

Does employing a race strategy to increase running speeds in 200–300 m of the 400-m race improve personal best among male long sprinters and hurdlers?

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ABSTRACT

There is no research that has improved the record in the 400m race by changing the pace distribution. This study aimed to determine whether 400-m male sprinters and hurdlers could improve their personal best after the sprint training designed to modify their race strategy. Methods: Sixteen 400-m male sprinters and hurdlers (20.5 ± 1.5 years, 173.6 ± 6.2 cm, 65.7 ± 6.5 kg) participated in a 4-week sprint training program designed to change their race strategy, focusing on increasing their running speed over the 200–300-m segment with less speed gain in the first 200 m of the 400 m. Pacing development was based on the percentage of each 100-m split time to 400-m time of a world champion sprinter. After the 4-week sprint training, the personal best times of all participants shortened from 49.61 ± 2.35 s to 48.92 ± 1.97 s (-0.69 s) for 400-m sprinters and from 51.82 ± 1.03 s to 51.41 ± 1.01 s (-0.41 s) for 400-m hurdlers in official races. The findings indicate that for 400-m sprinters and hurdlers, a 4-week sprint training designed to modify their race strategy, that is, running at optimal running speed until 200 m and then accelerating from 200 to 300 m, may be effective in updating personal best time.

Keywords: Performance analysis, Personal best, Split time, Pacing development, Sprint training.

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INTRODUCTION

An athletic 400-m race is a long sprint event that uses anaerobic and aerobic energy to obtain running speed (Duffield et al., 2005; Gastin, 2001), with world-class sprinters recording times in the 43-44 s. Because the anaerobic energy supply in maximal sprint for humans diminishes significantly after approximately 40 s (Gastin, 2001), an appropriate pacing development is important to achieve better records in the 400-m race. The passing times of 200 m in a 400-m race are slower than personal best times for a 200-m distance (Hanon & Gajer, 2009).

The development of the 400-m race has been analysed by the passing time or running speed at each 100 m (Sato et al., 2023; Stoyanov, 2016), percentage of the 100-m split time to the 400-m time (%ST) (Yoshimoto et al., 2025), and percentage of each 100-m passing time to the personal best time at that distance (%PB) (Saraslanidis et al., 2011). Previous studies that examined passing time revealed that 400-m race records were strongly correlated with the split times in the 200–250-m and 250–300-m segments for sprinters with times ranging from 43.18 to 44.60 s (Stoyanov, 2016). Sato et al. (Sato et al., 2023) also revealed that the running speed at the 270–280-m segment was a significant determinant of the 400-m race time using multiple regression analysis. Therefore, a high running speed in the 200–300-m segment of a 400-m race may lead to achieving a better 400-m record.

Two race strategies can be mainly employed to achieve higher running speeds in the 200–300-m segment of a 400-m race: leading sprinters covering the first 200 m run fast and then trying to maintain speed for as long as possible, and driven sprinters who either utilize an even-paced race, with roughly similar times for covering the first and second halves of the race or run the first half at a steady or slow pace and speed up in the second half (Schiffer, 2008). As for %PB, a study recommended a passing time of 94% of the personal best time of the 200-m race when sprinters reach the 200-m point of the 400-m race (Schiffer, 2008). Yoshimoto et al. (Yoshimoto et al., 2025) revealed that the %PB passing at 200 m was 95% for the world's elite sprinters and 96% for Japanese elite sprinters. As for %ST, Japanese elite sprinters tend to have a smaller %ST in the 0–100-m segment and a larger %ST in the 200–300-m segment than world elite sprinters (Yoshimoto et al., 2025). Therefore, studies have proposed that sprinters with a lower competitive level run with a relatively high running speed in the first half and then with a relatively low running speed in the second half of the 400-m race.

Saraslanidis et al. (Saraslanidis et al., 2011) examined the relationship between pacing development in the first 200- and 400-m times and revealed that limited running speed gain (equivalent to 93% of the maximum sprinting speed) up to the first 200 m may reduce lactic acid accumulation in the first 200 m, resulting in better 400-m run times. Leading sprinters could improve their records by modifying their pace distribution to reduce their running speed in the first 200 m, thereby increasing their running speed in the 200–300-m segment. In addition, Chiba et al. (Chiba et al., 2025) showed that the top Japanese sprinter was able to break the national record as a result of a pace distribution change from leading type to driven type with reference to past races.

