Introduction

The goal of this task was to facilitate time improvement in a 3km run through completing a 6-week training program. Through analysing pre and post unit training data and collecting other evidence, this allowed improvement to be measured in hand with completion of another 3km run post-training. In this task, the targeted movement concept explored was movement quality, relating to how the body moves, to target improvement. The movement strategy applied was executing movement, which refers to the application of movements within a certain strategy, which included a fitness and conditioning analysis, investigation of diet and hydration and use of technology to improve running technique.

Pre-Unit Analysis



Figure 1 - Initial 3km Run completed February 26th.

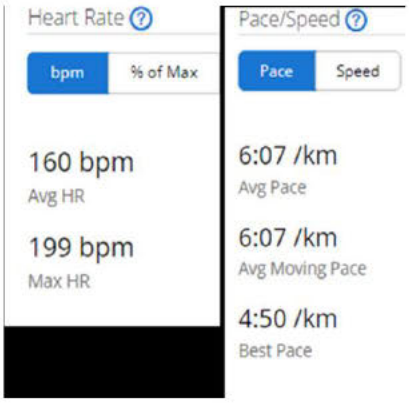


Figure 2 – Run Statistics

Figure 1 displays the first pre unit 3km run, completed in 18-minutes and 21-seconds. The key seen in **Figure 1** represents the changes in pace throughout the run, demonstrating where I began to walk or run quicker. Shown in **Figure 2**, I had an average pace of 6-minutes and 7-seconds per kilometre, however, my best pace throughout my run was 4-minutes and 50-seconds per kilometre. My heart rate sat an average of 160bpm, increasing to 199bpm as my maximum heart rate.

Figure 3 demonstrates that I began at too quick of a pace, causing a quick increase in my heart rate from approximately 1-minute to 3-minutes into the run. At the 4-minute mark, I crossed my lactate threshold, but shortly after found a steady pace, which I followed throughout the rest of the run, resulting in a steady heart rate. I took several breaks to walk, also resulting in dips in heart rate. At around 12-minutes, fatigue was evident as my running pace became more inconsistent with more walking breaks. Fatigue is also demonstrated through heart rate at 12-minutes 30-seconds into the run, where it increased to a maximum of 199bpm towards the end of the run. As lactic acid began to accumulate rapidly in the muscles, this resulted in the need to take more breaks.

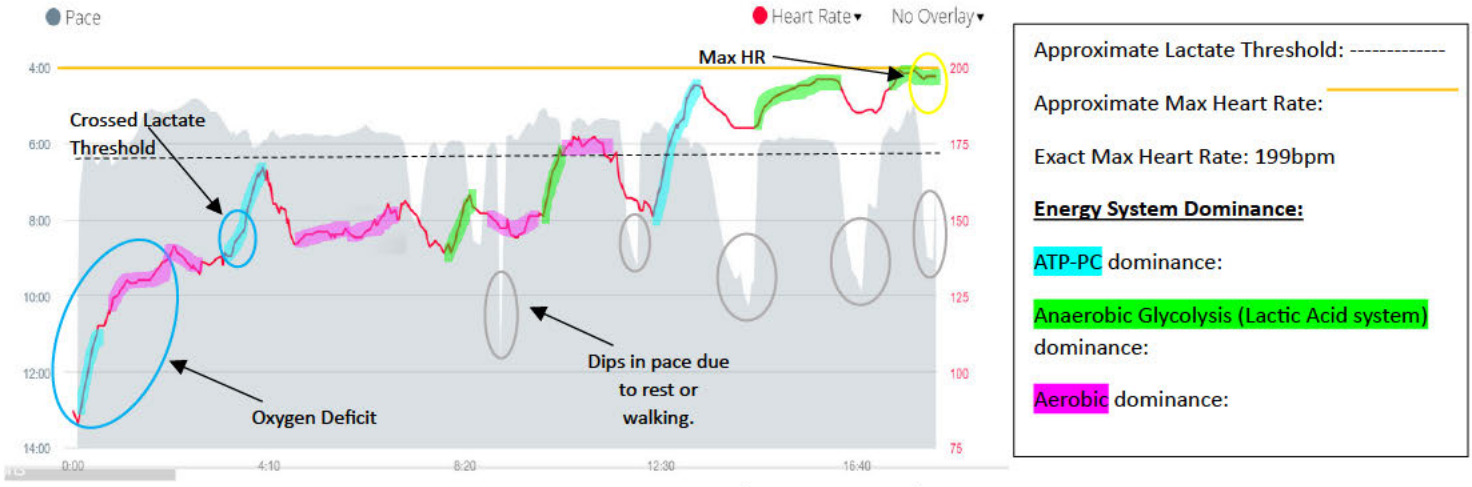


Figure 3 – Pace and Heart Rate Graph

Inconsistent heart rate, as well as inconsistent pace, shown in **Figure 3** demonstrates that I was not predominantly utilising my Aerobic system, and instead was utilising the Anerobic and ATP-PC systems, with constant interplay. Interplay is the contribution of the energy systems, which work hand in hand to supply ATP, with dominance from particular systems depending on the type or intensity of the exercise.[1] ATP resynthesis is the body's ability to restore and resynthesise ATP

[1] *Interplay of energy systems* 2024, viewed 8 May 2024, <http://sportscienceskc.weebly.com/interplay-of-energy-systems.html>.

stores through interplay of the three systems, allowing each system to restore whilst another system is dominant.[2] The dominant energy system throughout my run was the ATP-PC system, demonstrated through large spikes in my heart rate, where my intensity was high, but only lasting for short periods as ATP-PC stores deplete. This system can be seen utilised during the run mainly from 0-10 seconds, 4-minutes to 4-minutes 10-seconds where lactate threshold was crossed, and 12-minutes 30-seconds to 12-minutes 40-seconds. A pattern in my run was that the aerobic system showed dominance following the ATP-PC system, as fatigue built from ATP-PC system use. Use of the aerobic system is demonstrated by a steadying heart rate as the body works at a submaximal intensity, efficient for sustained energy production, however, operating at a slower rate. It relies on oxygen to break down carbohydrates, fats, and proteins to produce ATP. This system is mainly dominant at stages during the run including 20-seconds to 4-minutes, 4-minutes 20-seconds to 6-minutes 30-seconds, 8-minutes 30-seconds to 9-minutes, and 10-11 minutes. The Lactic Acid system was mostly dominant towards the end of the run when fatigue set in and PC stores depleted, causing heart rate to reach its maximum of 199bpm. As there is now not enough oxygen available, the body converts glycogen into pyruvate, then turned into the byproduct of lactic acid, which generates ATP.[3] Build-up of lactate can also cause fatigue, identified through several breaks taken towards the end of the run, as lactic acid causes muscle soreness.

Table 1 *– Initial 3km Run Statistics*

Activity statistics	3 km Run
Distance covered	3km
Total time	18.21
Time per km (pace in mins/km)	6:07 /km
Maximum speed identified (best pace)	4:50 /km
HR at commencement of activity	87 bpm
Maximum heart rate reached during run	199 bpm
Average heart rate	160 bpm
Average running cadence	152 spm
Average stride length	1.09 m
Calculate your lactate threshold	LT = (220-16) x 0.85 = 173 bpm
Calculate your resting heart rate	

After analysing my initial 3km run, there are several aspects that could be improved:

1. Maintain steady pace/state, improve consistency – Average pace greatly differs from fastest pace, therefore making these closer would help to improve my consistency when running, hopefully assisting in reducing the number of breaks needed.
2. Reduce my average stride length/increase steps per minute– Taking smaller steps and reducing stride length when running helps to improve running form to help absorb force from the ground, and instead use the force to push forwards. This will assist in pushing through fatigue and muscle soreness when running.
3. Run fastest split in third kilometre – Aiming to run my fastest split in the third/final kilometre will help me keep a steady pace and reserve my energy until the end of the run. Seen in **Figure 5**, my third split was about a minute slower than my first. Increasing intensity and running my fastest split in the third kilometre would mean that more time needs to be spent in HR Zone 5, which needs to be improved as in the pre-unit run, I took multiple breaks after exceeding Zone 5 and crossing my lactate threshold. Working for longer in Zone 5 would help improve my tolerance to lactic acid, also helping to reduce number of breaks due to muscle fatigue.



Figure 4 *– Heart Rate Zones*

Laps ▲	Time	Cumulative Time	Distance	Avg Pace	Avg GAP	Avg HR
1	5:29	5:29	1.00	5:28	--	135
2	6:16	13:12	1.00	6:15	--	159
3	6:36	18:21	1.00	6:58	--	190
Summary	**18:21**	**18:21**	**3.00**	**6:07**		**160**

Figure 5 *– Lap Split Times*

[2] ***Understanding the Three Energy Systems Used During Exercise*** **2022, www.army.mil, viewed 3 June 2024, <https://www.army.mil/article/254967/understanding_the_three_energy_systems_used_during_exercise#:~:text=It%20means%20our%20bodies%20constantly,as%20the%20phosphagen%20energy%20system.>.**

[3] **McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.**

To allow me to improve these three aspects of my initial 3km run, I have aimed to reduce my initial 3km run time by 3%, aiming to run a time of under 17 minutes and 48 seconds compared to my original time of 18 minutes and 21 seconds.

