The Effects of Pre-Race Apnoeas on 400-m Freestyle Swimming Performance

Original Research

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ABSTRACT
This study aimed to establish whether a series of three apnoeas prior to a 400-m freestyle time-trial affected swimming performance when compared to, and combined with a warm-up. Nine (6 males, 3 females) regional to national standard swimmers completed four 400-m freestyle time-trials in 4 randomized conditions: without warm-up or apnoeas (CON), warm-up only (WU), apnoeas only (AP) and warm-up and apnoeas (WUAP). Time-trial performance was significantly improved after WUAP (275.79 ±12.88 s) compared to CON (278.66 ±13.31 s, *P* = 0.035) and AP (278.64 ±4.10 s, *P* =0.015). However, there were no significant differences between the WU (276.01 ±13.52 s, *P* >0.05), and other interventions. Spleen volume compared to baseline was significantly reduced following the apnoeas by a maximum of ~45% in the WUAP and by ~20% in WU. This study showed that the combination of a warm-up with apnoeas could significantly improve 400-m freestyle swim performance compared to a control and apnoea intervention. Further investigation into whether long-term apnoea training can enhance this response is justified.

Key Words**:** Breath Holding; Hypoxia; Splenic Contraction; Warm-up

INTRODUCTION

The difference between a Gold and Silver medal in the men's 400-m Freestyle at the 2016 Rio Summer Olympic Games was 0.13s. This emphasizes the point that in elite swimming, marginal improvements are a key priority (10). At Olympic and World Championship level many swimmers have similar performance abilities determined by combinations of energy availability and technical effectiveness. Therefore, finding improvements in the performance of as little as 1% will have a significant effect on the race outcome (15).

The use of a warm-up is now widely accepted as common practice prior to an exercise bout (22). Two functions of a warm-up are to decrease the risk of injury and to prepare the athlete optimally for the demands of the event. This occurs by increasing muscle and body temperature, decreasing viscous resistance, increasing the rate of nerve impulses, and increasing efficiency of oxygen delivery (22). The effect of body temperature on exercise performance has recently been shown (24). The researchers found a significant improvement in jump height (3.8%) and 10-m sprint time (5.5%) when body temperature was increased after a warm-up. Further Research has found that a specific warm-up reduced viscous resistance significantly by a shortening of the time taken for voluntary contractions (8).

Research into the effects of an active warm-up on swimming performance has sometimes been contradictory, however, it is suggested that the warm-up becomes more effective as the distance of the time trial increases (22).

Apnoea has been proposed as a new potential training method that would influence performance (18). Through holding one's breath, a number of physiological processes occur. Due to the reduction of oxygen availability during an apnoea, hypoxemia occurs in the kidney and spleen. This response occurs in conjunction with hypercapnia, increased acidosis, bradycardia, reduced SpO_2 and a splenic contraction (4). During an initial apnoea, the hypoxemia is one of the potential stimuli for a splenic contraction. This contraction usually occurs as a stress response, especially when the demands of oxygen increase, and is correlated with the release of catecholamines from the adrenal gland and the postganglionic fibers in the sympathetic nervous system (23).

There is an improvement in the body's ability to transport oxygen due to an increased number of circulating erythrocytes, resultant of a splenic contraction. This has been confirmed when a 2%-5% increase hemoglobin (Hb) and hematocrit (Hct), independent of haemoconcentration, and a reduction in arterial oxygen desaturation, were seen after repeated apnoeas (3). This effect was confirmed when comparing splenectomized subjects against non-splenectomized subjects. Subjects without a spleen did not demonstrate the same hematological changes after an apnoea, or the ability to carry out the typical prolongation of repeated apnoeas, compared to their non-splenectomized counterparts (3, 4).

The strength of the splenic contraction has been suggested to be augmented by a series of apnoeas rather than a single breath hold, even though a study found a splenic contraction could potentially occur after a single apnoea (4). However, in the same study further apnoeas continued to steadily reduce splenic volume, thereby further increasing the circulating erythrocytes. The increase in circulating erythrocytes has been shown to last between 8-9 min following serial apnoeas (27) suggesting a potential method of acutely increasing oxygen transport, to improve short-term competitive performance.

From the involvement of both the central inspiratory and phasic pulmonary afferent mechanisms during apnoeas, heart rate becomes slower (Bradycardia). This is an essential oxygen conserving part of the diving response. The diving response can be augmented by cold-water (~10°C) face immersion after 25-30 s (19). This occurs due to the stimulation of the ophthalmic branch of the trigeminal nerve, situated in the upper facial region (2). This sensory output has therefore suggested to be beneficial for free divers (20), but also possibly swimmers who spend a large proportion of the race with their face immersed.

Based on the physiological research of the diving response and splenic contraction, a plausible assumption can be made that the acute effects of serial apnoeas can improve aerobic performance.

Sperlich, Zinner, Pfister, Holmberg, and Michels (30) was the first and currently the only study to apply the potential acute effects of repeated apnoeas prior to a cycling time-trial. The results showed no improvement in performance, as well as no rise in Hct or Hb, contradicting previous findings.

