Kinanthropometric Assessement

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Web page for New Zealand Anthropometry:
http:// homepages.ihug.co.nz/~rip/Anthropometry/

Introduction to anthropometrical assessment

Kinanthropometry is an emerging scientific specialization concerned with the application of measurement to appraise human size, shape, proportion, composition, maturation and gross function. It is a basic discipline for problem-solving in matters related to growth, exercise, performance and nutrition.

The area has been defined as the quantitative interface between anatomy and physiology. It puts the individual athlete into objective focus and provides a clear appraisal of his or her structural status at any given time, or, more importantly, provides for quantification of differential growth and training influences.

Without an understanding of the growth of children and youth and their structural evolution, selection of talent and monitoring of training is largely a matter of sophistry and illusion. Kinanthropometry provides the essential structural basis for the consideration of athletic performance.

Methodologies of anthropometrical assessment

Ostensibly, anthropometry is simple. In reality, it is not. Mastery of accurate measurement requires rigorous training and strict adherence to specified techniques. The anthropometric sites and descriptions in this book are based on those by Ross and Marfell-Jones (1991) and Norton et al. (1996). They are the standard specifications of the International Society for the Advancement of Kinanthropometry (ISAK).

Landmarks

Because the body can assume a variety of postures, anthropometric description is always in reference to the anatomical position. This is where the subject is oriented to a standing position with head and eyes directed forward, upper limbs hanging by the sides with the palms forward, thumbs pointing away from the sides with fingers pointing directly downward, and the feet together with the toes pointing directly forward. The following landmarks should be noted.

- **Vertex (v).** The most superior point on the skull, in the midsagittal plane, when the head is held in the Frankfort plane.
- **Suprasternale (sst).** Suprasternal notch. The superior border of the sternal notch (or incisura jugularis) in the mid-sagittal plane.
- **Dactylion (da).** Tip of the middle finger. The most distal point of the middle finger or digit when the arm is hanging and the fingers are stretched downward. The corresponding tips of the other fingers are designated dactylion i, ii, iv, and v (from the thumb side).
- **Sphyrion fibulare (sph f).** Malleolare laterale or malleolare externum. The most distal tip of the malleolare laterale (fibularis). The sphyrion fibulare is more distal than the sphyrion tibiale.
- **Pternion (pte).** The most posterior point on the heel of the foot when the subject is standing.
- **Akropodion (ap).** The most anterior point on the toe of the foot when the subject is standing. This may be the first or second phalanx. The subject's toenail may have to be clipped to make a measurement.

Instruments

- **Lufkin retractable metric measuring tape (Y22M)** with adapted footpiece used to measure stature.
- **Broca plane.** A simple triangular head board.
- **Anthropometric tape.** The tape of choice is Keuffel and Esser Whyteface steel tape (No. 860358) or the yellow-faced Lufkin specialty Executive Diameter tape (W606PM) (See Figure 1).
- **Bone calipers.** Adapted Mitutoyo bone calipers as described by Carter (1980) are recommended for humerus and femur widths. These calipers have extended branches with round pressure plates 15 mm in diameter. The inside diameter branches are removed and the locking device is fixed to permit easy manipulation (See Figure 2).
- **Anthropometer.** The recommended instrument is the Siber-Hegner GPM anthropometer of the Martin type (See Figure 3).
- **Skinfold calipers.** The preferred instruments are the Harpenden caliper or the Slim Guide skinfold calipers. An alternate model is the Lange caliper.
- **Widespreading calipers.** The large widespreading caliper (Siber-Hegner, GPM) is the classical instrument for the measurement of Anterior-Posterior chest depth (See Figure 4).
- **Weighing machine.** The instrument of choice is a portable beam-type balance, calibrated in kilograms and tenths of kilograms (Homs full capacity beam scale - general weighing scale, 150 kg). A substitute spring type balance (SECA) has been used in field studies.
- **Measuring platform.** In many field-test situations, floors are not level or are uncomfortable to the barefoot subject. A useful optional piece of equipment is a one meter square wooden 5-ply platform which may be leveled by wooden shims.

Figure 1: Lufkin retractable metric measuring tape

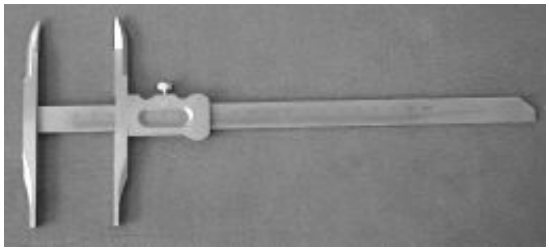

Figure 2: Bone calipers

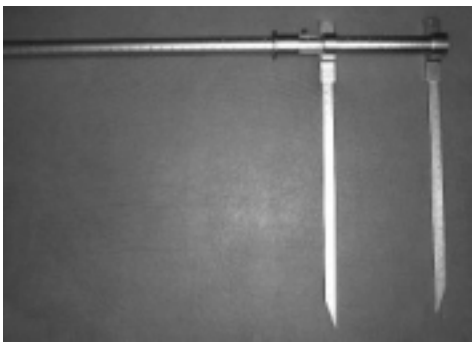

Figure 3: Anthropometer

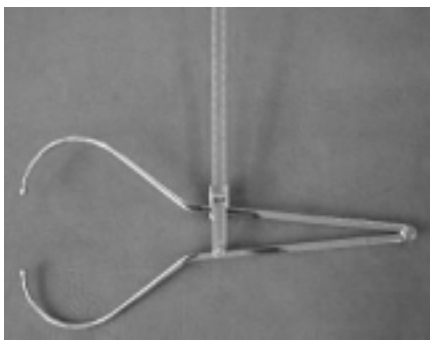

Figure 4: Widespreading calipers

Techniques

Anthropometry appears deceptively simple. Mastery, however, is somewhat analogous to playing a musical instrument with style and grace. With some formal training and persistent practice, it can be easy and enjoyable and can produce amazingly accurate data. The development of an anthropometrist's touch is seldom achieved without extensive practice. It varies from individual to individual, but most seem to achieve reasonable competence after triple-measurement and spot-checking for systematic error with criterion anthropometry measures on 100 or more subjects.

A "criterion anthropometrist", by definition, is one who purportedly does not make systematic errors from a prescribed technique. As a service to the international scientific community, the International Society for the Advancement of Kinanthropometry holds certification courses and workshops.

Precision and accuracy

In assessing individual status with respect to a particular norm, it is necessary that a high level of precision and accuracy be attained by the measurer. Precision is a matter of how consistent a measurer is with him or herself (intra-observer reliability) or with other measurers (inter-observer reliability). Accuracy is a matter of how closely obtained measures conform to true or ideal measures. Anthropometrists should verify their precision by calculating the Technical Error of Measurement (TEM) of their testing. It is not within the scope of this manual to explain TEM in detail. Readers are referred to Norton and Olds (1996), pages 77 to 96, for a detailed explanation. A simple computer programme to calculate TEMs using an Excel spreadsheet (Hume, 1999) is available through SSNZ. If measures are within the tolerance limits shown in Appendix 1, acceptable TEM levels will be achieved.