3%	1101 × 0.03 = 33 secs	1101 – 33 = 1068 secs	1068 / 60 = 17.80 0.80 x 60 = 48 secs 17 mins 48 secs	1068 / 3 = 356 356 / 60 = 5.93 0.93 x 60 = 55.8 (56 secs) 5 mins 56 secs

Table 2 *– Time Reduction Table (see full reduction table in appendices)*

Below displays the SMART goal I have set to achieve to reduce my 3km run time and overall improve my running: The table below demonstrates how this goal is achievable and reachable:

SMART Goal Setting	
Specific	I hope to reduce my initial 3km running time by 5%, therefore reducing my overall run time by 55 seconds. This calculates to my specific target time for my final 3km run to be aiming at under 16 minutes and 31 seconds. This also calculates to aim at running an average time of 5 minutes and 56 seconds per kilometre.
Measurable	To track the progress of my goal, I will utilise two applications called Strava and Garmin Connect. These apps will measure my progress by tracking data including my heart rate, pace, and distance ran. Fitness testing, including 4 circuit training sessions, 2 Coopers runs (12 minutes), 2 wall sits, and weekly runs, will also assist me in progressing my fitness, allowing me to achieve improvement and reach an average time of 5 minutes and 56 seconds per kilometre.
Achievable	This goal is achievable as I have previous experience in sports including Netball and Football, and currently also participate in Volleyball. I therefore know that with my fitness levels and prior participation that I am capable of consistently training allowing me to create a 3% cut in my original 3km time trial.
Realistic	This goal is as structure of sessions each week, as well as consistent input of effort and commitment will ensure that I facilitate improvement.
Timely	This training program will continue for a duration of 6 weeks, allowing room for multiple fitness testing sessions per week to achieve overall improvement in my 3km running time.

Table 3 *– SMART Goal Setting Table*

Week	5 (Term 1)	5 and 6	6	7	8	9	10	11	11
Activity	Initial 3km Run	Data Analysis (pre training)	Training					Training (tapered week)	Final 3km Run + Data Comparison & Analysis (post training)

Table 4 *– Training Program Schedule (see full training program in appendices).*

To improve running performance, several strategies will be implemented into the 6-week training program. The first strategy is a **training and conditioning program**, improving aerobic capacity through interval/continuous running, and muscular endurance through circuit training, helping to target specific fitness components relevant to a 3km run.

The second strategy will be diet, consisting of food and hydration. Diet is important in providing my body with enough hydration, protein, etc., for maximal recovery and preparation before exercise. Diet can also help to maintain blood plasma, CHO consumption, and glycaemic index.

Finally, running technique will be analysed and improved, allowing me to have an efficient and practical foot strike, stability, and cadence to improve my breathing and posture during exercise. Improving running form can also help to reduce chances of injury whilst running.

Strategy 1 – Fitness and Conditioning Analysis

In a 3km run, the dominant energy system utilised is the aerobic system, building aerobic endurance for sustained performance over extended periods. When running over extended periods, utilising mainly periods of anerobic dominance, muscular endurance is required for maximal performance to avoid fatigue. Utilising the aerobic system requires efficient delivery of oxygen to the muscles, therefore aerobic capacity is required for assisting muscular endurance.

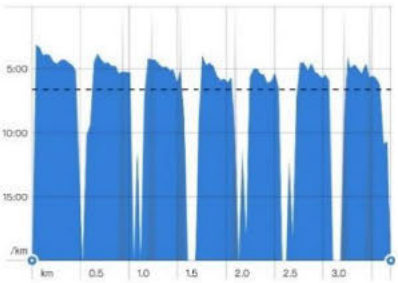


Figure 6 *– Pace Graph from interval run (2 minutes on, 2 minutes off x 7).*

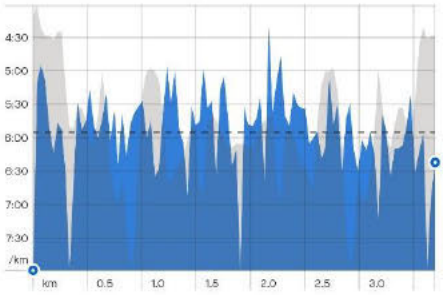


Figure 7 *– Pace Graph from continuous run (22 minutes).*

There were several training methods targeting aerobic capacity training utilised in the program, including continuous and interval training running (see **Figures 6** and **7**). Aerobic capacity is the body's maximum amount of oxygen that can be used at once during intense exercise.[4] Both types of runs help to improve oxygen efficiency by increasing the maximum amount of oxygen the body can intake during exercise (VO2 Max) endurance, and stamina, all helping to improve Lactate Threshold. Lactate Threshold is the point during exercise at which lactate builds accumulates in the bloodstream faster than the body can remove it when there is an insufficient oxygen supply, causing fatigue.[5] Therefore, improving Lactate Threshold through training aerobic capacity can help to maximise the intensity of extended exercise without the need for breaks or rest through build-up of lactic acid, whilst also delaying the onset of lactate threshold to continue at a higher intensity without fatigue for longer. Improvement in Aerobic Capacity was tested through completing Cooper's 12 Minute runs throughout the training program. **Figures 8** and **9** show a Cooper's run completed at the beginning of the program compared to one completed at the end of the program, showing evident improvement from an average pace of 6:10 per km to 5:23 per km, resulting in an increased distance of 280 metres.

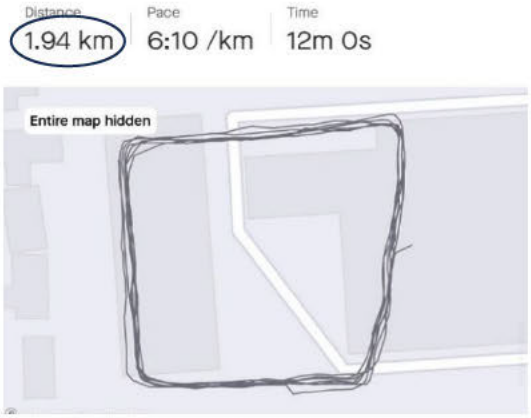


Figure 8 *– Cooper's Run completed March 22nd.*

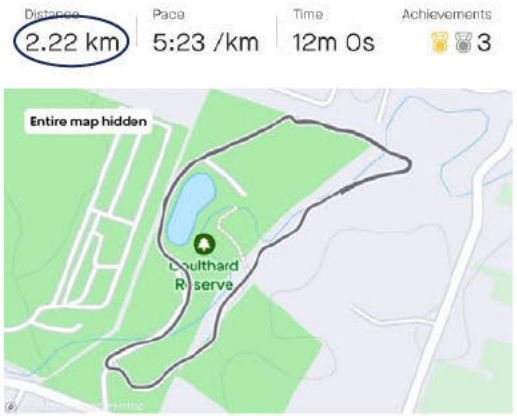


Figure 9 *– Cooper's Run completed April 7th.*

An anaerobic fitness component that requires improvement in the 3km run is Muscular Endurance, the ability for muscles to complete sustained exercise through repeated/held static contractions, facilitating muscular strength[6], improved through circuit training, implemented into the 6-week training program with a weekly session (see **Figure 10**). Circuit training includes performing different exercises each targeting different muscle groups/fitness components, with minimal rest between exercises to improve muscle strength, assisting in a 3km run through improving running form and technique, as well as helping to reduce muscle fatigue during exercise[7], assisting when working above Lactate Threshold when lactic acid is contributing to muscle fatigue.

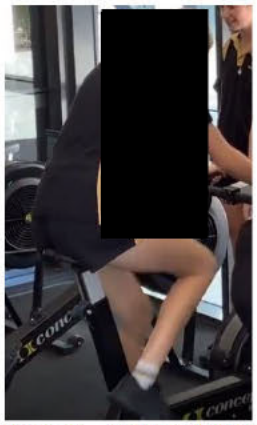


Figure 10 *– Evidence of circuit training on the bike, Week 4.*

[4] Bayless, K & Bayless, K 2022, *What Is Aerobic Capacity and How Can You Improve It?*, BODi, viewed 3 June 2024, <https://www.beachbodyondemand.com/blog/aerobic-capacity>.
[5] Ghosh, AK 2004, 'Anaerobic threshold: its concept and role in endurance sport', *The Malaysian journal of medical sciences : MJMS*, vol. 11, Malaysia, no. 1, pp. 24–36, viewed 1 May 2024, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3438148/>.
[6] McNaughton, N & Wilson, A (2020). Physical Education Workbook. Adelaide Tuition Centre, Adelaide.
[7] https://www.facebook.com/verywell 2022, *Circuit Training: Purpose, Benefits, and How to Get Started*, Verywell Health, viewed 14 May 2024, <https://www.verywellhealth.com/what-is-circuit-training-5224393>.

