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## **GROWTH MONITORING:- THE COVENTRY CONSENSUS**

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**Author's note:** This document has the main aim of setting out the debate behind the "Coventry consensus" a meeting of paediatricians, endocrinologists, public health doctors, GPs, and nurses from various disciplines, organised by the Child Growth Foundation, in July 1998.

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It was compiled by David Hall and had the broad support of most members of the consensus meeting. It is intended to offer guidance for clinical practice in the short term, but in the medium and longer term the aim is to provoke debate and new research proposals.

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Growth monitoring is a time-honoured part of child health care and the findings from critical analysis of the literature, and in particular the mathematics, of growth monitoring will seem counter-intuitive to many (and did to the author). Nevertheless, so far no-one has identified a flaw in the mathematical arguments and these must be studied carefully in order to understand the reasons for our recommendations.

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A summary version of the work on height monitoring is published in Archives of Disease in Childhood, January 2000. See also paper by CM Wright on weight gain.

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The bibliography included here is not comprehensive and has been updated recently but has not been re-checked. Additional references will be added in due course.

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Comments, discussion, additional material, new references, new arguments etc. are welcome.

## CONSENSUS ON GROWTH MONITORING

45 **Background** There is an extraordinary diversity of policy on the measuring of  
children across the UK<sup>1</sup>. Growth monitoring (GM) is the preferred term because  
of debate about whether measuring children can be considered as a screening  
programme. However, whether the GM programme consists of one  
50 measurement or several, the intention is to identify silent pathology in a large  
population of apparently healthy children. The question to be considered is  
whether GM can fulfil the criteria required of a screening programme. It is  
therefore helpful to apply the principles of screening to any proposed GM  
programme – see appendix 1 for the criteria adopted by the National Screening  
Committee.

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There are several reasons why GM might be useful:

- Identification of disorders and diseases affecting growth
- Generation of data of children's health for public health purposes
- 60 • Generation of data for future epidemiological research
- Reassurance of parents.

Of these, the 3<sup>rd</sup> is not considered sufficient reason to justify GM on a national  
scale. The 4<sup>th</sup> is important to the extent that parents worried about their child's  
65 growth should be able to access expert opinion, but is not otherwise justification  
for GM. If GM is to be undertaken it must be justified by the first two reasons.

### General principles:

- 70 • The aim underlying the concern over GM is to achieve the earliest possible  
identification of children with growth problems, on the grounds that ( a )  
some conditions have a better prognosis if treated early (b) parents prefer to  
know of any problems in their children as soon as possible. *GM is not an  
end in itself.*
- 75 • Many conditions affecting growth are identified at birth because of associated  
abnormalities.
- Infants of low birth weight for any reason are at increased risk of  
developmental delay and impaired growth and should be followed up by a  
paediatrician.
- 80 • Parents expressing concern about their child's growth should be offered a  
high standard of assessment to be specified in a guidelines document.
- Assessment of growth should be part of the minimum evaluation of any child  
presenting with chronic poor health, atypical development, other unexplained  
symptoms, or concern about their psychological and social wellbeing.
- 85 • Conditions causing growth impairment as the main feature are rare in the  
experience of any primary care team, but nevertheless raised awareness of the  
more important diagnoses could contribute to earlier diagnosis.

If all these principles are adhered to, there will be only a small number of  
90 children with pathological conditions affecting growth remaining to be detected  
by any screening or GM programme.

## Who does what?

95 Throughout this report, the aim is to specify good practice rather than to say  
which professional should undertake what tasks. Some GPs with paediatric  
interests and experience may feel confident to undertake more detailed  
assessments than others, and some general paediatricians will be better trained  
100 than others to assess and monitor growth problems. It is the quality and  
completeness of the assessment that counts. If a professional does not feel  
competent to undertake a task specified here, they should refer to someone else.

*Comment In this as in many other fields of health care, professional hesitation,  
reluctance to refer, poor measuring technique, inaccurate recording and  
105 plotting, and generally inadequate measuring during periods of observation  
probably account for more delays than lack of or weaknesses in a screening  
programme. The paper by Cole (ref 19) implies that unless measurement is  
carried out to the highest standards while monitoring, the period of  
110 monitoring is time wasted. There is evidence in the case of biliary atresia and  
in Duchenne muscular dystrophy that delay in diagnosis and referral at  
secondary care level accounts for many of the observed late diagnoses and the  
same may well be true for growth disorders – a study is needed to address this  
question..*

115 **GM is discussed here under three headings:**

1. Measuring length at birth
2. Monitoring growth in the first two years of life, when weight monitoring is a  
long established practice but length monitoring is difficult.
- 120 3. Height and weight measuring and monitoring after the age of two

### 1. Measuring weight and length at birth

125 *Birth weight* is an indicator of intrauterine growth and helps to predict the type  
of neonatal care needed. It is easy to obtain an accurate measurement. It is a  
prognostic marker for future health and development. Differences in birth  
weight between social groups is an index of social inequalities.

130 *Length.* It is possible to measure length at birth with acceptable accuracy<sup>2</sup>.  
Measuring the length of infants who are of low birth weight for any reason, or  
have dysmorphic features or other major medical problems, is good clinical  
practice and is important in research. Infants with important growth disorders  
affecting growth in length may present at birth, with obvious disproportion due  
135 to a range of syndromes. Among these are the skeletal dysplasias of which  
achondroplasia is the best known<sup>3</sup>.

Deciding whether an infant's length, weight and head circumference are in  
proportion is important in its own right. If length measurement is perceived to  
140 be important by the paediatrician, it is his/her responsibility to ensure that it is  
done, either by themselves or by someone whose measuring technique is sound.

145 Measuring the length of normal infants is often done by midwives. Currently, measurements are likely to be inaccurate because they are hastily done on inadequate equipment, but acceptable accuracy is achievable. Parents like to know their baby's length and an approximate measurement done solely for this reason, by the midwife, may indeed be justified on the grounds of consumer satisfaction.

150 The correlation between birth length and mid - parental height is 0.2 and for mother only is 0.14 (though assortative mating means that parents tend to be of more similar heights than expected by chance – the correlation between parental heights is 0.2 – 0.3 in most Western populations); by the age of 1, the correlation between infant and parent height is 0.3, and 0.35 – 0.4 for mid-parent height. By the age of 2, the child's length is likely to reflect the parents' heights more or less equally. If the parents are of very different heights, the baby's length will cross centiles to reach their genetically determined height. This, together with regression to the mean, makes it very difficult to interpret length measurements under the age of two and limits the value of neonatal length as a baseline for the future<sup>4,5</sup>.

