) levels
- increase GH production and IGF-1 levels

23

- ▶ Androgens alone promote growth but act synergistically with the rise in GH levels
- ▶ Ultimately rising sex steroid levels when sufficiently high stop further growth by causing the bony epiphyses to fuse to the shafts of the long bones
- ▶ Prolonged failure of puberty results in absence of the growth spurt, but low-grade growth continues and sometimes ultimate stature, achieved a lot later than normal, is tall due to failure of fusion of the epiphyses

The adolescent years II

GROWTH AT PUBERTY

- the contribution to ultimate weight and height that is achieved during puberty is enormous, but is proportionately much greater for weight than height
- boys and girls nearly double their weight over these years
- changes in weight and stature correlate with the other hormonally dependent secondary sexual characteristics of puberty

24

- ▶ Growth in stature at puberty is essentially acceleration followed by cessation
- ▶ Once epiphyses of long bones have fused to the shafts, no further growth in those bones is possible whatever the chronological age may be
- ▶ The significance of height and its velocity in puberty must be evaluated in relation to the stage of pubertal development and not to chronological age

The adolescent years II

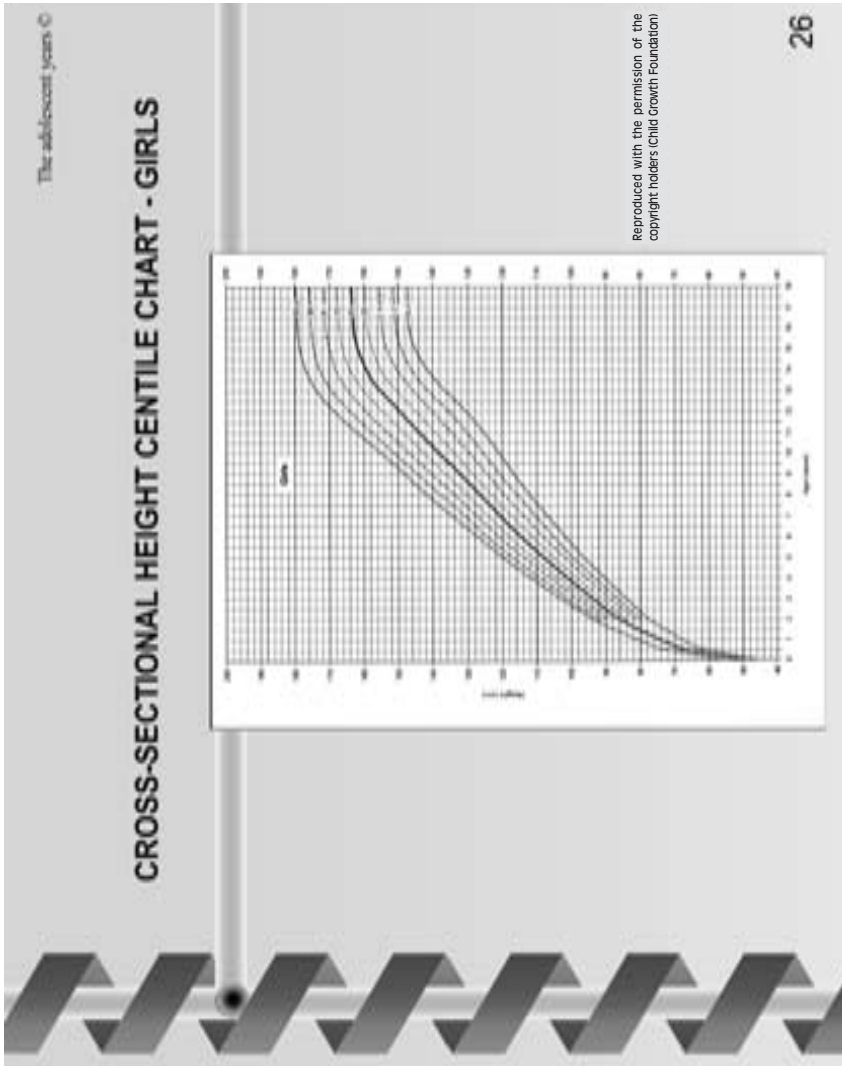
GROWTH SPURT AT PUBERTY

- sexual development in both sexes is associated with an acceleration of height (from a low prepubertal level) that reaches a peak velocity and then gradually falls to zero as adult height is reached
- in girls the growth spurt begins at the time of onset of breast development and reaches a maximum at breast stages 2 to 3
- in boys growth speeds up from the onset of puberty but continues to accelerate for longer till genital stage 4

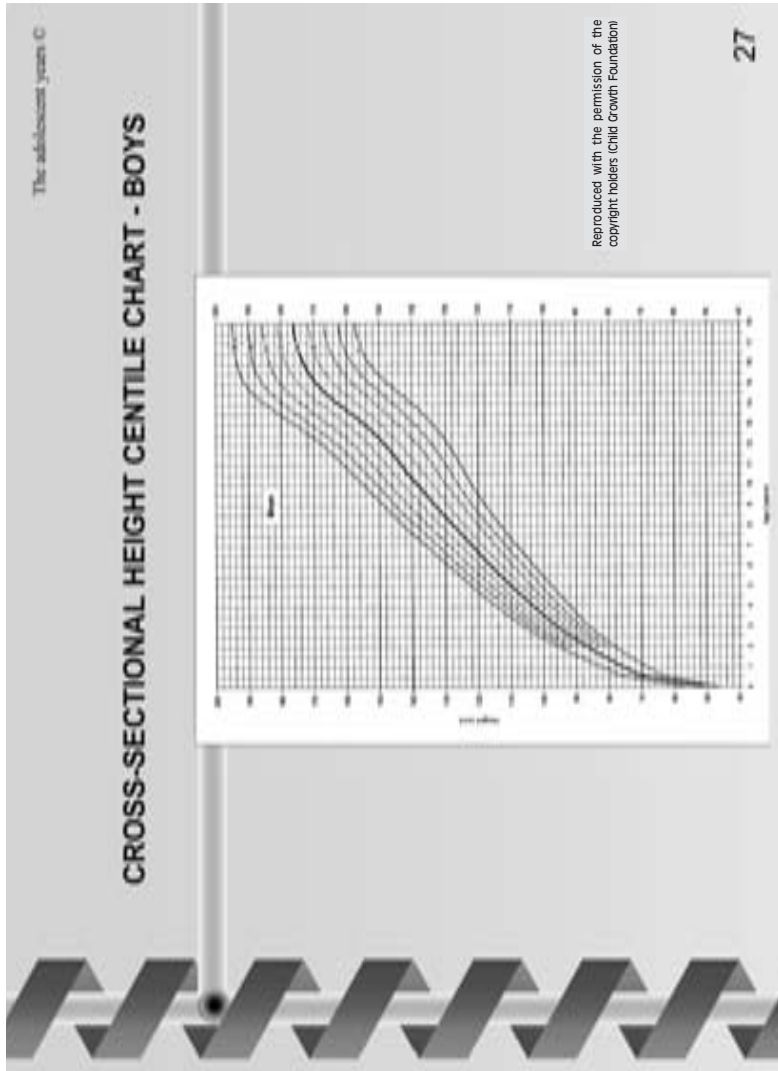
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- ▶ The magnitude of peak height velocity is greater in boys than girls and occurs on average 2 years later

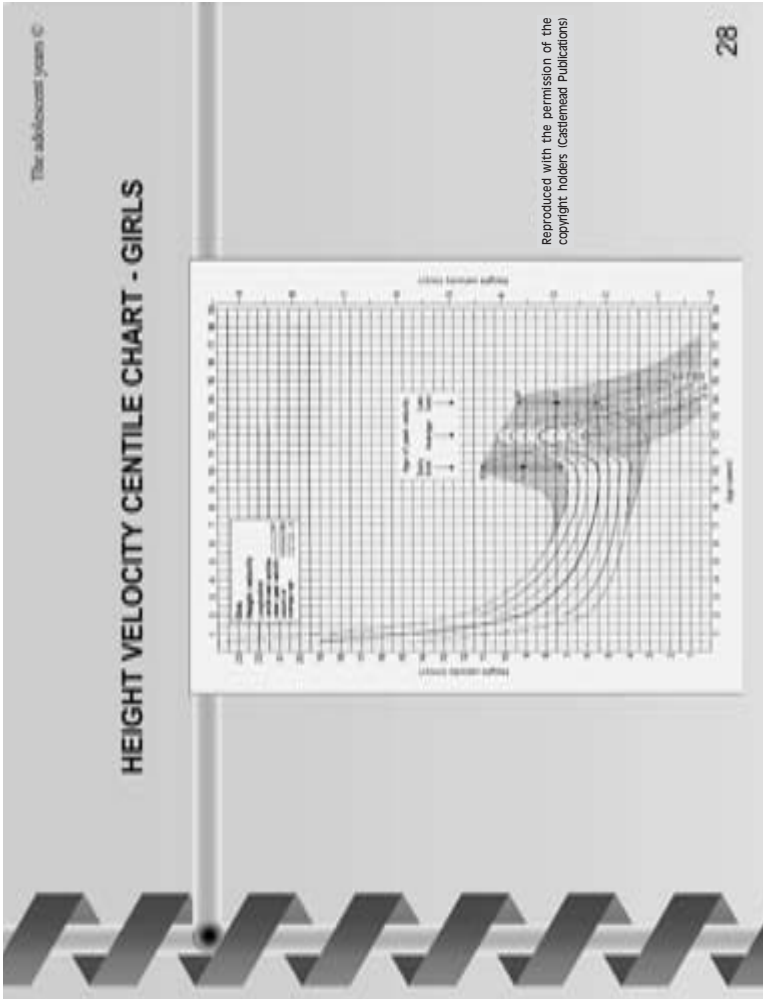
- ▶ Cross sectional growth charts are derived from single observations on large numbers of individuals
- ▶ They give a good indication of the distribution of measurements within the particular population from which they were derived
- ▶ They may not show the ongoing growth pattern of the individual



