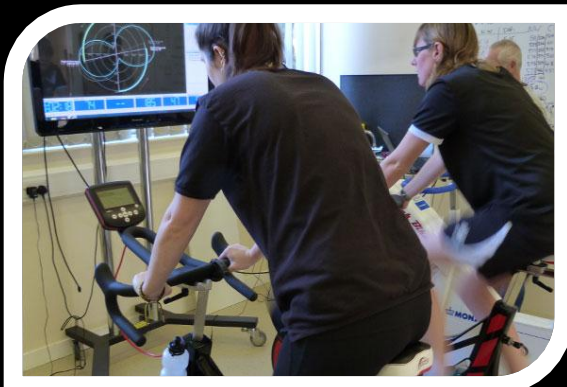


SHSS 4064

ASSESSING HEALTH AND FUNCTIONAL FITNESS

Laboratory Manual

January 2015



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Introduction

This laboratory manual contains the procedures for the practical sessions that form part of the sports nutrition and drugs module. It is your responsibility to keep the lab book up to date. The lab book forms part of the assessment for the module

Always:

- ✓ Bring the lab book to lectures, tutorials and laboratory practicals
- ✓ Record the data collected during your laboratory practical and the data of other groups if specified by your tutor
- ✓ Read your lecture notes and compare your findings with those from the current literature

Assessment

This lab book is used to collect data for assessment point 1, and forms 25% of the final mark for the module. You are required to submit ONE practical from this laboratory handbook. All of the laboratory practicals will have equal marks awarded, and so all are equally important. You do not need to submit the laboratory manual as part of assignment one, but you should answer the assignment task as a word document and submit this via turnit in on moodle. It is accepted that students will work in small groups to collect data and therefore tabulated data maybe identical. However, if other sections of the assignment task are identical or very similar this may be considered plagiarism. This will result in failure of the module.

Laboratory safety procedures and informed consent

Safety procedures

- ✓ Other than computers, students should not use any equipment in the laboratory without a member of staff being present
- ✓ All equipment should be left as found and any faults reported to the technician or tutorial staff
- ✓ No equipment may be removed from the laboratory
- ✓ Under no circumstances should you eat, drink, smoke or chew in the laboratory
- ✓ Bags should not be left lying around the lab
- ✓ Mobile phones should be turned off at all times in the laboratory
- ✓ Ensure that you sign your name on the register on attendance

Questionnaire

Please answer the following questions truthfully and completely. The purpose of this questionnaire is to ensure that you are in a fit and healthy state to complete exercise tests. Please inform the tutor if you are unable to participate.

Name:..... Date Of Birth:.....

Main Sport.....

1. Have you had to consult your doctor within the last 6 months? yes/no*

If yes, please give relevant details to test supervisor.

2. Are you presently taking any form of medication? yes/no*

If yes, please give details to test supervisor.

3. Do you suffer, or have you ever suffered, from:

Asthma?	yes/no*
Diabetes?	yes/no*
Bronchitis?	yes/no*
Epilepsy?	yes/no*
High blood pressure?	yes/no*

4. Do you suffer, or have you ever suffered from, any form of heart complaint? yes/no*
5. Is there a history of heart disease in your family? yes/no*
6. Do you currently have any form of muscle or joint injury? yes/no*
7. Have you had any cause to suspend your normal training in the last two weeks? yes/no*
8. Is there anything to your knowledge that may prevent you from successfully completing the tests that have been outlined to you? yes/no*

I confirm that I have answered these questions truthfully to the best of my knowledge.

Participant's

signature:.....Date:.....
.....

Informed Consent Form

Please complete all the details below. This information is required solely for laboratory records.

Name:..... D.O.B.:.....

Address:.....
.....

Telephone:.....

Please read the following statements carefully. Please sign only when you agree with the statements and when you have had any relevant questions answered.

- The full details of the tests have been explained to me. I am clear about what will be involved and I am aware of the purpose of the tests, the potential benefits and the potential risks.
- I know that I am not obliged to complete the tests. I am free to stop the test at any point and for any reason.
- The test results are confidential and will only be communicated to others such as my coach if agreed in advance.
- I have no injury or illness that will affect my ability to successfully complete the tests.

Signature of Participant:..... Date:.....

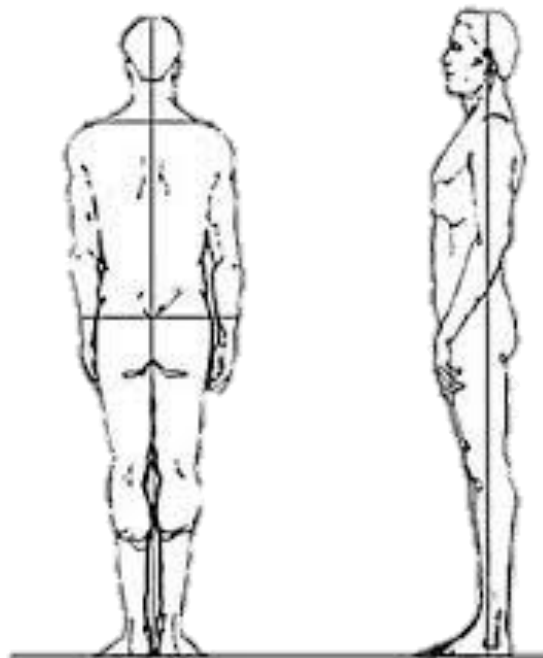
Signature of Tester:.....

Laboratory Practical 1

Postural Assessment

Posture is the alignment and maintenance of body segments in certain positions (Bloomfield, 1998). Britnell et al (2005) offered a definition of good posture to be a state of muscular and skeletal balance, which protects the supporting structures of the body against injury or progressive deformity.

Postural symmetry has long been debated as a risk factor for sports and exercise related injury and performance deficits. Traditionally, postural symmetry is assessed using a plumb line approach.



Lateral View

In normal standing, the plumb line should sit anterior to the lateral malleolus. It should then pass up between the mid-point of the tibiofemoral joint line, pass through the greater trochanter of the femur and the mid-point of the glenohumeral joint, before touching behind the ear and leaving the body through the top of the head.

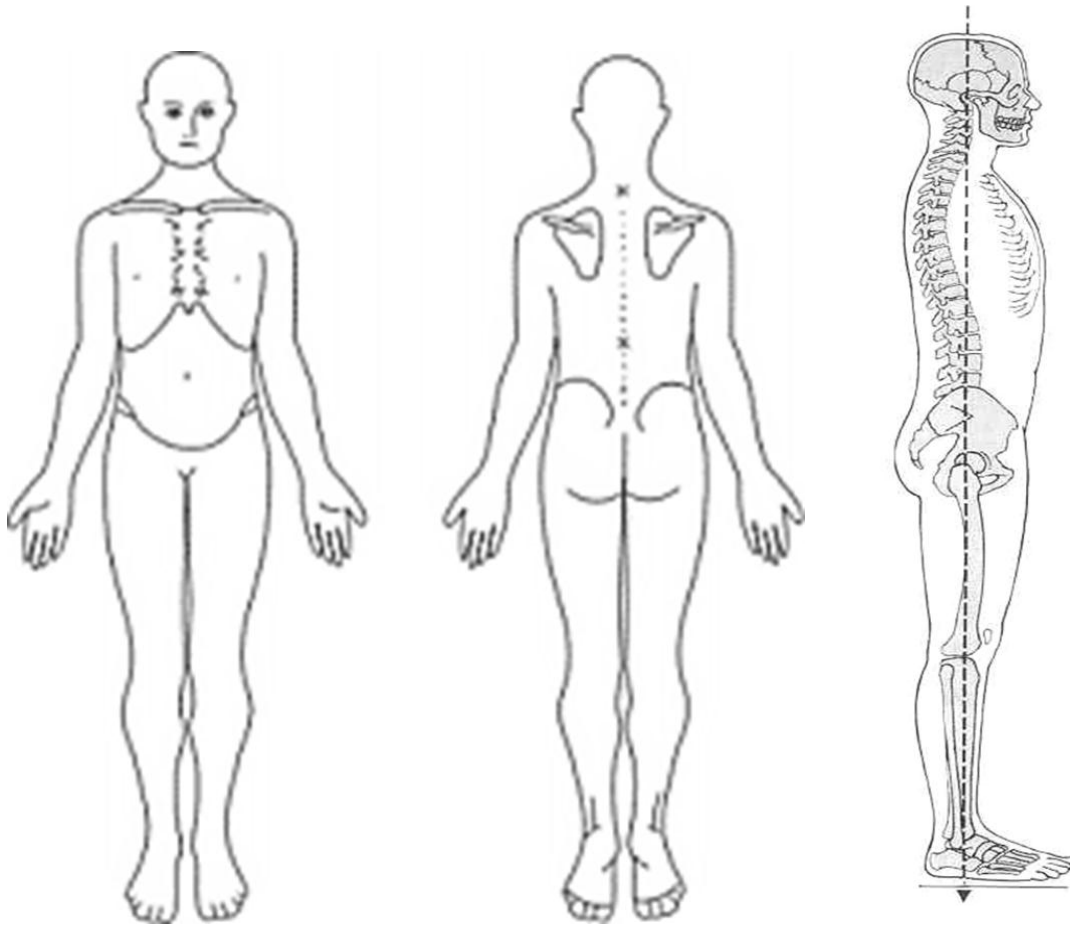
Posterior View

The plumb line should sit equidistant between the medial malleoli as your starting point. From the floor it should then pass through your sacrum and your vertebrae. It should pass equally between your scapulae as measured as the distance between the medial borders of the scapula and pass through the top of the head.

