Blank Children's Hospital
UnityPoint Health

Evidence-Based Clinical Practice Guideline on Linear Growth Measurement of Children

Authors: Jan M. Foote, DNP, ARNP, CPNP; Linda H. Brady, PhD, RN; Amber L. Burke, RN, CPN; Jennifer S. Cook, MD; Mary E. Dutcher, MS, RD, LD, CDE; Kathleen M. Gradoville, MA, ARNP, CPNP; Jennifer A. Groos, MD; Kimberly M. Kinkade, MSN, ARNP, CFNP; Reylon A. Meeks, MSN, MS, RN, CPN; Pamela J. Mohr, RN, CPN; Debra S. Schultheis RN, CPN; Brenda S. Walker, MSN, RNC.

RECOMMENDATIONS

The strength of evidence supporting each recommendation was graded according to modified U.S. Preventive Services Task Force (1996) Evidence-Based Practice Ratings:

A: There is good evidence to support the recommendation.

B: There is fair evidence to support the recommendation.

C: There is insufficient evidence to recommend for or against, but recommendations may be made on other grounds.

D: There is fair evidence to support exclusion of the practice.

E: There is good evidence to support exclusion of the practice.

NOTE: Key clinical practice recommendations are in bold text within shaded boxes.

A. MEASUREMENT INSTRUMENTS:

Section 1. Length Measurement Instruments

Clinical Practice	Rationale and References
1. Instruments for measuring recumbent length (length boards) must have these components: • **firm, flat horizontal surface for child to lie supine,** • **stationary headboard at a 90° angle to the horizontal surface,**	1. Measurements of infants and children need to be as accurate and reliable as possible. Measurements taken on instruments with these components have the best intra-examiner and inter-examiner reliability (Byrne & Lenz, 2002; Corkins et al., 2002; Davies & Holding, 1972; De Onis et al., 2004; Gordon et al., 1991; Johnson et al., 1999; Johnson et al., 1998; Johnson & Engstrom, 2002; Lampl, 1993; Lampl et al., 1992; Lawn et al., 2004; Smith et al., 1985; WHO MGRS Group, 2006). Experts agree that these components are necessary (Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002;

• **smoothly movable footboard at a 90° angle to the horizontal surface,** • **and attached fixed ruler. (A)**	Frisancho, 1993; Grimberg & De Leon, 2005; Grimberg & Lifshitz, 2007; Lampl et al., 2001; Moore & Roche, 1987; Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1988; Roche & Sun, 2003; Rosenfeld & Cohen, 2008; Schlenker & Raja, 2004; Smith & Wales, 1995; Tanner, 1994; U.S. DHEW, 1977; U.S. DHHS, n.d.; Wales et al., 2003; WHO, 2008; WHO, 1995).
2. The instrument's ruler should be marked in millimeter increments. **(A)**	2. Measuring in small increments improves the accuracy and precision of measurements (Davies & Holding, 1972; De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Lawn et al., 2004; Roche & Sun, 2003; WHO MGRS Group, 2006) compared to measuring in large increments (Byrne & Lenz, 2002; Colley et al., 1991; Doull et al., 1995). Experts agree that these increments are necessary (Cameron, 1986; CDC, 2007; Frisancho, 1993; Himes, 2009; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Schlenker & Raja, 2004; Spencer et al., 1996; U.S. DHHS, n.d.; Wales et al., 2003; WHO, 2008; WHO, 1995).
3. A tape measure should not be used to measure the length of infants and children. (E)	3. Using a tape measure by any method to obtain a length measurement results in poor intra-examiner and inter-examiner reliability (Byrne & Lenz, 2002; Corkins et al., 2002; Gibson et al, 2003; Johnson & Engstrom, 2002; Johnson et al., 1997; Johnson et al., 1998; Johnson et al., 1999; Rosenberg et al., 1992; Smith et al., 1985; Wilshin et al., 1999). Experts agree that a tape measure should never be used to measure length (Grimberg & De Leon, 2005; Grimberg & Lifshitz, 2007; Pinyerd-Zipf & Amer, 2002; U.S. DHHS, n.d.).

Section 2. Height Measurement Instruments

Clinical Practice	Rationale and References
1. Height measuring instruments (stadiometers) must have these components: • **vertical surface to stand against,** • **movable, horizontal headboard at a 90° angle to the vertical surface,** • **and attached fixed ruler. (A)**	1. Measurements of children need to be as accurate and reliable as possible. Measurements taken on instruments with these components have the best intra-examiner and inter-examiner reliability (Ahmed et al., 1990; Benefice & Malina, 1996; Chumlea et al., 1990; De Onis et al., 2004; Foster & Berenson, 1987; Foster et al., 1977; Gordon et al., 1991; Gordon-Larsen et al., 1997; Jordan et al., 1975; Klipstein-Brobusch et al., 1997; Regan et al., 1985; Roche & Sun, 2003; Roche et al., 1988; Voss et al., 1990, WHO MGRS Group, 2006). Experts agree that these components are necessary (Bailey, 2005; Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Cole, 2002; Frisancho, 1993; Grimberg & De

	Leon, 2005; Henry, 1992; Moore & Roche, 1987; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Schlenker & Raja, 2004; Smith & Wales, 1995; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; Voss, 2000; Wales et al., 2003; WHO, 2008; WHO, 1995).
2. There must be a footboard or other flat, firm, and uncarpeted surface for the child to stand upon that is at a 90° angle to the vertical surface. (B)	2. Standing upon an uneven or soft surface can result in an inaccurate and unreliable measurement. Experts agree that a footboard or other flat, firm surface is necessary (Cameron, 1986; CDC, 2007; Gordon et al., 1991; Pinyerd-Zipf & Amer, 2002; Roche & Sun, 2003; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; Voss, 2000; WHO, 2008; WHO, 1995).
3. The instrument's ruler or counter should be marked in millimeter increments. **(A)**	3. Measuring in small increments improves the accuracy and precision of measurements (De Onis et al., 2004; Gordon et al., 1991; Gordon-Larsen et al, 1997; Roche & Sun, 2003; Voss et al., 1990; WHO MGRS Group, 2006). Experts agree that these increments are necessary (Cameron, 1984; Cameron, 1986; CDC, 2007; Frisancho, 1993; Himes, 2009; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Roche & Sun, 2003; Schlenker & Raja, 2004; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; Voss, 2000; Wales et al., 2003; WHO, 2008; WHO, 1995).
4. A pedestal or step stool should be available for the measurer. This may be unnecessary if there is a digit counter on the stadiometer. **(C)**	4. When a child is taller than the measurer, standing on a pedestal or step stool allows the measurement on the ruler to be read at eye level, avoiding a parallax error (CDC, 2007; Chumlea & Guo, 2002; Moore & Roche, 1987; Schlenker & Raja, 2004; Tanner, 1994; U.S. DHHS, n.d.; Voss, 2000).
5. Less expensive measuring devices with a firm, vertical ruler and a horizontal, right angle headboard can have good precision and reliability when installed properly and calibrated regularly. (A)	5. Measurements taken on less expensive instruments with these components are comparable to measurements taken on more expensive stadiometers (Betts et al., 1992; Blizzard, 1988; Diamond et al., 1994; Henry et al., 1990; Roche et al, 1988; Voss & Bailey, 1994; Voss et al., 1990), provided that they are properly installed and calibrated. Experts agree that less expensive measuring devices can be accurate and reliable (Bailey, 2005; Cameron, 1984; Cameron, 1986; Chumlea & Guo, 2002; Grimberg & De Leon, 2005; Grimberg & Lifshitz, 2007; Henry, 1992; Moore & Roche, 1987; Tanner, 1994; Vogiatzi et al., 1998; Voss, 1995).
6. Wall charts and flip-up horizontal	6. Using these devices to measure height results in

bars (floppy-arm devices) mounted to weighing scales should not be used to measure the height of children. (E)	poor intra-examiner and inter-examiner reliability (Ahmed et al., 1990; Gray et al., 1985; Regan et al., 1985; Roche et al., 1988). Floppy-arm devices are not steady, do not maintain a right angle to the vertical ruler, and cannot provide an accurate and reliable height (Grimberg & De Leon, 2005; Grimberg & Lifshitz, 2007; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; U.S. DHHS, n.d.). The measuring rod is relatively sharp and poses a risk for harm to the child or the measurer (Pinyerd-Zipf & Amer, 2002; U.S. DHHS, n.d.). Other experts agree that these devices should never be used (Gordon et al., 1991; Henry, 1992; Himes, 2009; Tanner, 1994).

