SPRT2002 Prac Book

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Introduction

This lab book will be used over the semester to aid in your learning. This is to be used in conjunction with material on vUWS.

Please refer to the learning guide, which you can find on vUWS.

Important notes

- Pre screening must be completed before being able to participate in practical activties
- Data collected over the practicals will be used in your professional reports due in Weeks 9 and 14.
- Regarding assessments, an attempt must be made in ALL assessments to be able to pass the unit.
- Come to class prepared to exercise.

Keys for success over the unit

- KEEP UP WITH MATERIAL over the semester!!!
- Try to watch lecture material before practical classes.
- Attend practical classes

Communication

1. Learning guide, vUWS announcements
2. First 5 minutes of lecture material
3. Practicals
4. Classmates
5. Email
6. Zoom

1 Week 2 - Practical

1.1 Learning Outcome:

1. Understand measurement accuracy concepts and their application to exercise testing and measurement
2. Evaluate the feasibility of different tests according to environmental conditions and client characteristics
3. Demonstrate basic data processing and analytical techniques for calculating distribution based statistics (Mean, Standard Deviation)

1.1.1 ***Assessments***:

This is the first of three lab weeks (weeks 2, 3 and 4) where the data you collect will be used for your first professional report assessment (1-page report in week 9). *HELPFUL TIP:* The more attention you pay to the quality of your data during this lab, the easier it will be to complete your professional.

1.1.2 ***Background***:

Maximal sprinting speed and its derivative acceleration have both been shown to be key discriminators in playing status across many sports. Whilst, performing a maximal sprint test would give the most valid insight into these qualities, it may not always be possible to perform this test in a practical environment due factors such as, perceived risk of injury and cost of equipment (timing gates, radar gun etc). Hence, identifying cost effective test that may give insight into these qualities is of interest.

Two commonly used test that are used as both proxy measures of acceleration and sprinting speed respectively are the **standing broad jump** (SBJ) and assessment of lower limb stiffness. Whilst a number of techniques for measuring lower limb stiffness exist, the test we will focus on today is the **drop jump test**.

PART 1 of today will involve collecting data across a 0**-5 and 0-10m sprint tes**t, **standing broad jump** and **drop jump test** (look to get at least two trials across each test). PART 2 aims of today involve calculating basic summary statistics that represent the mean and spread/deviation of the data and other descriptive statistics discussed in the lecture.

1.2 ***Practical Procedures (PART 1):***

Before completing each assessment as a group discuss what you think would be an appropriate warm up and then action the warm up together before completing trials.

For each assessment make at least one individual is updating the results into the Google form below.

https://docs.google.com/spreadsheets/d/1ovjxRvN4N5482ikOBO_SK1qetU6CBPnkArYUs_rRigM/edit?usp=sharing

1.2.1 Broad Jump

https://www.youtube.com/watch?v=n0UeHxglMJ4

1. Position yourself accurately by standing behind the marker with your toes aligned directly with it - proper starting position is crucial for consistent measurement.
2. Utilize the permitted counter-movement effectively by bending your knees and trunk while swinging your arms before takeoff, as this motion helps generate maximum power for the jump.
3. Execute a proper two-foot takeoff and landing, ensuring both feet leave and touch the ground simultaneously - any step before takeoff will invalidate the attempt.
4. Maintain balance during landing since falling backward will require a repeat attempt - focus on landing firmly on both feet with controlled momentum.
5. Complete multiple attempts to achieve your maximal distance, which will be measured from the marker to the point of first contact (typically heel strike) upon landing.

1.2.2 *Max speed assessment*

1. Complete a standardized warm-up before beginning maximal 10m sprint testing, with timing gates positioned at both 5m and 10m distances
2. Organize into groups of 4-5 students and establish a clear testing order, with each athlete performing multiple maximal sprint effort
3. Record sprint times using both electronic timing gates (Swift SpeedLight Timing™ Gates) and handheld stopwatches, ensuring to match and record corresponding times from both measurement methods for each attempt
4. Ensure all group members complete their designated number of sprint attempts while maintaining accurate record-keeping of all times

1.2.3 *Drop Jump assessment*

Utilsing the EZ jumpmat.

1. Stand on a box or elevated platform behind.
2. Place your hands on your hips.
3. Keep your chest up and look forward.
4. Step off the box; then.
5. Land on the plates with both feet at the same time;
6. Immediately jump as high as possible whilst looking to minimize ground contact time; then
7. Land softly, remaining completely still on the jump mat.
8. Record RSI from device

1.2.4 *Interactive stiffness visual*

Below is simplified interactive visualization to help build intuition of how we can thinking about the legs as springs.

Click to expand

What difference do you notice between the two springs that have different stiffness values?

1.3 *Practical Procedures (PART 2):*

REMEMBER: the data you collect today and over the previous week's labs will be used for your first 1-page report…so be attentive and ask questions during PART 2 of the lab session!