You should be able to notice in this view a right to left comparison of symmetry too. Consider the muscle bulk of the triceps surae group in your calf, the crease at the back of the knee, the gluteal fold and gluteal muscle bulk, the height of the hands, scapula, shoulders and ears – are they even and level?

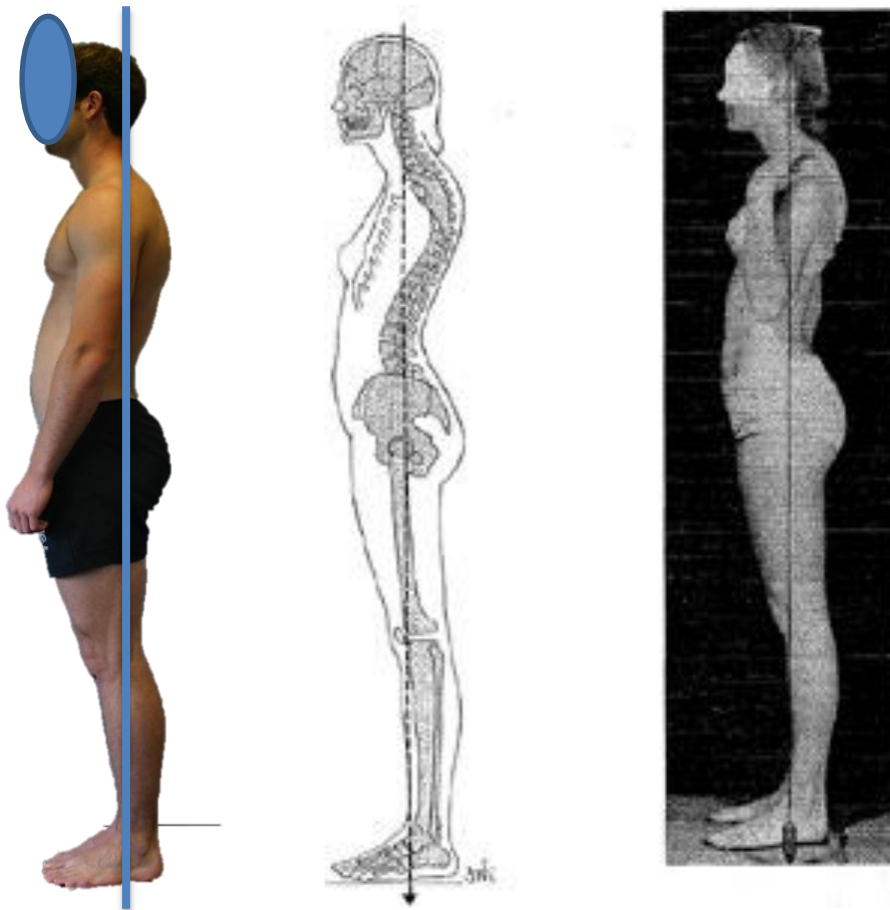
Task One

Undertake a plumbline assessment of static posture and annotate your findings on the images below:



Common Postural Faults

Lordotic/Kyphotic Posture



Observations of the Lordotic/Kyphotic posture include a greater trochanter which sits in front of the plumb line, an increased lumbar lordosis and anterior pelvic tilt, a humeral head which is also in front of the plumb line and protracted/medially rotated shoulders with a forward head posture.

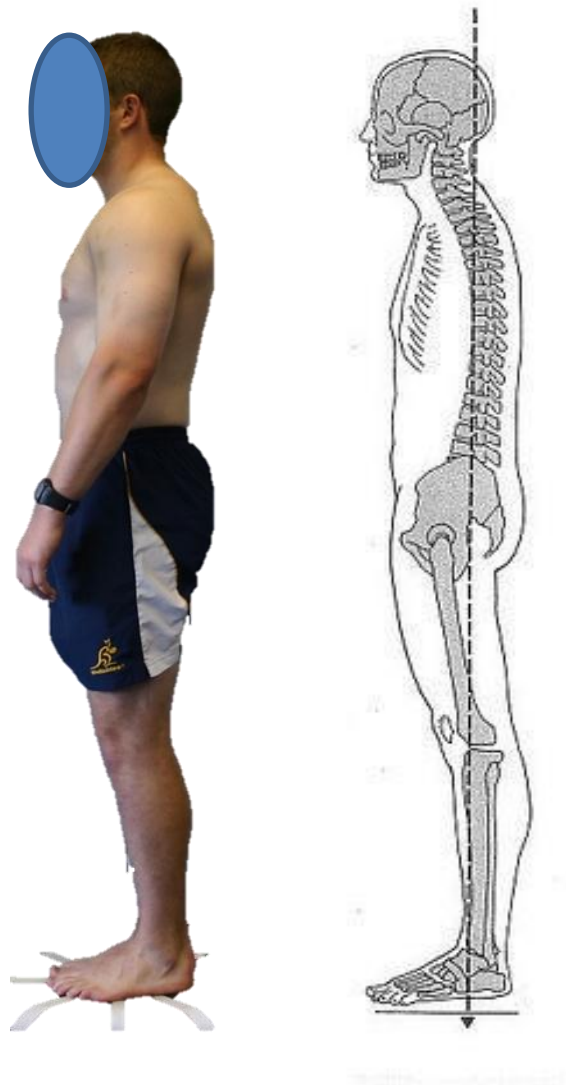
Lower Limb

In this position the lumbar spine soft tissue become short and tight. The main hip flexor- iliopsoas is also shortened. A few muscles are also lengthened in this position. For example the hamstrings and lower abdominals are lengthened by this positioning.

Upper Limb

With the protracted and medially rotated shoulder position pectoralis major often shortens and tightens. The forward head carriage often means a shortening of the cervical extensors at the back of the neck. In this position the neck flexors and the posterior shoulder muscles and rotator cuff are lengthened and weakened by this positioning.

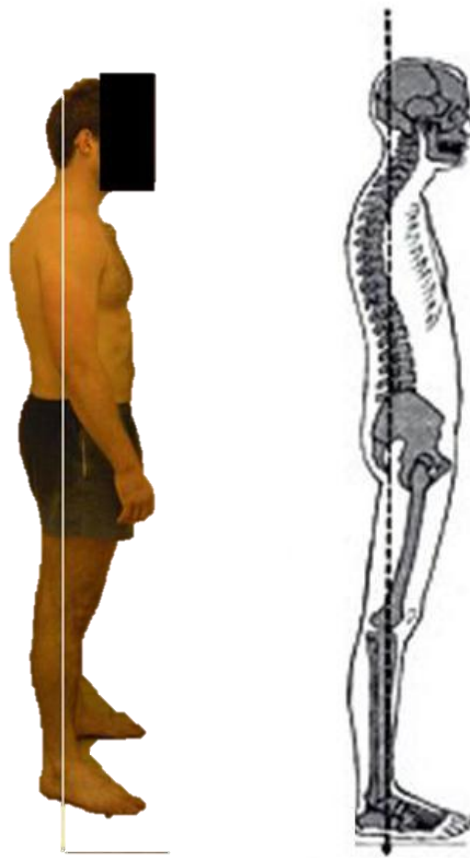
Flat Back Posture



This postural type is characterised by no obvious curvature of the spine. There is no obvious lordotic curvature in the lumbar spine or pronounced thoracic kyphosis.

This postural type is often caused by excessively strong abdominal muscles and excessively tight hamstrings.

Sway Back Posture



This type of posture is characterised by a posterior displacement of the upper torso and an anterior displacement of the lower torso and hips. The hips are forced in to a hyperextended position which is aggravated by dynamic movements such as running.

It is caused by a weakness of the abdominals (especially the external obliques) and the hip flexors.

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short questions (500 words)

Practical 1

Does static posture have any predictive value for sport and exercise injuries in athletic populations?

Laboratory Practical 2

Body Composition

The measurement of body composition has become a popular and standard practice for many physicians, athletic trainers, allied health professionals and researchers (Graves et al, 2006). Evidence supports the notion that being overweight (i.e. having excess body fat) is related to musculoskeletal injury, non-adherence to exercise training and reduced athletic performance. In addition, numerous health problems are associated with excess body fat, such as hypertension, diabetes mellitus, depression, hyperlipidaemia and coronary heart disease (NHS, 2015).

In this laboratory we will examine numerous indicators and measures of body composition.

Measurements Required: (all Right sided)

Each measurement should be repeated 3 times for consistency and the average scored used.

Total mass (kg)

The subject, wearing minimal clothing, stands in the centre of the scale platform. Record clients weight to the nearest tenth of a kilogram. A correction is made for clothing so that nude weight is used in subsequent calculations.