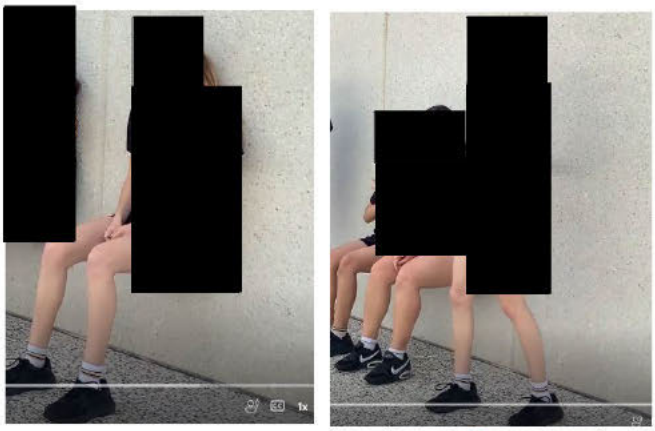


Figure 11 – Pre unit wall sit, lasting 53 seconds.



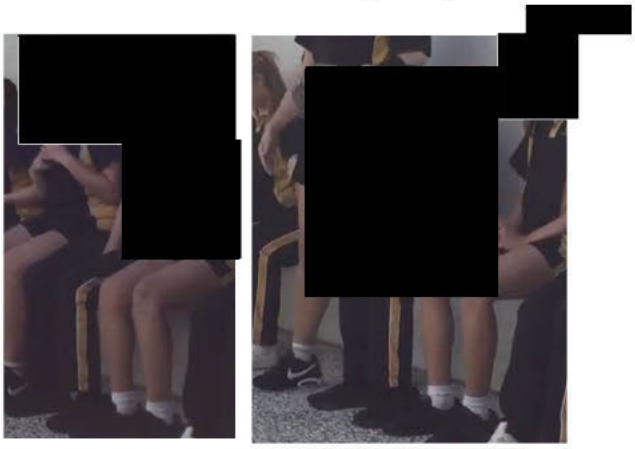


Figure 12 – Post unit wall sit, lasting 1 minute 38 seconds.



Improvement in Muscular Endurance was tested through completion of a wall sit in Week 1 and 5 of the training program, with **Figure 12** displaying a 45 second improvement compared to **Figure 11**

Training Principle 1: Variation

Training principles target different areas of a training program to gain maximum benefits from the exercise. Variation has been included into the training program through running in different locations/environments, improving engagement through increasing motivation, providing continuous challenges, and assisting in staying mentally fresh without becoming bored.[8] I also implemented variability through different training methods by completing both continuous and interval runs.

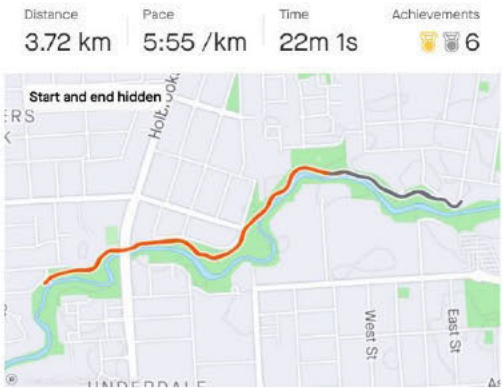


Figure 13 –Continuous run completed March 17th.

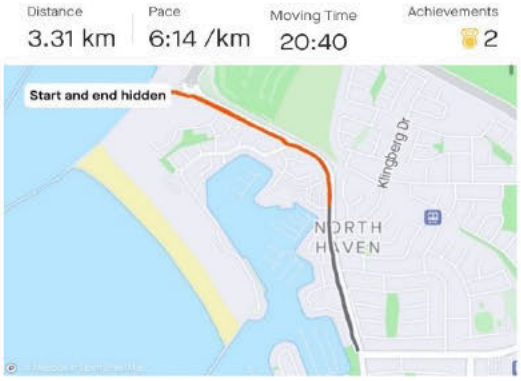


Figure 14 – Interval running (2 on 2 off x7), completed April 1st.

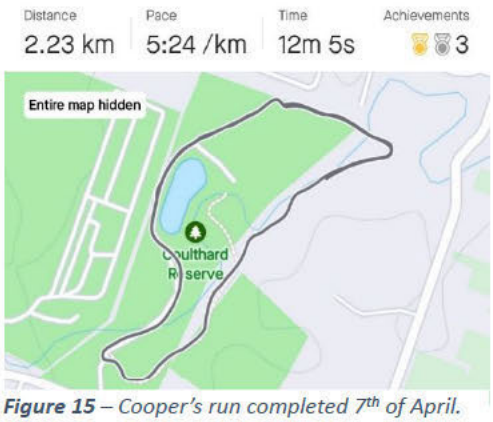


Figure 15 – Cooper's run completed 7th of April.

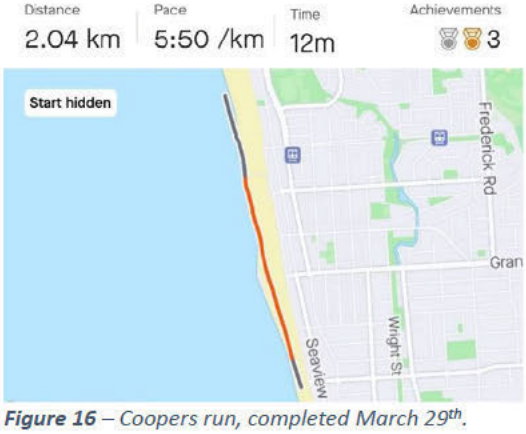


Figure 16 – Coopers run, completed March 29th.

[8] McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.

Training Principle 2: Recovery

Recovery allows the body to restore and rest after exercise. Without it, chances of injury, or worsening pre-existing trains/injuries are prone to occur. Recovery aims at repairing and building tissues and muscles that have been utilised and stressed during training.[9] To facilitate recovery in my training program, I utilised hydrotherapy by swimming in the ocean and a pool post-training seen in **Figures 17** and **18**. Hydrotherapy is useful in reducing inflammation and chance of delayed muscle soreness through constricting blood vessels in the water.[10] I also utilised a massage gun (**Figure 19**), facilitating blood flow to tissue in the body, reducing muscle soreness.[11]



Figure 17 *– Hydrotherapy in pool.*



Figure 18 *– Massage gun.*



Figure 19 *– Hydrotherapy at beach.*

Training Principle 3: Progressive Overload

Progressive overload involves gradually changing factors within training including changing rest time, distance, or work time to build sustained progress and improvement in the muscles and aerobic system. To facilitate progressive overload, I gradually increased the work time in my continuous and interval runs, seen in **Table 5.** Progressive overload was also included by increasing the heart rate zone that was predominantly worked in. Below compares heart rate zones from an interval run in week 3 (**Figure 20**) compared to week 5 (**Figure 21**), showing 23% more spent in zone 5 in the week 5 run, displaying more intensity, resulting in a higher work rate and heart rate.

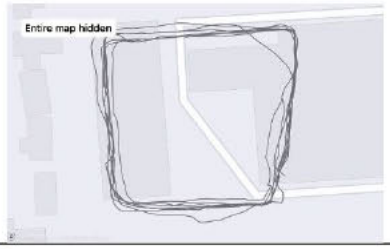
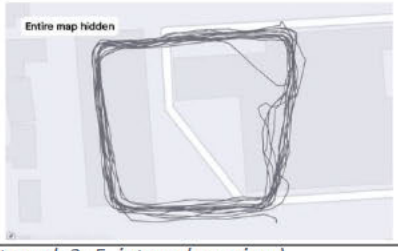
Week	Session 3 – Aerobic Focus
3	**Aerobic Capacity –Interval Running** *Warm Up:* Static stretching *Session details:* 4 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. *Cool Down:* Static stretching Evidence collected: Strava Distance 2.11 km · Pace 6:53 /km · Time 14m 32s · Achievements 1 
4	**Aerobic Capacity/Muscular Endurance – Long Interval Running** *Warm Up:* Static stretching *Session details:* 6 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. *Cool Down:* **Light jog** Evidence collected: Strava Distance 3.31 km · Pace 6:14 /km · Moving Time 20:40 · Achievements 2 
5	**Aerobic Capacity – Long Interval Run** *Warm Up:* *Session details:* 7 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. 5 or 6 2 min runs 85 – 90% intensity. *Cool Down:* Static stretching Evidence collected: Strava Distance 3.78 km · Pace 6:35 /km · Achievements 2 

Table 5 *– Training Program (Session 3 snippet week 3 -5, interval running.)*

[9] McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.
[10] Barraclough, A 2018, *Hot bath or ice bath – which is best for recovery?*, Runner's World, Runner's World, viewed 10 May 2024, <https://www.runnersworld.com/uk/training/a776522/hot-bath-or-ice-bath-which-is-best-for-recovery/>.
[11] Mateo, A 2024, *Are Massage Guns Worth It?*, Runner's World, Runner's World, viewed 10 May 2024, <https://www.runnersworld.com/health-injuries/a38926677/do-massage-guns-work/>.