It is clear there are gaps in the research regarding the effects of a series apnoeas on 400-m freestyle time-trial performance. Due to the potential acute physiological effects that the apnoeas may have on aerobic exercise, it seems logical for these to be placed immediately prior to the time-trial, adding to the potential effects already gained by the warm-up.

The aim of this research is to establish whether a series of apnoeas immediately prior to a 400-m freestyle time-trial, affects performance when compared to and combined with a warm-up.

METHODS

Experimental Approach to the Problem

A randomized, repeated measure cross-over design was used for this study. The testing took place during an aerobic capacity period of training when the pool was configured for short-course (25m). This setup included an indoor pool (Water Temperature, 28.37 ±0.26 °C; Air Temperature, 29.13 ±0.42 °C) consisting of anti-wave lane ropes (AntiWave Pool Products, Constantine, Michigan), OMEGA OSB11 starting blocks (Swiss Timing LTD, Corgémont, Switzerland) and OMEGA OCP5 Touchpad's (Swiss Timing LTD, Corgémont, Switzerland). A familiarisation session occurred prior to any testing to allow participants to habituate themselves with the apnoea protocol (Fig.1).

Participants were subject to 4 separate test conditions: No warm-up/No apnoeas (CON), with warm-up only (WU), apnoeas only (AP) and with warm-up and apnoeas (WUAP), on a 400-m freestyle time-trial. Visits were separated by at least 2 days and a maximum of 7 days.

Prior to each time-trial, the participants were asked to refrain from strenuous exercise (24 hours), caffeine (12 hours) and food (2 hours). Swim and land training sessions were controlled (low intensity, the rate of Perceived Exertion (RPE) < 12 (21)) and replicated 2 days leading into the trials as to not affect the performance outcome. In addition, participants were asked to replicate their dietary intake for the 24 hours prior to each time-trial.

Subjects

Nine well-trained swimmers (6 males, 3 females: Age 19 ± 1 and 19 ± 2 years; Stature 1.84 ± 0.05 m and 1.67 ± 0.03 m; Body mass 78.2 ± 7.2 kg and 61.6 ± 2.2 kg, respectively) volunteered to participate in this study. Personal best times in the 400-m Freestyle event were 257.99 ± 5.58 s and 262.06 ± 13.90 s for the male and female participants respectively. Participants were aged between 16 to 22 years of age and had competed at a regional/national level in middle-distance swimming events. They were free from any illnesses and injuries that may have affected their ability to compete in this study. Institutional ethical committee approval was gained for this project.

Procedures

The first visit was a familiarisation session to habituate the participants to the study protocol as none of the participants had any previous breath holding experience. This included carrying out the full apnoea protocol (fig.1) until they were confident with the procedure. The participants were screened when they first arrived to ensure they were healthy enough to complete the task. This screening protocol included a questionnaire established by using the American College of Sports Medicine (ACSM) Guidelines (1) and measurements of the participants' stature, mass and blood pressure were taken. Body mass was recorded to the nearest 0.1kg using Seca Scales 709 (Seca Ltd, Birmingham, UK). Stature was measured using a Harpeden Portable Stadiometer (Holtain Limited, Pembrokeshire, UK) to the nearest 0.01m.

During experimental trials, four different types of pre-time-trial condition were followed by an individual 400-m freestyle time-trial from a dive start. The order in which the participant carried out these trials was randomized. The participants carried out their time-trial at the same time of day to ensure their normal circadian rhythms did not affect the results. A schematic of the protocols can be seen in Figure 1.

Condition A was a control trial where neither the apnoea intervention nor pre-race warm-up occurred. Physiological measurements of Heart Rate (HR; Polar V800 HR monitor, Polar Electro, Kempele, Finland), SpO_2 (Nonin 8500 Hand Held Digital Oximeter, Plymouth, USA), Blood Lactate (BL; Lancet and Lactate Plus Meter, Nova Biomedical Corporation, USA), Hb (HemoCue, Radiometer Group, Sweden) taken from the ear and Spleen volume (Vivid I, GE Healthcare, General Electric, Fairfield, CT, USA) were all taken in a seated postition at baseline, pre and immediately post time-trial with the addition of RPE (6) taken post time-trial in all conditions.

Condition B introduced the standardized race warm-up (table 1). Here the physiological measurements were taken pre and post warm-up and pre and immediately post time-trial. In both conditions A and B, there was a 20-min seated passive rest period to stimulate a call room before the time-trial. During this passive rest, participants remained in their racing suits plus a towel that covered their bodies from their shoulders to waist, to ensure different items of clothing affected the results.

Condition C involved the apnoea intervention independent of a warm-up. The apnoea intervention consisted of three seated maximal breath-holds, until voluntary cessation. Between each apnoea, there was 2-min passive rest period. Physiological measurements were taken at baseline, pre and immediately post time-trial. HR, SpO_2 and spleen volume was measured pre, post and 1-min post each apnoea

Condition D was a combination of the interventions where both a standardized race warm-up and a series of apnoeas were carried out prior to the 400-m time-trial.