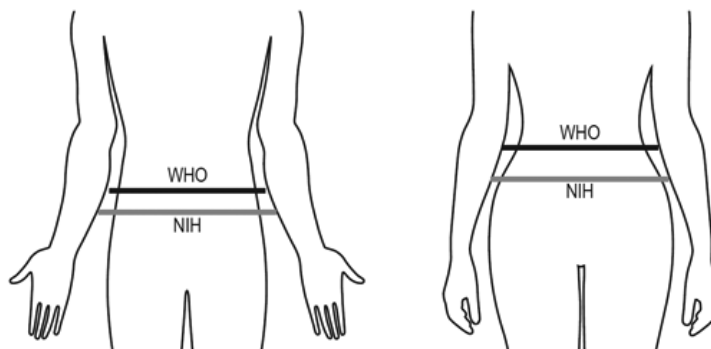
Stature (cm)

Taken against a height scale or stadiometer. Take height with the subject standing straight, against an upright wall or stadiometer, touching the wall with heels, buttocks and back. Orient the head in the Frankfort plane (the upper border of the ear opening and the lower border of the eye socket on a horizontal line), and the heels together. Instruct the subject to stretch upward and to take and hold a full breath. Lower the headboard until it firmly touches the vertex.

Waist Circumference

Using the World Health Organisation protocol, take the waist circumference from the mid-point of the iliac crest and the lowest rib.

Waist circumference measurement sites for men and women based on World Health Organization (WHO) and National Institutes of Health (NIH) protocols



Note: Following the WHO protocol, the measure is taken midway between the highest point of the iliac crest and the bottom of the ribcage. Following the NIH protocol, the measure is taken at the highest point of the iliac crest.

Skinfolds

Raise a fold of skin and subcutaneous tissue firmly between thumb and forefinger of the left hand and away from the underlying muscle at the marked site. Apply the edge of the plates on the caliper branches 1 cm below the fingers of the left hand and allow them to exert their full pressure before reading at 2 sec the thickness of the fold. Take all skinfolds on the right side of the body. The subject stands relaxed, except for the calf skinfold, which is taken with the subject seated.

Triceps skinfold (mm)

With the subject's arm hanging loosely in the anatomical position, raise a fold at the back of the arm at a level halfway on a line connecting the acromion and the olecranon processes.

Subscapular skinfold (mm)

Raise the subscapular skinfold on a line from the inferior angle of the scapula in a direction that is obliquely downwards and laterally at 45 degrees.

Supraspinale skinfold (mm)

Raise the fold 5-7 cm (depending on the size of the subject) above the anterior superior iliac spine on a line to the anterior axillary border and on a diagonal line going downwards and medially at 45 degrees.

Medial calf skinfold (mm)

Raise a vertical skinfold on the medial side of the leg, at the level of the maximum girth of the calf.

Abdominal Skinfold (mm)

A mark is made 5 cm adjacent to the umbilicus (belly-button), to the right side. The vertical pinch is made at the marked site, and the callipers placed just below the pinch. Be careful not to place the calliper or fingers inside the navel.

Thigh Skinfold (mm)

A mark is made on the mid-point of the anterior (front) surface of the thigh, midway between patella (knee cap) and inguinal fold. A vertical pinch is taken. This measurement is normally taken with the subject sitting and the knee bent at right angles. If there is difficulty in lifting a fold of skin, it may be easier with the leg extended, or with the thigh supported from below by the subject.

Body Mass Index

Body Mass Index, or BMI, is a popular method of establishing relative size based on the mass and height of an individual and is the standard index of measurement used in epidemiological research.

To calculate your BMI you will need the measurement for weight (Kg) and height (converted to Meters from centimetres) taken earlier in this session. Enter these values in to the equation below to calculate your BMI:

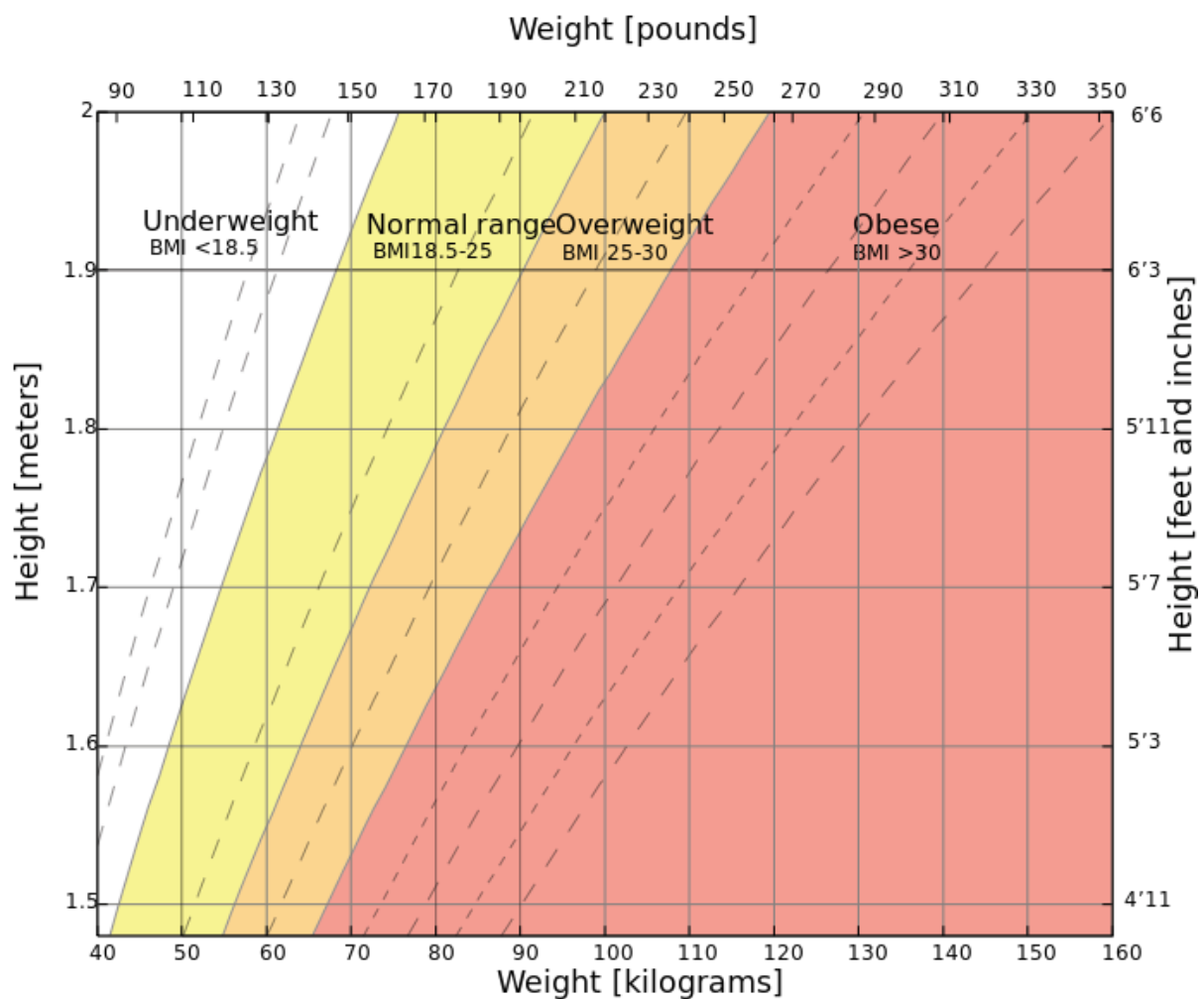
$$\text{BMI} = \text{Mass (Kg)} / (\text{Height}^2) \text{ M}$$

$$\text{Or BMI} = \text{Mass (Kg)} / (\text{Height} \times \text{Height}) \text{ M}$$

Once the BMI of the patient is calculated it is compared to normative data to classify their relative size:

Category	BMI range – kg/m ²
Very severely underweight	less than 15
Severely underweight	from 15.0 to 16.0
Underweight	from 16.0 to 18.5
Normal (healthy weight)	from 18.5 to 25
Overweight	from 25 to 30
Obese Class I (Moderately obese)	from 30 to 35
Obese Class II (Severely obese)	from 35 to 40
Obese Class III (Very severely obese)	over 40

Or plotted on a graph:



Waist Circumference

According to the National Obesity Forum, the following results should be noted:

	Increased Risk	Substantially increased risk
Men	≥ 94 cm	≥ 102 cm
Women	≥ 80 cm	≥ 88 cm

Skinfold Measurement of Body Fat Percentage

The premise behind skinfold measurements is that the skinfold is actually two layers of skin and two layers of fat pinched together between the callipers. This subcutaneous fat deposit is assumed to be a reflection of the deeper fat deposits in the body such as the visceral fat around the abdomen.

Once the multiple skinfold measurements have been taken, a calculation of body fat can be made. There are numerous skinfold sites and methods of calculating body fat ranging from a 2 site calculation to a 12 site calculation.

To calculate your body fat from 4 skinfold measurements use the following equation:-

You will need to total the sum of the abdominal, triceps, thigh and supraspinale skinfold sites (measured in mm)

For males:

$\% \text{ Body Fat} = (0.29288 \times \text{sum of skinfolds}) - (0.0005 \times \text{square of the sum of skinfolds}) + (0.15845 \times \text{age}) - 5.76377$

For females:

$\% \text{ Body Fat} = (0.29669 \times \text{sum of skinfolds}) - (0.00043 \times \text{square of the sum of skinfolds}) + (0.02963 \times \text{age}) + 1.4072$

Jackson A S, Pollock, M (1985) Practical assessment of body composition. *Physician and Sports Medicine*. 13: 76-90.

