

Time–Motion Analysis of a 2-Hour Surfing Training Session

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Purpose: To provide a descriptive and quantitative time–motion analysis of surfing training with the use of global positioning system (GPS) and heart-rate (HR) technology. **Methods:** Fifteen male surfing athletes (22.1 ± 3.9 y, 175.4 ± 6.4 cm, 72.5 ± 7.7 kg) performed a 2-h surfing training session, wearing both a GPS unit and an HR monitor. An individual digital video recording was taken of the entire surfing duration. Repeated-measures ANOVAs were used to determine any effects of time on the physical and physiological measures. **Results:** Participants covered 6293.2 ± 1826.1 m during the 2-h surfing training session and recorded measures of average speed, HR_{average} , and HR_{peak} as 52.4 ± 15.2 m/min, 128 ± 13 beats/min, and 171 ± 12 beats/min, respectively. Furthermore, the relative mean times spent performing paddling, sprint paddling to catch waves, stationary, wave riding, and recovery of the surfboard were $42.6\% \pm 9.9\%$, $4.1\% \pm 1.2\%$, $52.8\% \pm 12.4\%$, $2.5\% \pm 1.9\%$, and $2.1\% \pm 1.7\%$, respectively. **Conclusion:** The results demonstrate that a 2-h surfing training session is performed at a lower intensity than competitive heats. This is likely due to the onset of fatigue and a pacing strategy used by participants. Furthermore, surfing training sessions do not appear to appropriately condition surfers for competitive events. As a result, coaches working with surfing athletes should consider altering training sessions to incorporate repeated-effort sprint paddling to more effectively physically prepare surfers for competitive events.

Keywords: surfboard, GPS, HR, heart rate

Surfboard riding (surfing) is a popular sport that is performed competitively at both recreational and elite levels, as well as being performed for training purposes.¹ Successful surfing requires high levels of both technical proficiency and physiological fitness, the latter of which is used to provide propulsion through the water to be correctly positioned to catch the most appropriate waves. This propulsion occurs before the surfer stands up, through paddling and using dynamic balance and lower-body power to remain on the board and perform maneuvers.^{2–4}

Mendez-Villanueva et al⁴ characterized surfing as an intermittent activity that requires the athlete to perform random high-intensity bouts of exercise interspersed with low-intensity bouts of exercise and recovery. While surfing training sessions typically last up to several hours, a competitive surfing heat lasts 20 to 40 minutes, with multiple heats often performed each day.^{1,5} Recent research suggests that during both competitive heats and surfing training activity surfers spend ~50% of the total time in the water paddling, ~40% stationary, ~5% wave riding, and ~5% sprint paddling for waves.^{1,5,6} Furthermore, Farley et al⁶ reported the mean frequency of paddling, stationary, paddling for a wave, and wave-riding activities and documented these across a 20-minute competitive heat as 42 ± 9.4 , 30 ± 6.7 , 13 ± 4.1 , and 7 ± 1.9 , respectively. Taken together, the data demonstrate that the majority of time surfing is spent with surfers paddling to place themselves in a position to catch a wave, with a relatively smaller fraction of time spent catching and riding waves.

While 3 previous investigations have completed time–motion analyses of surfing, only 1 study to date has used global positioning system (GPS) and heart-rate (HR) monitor technology to quantify the physical demands of a competitive surfing session.⁶ However,

to date, an analysis of this kind is not available for surfing outside of competition. Considering that competitive surfers perform large volumes of surf-training,⁷ it is important to understand not only the demands of surfing competition but also the typical demands of surf training, to determine to what extent surf training prepares athletes for the rigors of competition. As such, the physical demands placed on a surfer during a surfing training session remain of interest, and therefore, the purpose of this study was to conduct a GPS integrated time–motion analysis of a surfing training session.