Section 3. Calibration of Instruments

Clinical Practice	Rationale and References
1. Instruments must be calibrated at regular intervals. (A) **All instruments should be calibrated at least monthly. (B)** **Instruments should be calibrated more frequently if variance is noted or if recommended by the manufacturer. Ideally instruments should be calibrated daily. (C)**	1. Length boards (Bunting & Weaver, 1997) and height measuring devices (Bunting & Weaver, 1997; Laing & Rossor, 1996; Voss et al., 1990) are frequently inaccurate by one centimeter or more. Many personnel are unaware of the inaccuracy of their instruments (Voss et al., 1990). Variability between measurements is increased when different instruments are used (Ahmed et al., 1990; Doull et al., 1995; Foster & Berenson, 1987; Foster et al., 1977; Henry et al., 1990; Lawn et al., 2004; Regan et al., 1985; Roche et al., 1988; Smith et al., 1985; Voss et al., 1990). It is not always possible to have children measured on the same instrument at each visit. Properly installed and calibrated instruments are more accurate and reliable. Experts agree that regular calibration is necessary (Bailey, 2005; Cameron, 1984; CDC, 2007; Cole, 2002; Gibson et al., 2003; Hearn et al., 1995; Henry et al., 1990; Himes, 2009; Pinyerd-Zipf & Amer, 2002; Rapaport & Bowlby, 2004; Reiter & Rosenfeld, 1998; Roche & Sun, 2003; Rosenfeld & Cohen, 2008; Tanner, 1994; Ulijaszek & Kerr, 1999; U.S. DHHS, n.d.; Voss, 1995; Voss, 2000; Voss et al., 1990).
2. In settings where many children with growth disorders or suspected growth disorders are seen, instruments should be calibrated daily. (B)	2. Children with growth disorders must be measured on instruments that are calibrated daily because accuracy and reliability of measurements are critical when making clinical decisions about growth,

	growth velocity, treatment, and the effects of therapy. These experts recommend that instruments are calibrated daily or before each clinic or measuring session (Tanner, 1994; Voss, 2000; Voss et al., 1990).
3. Portable and free standing stadiometers should be calibrated frequently and every time that they are moved. **(C)**	3. Portable and free standing stadiometers require frequent recalibration (Himes, 2009; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Voss & Bailey, 1994).
4. A rod of known and fixed height/length can be used to check the calibration of instruments. Measure the height/length of a calibration rod with the stadiometer/length board. Read the measurement to the last completed millimeter. The measurement reading should be exactly the same as the known height/length of the calibration rod (e.g., a 60.0 cm calibration rod should be measured as 60.0 cm with the instrument). If the measurement does not agree with the height/length of the calibration rod, adjust the instrument according to manufacturer instructions. **(B)**	4. Regular calibration ensures that instruments produce accurate and reliable measurements when proper measurement techniques are used (Bailey, 2005; Cameron, 1984; CDC, 2007; Cole, 2002; Gibson et al., 2003; Hearn et al., 1995; Henry et al., 1990; Himes, 2009; Pinyerd-Zipf & Amer, 2002; Rapaport & Bowlby, 2004; Reiter & Rosenfeld, 1998; Roche & Sun, 2003; Rosenfeld & Cohen, 2008; Tanner, 1994; Ulijaszek & Kerr, 1999; U.S. DHHS, n.d.; Voss, 1995; Voss, 2000; Voss et al., 1990).

B. MEASUREMENT TECHNIQUES:

Section 1. Personnel

Clinical Practice	Rationale and References
1. Personnel who measure the growth of infants, children, and adolescents need proper and regular education. (A) **Educational sessions and/or demonstrated competency should occur on an annual basis. Additional refresher sessions should occur when a**	1. Growth is well established as an important and sensitive indicator of health in children (Hindmarsh & Brook, 1988; Tanner, 1986a; Tanner, 1986b). Measuring growth is subject to human error due to poor technique (Ahmed et al., 1995; Gibson et al., 2003; Grimberg & De Leon, 2005; Himes, 2009; Lipman et al., 2000; Lipman et al., 2004; Mulligan et al., 1998; Richmond & Rogol, 2004; Stoddard et al., 2008; Vegelin et al., 2003; Waite, 1997). Ideally an infant or child should be measured by the same person at each visit because inter-examiner variability is greater than intra-examiner variability (Betts et al., 1992; Cameron, 1984; Chang et al., 1993; Chumlea et al., 1990; Davies & Holding, 1972; De Onis et al., 2004; Foster & Berenson, 19887; Foster et al., 1977; Gordon-Larsen et al., 1997; Johnson & Engstrom, 2002; Johnson et al., 1999; Johnston et al., 1998; Johnson et al., 1997; Himes, 2009; Klipstein-Brobusch et al., 1997; Lawn et al., 2004;

lack of standardization is observed. (C)	Marks et al., 1989; Mueller & Kaplowitz, 1994; Rosenberg et al., 1992; Smith et al., 1985; Ulijaszek & Lourie, 1994; Voss, 2000; Voss & Bailey, 1994; Voss et al., 1990; WHO MGRS Group, 2006). In many settings it is not practical to have children measured by the same person at each visit. It is possible to have good precision and reliability among different measurers (De Onis et al., 2004; Foster & Berenson, 1987; Foster et al., 1977; Gordon et al., 1991; Jordan et al., 1975; Klipstein-Grobusch et al., 1997; Roche & Sun, 2003; Tanner & Whitehouse, 1982; WHO MGRS Group, 2006). Proper education can improve the accuracy and reliability of linear growth measurements (Gibson et al., 2003; Lipman et al., 2004), and is necessary for quality assurance purposes.

Section 2. Length Measurement Techniques

Clinical Practice	Rationale and References
1. Remove the infant or child's shoes, socks, hat, and all clothing. The diaper should be removed or loosened. **(A)**	1. Removing shoes, socks, hats, and all clothing allows measurements to be more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 2001; Lampl et al., 1992; Roche & Sun, 2003; WHO MGRS Group, 2006). This allows the infant or child to be positioned correctly and for the examiner to visualize the positioning of the infant or child. Experts agree that shoes, socks, hat, and all clothing should be removed (Cameron, 1986; CDC, 2007; Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Schlenker & Raja, 2004; Smith & Wales, 1995; Tanner, 1994; Tanner & Whitehouse, 1982; WHO, 2008). Diapers can make it difficult to hold the infant's legs together and straighten them out fully (De Onis et al., 2004).
2. Remove hair ornaments and undo hair styles that are positioned upon the crown of the head. **(A)**	2. Hair ornaments, braids, pony tails, and the like may interfere with positioning of the head (De Onis et al., 2004; WHO MGRS Group, 2006) and cause lengths to be overestimated.
3. Cover the length board with a thin cloth or soft paper. Clean instruments between children. **(C)**	3. Covering the length board provides for the child's comfort, and along with cleaning, provides for improved hygiene (CDC, 2007; WHO, 2008).
4. Two measurers are required to obtain a length measurement. (A)	4. Correct positioning cannot be accomplished without two people. Length measurements taken by two measurers results in improved intra-examiner and inter-examiner reliability (Chang et al., 1993; Davies & Holding, 1972; De Onis et al., 2004; Doull et al., 1995; Gordon et al., 1991; Lampl, 1993; Lampl et al., 2001; Lampl et al., 1992; Lawn et al., 2004; Roche & Sun,

	2003; WHO MGRS Group, 2006) compared to measurements taken by a single measurer (Colley et al., 1991; Corkins et al., 2002; Johnson & Engstrom, 2002; Johnson et al., 1997; Johnson et al., 1999; Johnson et al., 1998; Miller & Hassanein, 1971; Rosenberg et al., 1992; Shinwell & Shlomo, 2003; Smith et al., 1985). Experts agree that two measurers are required (Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Cole, 2002; Frisancho, 1993; Grimberg & De Leon, 2005; Grimberg & Lifshitz, 2007; Hamill et al., 1979; Lampl et al., 2001; Lipman et al., 2000; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Rapaport & Bowlby, 2004; Reiter & Rosenfeld, 1998; Schlenker & Raja, 2004; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHEW, 1977; U.S. DHHS, n.d.; Wales et al., 2003; WHO, 2008; WHO, 1995).
5. A parent, guardian, or caregiver may substitute for one measurer when a second health professional is not available and procedures are carefully explained and understood. **(C)**	5. In many settings, only one health professional is available to obtain measurements. Experts agree that parents/guardians/caregivers can assist health professionals. (Lampl et al., 2001; Lipman et al., 2000; Moore & Roche, 1987; Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; Roche & Sun, 2003; Wales et al., 2003; WHO, 2008).
6. The infant or child should be placed in the supine position on the length board. (A) Encourage and comfort the child in a developmentally appropriate manner. This can be accomplished when a caregiver known to the child interacts calmly with them. Toys, pictures, or mobiles hanging from the ceiling may be useful distractions. **(C)** Never leave an infant or child unattended on the length board. **(C)**	6. Positioning the infant or child in the supine position allows for full extension of the body against a firm surface, and results in improved intra-examiner and inter-examiner reliability (De Onis et al., 2004; Gordon et al., 1991; Lampl, 1992; Lampl et al., 1992; Roche & Sun, 2003; Smith et al., 1985; WHO MGRS Group, 2006) compared to the lateral position (Johnson & Engstrom, 2002; Johnson et al., 1998; Wilshin et al., 1999). Experts agree that the infant/child should be placed in the supine position (Bailey, 2005; Cameron, 1984; Cameron, 1986; CDC, 2007; Moore & Roche, 1987; Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; Rapaport & Bowlby, 2004; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Schlenker & Raja, 2004; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; WHO, 2008; WHO, 1995). Lying an infant or child down may generate a sense of insecurity and lead to resistance and/or crying. The infant or child must be adequately protected from any physical injury.
7. The assistant measurer, standing directly behind the headboard, should	7. If the head is not touching the headboard, the measurement will be longer than the true length. When