Marking the subject

Identify and mark all anatomical sites for measurement. Relocate the site prior to measurement and check the position.

- **Acromiale (a).** The point at the superior and external border of the acromion process when the subject is standing erect with relaxed arms (See Figure 5). The five-step procedure is as follows: i) A marking pencil as a straight edge is applied to the lateral aspect of the acromion process at an angle of 45˚ to depress tissue and identify the superior border; ii) The most lateral point on the superior border is identified by the left thumb; iii) The pencil pressure is removed and the landmark is confirmed on the uncompressed surface; iv) The landmark is marked; v) The landmark is re-identified as a check, using steps i) to iii).
- **Subscapulare (ssc).** The undermost tip of the inferior angle of the scapula (See Figure 6). Palpate the inferior angle of the scapula with the left thumb. If there is difficulty locating the inferior angle, the subject can assist by reaching behind the back with the right arm. The site must not be marked, however, until the arm is returned to the side in the functional position.
- **Radiale (r).** The point at the upper and lateral border of the head of the radius (See Figure 7). Using the left thumb or index finger, the anthropometrist palpates downward in the lower portion of the lateral dimple of the elbow. Slight pronation/supination of the forearm is reflected by a rotary movement of the head of the radius. Marking and checking the landmark are done as above.
- **Mid-acromiale-radiale.** Arm girth, triceps and biceps skinfold sites. A line is marked horizontal to the long axis of the humerus at the mid-acromiale-radiale distance, as determined by an anthropometric tape. The horizontal line is extended to the posterior surface of the arm, where a vertical line at the most posterior surface is made to intersect with the horizontal line, to mark

the site where the triceps skinfold (See Figure 7) is raised. The biceps site is marked anteriorly (See Figure 8).

- **Stylion (sty).** The most distal point of the processus styloidus radius (See Figure 9). This is located in the so-called "anatomical snuff box" identified by extending the thumb. The anthropometrist places the nail of his/her left thumb or index finger in the triangular space outlined by the muscle tendons. The landmark is palpated by having the subject relax while the anthropometrist slightly manipulates the subject's hand from side to side. Marking and checking the landmark are done as above.
- **Mid-stylion (mid-sty).** The midpoint, on the anterior surface of the wrist, of the horizontal line at the level of the stylion (See Figure 9).
- **Mesosternale (mst).** The point on the corpus sterni at the intersection of the midsagittal and horizontal planes, at the mid level of the fourth chondrosternal articulation (See Figure 10). A two-handed palpation method provides for rapid location of the landmark. The anthropometrist places the index fingers on the top of the clavicles while the thumbs locate the first costal spaces, thus encompassing the first ribs. He/she then moves the index fingers to replace the thumbs which are lowered to the second intercostal spaces to identify the second ribs. The procedure is repeated for the third and fourth ribs. The landmark is at the mid-point of the sternum at the level of the center of the articulation of the 4th rib with the sternum.
- **Iliocristale (ic).** The most lateral point superior, of the iliac tupercle on the ilioaxilla line. This landmark is encompassed when obtaining biiliocristal breadth with an anthropometer. (See Figure 11).
- **Iliospinale (ispi).** The inferior aspect of the tip of the anterior superior iliac spine. The designated landmark is the undersurface of the tip of the anterior superior spine and not the most frontally curved aspect (See Figure 11). The subject takes the body weight on his/her left foot, lifts the right heel and rotates the femur outward. The anthropometrist grasps the hip with his/her left hand, and locates the landmark with the thumb. Since the sartorius muscle arises from the spinale, slight movement of the thigh enables identification of the muscle, which can then be followed to the landmark. Once the landmark is identified, the subject stands erect, with feet together, while the spinale is marked and checked.
- **Supraspinale (supsp).** A cross marking the intersection of the iliospinale mark to the anterior axillary border with the horizontal line of the superior border of the ilium at the level of the iliocristale (See Figure 11).
- **Trochanterion (tro).** The most superior point on the greater trochanter of the femur, not the most lateral point. (See Figure 12). The subject takes a short forward stride and rests his/her foot on a raised object about 15 cm high. The anthropometrist stands behind the subject, stabilizing him/her with the left hand, and starts palpating with the right hand on the lateral aspect of the gluteal muscle, on a line with the long axis of the femur. Once the greater trochanter is identified by firm downward pressure, the subject carefully assumes the erect stance with weight equally distributed on each foot, and the toes pointing directly forward. The anthropometrist then palpates upward to locate the most superior point on the greater trochanter. As usual, the pressure is released and reapplied so that the mark can be made on an undisturbed skin surface.
- **Mid trochanterion - tibiale laterale landmark.** Mid point between trochanterion and tibiale laterale landmarks (See Figure 13).
- **Mid thigh.** The mid point between the inguinal fold and the anterior aspect of the patella. (See Figure 14)

- **Tibiale laterale (tl).** The most proximal point of the margo glenoidalis of the lateral border of the head of the tibia at the same level as the tibiale mediale. It is above, and not to be confused with, the more inferior capitulum tibulare (See Figure 15).
- **Tibiale mediale (tm).** The most proximal point of the margo glenoidalis of the medial border of the head of the tibia (See Figure 16). It is easiest to locate the landmark if the subject flexes at the knee joint and places the right ankle on the left thigh. The margin of the bone can then be palpated easily as the joint space is increased in this position.
- **Sphyrion (sph).** Malleolare mediale or malleolare internum. The most distal tip of the malleolare medialis (tibialis). This landmark may be located most easily from beneath and dorsally. It is the distal tip and not the outermost point of the malleolus. (See Figure 17 & 18).
- **Mid-calf (calf).** The medial aspect of the calf at the widest girth (See Figure 19).

Figure 5: Acromiale landmark

Figure 6: Subscapulare landmark

Figure 7: Radiale triceps landmark

Figure 8: Biceps landmark

Figure 9: Stylion landmark

Figure 10: Mesosternale landmark

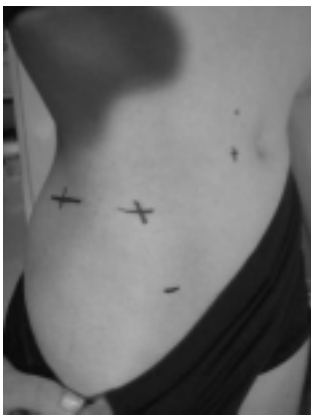

Figure 11: Iliocristale, ilispinale and suprospinale landmarks

Figure 12: Trochanterion landmark

Figure 13: Mid trochanterion - tibiale laterale landmark

Figure 14: Mid thigh skinfold landmark

Figure 15: Tibiale laterale landmark

Figure 16: Tibiale mediale landmark

Figure 17: Sphyrion landmark

Figure 18: Tibiale mediale and sphyrion landmarks

Figure 19: Calf skinfold landmark

Proforma

A standard proforma facilitates systematic data collection. In the measurement sequence, only right side values of the subject are taken in surveys. The convention of the IBP is to use left side; however, since kinanthropometrists and sports people are primarily interested in the most-dominant side, the right is preferred. When there is a question of bilateral asymmetry, however, both sides should be taken. In some athletes, asymmetry is an important factor in their structural appraisal. This may be of major concern in appraisal of trauma in tennis players, runners, and skaters.