The 400-m freestyle time-trial splits were taken every 50-m, by using the OMEGA OCP5 Touchpads. Time-trial analysis (stroke rate, distance per stroke and stroke index) was carried out during and immediately after the time-trial. Stroke rate (SR) was obtained using the stopwatch function on the Finis 3 x 300m stopwatch (Finis Inc, California, USA). This was computed by calculating the elapsed time for three stroke cycles. The timing started as the swimmers right hand entered the water and then stopped after the same hand had entered the water for the fourth time, thereby completing the three arm cycles. The measurements were taken between 10-m and 20-m to eliminate the effects of the start and turns. The SR values were then divided by 60 to get the SR per cycle (s.cycle^{-1}). Distance per stroke (DPS) and stroke index (SI) were obtained using a method devised by Vitor and Böhme (32). The 50-m splits from the time-trial were converted to swimming speed (m.s^{-1}), which allowed for DPS and SI to be calculated. Using the equation: swimming speed divided by SR, this gave a value for DPS (m.cycle^{-1}). SI (m^{2}.s^{-1}) was then calculated by multiplying swimming speed (m.s^{-1}) by DPS.

FIGURE 1 HERE

TABLE 1 HERE

Statistical Analysis

Statistical analysis was performed using SPSS software (version 22: SPSS Inc, Chicago, IL), with significance set at $P \leq 0.05$. Time-trial data were analyzed using a repeated-measures analysis of variance (ANOVA) with a post hoc Bonferroni correction to compare differences between the conditions. A pair-sample *t*-test was used when only two conditions were being compared.

Magnitude-based inferences (MBI), were calculated to establish whether the effects of the interventions on the time-trial were meaningful (5). Hopkins (5) created a spreadsheet that was used by converting the *p*-value into 90% confidence intervals (CI). To establish whether the effect was beneficial, trivial, or harmful, verbal descriptors were used according to the following scale: < 0.5 %, 'almost certainly not'; 0.5 – 5 %, 'very unlikely not'; 5 – 25 %, 'unlikely'; 25 – 75 %, 'possibly'; 75 – 95 %, 'likely'; '95-99.5 %', 'very likely' > 99.5 %, 'almost certainly'. When an odds ratio of benefit to harm of < 66 was identified the effect was deemed unclear, this corresponds to a 25 % chance of benefit and 0.5 % risk of harm (11). Based on the reduced inferential error rates compared with null-hypothesis significance testing MBI has been supported within exercise science and is used to facilitate direct interpretation of the magnitude of changes and whether these are meaningful (13). Subsequently, this approach was utilized and prioritized for evaluating TT performance.

20 swimmers (10 Male, 10 females) from the British swimming results database who have raced the 400-m freestyle in the past 12 months were analyzed to establish the typical error of this event. The swims were only included if it was in a short course pool (25-m) and was in the aerobic training phase (high volume, low intensity - phase agreed with by coach). The analysis using Hopkins "Spreadsheets for Analysis of Validity and Reliability" (12) gave a log-transformed typical error as a coefficient of variation, which was 0.6% between trials. All data are presented as mean and standard deviations (mean ± SD).

RESULTS

Time-Trial Performance

The 400-m freestyle time-trial results are shown in Fig 2. The time swam in the WUAP time-trial (275.79 ±12.88 s) was significantly faster than the CON (278.66 ±13.31 s, P = 0.035) and the AP time-trial (278.64 ±4.10 s, P =0.015). With a mean difference between the CON and WUAP of 2.87 s, the intervention was deemed very likely beneficial (96.0%), very unlikely trivial (3.2%), very unlikely negative (0.8%)). There was no significant difference between the WU (276.01 ±13.52 s,) and any of the other conditions. Even though it was not significant (P = 0.097) against the CON intervention, the WU intervention was still deemed likely beneficial when analyzed using MBI (likely beneficial (90.8%), unlikely trivial (6.7%), very unlikely negative (2.5%)). When compared to CON, the experimental conditions resulted in the following performance improvements: 1.03% (WUAP), 0.95% (WU) and 0.01% (AP). Comparing the WUAP and WU conditions there were no significant differences (P =

0.99) with the WUAP intervention being deemed unclear (Possibly beneficial (50%) or possibly negative (50%)).

FIGURE 2 HERE

Stroke parameters (SR, DPS, and SI) and swimming speed are shown in Fig. 3. SR was significantly higher *(P* = 0.002) on the 7th 50m and DPS was significantly greater on the 7th *(P* = 0.036) and 8th 50m (P = 0.011) for WUAP than in the AP intervention. SI was found to be higher in the WUAP than the CON throughout the trial, significantly in the 8th 50m *(P* = 0.038).

A significant difference was found between the post-trial RPE scores, with lower scores being reported in the WU time-trial (17.6 ±0.53) compared against the CON time-trial (18.4 ±0.53, *P* = 0.013) and AP time-trial (18.3 ±0.50, *P* = 0.004). Yet no difference was found between the WU and WUAP (17.9 ±0.78, *P =0*.99)

FIGURE 3 HERE

Physiological Results

HR (Fig. 4A) was significantly lower in the AP compared to the WUAP in the 1-min rest after the first apnoea (75 ±16 bpm vs 87 ±16 bpm; P = 0.04), the second apnoea (68 ±15 bpm vs 85 ±19, P = 0.003), before the third apnoea (86 ±14 bpm vs 104 ±11 bpm, P = 0.002) and finally after the third apnoea (71 ±15 bpm vs 80 ±20 bpm, P = 0.047). No other significant differences were found.