Use lecture material as a reference point to calculate mean and standard deviation of data collected. (you may use excel functions but also have a go going step by step through calculations)

- Practice plotting data has a histogram.
- Calculate the mean, SD and CV%
- Calculate Z – Scores (Also outlined in lecture material)

Reflection Question:

1. Why is important to understand how your data is distributed?
2. Why is the practical reason for us transforming numbers into a Zscore?
3. When trying to describe a distribution what are the most important components we would want to know?

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2 Descriptive statistics recap

Material discussed below was discussed in more detail in the week 2 lecture.

An essential component of being a sport and exercise scientist is the ability to summarise results collected from groups or individuals correctly. Luckily many of summary statistics that you will need are things that you would have covered in yr 8 and 10 mathematics. These are parameters such as **mean, median, mode**, **standard deviation (SD)** and **coefficient of variation (CV%)**.

An important aspect to remember is the idea that data we collect from a group consider a "sample" from the population. To help build your intuition around this, lets say I wanted to summarise the sprint test results collected from SPRT2002. Now imagine I only used one practical class sprint times to reflect the full cohort of SPRT2002. It would be reasonable for you to say that I am only using a sample from the full cohort to represent the sprint capability. This situation arises effectively any time we collect data from a group as there always some of the population of interest using missing from our sample.

2.0.1 Fig1

The visualization below demonstrates random sampling from a normal distribution with a fixed population mean of 50. You can adjust the population standard deviation using the slider, which changes the spread of the underlying distribution.

When you click "Add Samples," the tool draws a random sample from this population (visualized as green dots falling from the distribution curve), then calculates and displays key sample statistics including the mean, median, standard deviation, standard error, confidence intervals, range, and coefficient of variation.

This interactive demonstration illustrates an important statistical concept: in real-world research however, we never know the true population parameters (mean and SD). Instead, we only work with sample statistics to make inferences about the unknown population. By repeatedly drawing different samples, you can observe how sample statistics vary around the true population values, highlighting concepts like sampling variability and estimation precision

2.0.1.1 Reflection

What did you notice when you changed the population SD slider and sampled again?

Did you notice anything about the stability and or precision of the sample mean and SD estimates when sampling from lower sample sizes e.g. 5 to higher sample sizes e.g. 100? (The below interactive visual may help emphasize this relationship)

Download the data using the "Download Data" button and see if you are able to replicate the sample based parameters in excel (mean,median,SD,CV% and create a Zscore for each participant)?

2.0.2 Fig2

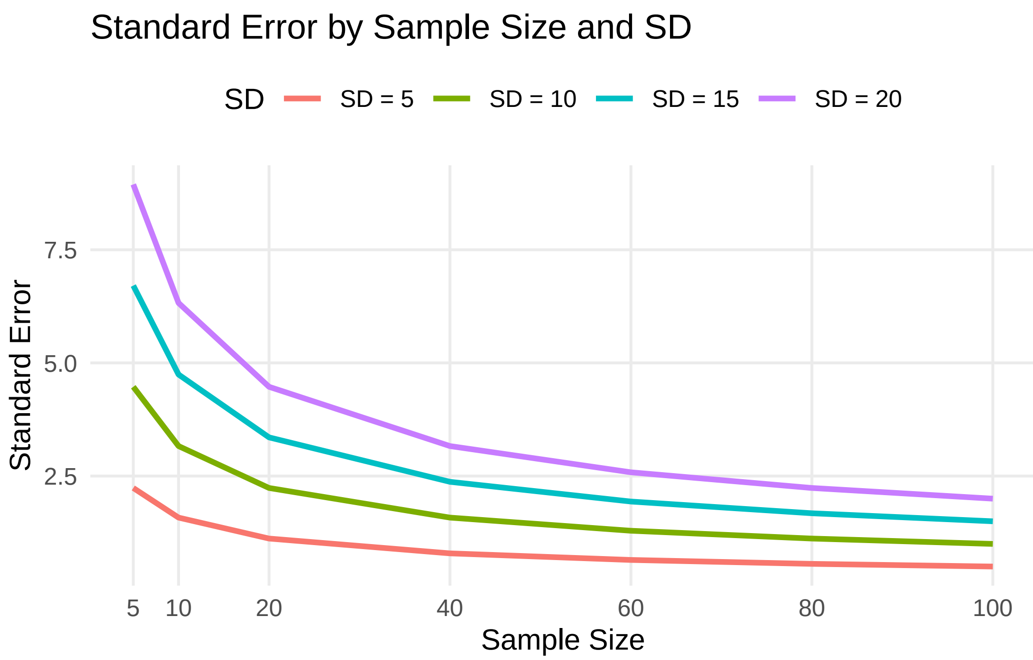
The figure below is just an extension of the figure above and may help better show how sample estimates may vary around the true population mean, and how the amount they vary are a function of both the sample size and SD.

To best utilise the visualization below,either leave one of the slider values constant while you change the value of the other slider.
For example, you may draw 10 samples with the sample size set to 30 and population SD set to 10, then change the sample size value to 50 draw 10 values, then 5, then 100 etc. You may flip this process around then altering the SD values leaving the sample size set at a constant value. Each time have a think about how you might describe what you are seeing.