160 Box 1.

165 Although standards could be improved so that an *accurate* baseline measurement could be obtained, and this might occasionally be useful in the event of concerns about growth later on, there seems to be no evidence as yet that the benefits to be obtained would be justified by the teaching investment and managerial effort needed to maintain a more rigorous approach to length measuring in the new-born. This is because size at birth is determined by maternal size and intrauterine environment (Box 1).

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### ***Recommendations***

1. *Birthweight, correctly taken and recorded, and related to gestational age, is an essential first step in GM.*
- 175 2. *Measuring the length of the normal neonate is not part of a national programme of GM.*
3. *Measuring the length of a neonate with an abnormality is a clinical decision to be made by, and is the responsibility of, the paediatrician.*

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### **2. Monitoring growth in the first two years of life, when weight monitoring is a long established practice but length monitoring is difficult.**

185 *Length* Growth in the first two years appears to be less dependent on growth hormone than in older children. While many disorders may affect growth in length, there are essentially no conditions that could not be detected at birth and are likely to affect growth in length in the absence either of an effect on weight or other symptoms and signs. Those with severe endocrine disorders, notably multiple pituitary hormone deficiency (MPHD) often present early with other problems (especially hypoglycaemia), as well as growth impairment<sup>6</sup> (see below). Possibly renal disease, for example renal tubular acidosis, might occasionally be an exception to this statement, but this is very uncommon.

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195 Length should be monitored as part of a child's care if there is any reason to be  
concerned about their growth. In these circumstances, the decision that GM is  
indicated should be made by a paediatrician and supervised by them.

### ***Recommendations***

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4. *No justification has been found for the routine monitoring of length in the first two years of life.*
5. *Monitoring the length of an infant is a clinical decision to be made by, and is the responsibility of, the paediatrician.*

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### **Weight monitoring**

210 Weight gain in the first few weeks of life, particularly in breast fed infants, is  
occasionally cause for concern. For example, a recent discussion on the RCPCH  
e-mail group highlighted a number of babies admitted with hypernatraemia  
associated with very low breast milk intakes in the first week or two of life.  
There seem to be rather few good data in this age group and further work is  
needed before evidence-based guidelines on the optimal frequency of weighing  
could be produced.

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In the first year of life, gain in weight is a valuable indicator of health and  
adequate nutrition. Attendance for immunisation at ages 2,3 and 4 months, for  
the child health surveillance review at 8 months, and for the MMR after the first  
birthday offers five opportunities when weight can be checked. Some parents  
220 ask for their babies to be weighed more frequently and occasionally this is  
requested by child protection case conferences. This is not generally desirable  
because short term fluctuations in weight are common and may simply increase  
parental anxiety and stress.

225 Weighing on the occasions suggested above is currently regarded as good  
practice; nevertheless, there is no evidence that regular weighing of a baby who  
looks well and is causing no concern is of any benefit. Weighing is valued by  
most parents for the reassurance it offers and also because it legitimises contacts  
for advice and support with health professionals.

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Weight monitoring cannot be considered as a screening procedure. The rate of  
gain in weight is not easy to interpret and it is just one of a range of markers of  
the baby's health. Furthermore, though some slow growing infants may benefit  
from intervention and a very small number will have unrecognised organic  
235 disease, the health gain resulting from identification of slow weight gain by GM  
is still uncertain.

### ***Recommendations***

- 240 6. *Babies should be weighed (nude) at the ages mentioned above.*

7. *Normally growing babies should not be weighed more than once per fortnight under the age of six months and no more than monthly thereafter, as this may simply increase anxiety.*
- 245 8. *Non-attendance and failure of the parent to make contact with the primary health care team at these key ages does not necessarily mean that there is cause for concern, since a few parents have strong views about immunisation and do not wish to make use of conventional health care - more often however they are a warning of possible problems and should alert health care staff.*
- 250 **Unusual patterns of weight gain** When babies are weighed regularly, some will show patterns of weight gain that worry parents and staff. It is therefore necessary for GPs and HVs to have an understanding of growth patterns and growth charts (see box 2).

- 255 • Growth charts show the measurements for babies and children at different ages, taken from large numbers of subjects at a range of ages. They do NOT mean that normal babies always grow along the lines shown on the chart.
- 260 • Size at birth depends more on maternal and intrauterine factors than genetic factors, but after birth genetic and nutritional influences become progressively more important. For this reason, there is little correlation between the centile position on the chart at birth and the position at age two - and therefore some babies will cross the centile lines. This is in itself normal.
- 265 • There is a tendency for the weight and length of babies to converge towards the mean (the 50<sup>th</sup> centile). This is called “regression to the mean”<sup>7</sup>. In other words, it is more likely that a baby who is on the 98<sup>th</sup> centile at birth will cross centiles downwards than upwards; and it is more likely that a baby who is on the 2<sup>nd</sup> centile at birth will cross centiles upwards than downwards. Nevertheless, this is not true for every baby and a baby who was on the 2<sup>nd</sup> centile at birth could cross centiles downwards and still be perfectly normal
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- 275 • In spite of these mathematical truths, when babies cross centile lines downwards it is natural for staff and parents to be worried. Of course, some babies with serious problems do show downwards crossing of centiles. Therefore, it is helpful to know how many babies cross centiles, how many centiles can be crossed without this necessarily meaning there is any pathology present, how much the probability of pathology increases as more centiles are crossed and at what ages and how fast this can happen. Unfortunately there is no simple answer to these questions. The answers vary according to the starting centile and the age of the baby.
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- 285 • By definition, only one baby in 250 will be below the 0.4 centile. The diagnosis for many such babies will have been established before discharge from the hospital after the birth, but if this is not the case such a baby should be fully assessed and an explanation should be sought but not all babies below the 0.4 are abnormal. The probability of there being serious pathology for a baby who is above the 99.6 centile is smaller and the few important conditions that might account for this are likely to have been identified in the neonatal period.
- 290 • Failure to gain weight in the first few weeks of life may indicate serious problems such as congenital heart disease and demands an explanation. Insufficient nutrition is an important cause and unrecognised under-feeding, particularly in the case of breast feeding, should always be considered.
- 295 • Short term loss of weight can occur during and immediately after a minor illness such as respiratory infections or gastro-enteritis. Such babies should be monitored until it is clear that they are gaining weight. Continuing loss of weight is an indication for referral and investigation.
- 300 • Any baby presenting with concerns about general health or feeding should be weighed and measured as part of the assessment, but the figures and the centile chart are just one factor in the management decision.
- 305 • Problems with feeding, particularly with weaning, are a common cause of poor weight gain. Some parents report a struggle with feeding their baby whether or not there is any faltering in weight gain - this is a distressing problem and merits intervention in its own right.
- 310 • Weight fluctuates from day to day and excessive emphasis on weight gain, particularly where there is concern about feeding problems, may simply encourage the parent to try forced feeding in a desperate attempt to get the baby to gain weight

BOX 2

310 “Failure to thrive” There is a group of babies in whom the only problem is the  
weight chart - the baby’s growth line crosses centiles downwards and this  
causes concern to parent and staff. The term “failure to thrive” (FTT) is often  
applied to these children<sup>8</sup>. FTT implies that there is a pathological reason for  
315 the slower than expected weight gain, which is not always the case. Current  
weight charts do not help health professionals decide to what extent a  
particular growth pattern is unusual or how likely it might occur in the  
population as a whole. This information would not directly answer the  
question as to whether the pattern is pathological, but it would help decide  
whether and when to refer for investigation or to intervene.