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short question (500 words)

Practical 2

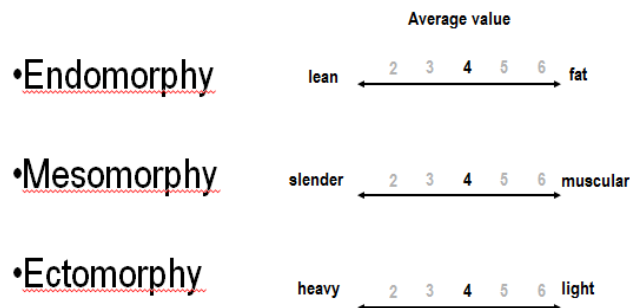
- Select a method of determining body composition taught within this session. Highlight some of the potential measurement errors for establishing body composition using this method.

Laboratory Practical 3

Somatotyping

Somatotype is a physique classification system which recognises a body shape category, which necessarily falls between pre-determined end limits. It is defined as a quantified expression and description of the present morphological conformation of a person. It is independent of size, age and gender (Carter and Heath, 1990).

Somatotype is a three figure reference which characterises physique and body shape. It comprises values, originally proposed on a 7-point scale, which summarise the physique, and can be plotted on the tri-polar somatochart.



Where

- Endomorphy: Roundness or fatness, based on 3 skinfolds Independent of size
- Mesomorph: Musculo-skeletal robustness, based on elbow & knee breadths, and corrected girths of calf and upper arm
- Ectomorphy: Relative fragility, based on height and weight

(Heath & Carter, 1967)

Measurements Required: (all Right sided)

Each measurement should be repeated 3 times for consistency and the average scored used.

Total mass (kg)

The subject, wearing minimal clothing, stands in the centre of the scale platform. Record clients weight to the nearest tenth of a kilogram. A correction is made for clothing so that nude weight is used in subsequent calculations.

Stature (cm)

Taken against a height scale or stadiometer. Take height with the subject standing straight, against an upright wall or stadiometer, touching the wall with heels, buttocks and back. Orient the head in the Frankfort plane (the upper border of the ear opening and the lower border of the eye socket on

a horizontal line), and the heels together. Instruct the subject to stretch upward and to take and hold a full breath. Lower the headboard until it firmly touches the vertex.

Upper arm circumference (cm)

Elbow flexed and tensed, right. The subject flexes the shoulder to 90 degrees and the elbow to 45 degrees, clenches the hand, and maximally contracts the elbow flexors and extensors. Take the measurement at the greatest girth of the arm.

Max. Calf circumference (cm)

The subject stands with feet slightly apart. Place the tape around the calf and measure the maximum circumference.

Femur breadth (cm)

Seat the subject with knee bent at a right angle. Measure the greatest distance between the lateral and medial epicondyles of the femur with firm pressure on the crossbars in order to compress the subcutaneous tissue.

Humerus breadth (cm)

The width between the medial and lateral epicondyles of the humerus, with the shoulder and elbow flexed to 90 degrees. Apply the caliper at an angle approximately bisecting the angle of the elbow. Place firm pressure on the crossbars in order to compress the subcutaneous tissue.

Skinfolds

Raise a fold of skin and subcutaneous tissue firmly between thumb and forefinger of the left hand and away from the underlying muscle at the marked site. Apply the edge of the plates on the caliper branches 1 cm below the fingers of the left hand and allow them to exert their full pressure before reading at 2 sec the thickness of the fold. Take all skinfolds on the right side of the body. The subject stands relaxed, except for the calf skinfold, which is taken with the subject seated.

Triceps skinfold (mm)

With the subject's arm hanging loosely in the anatomical position, raise a fold at the back of the arm at a level halfway on a line connecting the acromion and the olecranon processes.

Subscapular skinfold (mm)

Raise the subscapular skinfold on a line from the inferior angle of the scapula in a direction that is obliquely downwards and laterally at 45 degrees.

Supraspinale skinfold (mm)

Raise the fold 5-7 cm (depending on the size of the subject) above the anterior superior iliac spine on a line to the anterior axillary border and on a diagonal line going downwards and medially at 45 degrees.

Medial calf skinfold (mm)

Raise a vertical skinfold on the medial side of the leg, at the level of the maximum girth of the calf.

Somatotype Rating Form

HEATH-CARTER SOMATOTYPE RATING FORM									
NAME _____			AGE _____		SEX: M F		NO: _____		
OCCUPATION _____			ETHNIC GROUP _____			DATE _____			
PROJECT: _____			MEASURED BY: _____						
Skinfold thickness			SUM 3 SKINFOLDS (mm)						
Triceps =	Upper Limit	10.9 14.9 18.9 22.9 26.9 31.2 35.8 40.7 46.2 52.2 58.7 65.7 73.2 81.2 89.7 98.9 108.9 119.7 131.2 143.7 157.2 171.9 187.9 204.0							
Subscapular =	Mid-point	9.0 13.0 17.0 21.0 25.0 29.0 33.5 38.0 43.5 49.0 55.5 62.0 69.5 77.0 85.5 94.0 104.0 114.0 125.5 137.0 150.5 164.0 180.0 196.0							
Supraspinale =	Lower Limit	7.0 11.0 15.0 19.0 23.0 27.0 31.3 35.9 40.8 46.3 52.3 58.8 65.8 73.3 81.3 89.8 99.0 109.0 119.8 131.3 143.8 157.3 172.0 188.0							
SUM 3 SKINFOLDS =		x $\left(\frac{170.18}{ht^2}\right)$ = mm (height corrected skinfolds)							
Calf =		Endomorphy 1 1½ 2 2½ 3 3½ 4 4½ 5 5½ 6 6½ 7 7½ 8 8½ 9 9½ 10 10½ 11 11½ 12							
Height cm	129.2 141.5 161.3 151.2 156.9 158.8 167.6 166.4 170.2 174.8 177.8 181.6 185.4 189.7 193.0 196.9 200.7 204.5 208.3 212.1 215.9 219.7 223.5 227.3								
Humeral width cm	5.19 5.36 5.49 5.64 5.78 5.93 6.07 6.22 6.37 6.51 6.65 6.80 6.95 7.09 7.24 7.38 7.53 7.67 7.82 7.97 8.11 8.25 8.40 8.55								
Femur width cm	7.41 7.62 7.83 8.04 8.24 8.45 8.66 8.87 9.08 9.28 9.49 9.70 9.91 10.12 10.33 10.53 10.74 10.95 11.16 11.36 11.57 11.78 11.99 12.21								
Biceps girth - T*	23.7 24.4 25.0 25.7 26.3 27.0 27.7 28.3 29.0 29.7 30.3 31.0 31.6 32.2 33.0 33.6 34.3 35.0 35.6 36.3 37.0 37.6 38.3 39.0								
Calf girth - C*	27.7 28.5 29.3 30.1 30.8 31.6 32.4 33.2 33.9 34.7 35.5 36.3 37.1 37.8 38.6 39.4 40.2 41.0 41.7 42.5 43.3 44.1 44.9 45.6								
Mesomorphy % 1 1½ 2 2½ 3 3½ 4 4½ 5 5½ 6 6½ 7 7½ 8 8½ 9									
Weight kg =	Upper limit	39.65 40.74 41.43 42.13 42.82 43.68 44.18 44.84 45.53 46.23 46.92 47.58 48.25 48.94 49.63 50.33 50.99 51.68							
HI. / $\sqrt[3]{wt.}$ =	Mid-point	and 40.20 41.09 41.79 42.48 43.14 43.84 44.50 45.19 45.89 46.32 47.24 47.94 48.60 49.29 49.99 50.68 51.34							
	Lower limit	below 39.66 40.75 41.44 42.14 42.83 43.49 44.19 44.85 45.54 46.24 46.93 47.59 48.26 48.95 49.64 50.34 51.00							
Ectomorphy % 1 1½ 2 2½ 3 3½ 4 4½ 5 5½ 6 6½ 7 7½ 8 8½ 9									
Anthropometric Somatotype			ENDOMORPHY	MESOMORPHY	ECTOMORPHY	BY: _____			
Anthropometric plus Physiological Somatotype						RATER: _____			

* Calf girth in cm corrected for fat by subtracting medial calf skinfold value expressed in cm.

(Carter, 2002)

To calculate your scores:

Endomorphy

Add the skinfolds at the triceps, subscapular and supraspinale sites.

Multiply this sum by $170.18 / \text{height}$

This total (in mm) is “E” in the following calculation:

$$\text{Endomorphy} = -0.7182 + (0.145 \times E) - (0.00068 \times E^2) + (0.0000014 \times E^3)$$

Mesomorphy

Record height (H), humerus breadth (HB) and femur breadth (FB), max calf girth and max upper arm girth, with the arm flexed to 45° and tensed.

Calculate corrected arm (AG) and calf girth (CG) by subtracting triceps and medial calf skinfolds from the respective girths.

$$AG = \text{Girth} - \text{triceps skinfold}$$

$$CG = \text{Girth} - \text{Medial calf skinfold}$$

Substitute these values in the following equation:

$$\text{Mesomorphy} = (0.858 \times HB) + (0.601 \times FB) + (0.188 \times AG) + (0.161 \times CG) - (0.131 \times H) + 4.5$$

Ectomorphy

Record height in cm and weight in kg.

Divide the height by the cube root of weight to calculate the reciprocal of the ponderal index or RPI. The magnitude of the RPI determines which formula is used to calculate ectomorphy.