2.0.3 Reflection

Based on what you may noticed from changing both the sample size and standard devation (SD) in the above visualisation, the figure below looks summarise this relationship you may have observed. This summary will show how the SE - Standard error (discussed more below) changes as function of both the sample size and the size of the SD.

Click to expand



Looking at the above plot we can see that as sample size increases we see a reduction in a variable called the "standard error - (SE)". Likewise we can also see that larger SDs for a given sample size will have larger standard errors.

Based on how the SE is calculated (discussed below) if you want to reduce SE by half, you could either:

Reduce the SD by half (get a more homogeneous sample), OR Increase the sample size by a factor of 4 (Notice how there is diminishing returns in reducing the SE as the sample size gets larger)

2.0.4 But what is the standard error?

The standard error of the mean (**SE** and **SEM**) represents the expected variability of sample means if we were to repeatedly draw samples of the same sample size from the population. We could calculate the **SE** by taking the standard deviation of the sample means from the simulation above. However,unfortunately in research we often only ever have access to **one** sample to try and estimate a **SE** from. Luckily we can sill estimate a SE for one sample using the below formula

Standard error of the mean (SE) = sample SD/ sqrt(N)
where N is the number of participants.

This in a similar fashion to how the sample SD is measure of dispersion/spread of observations around the mean, can be thought of as the level of variability a sample means with some given sample size and SD would vary around the true population mean from repeated sampling.

2.0.5 Confidence intervals

Perhaps a simpler way to think of the SE is a measure of confidence we have that our sample mean would be reflective of the true population mean. In samples with lower number of participants we can be less confident that the sample mean is representative of the true population mean, whilst in higher sample size studies we can be more confident that the sample reflects the true population mean. One way we highlight this uncertainty/confidence is by using something called **confidence intervals CI**.

The simplest **confidence interval** would be to just use the calculated standard error from earlier to set lower and upper limits around the sample mean.
For example,

sample mean = 40,
SE = 5
LL = 40 - 5 = 35
UL = 40 + 5 = 45

The above would represent a 68% level confidence interval, I want you to have a think about why this might be termed a 68% confidence interval?

> Hint
>
> Think back to the normal distribution and how much the standard deviation tells us about the spread of data.

What is more commonly used however, is a 95% confidence interval which would be calculated by multiplying the **SE** by **1.96**.

In our example above this would equate to
95% LL = 40 - (5*1.96 = 9.8) = 30.2,
95% UL = 40 + (5*1.96 = 9.8) = 49.8.

The interpretation of a 95% confidence interval is that if we were to repeat this sampling process many times and calculate the interval each time, about 95% of these intervals would contain the true population mean. Wider confidence intervals indicate more uncertainty in our estimate, while narrower intervals suggest greater precision. This is why larger sample sizes (which lead to smaller standard errors) result in narrower confidence intervals and more precise estimates of the population mean.

To help visualize this, go back to Figure 2. You will notice a button called "Show Confidence Interval" which will display the 95% confidence interval around each sample mean, illustrating how the precision of our estimates changes with different sample sizes and population standard deviations

2.1 Test your learning

If you calculate a mean from a sample of 100 participants, this mean is:

- (A) Always exactly equal to the true population mean
- (B) Always lower than the true population mean
- (C) Not related to the true population mean
- (D) An estimate of the true population mean

When the population standard deviation increases, what happens to the standard error of the mean?

- (A) It decreases
- (B) It stays the same
- (C) It becomes zero
- (D) It increases

A researcher collects vertical jump data from 25 athletes and calculates a 95% confidence interval of [45cm, 55cm]. This means:

- (A) 95% of all athletes' jumps fall between 45cm and 55cm
- (B) The true population mean definitely lies between 45cm and 55cm
- (C) 95% of individual jump heights in this sample fall between 45cm and 55cm

- (D) If we repeated this sampling process many times, about 95% of the calculated intervals would contain the true population mean

If you have a sample mean of 50 and a standard error of 2, what is the 68% confidence interval?

- (A) [46, 54]
- (B) [47, 53]
- (C) [49, 51]
- (D) [48, 52]

Which of the following would NOT reduce the standard error of the mean?

- (A) Increasing the sample size
- (B) Reducing measurement error
- (C) Using more precise equipment
- (D) Calculating the median instead of the mean

The coefficient of variation (CV%) is 15% for a group of athletes' sprint times. This indicates:

- (A) The data varies by exactly 15 seconds
- (B) 15% of the data points are outliers
- (C) The confidence interval is 15% wide
- (D) The standard deviation is 15% of the mean value

Assuming a normal distribution (Bell curve) what proportion of the observations are contained between -1 to +1SD units around the mean?