hold the crown of the head against the stationary, vertical headboard by cupping the palms of the hands over the sides of the head. The hair should be compressed against the headboard (A) The assistant measurer may be able to hold the shoulders down at the same time. **(C)**	the crown of the head is against a headboard, measurements are more accurate and reliable (Davies & Holding, 1972; De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Lawn et al., 2004; Roche & Sun, 2003; WHO MGRS Group, 2006) than when there is no headboard (Corkins et al., 2002; Johnson et al., 1999; Johnson et al., 1998; Smith et al., 1985; Wilshin et al., 1999). Experts agree (Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Frisancho, 1993; Grimberg & Lifshitz, 2007; Lampl et al., 2001; Moore & Roche, 1987; Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHEW, 1977; U.S. DHHS, n.d.; Wales et al., 2003; WHO, 2008; WHO, 1995). The hair must be compressed to minimize the effect of hair thickness producing a false measurement (Cameron, 1986). Holding the shoulders down may help maintain normal positioning of the trunk.
8. The head should be positioned in the Frankfort vertical plane perpendicular to the long axis of the trunk. Make sure the chin is not tucked in against the chest or stretched too far back. (A)	8. If the head is not positioned in the Frankfort plane, the measurement may be shorter than the true length. To enhance reproducibility of head positioning, the head should be placed in the Frankfort plane. When the head is positioned in the Frankfort plane, measurements are more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Lawn et al., 2004; Roche & Sun, 2003; Smith et al., 1985; WHO MGRS Group, 2006). Experts agree (Cameron, 1984; Cameron, 1986; CDC, 2007; Grimberg & De Leon, 2005; Lampl et al., 2001; Pinyerd, 1992; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; WHO, 2008; WHO, 1995).
9. The lead measurer should align the fully extended body straight along the length board, with the head, shoulders and buttocks flat on the length board, legs together, and arms resting against the sides of the trunk. (A)	9. When positioned in this manner, measurements are more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Roche & Sun, 2003; Smith et al., 1985; WHO MGRS Group, 2006). Experts agree (Cameron, 1986; Chumlea & Guo, 2002; Moore & Roche, 1987; Schlenker & Raja, 2004; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; WHO, 2008; WHO, 1995).
10. The lead measurer places one hand on both knees to fully extend both legs flat on the length board. (A)	10. If the legs are not fully extended, the measurement will be shorter than the true length. With both legs fully extended, measurements are more accurate and

Note: In infants (especially newborns), care should be taken to extend the legs gently.	reliable (Corkins et al., 2002; De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Lawn et al., 2004; Roche & Sun, 2003; U.S. DHEW, 1977; Wales et al., 2003; WHO MGRS Group, 2006). Experts agree (Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Frisancho, 1993; Grimberg & De Leon, 2005; Grimberg & Lifshitz, 2007; Lampl et al., 2001; Moore & Roche, 1987; Pinyerd, 1992; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Schlenker & Raja, 2004; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; WHO, 2008; WHO, 1995).
11. Ensure that the subject does not change position (e.g., head no longer touching headboard; shoulders and/or hips rotated; back arched; or legs bent). Reposition as necessary. (A)	11. When the legs are fully extended, the head may move away from the headboard. During the procedure, the infant or child may resist and alter their position. When positioned properly, measurements are more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Roche & Sun, 2003; WHO MGRS Group, 2006). Experts agree (Cameron, 1984; Cameron, 1986; Chumlea & Guo, 2002; Lampl et al., 2001; Moore & Roche, 1987; Schlenker & Raja, 2004; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHEW, 1977; U.S. DHHS, n.d.; WHO, 2008; WHO, 1995).
12. With the other hand, the lead measurer moves the footboard against the heels of both feet at a right angle to the footboard, with the toes pointing upward. The pressure should be sufficient to compress the soft tissues of the heels but not enough to alter full extension of the body. (A)	12. With the footboard positioned correctly against the heels of both feet, measurements are more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Lawn et al., 2004; Roche & Sun, 2003; WHO MGRS Group, 2006) compared to measuring to the heel of only one foot (Chang et al., 1993; Colley et al., 1991; Corkins et al., 2002; Miller & Hassanein, 1971; Rosenberg et al., 1992). If the feet are not flat against the footboard or the feet are extended or the toes are bent, the measurement will be longer than the true length. If only one heel is positioned against the footboard, the measurement may be inaccurate and unreliable (Pinyerd-Zipf & Amer, 2002; U.S. DHHS, n.d.). Experts agree that length should be measured to the base of both heels (Cameron, 1984; Cameron, 1986; CDC, 2007; Frisancho, 1993; Grimberg & De Leon, 2005; Schlenker & Raja, 2004; Tanner, 1994; Tanner & Whitehouse, 1982; WHO, 2008; WHO, 1995).
13. Read the measurement, as the distance between the headboard and	13. Measurements rounded up to the nearest millimeter can produce statistical bias and invalidate estimates of

the footboard, to the last completed millimeter. (A) Centimeters may be converted to inches by dividing by 2.54. **(A)**	growth velocity (Cameron, 1984); therefore measurements should be read to last completed increment. Measuring in small increments improves the accuracy and reliability of measurements (Davies & Holding, 1972; De Onis et al., 2004; Gordon et al., 1991; Lampl, 1993; Lampl et al., 1992; Lawn et al., 2004; Roche & Sun, 2003; WHO MGRS Group, 2006) compared to measuring in large increments (Byrne & Lenz, 2002; Colley et al., 1991; Doull et al., 1995). Experts agree that measurements should be read to this degree of refinement to be as precise and accurate as possible (Cameron, 1986; CDC, 2007; Frisancho, 1993; Himes, 2009; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Schlenker & Raja, 2004; Spencer et al., 1996; U.S. DHHS, n.d.; Wales et al., 2003; WHO, 2008; WHO, 1995). Consistency is important in reading measurements.
14. Record the measurement immediately. **(C)**	14. If growth data are not recorded immediately, measurements may be recorded incorrectly. These experts agree that measurements should be immediately recorded (Henry, 1992; Moore & Roche, 1987; Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; U.S. DHHS, n.d.).
15. For an uncooperative child, it may be necessary to apply gentle immobilization or reattempt to measure the child later in the visit. In rare situations when it is not possible to obtain an accurate measurement, record the circumstances. **(C)**	15. Gentle immobilization may be necessary to ensure adequate positioning (Gordon et al., 1991). If unable to obtain an accurate measurement using gentle immobilization, it may be helpful to try to measure the child later in the visit after he or she calms down. In rare situations, an accurate measurement may not be possible.

Section 3. Height Measurement Techniques

Clinical Practice	Rationale and References
1. Remove the child's shoes, socks with thick pile, hat, and heavy outer clothing. **(A)**	1. Removing shoes, socks with thick pile, hat, and heavy outer clothing allows the child to be positioned correctly so measurements will be more accurate and reliable (Cotterill et al., 1993; De Onis et al., 2003; Foster & Berenson, 1987; Foster et al., 1977; Gordon et al., 1991; Gordon-Larsen et al., 1997; Jordan et al., 1975; Roche & Sun, 2003; Voss et al., 1990; WHO MGRS Group, 2006), and allows the examiner to visualize the positioning of the child. Experts agree that shoes, socks with thick pile, hats, and heavy outer clothing should be removed (Cameron, 1984;

	Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Grimberg & Lifshitz, 2007; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Schlenker & Raja, 2004; Smith & Wales, 1995; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHEW, 1975; U.S. DHHS, n.d.; Voss, 2000; Wales et al., 2003; WHO, 2008; WHO, 1995).
2. Remove hair ornaments and undo hair styles that are positioned upon the crown of the head. **(C)**	2. Hair ornaments, braids, pony tails, and the like may interfere with positioning of the head (De Onis et al., 2004) and cause heights to be overestimated. Experts agree (CDC, 2007; Chumlea & Guo, 2002; Henry, 1992; U.S. DHHS, n.d.; Pinyerd-Zipf & Amer, 2002; WHO, 2008).
3. The instrument should be kept clean. When children are in bare feet, the footboard or flat surface can be covered with a thin paper between children. **(C)**	3. Standing on a clean surface provides for improved hygiene.
4. The child stands fully erect on the footboard or flat surface with their back against the wall or vertical surface of the measuring device and their heels flush against the base. (A)	4. Positioning the child in this manner allows for full extension of the body against a firm surface, and allows measurements to be more accurate and reliable (De Onis et al., 2004; Foster & Berenson, 1987; Foster et al., 1977; Gordon et al., 1991; Gordon-Larsen et al., 1997; Jordan et al., 1975; Roche & Sun, 2003; Tanner, 1994; Tanner & Whitehouse, 1982; Voss et al., 1990; WHO MGRS Group, 2006). Experts agree (Cameron, 1984; Cameron, 1986; CDC, 2007; Grimberg & Lifshitz, 2007; Henry, 1992; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Rapaport & Bowlby, 2004; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Schlenker & Raja, 2004; U.S. DHHS, n.d.; Voss, 2000; WHO, 2008; WHO, 1995).
5. The weight of the child should be evenly distributed on both feet with heels together. (A) With the heels together, the medial (inner) borders of the feet may be at an angle with toes comfortably apart. **(C)**	5. Positioning the feet and heels in this manner allows the child to maintain an erect position and allows measurements to be more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Roche & Sun, 2003; WHO MGRS Group, 2006). Experts agree that heels should be together (Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Grimberg & De Leon, 2005; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Schlenker & Raja, 2004; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; Voss, 2000; WHO, 1995; WHO, 2008). If borders of the feet are parallel or nearly parallel,