320 In the past any baby below the 3<sup>rd</sup> centile was considered as a possible case of  
FTT. However, a baby who was on for example the 90<sup>th</sup> centile at birth and who  
grew poorly due to serious disease would take many months to fall below the 3<sup>rd</sup>  
centile. As it is common for a baby’s weight to cross centiles in the early  
325 months of life, FTT would more logically be defined on the basis of a rate of  
weight gain that is outside specified limits. The expected rate of weight gain in  
kg is dependent on the initial weight and the age, but FTT could be defined in  
terms of change in SD score – for instance, as a change in weight SD score of  
=>2SDs. Cole’s conditional charts can be used – these were devised to help  
330 health professionals decide whether a pattern of weight gain is abnormal. The  
Thrive Index (TI) was devised by Wright et al to assist the specialist in  
management of such cases (see box 3),

The following rules may be useful for primary care staff:

- 335
- Babies between the 9<sup>th</sup> and 91<sup>st</sup> centiles in the early weeks of life often cross one centile band in the first year of life.
  - Only 5% of babies show a sustained fall on two complete centile bands. (Babies who start above the 91<sup>st</sup> centile may fall more than this and the rule should be three bands: for babies who start below the 9<sup>th</sup> centile the rule is only one full band).
  - 340 • Only 1% of babies fall through 3 complete centile bands (4 if above 91<sup>st</sup>, 2 if below 9<sup>th</sup>).
  - Wright suggests that babies who have any symptoms or signs of illness, or where there is concern about the quality of parental care, should be fully assessed. The majority of these babies, even those who fall 3 bands, will not have organic disease. The yield of full investigation in hospital of babies who have “FTT” but no specific symptoms or signs is negligible.
  - 345 • In many of them there are feeding difficulties and sub-optimal intake<sup>9-11</sup>. In some there is insufficient food intake, due to several possible causes - disturbed parent-child relationships, parental disinterest or depression, abuse and neglect, inadequate food being offered (especially with breast feeding), difficulties with weaning, and oromotor dyspraxia. These may respond to dietary advice and guidance on feeding techniques.
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Cole’s and Wright’s work offers a rational way of dealing with this difficult problem. However, it would be premature to recommend this as a formal



screening programme. More development work is needed and there are a number of unanswered questions (Box 4).

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1. Take the weight at time 1 (for instance, 6 weeks): calculate the SD score = SD1
2. Do the same at time 2 (for instance, 9 months): calculate the SD score = SD2.
3. As there is not a perfect correlation between weight at time 1 and at time 2, the correlation  $r$  is less than 1.
- 365 4. The SD score at time 2 can be predicted from the SD score at time 1:
5. SDS predicted for time 2 = SDS at time 1  $\times r$ .
6. The difference between the actual SDS at time 2 and the SDS predicted from the score at time 1 is the Thrive Index.
- 370 7. The distribution of the TI can then be calculated and limits can be set on the TI as with other growth parameters.
8. Having a TI at the extreme of the distribution does not indicate definite pathology any more than a single weight or height does, but it identifies an infant who deserves careful appraisal.
9. The data have been used to develop a new chart to evaluate weight faltering.

BOX 3 (see reference <sup>12-14</sup>)

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- How good is the correlation with other similar charts such as the Cole conditional chart? One study suggests that it is weak<sup>15</sup> – does this matter? What does it mean?
- The same study suggests that the TI identifies many babies whose growth faltering is only between 9 and 12 months. Wright noted that about half her cohort were below the TI threshold in respect of only one 3 month period but did not specify if this was particularly the case at any one age – it might not be surprising if this was at age of weaning.
- 380 • Is it only the babies who have a low TI for longer than 3m who we should be worried about? Wright reports that such babies were shorted an lighter at age 8 though their intellect was not different. However, Dowdney and Skuse found a less good cognitive outcome at age 11<sup>16</sup>. They thought the problem of poor weight gain in fancy was complex, involving both biological and environmental factors, the latter being supported by an interesting difference between first and second born children. Their cohort was from a deprived population and defined on a different basis from that of Wright, and possibly was a more extremely deviant sample. See also ref.<sup>17</sup>
- 385 • Many babies with low TI show catch up growth without intervention<sup>18</sup>. Is this really catch up, implying that something was abnormal, or was it a peculiarity of their genetically programmed growth pattern?
- 390 • Most important, how effective is intervention? Wright in a community based RCT found a difference in favour of an intervention group<sup>18</sup>. Rudolf<sup>19</sup> in a clinic referred population found that both intervention and control groups gained weight well but there was a the high incidence of severe feeding problems due to inappropriate management and these may have benefited from intervention.
- 395 • Are some babies lean at one year for genetic reasons – i.e., they have lean parent(s)? Would knowledge of parental BMI and of correlations between parental BMI and the infant's help us to distinguish babies who are lean for this reason ?
- 400 • Wright reports that the incidence of iron deficiency was low in her series; Rudolf reports 30%; James reports that the combination of being “a picky eater” and being below the 10<sup>th</sup> centile for weight puts an infant at high risk. Where does iron deficiency fit into this whole story? Is it a separate issue?
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BOX 4

410 **Recommendations**

9. Primary care staff need to understand the principles outlined above - though they do not need to understand the mathematics.

415 10. Weighing babies is not a screening test in the sense of seeking 100% coverage and having pass-fail criteria.

11. However, as weighing babies is an entrenched practice and is likely to continue, the use of the rules outlined here (and the charts if experience confirms their value) is likely to result in more rational decision making than is the case at present.

420 12. Staff should either use the skills of others including dieticians or acquire these themselves and should be able to give advice that is not just about dietary content but also about feeding techniques in the social setting.

425 13. A minimum assessment of a baby who is growing slowly includes the following: appraisal of the growth chart including weight, length and head circumference; general health as assessed by history and examination of the baby; assessment of the parents' heights and weights, and their physical and mental health and quality of child care; assessment of feeding intake and methods based on report and preferably also on observation.

430 14. If this appraisal reveals any symptoms or signs suggestive of ill health, full investigation becomes mandatory.