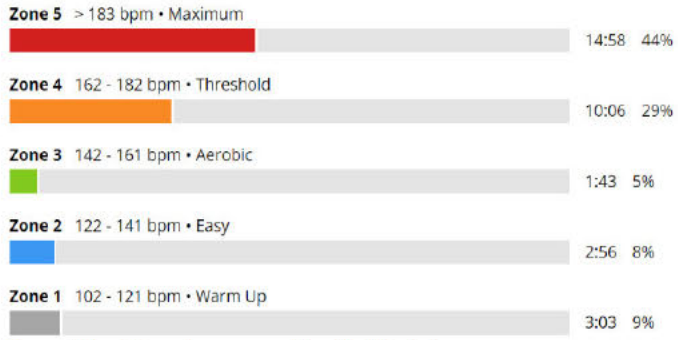


Figure 20 *– Interval run completed in Week 3*

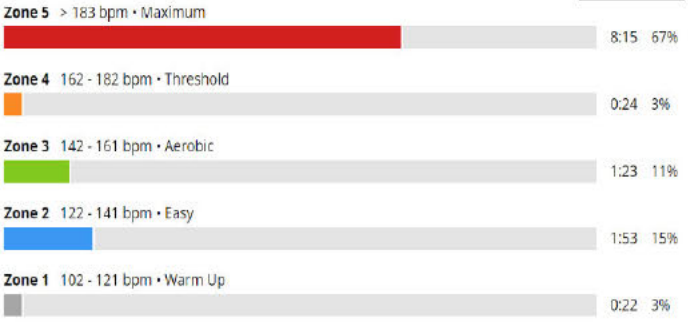


Figure 21 *– Interval run completed in Week 5*

The General Adaption Syndrome (GAS) Model (see **Figure 22**) refers to the three-stage process the body undergoes when stress is applied, in this case through a training session. The first phase is the alarm phase, causes a temporary decrease in performance, however the second resistance (adaptation) phase then improves performance beyond pre-training levels through the super compensation effect. In the GAS model, relevant to the training program, recovery and progressive overload must be applied for long-term performance to improve, and to avoid exhaustion.[12] Specific Adaptation to Imposed Demands (SAID Principle) relates to focuses on specific components in order to create overall improvement. In this training program, the relevant components contributing to overall 3km improvement include aerobic capacity, lactate threshold, and muscular strength. To target these principles, volume, intensity, and mode of training can be modified.[13]

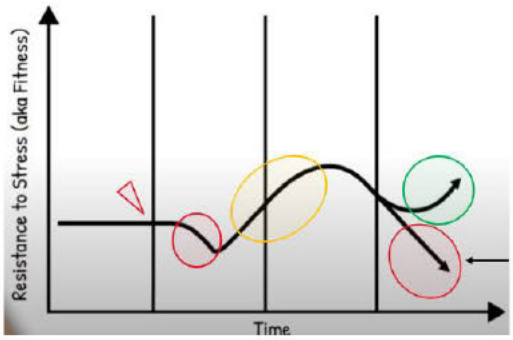


Figure 22 *– GAS Model.*

Through training, a range of physiological enhancements, called chronic adaptations, occur in the body through the circulatory, respiratory, and muscular system. In the circulatory system, cardiac output refers to the amount of blood the heart pumps per minute. Increasing this during high intensity exercise, in hand with increased stroke volume and heart rate, allows the body to meet the demands of intense exercise.[14] In the respiratory system, increased pulmonary diffusion allows the body to Increase the amount of oxygen available for circulation in the muscles, through an increase in the volume of oxygen that is diffused through the alveoli, lungs, and pulmonary capillaries.[15] In the muscular system, increased skeletal muscle capillarisation improves the body's ability to extract oxygen from the blood, and transport it into the mitochondria found in muscle cells, occurring through an increased number of myoglobin stores in the bloodstream.[16]These adaptations can collectively enhance performance in a 3km run, through improving cardiovascular efficiency, oxygen utilisation, and creating resistance to fatigue, resulting in overall better performance.

[12] *Carbone, P (2021), 'Running Fundamentals', [PowerPoint Presentation] (Accessed 2nd June 2024)*

[13] *Carbone, P (2021), 'Running Fundamentals', [PowerPoint Presentation] (Accessed 2nd June 2024)*

[14] Clinic, C 2022, *Understanding Cardiac Output and What It Means*, Cleveland Clinic, viewed 21 June 2024, <https://my.clevelandclinic.org/health/diagnostics/23344-cardiac-output>.

[15] McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.

[16] McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.

Strategy 2 – Diet & Hydration Analysis

Diet

There are several food science principles that are relevant to improving running performance. The Glycaemic Index (GI), on a scale of 0-100, measures the glucose content in food and drinks, effecting the rate at which they can increase the blood's glucose level.[17] Food and drinks with high glucose and sugar are be classified as high GI products, with a GI rating between 70-100, whereas low GI products are between 55-0 on the scale, containing high contents of fat, protein, or fibre.[18] When running, low GI products provide a sustained release of energy over an extended period, such as pasta, rice, and vegetables, shown in **Figure 23**. Consuming these the night before or hours before exercise avoids digestive discomfort caused by their contents. High GI products, including lollies and sports drinks, are beneficial just prior to exercise as they can quickly top up energy stores, releasing a quick spike of energy only lasting for a short period of time, shown in **Figure 23**.[19] Following exercise, it is also important to restore protein in the body as part of recovery, as it provides amino acids, assisting in repairing and rebuilding the muscles.[20]

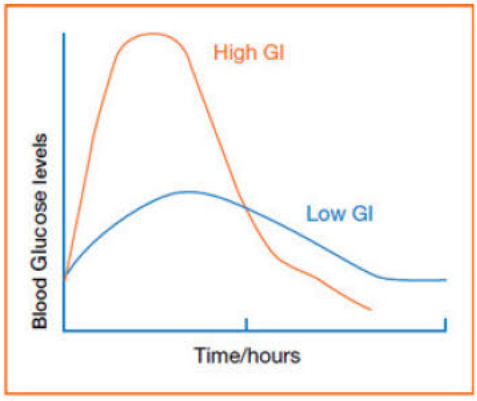


Figure 23 – *GI levels diagram (The University of Sydney, Glycaemic Index Research and GI News, 2024).*

	Monday (Circuit)	Tuesday (Rest Day)	Wednesday (Continuous Running Training)
Breakfast	Vegemite on toast + Green juice	Vegemite on toast + protein drink (for muscle recovery)	Avocado (fibers) & Vegemite on toast + Green juice 
Recess/ Snack	Banana (Rich in potassium to support muscle function)	Muesli bar (protein, fiber, carbohydrates to restore energy).	Lollies, chocolate bar (high GI for energy prior to continuous running)
Lunch	Ham and cheese toasty	Chicken, lettuce, cheese wrap (protein)	Ham and cheese roll
Dinner	Chicken & rice + salad 	Pasta (CHO dominant meal prior to training)	Omelete (high protein for muscle recovery after training) 

Conscious food choices provide a range of benefits, for example, I consumed carbohydrates the night before trainings and the final 3km to have a sustained store of energy leading up to the exercise. I also consumed high GI products before my training and 3km, providing a quick spike in my blood glucose levels to provide me with further energy.

Table 6 – *Week 3 Diet and Nutrition Table.*

[17] Health 2018, *Carbohydrates and the glycaemic index*, Vic.gov.au, viewed 15 May 2024, <https://www.betterhealth.vic.gov.au/health/healthyliving/carbohydrates-and-the-glycaemic-index>.
[18] Ajmera, R 2020, *Glycemic Index: What It Is and How to Use It*, Healthline, Healthline Media, viewed 15 May 2024, <https://www.healthline.com/nutrition/glycemic-index#what-it-is>.
[19] McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.
[20] *5 Facts About Protein and Post Workout Recovery* 2016, Clifbar, viewed 19 June 2024, <https://www.clifbar.com/stories/5-facts-about-protein-recovery-after-workout>

Hydration

Hydration replaces and sustains fluid flowing throughout the cells, organs, and tissues and through consumption of liquids and liquid-including foods.[21] Hydration can easily be lost through physical activity, depleting levels of fluid in the body through sweating, insufficient fluid intake, and high weather conditions, resulting in dehydration. Dehydration causes fatigue through loss of water through blood plasma, decrease in blood flow to muscles and skin, loss of balance, concentration, and coordination. [22]. Hydration sustains blood volume and plasma levels, which are crucial for the circulation of oxygen and nutrients throughout the body. It can be sustained through an increased consumption of fluids prior to physical activity. During running and excessive exercise, sweating causes the blood to become thicker as the presence of plasma decreases, therefore the body has to work harder to move around the thicker blood to the muscles, resulting in fatigue.[23] Muscle fatigue can also increase the likeliness of muscles cramping during exercise, negatively effecting performance.[24] Alternatives to water which provide hydration, including sports drinks, were implemented, also providing electrolytes and carbohydrates just before intense exercise. Water and electrolyte-specific drinks were also consumed after exercise for replenishment. The recommended water intake for an individual of my gender, age, and weight is shown in **Figure 24**.