Methods

Subjects

Fifteen male surfers (age 22.1 ± 3.9 y, height 175.4 ± 6.4 cm, body mass 72.5 ± 7.7 kg, arm span 177.3 ± 7.3 cm, sum of 7 skinfolds 65.6 ± 18.6 mm) volunteered to participate in this study. For inclusion in the study, subjects were required to be competing in regional-level competition, have a minimum competitive experience in at least 3 competitions at this level, and be currently free of any injury or medical condition. The study and its procedures were approved by the University of Newcastle Human Ethics Committee (approval number: H-2012-0014), and participants were provided with information detailing the study before providing informed consent, as well as being screened for medical contraindications.

Design

The purpose of the current study was to perform a time–motion analysis on a 2-hour surfing training session in competitive surfing athletes. This study aimed to provide a descriptive analysis of the total duration, mean duration, and frequency of various surfing activities (paddling, paddling for wave, stationary, wave riding, and recovery of board) throughout a typical surfing training session. Furthermore, the effect of time (across each 30-min quarter) for

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each activity was determined. The characteristics of each activity were determined using integrated digital video recording with physical movement (GPS) and physiological (HR) data aimed to determine the physical demands of and physiological responses to surfing training.

Methodology

Participants were required to perform a 2-hour surfing training session, with the verbal instructions to “surf as though you are preparing for a competition.” During the session participants wore a GPS unit (VX Sport VX110 Log, Visuallex Sport International Ltd, Lower Hutt, New Zealand), collecting at a frequency of 4 Hz, and had individual digital video recordings filmed of their surfing activity (Sony HDR-RX260 Camcorder, Sony Australia). The reliability (CV%) for estimation of distance and maximal speed for these units has been reported as 4.6% (4.1–5.3%) and 2.9% (2.6–3.3%), respectively.⁸ In addition, each participant wore a Polar T31 uncoded HR transmitter (Polar Electro Oy, Kempele, Finland) to record HR data at a frequency of 1 Hz in the internal memory of the GPS unit. The HR transmitter was worn under the participant’s wetsuit, with the sensor electrode placed over the sternum. All sessions were performed in offshore winds with a mean speed of 9.1 ± 4.3 knots, with a mean wave height of 0.91 ± 0.11 m.

All video recordings were filmed from the same location (on the lateral side, center of the break, 40 m from shoreline) overlooking the surfing beach. This position allowed for the best viewpoint and ensured that all activities were captured, including periods when the participants passed behind a wave.⁶ After the completion of the 2-hour surfing training session, the GPS and HR data were downloaded to a personal computer using the manufacturer’s software (v 2.106.0.0, Visuallex Sport International Ltd, Lower Hutt, New Zealand) for subsequent analysis. On download, HR and GPS data were individually synchronized to the initial stationary period. The end time of each file was set at exactly 120 minutes after the start time. During analysis, all data outside of the cropped start and end times were disregarded, and the remaining data were divided into 30-minute quarters. The relevant surfing training-session data were then exported to Microsoft Excel (Microsoft Corp, Redmond, Washington, USA) for subsequent storage and analysis. The data were analyzed to provide measures of total distance covered, maximum speed, average speed, and HR_{peak} and HR_{average} recorded during the

total 2-hour surfing training session. The GPS and HR data were also split into four 30-minute quarters to determine changes in the aforementioned measures across time during the surfing session.

On completion of all testing sessions, each individual session was synchronized for time and coded for activities in Windows Media Player 12 (Microsoft Corp, Redmond, WA, USA). Coded activities included: paddling to return to lineup, sprint paddle for wave, general paddling in the lineup, stationary, wave riding, and recovery of the surfboard and were adapted from Farley et al⁶ (Table 1). For the purpose of analysis, paddling to return to lineup, sprint paddling to catch a wave, and general paddling in the lineup were grouped to form a general paddling category. Video recordings were paused each time a change in activity occurred, with the start and end time for the activity recorded. These data subsequently allowed for a descriptive absolute and relative analysis of the total duration, mean duration, and frequency of each activity for the total 2-hour surfing training session. Finally, the activities completed within each 30-minute quarter were also analyzed to determine changes in surfing activities with time.