In the AP intervention, SpO_2 (Fig. 4B) was significantly higher (94 ±4%) than the WUAP (90 ±4%) after the first apnoea (P = 0.03). No other differences were found.

Spleen Volume (Fig. 4C) was significantly lower in the WUAP after the third apnoea compared to AP (150.90 ±31.84 ml vs 177.87 ±44.50 ml, P = 0.027), and in the WUAP (159.71 ±37.63 ml, P = 0.005) than in the CON (209.94 ±33.84 ml) pre-trial. Spleen volume was also significantly lower (20% - 37%) from baseline to post-trial in all interventions (CON (P = 0.013), WU (P = 0.001), AP (P = 0.001), WUAP (P < 0.001)).

FIGURE 4 HERE

No significant differences were found across the four conditions for BL (Table 2) and Hb (Table 3) when comparing the same time points across the protocol.

TABLE 2 & TABLE 3 HERE

Apnoea duration showed no differences when comparing the same time point in both interventions. However, in the WUAP each apnoea was longer than the one preceding it (1^{st} to 2^{nd} Apnoea ($P < 0.001$), 2^{nd} to 3^{rd} Apnoea ($P = 0.016$)). This was similar in the AP where the first apnoea was significantly shorter than the second apnoea (P =0.014) and third ($P = 0.014$), nevertheless, the third apnoea was not significantly longer in duration than the second (P =0.06).

FIGURE 5 HERE

Discussion

This is the first study to show that a combination of a warm-up with a series of three apnoeas can improve 400-m freestyle swimming performance against a control.

The finding that a warm-up and apnoea combination improves performance against a control is not consistent with previous research (30). Sperlich, Zinner, Pfister, Holmberg, and Michels (30) found no subsequent performance improvements after carrying out four maximal apnoeas after a warm-up.

It would be expected at a competition that an athlete would carry out a warm-up before a race, and although it was not significant in this study the warm-up improved performance by 0.95% compared to the CON. Yet, with the addition of a series of three apnoeas alongside a warm-up, performance was improved by 1.03% against the CON, yielding a statistically significant outcome. In elite sport, it has been shown that marginal improvements are key to increasing a swimmers chance of achieving an Olympic medal (26). Pyne (26) originally showed that a swimmer should improve their performance by 1% within a competition, then approximately 1% within the year leading up to the Olympics. A further enhancement of 0.4% would substantially increase the medal prospects of the swimmer. When putting this 1.03% improvement in the context of competition results, the improvement would have potentially allowed the second placed swimmer in the 400-m freestyle at both the World Swimming Championships 2015 and 2016 Rio Summer Olympic Games to win the gold medal.

The stroke parameter results in this study agree with Sperlich, Zinner, Pfister, Holmberg, and Michels (30) by finding that the stroke became more efficient in the WUAP. Initially, in the 7^{th} 50-m repeat both DPS and SR increased in the WUAP group. SI was improved by 12% (P = 0.038) during the last 50-m repeated compared to the CON. This improvement was due to the increased swimming speed, as well as a significantly longer DPS, leading to a more efficient stroke. It has been shown by Laffite, Vilas-Boas, Demarle, Silva, Fernandes and Louise Billat (17) that estimated anaerobic contribution increases in the final 100-m of a 400-m freestyle time-trial. Even though the lower BL was not statistically significant, this could potentially explain why the post time-trial BL was 18.96% lower in the WUAP than the WU condition.

When looking at the physiological results, one difference in the results could be caused by the variation of the method of which Splenic volume was calculated (20) in Sperlich, Zinner, Pfister, Holmberg, and Michels (30). This method uses a two-dimensional measurement to calculate spleen volume, and even though this has shown to have a strong positive correlation with actual spleen volume, the newly developed Pilström equation (28) has been specifically developed for the spleens irregular shape by adding a third dimension into the equation. Results from previous research (9, 25) have shown that a typical spleen volume in adults is usually between 200 – 250 ml, which has been supported by analysis of the participants in this study. However, Sperlich, Zinner, Pfister, Holmberg, and Michels (30) found different results with the largest mean spleen volume being 72± 10 ml.

Similarly, this study and Sperlich, Zinner, Pfister, Holmberg and Michels (30) found no change in Hb levels. One proposed explanation for not finding a change in the Hb levels after the splenic contraction could be that suggested by Schagatay, Richardson, and Lodin-Sundström (28). They showed that trained free divers have a stronger splenic contraction compared to their untrained counterparts and thereby improve their erythrocyte release. In this study, the participants were not specifically trained in carrying out maximal apnoeas. To expose the participants to the feelings of hypercapnia and hypoxia they had one familiarisation session until they felt comfortable with the protocol. If they had been provided with a longer period of apnoea training as in Engan, Richardson, Lodin-Sundström, Beekvelt, and Schagatay (7) the physiological response may have been different.