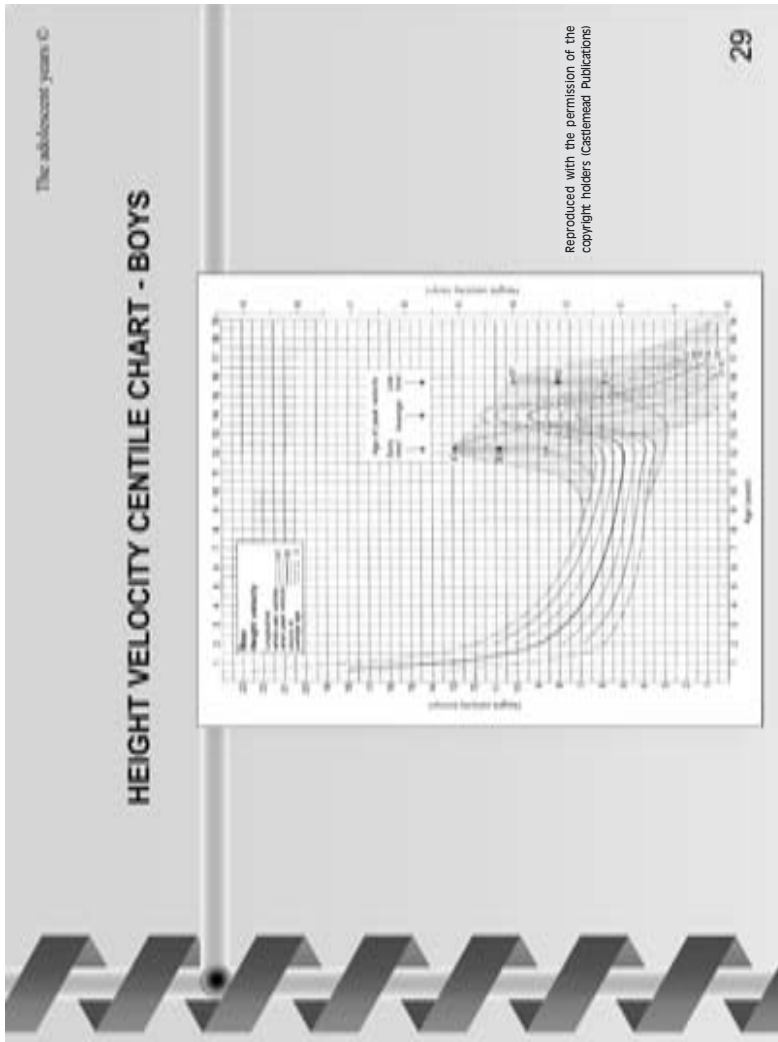
- ▶ The cross sectional charts were derived from a UK population and published in 1994
- ▶ Height measurements within a population show a Gaussian distribution (symmetrical on either side of the median, 50th centile)



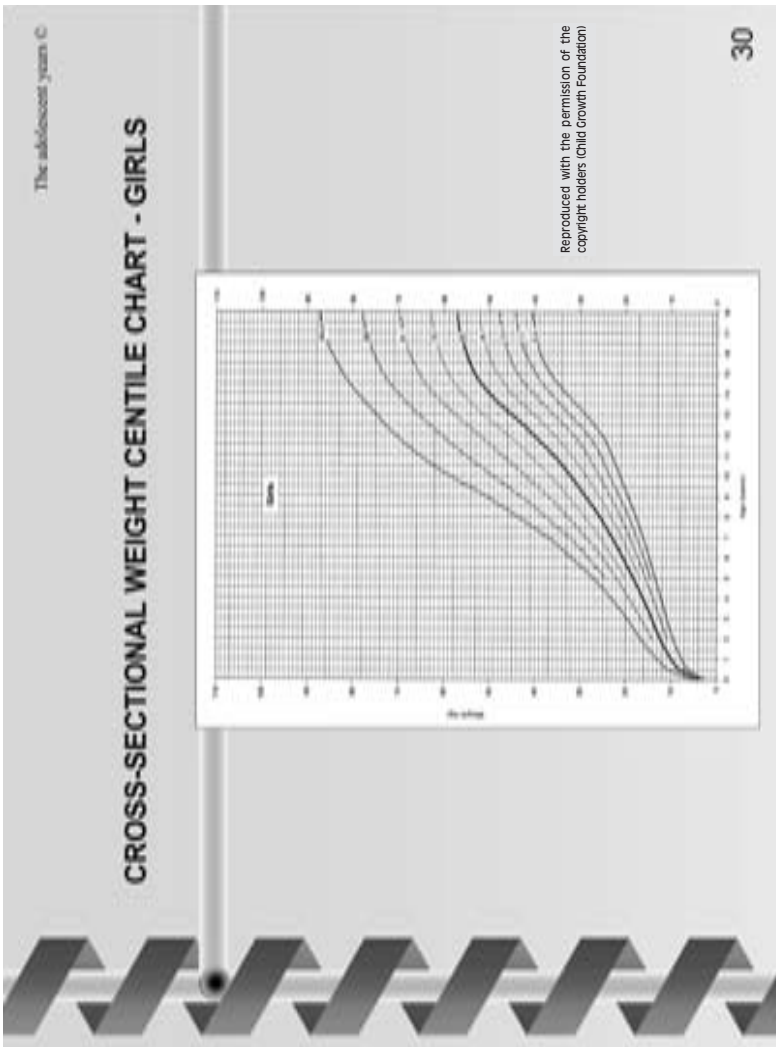
- ▶ Velocity represents the change in a measurement over time - for height, cm/year
- ▶ Height velocity is greatest in infancy, then declines rapidly for about 2 years followed by a continuous decline through early childhood
- ▶ The slowest velocity is that immediately before puberty
- ▶ In puberty growth accelerates for about 2 years before the ultimate slow down and stop
- ▶ These charts show the timing of growth of early, average-aged and late developers



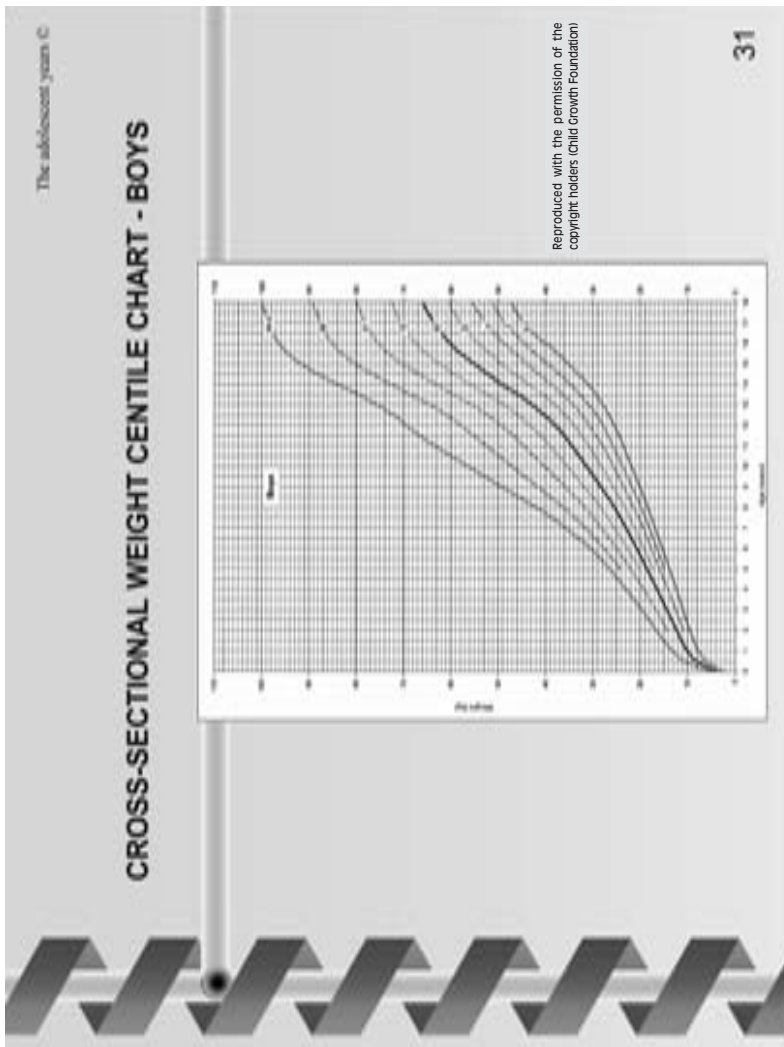
- ▶ The shape of boys and girls velocity charts is essentially similar
- ▶ Prior to puberty the measurements of velocity between the sexes are similar
- ▶ At puberty the timing of growth is different, boys being about 2 years later than girls and the magnitude of their velocity is greater
- ▶ Peak height velocity in boys and girls is almost twice the value of the minimum velocity just before puberty