If RPI is greater than 40.74,

$$\text{Ectomorphy} = (0.732 \times \text{RPI}) - 28.58$$

If RPI is between 39.65 and 40.74,

$$\text{Ectomorphy} = (0.463 \times \text{RPI}) - 17.615$$

If RPI is less than 39.65,

$$\text{Ectomorphy} = 0.5$$

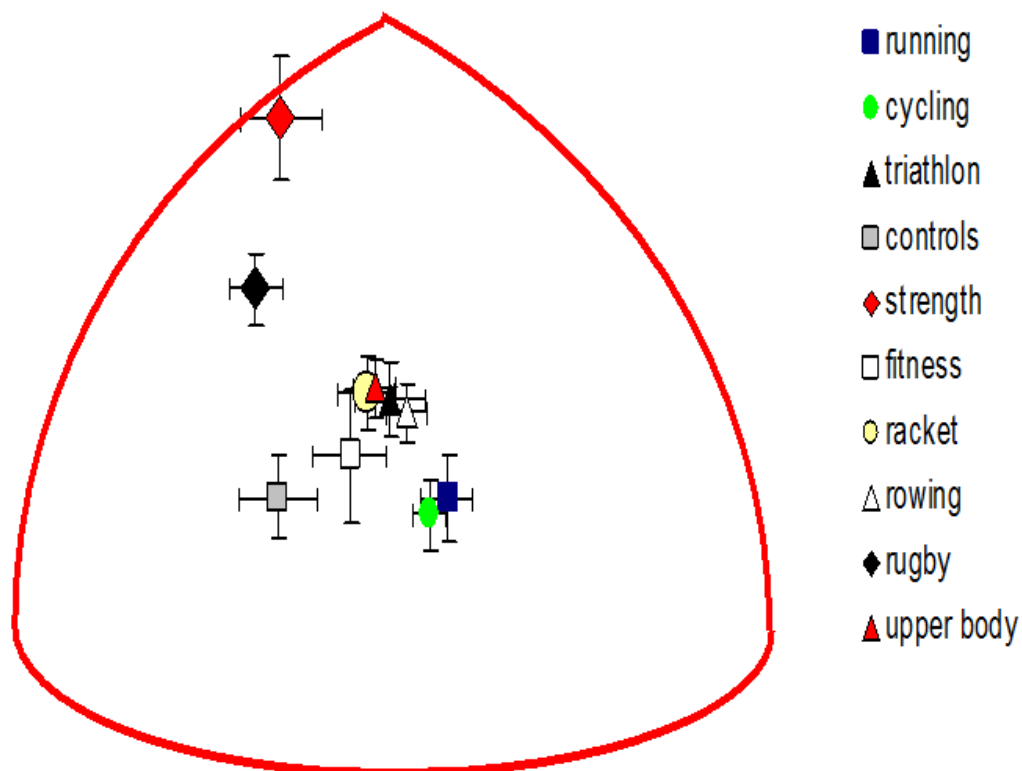
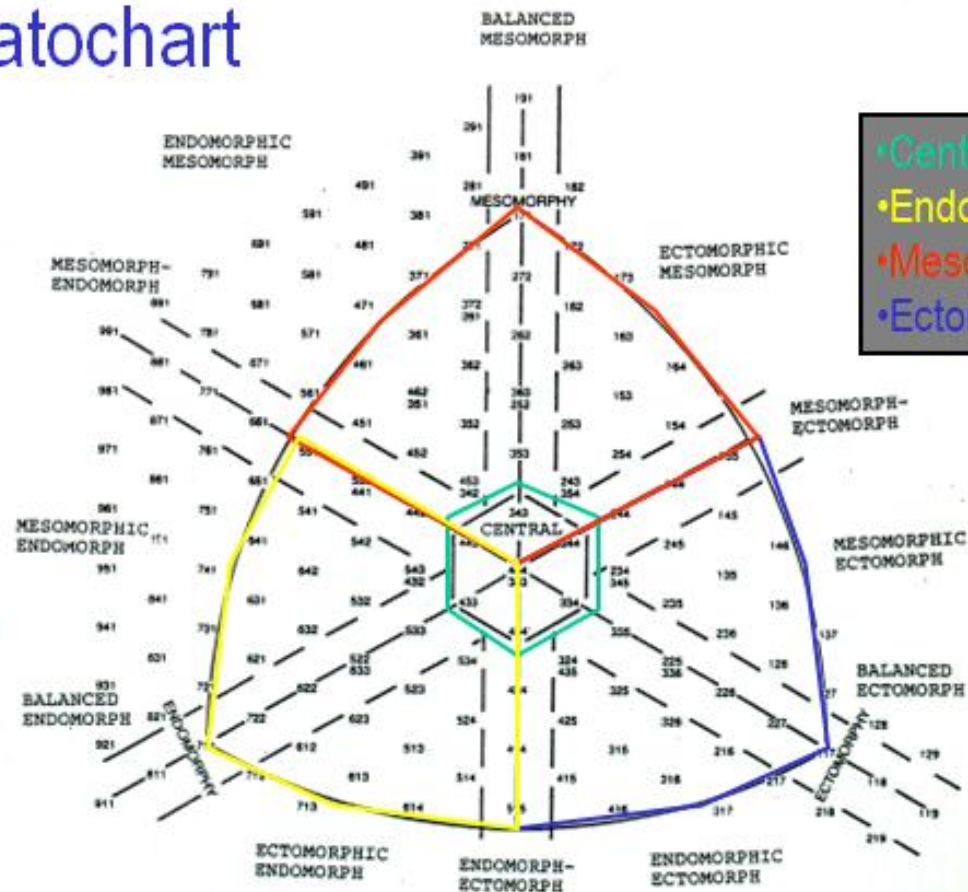
Reporting the Anthropometric Somatotype

In the box at the bottom of the Rating Form enter your 3 scores for Endomorph, Mesomorph and Ectomorph. You will need to use rounding to the nearest whole number. E.g.

1.7 – 4.3 – 1.4 would become 2 – 4 – 1.

You can then plot your somatotype on the Somatochart below.

Somatochart



Somatotyping of 106 Male Athletes (Stewart & Hannan, 2000)

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short question (500 words)

Practical 3

Referring to yourself as the 'client', please answer the following question:

- Is the client's somatotype reflective of any athletic populations or sporting characteristics?

Laboratory Practical 4

Establishing cardiovascular health

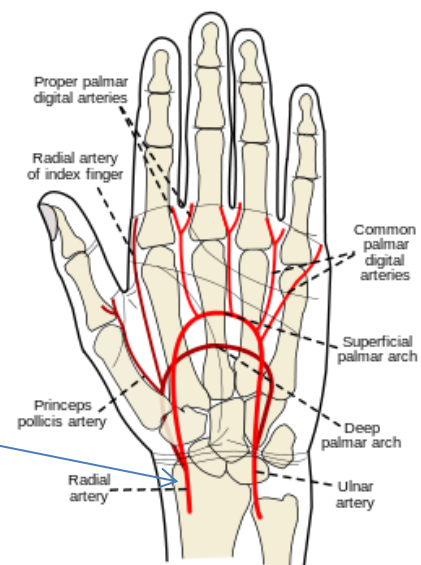
As exercise professionals we often use heart rate to indicate cardiovascular status and fitness of our patients/clients. Heart rate is defined as the number of contractions of the heart in a given time frame, usually expressed as beats per minute (bpm). The heart rate can vary according to the body's physical needs, including the need to absorb oxygen and excrete carbon dioxide. The normal resting adult human heart rate ranges from 60–80 bpm. Bradycardia is a slow heart rate, defined as below 60 bpm. Tachycardia is a fast heart rate, defined as above 100 bpm at rest.

Measuring Heart Rate

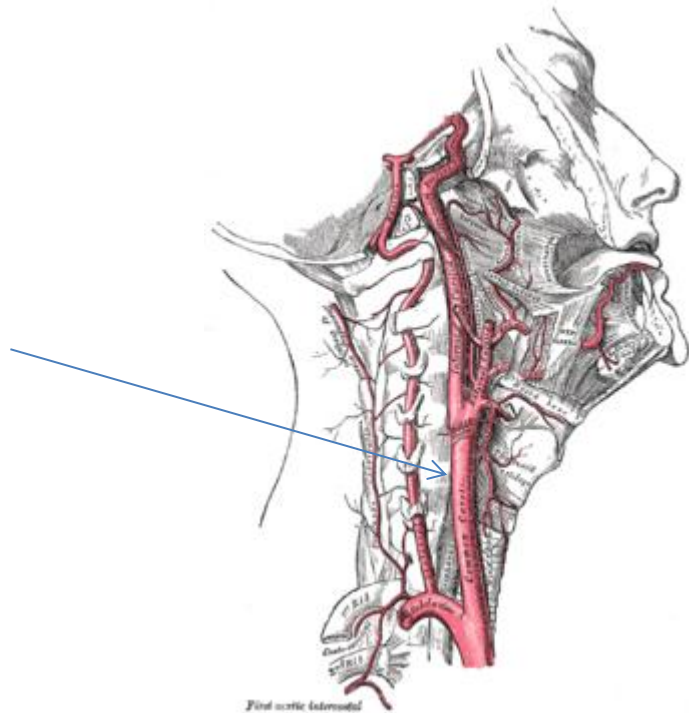
Manual measurement of heart rate is usually performed by finding the pulse of the heart. This pulse rate can be found at any point on the body where the artery's pulsation is transmitted to the surface by pressuring it with the index and middle fingers; often it is compressed against an underlying structure like bone. The thumb should not be used for detecting and measuring a pulse as it has a strong pulse of its own and may lead to the incorrect detection of a pulse where none is present or the incorrect measurement of your own pulse rather than the patients.