	some children are unable to maintain balance to stand erect (Gordon et al., 1991; Tanner, 1994).
6. The occiput, scapulae, buttocks, and heels should be in contact with the wall or vertical surface of the measuring device. (A)	6. When positioned properly with erect posture and proper instruments and techniques, measurements are more accurate and reliable (De Onis et al., 2004; Foster & Berenson, 1987; Foster et al., 1977; Gordon et al., 1991; Gordon-Larsen et al., 1997; Roche & Sun, 2003; Tanner, 1994; Voss et al., 1990; WHO MGRS Group, 2006). Experts agree (Cameron, 1984; Cameron, 1986; CDC, 2007; Cole, 2002; Frisancho, 1993; Grimberg & De Leon, 2005; Grimberg & Lifshitz, 2007; Henry, 1992; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Smith & Wales, 1995; U.S. DHHS, n.d.; Voss, 2000; WHO, 2008; WHO, 1995).
7. Ensure that any positional lordosis is minimized; the knees are fully extended; and the heels are flat. It may be necessary for an assistant, parent, guardian, or caregiver to place a hand on the abdomen, legs, or feet. (C)	7. If the child has positional lordosis or the knees are bent, the height may be underestimated. If the heels rise off the flat surface, the height may be overestimated. When positioned properly, measurements are more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Gordon-Larsen et al., 1997; Jordan et al., 1975; Roche & Sun, 2003; Tanner, 1994; Tanner & Whitehouse, 1982; Voss et al., 1990; WHO MGRS Group, 2006). Experts agree that positional lordosis should be minimized (Grimberg & De Leon, 2005; Henry, 1992; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; WHO, 2008). Experts agree that knees need to be fully extended and heels must be flat (Cameron, 1984; Cameron, 1986; Chumlea & Guo, 2002; Grimberg & Lifshitz, 2007; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Schlenker & Raja, 2004; U.S. DHHS, n.d.; Voss, 2000; WHO, 2008; WHO, 1995).
8. The shoulders should be relaxed, with arms hanging down freely by the sides of the trunk. (C)	8. When positioned properly, measurements are more accurate and reliable (Gordon et al., 1991; Gordon-Larsen et al., 1997; Jordan et al., 1975; Roche & Sun, 2003; Voss et al., 1990). Experts agree that shoulders should be relaxed (Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Grimberg & De Leon, 2005; Henry, 1992; Pinyerd-Zipf & Amer, 2002; Schlenker & Raja, 2004; Smith & Wales, 1995; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; Voss, 2000; Wales et al., 2003; WHO, 1995).
9. Gently position the head in the	9. When the head is positioned with only the eyes

Frankfort horizontal plane. (A)	looking straight ahead, the measurements are less accurate and less reliable (Gordon et al., 1991) and the measurement may be shorter than the true height. To enhance reproducibility of head positioning, the head should be placed in the Frankfort plane. When the head is positioned in the Frankfort plane, measurements are more accurate and reliable (Benefice & Malina, 1996; De Onis et al., 2004; Gordon et al., 1991; Gordon-Larsen et al., 1997; Jordan et al., 1975; Roche & Sun, 2003; Voss et al., 1990; WHO MGRS Group, 2006). Experts agree that the head should be positioned in the Frankfort plane (Bailey, 2005; Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Frisancho, 1993; Grimberg & De Leon, 2005; Pinyerd-Zipf & Amer, 2002; Rapaport & Bowlby, 2004; Reiter & Rosenfeld, 1998; Tanner, 1994; Tanner & Whitehouse, 1982; Wales et al., 2003).
10. The child may continue normal breathing. **(B)** Asking the child to take a deep breath and hold it while taking the measurement is not recommended. **(D)**	10. Measurements are accurate and reliable while the child is breathing normally (De Onis et al., 2004; WHO MGRS Group, 2006). Experts agree that the child may continue normal breathing. (Bailey, 2005; Grimberg & Lifshitz, 2007; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Tanner, 1994; Tanner & Whitehouse, 1982; Voss, 2000; WHO, 2008). The shoulders may be naturally raised when the child takes a deep breath, and some children may have difficulty taking a deep breath and holding it.
11. Encourage the child to maintain a fully erect position while moving the headboard down and onto the most superior point on the head with sufficient pressure to compress the hair. (A)	11. With the headboard positioned correctly against the head, measurements are more accurate and reliable (De Onis et al., 2004; Gordon et al., 1991; Gordon-Larsen et al., 1997; Roche & Sun, 2003; Voss et al., 1990; WHO MGRS Group, 2006). Experts agree (Bailey, 2005; Cameron, 1984; Cameron, 1986; CDC, 2007; Chumlea & Guo, 2002; Frisancho, 1993; Grimberg & Lifshitz, 2007; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Schlenker & Raja, 2004; Smith & Wales, 1995; Tanner, 1994; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; Voss, 2000; Wales et al., 2003; WHO, 2008; WHO, 1995). The hair must be compressed to minimize the effect of hair thickness producing a false measurement (Cameron, 1986; Frisancho, 1993).
12. Read the measurement at eye level, as the distance from the footboard or floor to the headboard, to the last	12. Height rounded up to the nearest millimeter can produce statistical bias and invalidate estimates of growth velocity (Cameron, 1984); therefore

completed millimeter. (A) Centimeters may be converted to inches by dividing by 2.54. **(A)**	measurements should be read to last completed increment. Measuring in small increments improves the accuracy and reliability of measurements (De Onis et al., 2004; Gordon et al., 1991; Gordon-Larsen et al., 1997; Roche & Sun, 2003; Voss et al., 1990; WHO MGRS Group, 2006). Experts agree that measurements should be read to this degree of refinement to be as precise and accurate as possible (Cameron, 1984; Cameron, 1986; CDC, 2007; Frisancho, 1993; Himes, 2009; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Schlenker & Raja, 2004; Smith & Wales, 1995; Tanner & Whitehouse, 1982; U.S. DHHS, n.d.; Voss, 2000; Wales et al., 2003; WHO, 2008; WHO, 1995). Consistency is important in reading measurements.
13. Record the measurement immediately. **(C)**	13. If growth data are not recorded immediately, measurements may be recorded incorrectly. Experts agree that measurements should be immediately recorded (Henry, 1992; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; U.S. DHHS, n.d.).

Section 4. Diurnal Height Variation

Clinical Practice	Rationale and References
1. The time of day should be recorded when measurements are taken. **(A)**	1. Studies have shown that mean height loss in children from morning to afternoon or evening can range from 0.47 to 2.8 cm (Buckler, 1978; Kobayashi et al., 1999; Kobayashi & Togo, 1993; Lampl, 1992; Rodriguez et al., 2000; Siklar et al., 2005; Strickland & Shearin, 1972; Tillmann & Clayton, 2001; Voss & Bailey, 1997) related to changes in the fluid content of intervertebral discs associated with axial loading of the spine and gravity (Boos et al, 1993; Keller & Nathan, 1999; Roberts et al, 1998). For children in whom there are concerns about growth, serial measurements should ideally be taken at the same time of day to establish an accurate growth velocity (Bailey, 2005; Buckler, 1978; Grimberg & De Leon, 2005; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Ulijaszek & Lourie, 1994; Voss, 2000; Wales & Gibson, 1994; Wales et al., 2003). Early morning appointments, shortly after rising, may be useful in obtaining a measurement closer to maximum height. Afternoon appointments may be recommended for serial measurements of some children because most of the height loss occurs early in the day (Buckler, 1978; Rodriguez et al., 2000; Tillmann & Clayton, 2001, Voss, 2000, Voss & Bailey, 1997). Always measuring at the same time of day is not practical in most settings. Awareness of diurnal variation and recording of

	the time of day is an alternative (Roche & Sun, 2003; Rosenfeld & Cohen, 2008; Siklar et al., 2005; Voss, 2000).
2. Stretching of the spine by applying gentle upward pressure under the mastoid processes is not recommended. (E)	2. "Stretching" may reduce but doesn't prevent diurnal variation (Tillmann & Clayton, 2001; Voss & Bailey, 1997; Whitehouse et al., 1974). Different measurers "stretch" by different amounts (Bailey, 2005). "Stretching" may increase the inter-examiner variance and error (Bailey, 2005; Gordon et al., 1991; Hall, 2000; Voss, 2000; Wales et al., 2003). The "unstretched" technique gives similar values for estimating growth velocity (Thomsen et al., 1990; Tillmann & Clayton, 2001). Good reliability has been demonstrated using a "non-stretched" technique (De Onis et al., 2004; Foster & Berenson, 1987; Foster et al., 1977; Gordon et al., 2003, Roche & Sun, 2003; WHO MGRS Group, 2006). Other experts do not recommend "stretching" (Bailey, 2005; CDC, 2007; Chumlea & Guo, 2002; De Onis et al., 2004; Gordon et al., 1991; Grimberg & Lifshitz, 2007; Moore & Roche, 1987; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Roche & Sun, 2003; Rosenfeld & Cohen, 2008; Schlenker & Raja, 2004; Ulijaszek & Lourie, 1994; U.S. DHHS, n.d.; Voss, 2000; Wales et al., 2003; WHO, 2008; WHO, 1995).