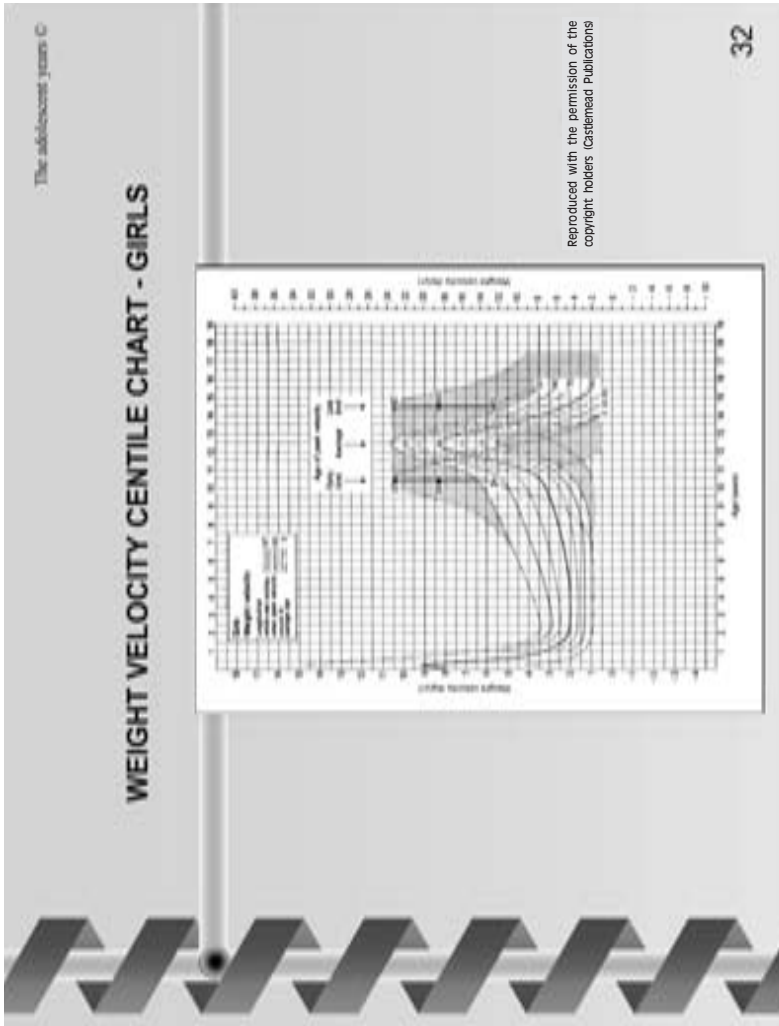
- ▶ Unlike height and other bony measurements, weight is not evenly distributed on either side of the 50th centile
- ▶ Mean weight of a population is considerably higher than the median (50th centile) value



- ▶ Unlike height where no increase is possible at the end of puberty, continuing weight gain is possible and likely in adulthood
- ▶ Weight approximately doubles over the course of puberty in boys and girls
- ▶ The proportionate increase in weight is much greater than that of height

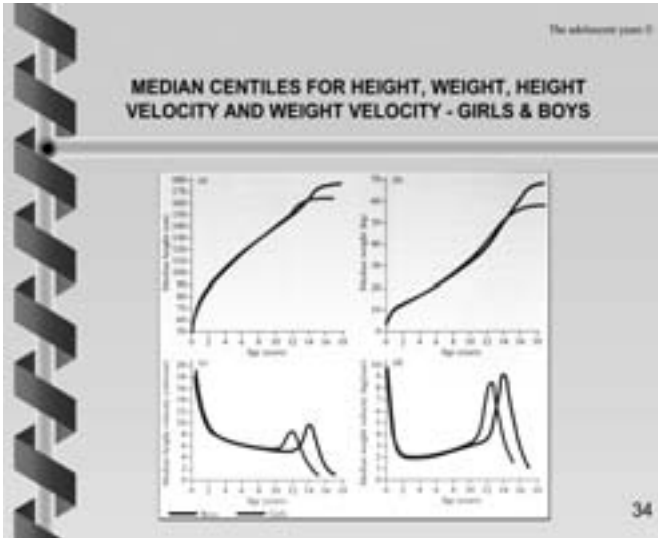


- ▶ Like height velocity, weight velocity falls rapidly over the first 2 years of life from the very high levels at birth
- ▶ Unlike height, weight velocity is at its lowest in early childhood between the ages of 2 and 4 years
- ▶ Weight velocity rises gradually through prepubertal childhood, but then increases rapidly in puberty to a peak at about the same age as peak height velocity



- ▶ Weight velocity at its peak in puberty in boys and girls approximately trebles that at its onset (which is itself greater than in early childhood)
- ▶ The relative increase in weight velocity over puberty is much greater than that of height velocity
- ▶ Unlike height velocity, a negative weight velocity can easily occur as the result of illness, reduced food intake etc, but is usually short lasting. If prolonged, investigation is indicated





- ▶ This picture showing median values illustrates several of the features referred to in previous pictures, notably clarifying the differences between the sexes
- ▶ Before puberty the measurements of height and weight of average boys and girls are almost identical and between infancy and puberty the velocities are low and change little
- ▶ Between the ages of 11 and 13 years the average girl is slightly bigger than the average boy due to the earlier growth spurt
- ▶ The average adult man is 12.5 cm taller than the average woman due to the extra 2 years baseline growth accumulated before the spurt of puberty and the greater magnitude of that spurt

BODY MASS INDEX (BMI)

- BMI is weight in kg divided by the square of the height in metres (W/H²)
- in adults the index is frequently used as an indication of fatness or thinness
- the index increases rapidly in adolescence from low levels in prepuberty to higher adult levels

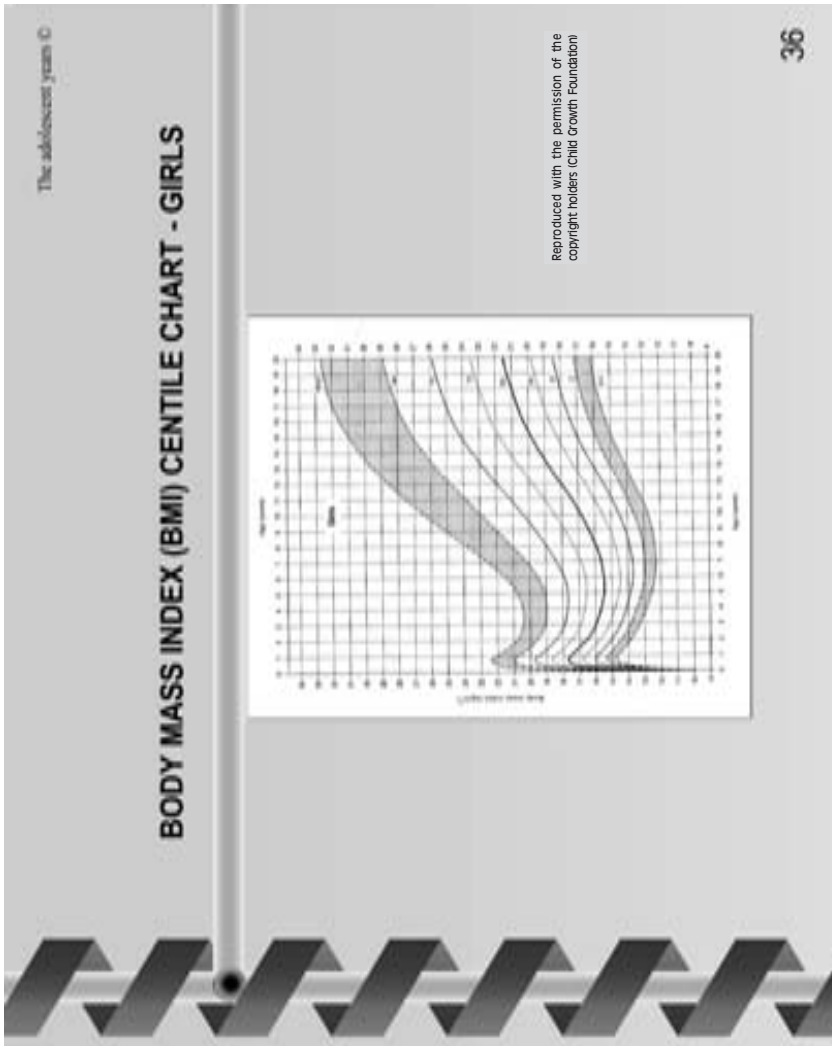
Definition of:

Overweight: BMI values higher than 85 centile for age and sex

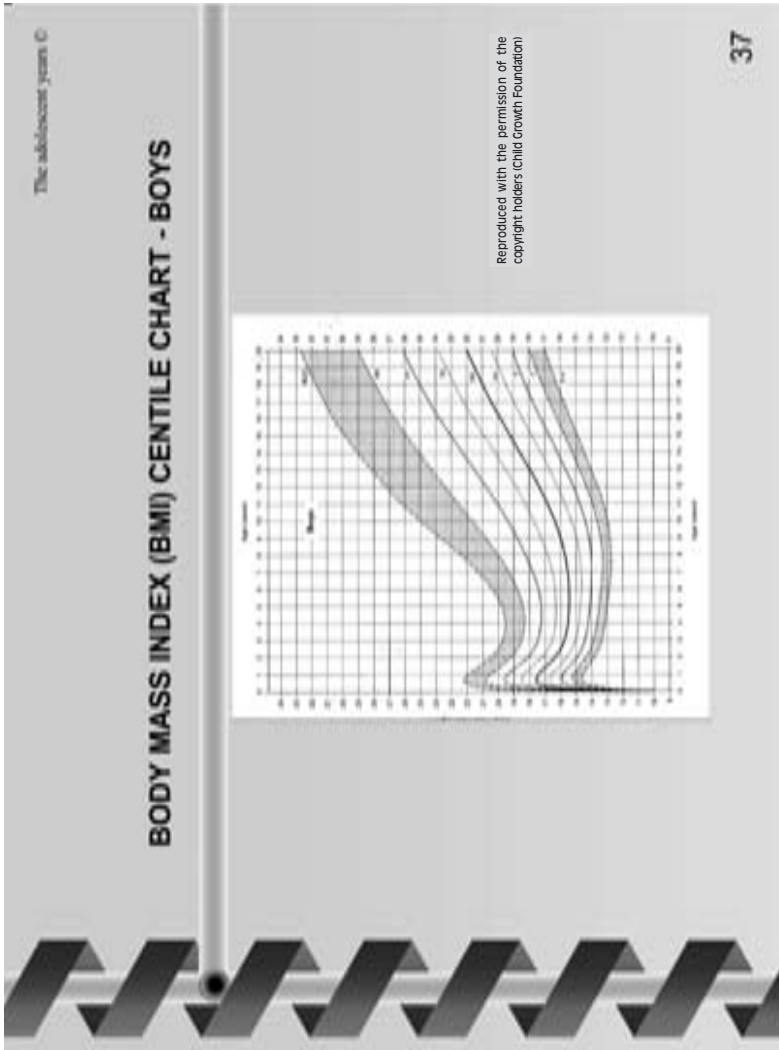
Obesity: BMI values higher than 97 centile for age and sex