The most common sites for manually measuring a pulse are either the radial artery in the wrist or the carotid artery in the neck.

The radial artery can be located lateral to the extensor tendons of the thumb



The pulse is taken by palpating the artery just deep to the anterior border of the sternocleidomastoid muscle at the level of the superior border of the thyroid cartilage



Although we measure heart rate in Beats per Minute (bpm) we often measure pulse over a shorter duration and adjust the figure to reflect 1 minute, e.g. 15sec sample multiplied by 4, or a 10sec sample multiplied by 6.

Alternatively an electronic measurement can be made by a heart rate monitor.

Heart Rate Maximum

The maximum heart rate (HR_{max}) is the highest heart rate an individual can achieve without severe problems through exercise stress and generally decreases with age. This can be directly measured through maximal testing (i.e. testing to maximal exhaustion by means of a cardiac stress test) however this is ill advised in unhealthy, unfit or unwell individuals as their response to volitional exhaustion may be extreme and potentially harmful. An alternative to the direct measurement of HR_{max} is an estimation of HR_{max} . A number of formulas are used to estimate HR_{max} .

Formula	Authors	My calculated HR_{max} (Bpm)
$HR_{max} = 220 - \text{age}$	Haskell and Fox (1970)	
$HR_{max} = 208 - (0.7 \times \text{age})$	Tanaka, Monahan, & Seals (2001)	
$HR_{max} = 205.8 - (0.685 \times \text{age})$	Robergs and Landwehr (2002)	

Heart Rate Reserve

Heart rate reserve ($HR_{reserve}$) is the difference between a person's measured or predicted maximum heart rate and resting heart rate. It takes into account the patients resting heart rate and as such is useful for unfit or unhealthy clients and is used in the prescription of exercise intensity for GP

Exercise Referral Patients. Additionally, as a person increases their cardiovascular fitness, their HR_{rest} will drop, thus the heart rate reserve will increase.

Use the following equation to estimate your Heart Rate Reserve ($HR_{reserve}$):

$$HR_{reserve} = HR_{max} - HR_{rest}$$

Measuring Blood Pressure

Blood pressure (BP) is the pressure exerted by circulating blood upon the walls of blood vessels. The term 'blood pressure' usually refers to the arterial pressure of the systemic circulation, usually measured at a person's upper arm. A person's blood pressure is usually expressed in terms of the systolic blood pressure (SBP) over diastolic blood pressure (DBP) and is measured in millimeters of mercury (mm Hg).

Systolic blood pressure is defined as the amount of pressure exerted by the blood upon the walls of the blood vessels when the heart is contracting (in systole and therefore under a lot of force).

Diastolic blood pressure is defined as the amount of pressure exerted by blood upon the walls of the blood vessels when the heart is in a relaxed or in a state of diastole. This is usually a low force environment.

Normal resting blood pressure for an adult is approximately 120/80 mm Hg (SBP/DBP).

Manual measurement of blood pressure

Manual measurement of blood pressure requires auscultation (from the Latin word meaning to listen) using a stethoscope and a sphygmomanometer (pressure cuff).

A sphygmomanometer cuff is placed around the upper arm. Your left and right arm will have slightly different blood pressure readings so it is useful if you standardise the arm you use for testing for consistency.

Korotkoff sounds

Korotkoff sounds are the sounds that medical personnel listen for when they are taking blood pressure using a non-invasive procedure. There are 5 Korotkoff sounds:-

1. The first Korotkoff sound is the snapping sound first heard at the systolic pressure. Clear tapping, a repetitive sound for at least two consecutive beats is considered the systolic pressure.
2. The second sounds are the murmurs heard for most of the area between the systolic and diastolic pressures.
3. The third sound was described as a loud, crisp tapping sound.
4. The fourth sound, at pressures within 10 mmHg above the diastolic blood pressure, was described as "thumping" and "muting".
5. The fifth Korotkoff sound is silent as the cuff pressure drops below the diastolic blood pressure. The disappearance of sound is considered diastolic blood pressure – 2 mmHg below the last sound heard.

The second and third Korotkoff sounds have no known clinical significance.

A cuff of appropriate size is fitted around the patient's upper arm, and then inflated manually by repeatedly squeezing a rubber bulb until the artery is completely occluded. Listening with the stethoscope to the brachial artery at the antecubital fossa over the anterior aspect of the elbow, the examiner slowly releases the pressure in the cuff. When blood just starts to flow in the artery, the turbulent flow creates a "whooshing" or pounding (first Korotkoff sound). The pressure at which this sound is first heard is the systolic blood pressure. The cuff pressure is further released until no sound can be heard (fifth Korotkoff sound), at the diastolic arterial pressure.

Classification of blood pressure for adults:

Category	systolic, mm Hg	diastolic, mm Hg
Hypotension	< 90	< 60
Desired	90–119	60–79
Prehypertension	120–139	80–89
Stage 1 hypertension	140–159	90–99
Stage 2 hypertension	160–179	100–109
Hypertensive emergency	≥ 180	≥ 110

Pulse Pressure

Pulse pressure is the difference between the systolic and diastolic pressure readings. It is measured in millimeters of mercury (mmHg). It represents the force that the heart generates each time it contracts. If resting blood pressure is 120/80mmHg then the pulse pressure is 40mmHg.

Low (Narrow) Pulse Pressure

A pulse pressure is considered abnormally low if it is less than 25% of the systolic value.

High (Wide) Pulse Pressure

Usually, the resting pulse pressure in healthy adults, sitting position, is about 30-40 mmHg. The pulse pressure increases with exercise due to increased stroke volume and healthy pulse pressure values can increase 100 mmHg.

Recent work suggests that a high pulse pressure is an important risk factor for heart disease.

Practical Tasks

1. Working in small groups, allow your subject to sit quietly for 5 min before measuring his/her resting blood pressure several times. Record the resting values.
2. Once you are confident that you can take this measurement reliably see if you can repeat the measurement whilst your subject pedals at 60 rev.min^{-1} on a cycle ergometer with 2 kg braking mass. Note the cradle weighs 1 kg, so you only need to add 1 kg.
3. Measure diastolic and systolic blood pressure and heart rate after 2, 4 and 6 min exercise and record these values.

Rest	2 minutes	4 minutes	6 minutes
HR			
SBP			
DBP			
PP			

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short question (500 words)

How useful is pulse pressure as an indicator of heart health?

Laboratory Practical 5

Assessing Respiratory Function

Asthma is a condition characterised by an increased sensitivity of the airway passages, which manifests itself as a reversible narrowing of the air passage, principally the bronchioles.

This narrowing is produced by a swelling of the mucus membrane lining with copious thick mucus and a constriction of the smooth muscles surrounding the bronchioles.

Diagnosing Asthma

1. History: Symptoms include:

- Chronic cough, that may be the only feature
- Wheeze
- Tightness of the chest
- Shortness of breath
- The important features of these symptoms are: variable, intermittent, worse at night and trigger factors including exercise.

2. Testing

Peak Flow and FEV₁ are the key variables measured for the diagnosis and monitoring of asthma

- Peak Flow is defined as the maximum flow rate of air breathed out during forced expiration.
- FEV₁ relates to the forced expiratory volume, per second.

We can also use other information gathered such as:

- FVC is an abbreviation of Forced Vital Capacity, and indicates the maximum volume of air expired after maximum inspiration
- FER is an abbreviation for Forced Expiratory Ratio which is the Percentage of FVC expelled in the first second of a forced expiration $[(FEV_1 / FVC) \times 100]$
- PEF is an abbreviation for Peak Expiratory Flow and is a measure of how fast a person can exhale while breathing out as hard and fast as possible. PEF is used to evaluate the condition of the airways in people who have asthma or other conditions that affect the ability to breathe.

Using the Micro Plus Spirometer:-

- Switch the unit on by moving the switch to the BLOW position. The display will now indicate "BLOW" and 3 zeros
- Breathe in until your lungs are completely full
- Seal your lips around the mouthpiece and blow out as hard and as fast as possible until you cannot push any more air out.
- When you have finish this manoeuvre FEV1 will be indicated on the display.
- To read the FVC push the switch upwards to the "VIEW" position and the display will indicate FVC. If the switch is left in this position the measurements of FEV1, FVC, FER and PEF will be displayed in rotation until the unit is switched off.
- Record your results in the table below
- Use the Micro Medical Lung Function Calculators to find your predicted values for all four variables

Parameters Measured	Your results	Your Predicted
FEV ₁		
FVC		
FER		
PEF		

In asthmatics:

- FEV1 and FVC will be significantly below their predicted values.
- The FEV1 and FVC are usually measured over 3 days a week for 2 weeks. Variability of 20% or more is highly suggestive of asthma. Variability is calculated using the following equation;

$$[(\text{highest-lowest}) / \text{highest}] \times 100$$

Exercise Testing for Asthma

Practical Task Protocol

- Take a resting measurement of all 4 variables
- Calculate the patients HR_{max}
- Calculate an exercise intensity of 60% of HR_{max}
- Client will cycle at 60% HR_{max} for 8 minutes
- Re-measure all 4 variables at 4 minutes and 8 minutes during exercise
- Re measure all 4 variables at 5 and 10 minutes post exercise

Results

Time	FEV ₁	FVC	FER	PEF
Rest				
4 mins				
8 mins				
5 mins post				
10 mins post				

Interpretation of Results

A positive test for asthma can also be determined by a decrease in FEV₁ of more than 15% at any point during the test.