Statistical Analysis

The mean $\pm$ SD were reported for all physical measures and activities. Data were presented as either per 30-minute quarter or for the total 2-hour surfing training session. A repeated-measures ANOVA was performed on all variables reported in 30-minute quarters to identify any significant differences across time periods. All data were assessed for sphericity using a Mauchly test of sphericity. In the event that the assumption of sphericity was violated, the Greenhouse-Geisser correctional adjustment was used. Where a significant main effect was found, a least-significant-difference post hoc test was used to identify individual statistical differences. All statistical analyses were performed using a statistical analysis package (SPSS, version 20.0, Chicago, IL) with statistical significance set at $P \leq .05$.

Results

GPS and HR Data

The distance, speed, and recorded HR data of the current study are presented in Table 2. Across a 2-hour surfing session, participants

Table 1 Definitions of the Various Surfing Activities Reported in the Current Study (Adapted From Farley et al⁶)

Activity	Definition
Paddling	The propulsion of the surfboard in a forward direction, through the use of alternate-arm paddling strokes.
Paddling to return to lineup	The total time required for the surfer to return to the lineup, through performing paddling, after wave riding. The time was recorded from the first alternate-arm stroke, after the participant assumed a prone position on the surfboard, to the completion of the last alternate-arm stroke, when the participant was deemed to be in the lineup.
Sprint paddle for wave	The total time from the first “aggressive” alternate-arm stroke, in the direction of an approaching wave, to the last alternate-arm stroke preceding wave riding, or the completion of “aggressive” paddling.
General paddling in the lineup	The total time from the first alternate-arm stroke to the last, before the participant either began to sprint paddle for wave or remain stationary. This activity required the participant to already be within the lineup.
Stationary	Any occurrence when the participant was either lying prone on the surfboard and not performing any alternate-arm stroke or sitting on the surfboard.
Wave riding	The total time from the participant initiating the “pop-up” to either riding off the back of the wave or losing contact with the surfboard.
Recovery of the surfboard	The total time from the participant losing contact with the surfboard to assuming the position of either lying prone or sitting on the surfboard.

covered 6293.2 ± 1826.1 m (range 4491–9527 m). No significant difference was present in distance covered across the 30-minute quarters ($P = .80$). The mean average speed was 52.4 ± 15.2 m/min, with a mean maximum speed 35.3 ± 4.9 km/h. Similarly, no significant differences were observed between quarters for average speed ($P = .91$) or peak ($P = .56$) speed from the GPS data.

A significant decline was consistently identified for the HR_{peak} ($P < .001$) between quarter 1 and the second, third, and fourth quarters ($P = .03$, $P < .01$, $P < .01$, respectively), as well as quarter 2 and quarter 4 ($P = .03$). Similarly, a significant reduction ($P = .001$) was reported for the recorded HR_{average} between quarter 1 and the second, third, and fourth quarters ($P = .02$, $P < .01$, $P < .01$, respectively).

Analysis of Surfing Activities

Relative Time Spent in Activities. The relative times (%) spent performing each activity during the 2-hour surfing session are

presented in Table 3. No significant differences were present between the absolute and relative percentages of time recorded in each 30-minute quarter of the surfing session for any of the activities.

Bout Duration and Frequency. As is presented in Table 4, a significant increase in the mean bout duration for general paddling in the lineup ($P = .04$) was observed between quarter 1 and the third and fourth quarters ($P = .03$ and $P < .01$, respectively). In addition, significant increases in the mean bout duration of stationary activities ($P = .03$) were identified between quarter 3 and the first and second quarters ($P = .03$ and $P = .04$, respectively). Furthermore, Table 5 shows significant reductions in the mean bout frequency for total paddling ($P = .02$) between quarters 1 and 2 and the third and fourth quarters ($P = .02$ and $P = .03$, $P = .02$ and $P < .01$, respectively). Similarly, significant decreases across the surfing session were calculated for general paddling in the lineup ($P = .03$) between quarter 3 and the first and second quarters ($P < .01$ and

Table 2 Global Positioning System and Heart-Rate Data (Mean $\pm$ SD) for Each 30-Minute Quarter and the Total 2-Hour Session