- ▶ Obesity is not defined as a weight above a certain centile, but depends on the relationship of weight to the corresponding height
- ▶ In children it is difficult to use BMI as an index of fatness
- ▶ Due to the rapid increase through puberty and the wide variability in the age of puberty, BMI could only be meaningful if compared with average values not for age but for stage of pubertal development. This is impractical
- ▶ The same comments apply to any weight - height ratios through the teenage years

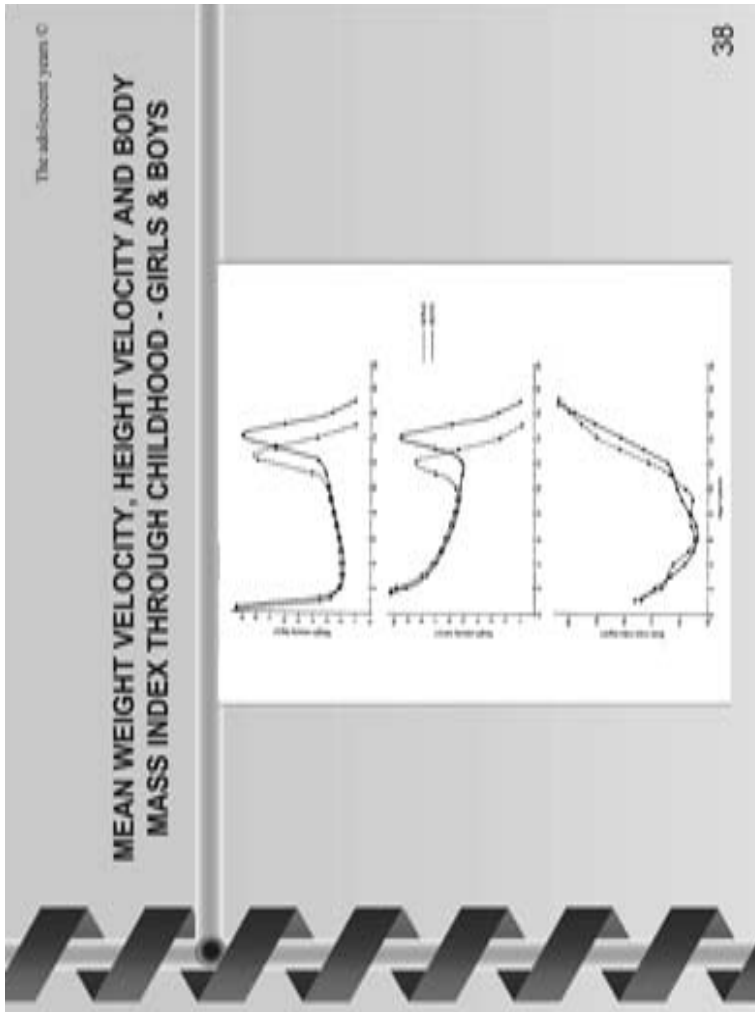
- ▶ These BMI centiles show the changes and distribution of measurements from infancy to adult
- ▶ As with weight and other non-bony measurements, the distribution is markedly skewed. The mean value corresponds approximately to the 85th centile. This is the value above which individuals are defined as overweight



- ▶ Through the years of adolescence and ultimately at maturity, the difference in BMI between the sexes does not reflect the greater degree of fatness shown by females



- ▶ The data are derived from a longitudinal study of the growth of a group of English girls and boys
- ▶ The increase in BMI over the course of puberty is due to the greater proportionate increase in weight compared to height
- ▶ This increase is not due to an increase in fatness but to lean body mass and is not therefore a reflection of developing obesity



The adolescent years 0

GENDER DIFFERENCES IN WEIGHT CHANGES

- the amount of weight gained by boys over the growing teenage years is much greater, but later, than in girls
- the weight gain in boys is predominantly "lean body mass" (mainly muscle and bone)
- in girls a much greater proportion of the weight increase is normally due to fat

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- ▶ The greater fat accrued by girls in puberty is mainly on the trunk, breasts, lower abdomen, hips and thighs
- ▶ From similar values of muscle bulk before puberty, boys on average increase this by 120% and girls by 70% through the course of puberty

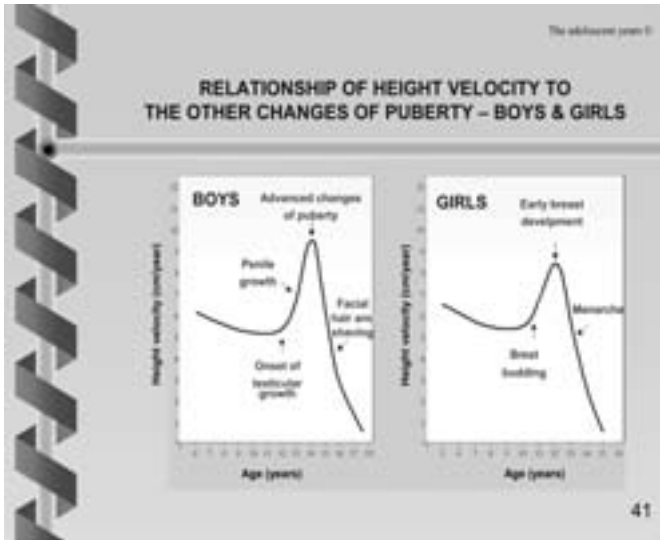
The adolescent years 0

PROPORTIONS OF FAT AND LEAN BODY MASS IN THE TOTAL BODY WEIGHT AT VARIOUS AGES THROUGH PUBERTY - BOYS & GIRLS

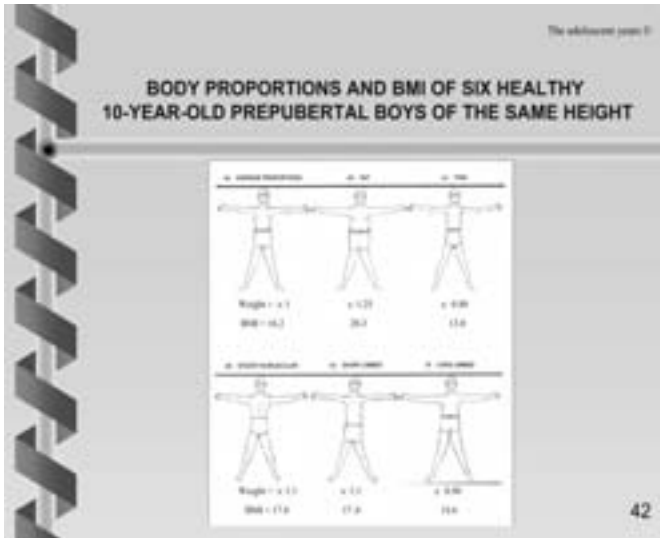
Age	Gender	Lean Body Mass (%)	Body Fat (%)
10	Boys	~82	~18
10	Girls	~74	~26
12	Boys	~80	~20
12	Girls	~70	~30
14	Boys	~78	~22
14	Girls	~65	~35
16	Boys	~75	~25
16	Girls	~60	~40
18	Boys	~82	~18
18	Girls	~70	~30

40

- ▶ The greater increase in lean body mass in boys compared with girls is due to greater stature and bone structure in addition to the greater muscle bulk
- ▶ Though before puberty weights and heights of boys and girls are similar, the body composition in terms of fat and lean body mass is different before puberty, about 26% of the body weight of girls is fat, in boys this figure is 18%
- ▶ At the completion of puberty, the proportion of body weight that is fat is about 30% for females and 18% for males



- ▶ The information on this picture is simplified and only a guideline
- ▶ The mean ages of comparable stages of puberty are approximately 2 years earlier in girls than they are in boys
- ▶ Peak height velocity is relatively early in the sequence of events in girls and relatively late in boys
- ▶ The menarche in girls and well marked facial hair in boys are late features of puberty when little further growth in stature is to be expected



- ▶ This illustration shows the many different types of body build and composition that can occur in healthy prepubertal girls and boys
- ▶ These differences are likely to be maintained through adolescence to adulthood
- ▶ The great range in BMI is entirely dependent on weight differences, but these are shown to be due to many possible causes (not just to degrees of fatness)

The adolescent years 0

AVERAGE AGES OF APPEARANCE OF FEATURES OF PUBERTY - GIRLS & BOYS

Average	Girls	Boys
age of:		
• first sign (breast or genital growth)	11 yrs	12½ yrs
• first appearance of pubic hair	11¼ yrs	13¼ yrs
• fastest growth	12 yrs	14 ¼ yrs
• menarche	13¼ yrs	

43

▶ These values are derived from a longitudinal study of cohorts of girls and boys in England

- The adolescent years 0
- ### FACTORS RELATING TO THE TIMING AND COURSE OF PUBERTY
- general health (chronic illnesses delay puberty)
 - family tendency (parents who developed early or late may expect their children to do likewise)
 - nutrition (underweight and malnutrition delay puberty; obesity usually tends to speed it up, particularly in girls; severe weight loss leads to delayed puberty or failure to progress)
 - social circumstances (their improvement favours earlier puberty)
 - stress - negative psychological events delay puberty
 - physical activity (extreme competitive sports delay puberty)
- 44

▶ In many children there is no explanation for a deviation in the timing of puberty

▶ There may be marked differences in the timing of puberty between same sex siblings or between dizygotic twins

The adolescent years II

DURATION OF PUBERTY

- there is no standard for the duration of normal puberty
- the whole process may be completed in as short a time as 2 years in some children, in others it may take over 5 years
- body hair can continue to develop for many years into adult life
- the onset of menstruation (menarche) usually precedes actual fertility by several months