15. Otherwise, dietary and feeding advice and further observation should be undertaken.

435 16. Weighing too frequently is unlikely to be helpful except in situations where a baby has been losing weight progressively, and often compounds parental anxiety - once a fortnight is often enough for most situations.

17. Progressive weight loss is an indication for specialist referral.

**3. Monitoring height and weight in children aged two upwards**

440 The main justification for measurement and / or monitoring in this age group is the early identification of disorders affecting height. In general, such conditions are chronic rather than acute. GM is a complex issue because it aims to detect not one but a range of conditions; table 1.

445 Monitoring of weight may be useful as well. Evidence is limited. Perhaps its main value is in interpreting height measurements. The current low effectiveness of either primary prevention or treatment measures limits the role of weight monitoring for obesity, even though this is becoming a major public health problem of the Western world.

450 The question of height monitoring can be considered both on a theoretical basis and by reference to published series describing what happens in practice. Both approaches must address two issues: *individual measurements at a single point in time* to detect absolute short stature and *two or more measurements over a period of time* designed to detect a decline in growth rate irrespective of the starting height (growth failure).

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**Growth charts and good measurements.** These are essential pre-requisites to any form of growth monitoring.

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Growth charts are a vital tool in measuring and monitoring. The Joint Working party on Child Health Surveillance recommended the 1990 9-centile charts<sup>20</sup>.

465 These are cross sectional charts based on a recent, substantial and well-documented set of growth data<sup>21</sup>. They have been constructed to show the 0.4 and 99.6 centiles; only 1 in 250 children is outside these limits.

470 The alternative charts are the Buckler-Tanner charts, which are longitudinal charts based on older data that are no longer accessible for re-analysis<sup>22</sup>. These charts are similar in the pre-pubertal period though they do not have the advantage of the 99.6 and 0.4 centiles; but the two charts differ, because of their different construction, in the pubertal period. From the community perspective of GM, this does not matter. For reasons discussed below, there is no indication for routine GM after the age of 7. Endocrinologists may use either chart but for the non-specialist the 9-centile chart is preferred.

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Precise careful measuring technique and robust equipment, correctly installed, are essential<sup>23-28</sup>. Persuading non-specialist staff of the need for care and accuracy in measuring is difficult. Note that even when equipment and technique are satisfactory, imprecision is inevitable (Box 5).

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- The main source (over 90%) of variability in measuring is in the child. People, not being rigid objects, do not have an exact or “correct” height.
- Different observers do not measure in exactly the same way so multiple observers over time increase the imprecision.
- 485 • Different instruments do not give identical results.
- Diurnal variation in height is a further potential source of error – height decreases during the day.

490 It is inevitable that any screening system has cut off points but the inherent imprecision in measurement must not be compounded by sloppy technique. Anything other than the most careful measurement will reduce the value of the screening process. Provided that the measurement is taken on suitable equipment with proper care and correctly plotted, a single measurement is, in principle, sufficiently precise to be a useful screening method.

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500 The best measurement of the precision of height measurement is the standard deviation of a single height measurement (SDsh<sub>m</sub>) which, for school age children, has a value around 0.2 – 0.3 cm. The 95% confidence interval for a child’s height therefore extends about 0.5 cm (2SDsh<sub>m</sub>) on either side of the measured height so that, if a child’s height is observed to be on the 3<sup>rd</sup> centile we can be very confident that the true height lies between the 2<sup>nd</sup> and the 4<sup>th</sup> centile.

505 The interval width is similar for 3 year olds, but for two year olds it is double in size. So the 95% confidence limits of a two year old boy’s height, measured at 79 cm, would be 78 cm (i.e., on the 0.2 centile) and 80 cm (on the 1.2 centile).

**BOX 5**

510 The 95% confidence limits to a single height velocity, measured over a full year by the same measurer on both occasions, lie  $\pm 2(\text{SDsh}_m)\sqrt{2}$  cm/yr about the measured velocity. For school age children, this works out at  $\pm 0.71$  cms / yr. Consequently, a child whose measured velocity over the period five to six years falls on the 25<sup>th</sup> centile might have a true velocity between the 8<sup>th</sup> (worryingly slow) and the 50<sup>th</sup> (very satisfactory). These confidence limits would have to be doubled if two measurements were taken only 6 months apart.

515 There is no correlation between successive velocities. Single estimates of velocity are meaningless and every child is likely, sooner or later, to show a period of “poor” growth.

520 Data collected routinely tend to be of poorer quality than research data or data obtained in speciality clinics<sup>29</sup>. Cole showed that whereas a measurement error of 0.25cm would result in only 0.03% of children falling one centile band or more over one year from age 5 to age 6, an error of 0.8cm would result in 1% of children showing such a fall. The figure would be 5% between 2 and 3 years. Using data from a French longitudinal study as the gold standard, in which the measurement error (SDsh<sub>m</sub>) was assumed to be 0.25cm, data collected in routine practice in Kent were analysed and the measurement error was shown to be 1.7cm between the ages of 2 and 3.5, and 0.5cm between the ages of 5 and 6. (Hulse, JA, Hall DMB, Cole TJ, et al – in prep.).

530 These calculations relate only to children randomly chosen from the population. For such children, the correlation between annual height measurements increases with age, so that pre-school children are more likely to cross centile bands than school-age children. Centile crossing is also more likely with longer measurement intervals.

535 If a child is measured a second time only because the first measurement gave cause for concern (for instance because the child was considered unusually short), any inference about that child’s growth should take into account that the expected velocity is not the same for every child, but is conditional on the initial height. To stay on the 3<sup>rd</sup> centile needs an average velocity on the 25<sup>th</sup> centile, while to stay on the 97<sup>th</sup> needs an average velocity on the 75<sup>th</sup> centile.

**BOX 6**

545 *What cut-off to use for single height measurements?* The fundamental problem with screening for growth disorders is that if (for example) the 0.4 centile is taken as the cut-off, the children thus identified have a considerable chance of having some pathology (specificity good) but many cases who are not quite so short will be missed (low sensitivity). If the cut-off is raised to the 2<sup>nd</sup> centile, sensitivity will be better but specificity will be much lower – 2% of all children would need to be investigated (14,000 per year in the UK). This would not matter unduly if the investigation needed to exclude the main causes of growth

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555 impairment were easy. Unfortunately, although exclusion of many causes of short stature is cheap and straightforward, the most important target disorder, GHD, is difficult to diagnose and there is no simple single test<sup>30</sup>. Using the 0.4 centile seems preferable in order to ensure that the number of cases referred is small enough that they can be investigated thoroughly.

560 *The limitations of single height measurements.* Single height measurements will only identify children whose growth is so slow that their height centile has dropped below the cut-off point chosen. Ideally, it would be preferable to identify them before they reached this point. Children may have either congenital or acquired disorders affecting growth but still be well above the cut-off centiles in the early stages of their disease. If growth rate could be monitored they would be found sooner.