- (A) 95%
- (B) 34%
- (C) 99%
- (D) 68%

3 Week 3 - Practical

3.1 Learning Outcome:

1. Understand measurement accuracy concepts and their application to exercise testing and measurement
2. Evaluate the feasibility of different tests according to environmental conditions and client characteristics
3. Demonstrate basic data processing and analytically techniques

3.2 Practical Goals:

1. 2nd round of data collection for practical report 2
2. Practice developing skills at running and collecting commonly used test for vertical power assessment.
3. Understand basic intuition and use of bland Altman plots for exercise and sport science. (This will be developed more in seminar content next week)
4. Build confidence in analysing reliability based metrics such as typical error (TE), $CV_{TE}\%$, minimal detectable change (MDC). (Use lecture notes for help)

3.3 Example case study

You are hired by an elite sporting organization to help them decide whether they should invest in the purchase of a force plate ($20,000+). The organization currently has access to a range of other measures that can give indications of vertical jump ($400 to $2000) height but the company they are thinking of purchasing the force plate from has loaned them a force plate for two weeks to test it out.

What are some important factors that you might consider when helping the organization make this decision?

3.3.1 Bland-Altman plot

One of the key ways we look to assess the ability to interchange between testing technologies that are attempting to measure the same trait is use of a Bland-Altman plot.

We will discuss Bland-Altman plots in more detail in the lecture in Week 4 but quite simply all the Bland-Altman plot attempts to show us is the difference between one test compared to another test measuring the same thing/

For example we might compare jump height collected from a force plate and linear position transducer. From this we are interested in knowing the mean difference between measures **(BIAS)** and limits of agreement **(LOA)**. LOA is calculated by looking at the **standard deviation of the differences** between test and multiplying by 2 (technically 1.96).

The **ULOA** is then **BIAS + LOA**

and

LLOA calculated as **BIAS - LOA**

> Click for interactive Bland-Altman plot

3.4 Practical Procedures (PART 1)

1. Get yourself into groups of 5-7 people. Your tutor will allocate each group to a testing location. The tutor will explain how to use technology and equipment to each group at each testing location once.
2. It is then the responsibility of each group to educate the following group on how to successfully perform and run test for each testing station.
3. Continue the above until you have completed each testing station.
4. Aim to perform at least 2 repetitions per station making sure to upload the results on the Google form link below. (This can be done by one person per group)

3.4.1 Practical Procedures reflection

1. What were the key differences you noticed between the technologies used?
2. Based on your experience using the technologies which technology would you lean towards using and why?

3.5 Section 2 - Typical Error of Measurement

In the following section the aim is to try and calculate the Typical Error (**TE**), $\mathbf{CV_{TE}\%}$, minimal detectable change (**MDC95**).

In the visual below, set the number of trials to 2 and then download the data.

See if you are able to replicate the results in the text box above the visual (hint,the back end of this weeks lecture will help you figure out how to do this)

3.5.1 Visual 1

3.5.2 Visual 2

The visual below looks to highlight the importance of wanting to minimise Typical Error. You hopefully feel comfortable with the idea that any measurement we collect has some uncertainty around it. That uncertainty may be due to biological variation, technology and or methodology error, which all limit our confidence in reporting a "true" measurement. We aim to represent this uncertainty in a similar fashion to what we did last week with the 95% **Confidence Interval (CI)**.

To calculate the **CI** around the observed scores (point A and B), we use a similar formula that we did last week when we calculated the 95% CI around a sample mean, the only difference being instead of using a standard error, we will use the **Typical Error (TE)**.

For example,

Point A score = 50. For a given value of the Typical Error slider, e.g. 3 the 95 % CI would be

50 - (3 $\times$ 1.96) = **44.1** to 50 + (3 $\times$ 1.96) = **55.9**

This interval represents our uncertainty around where we believe the true measurement might be. From an interpretation perspective we **can't** say the probability of the true value being between the lower limit and upper limit is 95%, rather that the method we used to create the interval has a 95% success rate in capturing true values over the long run.

We can also calculate an uncertainty around the change score observed between these two measurements (A and B). Now that we are comparing two measurements that both come with uncertainty we have to adjust our calculation slightly to account for this when calculating a CI for a change score we do so with the equation below.

Change 95% LL = (Point B - Point A observed values) - $\sqrt{2}$ $\times$ TE $\times$ 1.96 Change 95% UL = (Point B - Point A observed values) + $\sqrt{2}$ $\times$ TE $\times$ 1.96

The $\sqrt{2}$ is included because we now have two trials that both have a potential source of uncertainty. The addition of the $\sqrt{2}$ as you can see makes the CI larger for change scores than for individual observations.

Two more measures we discussed in the lecture that can also be calculated from an understanding of TE are the minimal detectable change **MDC** and minimal clinically import difference **MCID**. Both of these are commonly reported to a 95% confidence level so will be multiplied by 1.96 respectively. The key take away is that the **MDC** is looking to tell you how the large the change would need to be for you to be confident at the 95% level that the observed change wasn't due to measurement noise. However the **MDC** only tells you whether a change is statistically different from zero which may not indicate that the change is meaningful in a practical sense. The **MCID** however, aims to let you know whether the change observed is greater than some magnitude of importance often termed the **smallest worthwhile change (SWC)**.