Section 5. Replicate Measurements

Clinical Practice	Rationale and References
1. All children should be measured at least twice (ideally three times) in succession during each encounter, while repositioning between each of the measurements. (A)	1. Living subjects do not have fixed heights or lengths. All measurements have intrinsic variability or precision error when repeated. Measurements can be variable due to the instrument, the technical capacity of the measurer, and the time of day; however a significant amount of the variance can be attributable to the child's behavior, posture, movement, and cooperation (Ahmed et al., 1990; Lampl et al., 2001; Voss & Bailey, 1994; Voss et al., 1990). Single measurements do not compare well to the mean of more than one measurement (Ahmed et al., 1990; Corkins et al., 2002). Growth assessments are compromised without precise measurements. To reduce precision error, measurements need to be repeated. Experts agree that precision is increased by measuring more than once and using the mean of the measurements (Cameron, 1984; Chumlea & Guo, 2002; De Onis et al.,

	2004; Doull et al., 1995; Feucht, 2000; Frisancho, 1993; Grimberg & De Leon, 2005; Hamill et al., 1979; Healy, 1989; Henry, 1992; Himes, 2009; Himes, 1989; Marks et al., 1989; Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008; Tanner, 1994; Ulijaszek & Kerr, 1999; Ulijaszek & Lourie, 1994; U.S. DHHS, n.d.; Voss, 1995; WHO MGRS Group, 2006). Some experts recommend that three measurements should be taken (Grimberg & De Leon, 2005; Henry, 1992; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008). If the infant or child is not repositioned before measuring again, the measurer is simply reading the measurement again rather than measuring the child again.
2. Record the mean of the values if the variation in measurements is within 0.5 cm (ideally within 0.3 cm). If the variation exceeds the limit, then measure again and use the mean of the measures in closest agreement. If none of the measures are within these limits of tolerance, have another measurer assist with the measurement, check your technique, and plan an education session. **(C)**	2. For quality assurance purposes, there must be a set limit of tolerance (Chumlea & Guo, 2002; Chumlea et al., 1990; Cole, 2002; De Onis et al., 2004; Feucht, 2000; Ulijaszek & Lourie, 1994; U.S. DHHS, n.d.; Voss, 1995; WHO MGRS Group, 2006).
3. For children with growth disorders or suspected growth disorders, they should be measured three times in succession and the limit of tolerance should be no more than 0.3 cm between the three measurements. **(C)**	3. Children with growth disorders or suspected growth disorders must have growth measurements that are as accurate and precise as possible. Experts agree. (Grimberg & De Leon, 2005; Henry, 1992; Pinyerd-Zipf & Amer, 2002; Reiter & Rosenfeld, 1998; Rosenfeld & Cohen, 2008).

Section 6. Blind Measurements

Clinical Practice	Rationale and References
1. The measurer should not refer to or attempt to recall the previous height or length of the child, when it is known, prior to measuring the child at subsequent visits. **(B)**	1. A measurer may consciously or otherwise continue measuring the child until they get a reading that is expected. When measurements are "blind", bias can be reduced (Hamill et al., 1979; Voss, 2000; Voss et al., 1990).
2. If the mean value of the replicate measurements is in an unexpected range for the child, reposition the child and	2. Apparent decreases or extreme increases in length or height suggest possible measurement, recording, or plotting errors. The child should be measured

measure again. (C)	again to determine if a measurement or recording error has occurred.

Section 7. Measuring Length Vs. Height

Clinical Practice	Rationale and References
1. Length should be measured in children less than 24 months of age and in children who cannot stand unassisted. (A)	1. Children who are under 24 months of age and those who cannot stand unassisted cannot be properly positioned to obtain a height measurement as accurate and reliable as a length measurement (Betts et al., 1992; De Onis et al., 2004; Gordon et al., 1991; Lipman et al., 2000; Roche & Sun, 2003; U.S. DHHS, n.d.; WHO MGRS Group, 2006).
2. Between 24 and 36 months of age, either length or height or both may be measured. The type of measurement must be noted. **(C)**	2. Between 24 and 36 months of age, either length or height or both measurements may be obtained. Both growth reference curves exist for this age group (Kuczmarski et al., 2000). Recording both measurements allows for comparisons to be made, and valid growth velocity to be calculated for current and future visits (Pinyerd, 1992; Pinyerd-Zipf & Amer, 2002; Tanner, 1994). The type of measurement must be noted because length and height vary systematically. Standing height is less than recumbent length with mean differences ranging from 0.4 to 2.3 cm between 18 and 36 months of age (Betts et al., 1992; Fredriks et al., 2000; Grimberg & De Leon, 2005; Haschke et al., 2000; Roche & Davila, 1974; WHO, 2008). Plotting height on a length growth curve will give the false perception that growth has decelerated (Grimberg & De Leon, 2005; Lipman et al., 2000), and plotting length on a height growth curve will give the false perception that growth has accelerated.

Section 8. Special Considerations

Clinical Practice	Rationale and References
1. If the child cannot easily place their head, scapulae, buttocks, and heels in one vertical plane, a minimum of two contact points (the back of the head and buttocks, or the heels and buttocks) should be in contact with the wall or vertical surface of the measuring device with the trunk vertical and balanced over the waist. Record the presence of the condition. **(C)**	1. Some children, such as those who are overweight, cannot place the back of their head, scapulae, buttocks, and heels in one vertical plane while maintaining a reasonable natural stance and balance (CDC, 2007; Gordon et al., 1990; Pinyerd-Zipf & Amer, 2002; Roche & Sun, 2003; Voss, 2000; WHO, 2008).
2. If the child has genu valgum, feet should be separated so that the medial borders of the knees are in contact but not overlapping. Record the	2. Some allowance must be made where the child has genu valgum so the knees are not overlapping or bent (Cameron, 1984; Cameron,

presence of genu valgum. **(C)**	1986; Gordon et al., 1991; Roche & Sun, 2003; Voss, 2000).
3. If the child has leg length asymmetry, the child should stand on the longer leg with the shorter leg supported by a block or wedge of suitable height until the pelvis is level and both knees are fully extended. When measuring length, keep the legs together and measure to the heel of the longest leg. Record the presence of leg length asymmetry. **(C)**	3. If the child is not positioned correctly, the measurement may be different from the true value of the height. Experts agree that some allowance must be made where the child has leg length asymmetry (Cameron, 1984; Cameron, 1986; Gordon et al., 1991).
4. If the child has scoliosis, ensure that the child is achieving his or her maximum height and record the presence of scoliosis. **(C)**	4. Scoliosis is a common problem and should be considered in the measurement of children (Cameron, 1984).
5. If the child has low-set ears, the child's eyes should be looking straight ahead if she or he is standing, and the eyes should be looking straight up if she or he is lying down. Record the presence of low-set ears. **(C)**	5. Some children have low-set ears and positioning them in the Frankfort plane would not achieve their full height or length.
6. Be aware that measured length in newborns may be influenced by their normal flexor posture, breech presentation, the presence of molding, and/or caput succedaneum. Record the presence of the condition. Their length may need to be reassessed after these conditions subside. **(C)**	6. Newborns have a posture of marked limb flexion from their intrauterine position that gradually decreases (Shinwell & Shlomo, 2003), but may result in a measured length being underestimated. Some newborns have temporary molding of the skull and/or diffuse swelling of the scalp that may result in a measured length being overestimated.
7. When a supine length cannot be measured in infants and children due to conditions such as potential airway obstruction, neural tube defects, other defects of the posterior cranium or spine, or post-operative status, length may be measured in the lateral position. Record the presence of the condition. **(C)**	7. Some infants and children may not tolerate supine positioning.
8. Alternative measurements to height or length may be taken when a child over 36 months of age has special health care needs. (B) If full body recumbent length is measured in a child with spasticity, contractures, and/or other musculoskeletal abnormalities, measure the side of the body that is unaffected or less affected and that can be extended the fullest. Record the side measured and the presence of spasticity, joint contractures, and/or other musculoskeletal	8. Some children with special health care needs are unable to stand unassisted and/or have physical disabilities (e.g., spasticity, joint contractures, other musculoskeletal abnormalities, and poor cooperation due to cognitive deficits) that make it difficult to obtain accurate and reliable measurements. Alternative measurements, such as arm span, crown-rump length, sitting height, knee height, and other segmental lengths, may be taken to assess growth (Cameron, 1984; Eckvall, 2005; Feucht, 2000; Gauld et al., 2004; Kong et al., 1999;

abnormalities. **(C)**	Krick et al., 1996; Lohman et al., 1991; Murphy, 2002; Pipes & Pritkin, 1997; Spender et al., 1989; Stallings et al., 1993; Stevenson, 1996; Stevenson, 1995; University of Virginia Health System, 2006; U.S. DHHS, n.d.). Measurements of length can be significantly greater on the unaffected side compared to the affected side in children with hemiplegic cerebral palsy (Stevenson et al., 1995). Consistency is important in obtaining measurements.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

The quality of supporting evidence was rated according to the U.S. Preventive Services Task Force (1996) Evidence-Based Practice Ratings:

I: Evidence obtained from at least one properly randomized controlled trial.

II-1: Evidence obtained from well-designed controlled trials without randomization.

II-2: Evidence obtained from well-designed cohort or case-control analytic studies preferably from more than one center or research group.