565 *Detecting children who grow slowly* Poor growth can be detected by calculating either the growth velocity or the change in height SDS. Neither can be measured directly – both are based on two single measurements and therefore combines the imprecision of the two measurements (Box 6). Single estimates of velocity vary widely and it is not possible to define a “normal” velocity. Every child will sooner or later show a period of “poor” growth which if correctly identified would result in referral. This is equally true whether the child is short or tall to start with. However, velocity is conditional on the height of the child. To stay on the 3<sup>rd</sup> centile a child must have an *average* velocity on the 25<sup>th</sup> centile; to stay on the 97<sup>th</sup>, the *average* velocity must be on the 75<sup>th</sup> centile.

580 If short children have been identified at age five, when they start school, there is no logic in a school nurse carrying out a further measurement to estimate velocity one year after school entry just for short children. If height monitoring is to be done, its aim is to detect acquired pathology which can affect a child of any size. The question is whether this is worthwhile.

585 If school entry is taken as the most obvious time to measure height, could more use be made of height velocity by starting earlier or re-measuring later? If the first measurement were to be made at age two or three, the imprecision is greater (see above), although this has only a modest effect on the confidence limits for velocity (21<sup>st</sup> – 79<sup>th</sup> versus 25<sup>th</sup> – 75<sup>th</sup> for 5 year olds). Conversely, if a second measurement were to be made at, say, two or three years after starting school, at an age when measurement is more precise, the precision of velocity assessment would improve and the error as a proportion of the total increase in height would be less. However, the same fundamental problems with measuring velocity still apply as set out in Box 7. In particular, point 4 in the Box indicates how height velocity lacks sensitivity as a screen<sup>31</sup>.

- 595
- 600
1. The “normal” velocity for a child is not a fixed limit but varies according to the starting height. The shift in SD score is more or less independent of starting height, but is conditional on age and measurement interval.
  2. The correlation between annual height measurements increases with age, so that pre-school children are more likely to cross centile bands than school age children. Centile crossing is also more likely with longer measurement intervals.

- 605
- 610
- 615
3. Over a three year period, few school age children change their position on the chart by more than  $\pm$  one centile band (0.67 SDs); but there are no data that specify the sensitivity and specificity of using such data to identify pathology.
  4. The growth charts developed for Turner's syndrome show that most girls with Turner's would not be identified by this means as they do not shift centiles by this amount between five and nine years<sup>32</sup>, but there are no comparable data for other growth disorders (figure 1)
  5. For the screener, the task is difficult firstly because of the concepts involved and secondly because crossing of centile bands would have to be assessed by eye. These problems could be overcome if a dedicated calculator or PC were to be provided.
  6. From the clinician's point of view, growth becomes increasingly difficult to assess after school entry, because some children show a marked transient faltering in growth before the puberty growth spurt.

Box 7

Figure 1: Turner's syndrome chart superimposed on standard chart: note that line crosses < one centile channel between five and nine years:

Insert XOchart here (ppt. File)

**Recommendation:**

620 18. Single height measurements can be used to identify short children,  
preferably using the 0.4 centile, but growth velocity is not useful for community  
based growth monitoring. **A guideline for the extent and rate of centile band  
crossing that could be regarded as a referral trigger cannot be given unless  
one knows the measurement error for the staff and community in question.**

625

**Adjustments for family heights.** Since a common cause for a child to be short  
is that s/he has short parents, one approach to improving the performance of  
height measures for screening is to adjust for size of parents or siblings. The  
measured height can be corrected using the mid-parental height (MPH)<sup>33</sup> and the  
630 “target” height, the adult height predicted for the child, can be calculated. The  
correlation between the child’s height and that of one parent is less than that for  
MPH (0.3 at age 5) but could still be useful; correlation with sibling height is  
almost 0.5. Thus, in principle, knowing the height of one parent only, or of a  
sibling, could improve the screening performance of a single height  
635 measurement .

*There are both practical and theoretical problems about using MPH.*

*Practical problems:*

- 640
- requires an additional action by the screener;
  - the screener would have to make a series of decisions as to what data to use  
and would have to use tables, charts or a PC to assess the interpretation of the  
data – which is undesirable, though not unattainable, in a screening  
programme;
  - 645 • the data are often not available however much effort is made;
  - parents’ estimates of their own and their partner’s height are unreliable, so  
that only actual measurements are likely to be useful<sup>15; 34</sup>;
  - the father’s height may not be available in a one-parent family;
  - paternity is not always certain;
  - 650 • recording heights in the antenatal period, at birth or at the first health visitor  
visit is possible but the data must be transferred to the child’s records.
  - Further work would be needed to determine whether this is a practical  
proposition.

655 *Theoretical problems:*

- Parental height may be abnormal because of some pathology which has been  
passed to the child.
- 660 • Parental height may not be a true reflection of their genetic potential,  
particularly in the case of immigrants who were under-nourished in  
childhood. As many small children are of Asian origin this may not be a  
trivial problem.
- The predicted height of the short child of very short parents is under-  
estimated by the Tanner method; this suggests that the relationship between  
665 child and parents heights may not be the same for very short people as for



the rest of the population<sup>35</sup> (the genetic determinants of stature may throw further light on this in due course<sup>36</sup>).

- Regression to the mean results in a risk that there will be over-correction; in other words, a child's short stature will be wrongly attributed to his having short parents<sup>37</sup>.
- Sibling height may be abnormal for the same reason as in the index case – organic disease or deprivation.

*Practical experience:*

A recent report shows that short children with pathology can nevertheless have short parents<sup>34</sup>. In other words, if the screener dismisses short children whose parents are short, pathology will be missed. The numbers were small but the finding was important<sup>1</sup>.

**Conclusion:** *MPH appears to offer a simple way of improving the GM programme, but the considerable difficulties listed above currently suggest that the simplicity is deceptive.*

**Recommendation:**

*19. The primary aim is to find children with absolute short stature. It is also important but more difficult to find those with stature that is inappropriate for parental height, regardless of absolute height. However, the use of data about parent and sibling height should be undertaken as part of a second stage process since the judgements needed are too sophisticated to be part of a screening process.*

**Ideal target conditions.** To consider single height measurements further as a screening tool, it is necessary to focus on individual target conditions which are not otherwise apparent and which produce substantial growth impairment. The table shows that for most conditions these criteria are not met. Although it is common for many of these conditions to be associated with impaired growth at presentation, the argument for identification by screening is weak:

- Many of these disorders are acquired, and cause reduction in growth rate, but unless the child was short to start with, do not necessarily result in individual height measurements falling below the normal range. They can therefore only be detected by monitoring changes in height centile over time which as explained above, is not a practical proposition.
- In many cases there is likely also to be parent concern based on symptoms and signs which indicate the presence of significant pathology;
- If this is not the case such features are likely to emerge within a short time;
- Treatment in the pre-symptomatic phase has at best only modest benefits over treatment started when symptoms appear.