This study aimed to determine whether 400-m male sprinters and hurdlers could improve their personal best times after the sprint training designed to modify their race strategy, with a focus on the 200–300-m distance of the 400-m race. This study tested the hypothesis that sprint training designed to modify the race strategy will improve the personal best times of male 400-m sprinters and hurdlers.

MATERIAL AND METHODS

Participants

Sixteen male 400-m sprinters ($n = 13$) and hurdlers ($n = 4$) (age, 20.5 ± 1.5 years; height, 173.6 ± 6.2 cm; weight, 65.7 ± 6.5 kg) participated in this study. One sprinter participated in both the 400-m sprint and 400-m hurdle races. Table 1 shows their regular training program before changing their pacing development. Briefly, the training sessions were divided into short, middle, and long sprints, and participants were instructed to run as fast as possible from the start to shorten the time at each distance. No participants had upper or lower extremity disabilities and were not taking any medications that could affect muscle function.

The experiment was conducted in accordance with the scientific and ethical norms of the Declaration of Helsinki and was approved in advance by the Josai University Ethics Committee. Before measurements, the purpose of the study and risks associated with participation in the experiment were fully explained to the participants, and they provided written informed consent.

400-m race time

The 400-m race in this study was based on the times in the official competitions of the Japan Association of Athletics Federations. The competitions in which each sprinter participated were held between June 10, 2023, and August 8, 2023.

Training program

The %ST of the world's elite sprinters in a previous study (Yoshimoto et al., 2024) were used as a reference to set the passing times for each 50-m and 100-m segment to achieve a time between 46 and 52 s. In addition, the individual's %PB was determined based on his target 400-m race time and personal best times in 100-m, 200-m, and 300-m races. The %ST of each 100-m split time relative to the 400-m race time were 25.03% for 0–100 m, 22.80% for 100–200 m, 24.36% for 200–300 m, and 27.82% for 300–400 m. The training program was conducted twice a week for 4 weeks (June 5 to August 4, 2023). The new training consisted of passing the 200 m point at 50–51% of the target 400 m race record time and then sprinting as fast as possible for 30 m, 50 m, or 100 m from there (Chiba et al., 2025).

Statistical analysis

All values are presented as means and standard deviations (SDs). In this study, because all participants were willing to change their race strategies, a control group could not be set. To clarify the effect of changing race development, the means and SDs of the 400-m race times for three or more races before the race strategy change after 2022 for each participant were calculated. Then, the SD was multiplied by 0.2, and the value was set as the small worth criterion (SWC), which indicates a record-breaking event (Hopkins, 2009). Whether the 400-m times after changing race development were below the SWC values for each participant was examined. In addition, after converting the 400-m times before and after race development into WA score in 22nd (World Athletics, 2023), a paired t-test was used to test the significant difference in the 400-m time before and after changing race development.

Pearson's product-rate correlation coefficient (r) was calculated for the relationship between the WA score at baseline and the relative change in 400-m time before and after training. IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses. The significance level was $<5\%$.

RESULTS

After the prescribed sprint training, all participants updated their personal best times: their 400-m race times were shortened from 49.61 ± 2.35 s to 48.92 ± 1.97 s, and the 400-m hurdle times were shortened from 51.82 ± 1.03 s to 51.41 ± 1.01 s (Figure 1).