Figure 24 *– Recommended Water Intake for myself.*

Daily Water Intake Table

Time	Amount (cups)	Amount (L)	Notes
By 9am	2 cups	0.48	After waking up
By 1pm	1.5 cups	0.36	Around 11:00 AM
By 5pm	1.5 cups	0.36	Around 1:00 PM
By 9pm	1.5 cups	0.36	Around 3:00 PM
Dinner	1.5 cups	0.36	Around 6:30 PM
Evening	1 cup	0.24	Around 9:00 PM

Table 7 *– Daily Hydration Table*

It is important to evenly distribute water intake throughout the day, specifically before and after exercise in order to replenish lost fluids through exercise, allowing optimal recovery and performance.

[21] Bellingham, A 2019, *What is Hydration? Let's Make Hydration a Priority - Healthera | Order NHS Prescriptions & Medicines Online*, Healthera | Order NHS Prescriptions & Medicines Online, viewed 21 May 2024, <https://healthera.co.uk/articles/what-is-hydration-lets-make-hydration-a-priority/>.

[22] McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.

[23] McNaughton, N & Wilson, A (2020), Physical Education Workbook, Adelaide Tuition Centre, Adelaide.

[24] Health 2024, *Muscle cramp*, Vic.gov.au, viewed 21 May 2024, <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/muscle-cramp>.

The table below demonstrates the diet and hydration considerations in the 48 hours leading up to the final 3km run, assisting in facilitating improvement.

Diet Considerations Pre - Final 3km Run					
Meal	WEDNESDAY		THURSDAY		Evidence
	Foods consumed	Considerations	Foods consumed	Considerations	
Breakfast	Vegemite and Avocado on Toast Water 500mL	Hydration Fibres, nutrients	Vegemite and Avocado on Toast Water 500mL Energy Drink	Hydration Fibres, nutrients Energy, sugar (high GI)	
Recess	Chips Water 500mL Banana	Salt Hydration Rich in potassium to support muscle function.	Lolly snakes pre-run – high GI for quick energy boost 9:00 scheduled run start time		
Lunch	Chicken Wrap Water 500mL	Protein Hydration	Rice Water 500mL	Carbohydrates to restore energy post-run. Hydration	
Afternoon snack	Banana Water 500mL	Potassium Hydration	Muesli bar Water 500mL	Protein to support muscle recovery post-run. Hydration	
Dinner	Pasta Tomato bolognaise sauce Water 500mL	Low GI CHO Protein / Iron Hydration	Chicken and rice Water 500mL	High protein for muscle recovery. Hydration	

Table 8 *– Diet Consideration Pre-run*

Strategy 3 – Running Technique

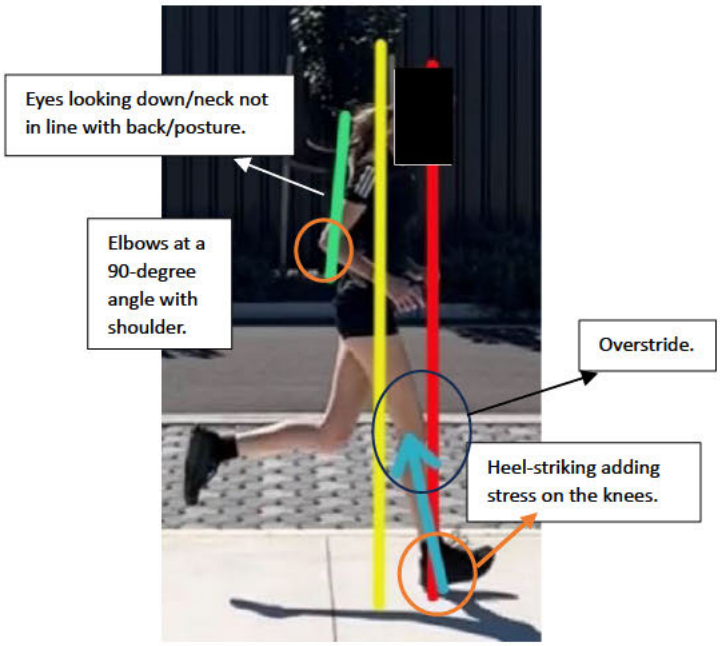
There are several key concepts to correct running technique and improving efficiency to assist in the 3km run. Foot strike is the point of the foot that makes first contact with the ground.[25] Ideally, mid-foot strike allows for more joints and soft tissue to absorb the load and stress, compared to heel-striking which increases stress on the knees, seen in **Figure 25**.[26] Stacking the foot under the knee helps load absorption through *Newton's Third Law*, which states that '*every reaction has an equal and opposite reaction*'. The foot exerts a force on the ground whilst the ground responds with an equal force back onto the foot, helping to distribute forces evenly.[27]



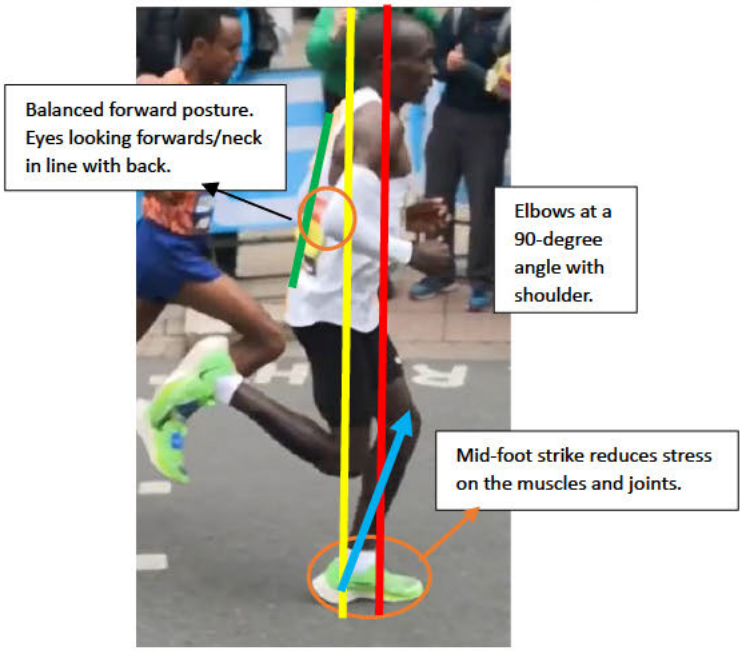
Figure 25: *Example of fore/midfoot strike. Demonstrates alignment of foot/knee in line.*
(Does your running foot strike matter? The Peaceful Runner, 2023)

Decreasing stride length can improve running technique through increasing cadence. Taking shorter steps reduces the force put on the joints and muscles, whilst covering further distance and decreasing time that the body is in contact with the ground, assisting in conserving energy. An increased cadence, resulting in shorter steps, also helps to improve posture whilst running.[28] Maintaining a good posture assists in engaging the core, glutes, and also hip drive, creating more power, and distributing force evenly through the body.[29] Arm rotation also creates momentum and power with the elbows bent at a 90-degree angle, with a forward-and-back motion swinging motion.[30]

Pre-Unit Running Technique – Figure 26



Elite Performer Technique (Eliud Kipchoge) – Figure 27



[25] *Carbone, P (2021), 'Running Fundamentals', [PowerPoint Presentation] (Accessed 22nd May 2024)*
[26] *Heel strike running | The Problems with a Heel Strike | Core Advantage* 2016, Coreadvantage.com.au, viewed 22 May 2024, <https://www.coreadvantage.com.au/blog/the-problems-with-a-heel-strike#:~:text=Reduce%20Risk%20of%20Runner's%20Knee,risk%20of%20developing%20runner's%20knee.>.
[27] Linear 2024, *Linear Forces Exerted on the Body*, Physics of Running, viewed 22 May 2024, <https://phys207-project.physics.wisc.edu/michael-pienkos/force-exerted-on-the-body/>.
[28] *What Is Cadence Running? A Complete Guide For Runners | Sportitude* 2015, Sportitude.com.au, viewed 23 May 2024, <https://www.sportitude.com.au/blog/what-is-cadence-running-a-complete-guide-for-runners#:~:text=It%20is%20often%20measured%20as,runs%20smoother%20and%20more%20efficient.>.
[29] Davis, J 2012, *How to Run with More 'Power': The Role of Hip Drive in the Running Stride - Runners Connect*, Runners Connect -, viewed 23 May 2024, <https://runnersconnect.net/hip-drive-running-stride/>.
[30] Gruenke, J 2014, *How You Should Swing Your Arms When Running*, The Balanced Runner™, viewed 24 May 2024, <https://www.balancedrunner.com/how-you-should-swing-arms-running-the-balanced-runner-keys-series/>.

Figures 26-27 above compare the pre-unit running technique of the student compared to an elite performer's technique. The red line shows the point of the foot that makes first contact with the ground, whilst the blue line demonstrates the force reaction with the ground, from the foot. The yellow line shows the estimated centre of gravity of the individual, and the green line demonstrates posture.