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<sup>1</sup> This is an interesting finding. It might suggest that to be identified in growth screening, a child may need to have pathology superimposed on genetic short stature. There may be children who are being missed by parents and by screening because they have mild or moderate pathology but this is superimposed on normal or tall genetic stature.

*The best case for screening* can be made in respect of conditions which produce marked short stature detectable by a single height measurement and are not associated with any other obvious warning signs so that they are easily missed.

715 The two conditions which fit these criteria in respect of short stature are isolated growth hormone deficiency and Turner's syndrome. Although a number of other conditions may lead to abnormal increase in height, they are individually and collectively very uncommon, and are usually associated with other features. One disorder for which a case for screening might be made, Marfan's syndrome, 720 is not invariably associated with a height over the 99.6 centile. The issue of tall children was not considered further by the consensus meeting.

*Isolated GH deficiency.* Growth hormone deficiency is an eminently treatable condition and may present only with short stature, so it is a candidate for 725 screening. The Utah study<sup>38</sup> quoted a minimum incidence of 1: 3480 and reviewed other studies which suggested lower rates, perhaps 1: 4000. If borderline cases are included the figure may be as high as 1:2000.

730 The ratio of isolated idiopathic GHD to multiple pituitary hormone deficiency (MPHD) is said to be 60:40 but the isolated form may be in decline (there may be a relationship between this condition and obstetric practice). In one series of 29 cases of MPHD, failure to thrive, obesity hypoglycaemia, or micropenis brought these children to medical attention, many of them well before two years of age<sup>6</sup>. Thus the benefits of height monitoring would be more obvious for cases 735 of isolated GHD. (Clearly screening is not or should not be needed for children at high risk, for example those followed in the oncology clinic).

It is difficult to be sure how many children would be picked up, and at what cost in increased number of referrals, with differing cut off points at age 5. In cases 740 described by Milner (1979) most cases would have been found by a cut-off of below 0.4 centile, but the Smith series (1988)<sup>39</sup> suggests that only 30% would have been below this point at age 5 (and only 55% at age 8). A further complication is that in children with only modest degrees of short stature there is less confidence that they were in fact GH deficient, since re-testing suggests that 745 some were not.

It seems reasonable to conclude on present knowledge that: most cases of MPHD would present clinically before the age of two; cases secondary to other disease should be identified by their clinician; there would be a small but 750 worthwhile yield of cases of GHD by screening using the 0.4 centile at age 5; the precise size of this yield is unknown; the cases thus found would be the more severe ones who would benefit most from treatment; the yield would increase by raising the cut-off to the 2<sup>nd</sup> centile but at a cost of a five fold increase in referrals.

755 *Yield per 100,000 five year olds screened.* The potential maximum yield of isolated GHD might be as high as 1:2000, but 1:4000 seems more realistic. Of these some, at least 20%, might be missed because they were not short enough to be detected by the screen; so of the 25 per 100,000 available to be found, 20

760 might be identified. This assumes that no cases had been found earlier by  
parents or GP.

*Turner's syndrome.* Turner's syndrome girls may benefit from oestrogen  
treatment; growth hormone treatment may also be used though it may offer  
765 relatively little benefit in terms of final height. This is a condition often  
associated with subtle learning and socialisation problems and with considerable  
emotional impact, so that parents and the girls themselves may welcome early  
diagnosis.

770 The incidence is said to be 1:2500 girls. Probably many of these are not  
identified. Some (estimates vary from 20% to 50% or more) present neonatally;  
it may be possible to increase this figure if those examining the newborn were  
better trained. Of the remainder a few come to attention because of health or  
developmental problems. There are many others who will be missed as they  
775 have no obvious features until they fail to enter puberty alongside their peers.

TS girls are shorter than their peers; TS women are 18-19 cm shorter than the  
average adult woman (Lyon)<sup>40</sup> and another report (Dacou)<sup>41</sup> suggests 13 cm  
shorter than their target height, but these differences are less marked in  
780 childhood since much of the height deficit arises from failure of the puberty  
growth spurt.

By superimposing the TS chart on the normal chart it can be seen that perhaps  
50% of girls could be diagnosed by a height measurement at age 5<sup>32</sup>. The  
785 growth velocity is only marginally lower than that of normals and would not  
distinguish them even if velocity monitoring were to be attempted.

*Maximum yield.* Among 50,000 girls, there should be 20 cases. Of these  
perhaps one fifth are identified at birth, leaving 16. 56% of cases could be found  
790 by using the 0.4 centile at age 5; that is, 9. This assumes that no further cases  
were identified between birth and age 5.

*Thus the maximum total yield of single height measurement* in 100,000 children  
aged five is 9 cases of TS, and 20 of GHD. In addition there would be a number  
795 of miscellaneous diagnoses of other conditions which could be regarded as  
secondary gains of the screening. To ensure identification of the cases of GHD  
and TS by examining all children under the 0.4 centile, it would be necessary to  
refer 400 children. One positive diagnosis of the target disorders would be made  
for every 13 children seen. This might well be acceptable – though the  
800 assumptions made in the above calculations were probably very optimistic.

However, while the success of *screening* might be assessed in terms of  
diagnoses made, the success of the *overall growth monitoring programme*  
would be judged on how *few* cases were found, because an effective programme  
805 within the primary care setting would find most cases before school entry. Thus  
the five year old measurement would be a final safety net rather than the main  
screen.

810 **Conclusion:** *no approach to height measurement or monitoring could hope to*  
*find all cases. If identification of all cases of TS were to be considered essential,*  
*there would be better (though more expensive) ways of doing it than measuring*  
*height. Height screening could not easily be justified solely by identification of*  
*TS; but a single measurement at age five does allow detection of at least half*  
815 *of previously unknown cases. When taken together with the diagnosis of GHD,*  
*however, the potential yield increases to more acceptable levels.*

### **The benefits of height measurement at and after five – empirical evidence**

820 Several reports have noted the high incidence of organic disease among children  
below the 3<sup>rd</sup> or 2<sup>nd</sup> centile at school entry. In most, however, the incidence of  
*previously unsuspected* disease was low. The Wessex growth study<sup>42</sup> involved  
measuring over 14,000 school entrants. 180 were below the 3<sup>rd</sup> centile and of  
these 25 had known disorders and there were 8 new diagnoses. Of these 8, at  
825 at least half must have had other features in addition to short stature; and probably  
all but one could equally well have occurred (and perhaps did) in children who  
were above the 3<sup>rd</sup> centile in height. Only one new case of GHD was found (in  
a child with known learning difficulty) and there was one case in the group  
already known (who also had Down's syndrome). The shorter the child, the  
greater was the chance of organic disease.