Another potential reason for not seeing a Hb change could be the timing of the splenic contractions occurring and the taking of blood measurements. Studies have shown that a peak can occur up to 15 – 25mins after the spleen has contracted (31). It is believed that this delay is due to the equilibrium between the splenic reservoir and the venous circulatory blood pool, yet there is no substantive evidence to back this claim (14).

Due to the participants having had no prior experience in apnoea training, hyperventilation prior to the apnoeas was not used. This could be another reason as to why Hb levels did not change, with studies showing that blood plasma volume is reduced from the prior hyperventilation, which resulted in a higher Hb concentration (29).

Practical Implications

The inclusions of apnoeas into training should be carried out with caution and under the supervision of a trained individual (apnoea coach). This is due to their potential hazards such as blackouts that are associated with this method of training, especially with those not experienced in maximal breath holds. Once competent and the swimmer is confident and comfortable with apnoeas, they could be integrated into the swimmers' pre-race routine for a 400-m freestyle swim. Once integrated the current results show that the swimmer could use this method to potentially enhance their 400m freestyle performance.

Conclusions

This study has shown that a combination of a warm-up with a series of three apnoeas (WUAP) can improve 400-m freestyle swimming performance against a Control intervention (CON). The WUAP was shown to be significantly faster than CON and apnoea (AP) intervention.

Physiologically there was no change in the level of Hb, yet there was a significant reduction in spleen volume in the WU, AP and WUAP conditions suggesting the occurrence of a splenic contraction.

The findings of this research support the need for further investigation to find ways of optimizing the use of apnoeas to enhance performance.

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FIGURES

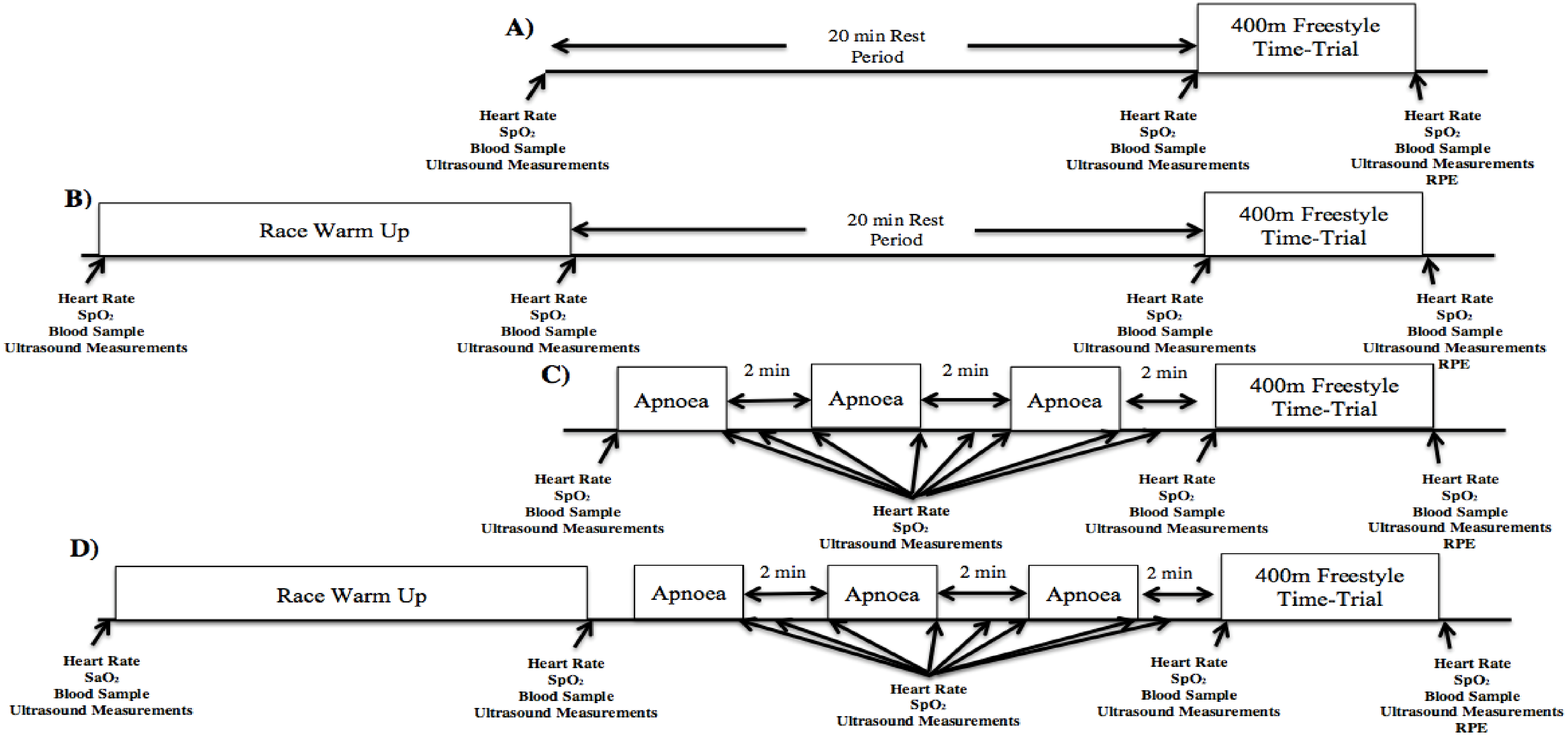


Figure 1. The protocols used in each intervention with measurement time points. Participants completed the interventions at least 2 days apart, and a maximum of 7 days. A) Control (No warm-up/apnoeas), B) Warm-Up, C) Apnoeas, D) Warm-up and apnoeas combined.