Proformas can contain as many or as few variables as the user desires. The two standard ISAK proformas are the full Proforma (Appendix 2), which contains 42 measurement variables, and the shortened Level 1 Proforma (Appendix 3) which is used for training and assessing Level 1 anthropometrists (technician - restricted profile). Since many sport scientists have neither the time nor the need to measure/re-measure 42 variables, The O-Scale Proforma (Appendix 4) which is commonly used in conjunction with the O-Scale data-analysis computer programme has been included. The O-Scale Proforma contains 22 measurement variables. The Heath-Carter Somatotype Proforma (Appendix 5) contains the 10 variables needed to calculate the Heath-Carter Somatotype.

Skinfold thicknesses

Instrument: Harpenden skinfold caliper (or substitutes, e.g. Slimguide). The instrument is designed to provide a constant pressure of 10.0 g.mm^2 of the caliper face at all thicknesses. The dial is calibrated in 0.2 mm increments. It may be read, by interpolation, to the nearest 0.1 mm. Correct calibration of the caliper is essential. Readers are referred to Carlyon et al.'s (1996) excellent discussion on Harpenden caliper calibration.

General technique: The caliper is used to obtain a skinfold thickness. This includes a double layer of skin and the underlying adipose tissue, but not the muscle. The skinfold is raised by the pinching, slightly rolling action of the left thumb and index finger. The fold is raised perpendicularly to the surface of the body at the measurement site. The long axis of the fold should be parallel to the natural cleavage lines of the skin (Langer's lines) in the region of measurement. The grasp is large enough to get a complete double layer. The amount of skin elevated must form a fold with approximately parallel sides. The fold is grasped firmly and held throughout the measurement. The skinfold is raised at the designated site and the caliper is applied so that the near edge of the pressure plate is one centimetre from the lateral side of the controlling thumb and index finger. Care must be taken to assure the caliper is applied at right angles to the fold at all times. The reading on the dial is taken after permitting full spring pressure of the instrument by a complete release of the caliper trigger. The investigator must allow time for the full pressure of the caliper to take effect, but not so long that the adipose tissue becomes compressed out of the skinfold. Considerable practice is required to make this judgment for skinfolds of varying sizes and varying

degrees of compressibility. The reading is made approximately two seconds after application, when the needle slows. In measuring obese subjects, firm pressure of the thumb and index finger helps reduce excessive movement of the indicator. When skinfold thicknesses are difficult to raise, the caliper can be forced to the muscle level and then slightly withdrawn when the fold is controlled by the grasp. Measurement is taken to the nearest 0.1mm (take an average of two readings that are within 0.2mm of each other). The sum of the six measures is calculated and recorded. All measurements are taken on the right side of the body with the subject standing in the anatomical position unless otherwise indicated.

- **Triceps.** The caliper is applied 1 cm distally from the left thumb and index finger raising a vertical fold at the marked mid-acromiale-radiale line on the posterior surface of the right arm (See Figure 20).
- **Subscapular.** The caliper is applied 1 cm distally from the left thumb and index finger, raising a fold oblique to the inferior angle of the scapula in a direction running obliquely downwards in a lateral direction at an angle of about 45˚ from the horizontal along the natural fold (Langer line) (See Figure 21).
- **Biceps.** The caliper is applied 1cm distally from the left thumb and index finger raising a vertical fold at the marked mid-acromiale-radiale line on the anterior surface of the right arm (See Figure 22).
- **Iliac crest.** The caliper is applied 1cm anteriorally from the left thumb and index finger raising a fold immediately superior to the iliac crest at the mid-axillary line (i.e. above the crest on the mid-line of the body). The fold runs anteriorally downwards and usually is progressively smaller as one moves in this direction away from the designated site (See Figure 23).
- **Supraspinale** (formerly Heath-Carter suprailiac). The caliper is applied 1cm anteriorly from the left thumb and index finger raising a fold at the intersection of the border of the ilium (project a horizontal line from the iliac crest mark) and a line from the spinale to the anterior axillary border (armpit). The fold follows the natural fold lines running medially downwards at about a 45˚ angle from horizontal (See Figure 24).
- **Abdominal.** The caliper is applied 1 cm inferiorly to the left thumb and index finger, raising a vertical fold on the right side 5 cm lateral to, and at the level of, the omphalion (midpoint of the navel) (See Figure 25).
- **Front thigh.** The caliper is applied 1 cm distally to the left thumb and index finger, raising the fold on the anterior of the right thigh, along the long axis of the femur, when the leg is flexed to a 90˚ at the knee by placing the foot on a box. The mid-thigh position for this measure is the estimated half-distance between the inguinal crease and anterior patella. In those subjects where the fold is difficult to raise, the calipers can be pushed to the muscle level and slightly retracted with the subject assisting by supporting the underside of the leg. In particularly heavy-thighed subjects, the anthropometrist can give further support to the underside of the leg by using his/her own knee and thigh. A further tactic is to have an assistant use two hands to raise the fold. The anthropometrist applies the caliper from the subject's right side when the assistant on his left raises the fold with his right thumb and index finger at the prescribed site; the anthropometrist positions the caliper and a second grasp of the fold is attempted with the assistant's right thumb and index finger one centimetre distal to the caliper. The measurement is made on the double grasped fold (See Figure 26).
- **Medial calf.** The caliper is applied 1cm distally to the left thumb and index finger, raising a vertical fold on the relaxed medial right calf at the estimated level of the greatest circumference.

This is easiest to obtain when the subject's leg is flexed to an angle of 90˚ at the knee by placing the foot on a box (See Figure 27).

Figure 20: Triceps skinfold

Figure 21: Subscapular skinfold

Figure 22: Biceps skinfold

Figure 23: Iliac crest skinfold

Figure 24: Supraspinale skinfold

Figure 25: Abdominal skinfold

Figure 26: Front thigh skinfold

Figure 27: Medial calf skinfold

Segment lengths

Instrument: Segmometer - A Lufkin retractable metric measuring tape with cotter-pin modified end-plate and cotter-pin positioned at tape exit point. The tips of the cotter pins are uni-directionally bevelled to coincide with the graduations on the tape. Alternatively an anthropometer can be used.