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short question (500 words)

What are the effects of long term adherence to exercise on Asthma Patients?

Laboratory Practical 6

Measuring Aerobic Capacity

The body's ability to perform exercise is dependent on the ability of the exercising muscles to harness the available energy. The release of energy for prolonged periods in exercising muscles is driven by the availability of oxygen. The uptake of oxygen is driven by the respiratory system whilst the transport of oxygen to the muscles is driven by the cardiovascular system which pumps oxygenated blood to the muscles. The effectiveness and efficiency of these systems to provide the muscles with oxygen and of the muscles themselves to utilise oxygen in the release of energy can be termed aerobic fitness (VO_2max). An individual's aerobic fitness can be measured in a number of ways, either by using complex laboratory based equipment and procedures (taught in level 5) or by using simpler, less complex predictive tests which give an estimate of the body's ability to supply and utilise oxygen. This laboratory session introduces two of the commonly used predictive tests of aerobic fitness.

Procedure

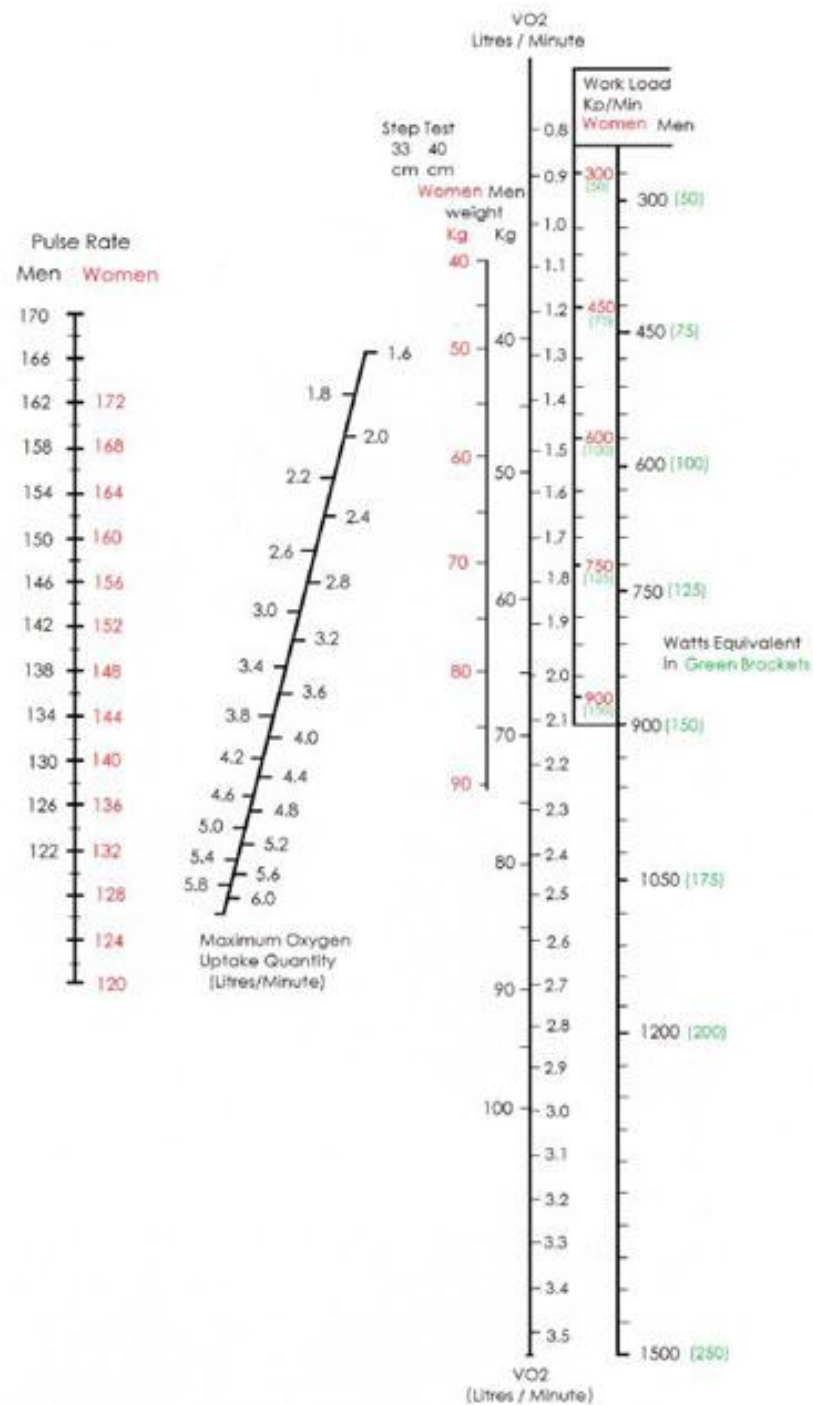
Astrand Rhyming Cycle Test

1. Adjust the saddle height of the ergometer and set the exercise intensity to 100 W (e.g. 50 rpm at 2 kg).
2. Ask the subject to cycle for 3 minutes and record the heart rate at the end of the 3rd minute.
3. If the heart rate is less than 120 beats per minute increase the exercise intensity by 50 W and ask the subject to continue exercising for a further 3 minutes. If the heart rate is greater than 170 beats per minute stop the exercise test.
4. Record the heart rate and exercise intensity in the table below.
5. Use the nomogram provided to estimate the the maximum oxygen uptake (VO_2max) score.

Astrand Rhyming Step Test

1. The step test for men requires subjects to step up and down on a 40 centimetre (16 inch) bench for 5 minutes at the rate of 90 steps per minute.
2. Women perform the test on a 33 centimetre (13 inch) bench for 5 minutes at the rate of 90 steps per minute
3. Heart rate is measured from exactly 15 to 30 seconds following completion of the test
4. Again, using the nomogram below, plot the patient's weight against their heart rate post-test. Where your line crosses the diagonal line in the middle, this figure represents your maximal oxygen uptake in Litres per Minute. This can be adjusted body mass using the equation below.

Modified Astrand-Ryhming Nomogram



Reference: ACSM Guidelines for Exercise Testing & Prescription, Edition 5

Results

Predicted Maximum Oxygen Uptake

Subject	Astrand-Rhyming Cycle Test			
	Heart Rate @ 3 min	Final Heart Rate	Final Exercise Intensity	Predicted VO ₂ max
Subject	Astrand-Rhyming Step Test			Predicted VO ₂ max
	Final Heart Rate (25-30sec post-test)			Predicted VO ₂ max

To convert Litres per minute (L.min⁻¹) to milliliters per kilogram per minute (ml.kg.min⁻¹) use the following formula

ml.kg.min⁻¹ = divide L.min⁻¹ by the subject's body weight in kg, then multiply x 1000

$$[\text{L.min}^{-1} / \text{BW(Kg)}] \times 1000$$

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short question (500 words)

Compare the results of two indirect VO_{2max} assessment methods and where a discrepancy is found, discuss the possible errors that may exist to produce the difference predictions. Of the two scores which is the most reliable indirect measure of your VO_{2max}?

Laboratory Practical 7

Assessing Anaerobic Capacity

Aerobic metabolism cannot solely provide the body with the energy requirements for muscle work. At the onset of exercise, a lag in oxygen transport occurs. The result of this lag is that during the first several minutes of any rest-to-exercise transition, a considerable amount of muscular work completed cannot be generated by the aerobic system. The work performed in this period is labelled as 'oxygen deficit'. Anaerobic metabolism is also observed during exercise intensities greater than VO_{2max} when muscular demands exceed the capabilities of the aerobic system.

Wingate Anaerobic Test

The 30 second Wingate Anaerobic Test (Bar-Or, 1987) is a popular cycle ergometer test used as an indicator of anaerobic power output.

Protocol

1. Weigh the client/patient and record (Kg)
2. Calculate the resistance required for the test. Your patient will cycle against a breaking force of 0.075Kg per Kg body mass
 - a. Breaking force (Kg) = $0.075 \times \text{Body Mass (Kg)}$
3. Adjust the cycle ergometer for client comfort
4. Ensure the patient completes the warm up
 - a. 3 minutes at 60W
 - b. 2 minutes at 90W
5. Apply the correct breaking force for the patient's weight but use the lever to raise the cradle up and de-load the cadence. Ask the patient to cycle as fast as possible against zero resistance
6. Simultaneously start the Wingate Software and drop the cradle, releasing the weight
7. The patient should continue to cycle as fast as possible for 30sec
8. Note the peak (corrected) power in Watts for each second of the test

Results

Calculate the patients fatigue index (also called anaerobic fatigue) using the following equation:

$$\text{Fatigue Index (\%)} = [(\text{Highest PP} - \text{Lowest PP}) / \text{Highest PP}] \times 100$$

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short question (500 words)

What is the optimal resistance for maximum power output on the Wingate Anaerobic Test ?

Laboratory Practical 8

Assessing Strength, Speed and Power

Power is defined as the rate at which energy is used or created from other forms. Power can be calculated by the following formula

$$\text{Power} = \text{force (strength)} \times \text{velocity (speed)}$$

As you can see from above, power is a function of the *force* that can be produced and the *speed* of that force application.

Assessing Strength

Grip strength is a general term used by strength athletes, referring to the muscular power and force that they can generate with their hands.