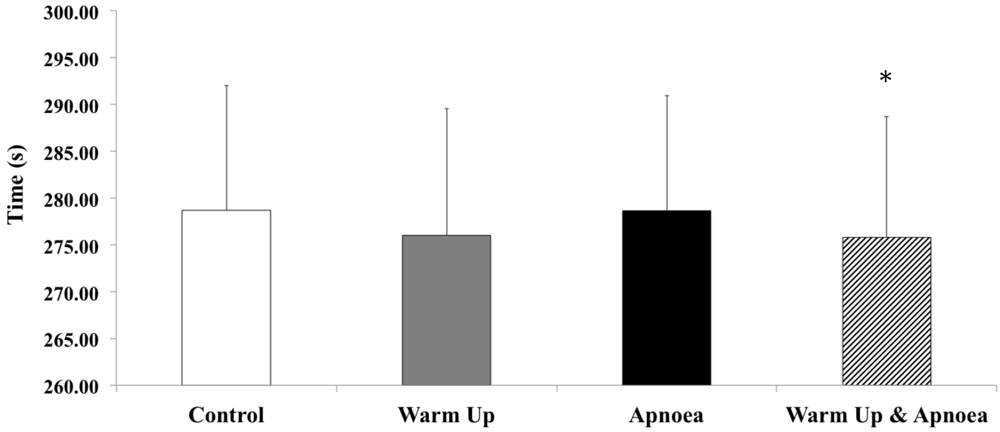
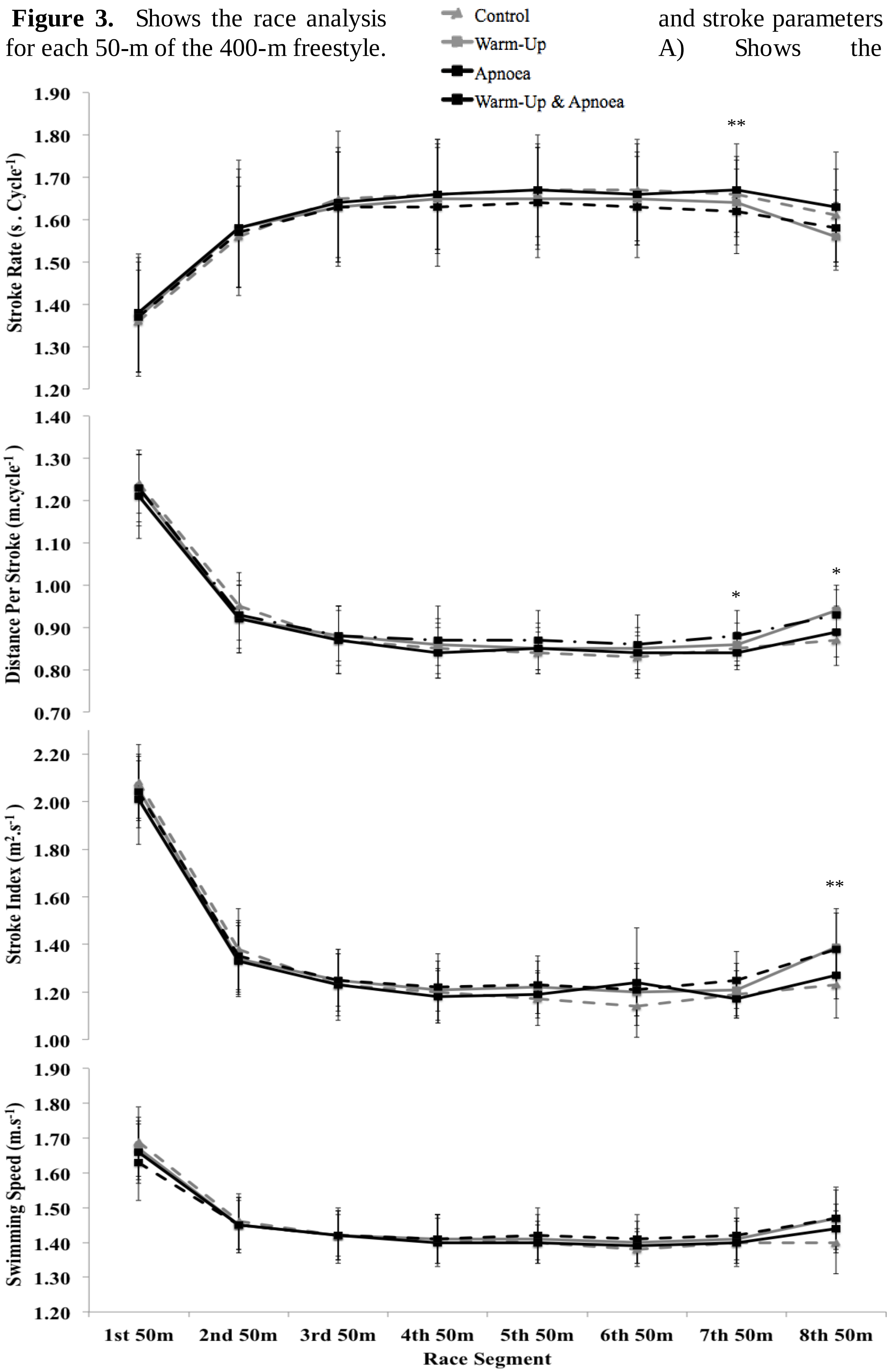


Figure 2. Time taken to complete the 400-m freestyle. Warm-up and Apnoea intervention was significantly faster than the control and apnoea intervention. Error bars are represented as the SD. Significant differences are denoted by * for $P < 0.05$.