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Distance (m)	1572.2 $\pm$ 412.6	1579.9 $\pm$ 430.4	1538.7 $\pm$ 551.0	1600.9 $\pm$ 510.5	6293.2 $\pm$ 1826.1
Maximum speed (km/h)	31.1 $\pm$ 5.1	32.4 $\pm$ 4.9	31.4 $\pm$ 5.5	30.2 $\pm$ 5.6	35.3 $\pm$ 4.9
Average speed (m/min)	52.4 $\pm$ 13.8	52.7 $\pm$ 14.3	51.3 $\pm$ 18.4	53.4 $\pm$ 17.0	52.4 $\pm$ 15.2
HR_{peak} (beats/min)	173 $\pm$ 16 ^{a,b,c}	166 $\pm$ 13	163 $\pm$ 14	161 $\pm$ 13	171 $\pm$ 12
HR_{average} (beats/min)	135 $\pm$ 12 ^{a,b,c}	130 $\pm$ 13	124 $\pm$ 16	125 $\pm$ 16	128 $\pm$ 13

^a Significant difference from quarter 2. ^b Significant difference from quarter 3. ^c Significant difference from quarter 4.

Table 3 Relative Time (Mean $\pm$ SD) Spent Performing Various Surfing Activities for Each 30-Minute Quarter and the Total 2-Hour Session

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Paddling (%)	46.4 $\pm$ 10.4	41.5 $\pm$ 10.9	40.6 $\pm$ 14.7	43.2 $\pm$ 12.8	42.6 $\pm$ 9.9
Paddle to return to lineup (%)	24.2 $\pm$ 8.9	20.2 $\pm$ 11.7	20.5 $\pm$ 14.9	21.2 $\pm$ 16.5	20.9 $\pm$ 10.2
Sprint paddle for wave (%)	4.3 $\pm$ 1.6	4.6 $\pm$ 1.9	4.0 $\pm$ 1.5	3.7 $\pm$ 1.3	4.1 $\pm$ 1.2
General paddling (%)	17.9 $\pm$ 6.6	16.8 $\pm$ 8.4	16.1 $\pm$ 8.0	18.3 $\pm$ 8.6	17.6 $\pm$ 5.9
Stationary (%)	49.5 $\pm$ 12.5	53.9 $\pm$ 13.4	54.8 $\pm$ 18.0	51.3 $\pm$ 16.4	52.8 $\pm$ 12.4
Wave riding (%)	2.3 $\pm$ 1.8	2.8 $\pm$ 2.0	2.6 $\pm$ 2.6	2.9 $\pm$ 2.7	2.5 $\pm$ 1.9
Recovery of surfboard (%)	1.8 $\pm$ 1.4	1.8 $\pm$ 1.7	2.0 $\pm$ 1.7	2.6 $\pm$ 2.6	2.1 $\pm$ 1.7

Table 4 Average Bout Duration (Mean $\pm$ SD) of Various Surfing Activities for Each 30-Minute Quarter and the Total 2-Hour Session

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Paddling (s)	19.3 $\pm$ 3.3	17.9 $\pm$ 5.5	19.7 $\pm$ 3.4	21.2 $\pm$ 5.5	19.2 $\pm$ 3.0
Paddle to return to lineup (s)	68.4 $\pm$ 21.8	54.7 $\pm$ 21.0	66.2 $\pm$ 45.1	58.3 $\pm$ 21.7	63.8 $\pm$ 19.0
Sprint paddle for wave (s)	6.5 $\pm$ 1.2	6.5 $\pm$ 1.3	6.1 $\pm$ 0.7	6.3 $\pm$ 0.9	6.3 $\pm$ 0.8
General paddling (s)	13.0 $\pm$ 3.2 ^{b,c}	13.5 $\pm$ 5.7	15.8 $\pm$ 5.4	15.9 $\pm$ 5.0	14.5 $\pm$ 3.9
Stationary (s)	30.6 $\pm$ 11.4 ^b	33.2 $\pm$ 9.7 ^b	42.0 $\pm$ 19.0	35.9 $\pm$ 12.9	34.2 $\pm$ 9.1
Wave riding (s)	6.5 $\pm$ 2.1	7.6 $\pm$ 3.2	7.0 $\pm$ 2.8	7.5 $\pm$ 3.1	7.5 $\pm$ 1.7
Recovery of surfboard (s)	7.4 $\pm$ 2.1 ^c	8.1 $\pm$ 4.1	6.8 $\pm$ 3.6 ^c	10.4 $\pm$ 5.0	8.7 $\pm$ 2.1

^b Significant difference from quarter 3. ^c Significant difference from quarter 4.