MDC_95 = TE × $\sqrt{2}$ × 1.96
MCID_95 = MDC_95 + **SWC**

Whilst there are may ways we can identify a value considered the **SWC**, a commonly used method is to multiply the between subject SD by some factor. In exercise and sport science a commonly used factor is 0.2 therefore;

$\mathbf{SWC_{sml}}$ = SD × 0.2 (Small)
$\mathbf{SWC_{mdr}}$ = SD × 0.6 (Moderate)
$\mathbf{SWC_{lrg}}$ = SD × 1.2 (Large)

3.6 Test your learning

What does a Bland-Altman plot show?

- (A) The difference between measurements plotted against time
- (B) The difference between measurements plotted against the mean of both measurements
- (C) The correlation between two measurements
- (D) The mean of both measurements plotted against time

What does the mean difference line (bias) in a Bland-Altman plot represent?

- (A) Random error in the measurements

- (B) The standard deviation of the differences
- (C) Systematic differences between measurements
- (D) The reliability of the measurement

What does the Typical Error (TE) represent?

- (A) The average difference between measurements
- (B) The typical variation in repeated measurements for an individual
- (C) The minimum detectable change
- (D) The correlation between measurements

If you have a single measurement (e.g., 45 kg) and know the Typical Error (TE) is 2 kg, how would you construct a 95% confidence interval around this measurement?

- (A) Add and subtract 1×TE from the measurement
- (B) Add and subtract 1.96×TE from the measurement
- (C) Add and subtract 2×TE from the measurement
- (D) Add and subtract the MDC95 from the measurement

If you measure an athlete's max strength as 80 kg with a TE of 3 kg and calculate a 95% confidence interval of 74.1-85.9 kg, what does this interval represent?

- (A) The athlete will score between 74.1-85.9 kg on 95% of future tests
- (B) 95% of athletes with similar measured strength have a true strength in this range
- (C) If we could measure this athlete's strength at this exact moment repeatedly without fatigue, 95% of the confidence intervals calculated using the above procedure would contain their true strength
- (D) The athlete's strength will improve by up to 5.9 kg or decrease by up to 5.9 kg with 95% probability

What does the Minimum Detectable Change (MDC95) represent?

- (A) The smallest change that could occur by chance

- (B) The average change between measurements
- (C) The minimum change needed to be confident a real change has occurred at the 95% confidence level
- (D) The typical error multiplied by 0.68

When monitoring an individual's changes over time, which criterion should you use to determine if a real change has occurred?

- (A) The change is significant if it exceeds the TE
- (B) The change is significant if it exceeds the MDC95
- (C) The change is significant if it exceeds the mean bias
- (D) The change is significant if it exceeds the CV

Why is the Coefficient of Variation (CVTE%) useful?

- (A) It allows comparison of reliability between different units
- (B) It expresses error relative to the mean
- (C) It's useful when error increases with larger values
- (D) All of the above

If you want to construct a 95% confidence interval around an individual's measurement, you should use:

- (A) $\pm 1 \times$ TE from the measured value
- (B) $\pm 1.96 \times$ TE from the measured value
- (C) $\pm 1 \times$ MDC from the measured value
- (D) $\pm 2 \times$ CV from the measured value

4 Week 4 - Practical

4.1 Learning Outcome:

1. Understand measurement accuracy concepts and their application to exercise testing and measurement
2. Evaluate the feasibility of different tests according to environmental conditions and client characteristics
3. Demonstrate basic data processing and analytically techniques

4.2 Practical Goals:

1. 3rd round of data collection for practical report 2
2. Practice developing skills at running and collecting commonly used test for assessment of cardiovascular fitness and parasympathetic vs sympathetic activity.
3. Understand how measures collected would be practically applied in the field, considering important limitations to the measures.
4. Understand basic intuition around how correlation plots can be used as a measure of convergent validity between measures testing the same trait/construct.
5. Time permitting; practise making Bland-Altman plots using data collected from previous weeks.

4.3 Example case study

You hired by an organisation that are use different testing modalities to infer cardiovascular fitness. Namely, they are currently using a combination of a 3 minute step up test, 4 minute fixed wattage bike test and 4 minute run test at 8.5km.hr. The company/team want to know how related these test are. More explicitly they want to know if they knew the result of one test could they use it to infer what the individual may have got on one of the other test.

How might you go about answering this?

4.3.1 Correlation and regression

In this situation the business/club is asking a question about how much does one test tell us about another test. Or put another way how correlated/associated is one test with another.

Whilst, there are may different ways to get a measure of association/correlation, the most common method is via using simple linear regression (think line of best of fit), and calculating something called a correlation coefficient.

We will go over these measures in a lot more detail in the Week 5 lecture.

Interactive regression

4.4 Practical Procedures (PART 1)

1) Your tutor will put you into groups of 3.
2) We are looking for individuals who think they could participate in at least two of the test mentioned above.
3) During the 3-4 minute sub maximal task, you will track the individual Heart Rate at the end of each minute and their HR at the end of 1 minute resting HR
4) You will additionally track there HR recovery or the heart rate after resting 60 seconds.