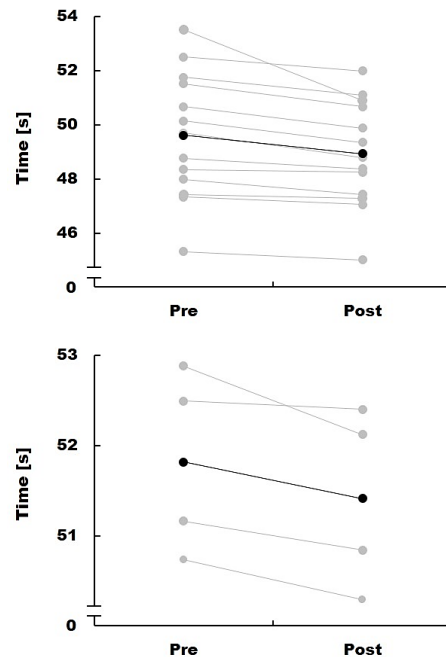


Figure 1. Comparison of personal records before and after the prescribed training in 400m sprinters and hurdlers. Gray and black solid lines represent individual data and mean value.

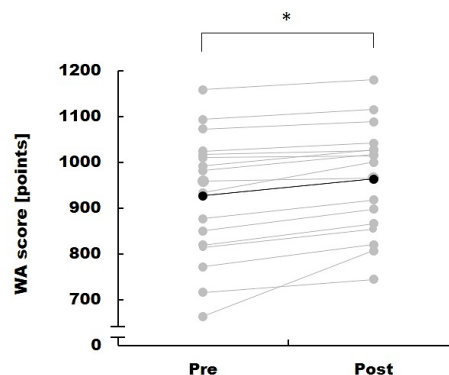


Figure 2. Change in WA score in all participants. Gray and black solid lines represent individual data and mean value.

Changes in the 400-m time were 0.69 ± 0.64 s (0.10–2.61 s) for the 400-m race and 0.40 ± 0.28 s (0.09–0.76 s) for the 400-m hurdle. The personal best times were below the SWCs (Table 1). The WA score increased significantly from 927 ± 138 to 964 ± 119 points (Figure 2). A significant negative correlation ($r = 0.70$, $p < .05$) was found between the WA score at baseline and its relative change before and after the sprint training. None of the 400-m hurdlers changed the number of steps between hurdles, lead leg, or stepping leg before and after the training.

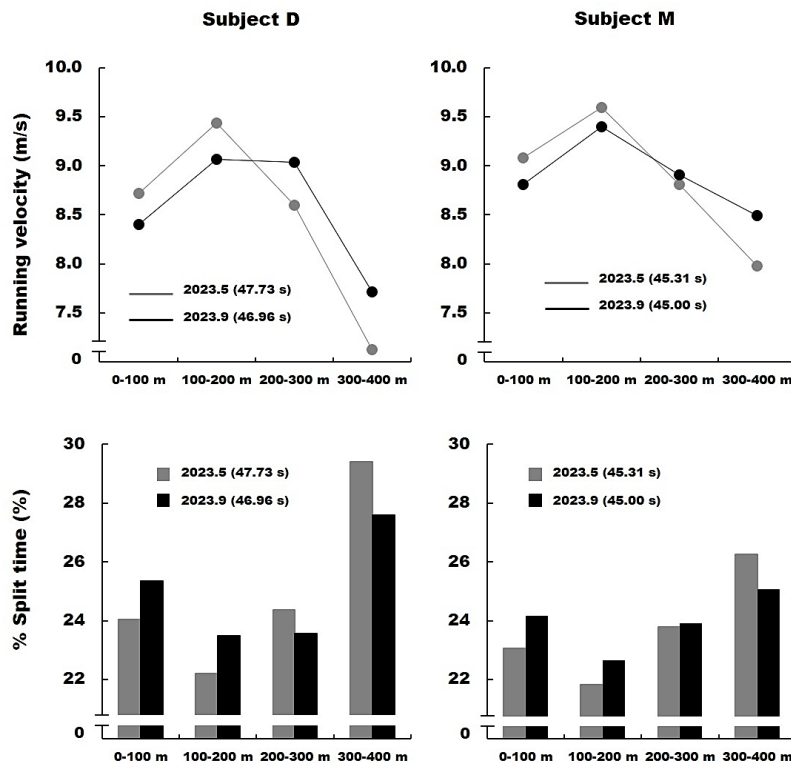


Figure 3. Running speeds and % Split time for each 100 m interval of the 400 m race during the control test 400 m sprint measured as the control test before and after changing pacing strategy.

Table 1. Changes in time taken for 400 m time after changing their pace strategy.