Figure 3. Shows the race analysis for each 50-m of the 400-m freestyle. and stroke parameters A) Shows the swimming speed ($m.s^{-1}$) B) Shows the stroke rate (s.cycle-1) C) Shows the Distance Per stroke (DPS) D) Shows the Stroke index ($m^2.s^{-1}$) worked out by multiplying the



DPS by the swimming speed. Error bars represent the ±SD. Significant difference is denoted by *for p < 0.05 and ** for p < 0.

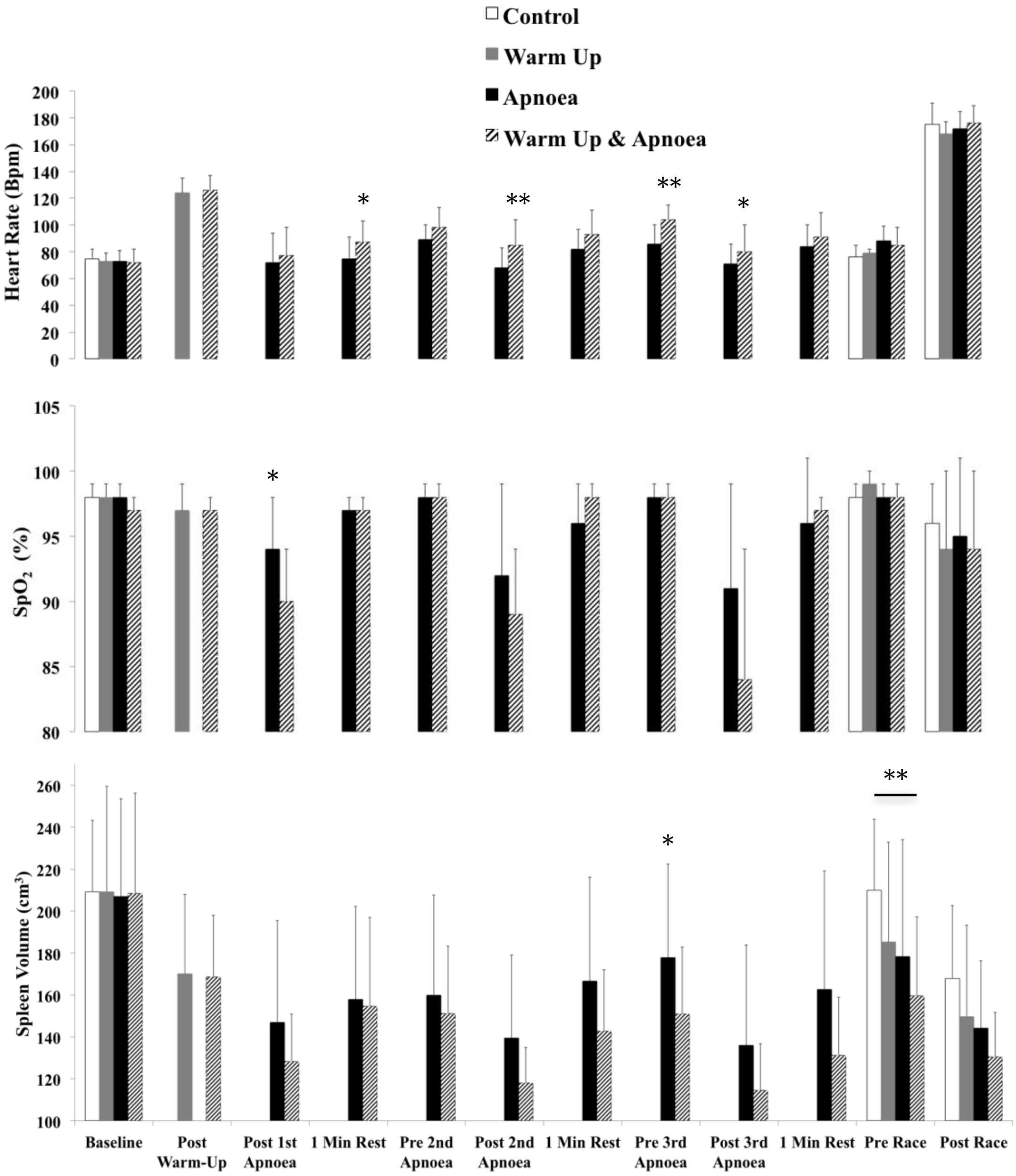


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Figure 4. A) Heart Rate B) SpO_2 (error bars are represented as the upper limits of the 95% CI due to the large size of the SD and C) Spleen Volume at different time points during the interventions. For B) & C) Error bars represent the +SD. Significance is denoted by * for *P*<0.05 and ** for *P*<0.01. *Due to Conditions A and B having no apnoeas there are no data at these points. Due to Conditions A & C not including a warm-up, there are no data at these points*