Enter data into the Google form that will be provided on VUWS.

https://docs.google.com/forms/d/1le3rZQVx7EUl6UI5dluZLv0H_IiBPgPZBZsqm8JeyxU/preview

1) **4 minute run test**: this is done at speed of 8.5km.hr on the treadmill. (If the participants heart rate is below 100 at 2 minutes in, you may raise the speed to 9km.hr for the final two minutes)

2) **YMCA step test**: download a metronome app and set it 96 BPM, https://www.metronomeonline.com/

- Set the metronome to 96 beats per minute and turn the volume up loud enough that you can hear each beat.
- Stand facing your step.
- When ready to begin start the stopwatch or timer and begin stepping on and off the step to the metronome beat following a cadence of up, up, down, down.
- Continue for 3 minutes.
- As soon as you reach 3 minutes, stop immediately and sit down.

3) **4 minute Monark Bike test**: Cycle at 60 RPM and KP of 1.5 for 4 minutes. If at 2minutes the heart rate is below 100, increase speed to 70 RPM.

   If for any reason you feel faint or ill during any of testing it is fine to stop.

4.5 Reflection

How could have we better controlled for potential sources of noise/error in the testing procedure we did today?

Why would using a Bland-Altman plot not be appropriate to compare HR's in this situation?

4.6 Section 2 - Bland Altman plot

In week 3 practical we introduced the Bland-Altman plot, we then discussed use of this plot in more detail in the Week 4 seminar.

Similar to previous weeks you will now have time to practise making a Bland-Altman plot.

Download data from the below tab, and use the excel document used in this weeks seminar(1hr and 2minutes in) to see if you can replicate the results.

> Seminar content
>
> https://www.youtube.com/watch?v=-dabHxo1dU4

> Click for interactive Bland-Altman Plot

5 Week 5 - Practical

5.1 Learning Outcome:

1. Understand measurement accuracy concepts and their application to exercise testing and measurement
2. Evaluate the feasibility of different tests according to environmental conditions and client characteristics
3. Demonstrate basic data processing and analytical techniques
4. Communicate test results and their implications to hypothetical client scenarios

5.2 Practical Goals:

- Consolidate previous 5 weeks of practical and seminar material.
- Preliminary introduction to performing a systematic review search.
- Build confidence in verbally discussing results

5.3 Key Terms Discussed So Far This Semester

A useful step to build confidence for your professional report would be to make sure you feel confident calculating and discussing the key terms listed below.

Week 2 material

Validity (Logical and Statistical):
- Logical = (Face, Ecological, Content)
- Statistical = Criterion (Concurrent and Predictive) and Construct
Descriptive Stats:
- Mean - Standard Deviation (SD)
- Coefficient Variation (CV%)
- Standard Error (SE)

- Confidence Interval (CI)
- Zscore

Week 3 material

Dose Response relationships (Neuromuscular)
Reliability:
-Typical Error (TE)
-CV_{TE}%
-Minimal Detectable Change (MDC)
-Smallest Worthwhile Change (SWC)
-Minimal Clinically important Difference (MCID)

Week 4 material

Dose Response relationships (Internal, Biochemical)
Bland-Altman Plots:
-Bias
-Limits of Agreement (LOA)
-Proportional Bias
-Heteroskedasticity

- Please note the final two points are discussed in Week 5

Week 5 material

Correlations
Scatter plots:
- Pearsons Correlation Coefficient (r)
- r^2 (r squared)
- y = bX+c = Linear regression equation
- b = Slope of the regression line
- c = Intercept of regression line when X = 0
- SEE = Standard Error of the Estimate

5.4 Task 1:

Over the last 5 weeks we have learnt about concepts relating to descriptive statistics, validity, reliability and dose response relationships. In particular, a focus a was made regarding the importance of reliability and how it can help identify was can be considered a practically meaningful effect.

In the first task, your tutor will rotate you in pairs. One of you will act as the client and one of you will act as the trainer. The trainer, using the interactive document below is to draw a random sample of data, and then summarise the data to their partner as if they were a client.

https://r2mu.github.io/ETM_Wk5/

> Example
>
> Mean 1-RM squat: 120 kg and Standard deviation (SD): 15 kg Test-retest reliability showed a SD of difference scores = 5.66 kg
> Calculations:
> **Typical Error (TE)** = SD_diff/√2 = 5.66/1.414 = 4 kg
> CVTE = 4/120*100 = 3.33%
> Interpretation: On average, repeated measurements will vary by about 4 kg due to measurement variability.
>
> **Minimal Detectable Change (MDC)** = TE×√2×1.96 = 4×1.414×1.96 = 11.1 kg
> Interpretation: A change of at least 11.1 kg is needed to be 95% confident the change is real and not due to measurement error.
>
> **Smallest Worthwhile Change (SWC)** = 0.2×SD = 0.2×15 = 3 kg
> Interpretation: A change of 3 kg would be considered practically meaningful for these athletes.
>
> **Minimal Clinically Important Difference (MCID)** = MDC+SWC = 11.1+3 = 14.1 kg
> Interpretation: An increase of at least 14.1 kg represents a change that is both statistically significant and practically meaningful.

5.5 Task 2:

You are hired by a organisation (sports team , high school, private clinic) to help increase the rigour of their testing procedures via development of evidenced-based position statement for best practice guidelines. This includes from testing justification, testing methodology to testing application.