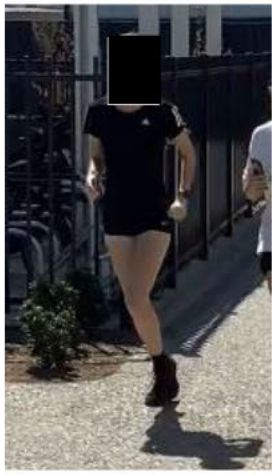
To facilitate improvement in running technique, running cadence was tracked throughout the training program. **Figure 28** demonstrates my average running cadence in Week 1 of the training program, which was 135spm. To improve cadence, I aimed to take shorter, lighter steps to avoid overstriding, which was evident in my pre-unit running technique in **Figure 26**. Lighter steps increased my average cadence to 144spm in Week 6 of the training program, shown in **Figure 29**. To improve foot strike and reduce striking the ground with the heel, short warmups were completed throughout the training program, shown in **Figure 30**, consisting of short jogs, aimed at emphasizing and focusing on mid-foot strike. To also assist in developing muscular endurance, calf raises, and stork tests were incorporated into the weekly training program, improving leg strength and posture to help running technique, shown in **Figure 31**.



Figure 28 *– Continuous Run Average Cadence Week 1*



Figure 29 *– Continuous Run Average Cadence Week 6*



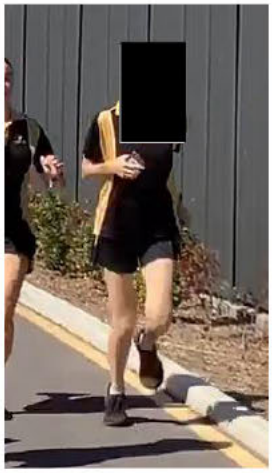
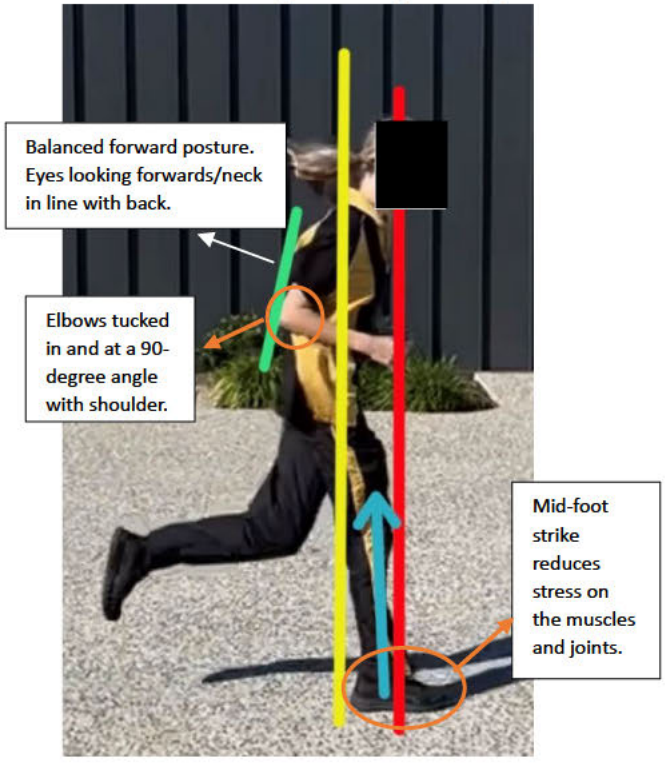


Figure 30 *– Evidence of warmup to work on mid-foot strike.*



Figure 31 – *Completion of stork Test.*

Post-Unit Running Technique – Figure 32



Post Unit running technique, displayed in **Figure 32**, demonstrates clear improvements as there is evident mid-foot strike compared to the heel-strike in the pre-unit running technique, resulting in better force against the ground (represented by blue line), helping decrease the stress on the knees, with the foot and knee stacked better. Posture has evidently improved, with the neck in line with the back and eyes looking forwards. The elbows have remained tucked inwards creating a 90-degrees angle with the shoulders, creating effective momentum.

Post Unit Analysis and Evaluation of Strategies

Post-unit 3km run was completed in an improved time of 17 minutes and 26 seconds compared to the pre-unit 3km run, with a time of 18 minutes and 21 seconds. There was an overall improvement of 5% in the post-unit run, exceeding the goal to improve running time by 3%.

	Pre training	Post training
Time	18.21 mins	17.26 mins
% change*	[redacted]	5%
Average running pace (min/km)	6:07/km	5:49/km
% Max HR reached	98%	99%
Time above 90% Max HR (Zone 5)	4.46 (25%)	12.05 (69%)
Maximum speed	12.4 kph	12.2 kph
Average Cadence	152 spm	163 spm

Table 9 – *Pre & Post training statistics*

Activity statistics – Post-Unit Run	3 km Run
Distance covered	3km
Total time	17:26
Time per km (pace in mins/km)	5:49 /km
Maximum speed identified (best pace)	4:56 /km
HR at commencement of activity	100 bpm
Maximum heart rate reached during run	201 bpm
Average heart rate	182 bpm
Average running cadence	177 spm
Average stride length	1.06 m
Calculate your lactate threshold	LT = (220-16) x 0.85 = 173 bpm
Calculate your resting heart rate	

Table 10 – *Post-Unit Run Activity Statistics*

My post-unit 3km run shows several improvements compared to my pre-unit 3km run prior to the 6-week training program. Some key statistics (**Table 9**) that highlighted improvement included running cadence, which was increased from 152 steps per minute (spm) to 163 spm.

Average running pace, which was 6:07/km, was ultimately improved to 5:49/km.

Time that heart rate sat in Zone 5 also increased, displaying heightened intensity in the post-unit run, increasing to 12 minutes and 5 seconds spent in Zone 5 (69%) compared to 4 minutes and 46 seconds (25%) spent in Zone 5 in the pre-unit run.

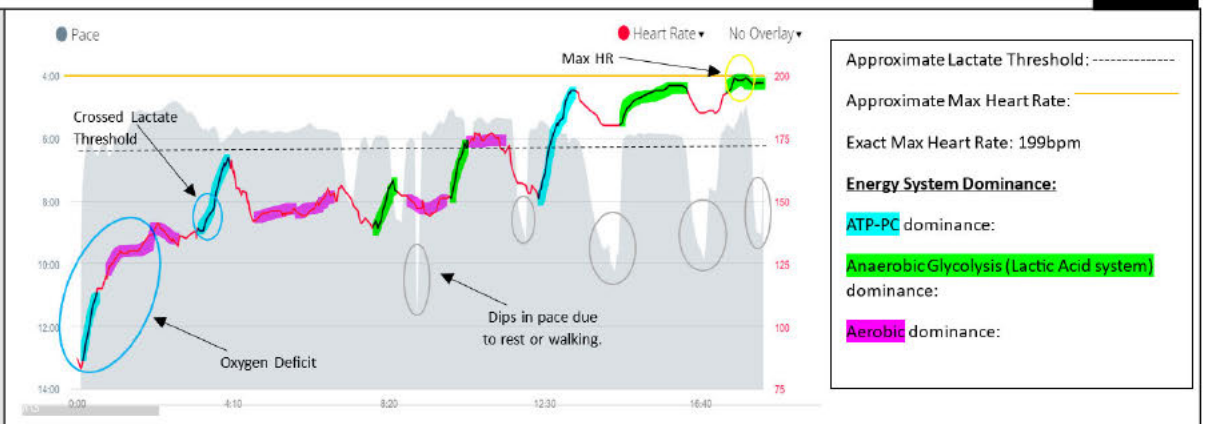
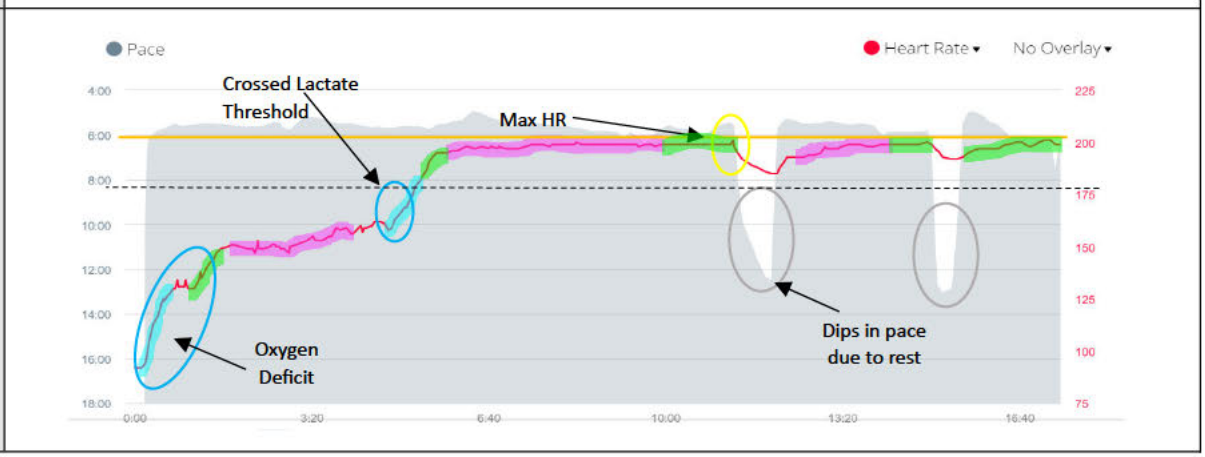
Pre-Unit commencing HR	
Post-Unit Commencing HR	

Table 11 – HR Stats Pre-Unit & Post-Unit Run.