General technique: The segmometer housing is held in the right hand throughout all the direct length measurements. The lengths are measured with the tape parallel to the long axis of a bone or body segment. The tape is held so the ends of the cotter pins are in contact with the marked sites at the end of each segment or length and the reading is taken at the edge of the housing end cotter pin, at the side to which the bevel runs upward, to the nearest 0.1 cm.

- **Arm length** (Acromiale - radiale). The distance from the marked acromiale to the marked radiale. The subject stands erect with the arms at the sides, palms against the thighs (See Figure 28).
- **Forearm length** (Radiale - stylion). The distance from the marked radiale to the marked stylion. The elbow is flexed and the orientation of the tape is such that it parallels the long axis of the radius (See Figure 29).
- **Hand length** (Midstylion - dactylion). The distance from the marked mid-stylion (at the distal wrist crease) to the dactylion. The subject extends the right hand supinated, fully extending the fingers. The end pointer is placed on the marked mid-stylion line, the housing pointer applied to the dactylion (See Figure 30).
- **Tibial length** (Tibiale mediale - sphyrion tibiale). The distance from the marked tibiale mediale to marked sphyrion tibiale. The subject sits on the box and crosses the right ankle over the left knee to present the medial surface of the right leg horizontally. The end pointer is applied to the marked tibiale mediale and the housing pointer is extended to the marked sphyrion tibiale (See Figure 31).
- **Iliospinale-base height.** The distance from the box to the marked iliospinale. The subject stands facing the box, feet together, with the toes underneath the box. The end pointer is placed flush on the box and the housing pointer extended vertically upward to the marked iliospinale landmark. The height of the box is added to provide the overall height of the iliospinale (See Figure 32).
- **Trochanterion-base height.** The distance from the box to the marked trochanterion. The subject stands, feet together, with the side of the right leg against the box. The end pointer is placed flush on the box and the housing pointer extended vertically upward to the marked trochanterion landmark (See Figure 33).
- **Thigh length** (Trochanterion - tibiale laterale). The distance from the marked trochanterion to the marked tibiale laterale. The subject stands with feet together on the box with the right leg facing the anthropometrist (See Figure 34).
- **Tibiale laterale - base height.** The distance from the box to the marked tibiale laterale. The subject stands with feet together on the box with the right leg facing the anthropometrist. The end pointer is placed flush on the box and the housing pointer extended vertically upward to the marked tibiale laterale landmark (See Figure 35).

Figure 28: Acromiale - radiale length

Figure 29: Radiale-stylion length

Figure 30: Midstylion - dactylion length

Figure 31: Tibiale mediale - sphyrion tibiale length

Figure 32: Iliospinale-base height

Figure 33: Trochanterion-base height

Figure 34: Trochanterion - tibiale laterale length

Figure 35: Tibiale laterale - base height

Girths

Instrument: Flexible steel tape, calibrated in centimetres with millimetre gradations; 1.5 to 2.0 meters long with an end tab before the zero marking; enclosed in a case with a button spring release for retraction.

General technique: The metal case is held in the right hand throughout all the girth measurements. The girths are measured with the tape at right angles to the long axis of a bone or body segment. The tape is passed around the part and held so the stub end and the scale calibrations are in juxtaposition, i.e., one reads to a scale mark and not across a tape space. The reading edge of the tape is manipulated to the designated level, e.g., the marked mid-arm site. When measuring, the tape is pulled out of its housing and around the part by the left hand, which then transfers the stub end to the right hand. The tape is then controlled by the right hand which can pull it slightly to maintain it at the designated level. The left hand then resumes control of the stub end and can make any further adjustments to the tape. The so-called "cross-handed" technique is simply a matter of reaching across with the left hand and gripping the stub end of the tape with the thumb and index finger while the right hand similarly grasps the tape at the housing end. The tape is then brought into juxtaposition using the third digit of each hand to control or make adjustments. The aim is to obtain the perimeter distance of the part with the tape in contact with, but not depressing, the fleshy contour. The development of this light touch requires considerable practice since the pressure on the tape is not constant, but is governed by the compressibility of the fleshy contour which varies among individuals. Careful attention must be given to the girth specifications. The arm girth relaxed is at a designated and marked level whereas the flexed-and-tensed arm girth is obtained at the site of the greatest perimeter over volitionally-contracted musculature.

- **Arm girth relaxed.** The perimeter distance of the right arm parallel to the long axis of the humerus when the subject is standing erect and the relaxed arm is hanging by the sides. The level of the tape is at the measured and marked mid-acromiale-radiale distance (See Figure 36).
- **Arm girth flexed and tensed.** The maximum circumference of the right arm raised to the horizontal position in the sagittal plane with the fully-supinated forearm flexed at the elbow to an angle of 45˚. The subject is encouraged to "make a muscle" by fully tensing his/her biceps. In making this measurement, a preliminary flexing permits the investigator to adjust the tape to the maximal girth which is then achieved at a second trial where the subject is encouraged verbally "Up, up, up, up". This measure is obtained with the anthropometrist standing laterally to the right of the subject (See Figure 37).
- **Forearm girth.** The maximal girth of the right forearm when the hand is held palm up and relaxed. The measure is made no more distally than 6 cm from the radiale. In subjects with pronounced forearm development where the belly of the muscle is more distal than normal, a "true" maximal value will differ from the conventional forearm girth which is taken at the more proximal level (See Figure 38).
- **Wrist girth.** The perimeter of the right wrist taken distal to the styloid processes (See Figure 39).
- **Chest girth.** The perimeter at the level of the mesosternale. The subject slightly abducts his/her arms to permit the anthropometrist, standing to the subject's right facing him/her, to pass the tape around the chest; the tape and housing is held in the right hand while the anthropometrist's left hand adjusts the tape at the subject's back to the horizontal level of the marked mesosternale. The cross-handed technique is used to put the tape scale in juxtaposition with the zero on the stub end of the tape. The reading is obtained at the end of a normal expiration (end tidal) (See Figure 40).