In groups of 7, you are to pick a scenario (sport, school based, clinic), you are to pick 3 test that you believe measure the most important constructs within the scenario you have chosen.

Your focus however,is to convince the organisation that these are indeed the the three best test to use.

Using aspects that we have discussed over the previous 5 weeks you are to create a mini representation (aim for 1-2 slides per test), that talks about validity and reliability of each of the test and aspects that could increase measurement accuracy. You will be expected to use research to support your claims.

5.5.1 Useful resources:

WSU library & Google Scholar systematic search

For example try and copy and paste the below into Google scholar

"Netball" AND (("validity" AND "reliability") OR "physical qualities" OR "determinants")

Book search:

Physiological Test for Elite Athletes (2nd Edition) (Available online in library)

Additional resources:

https://www.ais.gov.au/position_statements

5.5.2 Reflection:

What aspects of the presentations you heard today made you feel most confident in the test that were chosen from each group for their scenario?

What additionally information do you think would have been relevant for them to add?

Would you have chosen different test?

5.6 Task 3:

Using the scatter interactive regression plot from Week 4 (3.3.1) Practice making a scatter plot with regression and correlation statistics.

> Scatter plot and regression helper video
>
> https://www.youtube.com/watch?v=isgH4SBAMp4

5.7 Test your learning

In the linear regression equation y = mx + b, which statement correctly describes the relationship?

- (A) y equals the sum of x and b
- (B) y equals the product of x and m, minus b
- (C) y equals the product of m and x, plus b
- (D) y equals the sum of m and x, divided by b

In a linear regression equation y = mx + b, what does the slope (m) represent?

- (A) The value of y when the analysis begins
- (B) The amount y changes when x increases by one unit
- (C) The starting point of the regression line
- (D) The amount x changes when y increases by one unit

In a linear regression equation y = mx + b, what does the y-intercept (b) represent?

- (A) The average value of all y measurements
- (B) The point where the regression line crosses the x-axis
- (C) The predicted value of y when x equals zero
- (D) The minimum possible value for y in the dataset

What does Pearson's correlation coefficient (r) represent in the context of linear regression?

- (A) The proportion of variance in y explained by x
- (B) The average error in the prediction model
- (C) The slope of the regression line
- (D) The strength and direction of the linear relationship between x and y

What does the coefficient of determination (R^2) represent in linear regression?

- (A) The square root of the average squared error
- (B) The square of the slope in the regression equation
- (C) The proportion of variance in the dependent variable explained by the independent variable
- (D) The average distance between predicted and actual values

What does the standard error of the estimate represent in linear regression?

- (A) The average distance of data points from the mean
- (B) The average distance between observed values and predicted values on the regression line
- (C) The standard deviation of the slope coefficient
- (D) The standard deviation of the x variable

If a regression equation is TestScore = 2x + 65, where x is hours spent studying, what is the correct interpretation if a student increases their study time from 10 to 15 hours?

- (A) 5 additional hours of studying has no effect on test scores
- (B) 5 additional hours of studying is associated with a 10-point increase in test scores
- (C) Each hour of studying is associated with a 2-point increase in test scores
- (D) For every 2 points increase in test scores, students study 1 additional hour

If Pearson's r = 0.8 for the relationship between two variables, what does the corresponding $R^2 = 0.64$ tell us?

- (A) The relationship is perfectly linear
- (B) There is no relationship between the variables
- (C) About 64% of the variation in y can be explained by its linear relationship with x
- (D) The slope of the regression line is 0.8

What does a Pearson's r value of -0.7 indicate about the relationship between variables x and y?

- (A) The relationship between x and y is weak
- (B) As x increases, y remains constant
- (C) As x increases, y tends to decrease
- (D) As x increases, y tends to increase

If the standard error of the estimate for a regression model is 3.0, what does this tell us?

- (A) The regression model perfectly predicts all y values
- (B) The correlation between x and y is very strong
- (C) The observed y values tend to differ from predicted values by about 3 units on average
- (D) The slope of the regression line is changing by 3 units

6 Week 6 - Practical

6.1 Learning Outcome:

1. Understand measurement accuracy concepts and their application to exercise testing and measurement
2. Evaluate the feasibility of different tests according to environmental conditions and client characteristics
3. Demonstrate basic data processing and analytical techniques
4. Communicate test results and their implications to hypothetical client scenarios

6.2 Practical Goals:

- Consolidate previous 5 weeks of practical and seminar material.
- **Professional report 1 overview**
- Introduction to pivot tables.

6.3 Case Study

Over the semester we have learnt about different ways we can assess the validity and reliability of metrics. In particular, you have calculated descriptive statistics (mean, SD and CV%), reliability statistics (TE,CV_{TE}%, MDC, SWC & MCID), created a Bland-Altman plot and create a scatter plot with a regression line. The interactive documents that allow you to download the datasets to practise calculating these statistics however, have largely been optimised to make the analysis as easy as possible for you.

In reality however, the datasets you will work with will often require some transformation to get it into a format that allows you to do the analysis you want.