Comparing my initial 3km run HR and pace data to my post-unit 3km results, it is evident that in post-unit I have a much more consistent pace, with less fluctuations and only two prominent dips in pace, which were walking breaks, compared to 5 breaks in my pre-unit run. Having a more consistent pace, as well as reducing the number of breaks taken throughout the run, were two goals I set at the beginning of the 6-week training program. I did not meet my goal of running my fastest split in the final kilometer, however, I reduced the time difference between my first and third split (see **Table 12**). I ran my 2nd km quicker by 5-seconds in my post-unit run compared to a 47-second decrease in time in the 1st 3km run. Furthermore, my final km was quicker by 17-seconds in the final run, demonstrating aerobic improvement.

Pre-Unit splits

Laps ▲	Time	Cumulative Time	Distance	Avg Pace	Avg GAP	Avg HR
1	5:29	5:29	1.00	5:28	--	135
2	6:16	13:12	1.00	6:15	--	159
3	6:36	18:21	1.00	6:58	--	190
Summary	**18:21**	**18:21**	**3.00**	**6:07**		**160**

Post-Unit splits

Laps ▲	Time	Cumulative Time	Distance	Avg Pace	Avg GAP	Avg HR	Max HR
1	5:36	5:36	1.00	5:34	--	148	193
2	5:31	11:07	1.00	5:31	--	198	200
3	6:19	17:26	1.00	6:20	--	196	201
Summary	**17:26**	**17:26**	**3.00**	**5:49**		**182**	**201**

Table 12 – Pre-Unit & Post-Unit Splits

Aerobic capacity was evidently improved as I reached my lactate threshold at 4-minutes 50-seconds in the pre-unit run compared to 4-minutes in the pre-unit run. This demonstrates that I extended the duration of time spent utilising the aerobic system before crossing lactate threshold, showing effectiveness of the fitness and conditioning strategy, implementing aerobic training through interval and continuous runs to build endurance and increase VO2 max, improving aerobic capacity.

Improvement is further displayed through the Cooper's 12-minute run, running a further 28 meters in the post-unit run, demonstrating better delivery of oxygen.

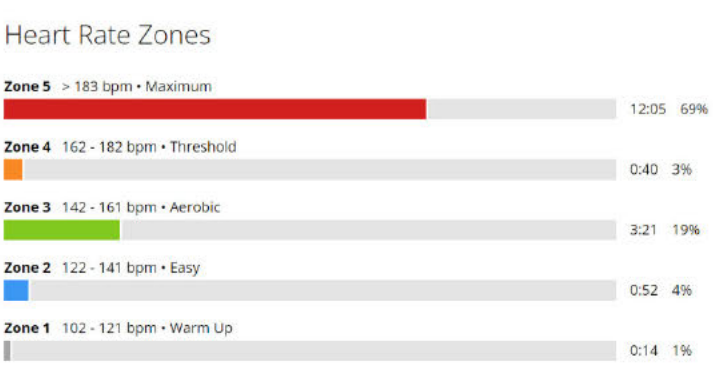
Pre-Unit HR zone	Post-Unit HR zone
	

Table 13 *– Pre-Unit & Post-Unit HR Zones*

In the post-unit run, I spent a significant more amount of time in HR Zone 5, demonstrating increased anerobic capacity through an ability to work at 85% intensity in HR Zone 5 for 69% of the post-unit run, compared to 25% in the pre-unit run. This displays improved muscular endurance meaning my muscles were able to repeatedly exert a force and contract over a longer period at higher aerobic intensities despite lactic acid accumulation, improving tolerance to lactic acid to delay the point lactate threshold was crossed, and the onset of fatigue. Increased tolerance and better muscular endurance is also displayed through wall sit results, with a 45-second improvement in the post-unit wall sit compared to the pre-unit, through consistent weekly completion of circuit training within the 6-week training program.

Fitness Test	Wall Sit (mins)	Cooper's 12-Minute Run (km)
Pre-Training Result	0:53	1.94
Post-Training Result	1:38	2.22
Differential	0:45	0.28
% Change	45.92	12.61

Table 14 *– Fitness Test Stats*

There was evident completion of a warmup prior to the post-unit run, preparing the muscles for physical activity, and engaging the aerobic system earlier to delay the onset of fatigue, as well as reducing oxygen deficit. This is shown through the starting heart rate of the post unit run, which was 92bpm compared to 87bpm in the pre-unit run without a warmup completed.

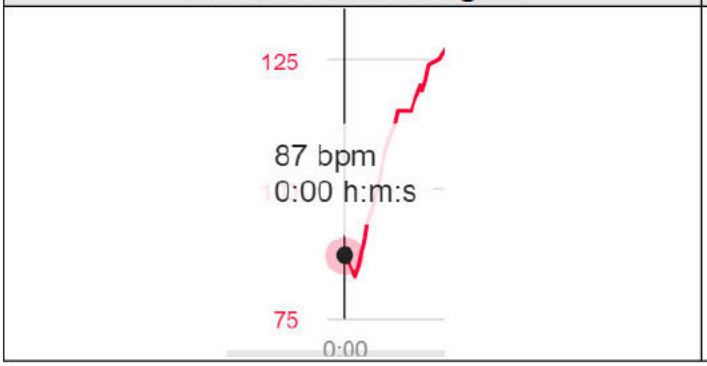
Pre-Unit Commencing HR	Post-Unit Commencing HR
	

Table 15 *– Pre & Post-Unit Commencing HR*

Throughout the training program and in the 48 hours leading up to the final 3km run, there were several diet and hydration considerations made to improve performance. The night before the final 3km, I consumed a low GI meal, providing me with a sustained store of energy for throughout the run. I also consumed lollies and energy drinks (see **Figure 33-34**) before runs and training. This provided a quick spike in my blood glucose levels to provide more energy, allowing me to increase high intensity contractions during my running, seen in **Table 13**. During the training program, I also incorporated high protein intakes following training sessions, such as protein shakes, to enhance my recovery and therefore improve performance in following training sessions.



Figure 33: *Energy Drink, with high GI and providing hydration.*



Figure 34: *Lolly Snakes, with high GI.*

To stay hydrated throughout the training program, I utilised a hydration calculator, providing me with the amount of water intake recommended per day for someone my age and weight. Through incorporating this into my hydration table, this allowed me to distribute my water intake to prevent me from dehydration and keeping my blood thinner for circulation of oxygen and nutrients.

Changes were made to biomechanical technique to improve running form, facilitating improvement in the final 3km run. Completion of short warmups prior to training prompted focus on reducing heel strike to reduce stress on the knees, resulting in better force against the ground. Through keeping the foot and knee stacked better, in warmups, I developed a mid-foot strike, as well as reducing overstriding. Shown in **Figures 35-36** below, running cadence was improved in the post-unit run, resulting in shorter, lighter steps, therefore I could use my energy more efficiently to work at higher intensity with similar levels of fatigue to the pre-unit technique, delaying time to exceed lactate threshold. Posture was also improved, with the neck in line with the body shown more in the post-unit running technique, helping to reduce overstriding. Muscular strength and endurance were also improved through calf raises and stork tests (see **Figure 37**), which were incorporated into the training program, assisting in minimising the effects of fatigue throughout the final 3km run.

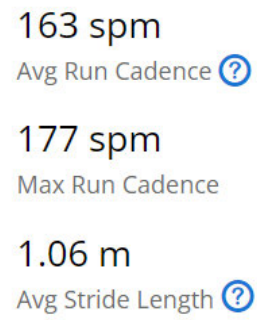


Figure 35: *Post-Unit Run Cadence & Stride Length*

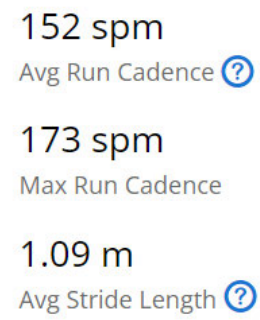


Figure 36: *Pre-Unit Run Cadence & Stride Length*



Figure 37 – *Completion of stork Test.*

The percentage improvement for the final 3km run compared to the pre-unit run was 5%, exceeding the targeted percentage improvement of 3%. The SMART goal setting was effective demonstrating improvement which I was successfully able to measure through reliable and accurate evidence through Cooper's 12-minute runs, interval runs, and continuous runs using reliable equipment including Strava and Garmin Connect. Implementation of variability led to increased motivation in my training through different locations, implementing progressive overload to complete different types of runs including continuous and interval, and completing fortnightly fitness tests. Evidence shows that a six-week training program with a variety of strategies targeting fitness and conditioning, consideration of running technique, diet and hydration consideration, will facilitate improvement in aerobic performance, demonstrated through a 55 second improvement in my post-unit 3km.