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- ▶ Regression in the features of puberty or prolonged failure to progress is a cause for concern
- ▶ This may be due to severe illness, weight loss, adverse social circumstances, physical or psychological stress or excessive competitive sporting and training activities

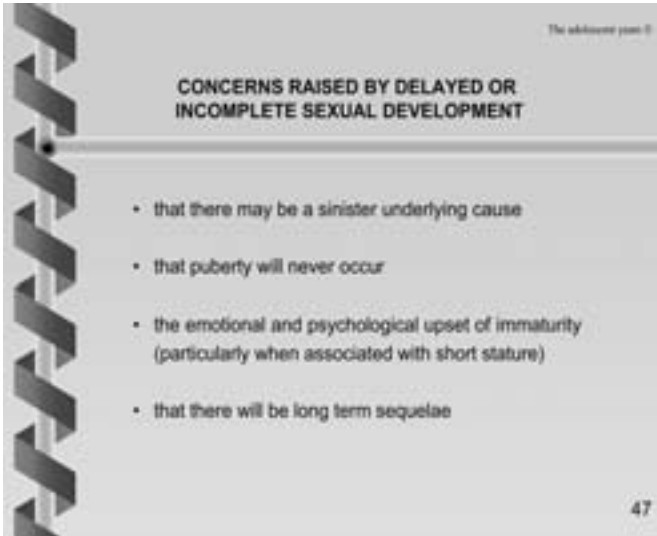
The adolescent years II

SIGNIFICANCE OF THE VARIATION IN THE PATTERN OF GROWTH IN PUBERTY

- variation in the pattern of growth in teenage years is physiological, not pathological, in the vast majority of cases
- different patterns of growth are dependent on the different timing of puberty
- where there is marked deviation in the timing of puberty, if underlying pathology can be excluded as usually it can, it is important to reassure these children and their parents

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- ▶ A family history of similar pubertal characteristics is common and this knowledge can be very reassuring



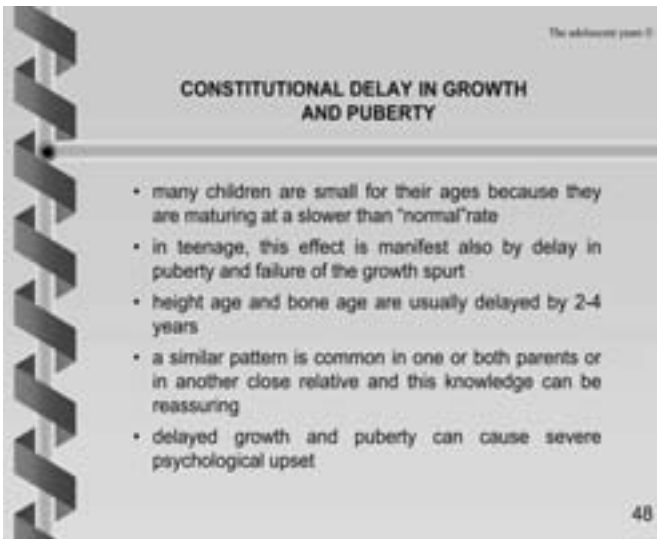
The adolescent years 0

CONCERNS RAISED BY DELAYED OR INCOMPLETE SEXUAL DEVELOPMENT

- that there may be a sinister underlying cause
- that puberty will never occur
- the emotional and psychological upset of immaturity (particularly when associated with short stature)
- that there will be long term sequelae

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- ▶ The concern may be expressed by many other individuals (such as relatives, teachers, members of the medical profession or friends), in addition to the child and the parents
- ▶ This is a much commoner problem with boys than girls
- ▶ Excessive anxiety caused by these fears may create a level of stress which in itself can contribute to the delay. This is particularly saw in relation to the marked fall off in stature
- ▶ An explanation of the range of normality within puberty is very reassuring
- ▶ Long term sequelae are extremely rare



The adolescent years 0

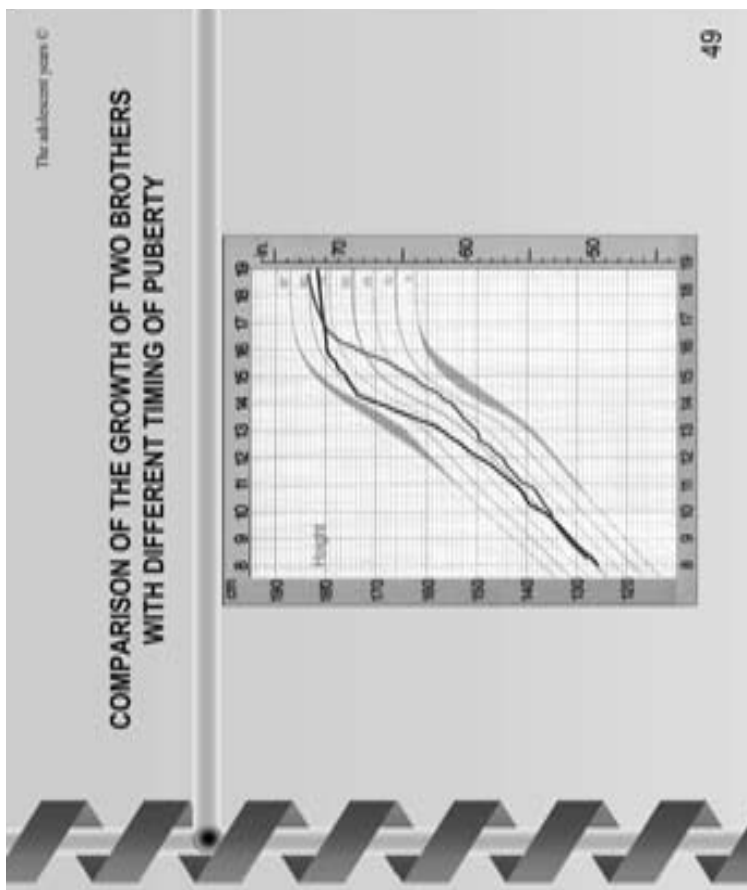
CONSTITUTIONAL DELAY IN GROWTH AND PUBERTY

- many children are small for their ages because they are maturing at a slower than "normal" rate
- in teenage, this effect is manifest also by delay in puberty and failure of the growth spurt
- height age and bone age are usually delayed by 2-4 years
- a similar pattern is common in one or both parents or in another close relative and this knowledge can be reassuring
- delayed growth and puberty can cause severe psychological upset

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- ▶ Though commoner in boys this problem can occur in both sexes
- ▶ Concern can be due to failure of virilisation or feminisation or by growth retardation or by both
- ▶ The delay in growth and sexual development may result in teasing, bullying, etc and great emotional and psychological stresses
- ▶ There is greater pressure for men to be tall and more small boys are referred for growth evaluation than are small girls

- ▶ This chart shows the deviation upwards from the centile of the early developer and the deviation downwards of the late developer
- ▶ In contrast to the pattern of normal growth before puberty, most individuals deviate from the centile line at puberty, usually returning to the original line when pubertal growth is completed
- ▶ From a similar 50th centile position before puberty, there is a 13 cm difference in stature at the age of 14 years, yet ultimately the late developer ends up the taller
- ▶ If the cause for this discrepancy is not recognised as being due to the difference in timing of puberty, much unnecessary concern would result
- ▶ In this particular example the heights of both brothers ended up at considerably higher centile positions than their initial ones – which is unusual



The adolescent years 2

MANAGEMENT OF DELAYED GROWTH AND PUBERTY

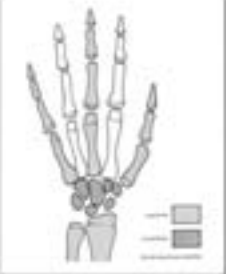
- if pathology can confidently be excluded, counseling, particularly to explain that normal pubertal development will occur spontaneously in due time, usually gives sufficient reassurance
- sometimes when psychological stress is severe, short-term treatment with low dose steroids to trigger the onset of puberty is justified and beneficial

50

- ▶ Underlying pathology is very rare
- ▶ In boys with delayed puberty, examination frequently shows (when looked for) that testes are already enlarging. This is convincing evidence that puberty is imminent
- ▶ Short term, low dose treatment with steroids has no adverse effect on ultimate stature or any other aspect of development

The adolescent years 2

BONE AGE (SKELETAL AGE)



Bone ages are of value:

- (a) in the diagnosis of short stature conditions
- (b) in the diagnosis of tall stature conditions
- (c) in predicting growth potential and adult height
- (d) in monitoring progress

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- ▶ Bone age estimates give an indication of physiological age and its relation to actual age
- ▶ The Tanner-Whitehouse method is commonly used. This is illustrated in the picture, which shows the 20 bones of the wrist and hand examined
- ▶ The Greulich-Pyle method is simpler and quicker, but less accurate. This involves comparison between the x-ray of the hand of the child and a series of pictures corresponding to different bone ages

The adolescent years II

DELAYED PUBERTY IN CHRONIC DIETING

- adolescence is characterised by a preoccupation with physical appearance and peer acceptance
- in many Western cultures there is a glorification of thinness and a stigma associated with obesity
- the obsession with thinness can lead to weight loss in adolescents, and delayed puberty may occur (girls are at greater risk)
- some chronic dieters do have the clinical characteristics of anorexia nervosa

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- ▶ Loss of weight or severe underweight is one of the commonest causes of avoidable delay in puberty or failure to progress in puberty

The adolescent years II

PATHOLOGICAL CAUSES OF DELAYED PUBERTY

Impaired hypothalamic or pituitary function:

- delayed or impaired GnRH and/or gonadotropin secretion

These are associated with low blood gonadotrophin levels

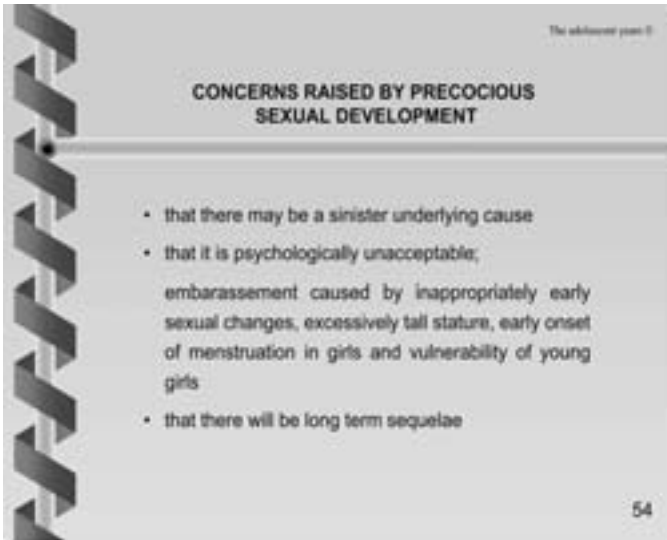
Impaired gonadal function:

- gonadal dysgenesis
- primary ovarian failure
- primary testicular failure

These are associated with high blood gonadotrophin levels

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- ▶ These conditions are rare
- ▶ There are frequently other associated clinical abnormalities



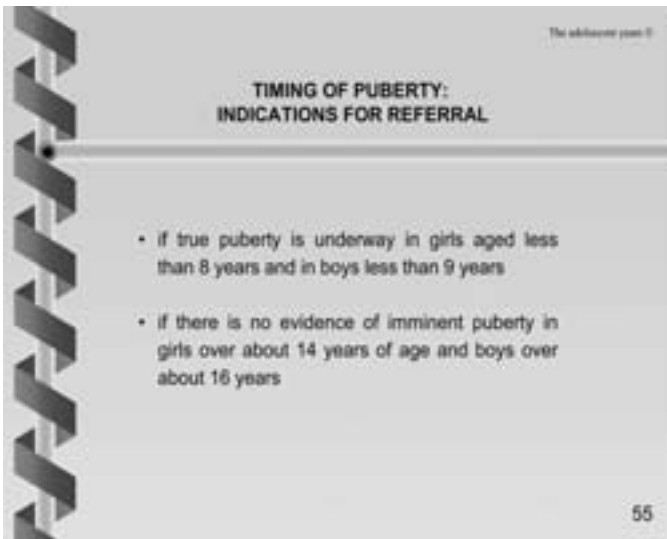
The adolescent years II

CONCERNS RAISED BY PRECOCIOUS SEXUAL DEVELOPMENT

- that there may be a sinister underlying cause
- that it is psychologically unacceptable; embarrassment caused by inappropriately early sexual changes, excessively tall stature, early onset of menstruation in girls and vulnerability of young girls
- that there will be long term sequelae

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- ▶ Patients and parents may have many concerns
- ▶ The condition is much commoner in girls than boys but more frequently benign
- ▶ The concerns may be justified or they may be unnecessary but they should always be taken seriously
- ▶ Explanation is important and also reassurance but only when it can be justified
- ▶ A family pattern contributes to grounds for reassurance



The adolescent years II

TIMING OF PUBERTY: INDICATIONS FOR REFERRAL

- if true puberty is underway in girls aged less than 8 years and in boys less than 9 years
- if there is no evidence of imminent puberty in girls over about 14 years of age and boys over about 16 years

55

- ▶ These suggested ages are arbitrary and should only act as guidelines
- ▶ A family history allows greater latitude
- ▶ Isolated features of sexual development without indicating true puberty may act as grounds for investigation in their own right
- ▶ Features dependent on adrenal androgen production may occur in the absence (or may precede) those indicating the gonadal activity of true puberty

The adolescent years II

FEATURES SUGGESTING THAT SEXUAL DEVELOPMENT IS TRUE PUBERTY

Features which suggest that true puberty is under way are:

- growth of the gonads (an observation that without investigation is only possible in boys)
- acceleration of growth in stature and weight (with advancement of bone age)
- secondary sexual characteristics

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- ▶ Growth of the testes is a fundamental observation necessary for the diagnosis of true puberty in boys
- ▶ Bone age accelerates in parallel with the acceleration of growth in puberty
- ▶ In girls a diagnosis of true puberty requires evidence of estrogen activity
- ▶ Androgenic features (including acceleration of growth) may result from adrenal activity alone

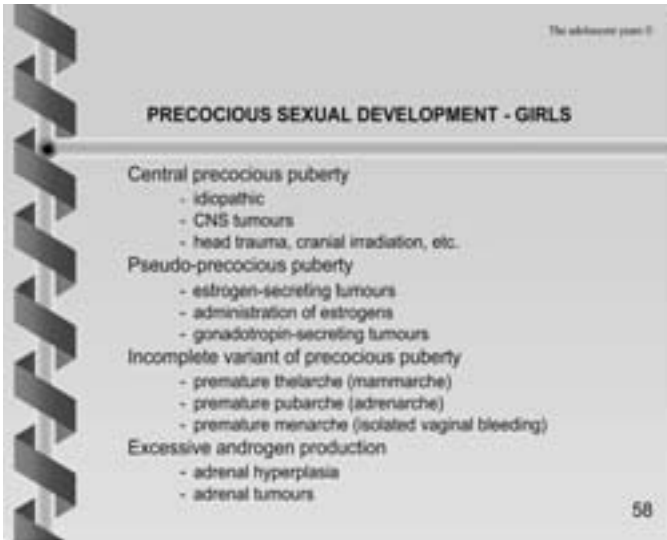
The adolescent years II

TRUE CENTRAL PRECOCIOUS PUBERTY

- this is more frequent in girls than in boys
- the majority of cases in girls are idiopathic
- the condition in boys is rare and in many is the result of underlying pathology - usually intracranial
- the acceleration of growth may, at the time, result in conspicuous tallness compared with peers (but subsequent premature cessation of growth may well result in short stature ultimately)

57

- ▶ Central precocious puberty has the features of normal puberty, but at an early age
- ▶ The sequence of hormonal production is the same as normal puberty (GnRH ? gonadotrophins ? gonadal production of sex hormones)
- ▶ There is commonly a similar history in a parent
- ▶ The psychological and social implications are considerable, including those related to growth
- ▶ Unexplained central precocious puberty in boys always warrants full investigation



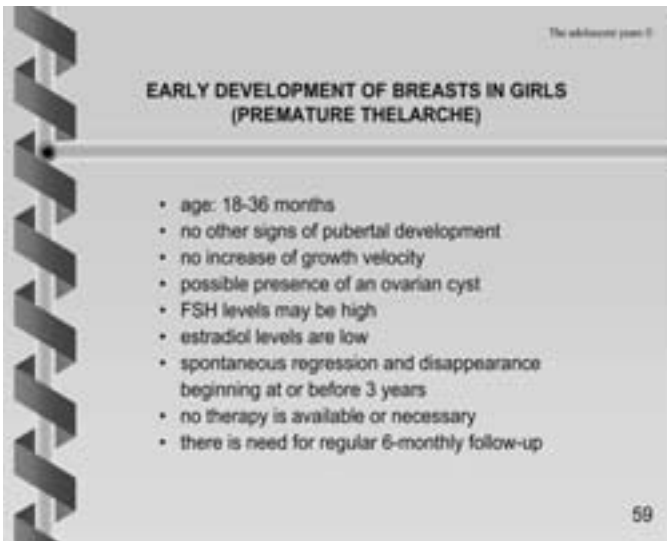
The adolescent years II

PRECOCIOUS SEXUAL DEVELOPMENT - GIRLS

- Central precocious puberty
 - idiopathic
 - CNS tumours
 - head trauma, cranial irradiation, etc.
- Pseudo-precocious puberty
 - estrogen-secreting tumours
 - administration of estrogens
 - gonadotropin-secreting tumours
- Incomplete variant of precocious puberty
 - premature thelarche (mammarche)
 - premature pubarche (adrenarche)
 - premature menarche (isolated vaginal bleeding)
- Excessive androgen production
 - adrenal hyperplasia
 - adrenal tumours

58

- ▶ It is important in diagnosis to recognise which cases are central precocious puberty
- ▶ Most of the cases of precocious sexual development in girls are benign and frequently familial



The adolescent years II

EARLY DEVELOPMENT OF BREASTS IN GIRLS (PREMATURE THELARCHE)

- age: 18-36 months
- no other signs of pubertal development
- no increase of growth velocity
- possible presence of an ovarian cyst
- FSH levels may be high
- estradiol levels are low
- spontaneous regression and disappearance beginning at or before 3 years
- no therapy is available or necessary
- there is need for regular 6-monthly follow-up

59

- ▶ This is a common and benign condition
- ▶ Breasts can transiently be well developed
- ▶ The explanation is obscure

The adolescent years II

EARLY DEVELOPMENT OF PUBIC & AXILLARY HAIR (PREMATURE ADRENARCHE)

- age: before 7 years in girls and 8 years in boys
- no breast development in girls
- no increase in testicular size in boys
- possible slight increase in growth velocity
- possible slight increase in bone age
- adrenal androgens slightly elevated
- it is important to rule out late presenting congenital virilizing adrenal hyperplasia (CAH)

60

- ▶ The features may regress spontaneously, but more commonly persist until puberty occurs
- ▶ The diagnostic exclusion of late presenting CAH is important but usually simple
- ▶ CAH is associated with higher androgen levels, increased height velocity and rapidly advancing bone age

The adolescent years II

BREAST PROBLEMS - GIRLS

- difference in size of the 2 breasts
- breasts that seem too small or too big
- unusual shape of the breasts
- "milk" from the breasts