400m	Personal record (s)	After pace strategy (s)	Δ Time (s)	SWC (s)	Feasible
A	48.35	48.25	0.10	-	-
B	47.43	47.29	0.14	0.13	Favor
C	48.76	48.37	0.39	0.21	Favor
D	47.33	47.05	0.28	0.22	Favor
E	50.67	49.87	0.80	-	-
F	47.98	47.43	0.55	0.20	Favor
G	49.69	48.79	0.90	0.10	Favor
H	50.14	49.34	0.80	0.40	Favor
I	51.75	51.09	0.66	0.10	Favor
J	51.51	50.66	0.85	-	-
K	52.50	51.99	0.51	0.41	Favor
L	53.50	50.89	2.61	-	-
M	45.31	45.00	0.31	0.13	Favor
400 m Mean	49.97	49.25	0.72	-	-
400 m SD	2.09	1.70	0.66	-	-
400m hurdle	Personal record (s)	After pace strategy (s)	Δ Time (s)	SWC (s)	Feasible
A	50.73	50.29	0.44	0.29	Favor
O	52.88	52.12	0.76	0.24	Favor
P	52.49	52.40	0.09	0.09	Favor
Q	51.16	50.84	0.32	0.21	Favor
400mH Mean	51.82	51.41	0.40	-	-
400mH SD	1.03	1.01	0.28	-	-

DISCUSSION

This study found that male 400-m sprinters and hurdlers improved their personal best records after the proposed sprint training. The finding indicates that the sprint training designed to modify an individual's race development to reduce running speeds in the first 200 m, thereby increasing their running speeds in the 200–300-m segment, may be effective to improve personal best time. In this study, no data for %SP before and after an individual's official race in most sprinters and hurdlers were collected because participants took part in official races at separate venues. However, the split times for each 100 m interval during the official race could be measured before and after training in two participants (participant D: 47.73 s for 2023.5 to 46.96 s for 2023.9; participant M: 45.31 s for 2023.5 to 45.00 s for 2023.7), and the results are shown in Figure 3. The running speeds in the first half of the race decreased after the training, and the 400-m race time improved by acquiring higher running speed in the second half of the race. This demonstrates that the pacing distribution after the change in race strategy may update the personal best time. Notably, the participant M won the gold medal at the 25th Asian Athletics Championships 2023 with a personal best time of 45.00 s, which was achieved during the course of this study.

The potential mechanisms for improvement in personal best time may include the following: 1) a higher running speed in the 200–300-m segment after a lower running speed in the 0–100 m segment and 2) changes in the energy supply system, 3) changes in spatiotemporal variables during sprinting. First, the 400-m times are strongly associated with the split time in the 200–300-m segment (Sato et al., 2023; Stoyanov, 2016). A fast pace for the first 200 m is followed by a slow pace for the second 200 m (Coppenolle, 1980). The results illustrated in Fig. 3) support the previous findings (Coppenolle, 1980; Stoyanov, 2016; Yoshimoto et al., 2025). Therefore, by reducing the running speeds in the first 200 m, the running speed in the 200–300-m segment could have been increased, improving the 400-m time.

Second, reducing the running speeds in the first 200 m may have altered the energy supply system during the 400-m sprinting. Sarasilanidis et al. (Sarasilanidis et al., 2011) demonstrated that compared with high running speed gain (equivalent to 98% of the maximum speed), less running speed gain (equivalent to 93% of the maximum speed) up to the first 200 m reduced the accumulation of lactic acid in the first 200 m, resulting in better 400-m run times. The decrease in lactate concentration implies the contribution of the glycolytic system to the energy supply. In maximal exercise in humans, adenosine triphosphate is resynthesized immediately after the start through an anaerobic energy supply, primarily via the adenosine triphosphate–phosphocreatine and glycolytic systems (Gastin, 2001). However, the mobilization of these systems decreases significantly after approximately 30–40 s (Gastin, 2001). Therefore, limiting the running speeds in the first 200 m might diminish the utilization of the glycolytic system, allowing for a higher running speed in the second 200 m. However, we have no relevant data on the change in physiological parameters during the 400 m. Further, investigations are needed for this issue.