II-3: Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments could also be regarded as this type of evidence.

III: Opinions of respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees.

REFERENCES:

Ahmed, M. L., Allen, A. D., Dunger, D. B., & Macfarlane, A. (1995). The Oxford growth study: A district growth surveillance programme 1988-1994. *Journal of Medical Screening, 2,* 160-163. **(III)**

Ahmed, M. L., Yudkin, P. L., Macfarlane, J. A., McPherson, K., & Dunger, D. B. (1990). Are measurements of height made by health visitors sufficiently accurate for routine screening of growth? *Archives of Disease in Childhood, 65,* 1345-1348. **(II-1)**

Bailey, B. J. R. (2005). Anthropometry. In P. Armitage & T. Colton, (Eds.), *Encyclopedia of biostatistics* (2nd ed., Vol. 1.) (pp. 207-212). Hoboken, NJ: Wiley. **(III)**

Benefice, E., & Malina, R. (1996). Body size, body composition and motor performances of mild-to-moderately undernourished Senegalese children. *Annals of Human Biology, 23*(4), 307-321. **(II-2)**

Betts, P. R., Voss, L. D., & Bailey, B. J. R. (1992). Measuring the heights of very young children. *British Medical Journal, 304,* 1351-1352. **(II-2)**

Blizzard, R. M. (1988). Editor's comment. *Growth, Genetics, and Hormones, 4*(2). **(III)**

Boos, N., Wallin, A., Gbedegbegnon, T., Aebi, M., & Boesch, C. (1993). Quantitative MR imaging of lumbar intervertebral disks and vertebral bodies: Influence of diurnal water content variations. *Radiology, 188,* 351-354. **(I)**

Buckler, J. M. H. (1978). Variations in height throughout the day. *Archives of Disease in Childhood, 53,* 762. **(II-3)**

Bunting, J., & Weaver, L. T. (1997). Anthropometry in a children's hospital: A study of staff knowledge, use and quality of equipment. *Journal of Human Nutrition and Dietetics, 10,* 17-23. **(III)**

Byrne, M. W., & Lenz, E. R. (2002). Reliability of transportable instruments for assessment of infant length. *Journal of Nursing Measurement, 10*(2), 111-121. **(II-1)**

Cameron, N. (1984). *The measurement of human growth.* London: Croom Helm. **(III)**

Cameron, N. (1986). The methods of auxological anthropometry. In F. Faulkner & J. M. Tanner, (Eds.), *Human growth: A comprehensive treatise* (2nd ed., Vol. 2.) (pp. 35-90). New York: Plenum Press. **(III)**

Centers for Disease Control and Prevention. (2007). *National Health and Nutrition Examination Survey (NHANES) anthropometry procedures manual.* Retrieved on January 3, 2009 from http://www.cdc.gov/nchs/data/nhanes/nhanes_07_08/manual_an.pdf. **(III)**

Chang, R. C., Robson, S. C., & Spencer, J. A. D. (1993). Neonatal morphometric indices of fetal growth: Analysis of observer variability. *Early Human Development, 35,* 37-43. **(II-2)**

Chumlea, W. C., & Guo, S. S. (2002). The assessment of human growth. In N. Cameron (Ed.), *Human growth and development.* (pp. 349-361). New York: Academic Press. **(III)**

Chumlea, W. C., Guo S., Kuczmarski, R. J., Johnson, C. L., & Leahy, C. K. (1990). Reliability for anthropometric measurements in the Hispanic Health and Nutrition Examination Survey (HHANES 1982-1984). *American Journal of Clinical Nutrition, 51,* 902S-907S. **(II-2)**

Cole, T. J. (2002). Assessment of growth. *Best Practice and Research Clinical Endocrinology and Metabolism, 16*(3), 383-398. **(III)**

Colley, N. V., Tremble, J. M., Henson, G. L., & Cole, T. J. (1991). Head circumference/abdominal circumference ratio, ponderal index and fetal malnutrition. Should head circumference/abdominal circumference ratio be abandoned? *British Journal of Obstetrics and Gynaecology, 98,* 524-527. **(III)**

Corkins, M. R., Lewis, P., Cruse, W., Gupta, S., & Fitzgerald, J. (2002). Accuracy of infant admission lengths. *Pediatrics, 109*(6), 1108-1111. **(II-1)**

Cotterill, A. M., Majrowski, W. H., Hearn, S. J., Jenkins, S., & Savage, M. O. (1993). Assessment of the reliability of school nurse height measurements in an inner-city population. (The Hackney Growth Initiative). *Child: Care, Health and Development, 19*(3), 159-165. **(I)**

Davies, D. P., & Holding, R. E. (1972). Neonatometer: A new infant length measurer. *Archives of Disease in Childhood, 47,* 938-940. **(II-2)**

De Onis, M., Onyango, A. W., Van den Broeck, J., Chumlea, W. C., & Martorell, R., for the WHO Multicentre Growth Reference Study Group. (2004). Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. *Food and Nutrition Bulletin, 25*(1), S27-S36. **(II-2)**

Diamond, Jr., F. B., Guevara-Aguirre, J., & Rosenbloom, A. L. (1994). Accurate determination of height using an inexpensive measuring device. *Clinical Pediatrics, 3,* 172-174. **(II-3)**

Doull, I. J. M., McCaughey, E. S., Bailey, B. J. R., & Betts, P. R. (1995). Reliability of infant length measurement. *Archives of Disease in Childhood, 72*(6), 520-521. **(II-1)**

Eckvall, S. W., Eckvall, V. K., Walberg-Wolfe, J., & Nehring, W. (2005). Nutritional assessment – all levels and ages. In S. W. Eckvall & V. K. Eckvall (Eds.), *Pediatric nutrition in chronic diseases and developmental disorders: Prevention, assessment, and treatment* (2nd ed.) (pp. 35-62). New York: Oxford University Press. **(III)**

Feucht, S. (2000). Assessment of growth: Part 1 equipment, technique and growth charts. *Nutrition Focus for Children with Special Health Care Needs, 15*(2). **(III)**

Foster, T. A., & Berenson, G. S. (1987). Measurement error and reliability in four pediatric cross-sectional surveys of cardiovascular disease risk factor variables—The Bogalusa Heart Study. *Journal of Chronic Disease, 40*(1), 13-21. **(II-1)**

Foster, T. A., Voors, A. W., Webber, L. S., Frerichs, R. R., & Berenson, G. S. (1977). Anthropometric and maturation measurements of children, ages 5 to 14 years, in a biracial community—The Bogalusa Heart Study. *American Journal of Clinical Nutrition, 30,* 582-591. **(II-1)**

Fredriks, A. M., Van Buuren, S., Burgmeijer, R. J. F., Meulmeester, J. F., Beuker, R. J., Brugman, E., et al. (2000). Continuing positive secular growth change in the Netherlands 1955-1997. *Pediatric Research, 47*(3), 316-323. **(III)**

Frisancho, A. R. (1993). *Anthropometric standards for the assessment of growth and nutritional status.* Ann Arbor, MI: University of Michigan Press. **(III)**

Gauld, L. M., Kappers, J., Carlin, J. B., & Robertson, C. F. (2004). Height prediction from ulna length. *Developmental Medicine and Child Neurology, 46,* 475-480. **(III)**

Gibson, A. T., Carney, S., Wright, N. P., & Wales, J. K. H. (2003). Measurement and the newborn infant. *Hormone Research, 59*(suppl 1), 119-128. **(III)**

Gordon, C. C., Chumlea, W. C., & Roche, A. F. (1991). Stature, recumbent length, and weight. In T. G. Lohman, A. F. Roche, & R. Martorell (Eds.), *Anthropometric standardization reference manual* (Abridged ed.) (pp. 3-8). Campaign, IL: Human Kinetics Books. **(III)**

Gordon-Larsen, P., Zemel, B. S., & Johnston, F. E. (1997). Secular changes in stature, weight, fatness, overweight, and obesity in urban African American adolescents from the mid-1950's to the mid-1990's. *American Journal of Human Biology, 9,* 675-688. **(III)**

Gray, D. S., Crider, J. B., Kelley, C., & Dickinson, L. C. (1985). Accuracy of recumbent height measurements. *Journal of Parenteral and Enteral Nutrition, 9*(6), 712-715. **(III)**

Grimberg, A., & De Leon, D. D. (2005). Disorders of growth. In T. Moshang, Jr. (Ed.), *Pediatric endocrinology: The requisites in pediatrics* (pp. 127-168). St. Louis, MO: Mosby. **(III)**

Grimberg, A., & Lifshitz, F. (2007). Worrisome growth. In F. Lifshitz (Ed.), *Pediatric Endocrinology* (5th ed.) (pp. 1-50). New York: Informa Healthcare, Inc. **(III)**

Hall, D. M. B. (2000). Growth monitoring. *Archives of Disease in Childhood, 82*(1), 10-15. **(III)**

Hamill, P. V. V., Drizd, T. A., Johnson, C. L., Reed, R. B., Roche, A. F., & Moore, W. M. (1979). Physical growth: National Center for Health Statistics percentiles. *American Journal of Clinical Nutrition, 32,* 607-629. **(III)**

Haschke, F., Van't Hof, M. A., & the Euro-Growth Study Group. (2000). Euro-Growth references for length, weight, and body circumferences. *Journal of Pediatric Gastroenterology and Nutrition, 31,* S14-S38. **(III)**