$P = .01$, respectively), as well as for stationary activities ($P = .02$) between quarter 3 and the first and second quarters ($P = .02$ and $P < .01$, respectively) and quarters 2 and 4 ($P = .02$).

Bout-Duration Percentages. The mean percentages of paddling bouts for increasing durations were 0 to 10 seconds $56.5\% \pm 5.4\%$,

11 to 20 seconds $17.4\% \pm 5.4\%$, 21 to 40 seconds $13.9\% \pm 3.3\%$, 41 to 90 seconds $9.3\% \pm 4.4\%$, and >90 seconds $3.0\% \pm 1.6\%$. In addition, the mean percentages of stationary bouts were $32.4\% \pm 7.8\%$, $18.6\% \pm 4.7\%$, $21.0\% \pm 4.2\%$, $19.6\% \pm 5.7\%$, and $8.5\% \pm 5.0\%$, respectively (Figures 1 and 2).

Table 5 Average Bout Frequency (Mean $\pm$ SD) of Various Surfing Activities for Each 30-Minute Quarter and the Total 2-Hour Session

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Paddling (n)	$43 \pm 12^{b,c}$	$42 \pm 9^{b,c}$	37 ± 12	35 ± 9	157 ± 34
Paddle to return to lineup (n)	7 ± 4	8 ± 5	6 ± 5	6 ± 4	27 ± 17
Sprint paddle for wave (n)	12 ± 4	13 ± 5	12 ± 5	10 ± 4	46 ± 14
General paddling (n)	24 ± 8^b	22 ± 9^b	19 ± 8	19 ± 9	84 ± 27
Stationary (n)	30 ± 7^b	$30 \pm 7^{b,c}$	26 ± 7	25 ± 8	111 ± 22
Wave riding (n)	6 ± 4	6 ± 5	6 ± 5	5 ± 4	23 ± 16
Recovery of surfboard (n)	4 ± 3	4 ± 4	5 ± 3	4 ± 3	16 ± 11

^b Significant difference from quarter 3. ^c Significant difference from quarter 4.

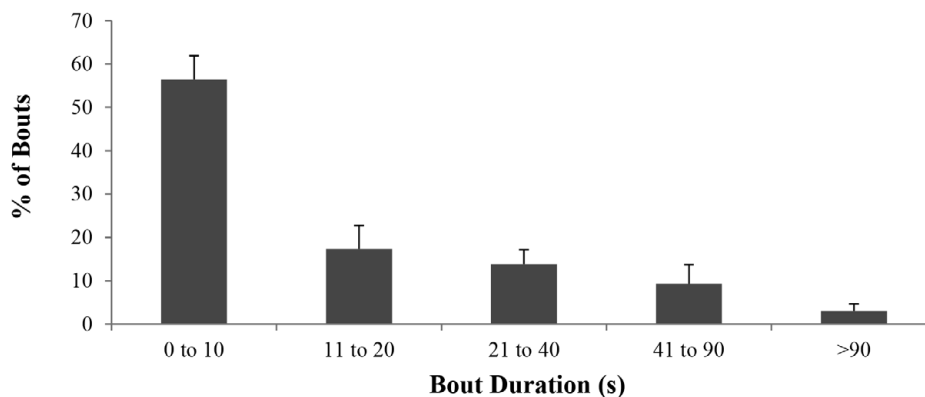


Figure 1 — Percentage of paddling bouts (mean $\pm$ SD) that lasted 0 to 10 seconds, 11 to 20 seconds, 21 to 40 seconds, 41 to 90 seconds, and >90 seconds during a 2-hour surfing training session.

