

KINEMATIC ANALYSIS OF THE 100-METER WHEELCHAIR RACE

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INTRODUCTION

In general, an able-bodied runner can reach the maximum speed in about 30-50 m and can maintain the maximum speed for 20-40 m before decelerating toward the end of a 100-m run. Although the speeds of able-bodied subjects during sprinting are well-documented, the corresponding data for the wheelchair racers are not currently available. The purpose of this study was to compare the speed and selected stroke cycle characteristics during different phases of the 100-m wheelchair race.

METHODS

Four male and 2 female T4 (functional upper extremities, abdominal, and lower back muscles) and 1 male and 3 female T3 (same as T4 except no functional abdominal and lower back muscles) highly-trained track athletes served as the subjects (age 15.2 ± 1.9 and 19.2 ± 4.7 yrs for females and males, respectively). Trials were conducted on a synthetic-surfaced track and each subject was asked to complete two 100-m races. Two subjects were tested at one time and competed in adjacent lanes.

Two S-VHS camcorders (Panasonic AG455, 60 fps) were used to cover the 1st and 2nd 50 m of the 100-m race, respectively. Forty-two background markers were placed at 5-m intervals along lanes 5 and 8. The cameras were panned horizontally to follow both subjects in each trial.

For the purpose of this study, a *stroke cycle* begins at the instant of initial hand contact with the handring and ends at the next initial contact. The instant the hands break contact with the handring (hand release) is used to divide a stroke into 2 phases — the *push* and *recovery phases*. The contact distance of a stroke is defined as the shortest distance between the location of the bottom of the front wheel and the starting line at the instant of initial hand contact (Figure 1). The trial with the shorter 100-m time from each subject was selected for subsequent analysis. For each trial being analyzed, the video fields for the instants of initial contacts were analyzed. A Peak motion measurement system was used to extract coordinate data from the video recordings. The contact distance of a stroke was determined using the procedures described by Chow (1987) and Hay and Koh (1988).

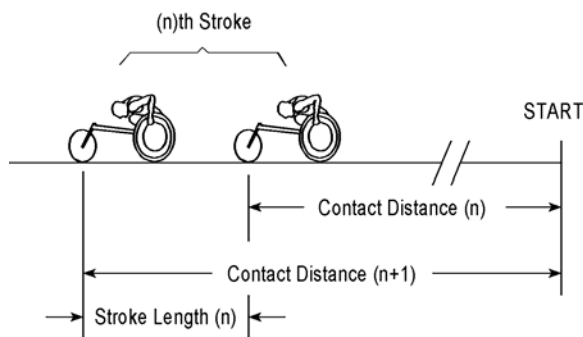


Figure 1: Contact distances were used to determine stroke lengths.

Stroke, push and recovery times were determined using field numbers for initial hand contacts and hand releases, and the known video field rate. The average speed

of a stroke was obtained by dividing the stroke length by the stroke time.

The maximum speed phase (MSP) is defined as the part of the 100-m race that consists of the five consecutive strokes that together have the largest average speed value. For each kinematic parameter, the average value during the first 10 m (initial phase, IP), the MSP, and the last 10 m (final phase, FP) of the race were determined. For each parameter, an ANOVA with repeat measures was performed and Tukey HSD post-hoc tests were completed when a significant main effect was found.

RESULTS AND DISCUSSION

The 100-m times for the trials analyzed ranged from 16.10 s (a T4 male) to 22.18 s (a T3 female) (mean 18.95 ± 1.97 s). Except for stroke frequency and stroke time, significant differences were found between IP and MSP and between IP and FP in all other parameters. No significant differences were found between MSP and FP in any of the measures.

The distance and time needed to reach the beginning of the MSP ranged from 48.4 m and 11.92 s (a T4 female) to 88.1 m and 18.77 s (a T3 female). Two of the subjects did not reach their maximum speed until the end of the 100 m. Comparing to able-bodied runners, wheelchair racers generally

need longer time and distance to reach their maximum speeds. The lower maximum speed and the longer time needed to reach the maximum speed explain why wheelchair racers have much greater 100-m times than able-bodied runners.

There was a significant decrease in push time (or increase in recovery time) when going from IP to MSP. However, stroke frequency (reciprocal of stroke time) values were relatively constant for different phases. This may suggest that racing wheelchair athletes like to maintain the same stroking rhythm throughout a 100-m race.

SUMMARY/CONCLUSIONS

Wheelchair 100-m is a race of acceleration. Athletes should focus on training methods that will shorten the duration of acceleration. The maximum speed values can be useful in determining the load setting in training on a roller system.

REFERENCES

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Table 1: Means (SDs) of different kinematic characteristics during different phases.

Phase	Speed (m/s)	Stroke length (m)	Stroke frequency (Hz)	Stroke Time (s)	Push Time (s)	Relative push time (%)	Recovery time (s)	Relative recovery time (%)
IP	2.69 ^{*#} (0.22)	1.463 ^{*#} (0.101)	1.85 (0.16)	0.545 (0.048)	0.274 ^{*#} (0.021)	50.4 ^{*#} (3.1)	0.271 ^{*#} (0.036)	49.6 ^{*#} (3.1)
MSP	6.60 [*] (0.71)	3.419 [*] (0.656)	1.97 (0.21)	0.514 (0.052)	0.117 [*] (0.020)	22.8 [*] (5.5)	0.398 [*] (0.063)	77.2 [*] (5.5)
FP	6.46 [#] (0.82)	3.562 [#] (0.570)	1.84 (0.18)	0.546 (0.041)	0.116 [#] (0.078)	21.6 [#] (5.7)	0.430 [#] (0.059)	78.4 [#] (5.7)

Note: Significant difference between ^{*}IP and MSP or [#]IP and FP ($p < 0.001$).