Healy, M. J. R. (1989). Measuring measuring errors. *Statistics in Medicine, 8,* 893-906. **(III)**

Hearn, S., Cotterill, A. M., Majrowski, W., Rohan, C., Jenkins, S., & Savage, M. O. (1995). Construction of a community height surveillance programme: The Hackney growth initiative. *Journal of Medical Screening, 2,* 31-34. **(III)**

Henry, B. W., Middaugh, P. A., Bourboulas, J., Amer, K., LaPorte, C., Tholl, D., et al. (1990). No shortcuts to height: Letter to the editor. *Journal of Parenteral and Enteral Nutrition, 14*(5), 552-553. **(III)**

Henry, J. J. (1992). Routine growth monitoring and assessment of growth disorders. *Journal of Pediatric Health Care, 6,* 291-301. **(III)**

Himes, J. H. (2009). Challenges of accurately measuring and using BMI and other indicators of obesity in children. *Pediatrics, 124* (suppl 1), S3-S22. **(III)**

Himes, J. H. (1989). Reliability of anthropometric methods and replicate measurements. *American Journal of Physical Anthropology, 79,* 77-80. **(III)**

Hindmarsh, P. C., & Brook, C. G. D. (1988). Auxological and biochemical assessment of short stature. *Acta Paediatrica Scandinavia, 343,* 73-76. **(III)**

Johnson, T. S., & Engstrom, J. L. (2002). State of the science in measurement of infant size at birth. *Newborn and Infant Nursing Reviews, 2*(3), 150-158. **(III)**

Johnson, T. S., Engstrom, J. L., & Gelhar, D. K. (1997). Intra- and interexaminer reliability of anthropometric measurements of term infants. *Journal of Pediatric Gastroenterology and Nutrition, 24*(5), 497-505. **(II-1)**

Johnson, T. S., Engstrom, J. L., Haney, S. L., & Mulcrone, S. L. (1999). Reliability of three length measurement techniques in term infants. *Pediatric Nursing, 25*(1), 13-17. **(II-1)**

Johnson, T. S., Engstrom, J. L., Warda, J. A., Kabat, M., & Peters, B. (1998). Reliability of length measurements in full-term neonates. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 27*(3), 270-276. **(II-1)**

Jordan, J., Ruben, M., Hernandez, J., Bebelagua, A., Tanner, J. M., & Goldstein, H. (1975). The 1972 Cuban national child growth study as an example of population health monitoring: Design and methods. *Annals of Human Biology, 2*(2), 153-171. **(I)**

Keller, T. S., & Nathan, M. (1999). Height change caused by creep in intervertebral discs: A sagittal plane model. *Journal of Spinal Disorders, 12*(4), *313-324.* **(III)**

Klipstein-Grobusch, K., Georg, T., & Boeing, H. (1997). Interviewer variability in anthropometric measurements and estimates of body composition. *International Journal of Epidemiology, 26*(1) (suppl 1), S174-S180. **(II-2)**

Kobayashi, M., Kobayashi, M., Tanaka, T., Uchiyama, Y., & Togo, M. (1999). Diurnal height variations in growth of children: Effects of gravity. *Journal of Gravitational Physiology, 6*(1), P23-P24. **(II-3)**

Kobayashi, M., & Togo, M. (1993). Twice-daily measurements of stature and body weight in two children and one adult. *American Journal of Human Biology, 5*(2), 193-201. **(II-3)**

Kong, C. K., Tse, P. W. T., & Lee, W. Y. (1999). Bone age and linear skeletal growth of children with cerebral palsy. *Developmental Medicine and Child Neurology, 41,* 758-765. **(III)**

Krick, J., Murphy-Miller, P., Zeger, S., & Wright, E. (1996). Pattern of growth in children with cerebral palsy. *Journal of the American Dietetic Association, 96*(7), 680-685. **(III)**

Kuczmarski, R. J., Ogden, C. L., Grummer-Strawn, L. M., Flegal, K. M., Guo, S. S., Wei, R., et al. (2000). *CDC growth charts: United States* (Advance data from vital and health statistics; No. 314). Hyattsville, MD: NCHS. **(III)**

Laing, G. L., & Rossor, E. B. (1996). Growth screening in schools: An evaluation of the programme in one district. *Child: Care, Health and Development, 22*(1), 11-17. **(III)**

Lampl, M. (1992). Further observations on diurnal variation in standing height. *Annals of Human Biology, 19*(1), 87-90. **(II-3)**

Lampl, M. (1993). Evidence of saltatory growth in infancy. *American Journal of Human Biology, 5,* 641-652. **(II-2)**

Lampl, M., Birch, L., Picciano, M. F., Johnson, M. L., & Frongillo, E. A., Jr. (2001). Child factor in measurement dependability. *American Journal of Human Biology, 13,* 548-557. **(II-3)**

Lampl, M., Veldhuis, J. D., & Johnson, M. L. (1992). Saltation and stasis: A model of human growth. *Science, 258,* 801-803. **(II-2)**

Lawn, C. J., Chavasse, R. J., Booth, K. A., Angeles, M., & Weir, F. J. (2004). The neorule: A new instrument to measure linear growth in preterm infants. *Archives of Disease in Childhood – Fetal & Neonatal Edition, 89*(4), F360-F363. **(II-1)**

Lipman, T. H., Hench, K. D., Benyi, T., Delaune, J., Gilluly, K. A., Johnson, L., et al. (2004). A multicentre randomised controlled trial of an intervention to improve the accuracy of linear growth measurement. *Archives of Disease in Childhood, 89*(4), 342-346. **(I)**

Lipman, T. H., Hench, K., Logan, J. D., Di Fazio, D. A., Hale, P. M., & Singer-Granick, C. (2000). Assessment of growth by primary health care providers. *Journal of Pediatric Health Care, 14,* 166-171. **(III)**

Lohman, T. J., Roche, A. F., & Martorell, R. (1991). *Anthropometric standardization reference manual* (Abridged ed.). Campaign, IL: Human Kinetics Books. **(III)**

Marks, G. C., Habicht, J., & Mueller, W. H. (1989). Reliability, dependability, and precision of anthropometric measurements: The second National Health and Nutrition Examination Survey 1976-1980. *American Journal of Epidemiology, 130,* 578-587. **(II-2)**

Miller, H. C., & Hassanein, K. (1971). Diagnosis of impaired fetal growth in newborn infants. *Pediatrics, 48*(4), 511-522. **(II-1)**

Moore, W. M., & Roche, A. F. (1987). *Pediatric anthropometry.* Columbus, OH: Ross Laboratories. **(III)**

Mueller, W. H., & Kaplowitz, H. J. (1994). The precision of anthropometric assessment of body fat distribution in children. *Annals of Human Biology, 21*(3), 267-274. **(I)**

Mulligan, J., Voss, L. D., McCaughey, E. S., Bailey, B. J. R., & Betts, P. R. (1998). Growth monitoring: Testing the new guidelines. *Archives of Disease in Childhood, 79,* 318-322. **(III)**

Murphy, K. (2002). Anthropometrics. In M. Nardella, L. Campo, & B. Ogata (Eds.), *Nutrition interventions for children with special health care needs* (2nd ed.) (pp. 13-39). Washington State Department of Health, DOH Publication No. 961-158. **(III)**

Pinyerd, B. J. (1992). Assessment of infant growth. *Journal of Pediatric Health Care, 6,* 302-308. **(III)**

Pinyerd-Zipf, B., & Amer, K. (2002). *Clinical perspectives on growth monitoring.* Pensacola, FL: Pediatric Endocrinology Nursing Society. **(III)**

Pipes, P. L., & Pritkin Glass, R. (1997). Nutrition and special health care needs. In C. M. Trahms & P. L. Pipes (Eds.), *Nutrition in infancy and childhood* (pp. 377-405). New York: McGraw-Hill. **(III)**

Rapaport, R., & Bowlby, D. A. (2004). Clinical aspects of growth and growth disorders. In O. H. Pescovitz & E. A. Eugster (Eds.), *Pediatric endocrinology: Mechanisms, manifestations, and management* (pp. 172-190). Philadelphia: Lippincott, Williams & Wilkins. **(III)**

Regan, R., Solomons, M., Alzaid, A., & Gill, D. (1985). Height measurement in children: A comparison of methods. *Irish Medical Journal, 78*(1), 25. **(II-2)**

Reiter, E. O., & Rosenfeld, R. G. (1998). Normal and aberrant growth. In J. D. Wilson, D. W. Foster, H. M. Kronenberg, & P. Reed Larsen, (Eds.), *Williams textbook of endocrinology* (9^{th} ed.) (pp. 1427-1508). Philadelphia: W. B. Saunders. **(III)**

Richmond, E. J., & Rogol, A. D. (2004). Diagnosis of growth hormone deficiency in children. *UpToDate.* Retrieved on October 6, 2008 from www.uptodate.com. **(III)**

Roberts, N., Hogg, D., Whitehouse, G. H., & Dangerfield, P. (1998). Quantitative analysis of diurnal variation in volume and water content of lumbar intervertebral discs. *Clinical Anatomy, 11,* 1-8. **(II-3)**

Roche, A.F., & Davila, G. H. (1974). Differences between recumbent length and stature within individuals. *Growth, 38*(3), 313-320. **(II-2)**