Therefore the goal of practicals this week is to introduce you to Pivot Tables in excel. Pivot tables allow you to relatively easily manipulate datasets into different formats that make analysis easier. You will be required to use a pivot table to manipulate the dataset given to you for your first professional report due in week 9.

6.4 By end of class

1) You should feel confident with the requirements for the professional report.
2) You should have chosen what variables you want to analyse for what aspects of the report.

- What three test will you analyse regarding reliability based metrics?
- What two test will you compare using a Bland-Altman plot?
- What two test will you compare using a scatter plot and regression analysis?

3) You should know where to find the relevant information regarding how to perform the appropriate analysis and its interpretation.

This material can be found in both the seminar content and prac work book.

7 Week 10 - Practical

7.1 Learning Outcome:

1. Understand measurement accuracy concepts and their application to exercise testing and measurement
2. Evaluate the feasibility of different tests according to environmental conditions and client characteristics
3. Demonstrate basic data processing and analytical techniques
4. Communicate test results and their implications to hypothetical client scenarios

7.2 Practical Goals:

- **Explore athlete monitoring tools and technologies:** Gain both theoretical and practical knowledge of the different tools available for monitoring athletes and how they fit within the AES scope of practice.
- **Apply monitoring techniques in real-world settings:** Experience hands-on the practical application of athlete monitoring technologies, improving your ability to gather, interpret, and apply data to enhance athletic performance.
- **Enhance professional practice skills:** Develop skills that align with the professional standards required for an AES, focusing on the integration of technology and practical tools to improve athlete outcomes.
- **Understand training load:** Develop a foundational understanding of the training load construct and its sub dimensions (e.g., internal versus external load), as well as how these are operationalised in practice to effectively monitor athlete physiology and performance.
- Time permitting quick overview of more advanced techniques for performing systematic search strategies

7.3 Background:

Over the last two weeks in seminar material we have discussed the construct of **"Training Load"**. Importantly we can think of training load being made up of two sub dimensions **Internal** and **External** load. **Internal Load** can be further subdivided into **Objective** and **Subjective** markers.

External load: Can quite simply just been thought of as a measure of how much work was done. e.g. 5km of running, 1000 steps, 100m swim.

Internal load: Is a measure of the bodies response to performing the external load. Most commonly used measures are Heart rate based indices that were discussed in Week 4. Internal load can also represent biochemical markers (Creatine Kinase, Lactic Acid), Hormonal responses (Testosterone, Cortisol) or Immunological markers (IGA, IL1,6). The above would be considered **objective** internal load makers whilst measures based on perception of effort assessing mood such as Borg,Session RPE, Profile of Mood States, DALDA or simply Athlete Reported Outcome Measures would be considered **subjective** makers of internal load.

7.3.1 Activity

In this weeks activity we are going to use a combination of external load and internal load markers as measured via integrated GPS/IMU and HR device from the Polar Team System and subjective outcome measures. This should help build your intuition around how interpreting both internal and external load can be useful in both categorising intensity of drills.

Task 1: Please used the document to complete a Wellness Questionnaire.

Task 2: After completing the wellness questionnaire, your supervisor will introduce the technology used to collect external and internal training loads throughout the workshop session.

Task 3: Exercise 1 (Continuous protocol) In this exercise, you will complete a running task, performing ~3 minutes of sub-maximal intensity running across 20-meter shuttles. One group member will be assigned to guide the pacing using a stopwatch and guide paper that indicates the required time to reach each cone. After completing the exercise, please submit your rating of perceived exertion (RPE).

Task 4: Exercise 2 (Intermittent protocol) In this exercise, you and your group will perform an intermittent activity consisting of 3 sets of 4 back-and-forth shuttles (each shuttle being 40 m long). The intensity should be self-paced at approximately 80% of maximal effort. Recovery periods between repetitions are self-chosen based on perceived exertion. After completing each set (i.e., 4 back-and-forth repetitions), there is a mandatory of 1-min rest at minimum. After completing the exercise, submit your RPE.

Task 5: Exercise 3 (Cross-training) In this exercise, you will complete 3 sets of burpees followed by jump rope. For each set perform 2 to 4 burpees (depending on your ability).

Immediately follow the burpees with 30 seconds of jump rope. After each set, you will have a 45 second recovery period. Repeat this sequence for 3 to 4 rounds. After completing the exercise, submit your RPE.

7.3.1.1 Save Results

Table 7.1

Protocol	Distance	HR	RPE
Continuous			
Intermittent			
Cross Training			

8 Week 12 - Practical

8.1 Learning Outcome:

1. Understand measurement accuracy concepts and their application to exercise testing and measurement
2. Evaluate the feasibility of different tests according to environmental conditions and client characteristics
3. Demonstrate basic data processing and analytical techniques
4. Communicate test results and their implications to hypothetical client scenarios

8.2 Practical Goals:

1. Build intuition around Hypothesis testing by performing your own hypothesis test
2. Practice interpreting results of your findings make sure to give context to the size of your effect, the precision around the effect you observed and confidence that these results may be reproducible in the future.

9 Why not updating

Test