- **Waist girth.** The perimeter at the level of the noticeable waist narrowing located approximately half way between the costal border and the iliac crest. In subjects where the waist is not apparent, an arbitrary waist measurement is made at this level (See Figure 41). Ask the subject some questions to ensure they do not hold their breath.
- **Gluteal girth** (hip girth). The perimeter at the level of the greatest posterior protuberance and at approximately the symphysion pubis level anteriorally. The subject, during this measure, stands erect, feet together, without volitionally contracting the gluteal muscles (See Figure 42).
- **Thigh girth 1** (1 cm gluteal line). The perimeter of the right thigh which is measured when the subject stands erect, legs slightly parted, weight equally distributed on both feet. The tape is raised to a level one centimeter below the gluteal line or the arbitrary join of the gluteal muscle protuberance with the thigh (See Figure 43).
- **Thigh girth 2 (mid tro-tib lat).** The perimeter of the right thigh perpendicular to the long axis of the femur at the mid trochanterion-tibiale laterale level. The subject position is the same as for thigh girth 1 (See Figure 44).
- **Calf girth.** With the subject in the same position as above, the tape is manoeuvred to obtain the maximum perimeter of the calf. This measure is obtained by manipulation of the tape taking a series of girth measurements to assure the largest value. This is achieved by relaxing and tightening the tape with manipulation to various levels facilitated by the anthropometrist's third digits (See Figure 45).
- **Ankle girth.** The perimeter of the narrowest part of the lower leg superior to the sphyrion tibiale. From the side, because of the ovoid shape of the leg, this is slightly below the visual impression of the narrowest point. The tape is manipulated by loosening and tightening to obtain the minimal girth measure. The anthropometrist's third digits are used to maintain the perpendicular orientation of the tape to the long axis of the tibia (See Figure 46).

Figure 36: Arm girth relaxed

Figure 37: Arm girth flexed and tensed

Figure 38: Forearm girth

Figure 39: Wrist girth

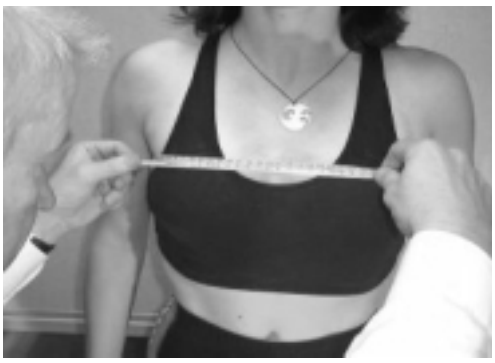

Figure 40: Chest girth

Figure 41: Waist girth

Figure 42: Gluteal girth

Figure 43: 1 cm gluteal line girth

Figure 44: Mid tro-tib lat girth

Figure 45: Calf girth

Figure 46: Ankle girth

Segment breadths/lengths

Instrument: Martin anthropometer assembled as a sliding caliper.

General technique: The anthropometer is held in the same manner as the bone caliper. The branches are gripped by the thumb and the index finger and rest on the backs of the hands. The scale is balanced on the forearms. Pressure is applied to the branches. The scale is read to the nearest 0.01 cm.

- **Biacromial breadth.** The distance between the most lateral points on the acromion processes when the subject stands erect with the arms hanging loosely at the sides. The anthropometrist stands behind the subject, locates the sites with the third digit and applies the branches of the anthropometer used as a sliding caliper to the sites. The branches of the caliper point upwards at an angle of about 45˚ from the horizontal to encompass the largest diameter between the acromial processes. Firm pressure is applied to the branches over the acromial sites by the anthropometrist's index fingers (See Figure 46).
- **Biiliocristal breadth.** The distance between the most lateral points on the superior border of the iliac crest. The anthropometrist stands in front of the subject, locates the sites with his/her third digits and applies the branches of the anthropometer used as a sliding caliper to the sites. The branches of the caliper point upwards at an angle of about 45˚ from the horizontal to encompass the largest diameter between the lateral aspects of the iliac crests. Firm pressure is applied to the branches over the iliac sites by the anthropometrist's index fingers (See Figure 47).
- **Foot length.** The distance between the akropodion and pternion obtained by the anthropometer used as a sliding caliper on the standing subject. The caliper is held parallel to the long axis of the foot. The anthropometrist holds the branch end of the caliper in the left hand, grasps the shaft with the right hand digits 2,3,4; in opposition to digit 5; while manipulating the cursor with the thumb. The sites are encompassed with minimal pressure (See Figure 48).
- **Transverse chest breadth.** The distance of the lateral aspect of the thorax at the level of the most lateral aspect of the fourth rib. This is obtained by applying the anthropometer used as a sliding caliper to the subject who is seated erect and faced by the anthropometrist. The caliper is applied at an angle of about 30˚ downward from the horizontal avoiding both the pectoral and latissimus dorsi muscle contours. When the site is approximated, the anthropometrist removes the thumbs from the pinch grasp of the branches and applies firm pressure with the index fingers. The measurement is made at the end of the normal expiratory excursion (end tidal) (See Figure 49).

Figure 46: Biacromial breadth

Figure 47: Biiliocristal breadth

Figure 48: Foot length

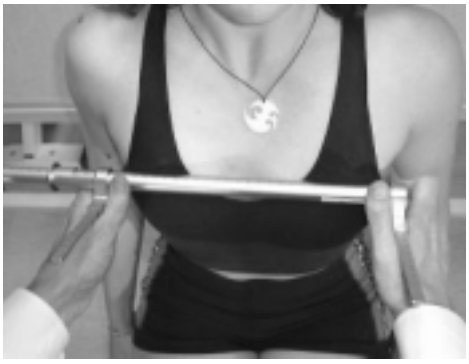

Figure 49: Transverse chest breadth

Bone breadths

Instrument: Small Mitutoyo adapted bone caliper.

General technique: The bone calipers are held in pistol-grip mode. The branches are gripped by the thumb and the index finger and rest on the backs of the hands. The middle finger is used to locate the landmark. Firm pressure is applied to the branches. The vernier scale on the smaller bone calipers can be read to the nearest 0.01 cm on some models and to the nearest 0.1 mm on others. Thus a typical value for the humerus might be 7.21 cm or 72.1 mm.

- **Humerus breadth** (bi-epicondylar). The distance between medial and lateral epicondyles of the humerus when the arm is raised forward to the horizontal and the forearm is flexed to a right angle at the elbow. The small bone caliper is applied pointing upwards to bisect the right angle formed at the elbow. The epicondyles are palpated by the third digits starting proximal to the sites. The measured distance is somewhat oblique since the medial epicondyle is lower than the lateral. However, with the altered plane, the anthropometrist keeps the calipers as close to horizontal as possible while ensuring the pressure plates are applied firmly to the encompassed sites (See Figure 50).
- **Wrist breadth** (bi-styloid). The bistyloid breadth when the right forearm is resting on a table or the subject's thigh and the wrist is flexed to an angle of about 90˚. The caliper is applied to bisect the angle formed at the wrist. The styloids are palpated by the third digits, starting proximal to the sites. Firm pressure is applied to minimize the intervening tissue, however, not great enough to alter position of the radius with respect to the ulna (See Figure 51).
- **Hand breadth** (bi-metacarpale). The distance between the metacarpale laterale and metacarpale mediale when the subject places the palm of the hand with fingers together firmly on a table. The anthropometrist holds the small bone caliper pointed downwards at a 45˚ angle and palpates the landmarks with the third fingers, then applies the faces of the caliper with firm pressure, but not to the extent of compressing the width (See Figure 52).
- **Femur breadth** (bi-epicondylar). The distance between medial and lateral epicondyles of the femur when the subject is seated and the leg is flexed at the knee to form a right angle with the thigh. The small bone caliper is applied pointing downwards to bisect the right angle formed at the knee. The epicondyles are palpated by the third digits starting proximal to the sites. The caliper pressure plates are applied firmly. If difficulty is encountered in locating the epicondyles, the third digits can search in a slightly circular motion and caliper pressure plates can be manipulated slightly to ensure the sites are encompassed (See Figure 53).