Appendix A: Percent improvement reduction table:

% reduction	Time reduction (to the nearest second)	Target time (initial time – reduction)	Time in minutes and seconds	Average time per KM (3km run)
1%	1101 × 0.01 = 11 secs	1101 – 11 = 1090 secs	1095 / 60 = 18.25 0.25 × 60 = 15 secs 18 mins 15 secs	1095 / 3 = 365 365 / 60 = 6.083 0.083 x 60 = 4.98 (5 secs) 6 mins 5 secs
3%	1101 × 0.03 = 33 secs	1101 – 33 = 1068 secs	1068 / 60 = 17.80 0.80 x 60 = 48 secs 17 mins 48 secs	1068 / 3 = 356 356 / 60 = 5.93 0.93 x 60 = 55.8 (56 secs) 5 mins 56 secs
5%	1101 × 0.05 = 55 secs	1101 – 55 = 1046 secs	1046 / 60 = 17.43 0.43 x 60 = 25.8 (26 secs) 17 mins 26 secs	1046 / 3 = 348.66 348.66 / 60 = 5.81 0.81 x 60 = 48.6 (49 secs) 5 mins 49 secs
10%	1101 × 0.1 = 110 secs	1101 – 110 = 991 secs	991 / 60 = 16.51 0.51 x 60 = 30.6 (31 secs) 16 mins 31 secs	991 / 3 = 330.33 330.33 / 60 = 5.51 0.51 x 60 = 30.6 (31 secs) 5 mins 31 secs

Appendix B:	6 Week Training Program Log (1st Macrocycle)			
Week	Session 1 – Aerobic Focus	Session 2 – Anaerobic Focus	Session 3 – Aerobic Focus	Session 4 – Aerobic & Anaerobic Focus
1	**Aerobic Capacity – Continuous Running** *Warm Up: (5 mins in total)* Dynamic stretching and 3-minute light jog. *Session details:* 2 x 10 min runs @ 75% with 5 min rest in between. *Cool Down: (5 mins in total)* Static stretching and light walk. Evidence collected: Strava	**Muscular Endurance - Circuit (25 mins)** *Warm Up:* (5 mins in total) Dynamic stretching and 3-minute full body warm-up (YouTube video) *Session details:* (15 mins in total) Conditioning in partners - 4 minutes of work at each station (bike, rower, ski-ergo) with 1 minute rest in between - Partner works for 6 calories or 100 metres then swaps with partner (resting) - Wall sit for max time at the end Cool Down: (5 mins in total) Static stretching and light walk Evidence collected: iPad / Garmin Connect	**Aerobic Capacity – Continuous Running** *Warm Up: (5 mins in total)* Dynamic stretching and 3-minute light jog. *Session details:* 2 x 10 min runs. 4 min break. *Cool Down: (5 mins in total)* Static stretching and light walk. Evidence collected: Strava	***NO SESSION***
2	**Aerobic Capacity – Continuous Running** *Warm Up:* Dynamic stretching. *Session details:* Continuous 18min run @ 70%. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava, Garmin Connect	**Muscular Endurance - Circuit** *Warm Up:* (5 mins in total) Dynamic stretching and 3-minute full body warm-up (YouTube video) *Session details:* (20 mins in total) Conditioning in partners - 4 minutes of work at each station (bike, rower, ski-ergo, free weight exercise) - Partner works for 6 calories or 100 metres then swaps with partner (resting) (30 seconds on free weight exercise) - 1 minute rest when in between changing station Cool Down: (5 mins in total) Static stretching and light walk Evidence collected: iPad / Garmin Connect	**Aerobic Capacity – Continuous Running** *Warm Up:* Light jog. Dynamic stretching. *Session details:* 2 x 11 min runs. 4 min break. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava, Garmin Connect	**Aerobic Capacity/Muscular Endurance – Fartlek/Interval Running** *Warm Up:* Light jog. Dynamic stretching. *Session details:* 4 × 2 min runs 80 – 85% intensity. *Cool Down:* Static stretching and light walk Evidence collected: Strava, Garmin connect

Appendix C:	6 Week Training Program Log (2nd Macrocycle)			
Week	Session 1 – Aerobic Focus	Session 2 – Anaerobic Focus	Session 3 – Aerobic Focus	Session 4 – Aerobic & Anaerobic Focus
3	**Aerobic Capacity – Continuous Running** *Warm Up:* Dynamic stretching. *Session details:* Continuous 18min run @ 70%. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava	**Muscular Endurance - Circuit** *Warm Up: (5 mins total)* Dynamic stretching and 3-minute full body warm up (YouTube video) Session details: Conditioning in partners - 5 minutes of work at each station (bike, rower, ski-ergo, free weight exercise) - Partner works for 6 calories or 100 metres then swaps with partner (resting) (30 seconds on free weight exercise) - 1-minute rest when in between changing station *Cool Down:* Evidence collected: Reps completed / iPad	**Aerobic Capacity –Interval Running** *Warm Up:* Light jog. Dynamic stretching. *Session details:* 6 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava, Garmin Connect.	**Aerobic Capacity/Muscular Endurance – Fartlek/Interval Running** *Warm Up:* Dynamic stretching. *Session details:* 6 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava, Garmin Connect.
4	**Aerobic Capacity – Continuous Running** *Warm Up:* Dynamic stretching. *Session details:* 2 × 12 min runs @ 70% with 5 min rest in between. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava, Garmin Connect.	**Muscular Endurance - Circuit** *Warm Up:* Dynamic stretching and 3-minute full body warm up (YouTube video) *Session details:* Conditioning in partners - 5 minutes of work at each station (bike, rower, ski-ergo, free weight exercise) - Partner works for 6 calories or 100 metres then swaps with partner (resting) (30 seconds on free weight exercise) - 30-second rest when in between changing station *Cool Down:* Evidence collected: Reps completed / iPad	**Aerobic Capacity/Muscular Endurance – Long Interval Running** *Warm Up:* Stretching. Light jog. *Session details:* 2 × 12 min runs @ 70% with 5 min rest in between. *Cool Down:* Dynamic stretching. Evidence collected: Strava	**Aerobic Capacity/Muscular Endurance – Fartlek/Interval Running** *Warm Up:* Light jog. Dynamic stretching. *Session details:* 7 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. *Cool Down:* Light jog Dynamic stretching. Evidence collected: Strava

Appendix D:	**6 Week Training Program Log (3rd Macrocycle)**			
Week	Session 1 – Aerobic Focus	Session 2 – Anaerobic Focus	Session 3 – Aerobic Focus	Session 4 – Aerobic & Anaerobic Focus
5	**Aerobic Capacity – Continuous Running** *Warm Up:* Dynamic stretching. *Session details:* Continuous 20min run @ 70%. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava, Garmin Connect.	**Muscular Endurance - Circuit** *Warm Up:* Dynamic stretching and 3-minute full body warm up (YouTube video) *Session details:* **5 minutes of work at each station (bike, rower, ski-ergo, free weight exercise)** **- Partner works for 6 calories or 100 metres then swaps with partner (resting) (30 seconds on free weight exercise)** **- 30-second rest when in between changing station** *Cool Down:* **Static stretching and light walk** Evidence collected: Reps completed / iPad	**Aerobic Capacity – Long Interval Running** *Warm Up:* Dynamic stretching. *Session details:* 7 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. *Cool Down:* Light 3 min jog Stretching Evidence collected: Strava	**Aerobic Capacity/Muscular Endurance – Fartlek/Interval Running** *Warm Up:* Dynamic stretching. *Session details:* 7 × 2 min runs 80 – 85% intensity. 2 min run, 2 min rest, etc. *Cool Down:* **Static stretching and light walk** Evidence collected: Strava, Garmin Connect.
6	*Warm Up:* Light jog. Dynamic stretching. *Session details:* 2 × 10 min runs @ 80% with 4 min rest in between. *Cool Down:* **Static stretching and light walk** Evidence collected: Strava	**Muscular Endurance - Circuit** *Warm Up:* Dynamic stretching and 3-minute full body warm up (YouTube video) *Session details:* **5 minutes of work at each station (bike, rower, ski-ergo, free weight exercise)** **- Partner works for 6 calories or 100 metres then swaps with partner (resting) (30 seconds on free weight exercise)** **- 30-second rest when in between changing station** *Cool Down:* Light 3 min jog Stretching Evidence collected: Reps completed / iPad	*Warm Up:* Light jog. Dynamic stretching. *Session details:* 6 x 2 min runs 90% intensity. 2 min run, 2 min rest, etc. *Cool Down:* **Static stretching and light walk** Evidence collected: Strava, Garmin Connect.	***NO SESSION***

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