830 The Utah study<sup>38</sup> screened over 114000 children and reported a significant yield  
of 16 new cases of GH deficiency, 6 cases (?all new) of Turner's syndrome and  
3 of hypothyroidism, by screening for children below -2SDs and a slow growth  
velocity; it appears that all but one were identifiable by the first measurement  
835 alone though the use of the growth velocity increased specificity.. There were  
53 with other conditions. The tables provide clear data on new versus  
previously known conditions only for GHD. Much primary care is given by  
paediatricians in the USA yet these cases had been missed.

840 GHD was diagnosed by 2 provocation tests on the same occasion; as many  
children with presumed GHD subsequently show a normal GH response, raising  
questions about the original diagnosis, it may be wise to interpret these data with  
care.

845 Vimpani found 13 severe cases and 25 mild or borderline cases of GHD in  
48000 children screened<sup>43</sup>. The Oxford study of 20,000 children identified 2  
new cases of GHD (also 2 of Turner's and 4 of Noonan's)<sup>44</sup>.

850 A study in the Netherlands suggested that only a minority of previously missed  
cases with GHD or TS would be identified by a programme of GM up to the age  
of 12 years<sup>45</sup>.

855 *Psychosocial issues.* It is said that deprivation and abuse are additional reasons  
for monitoring growth<sup>46; 47</sup>. There is undoubtedly a link between adverse social  
circumstances and impaired growth<sup>48; 49</sup>. It is not clear, however, that GM is an  
effective strategy for identifying previously unsuspected cases of abuse or  
deprivation<sup>48; 50</sup>.

860 *Short normal children* There is no justification for screening with the aim of  
finding short normal children. The argument that they can be reassured seems to  
hold little logic – if the parent or child are concerned they can seek help from  
their GP. Not all short children become short adults. There is currently no  
evidence to support treatment of these children, not is there evidence that they  
suffer psychological harm from being short.<sup>51-53</sup>

865

***Conclusion:** review of children under the 2<sup>nd</sup> centile in height will reveal some  
new and more known pathology; confining this to below the 0.4 centile will  
increase specificity but reduce specificity<sup>54</sup>. Much of the pathology detected is  
not specific to children with very short stature and might occur with similar  
870 frequency in children not identified by the screen. The detection of conditions  
which do not reliably produce marked height or growth deficits cannot logically  
be used as justification for screening. If screening is justified for these  
conditions, some other method must be sought. Their identification could be  
regarded as a secondary gain from GM but not a primary aim.*

875

**Height measuring before age 5 and after school entry.** Although diagnosis  
earlier than age 5 is desirable for these conditions, short stature is more difficult  
to identify in younger children except in the most severe cases. It takes time for  
short stature and poor growth to become obvious. Measurement is more difficult  
880 and error is greater in young children<sup>55</sup> (see above). However, many children  
will present clinically before this time because of parental concern and raised  
awareness of growth problems would facilitate earlier diagnosis.

885 Attempts to identify slow growth in the age range five to eight or nine are  
difficult because of the transient faltering in growth shown by many children  
before the pubertal growth spurt. This would result in unnecessary referrals and  
investigations.

890 *Several single height measurements.* Two or three measurements are probably  
little better than one in identifying the child who is growing slowly. Four may  
become more useful as a trend is established and the probability of several  
successive pairs of high quality measurements showing a downward trend purely  
by chance declines<sup>29</sup> - though even then the first and last points on the growth  
895 line can be misleading. At present it seems unlikely that regular monitoring of  
height over a period of years will result in earlier diagnosis of GH deficiency or  
Turner's syndrome. Evidence has been sought that countries where this is the  
norm as part of paediatric primary care have a better record in this regard but  
none has been found. Even if it could be shown that serial measurement is  
better than single or a few measurements, it seems obvious that in screening  
900 terms the percent coverage of the population would deteriorate as the number of  
measurements required increases. This is particularly the case for the UK where  
the case for multiple well-child assessments on other grounds (e.g.  
developmental assessment) has progressively weakened in recent years.

905 **Body weight and BMI.** Obesity is an increasing major problem in the  
Western world, and weight and BMI charts can only describe the observed  
weights of children – they cannot specify ideal weight or BMI. However, charts  
can be based on an arbitrary standard or a fixed point in time so that this can act

910 as a reference for the future. This is important if obesity continues to affect  
increasing numbers of children. Weight at age 5 would be a useful component  
of a minimum data set for children's public health<sup>56</sup>.

915 There is no satisfactory way of defining obesity and no justification for referring  
overweight children for investigation unless there are other problems as well.  
Very thin children may cause concern, but again there is no good way of  
deciding who is abnormally thin and other features are more important. It has  
been taught in clinical practice that children with constitutional obesity are  
usually tall and that the short fat child is more likely to have some abnormality,  
but we have found little support for this dictum and some clinicians disagreed  
920 with it.

**Public health data** Most developed nations have data on the heights and  
weights of their children. These data are useful to observe trends over time.  
They help monitor the impact of dietary changes. Differences between social  
925 classes should diminish if social inequalities are reduced. Linking data using the  
NHS number should greatly enhance the value of these data by making them  
part of a minimum data set.

***Recommendations:***

930

*21. The primary care team (GP, HV, Practice nurse) should regard height and  
weight measurement and charting as an intrinsic part of assessing any child  
presenting with a relevant clinical problem.*

935

*22. Every child should be measured and weighed at school entry at or around  
the age of five years. Alternatively this could be the responsibility of the PHCT.  
The measurement is intended to identify children not previously diagnosed  
within primary care and a low yield may be a sign that the primary care  
network is working well.*

940

*23. Height monitoring to detect centile crossing is not recommended; however,  
where height data have been collected over time for any reason, any child whose  
height crosses more than one centile band (> 0.67 SDs) between the ages of five  
and eight is exhibiting an unusual growth pattern that needs explanation.  
Comparable empirical data are not available for the under-fives.*

945

*24. The height and weight should be part of the minimum core data set for  
children's public health.*

*25. Children below the 0.4 centile in height must have further assessment  
without delay.*

950

*26. There is currently no evidence base on which to recommend referral of  
obese or thin children and staff must use their judgement.*

*27. The further assessment must meet minimum standards and guidelines should  
be developed, since it is not feasible to refer all short children to a paediatric  
endocrinologist.*

955

*28. On current evidence, there is no place for continued routine GM after school  
entry whatever the child's initial height. The child must either be referred or  
passed as normal.*

*29. Tall stature on its own is not an indication for referral unless there is some  
other concern as well but staff should be aware of the existence of conditions*