Figure 50: Humerus bi-epicondylar breadth

Figure 51: Bi-styloid breadth

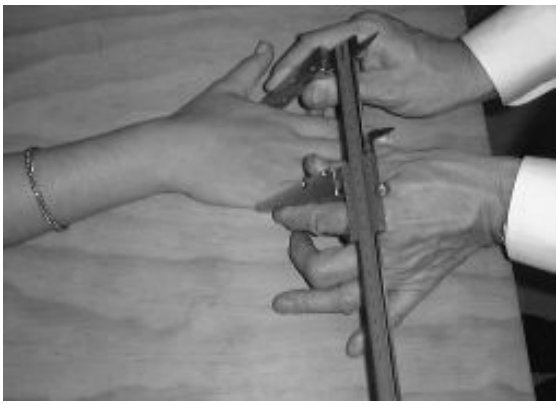

Figure 52: Bi-metacarpale breadth

Figure 53: Femur bi-epicondylar breadth

Body mass and stretch stature

- **Body mass (weight).** Ideally, body weight should be obtained on an accurately-calibrated beam-type balance and recorded to the nearest 0.1 kg. The subject should be weighed in clothing of known weight so a correction to nude weight can be made. As there are diurnal variations in weight, it is best to weigh the subject at the same time of day in each testing session. Recording the time of day at which measurements are made therefore necessary. The most stable values for monitoring weight change are those obtained routinely in the morning, twelve hours after having ingested food, and after voiding. An account should be made of the state of hydration that the subject is in. Calibrate the weighing machine or scales using reference weights of known mass. The subject is to stand still without support, with their weight evenly distributed over the centre of the scale, looking straight ahead, whilst the weight is recorded. Weight is recorded to the nearest 0.1Kg (See Figure 54).
- **Stretch stature (height).** There are four general techniques for measuring stature which yield slightly different values. These are: freestanding stature, stature against the wall, recumbent length and stretch stature. The standard method for this manual is stretch stature. An explicit description of the selected technique and strict adherence to it are important. The technique requires precise positioning of the subject in order to obtain useful measurements. The measurement is taken as the maximum vertical distance from the floor to the vertex of the head. Technically, the vertex is defined as the highest point on the skull when the head is held in the Frankfort plane. This position is achieved when the line joining the orbitale to the tragion is horizontal or at right angles to the long axis of the body. The orbitale is located on the lower or most inferior position on the margin of the eye socket. The tragion is the notch above or superior to the flap of the ear (tragus), at the superior aspect of the zygomatic bone. This position corresponds almost exactly to the visual axis when the subject is looking directly

ahead. In making the stature measurement, the measurer has the barefoot subject stand erect with heels together, both heels touching the base of the stadiometer, and arms hanging naturally by the sides. The heels, buttocks, upper part of the back and usually, but not necessarily, the back of the head are in contact with the vertical wall. The subject is instructed to "look straight ahead" and "take a deep breath". One of the measurers ensures that the subject's heels are not elevated while the other measurer applies stretch force, by cupping the subject's head and applying firm traction alongside the mastoid processes. The first measurer then brings the headpiece firmly down crushing the hair and making firm contact with the vertex and makes a pencil mark on the paper tape level with the underside of the headpiece. Measurement is made before the subject exhales. The subject then steps away from the wall, the headpiece is removed and the vertical distance from floor to pencil mark is measured with the retractable metal tape stadiometer (see section on Instruments). The measurement is read to the nearest 0.1 cm. Figure 55 shows standing stretch stature.

Figure 54: Body mass

Figure 55: Stretch standing stature

Sitting height, span, a-p chest depth, head and neck girths

In these measures posture and orientation of the head can introduce error. Thus, in all four measurements, the subject's head should be in the Frankfort plane and an upright sitting posture be assumed. Sometimes, this is achieved by touching the subject's back and using verbal encouragement to "sit tall".

- **Sitting height.** The distance from the vertex to the base sitting surface when the seated subject is instructed to sit tall and gentle traction is applied to the head. This measurement is usually made when the subject is seated on the box with the feet on the floor. Care must be taken to ensure that the subject does not push with the legs. An assistant orients the subject's head in the Frankfort plane, instructs him or her to take a breath and sit as tall as possible, and applies gentle traction to the mandible and the base of the skull. The anthropometrist positions the anthropometer on the sitting base and brings the branch down, crushing the hair and making firm contact with the vertex (See Figure 56).
- **Arm span.** The distance from the left to the right dactylion when the palms are facing forward and the outstretched arms are abducted to the horizontal. The subject faces a wall (head turned to one side) and places one dactylion against an edge or side wall. This dactylion is held in position by an assistant. The other dactylion is volitionally stretched along the wall for maximal

span which is identified and then measured to the nearest 0.1 cm. The measurement can be made by anthropometric tape or against a calibrated wall chart with marked distances (See Figure 57).

- **A-P chest depth.** The anterior-posterior depth of the chest at mesosternale level. This measure is easiest to obtain from the right side of the subject seated in an erect position. The caliper is applied over the right shoulder in a downward direction. The olive tip of the caliper branch is held at the marked mesosternale by a pinch grip of the index finger and thumb anchoring the tip to the site. The tip of the other branch is placed on the spinous process of the vertebra at the level of the mesosternale. Again, the olive tip is anchored to the site by the index finger and thumb. The top of the widespreading caliper rests on the anthropometrist's chest. The pressure, when measuring, should be only moderate as the olive tips can easily cause pain when firm pressure is applied. The measurement is taken at the end of a normal expiration (end tidal) (See Figure 58).
- **Head girth.** The maximum perimeter of the head when the tape is located immediately superior to the glabella (midpoint between the brow ridges). The tape is located perpendicular to the long axis of the seated subject whose head is oriented in the Frankfort plane. Because of intervening hair, the usual light touch for girths is replaced by a firmer measure that crushes hair to minimise its influence on the measurement (See Figure 59).
- **Neck girth.** The perimeter of the neck taken immediately superior to the larynx (Adam's apple). The tape is located perpendicular to the long axis of the neck of the seated subject whose head is oriented in the Frankfort plane. The usual light anthropometric touch is applied to the tape (See Figure 60).

Figure 56: Sitting stretched height

Figure 57: Arm span

Figure 58: A-P chest depth

Figure 59: Head girth

Figure 60: Neck girth

Photographic assessment of segment lengths

The subject stands upright in front of the marker grid in anthropometric posture; standing upright, arm parallel to the sides, palms forward and facing outward. The subject is photographed from the front and side simultaneously. Limb, head, and trunk lengths as well as estimates of segment inertial parameters are determined from measurements off the photographs.