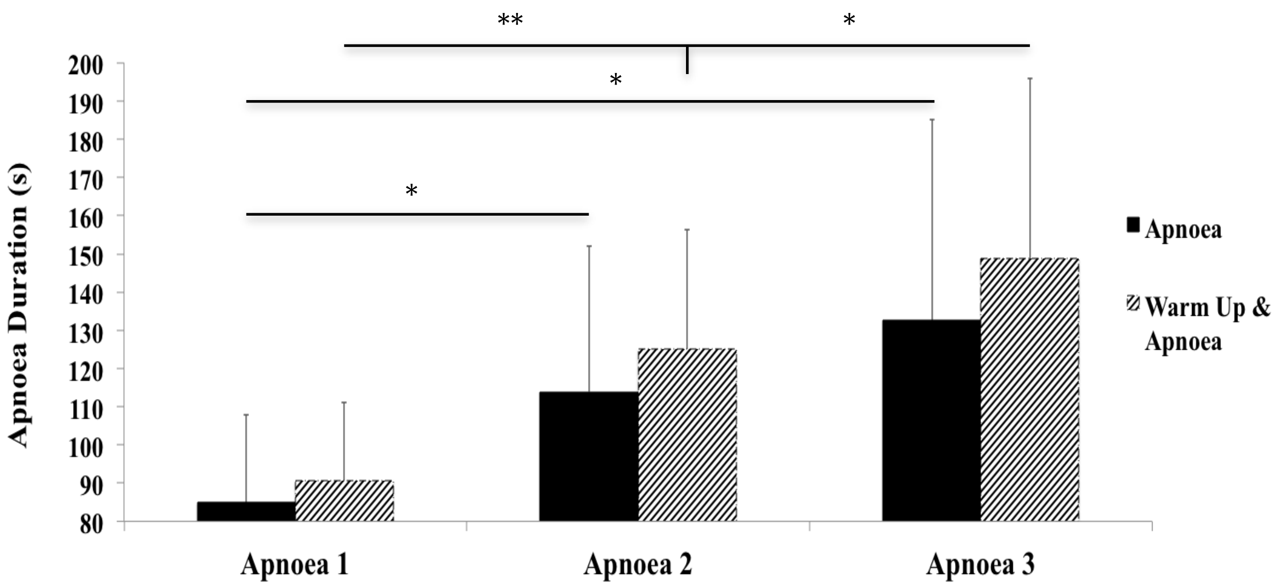

Figure 5. Shows the apnoea duration in the apnoea intervention and warm-up and apnoea combined intervention. Error Bars represent the +SD. Significant Differences are denoted by * for $p < 0.05$ and ** for $p < 0.01$

Tables

Table 1. Shows the standardized warm-up used before the 400-m freestyle time trial in the warm-up intervention and warm-up and apnoea combined intervention.

400m Freestyle	30 Seconds Rest
200m Pull	30 Seconds Rest
200m Kick	30 Seconds Rest
200m Drill	30 Seconds Rest
200m Individual Medley	30 Seconds Rest
4 x 50 @ 400m Race Pace	On 1 Minute
200m Steady	

Table 2. Show mean ± SD (95% CI) of Blood Lactate (mmol.L^{-1}) in all four interventions at different time points during the testing protocol

Intervention	**Time Point**			
	Baseline	**Post-Warm Up**	**Pre Time-Trial**	**Post Time-Trial**
Control	1.23±0.33		1.18±0.47	9.84±3.67
	(0.97-1.49)		(0.82-1.55)	(7.02-12.66)
Warm Up	1.27±0.32	3.20±1.35	1.67±0.55	11.24±2.54
	(1.02-1.52)	(2.17-4.24)	(1.25-2.09)	(9.29-13.19)
Apnoea	1.26±0.61		1.16±0.45	9.52±2.12
	(0.79-1.73)		(0.81-1.50)	(7.89-11.14)

Warm Up & Apnoea	1.01±0.49 (0.64-1.39)	2.29±0.88 (1.61-2.97)	1.43±0.68 (0.90-1.96)	9.11±2.59 (7.11-11.10)

Table 3. Shows the mean ± SD (95% CI) hemoglobin (g.L^{-1}) levels at different time points during the four interventions

Intervention	**Time Point**			
	Baseline	**Post-Warm Up**	**Pre Time-Trial**	**Post Time-Trial**
Control	155±10 (143-160)		149±11 (141-157)	153±12 (144-162)
Warm Up	150±13 (140-161)	150±11 (142-159)	151±15 (140-163)	153±10 (146-161)
Apnoea	153±12 (144-164)		153±9 (146-163)	150±13 (141-160)
Warm Up & Apnoea	151±15 (139-164)	150±10 (143-159)	150±10 (143-157)	152±16 (140-164)