*that can cause tall stature and should particularly be on the alert when a child is inappropriately tall in relation to parental height..*

960 30. *The standards of measuring, weighing and interpretation are as set out in the guideline.*

31. *A guideline for the investigation of short children at secondary care level is needed.*

965

965 **APPENDIX: HOW TO MEASURE (WITH THANKS TO DR LINDA VOSS)**

STANDARDISED TECHNIQUE FOR HEIGHT MEASUREMENT

970 Reliable growth data does not require expensive equipment, just some care. If universally adopted, a standardised technique would increase precision and minimise inter-observer bias. The method described here is evidence-based and was debated and accepted at Coventry. The degree of accuracy and precision required depends, ultimately, on how the data are to be used. There are two key questions to keep in mind:

- 975
- Is the reading accurate? The accuracy of the measurement depends on the correct installation and regular maintenance of the instruments used.
  - Is the reading reproducible? The validity and thus the interpretation of growth data depends on the reproducibility or precision of the measurements. It is crucial to know whether the size of any increment observed over time is likely to be real and not due to measurement error.
- 980

COMMON SOURCES OF ERROR

985 *Careless technique* Most errors arise from the careless reading and recording of data. They will not be obvious unless very large.

990 *Diurnal variation* Height is greatest on getting up in the morning - up to 2.0 cm can be lost over the whole day. Measurements made at different times of day can significantly affect the measured height and, thus, the estimated rate of growth. Subsequent measurements should be made at the same time of day, or at least in the afternoon, when the rate of height loss slows down. N.B.: Stretching is ineffective in preventing diurnal variation.

995 *Observer differences* Different observers, even apparently using the same technique, may record significantly different heights for a child. Ideally, a child should be monitored using the same observer and instrument, but this is not always feasible. An unstretched technique is therefore recommended, as it gives the same degree of intra-observer precision as a stretched method, but minimises inter-observer bias resulting from different degrees of stretching.

1000 *Non-blind measurement* Where the previous height of the child is known, a further source of bias may be introduced. Measurements should be "blind". Observers should not look at previous data and should not keep measuring until they get the reading they expect to see.

1005 **INSTALLATION OF HEIGHT MEASURING EQUIPMENT**

Ideally, use a self-calibrating stadiometer. It should be placed on a hard, uncarpeted surface, against a bare wall. Wall-mounted instruments, if used, must be hung from a permanently fixed nail, not plastic putty. The accuracy of all instruments should be checked with a calibrated rule both before and after each session. Worn instruments should be replaced.

1010

MEASUREMENT TECHNIQUE FOR STANDING HEIGHT

1015 Check instrument with calibrated rule.

Measure children, ideally, in vest and pants. In all cases, remove shoes, socks, bulky clothing and hair ornaments. Undo hair.

1020 Place feet together with heels, buttocks and shoulder blades against wall or back of instrument.

Check feet are flat, legs straight, shoulders relaxed, arms hanging loosely.

Gently ease head into correct plane i.e. eyes looking very slightly down so that centre of ear hole is level with lower border of eye socket.



1025

Do not measure a child who is holding his or her breath - encourage normal breathing.

Lower headboard and ensure good contact with head.

1030

Read instrument at eye level to avoid parallax error, rounding down to nearest mm.

Record measurement with care - write figure down and plot height on growth chart.

Note time of day, instrument used, and name of measurer.

1035

*Notes:*

1. Some allowance must be made in cases where child is knock-kneed, or obese.

1040

2. With very young children, an assistant is required to ensure knees do not bend and heels remain down.

3. Some practitioners like a weight on the headboard to counteract springy hair. If used, it should be used every time and recorded..

1045



CONDITION	PREVALENCE	AGE & HEIGHT AT DIAGNOSIS	CONCLUSIONS
Growth hormone deficiency <sup>6, 38; 57-63</sup>	1:4000 for severe - 1:2000 to include mild / borderline cases	MPHD present at 2.8yrs (0.6) with height SDS -4 (0.2). 88% present with growth failure prior to age 5y. Isolated GH presents at mean age 5.5 (1.2) and height SDS of -3 (0.2). GH therapy necessary to achieve best final height. Incidence may be declining in recent years - ?better obstetric care.	Screening at school entry should identify cases not found earlier - children would be below 0.4 centile (2.67 SDs) in most cases. Might identify >60% of available cases. Sensitivity improved if MPH available as milder cases might still be above 2 <sup>nd</sup> centile at age 5. Yield still very small and problems with specificity - see text.
Turner's syndrome <sup>38; 40; 41; 44; 45; 58; 60; 64; 65</sup>	1:2500 female births	Significant number of cases found at birth or first two years of life due to other features. Growth is normal during first 4 years of life, but average height is below 2 <sup>nd</sup> centile. 0.4 centile cut-off identifies 56% of girls at age 5y. Yield increased to 80% if parental heights known as TS girls are on average 22cms below MPH. Growth failure detectable by monitoring until 9y but neither sensitive nor specific. Early treatment probably useful for height and other reasons.	Measuring at age 5 could detect most cases not found earlier if MPH available.
Hypothyroidism <sup>66</sup>	1:6000 or less.	Little data available. Mean height at diagnosis -1.18: mean weight -0.12. 3/10 cases <2 <sup>nd</sup> centile, 1/10 <0.4 centile.	Children with heights below 0.4 centile merit exclusion of hypothyroidism but rarity of short stature as sole presenting complaint do not justify screening or GM.
Inflammatory bowel disease <sup>67-69</sup>	Data awaited from BPSU study	Ulcerative colitis unlikely to present with growth failure. Crohn's may do: mean height at presentation -1.11 ( $\pm$ 1.28) and 21% below 3 <sup>rd</sup> centile. 13% in another series had height below -2.0SDs but delay only averaged 7m.	growth failure in absence of other symptoms is recognised in Crohn's but accounts for a small proportion - very uncommon condition, GM not justified on this basis.
Coeliac disease <sup>70-74</sup>		Height at diagnosis -1.8 (0.9), none below -3SDs. Complete catch-up growth on gluten free diet. Another study, 30% <2SDs. One series with sever growth retardation. Asymptomatic short stature unusual.	Most cases symptomatic; GM not justified for detection of rare cases with isolated short stature.
Chronic renal disease		no data	
Skeletal dysplasias <sup>3</sup> .		Most cases present earlier - no data on those mild cases who might present in childhood.	
Noonan's <sup>75</sup>			
<b>Conditions causing tall stature</b>			
Marfan's syndrome <sup>76; 77</sup>	Rare	Pre-puberty, identification by height alone is very difficult	
Thyrotoxicosis <sup>78-82</sup>	Rare - <1:100,000		
Klinefelter's syndrome <sup>83</sup>	1:500 males	No data	
pituitary gigantism		Very rare	

1050

1050

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