Data analysis

The major purpose of this chapter of the manual is to provide the reader with the correct descriptions and instructions for taking standard anthropometric measurements. Therefore, data analysis will only be dealt with briefly and the reader is encouraged to access the referenced texts if he/she wishes to perform extensive analysis and to understand the underlying theory of the various applications. An example of each of the types of data analysis discussed is shown in Appendix 7.

Skinfolds

The most often-used data from anthropometric measurement is that obtained from skinfolds. It has been very popular to use the sum of varying numbers of skinfolds to calculate percentage body fat. As the assumptions underlying such calculations are known to be flawed, SSNZ does not recommend the calculation of percentage body fat. Rather, SSNZ recommends using the sum itself consisting, as it does, of direct and repeatable measurements. This data can then be used on either a cross-sectional or longitudinal basis. The most useful application of skinfold data is the comparison over time of repeat measures on an individual to determine and quantify sub-cutaneous fat loss or gain. Any combination of skinfolds can be used, but if a realistic assessment of subcutaneous fat is to be gained, sites must be chosen from both the upper and lower body. The most commonly-used combination features six sites - triceps, subscapular, supraspinale, abdominal, front thigh and medial calf. The subject in Appendix 7, “Oscar”, has an extremely large amount of subcutaneous adipose tissue, as can be seen from his Sum6Skinfolds of 191.7 mm.

Somatotype

A somatotype is a classification of physique based on the concept of shape, disregarding size. The pre-eminent system of somatotype classification is the Heath-Carter somatotype. This shows the relative dominance of Endomorphy (relative fatness), Mesomorphy (relative musculo-skeletal robustness) and Ectomorphy (relative linearity). Each component is identified in the sequence endomorphy-mesomorphy-ectomorphy and, when anthropometrically-derived, expressed to the nearest one-tenth rating, e.g, 1.4-6.0-3.2, an ectomorphic mesomorph, or ecto-mesomorph. Ratings of 2 to 2.5 are considered low, 3 to 5 are moderate, 5.5 to 7 are high and 7.5 and above are very high (Carter, 1996). The derivation equations for each component are as follows.

Endomorphy

- $-0.7182 + 0.1451*\sum SF - 0.00068*\sum SF^2 + 0.0000014*\sum SF^3$

  [where (SF = sum of triceps, subscapular and supraspinale skinfolds multiplied by (170.18/ height in cms)]

Mesomorphy

- 0.858*humerus breadth +0.601*femur breadth + 0.188* corrected arm girth + 0.161*corrected calf girth - height*0.131 + 4.5

Ectomorphy

- One of three equations is used depending on the value of the calculated Height Weight Ratio (HWR) of the subject. [HWR is height/mass.^{333}].
  - If HWR is greater than, or equal to 40.75 then ectomorphy = 0.732*HWR - 28.58
  - If HWR is less than 40.75 and greater than 38.25 then ectomorphy = 0.463*HWR - 17.63
  - If HWR is equal to or less than 38.25 then ectomorphy = 0.1

To take the drudgery out of these calculations, a simple computer program is available from SSNZ to do the job for you. All you will need to do is input the necessary measured values into the required cells.

Somatotype data can be statistically analysed. Those interested in such analysis are referred to Lindsay Carter's most recent publication *"Kinanthropometry and Exercise Physiology Laboratory Manual: Tests, Procedures and Data"* (Duquet and Carter, 1996).

"Oscar's" somatotype, 6.9-6.9-0.1 shows that he is both highly mesomorphic and highly endomorphic. Concomitantly, his ectomorphy rating is negligible.

Proportionality

Middle distance runners tend to be long in the legs and arms, short in the trunk and narrow in the hips. "Long", "short" and "narrow" are subjective evaluations based on some kind of metaphorical model of a human.

Proportionality is the relationship of body parts, one to another or to the whole body. It is both enlightening and useful to be able to compare athletes proportionally as well as absolutely. A simple device for achieving this type of comparison is the unisex Phantom devised by Ross and Wilson (1974) and updated by Ross and Ward (1982). This device makes use of a single, arbitrary, unisex reference human where sizes (p) and standard deviations (s) are specified as indicated in Appendix 6. The following general formula is used to translate raw scores into Phantom z-values.

$$z = \frac{1}{s}\left[v - \left[\frac{(170.18)^d}{(h)} - P \right] \right]$$

where:

z	is a Phantom z-value
s	is a specified Phantom standard deviation for variable v
v	is the obtained measure of variable v
170.18	is the Phantom stature constant
h	is the obtained stature

d is the dimensional exponent. In the geometrical similarity system d is: 1 for all lengths, breadths, girths, and skin fold thicknesses; 2 for all areas; 3 for mass or volume of the whole body or any part

p is the specified Phantom value for variable v.

The general formula has the effect of geometrically adjusting all measures to a common stature, much as achieved by changing focal lengths on a slide projector.

The d values described above are for geometrical scaling.

Variables other than stature can be used as the scaling standard by substituting the phantom value for the chosen variable in place of the phantom height (170.18) and the individual's value for that measure in the place of "h" in the formula.

A z-value of 0.0 indicates variable v has the same proportion as the Phantom; a z-value greater than 0.0 indicates that the variable is proportionally larger; a negative z-value indicates it is proportionally smaller. Z-values can be subtracted to show differences or treated statistically as one would any standard score.

To remove the drudgery out of these calculations, a simple computer program is available from SSNZ to do the job for you.

"Oscar" is absolutely larger than the phantom in all measures except hand breadth. (Compare his values in Appendix 7 with the phantom "p" values in Appendix 6.) He is proportionally smaller, however, in all those measures with a negative z-value (see Appendix 7). Of particular interest is how small his hands are for a big man and how short his tibia is.