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- ▶ One breast commonly appears before the other and asymmetry of the developing breasts occurs in about 10% pubertal girls and may persist through puberty, but is seldom evident in fully developed breasts
- ▶ The size of fully developed breasts is seldom indicative of potential milk production
- ▶ Small breasts may be due to weight reduction
- ▶ Discharge from the nipple is usually associated with pregnancy and warrants investigation.
- ▶ These problems mostly resolve by maturity

The adolescent years II

PROBLEMS OF MENSTRUATION

- delay in onset
- early menstrual cycles
- infrequent menstrual cycles
- painful periods

62

- ▶ Delay in menstruation is most commonly to be expected as part of overall delay in puberty (see 48-51) and does not need investigation in its own right
- ▶ Early menstrual cycles are irregular (and are anovulatory) with variation in frequency, duration and heaviness
- ▶ A regular menstrual pattern is established within 2 years of onset in most girls but delay can be longer
- ▶ After the cycle is well established, but not before, missed periods are most commonly accounted for by pregnancy but may be due to excessive weight loss or stress
- ▶ Menstrual pain is associated with ovulation and is common, and if severe and with other symptoms needs medical help

The adolescent years II

PRIMARY AMENORRHEA

- this is defined as the lack of spontaneous bleeding by the age of 16 years when growth and other features of pubertal development are otherwise normal
- it is not a clinical entity in itself. It represents a symptom, not a disease
- it is important to rule out anatomical defects in the genital tract before considering endocrinopathies or genetic disorders

63

- ▶ The menarche most commonly occurs about 2½ years after the onset of puberty and 1½ years after the age of peak height velocity, whatever the age, but these times can be longer
- ▶ Delay in onset may occur in individuals who are severely underweight, overweight or undergoing intensive physical training

The adolescent years II

PRECOCIOUS SEXUAL DEVELOPMENT - BOYS

- True central precocious puberty
 - idiopathic (sporadic, familial)
 - due to CNS disorders
- Gonadotropin and HCG secreting tumours
- Adrenal overactivity
 - late presenting congenital adrenal hyperplasia (CAH)
 - virilizing adrenal tumours
- Untreated hypothyroidism

64

- ▶ This is rare in boys, seldom idiopathic unless familial, and usually needs investigation
- ▶ As previously indicated (21 and 56), observation of testicular size is crucial in diagnosis

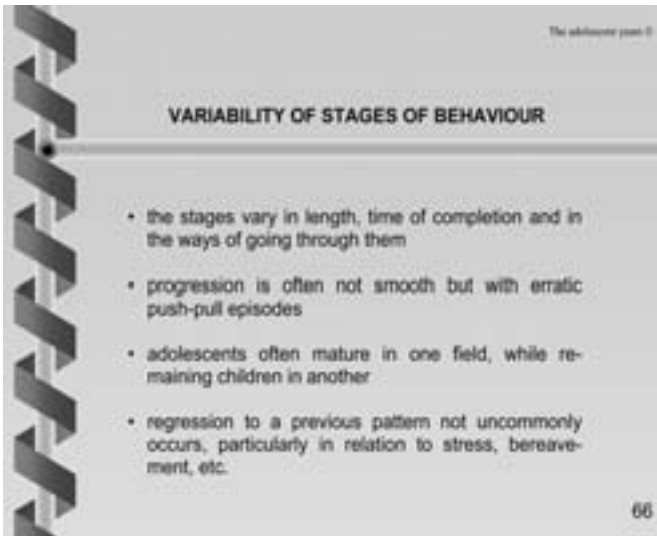
The adolescent years II

THE GOALS TO BE ACHIEVED IN ADOLESCENCE

- formation of a positive stable personality
- establishing independence from adults (notably parents)
- acquiring skills for future economic independence
- developing relationships with others outside the family
- learning to function properly in the appropriate sexual role

65

- ▶ As children grow up, they need love, discipline and independence, but love should remain constant, discipline get less and independence increase
- ▶ It is important to establish self-esteem
- ▶ The teenager seeks for independence and yet cannot avoid still being dependent
- ▶ Peer relationships, with pressures to conform, become strong during adolescence and replace, to varying degree, those of the family



The adolescent years II

VARIABILITY OF STAGES OF BEHAVIOUR

- the stages vary in length, time of completion and in the ways of going through them
- progression is often not smooth but with erratic push-pull episodes
- adolescents often mature in one field, while remaining children in another
- regression to a previous pattern not uncommonly occurs, particularly in relation to stress, bereavement, etc.

66

- ▶ There is no optimal, standard pattern of adolescent behavioural development
- ▶ Psychological and emotional development parallels physical development and is linked with 'physical' age not chronological age



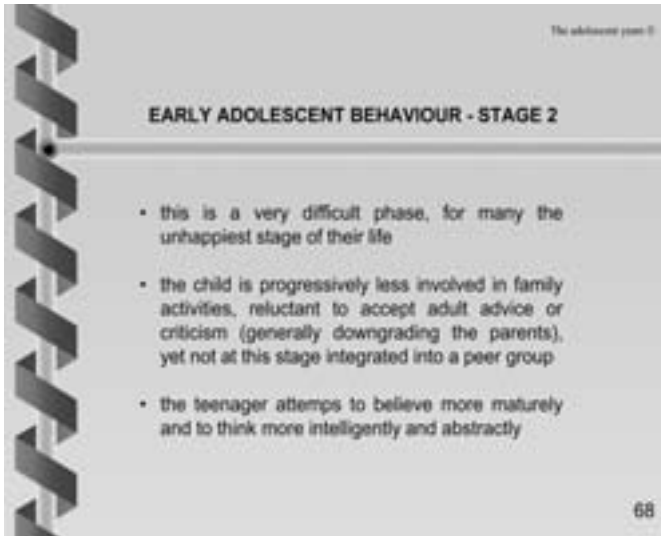
The adolescent years II

PREADOLESCENT BEHAVIOUR - STAGE 1

- this is the early stage before obvious features of puberty or sexuality are apparent
- boys tend to be physically very active but to fall back in behaviour, to be afraid of girls, being awkward or actively hostile to them
- girls begin to show an apparent interest in boys. They do not show the regression of boys

67

- ▶ To many parents these changes in behaviour are an indication that puberty is imminent



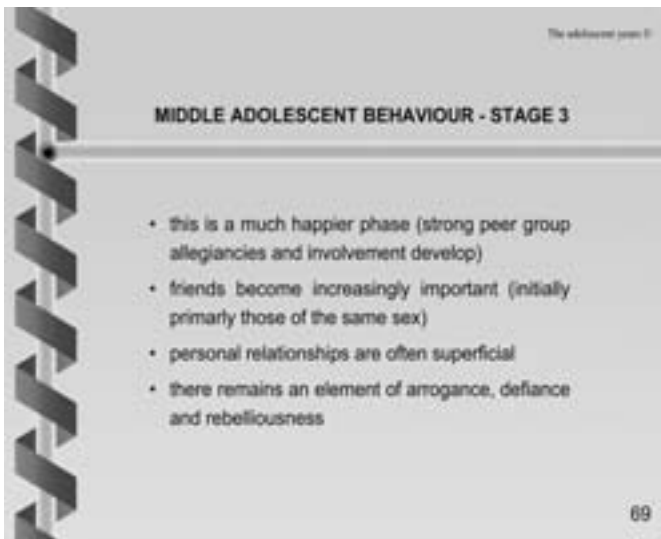
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EARLY ADOLESCENT BEHAVIOUR - STAGE 2

- this is a very difficult phase, for many the unhappiest stage of their life
- the child is progressively less involved in family activities, reluctant to accept adult advice or criticism (generally downgrading the parents), yet not at this stage integrated into a peer group
- the teenager attempts to believe more maturely and to think more intelligently and abstractly

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- ▶ This stage is the beginning of the struggle between dependence and independence
- ▶ As a 'normal' phase the parents should theoretically welcome it but the negative, confrontational, self-centred attitude is not easy to accept in practice



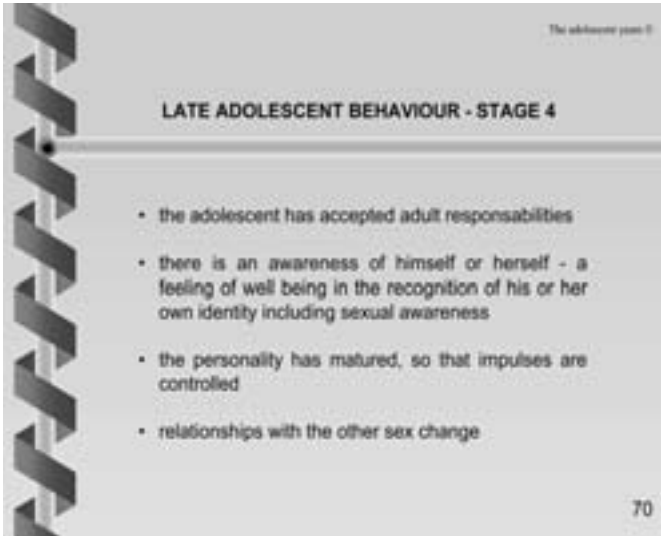
The adolescent years II

MIDDLE ADOLESCENT BEHAVIOUR - STAGE 3

- this is a much happier phase (strong peer group allegiances and involvement develop)
- friends become increasingly important (initially primarily those of the same sex)
- personal relationships are often superficial
- there remains an element of arrogance, defiance and rebelliousness