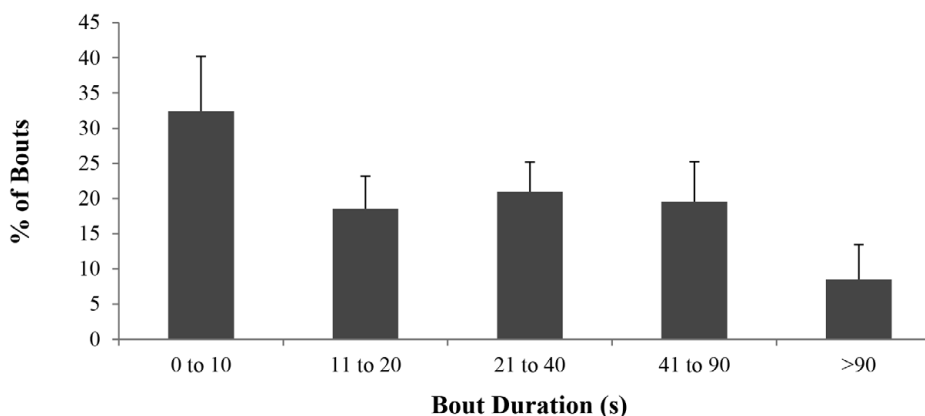


Figure 2 — Percentage of stationary bouts (mean $\pm$ SD) that lasted 0 to 10 seconds, 11 to 20 seconds, 21 to 40 seconds, 41 to 90 seconds, and >90 seconds during a 2-hour surfing training session.

Discussion

The purpose of this study was to conduct a GPS and HR integrated time–motion analysis of a surfing training session, as the physical demands placed on a surfer during a surfing session of this nature have not previously been investigated. During the 2-hour surfing training session it was determined that the total mean distance covered was 6293.2 ± 1826.1 m (range 4491–9527 m), with a consistent decline in both HR_{peak} and $HR_{average}$ observed across the 30-minute quarters. Furthermore, an analysis of surfing activities indicates that across the 2-hour surfing training session there was a significant increase in the mean bout duration and frequency of stationary activities, whereas the mean bout duration and frequency of paddling activities significantly decreased.

It is necessary to note that the current study and that of Farley et al⁶ are the first 2 studies to use GPS and HR monitors to investigate the physical demands of surfing. These studies used a different cohort of subjects and different surfing breaks, and, therefore, comparisons must be made with care. However, the reported mean distance covered during the 2-hour surfing training session of 6293.2 ± 1826.1 m (range 4491–9527 m) equates to an average speed of 37.4 to 79.4 m/min. This is considerably lower than that reported by Farley et al⁶ of 71.7 to 90.3 m/min. Considering that Farley et al analyzed competitive surfing events, it appears that surfing training is likely completed at a lower intensity than competitive events. These results are in agreement with previous research that has reported lower intensity of activity in dry-land-based team-sport training sessions than in competition.^{9,10}

It may be suggested that the decreased intensity identified for the surfing training session is the result of a pacing strategy used by the subjects, due to the reduced requirement to catch as many waves as possible within a short time. However, the observation of a significant decline in HR responses across the surfing session, as well as an increase in the mean bout duration and frequency of stationary activities and a decrease in paddling activities, may also indicate the onset of fatigue. As a result, it appears that the lower intensity identified for the surfing training session, as evidenced by the reduced average speed, may be due to the manifestation and presence of muscle fatigue across the surfing session.

To date, only limited research has reported on the HR responses during surfing activity.^{5,6} While Meir et al⁵ investigated the HR responses during recreational surfing, the data were made relative to a participant's estimated age-predicted HR_{max} , which inherently makes it difficult to make valid comparisons between the results, as the HR_{max} of the participants of the current study were not recorded. Conversely, Farley et al⁶ recently reported on the absolute HR responses of surfing, which allows comparisons with competition data. The participants in the current study recorded a mean HR_{peak} and $HR_{average}$ of 171 ± 12 and 128 ± 13 beats/min, respectively, with Farley et al⁶ reporting 190 ± 12 and 134 ± 11 beats/min. A comparison of the results indicates that considerably greater HR responses were observed in the study of Farley et al,⁶ further supporting the suggestion that a higher physiological intensity is sustained during competition than during training.

