6.1: Statistical Analysis

6.1.1 Outline that error bars are a graphical representation of the variability of data

(standard deviation)

6.1.2 Calculate the mean and standard deviation of a set of values

6.1.3 Standard deviation

Standard deviation is used to summarize the spread of values around the mean, and that within a normal distribution approximately 68% and 95% fall within + or - 1 or 2 standard deviation points respectively.

6.1.4 Explain how the standard deviation is useful for comparing the means and the spread of data between two or more samples

A small standard deviation indicates that the data is clustered closely around the mean value.
Conversely, a large standard deviation indicates wider spread around the mean.

6.1.5 Outline the meaning of coefficient variation

Coefficient variation is the ratio of the standard deviation to the mean expressed as a percentage.

6.1.6 Deduce the significance of the difference between two sets of data using calculated values for *t* and the appropriate tables

6.1.7 Explain that the existence of a correlation does not establish that there is a causal relationship between two variables

6.2 Study Design

6.2.1 Outline the importance of specificity, accuracy, reliability, and validity with regard to fitness testing

6.2.2 Discuss the importance of study design in the context of sport and exercise sciences.

Causality in experimental results by the inclusion of:

- control in groups
- randomization
- placebos
- blinding and double-blinding
- statistical analysis

6.2.3 Outline the importance of the PAR-Q

Assesses the readiness for an individual to partake in a general training program

6.2.4 Evaluate field, laboratory, sub-maximal, and maximal tests of human performance

****evaluation is discussed below

6.3: Components of Fitness

6.3.1 Distinguish between the concepts of *health-related fitness* and *performance-related (skill-related) fitness*

6.3.2 Outline the major components of fitness

Health-related

- body composition (endomorph, ectomorph, mesomoprh - percentage of the body that is fat, muscle, or bone_
- cardio-respiratory fitness (aerobic capacity)
- flexibility (range of movement possible at a joint)
- muscular endurance (the ability for your muscles to be used for long periods of time)
- strength (the ability for your muscles to exert large amounts of force)

****Used in every day life, needed to survive.

Skill related

- agility
- balance
- coordination
- power
- reaction time
- speed

****Specialized components, needed more during sport events.

Some components of performance-related fitness could become health-related for certain group such as the elderly suffering from hypo-kinetic diseases.

Distinguish between the concepts of health-related fitness and performance-related fitness.

The components that make up health-related fitness are: muscular strength, muscular endurance, flexibility, body composition and cardiovascular endurance. The components forming performance-related fitness are: speed, power, agility, balance, reaction time, and coordination.

The concept of HRF is that each of the components are required to a certain extent for day to day activity. You would need cardiovascular endurance to make the walk up the stairs to get to work for example. The focus of HRF is to improve the overall health of an individual.

Although the components of HRF are also requires in sport, the way in which HRF and PRF differ are that the components of PRF are required for specific sports. Not all the sports need all the PRF components. Whereas a sprinters main component would be speed and not agility, a tennis player would require much more agility and less speed than the sprinter. Components of PRF, unlike HRF are not needed in day to day life, yet HRF is beneficial to all sports. In some specialized cases, PRF can be determined a HRF, like in the case of the elderly where balance and coordination may be required to lead a healthy life and contribute to the general wellbeing of the human.

6.3.3 Outline and evaluate a variety of fitness tests

Health-related components:

Aerobic capacity

Fitness Test	Component Tested	How it is carried out	Validity	Reliability and Advantages	Limitations
Multistage Fitness Test / Bleep Test	Aerobic Capacity	A measure of aerobic capacity of 20m shuttle runs. On time with beeps periodically increasing. Maximal test.	High	Reliability: Air con or outside can affect results. Hard to monitor if done with a lot of people. Simple to set up and conduct. More than one athlete can be tested at once. Can be administered indoors and outdoors.	Need mental motivation and strength. Environmental factors can affect result. Need to be well rested before the test. Prediction of your VO2max rather than concrete maximal levels. Lack of motivation can hinder results. Score is known by participants. Safety and ethics must be considered. Could be dangerous - bringing in agility.
Cooper's 12 Minute Run	Aerobic Capacity	The assistant gives the command "GO", starts the stopwatch and the athlete commences the test The assistant keeps the athlete informed of the remaining time at the end of each lap (400m) The assistant blows the whistle when the 12 minutes has elapsed and records the distance the athlete covered to the nearest 10 metres	Medium/ High	Minimal equipment required. Simple to set up and conduct. More than one athlete can participate at once. The test can be administered by the athlete.	Specific facilities required - 400m track Assistant required to administer the test
Harvard Step Test	Aerobic Capacity	The assistant gives the command "GO" and starts the stopwatch The athlete steps up and down onto a standard gym bench once every two seconds for five minutes (150 steps) The assistant stops the test after 5 minutes The assistant measures the athlete's heart rate (bpm) one minute after finishing the test - Pulse1 The assistant measures the athlete's heart rate (bpm) two minutes after finishing the test - Pulse2 The assistant measures the athlete's heart rate (bpm) three minutes after finishing the test - Pulse3	Medium	Minimal equipment required Simple to set up and conduct Can be conducted almost anywhere	Assistant required to administer the test

Flexibility

Fitness Test	Component Tested	How it is carried out	Validity	Reliability and Advantages	Limitations
Sit and Reach	Flexibility	Participant removes shoes. The assistant secures the ruler to the box top with the tape so that the front edge of the box lines up with the 15cm (6 inches) mark on the ruler and the zero end of the ruler points towards the athlete The athlete sits on the floor with their legs fully extended with the bottom of their bare feet against the box The athlete places one hand on top of the other, slowly bends forward and reaches along the top of the ruler as far as possible holding the stretch for two seconds The assistant records the distance reached by the athlete's finger tips (cm) The athlete performs the test three times The assistant calculates and records the average of the three distances and uses this value to assess the athlete's performance		Minimal equipment required Simple to set up and conduct Can be conducted almost anywhere	Specialist equipment required Assistant required to administer the test

Muscular Endurance

Fitness Test	Component Tested	How it is carried out	Validity	Reliability and Advantages	Limitations
Maximum Sit Ups	Muscular Endurance	The athlete lies on the mat with the knees bent, feet flat on the floor and their hands on their ears where they must stay throughout the test The assistant holds the athlete's feet on the ground The assistant gives the command "GO" and starts the stopwatch The athlete sits up touching the knees with their elbows, then returns back to the floor and continues to perform as many sit-ups as possible in 30 seconds The assistant keeps the athlete informed of the time remaining The assistant counts and records the number of correct sit-ups completed in the 30 seconds and uses this recorded value to assess the athlete's performance		Minimal equipment required Simple to set up and conduct Can be conducted almost anywhere	Assistant required to administer the test
Maximum Push Ups	Muscular Endurance	The athlete lies on the ground, places their hands by the shoulders and straightens the arms - see Figure 1 (start position) The athlete lowers the body until the elbows reach 90° (see Figure 2) and then extends the arms to return to the start position The athlete continuous this press-up action, with no rest, until they are unable to continue The assistant counts and records the number of correctly completed press-ups		No equipment required Simple to set up and conduct The test can be administered by the athlete Can be conducted almost anywhere	Only testing the muscular endurance of one area of the body. Good technique is needed. Assistant required.
Flexed Arm Hang	Muscular Endurance	The athlete warms up for 10 minutes The athlete uses a flexed arm hang position with the palms of the hand facing them Using their arms the athlete raises their chin above the bar to the "start position" Once the athlete is in the "start position" the assistant starts the stopwatch The athlete is to maintain the "start position" for as long as possible The assistant stops the stopwatch when the athlete's chin drops below the top of the bar or 30 seconds has elapsed The assistant records the time it was held for		Minimal equipment required. Simple to set up and conduct.	Assistant required to administer the test.