Grip Strength Protocol

- The patient takes hold of the grip strength dynamometer in their dominant hand and moves their shoulder in to full flexion with the elbow and wrist in extension.
- The patient takes a breath in, and as they exhale they squeeze the dynamometer with maximum force whilst lower the arm from flexion to neutral (arm by the side).
- Record the maximum reading (kg)
- The patient repeats the test 3 times and a maximum reading is recorded.
- Compare the maximum strength in the dominant and non-dominant hand.

Assessing Speed

- Using the Smartspeed™ light gates, place a pair of timing gates at 0m, 10m and 40m interval on an appropriate sprinting surface.
- Ensure the timing gates are paired and calibrated.
- Ensure the athlete lines up 10cm behind the first timing gate. In their own time, the athlete is to sprint through the timing gate as fast as possible.
- A recording of the data will be displayed on the Smartspeed handheld computer.

Assessing Power

A number of direct and indirect power tests exist in the literature. The Margaria-Kalamen Power Test (Margaria et al, 1966) is a stair climbing test used to measure peak power production. The test involves ascending nine steps, 3 at a time.

- Using the Smartspeed™ light gates, place a pair of timing gates at stair 3 and stair 9.
- Measure the height of the ninth step from the floor (m)
- Allow the athlete a short run up of no more than 6m.
- Allow the athlete to familiarise themselves with the co-ordination of the movement first before allowing a maximal attempt.
- Record the fastest time the athlete takes to climb the 9 stairs.
- Use the formula below to calculate the athletes Power:

$$\text{Power (W)} = \frac{[\text{body mass (Kg)} \times \text{stair height (m)} \times 9.8]}{\text{Time (sec)}}$$

Power output on this test can range from 700W in untrained females to 1500W in trained males.

Assignment Task

If you decide to submit your assignment 1 on this topic you should answer the following short question (500 words)

Is grip strength a fair representative of total body strength?

Laboratory Practical 9

Assessing Flexibility

Flexibility, particularly of the lower back and hamstrings was once considered an important component of mechanical lower back pain and musculoskeletal injuries. The sit-and-reach test provides an indirect, linear measurement of range of movement and is frequently included in most health-related fitness test batteries. Several variations of the sit-and-reach test have been developed to measure flexibility in inches or centimetres.

Standard Sit-and-Reach Test

The American College of Sports Medicine (2014) recommend using the standard sit-and-reach test to assess hip and hamstring flexibility. It uses the standard sit-and-reach box with a zero point at 26cm.

- The client should sit on the floor with their knees extended and the soles of their feet flat against the edge of the box
- The feet should be 6inches/ 15.2cm apart
- Whilst keeping their knees fully extended and the arms evenly stretched, instruct the client to reach forward as far as possible along the top of the box.
- Once the client feels they have reached their maximum reach, instruct them to hold the position for 2 seconds.
- Repeat the protocol twice and record the reach score to the nearest 0.5cm.

Results

Age (Years)						
	15-19	20-29	30-39	40-49	50-59	60-69
Men						
Excellent	>39	>40	>38	>35	>35	>33
Very Good	34-38	34-39	33-37	29-34	28-34	25-32
Good	29-33	30-33	28-32	24-28	24-27	20-24
Fair	24-28	25-29	23-27	18-23	16-23	15-19
Requires Improvement	<23	<24	<22	<17	<15	<14
Women						
Excellent	>43	>41	>41	>38	>39	>35
Very Good	38-42	37-40	36-40	34-27	33-38	31-34
Good	34-37	33-36	32-35	30-33	30-32	27-30
Fair	29-33	28-32	27-31	25-29	25-29	23-26
Requires Improvement	<28	<27	<26	<24	<24	<22

ACSM (2014)

The Modified Sit-and-Reach Test

Developed by Hoeger (1989), the modified sit-and-reach test takes in to consideration limb length and the distance between the end of the fingers and the box in a seated posture.

- The patient is seated on the floor against a wall with the buttocks, shoulders and head in contact with the wall.
- The sit-and-reach box is placed up against the patients feet.
- The client reaches forward with one hand over the other, without losing the contact points with the wall. This establishes the 'zero' point for the client.
- The client is then instructed to reach forward as far as possible and is permitted to leave contact with the wall, but must maintain extended knees.
- The difference in 'zero' to maximum reach is recorded in inches.
- Compare your results to those listed below.

Percentile	Women			Men		
	<35years	36-49years	>50years	<35years	36-49years	>50years
99	19.8	19.8	17.2	24.7	18.9	16.2
95	18.7	19.2	15.7	19.5	18.2	15.8
90	17.9	17.4	15.0	17.9	16.1	15.0
80	16.7	16.2	14.2	17.0	14.6	13.3
70	16.2	15.2	13.6	15.8	13.9	12.3
60	15.8	14.5	12.3	15.0	13.4	11.5
50	14.8	13.5	11.1	14.4	12.6	10.2
40	14.5	12.8	10.1	13.5	11.6	9.7
30	13.7	12.2	9.2	13.0	10.8	9.3
20	12.6	11.0	8.3	11.6	9.9	8.8
10	10.1	9.7	7.5	9.2	8.3	7.8
5	8.1	8.5	3.7	7.9	7.0	7.2
1	2.6	2.0	1.5	7.0	5.1	4.0

Hoeger, (1989)

Back Saver Sit-and-Reach Test

The back-saver sit-and-reach was developed to relieve some of the neural discomfort often experienced during the standard and modified tests. It involves measuring flexibility one leg at a time.

The protocol is similar to the standard sit-and-reach with the exception that the non-test leg is allowed to flex though the sole of the foot must remain flat on the floor approximately 2-3inches from the test leg.

This protocol allows you to collect data for the right and left leg and establish asymmetries.

Modified Back Saver Sit-and-Reach Test

If the client complains of discomfort in the non-test leg during the back saver sit and reach test, a further modification can be made by completing the test off the edge of a bench. Developed by Hui and Yuen (2000), the test involves the client performing the test on a 12inch/ 30.5cm bench.

- Instruct the client to place the non-test leg on the floor, with the knee flexed to a 90o angle. Align the sole of the foot of the test leg with a 50cm mark on a tape measure or meter rule.
- Ask the client to place one hand over the other and reach as far as they can along the inside of their test leg.
- As per the original protocol the client should hold their final reach for 2 secs and a measure should be taken.
- Again, a right/left comparison can be made.
- Norms for this test have not yet been established.

Students have no assignment task option for this element as the hand in date has passed.

Laboratory Practical 10

Assessing Proprioception

We often refer to the 'A, B, C's of proprioception as is comprised of Agility, Balance and Co-ordination. The easiest measure of proprioception is balance and a number of tests for balance exist.

Double Leg Stance

This test is simple to administer and complete and is used during a comprehensive concussion assessment. The patient is instructed to stand with feet together, shoes and socks off, with their hands on their hips and eyes closed. Once they are steady the examiner starts the stopwatch and times how long the patient can balance for.

The following instructions are given to client:

"Please stand with your feet together, your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes"

The patient should be able to balance in this position for 20seconds without any errors.

Single leg stance

The single leg stance test is, as suggested, performed on one leg. This is the non-dominant leg. To determine which leg to test ask the patient "If you were to kick a ball, which foot would you use?" The foot they use to kick the ball is their dominant foot and so the other leg should be used for testing.

Ask the patient to stand on their non-dominant foot and ask the patient to hold their non-weight bearing leg in approximately 30 degrees of hip flexion and 45 degrees of knee flexion.

The patient is asked to close their eyes and balance without error for 20seconds.

If the patient moves out of position they should open their eyes, return to the start position and continue balancing.

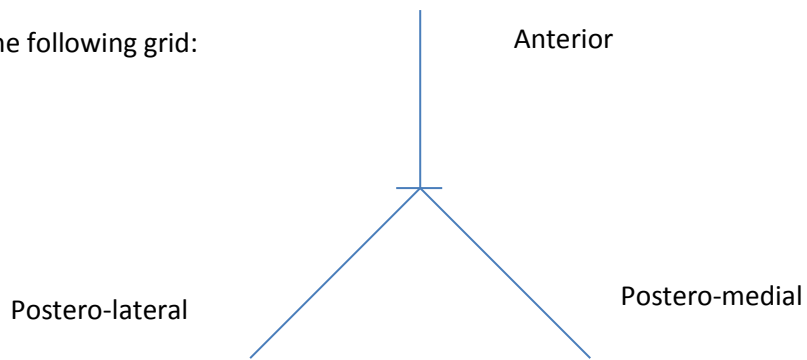
Tandem stance

This test is often the most sensitive test for concussive head injuries in sport. The patient is instructed to stand heel-to-toe as if they are on a tightrope, with their non-dominant leg at the back. Once in this position, the patient is told to close their eyes. Again, they should balance for 20seconds without error. If they move out of position, they should return to the start position and continue balancing.

Star Excursion Test

The star excursion balance test (sometimes referred to as the Y Balance test) is a measure of dynamic balance that provides a significant challenge to athletes and physically active individuals.

Set up the following grid:



The lines should be placed at 120o intervals with a tape measure attached.

The player should stand barefoot with the heel on the line in the centre of the grid. They are then instructed to reach forward (anterior) with their non-weight bearing leg as far as they can without losing balance or needing to put full weight through their reach leg. Their score is recorded for the right and left leg. Note: the stance leg is recorded as the test leg NOT the non-weight bearing leg.

The player then repeats the reach for postero-lateral and postero-medial lines.

A bilateral comparison of reach can then be made.