69

- ▶ Peer group attitudes and customs lead to a desire to conform and be accepted



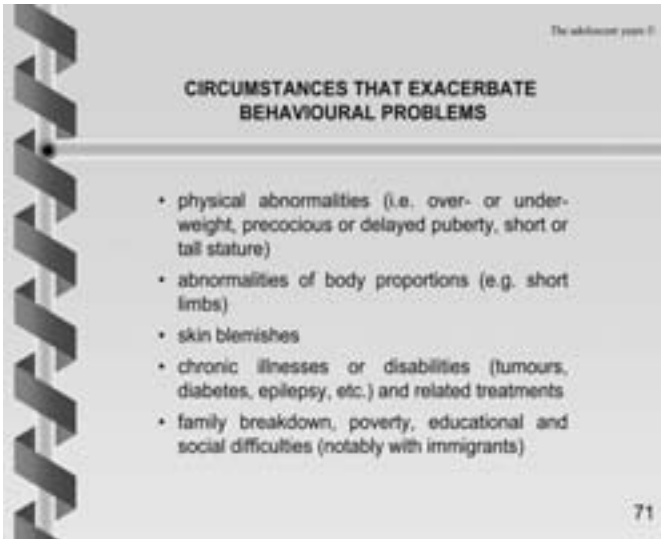
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LATE ADOLESCENT BEHAVIOUR - STAGE 4

- the adolescent has accepted adult responsibilities
- there is an awareness of himself or herself - a feeling of well being in the recognition of his or her own identity including sexual awareness
- the personality has matured, so that impulses are controlled
- relationships with the other sex change

70

- ▶ The individual becomes confident with a commitment to work
- ▶ This ideal outcome is not invariable and depends greatly on the attitude and influence of family and peer group




The adolescent years II

CIRCUMSTANCES THAT EXACERBATE BEHAVIOURAL PROBLEMS

- physical abnormalities (i.e. over- or under-weight, precocious or delayed puberty, short or tall stature)
- abnormalities of body proportions (e.g. short limbs)
- skin blemishes
- chronic illnesses or disabilities (tumours, diabetes, epilepsy, etc.) and related treatments
- family breakdown, poverty, educational and social difficulties (notably with immigrants)

71

- ▶ These circumstances represent anything that makes the individual stand out in a negative way
- ▶ The individual wants to appear and be accepted as 'normal' and may exaggerate in his or her mind the significance of these adverse factors



The adolescent years II

FOOD REQUIREMENTS IN ADOLESCENCE

- food requirements increase enormously during the teenage years particularly in boys
- actual energy needs vary greatly with activity
- appetite alone may not ensure that food is qualitatively appropriate

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► Weight should be increasing but appropriately in terms of the relative contributions of lean body mass and fat



The adolescent years II

INAPPROPRIATE FOOD CONSUMPTION

- skipping meals
- eating snacks between meals
- having increased numbers of meals away from home
- junk foods

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► Food is frequently consumed fast, alone, while doing something else, not as a social event

The adolescent years II

ASSESSMENT OF NUTRITIONAL STATUS

- physical examination
- body measurements (i.e. weight, height, weight for height, weight velocity, height velocity, skinfold measurements for fatness)
- laboratory investigations of body composition and energy expenditure when indicated

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- ▶ Simple serial physical observations are usually sufficient
- ▶ These should be correctly interpreted recognising what should be expected in terms of height and weight gain at that particular stage of pubertal growth
- ▶ In the recognition of underweight or overweight the weight must be related to height by comparing the centile positions

The adolescent years II

OBESITY – EXOGENOUS AND ENDOGENOUS

	Cause	Stature	Physiological age (BA and puberty)	Incidence	Family history
Exogenous	non-pathological (food intake excessive for amount of energy used)	tall	advanced	common	common
Endogenous	underlying pathology	short	retarded	rare	rare

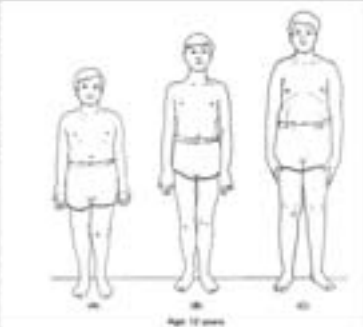
BA, bone age

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- ▶ Endogenous obesity is that caused by an underlying pathology
- ▶ Exogenous obesity is much the commoner type (over 90% cases), without pathology
- ▶ The clue to the cause (type) of obesity in the growing child is shown by the height
- ▶ Overweight speeds up overall physical development except when it is caused by or associated with an underlying pathology
- ▶ Exogenously obese children end up with appropriate stature as adults – not inappropriately tall as they stop growing early
- ▶ As exogenous obesity is so common in the overall population, it may therefore occur in association with pathological conditions in which it is not a regular feature

The adolescent years II

THE RELATIONSHIP OF HEIGHT TO WEIGHT IN DIFFERENT TYPES OF OBESITY



A: endogenous obesity
B: lean normal
C: exogenous obesity

Age: 12 years

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- ▶ The picture illustrates the extreme difference in stature of these 3 boys all aged 12 years
- ▶ The tallness of the physiologically obese boy may be even more marked if he has gone into puberty early and is experiencing some of his growth spurt

The adolescent years II

FACTORS RELATED TO THE DEVELOPMENT OF EXOGENOUS OBESITY

Obesity is the result of an interaction between genetic, environmental and psychological factors and, as such, has a complex aetiology

- high caloric intake in combination with low physical activity
- psychosocial factors (eating disorders, affective disorders, socio-economic background, ethnic factors)
- genetic factors
- altered function of adipose tissue
- decreased energy expenditure

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- ▶ Exogenous obesity is essentially due to an imbalance between calories taken (food) and calories used in energy production and in growth (in children)
- ▶ Exogenous obesity commonly runs in families, but as well as having a genetic basis, this depends on the common environment and attitude to food, feeding habits and activity

The adolescent years II

THE GROWTH OF TWO HEALTHY GIRLS, ONE LEAN AND ONE OBESE THROUGH THE TEENAGE YEARS



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- ▶ Children with exogenous obesity are physically advanced (as shown by bone age) and girls often pass through puberty earlier than their thinner counterparts. This is not so common in boys
- ▶ Although physiologically obese children are taller throughout childhood and adolescence, they do not end up excessively tall or taller than comparable thin children do. They have similar overall increase in stature, but it is achieved earlier

The adolescent years II

ADVICE FOR THE OBESE ADOLESCENT AND THE FAMILY

- avoid rigid dieting
- physical activity
- avoid family conflicts and stress
- explain the problem
- encouragement and increasing self esteem

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- ▶ Involvement of the family is important. The children hate to be treated differently from those around
- ▶ If physical activity can be fun, enjoyed and regular, so much the better. Obese adolescents frequently suffer from boredom
- ▶ If possible aim to reduce the sedentary life style (e.g. less time with TV, computer etc, travel by foot or bicycle rather than in vehicles, etc.)

The adolescent years ①

IMPLICATIONS OF UNDERNUTRITION

- primary disturbances of nutrition retard weight gain more than linear growth
- linear growth is retarded by undernutrition when that is sufficient to cause a deficit of weight more than about 8%
- depending on the duration of undernutrition and the degree of its reversal, children either catch-up in height or continue to follow a delayed growth pattern

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- ▶ Weight falls off first as a consequence of undernutrition and height then follows
- ▶ A growth disturbance where weight is affected to a greater degree than height (as suggested by the centile positions) suggests it is due to undernutrition
- ▶ This may be due to inadequate food taken in and retained or to a defect in digestion and absorption
- ▶ Undernutrition is frequently associated with emotional and psychological upset whether as a cause or consequence, which exacerbates these problems

The adolescent years ①

ANOREXIA NERVOSA

- this is seen most commonly in young white women under the age of 25 years (it is particularly common in adolescence). It can occur in boys, but rarely
- it presents as a classic triad: amenorrhea, weight loss, behavioural changes
- it is an insidious condition with progressive reduction in food intake or failure to retain food because of self-induced vomiting

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- ▶ Most adolescents who appear thin are healthy and normal
- ▶ Anorexia nervosa involves a severe progressive weight loss and is associated with underlying psychological disturbance
- ▶ The implications are serious as this is a potentially fatal condition, and the condition demands urgent medical and psychological help (involving also the family)

The adolescent years II

ANOREXIA NERVOSA - DIAGNOSTIC CRITERIA

- refusal to maintain body weight over a minimal normal weight for age and height
- intense fear of gaining weight or becoming fat despite being underweight
- disturbance in the way, in which the subject interprets her own body weight, size or shape
- in females, there is absence of at least 3 consecutive menstrual cycles when otherwise expected to occur (assuming not pregnant)

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- ▶ If puberty is underway, its progress is halted and features usually regress. Sexual hair is often replaced by fine downy hair
- ▶ If a girl has passed the menarche, menstrual cycles always stop, and do not resume until a critical weight (for that individual) is regained
- ▶ Despite appalling weight loss these individuals maintain that they are healthy and that nothing is wrong and often lead an active life until the condition is well advanced

The adolescent years II

ANOREXIA NERVOSA - CAUSES

- sometimes it appears to be dependent on an initial unacceptable "body image", the subjects considering themselves too fat
- sometimes the condition seems to be a reaction, usually subconscious, to stress within the home and family
- sometimes it seems an attempt to delay and perhaps to avoid the process of adolescence and growing up with all its unacceptable implications

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- ▶ The psychological background is very complex and many theories have been put forward to account for it

The slide features a vertical decorative graphic on the left side consisting of a series of overlapping, slanted rectangular blocks. The main content is centered on a light gray background. At the top right, there is a small text element: 'The adolescent years II'. The title 'ANOREXIA NERVOSA - AT RISK GROUPS' is displayed in a bold, black, sans-serif font. Below the title, a list of three bullet points is presented. The first bullet point reads: '• adolescents who undertake chronic dieting to achieve a thin body image'. The second bullet point reads: '• adolescents with excessive weight concern'. The third bullet point reads: '• ballet dancers, models, gymnasts, endurance runners, figure skaters, people in sports or professions in which low body weight is valued'. In the bottom right corner of the slide, the number '84' is displayed.

The adolescent years II

ANOREXIA NERVOSA - AT RISK GROUPS

- adolescents who undertake chronic dieting to achieve a thin body image
- adolescents with excessive weight concern
- ballet dancers, models, gymnasts, endurance runners, figure skaters, people in sports or professions in which low body weight is valued

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► The psychological component of the condition is not always apparent in the early stages

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