Roche, A. F., Guo, S., Baumgartner, R. N., & Falls, R. A. (1988). The measurement of stature: Letter to the editor. *American Journal of Clinical Nutrition, 47,* 922. **(II-3)**

Roche, A., & Sun S. (2003). *Human growth: Assessment and interpretation.* New York: Cambridge University Press. **(III)**

Rodriguez, G., Moreno, L. A., Sarria, A., Fleta, J., & Bueno, M. (2000). Assessment of nutritional status and body composition in children using physical anthropometry and bioelectrical impedance: Influence of diurnal variations. *Journal of Pediatric Gastroenterology and Nutrition, 30,* 305-309. **(II-3)**

Rosenberg, S. N., Verzo, B., Engstrom, J. L., Kavanaugh, K., & Meier, P. P. (1992). Reliability of length measurements for preterm infants. *Neonatal Network, 11*(2), 23-27. **(II-1)**

Rosenfeld, R. G., & Cohen, P. (2008). Disorders of growth hormone/insulin-like growth factor secretion and action. In M. A. Sperling (Ed.), *Pediatric endocrinology* (4th ed.) (pp. 254-334). Philadelphia: Saunders. **(III)**

Schlenker, J., & Raja, S. (2004). A health professional's guide to using growth charts. *Paediatrics and Child Health, 9*(3), 174-176. **(III)**

Shinwell, E. S., & Shlomo, M. (2003). Measured length of normal term infants changes over the first two days of life. *Journal of Pediatric Endocrinology and Metabolism, 16,* 537-540. **(II-3)**

Siklar, Z., Sanli, E., Dallar, Y., & Tanyer, G. (2005). Diurnal variation of height in children. *Pediatrics International, 47,* 645-648. **(II-1)**

Smith, C., & Wales, J. K. H. (1995). How to do it in paediatrics 4: Auxology. *British Journal of Hospital Medicine, 53*(10), 513-514. **(III)**

Smith, R. A., Newcombe, R. G., Coggins, A. M., & Gray, O. P. (1985). Length measurement in small neonates. *Archives of Disease in Childhood, 60,* 837-839. **(II-2)**

Spencer, N., Lewando-Hundt, G., Kaur, B., Whiting, K., & Hors, C. (1996). Routine weight monitoring and length measurement in child health surveillance: Facilities, equipment and professional knowledge. *Ambulatory Child Health, 2,* 3-13. **(III)**

Spender, Q. W., Cronk, C. E., Charney, E. B., & Stallings, V. A. (1989). Assessment of linear growth of children with cerebral palsy: Use of alternative measures to height or length. *Developmental Medicine and Child Neurology, 31,* 206-214. **(III)**

Stallings, V. A., Charney, E. B., Davies, J. C., & Cronk, C. E. (1993). Nutritional status and growth of children with diplegic or hemiplegic cerebral palsy. *Developmental Medicine and Child Neurology, 31,* 206-214. **(III)**

Stevenson, R. D. (1995). Use of segmental measures to estimate stature in children with cerebral palsy. *Archives of Pediatric and Adolescent Medicine, 149,* 658-662. **(III)**

Stevenson, R. D. (1996). Measurement of growth in children with developmental disabilities. *Developmental Medicine and Child Neurology, 38,* 855-860. **(III)**

Stevenson, R. D., Roberts, C. D., & Vogtle, L. (1995). The effects of non-nutritional factors on growth in cerebral palsy. *Developmental Medicine and Child Neurology, 37*(2), 124-130. **(III)**

Stoddard, S. A., Kubik, M. Y., & Skay, C. (2008). Is school-based height and weight screening of elementary students private and reliable? *Journal of School Nursing, 24*(1), 43-48. **(III)**

Strickland, A. L., & Shearin, R. B. (1972). Diurnal height variation in children. *Journal of Pediatrics, 80*(6), 1023-1025. **(II-3)**

Tanner, J. (1994). Auxology. In M. S. Kappy, R. M. Blizzard, & C. J. Migeon, (Eds.), *Wilkins the diagnosis and treatment of endocrine disorders in childhood and adolescence* (4th ed.) (pp. 137-192). Springfield, IL: Charles C. Thomas. **(III)**

Tanner, J. M. (1986a). Normal growth and techniques of growth assessment. *Clinics in Endocrinology and Metabolism, 15*(3), 411-451. **(III)**

Tanner, J. M. (1986b). Physical development. *British Medical Bulletin, 42*(2), 131-138. **(III)**

Tanner, J. M., & Whitehouse, R. H. (1982). *Atlas of children's growth. Normal variation and growth disorders.* London: Academic Press, Inc. **(III)**

Thomsen, J., Evald, P., Skieller, V., & Björk, A. (1990). A comparative study of two different methods of measuring stature and the velocity of growth in children and adults. *European Journal of Orthodontics, 12,* 166-173. **(II-2)**

Tillmann, V., & Clayton, P. E. (2001). Diurnal variation in height and the reliability of height measurements using stretched and unstretched techniques in the evaluation of short-term growth. *Annals of Human Biology, 28*(2), 195-206. **(II-3)**

Ulijaszek, S. J., & Kerr, D. A. (1999). Anthropometric measurement error and the assessment of nutritional status. *British Journal of Nutrition, 82,* 165-177. **(III)**

Ulijaszek, S. J., & Lourie, J. A. (1994). Intra- and inter-observer error in anthropometric measurement. In S. J. Ulijaszek & C. G. N. Mascie-Taylor, (Eds.), *Anthropometry: The individual and the population.* (pp. 30-55). New York: Cambridge University Press. **(III)**

University of Virginia Health System. (2008). *North American Growth in Cerebral Palsy Project.* Retrieved on December 15, 2008 from http://www.healthsystem.virginia.edu/Internet/NAGCePP/home.cfm. **(III)**

U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau. (n.d.). *Growth charts training [electronic training modules]*. Retrieved on November 28, 2008 from http://depts.washington.edu/growth/mainover.htm. **(III)**

U.S. Department of Health, Education, and Welfare. (1977). *NCHS growth curves for children birth-18 years* (DHEW Publication No. 78-1650). Hyattsville, MD: Author. **(III)**

U.S. Preventive Services Task Force. (1996). *Guide to clinical preventive services: Report of the U.S. Preventive Services Task Force* (2nd ed.). Philadelphia: Lippincott, Williams & Wilkins. **(N/A)**

Vegelin, A. L., Brukx, L. J. C. E., Waelkens, J. J., & Van den Broeck, J. (2003). Influence of knowledge, training and experience of observers on the reliability of anthropometric measurements in children. *Annals of Human Biology, 30*(1), 65-79. **(III)**

Vogiatzi, M. G., & Copeland, K. C. (1998). The short child. *Pediatrics in Review, 19*(3), 92-99. **(III)**

Voss, L. D. (1995). Can we measure growth? *Journal of Medical Screening, 2,* 164-167. **(III)**

Voss, L. D. (2000). Standardised technique for height measurement. *Archives of Disease in Childhood, 82*(1), 14-15. **(III)**

Voss, L. D., & Bailey, B. J. R. (1994). Equipping the community to measure children's height: The reliability of portable instruments. *Archives of Disease in Childhood, 70*(6), 469-471. **(II-1)**

Voss, L. D., & Bailey, B. J. R. (1997). Diurnal variation in stature: Is stretching the answer? *Archives of Disease in Childhood, 77,* 319-322. **(II-1)**

Voss, L. D., Bailey, B. J. R., Cumming, K., Wilkin, T. J., Betts, P. R. (1990). The reliability of height measurement (The Wessex Growth Study). *Archives of Disease in Childhood, 65,* 1340-1344. **(I)**

Waite, F. L. (1997). Creation of a program to teach health providers accurate measurement of children and an understanding of growth patterns as indicators of health. *Programs and abstracts of the Pediatric Endocrinology Nursing Society, 23.* **(III)**

Wales, J. K. H., & Gibson, A. T. (1994). Short term growth: Rhythms, chaos, or noise? *Archives of Disease in Childhood, 71,* 84-89. **(III)**

Wales, J. K. H., Wit, J., & Rogol, A. D. (2003). *Pediatric endocrinology and growth* (2nd ed.). Philadelphia: Saunders. **(III)**

Whitehouse, R. H., Tanner, J. M., & Healy, M. J. R. (1974). Diurnal variation in stature and sitting height in 12-14-year-old boys. *Annals of Human Biology, 1*(1), 103-106. **(III)**

WHO Multicentre Growth Reference Study Group. (2006). Reliability of anthropometric measurements in the WHO Multicentre Growth Reference Study Group. *Acta Paediatrica, Suppl 450,* 38-46. **(II-2)**

Wilshin, J., Geary, M., Persaud, M., & Hindmarsh, P. (1999). The reliability of newborn length measurement. *British Journal of Midwifery, 7*(4), 236-239. **(II-3)**

World Health Organization. (1995). *Physical status: The use and interpretation of anthropometry. Report of a WHO expert committee* (Technical Report Series No. 854). Geneva, Switzerland: World Health Organization. **(III)**

World Health Organization. (2008). *Training course on child growth assessment. WHO child growth standards. B: Measuring a child's growth.* Retrieved on March 28, 2009 from http://www.who.int/childgrowth/training/module_b_measuring_growth.pdf. **(III)**