Third, it is possible that the spatiotemporal variables during the race changed as a result of the altered pace distribution. In a previous study where the pace distribution in a 400 m sprint was shifted from a leading type to a driven type, it was reported that the running speed decreased in the first half of the race and increased in the second half, leading to improved performance records (Chiba et al., 2025). Furthermore, when spatiotemporal variables during the race were examined, it was found that step length increased throughout the race, while step frequency decreased in the first half and increased in the second half. Although the present study did not analyse spatiotemporal variables and therefore cannot provide a detailed evaluation, it is possible that similar changes in spatiotemporal variables occurred, given that the same pace distribution changes were applied as in the previous study.

A significant negative correlation was found between the WA score at baseline and the relative change in this score before and after the prescribed sprint training. Yoshimoto et al. (Yoshimoto et al., 2025) demonstrated that 400-m sprinters with higher records ran relatively slower in the first half and faster in the second half than 400-m sprinters with lower records. Therefore, sprinters with lower records may have greater improvements in their personal best times after changing their pacing strategy.

CONCLUSIONS

In this study, the 4-week sprint training program designed to change the race strategy of sprinters and hurdlers, focusing on increasing their running speed over the 200–300-m segment with less speed gain in the first 200 m of the 400-m race, improves the personal best time of the participants.

AUTHOR CONTRIBUTIONS

YC, TY, KS, and YT conceived the idea of the study. TY drafted the original manuscript. YC, and TY developed the statistical analysis plan and conducted statistical analyses. YC, TY, KS, and YT contributed to the interpretation of the results. All authors reviewed the manuscript draft and revised it critically on intellectual content. All authors approved the final version of the manuscript to be published.

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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REFERENCES

- Chiba, Y., Sato, K., Yoshimoto, T., Ohnuma, H., Yamanaka, R., Takahashi, K.,...Takai, Y. (2025). Revamping Pace Distribution: A Case Study on Elevating the Men's 400 m Track and Field Japanese National Record After 32 Years. *Journal of Strength and Conditioning Research*, 39(4), e610-e615. <https://doi.org/10.55860/UDQX4879>
- Coppenolle, H. (1980). Analysis of 200-metres intermediate times for 400-metres world-class runners. *Track and Field Quarterly Review*, 80(2), 37-39.
- Duffield, R., Dawson, B., & Goodman, C. (2005). Energy system contribution to 400-metre and 800-metre track running. *Journal of Sports Sciences*, 23(3), 299-307. <https://doi.org/10.1080/02640410410001730043>
- Gastin, P. B. (2001). Energy system interaction and relative contribution during maximal exercise. *Sports Medicine*, 31(10), 725-741. <https://doi.org/10.2165/00007256-200131100-00003>
- Hanon, C., & Gajer, B. (2009). Velocity and stride parameters of world-class 400-meter athletes compared with less experienced runners. *Journal of Strength and Conditioning Research*, 23(2), 524-531. <https://doi.org/10.1519/JSC.0b013e318194e071>

- Saraslanidis, P. J., Panoutsakopoulos, V., Tsalis, G. A., & Kyprianou, E. (2011). The effect of different first 200-m pacing strategies on blood lactate and biomechanical parameters of the 400-m sprint. *European Journal of Applied Physiology*, 111(8), 1579-1590. <https://doi.org/10.1007/s00421-010-1772-4>
- Sato, K., Yoshimoto, T., Ohnuma, H., & Chiba, Y. (2023). Study of critical sprinting phase in 400-m sprint performance and race development characteristics of top sprinters in Japan. *Japan of Sprint Research*, 32, 15-24.
- Schiffer, J. (2008). The 400 metres. *New Studies in Athletics*, 23(2), 7-13.
- Stoyanov, H. (2016). Opportunities for breaking 43 seconds in the men's 400m. *New Studies in Athletics*, 31(1-2), 59-68.
- Yoshimoto, T., Chiba, Y., Sato, K., Ohnuma, H., & Takai, Y. (2025). A study of men's 400m pacing strategy. *Japan Society of Sprint Research*, 33, 19-28.



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