Time–motion analysis revealed that paddling accounted for $42.6\% \pm 9.9\%$ of the total 2-hour surfing training session. These results were similar to those of Meir et al⁵ (~44%) but lower than those of Mendez-Villanueva et al¹ (~51.4%) and Farley et al⁶ (54% $\pm$ 6.3%). Conversely, the current participants were stationary for 52.8% $\pm$ 12.4% of time, which was greater than in the studies of either Mendez-Villanueva et al¹ (~42.5%) or Farley et al⁶ (28% $\pm$ 6.9%). Taken together, these data suggest that surfers will typically

perform less relative time paddling and a greater relative time stationary in surfing training sessions than during competition. When taken in combination with other results indicating that a lesser average speed was recorded, it appears that the intensity of a surfing training session may be significantly lower than that of a competitive surfing event; however, further research is required to support this. Such future research should use the same cohort of surfers performing competition and surfing training sessions on the same surfing break, to reduce the reliance on accurate GPS measurement, as the use of this technology in surfing is yet to be validated.

Furthermore, the mean paddling bout duration in the current study was 19.2 ± 3.0 seconds, which included paddling to return to the lineup (63.8 ± 19.0 s), sprint paddling to catch a wave (6.3 ± 0.8 s), and general paddling in the lineup (14.5 ± 3.9 s). Similarly, Farley et al⁶ reported the mean paddling bout duration as 16.0 ± 4.5 seconds, which is interesting considering that the current study reported a reduced average speed. Worthy of note, though, is that the mean stationary bout duration of the current study was recorded as 34.2 ± 9.1 seconds, which is considerably greater than that recorded by Farley et al⁶ (~10–15 s). Although no clear differences were noted between the mean paddling bout durations of the 2 studies, there are large discrepancies between the mean stationary bout durations, which appears to explain the larger average speed recorded by Farley et al.⁶ These data indicate that during surfing training, the surfers perform work bouts similar in duration to those of competition, but the recovery time between these bouts may be significantly larger in training. As a result, surfing training sessions appear to provide surfers with increased recovery duration between high-intensity work periods and, as such, do not appropriately condition surfers for competitive events, particularly for sprint-paddling repeatability. To ensure that surfers are in appropriate condition for competitive surfing events, it is likely necessary for strength and conditioning and sport science practitioners to prescribe either simulated “competitive heats” during training sessions or lactate-clearance and tolerance paddling sessions¹¹ when leading into a competitive surfing event.

The results of the current study appear to confirm that although the majority of a surfing training session is performed at submaximal intensity, there are frequent periods where the surfer must perform at near-maximal intensity. While the HR responses of the current study were lower than those reported by Farley et al,⁶ it is important to note that periods of high-intensity work were performed throughout the surfing training session. These data demonstrate that surfing training sessions and competitive surfing heats place large physical and metabolic demands on a surfer. In particular, past research has indicated that junior competitive surfers typically perform surfing training sessions for 18.1 ± 5.3 h/wk, with these sessions also occurring before and during competitive events.⁷ As a result of this high training volume, as well as the appearance of fatigue potentially reducing the intensity of the surfing training sessions, it is recommended that training load be monitored in surfers to allow correct training periodization, prevent nonfunctional fatigue, and assist in injury minimization.

Practical Applications

Surfing training involves a reduced intensity compared with competitive surfing, likely due to a lower pacing strategy used by the participants. Furthermore, the results indicate that self-paced surfing training sessions do not provide adequate conditioning responses to effectively prepare for competitive events. As a result, it may be that coaches must include repeated high-intensity sprint-paddling

efforts in a surfer's training program and alter the design of a training session to evoke physical and physiological responses that are more similar to those observed in competition. In addition, as surfers typically perform a high frequency of extended-duration surfing training sessions, training-load monitoring appears warranted, as these extended sessions involve a large portion of surfing performed at a reduced intensity, likely from fatigue, thereby reducing the effectiveness of the training and possibly increasing injury risk.

Acknowledgments

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