Body Composition
Strength

Hand Grip Dynamometer	Strength	The athlete using their dominant hand applies as much grip pressure as possible on the dynamometer The assistant records the maximum reading (kg) The athlete repeats the test 3 times The assistant uses the highest recorded value to assess the athlete's performance		Minimal equipment required Simple to set up and conduct Can be conducted almost anywhere	Specialist equipment required Assistant required to administer the test

Skill-related components:
Agility

Fitness Test	Component Tested	How it is carried out	Validity	Reliability and Advantages	Limitations
Illinois Agility Test	Agility	The assistance sets up the course as detailed in the diagram The athlete lies face down on the floor at the "Start" cone The assistant gives the command "GO" and starts the stopwatch. The athlete jumps to his/her feet and negotiates the course around the cones following the red line route shown in the diagram to the finish The assistant stops the stopwatch and records the time when the athlete passes the "Finish" cone	High	Minimal equipment required Simple to set up and conduct The test can be administered by the athlete Can be conducted almost anywhere	Difficult to set up Assistant required to administer the test

Speed

40 Meter Sprint	Speed	The assistant marks a 40 metre straight section with cones on the track The assistant gives the command "GO" and starts the stopwatch The athlete sprints the 40 metres as fast as possible The assistant stops the stopwatch when the athlete's torso crosses the finishing line and records the time The athlete rest for 30 seconds The athlete performs 6 x 40m sprints with 30 seconds recover between each sprint and the assistant records the time for each of the 40 metre sprints		Minimal equipment required Simple to set up and conduct The test can be administered by the athlete Can be conducted indoors or outdoors	Assistant required to administer the test

Balance

Stork Stand	Balance	Stand on one foot and balance as long as possible.	Low	Easy to administer.	Never occurs in a real sporting situation. Situation affects.

Coordination

Hand Ball Test	Coordination	Bounce a ball and catch as many times in 30 seconds.	Medium	Easy to set up. Minimal equipment.	Technique also affects. Only measure hand eye - only applicable to specific

Power

Vertical Jump	Power	Start with hand outreached. Use a ruler taped to the wall. With chalk jump and draw as high as possible.	Low	Minimal equipment required. Simple to set up and conduct. The test can be administered by the athlete. Can be conducted almost anywhere.	Hard to control chalk. Difficult to jump with arm outstretched.
Standing Broad Jump	Power	Jump as far as possible from a stand still.	Maximal. High validity.	Minimal equipment required The test can be administered by the athlete Simple to set up and conduct	Leg length varies. Body weight. Technique is important. Only tests leg power. Only measures a one-off jump - not realistic in relation to some sports (volley ball + basketball). Environment (sand pit vs hard ground).

Reaction Time

Drop Test	Reaction Time	Assistant holds ruler and participant hovers fingers griped at base of the ruler with arm perpendicular. when assistant drops ruler, participant catces as fast as possible and distance is measured.		Easy to set up. Minimal equipment.	Assistant required to administer the test

SAMPLE QUESTION:

Evaluate the multistage fitness test as a test of cardio-respiratory fitness for use with long distance runners and games players. (4)

The MSFT measure cardiorespiratory fitness by slowly increasing the speed at which participants must run a set distance, which slowly builds up to sprinting. The build up to a sprint is especially beneficial for a games player, like a footballer, as late on in the game after already lots of running, they must sprint to defend a break that the other team has gained in order to prevent a goal. The MSFT is a test that can be administered to many participants at once so a coach can test his entire team together to easily compare individuals players. The constant sprint, stop, turn aspect of the MSFT adds a sense of agility and ecological validity as again this type of movement would be seen often in a games sport such as a football game where the player sprints for the ball, turns and passes to another player.

As the MSFT predominately measures sprinting, it is not as useful for long distance runners who usually maintain a continuos pace for the majority of the race. However, the sprinting can be good for the beginnings and ends of a long distance race, and the MSFT especially caters to the end of the race which pushes you to sprint although exhausted. The MSFT also measures mental endurance which is helpful to long distance runners as throughout the race they must continue to be motivated and maintain or increase their pace.

The test itself is easily measurable and is widely done so many comparison and average tables are available. It is inexpensive to administer and easy to set up, however, the duration of the test takes a long time and can be seen as a limitation. The test if done properly is a test of maximal anaerobic capacity, and can therefore be dangerous to participants despite offering accurate results.

SAMPLE QUESTION:

In soccer (football), fitness testing is often used during the pre season period.
Identify two different tests that would give an assessment of a player's anaerobic power and outline the strengths and weaknesses of each. (6)

To test a footballers anaerobic power the participant can take part in the standing broad jump and the sergeant jump test.