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Appendix 1

Anthropometric Tolerances

Triceps sf	5%
Subscapular sf	5%
Biceps sf	5%
Iliac Crest sf	5%
Supraspinale sf	5%
Abdominal sf	5%
Front Thigh sf	5%
Medial Calf sf	5%
Acromiale-radiale	2 mm
Radiale-stylion	2 mm
Midstylion-dactylion	2 mm
Tibiale mediale-sphyrion tibiale	2 mm
Iliospinale b. ht	2 mm
Trochanterion b. ht	2 mm
Trochanterion-tibiale laterale	2 mm
Tibiale laterale ht	2 mm
Arm girth relaxed	2 mm
Arm girth flexed and tensed	2 mm
Forearm girth (max. relaxed	2 mm
Wrist girth (distal styloid)	2 mm
Chest girth (mesosternale)	1 %
Waist girth (min.)	1 %
Gluteal girth (max.)	1 %
Thigh girth (1 cm dist. glut. line)	2 mm
Thigh girth (mid tro-tib lat)	2 mm
Calf girth (max.)	2 mm
Ankle girth (min.)	2 mm
Biacromial breadth	2 mm
Biiliocristal breadth	2 mm
Foot length (ak-pt)	2 mm
Transverse chest breadth	2 mm
Humerus breadth (biepicondylar)	2 mm
Wrist breadth (bistyloid)	2 mm
Hand breadth (bimetacarpale)	2 mm
Femur breadth (biepicondylar)	2 mm
Body mass	.5 kg
Stretch stature	5 mm
Sitting height	5 mm
Span	5 mm
A-P chest depth	1 %
Head girth	2 mm
Neck girth	2 mm

Appendix 2

ANTHROPOMETRIC PROFORMA

Subject Name (first, last) _____ Subject ID# _____

Country _____ Ethnicity _____ Sex _____

Date of Birth — Day | Month | Year — Box Height

Date of Measurement — Day | Month | Year — Checker ID#

	First Measure			Second Measure			Third Measure			Recorded Data		
Triceps sf												
Subscapular sf												
Biceps sf												
Iliac Crest sf												
Supraspinale sf												
Abdominal sf												
Front Thigh sf												
Medial Calf sf												
Acromiale-radiale												
Radiale-stylion												
Midstylion-dactylion												
Tibiale mediale-sphyrion tibiale												
Iliospinale b. ht												
Trochanterion b. ht												
Trochanterion-tibiale laterale												
Tibiale laterale ht												
Arm girth relaxed												
Arm girth flexed and tensed												
Forearm girth (max. relaxed)												
Wrist girth (distal styloid)												
Chest girth (mesosternale)												
Waist girth (min.)												
Gluteal girth (max.)												
Thigh girth (1 cm dist. glut. line)												
Thigh girth (mid tro-tib lat)												
Calf girth (max.)												
Ankle girth (min.)												
Biacromial breadth												
Biiliocristal breadth												
Foot length (ak-pt)												
Transverse chest breadth												
Humerus breadth (biepicondylar												
Wrist breadth (bistyloid)												
Hand breadth (bimetacarpale)												
Femur breadth (biepicondylar)												
Body mass												
Stretch stature												
Sitting height												
Span												
A-P chest depth												

Appendix 3

ISAK LEVEL 1 PROFORMA

Subject Name (first, last) _____ Subject ID# _____

Country _____ Ethnicity _____ Sex _____

	Day	Month	Year		
Date of Measurement				Measurer	
Date of Birth				Recorder	

	First measure	Second measure	Third measure	MEDIAN
Triceps sf				
Subscapular sf				
Biceps sf				
Iliac Crest sf				
Supraspinale sf				
Abdominal sf				
Front Thigh sf				
Medial Calf sf				
Arm girth relaxed				
Arm girth flexed and tensed				
Waist girth (min.)				
Gluteal girth (max.)				
Calf girth (max.)				
Humerus breadth (biepicondylar)				
Femur breadth (biepicondylar				
Body mass				
Stretch stature				

Error Analysis

Skinfolds % TEM = _____ %

Other Measures % TEM = _____ %

Examiner: _____ **PASS**

Date: _____ **FAIL**

Post-course	Post-profiles
SKINFOLDS	
Inter-tester < 12.5%	Inter-tester < 10%
Intra-tester < 10%	**Intra-tester < 7.5%**
OTHER	
Inter-tester < 2.5%	Inter-tester < 2%
Intra-tester < 2%	**Intra-tester < 1.5%**

Appendix 4

O-SCALE PROFORMA

Subject Name (first, last) _____ Subject ID#

Country _____ Ethnicity _____ Sex _____

Date of Measurement — Day | Month | Year — Checker ID#

Date of Birth — Day | Month | Year

	First measure	Second measure	Third measure	MEDIAN
Body mass				
Stretch stature				
Triceps sf				
Subscapular sf				
Biceps sf				
Iliac Crest sf				
Supraspinale sf				
Abdominal sf				
Front Thigh sf				
Medial Calf sf				
Arm girth relaxed				
Arm girth flexed and tensed				
Forearm girth (max. relaxed)				
Wrist girth (distal styloid)				
Chest girth (mesosternale)				
Waist girth (min.)				
Gluteal girth (max.)				
Thigh girth (1 cm dist. glut. line)				
Calf girth (max.)				
Ankle girth (min.)				
Humerus breadth (biepicondylar)				
Femur breadth (biepicondylar				

Appendix 5

HEATH-CARTER SOMATOTYPE PROFORMA

Subject Name (first, last) _____ Subject ID# _____

Sex _____ Ethnicity _____ Country _____ Team _____

Date of Birth — Day _____ Month _____ Year _____ Box Height _____

Date of Measurement — Day _____ Month _____ Year _____ Checker ID# _____

Sport _____ Event (s) _____

	First Measure	Second Measure	Third Measure	Recorded Data
Triceps sf				
Subscapular sf				
Suprapinale sf				
Medial Calf sf				
Arm girth flexed and tensed				
Calf girth (max.)				
Humerus breadth (biepicondylar)				
Femur breadth (biepicondylar)				
Body mass				
Stretch stature				

Appendix 6

PHANTOM VALUES

	P value	S value
Triceps s.f.	15.40	4.47
Subscapular s.f.	17.20	5.07
Biceps s.f.	8.00	2.00
Iliac crest s.f.	22.40	6.80
Supraspinale s.f.	15.40	4.47
Abdominal s.f.	25.40	7.78
Front thigh s.f.	27.00	8.33
Medial calf s.f.	16.00	4.67
Acromiale-Radiale length	32.53	1.77
Radiale-Stylion length	24.57	1.37
Mid-stylion-Dactylion length	18.85	0.85
Trochanterion-Tibiale laterale length	41.37	2.48
Tibial mediale-Sphyrion length	36.81	2.10
Arm girth relaxed	26.89	2.33
Arm girth flexed and tensed	29.41	2.37
Forearm girth	25.13	1.41
Wrist girth	16.35	0.72
Chest girth	87.86	5.18
Waist girth (min)	71.91	4.45
Gluteal girth(max)	94.67	5.58
Thigh girth (1)	55.82	4.23
Calf girth	35.25	2.30
Ankle girth	21.71	1.33
Biacromial breadth	38.04	1.92
Biiliocristal breadth	28.84	1.75
Foot length	25.50	1.16
Transverse chest breadth	27.92	1.74
Humerus breadth	6.48	0.35
Wrist breadth	5.21	0.28
Hand breadth	8.28	0.50
Femur breadth	9.52	0.48
Body mass	64.58	8.60
Stretch stature	170.18	6.29
Sitting height	89.92	4.50
Span	172.35	7.41
A-P chest depth	17.50	1.38
Head girth	56.00	1.44
Neck girth	34.91	1.73