The standing broad jump measures leg power in a horizontal distance. Strengths of the SBJ include its easiness to administer, its use of minimal equipment and its quickness of completion. This means the test can be done many times by the performer and so that an accurate average distance or maximum distance can be determined due to multiple trials. The weaknesses of this test is that the body composition such as height and leg length can make an inaccurate comparison between different performers. However, the test is easily replicated so instead of comparison to other participants, the same participant can be measured over a period of time an compared to their individual results.

The sergeant jump test also measures leg power, but it measures vertical jumping power. Similar to the SBJ, the test uses minimal equipment, and is easy and fast to carry out. The tests' areas of weakness include similar external factors such as height and weight, but are more easily counterbalanced with measuring from the top of the arm at flat foot to maximal height at the peak of the jump. The difference is then recorded, minimizing the unfairness of height. Another weakness of this test if the difficulty of accurately marking the top of the jump while still maintain close enough to the wall to do so. The technique required in the SJT requires a specific and difficult technique, so those who have done the test before may perform better than participants who never have because of experience.

SAMPLE QUESTION:

Outline a fitness test for a tennis player to asses the following:
- Strength

A tennis player could use a hand grip dynamometer to measure their hand strength, which is vital in tennis for a strong and accurate grip of the racket. The test measures the maximum grip strength of the hand and forearm muscles and is tested three times, with rest in between, so that an average of the trials can be obtained for more accurate results.

6.4: Principals of Training

6.4.1 Describe the essential elements of a general training program

SAMPLE QUESTION:

Identify three elements that should be included in a general training program for health and fitness, and outline the importance of each. (6)

1. Warm up and stretching should be included in a general training program and should be the first thing done, before the main even is carried out. This is because the warm up prepares the body for the more strenuous exercise that is about ready to occur. To do this the warm up increase you heart rate and breathing rate and warms the body up.

2. A general training program should also include a cool down as to slowly reduce the intensity of the activity done as the main event. This slow decline from an endurance activity helps prevent muscle soreness due to a build up of the bye product of lactic acid. To maintain the flexibility and help keep muscles loose the cool down should also include stretching activities.

3. A general training program should also include recreational activities to keep the performer enjoying sport and keeping relaxed an healthy. Doing these sorts of activities contributes to a both better physical and mental wellbeing.

Static stretching

Static stretching refers to **stretching exercises that are performed without movement**. In other words, the individual gets into a stretch position and holds the stretch for a specific amount of time.

A static stretch can be performed by placing the body in a position whereby the **muscle to be stretched is under tension. At this point the position is held to allow the muscle to lengthen**. This is a very safe and effective form of stretching with a limited threat of injury. See figure 5.14 as an example of a static stretch.

Active stretching

Active stretching is **slow stretching in which flexibility is achieved without assistance**. This form of stretching involves using only the strength of the opposing muscles (antagonist) to generate a held stretch (held for 10-15 seconds) within the agonist. The contraction of the opposing muscles helps to relax the stretched muscles. See figure 5.15 as an example of an active stretch. Active stretching is a very effective form of conditioning.

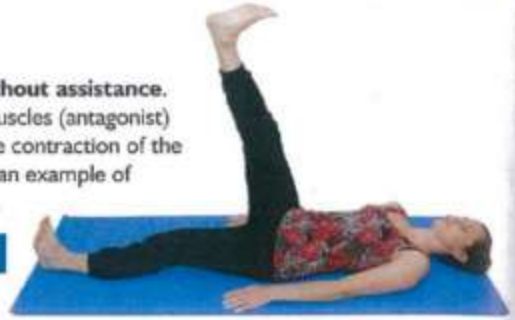

figure 5.15 – active stretch

Passive stretching

Passive stretching is similar to static stretching, however a **partner or apparatus can be used to help further stretch the muscles and joints**. Figure 5.16 is an example of a passive stretch in which the floor is assisting the position.

figure 5.16 – passive stretch

Proprioceptive Neuromuscular Facilitation (PNF)

PNF is a progression on passive stretching, whereby **after the stretch is held, the muscle is contracted isometrically for between 6-10 seconds**. It then relaxes and is contracted again, usually going further the second time. Known as the **CRAC** method (Contract-Relax-Antagonist-Contract). The aim of PNF is to toughen up or inhibit proprioceptors (such as muscle spindles and Golgi tendons) in the relaxation of muscle tissue.

6.4.2 Discuss the key principles of training program design

progression: gradually increasing the amount of exercise

overload (frequency, intensity and duration): FITT principles

specificity: The process of replicating the characteristics of physical activity in training to ensure its benefit performance.

reversibility: How long it takes you to lose that base fitness. If the athlete does not use, she/he will lose it.

variety: Providing different activities, formats and drills in training while still addressing the aims of the training program. Helps to decrease boredom

periodization: A structured, Organized approach to training

SAMPLE QUESTION:

Discuss how overload and progression can be used to maximize the effectiveness of a sprinter's weight training program.

Overload is the concept of making the weights that the sprinter is using are heavy enough to cause stress on the muscles being worked. The sprinter may be working on leg muscles to increase their power for the start of the sprint. Here they may be using the leg press machine, where they must be careful to apply overload, but not to the extent of causing injury because of an unmanageable weight. This weight will increase with the concept of progression, where, when an adaptation due to training has occurred, the weight goes up gradually to continually apply stress on the sprinter and to move the training and results of hypertrophy due to these two concepts forward. Progression also avoids overtraining as it only allows the reps and sets, or weight to be increased gradually in line with the improvements the participant has made. Following these two concepts maximize the effectiveness of the weight training program for the sprinter as it allows the most rapid form of an increase in fitness without risk of injury.

6.4.3 Outline ways in which exercise intensity can be monitored

Use of heart rate (based upon its relationship with oxygen uptake)

Karvonen Method

KARVONEN METHOD

A training heart rate can be established by using the concept of maximum heart rate reserve. MHR = 220- age (of performer)

HRR (heart rate reserve) is calculated = MHR - HR rest

Karoven suggests that an aerobic training zone of 60-75% of max HRR reserve should be used when designing training programmes. This confirms that work is done at the correct intensity. This allows a training rate to be calculated.

Eg- THR 75% = HRrest + 0.75 (HR max – HR rest)

This gives THR% which is the same as 75% 0f VO2max.

Ratings of perceived exertion

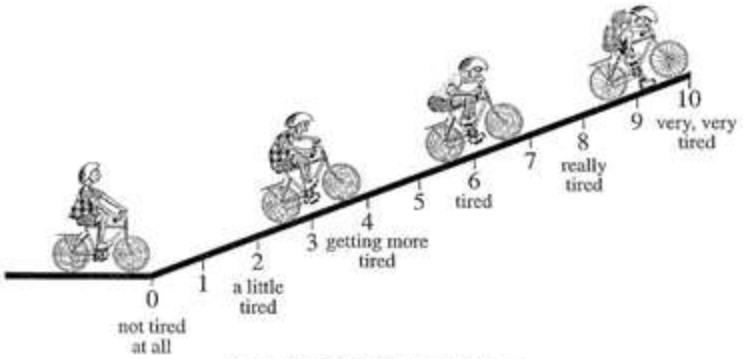

Figure 1—Children's OMNI Scale of Perceived Exertion

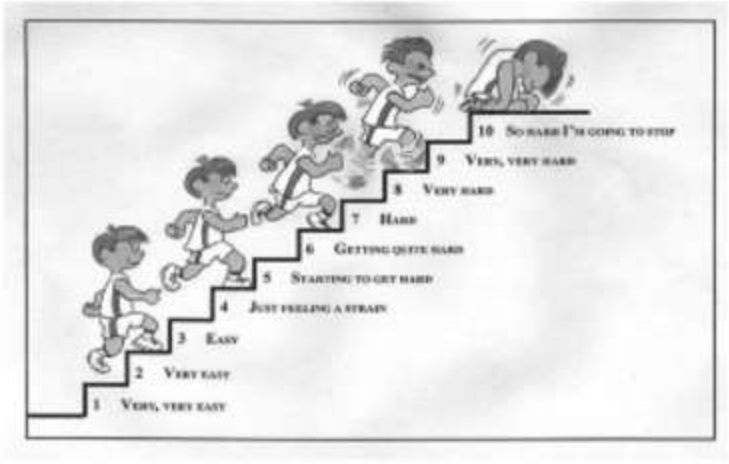

Figure 1 The Pictorial Children's Effort Rating Table (PCERT)