1 **TITLE: RELATIONSHIPS BETWEEN TRIATHLON PERFORMANCE AND**
2 **PACING STRATEGY DURING THE RUN IN AN INTERNATIONAL**
3 **COMPETITION**
4
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6

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1 **ABSTRACT**

2

3 **Purpose:** The purpose of the present study was to examine relationships between athlete's

4 pacing strategies and running performance during an international triathlon competition.

5 **Methods:** Running split times for each of the 107 finishers of the 2009 European Triathlon

6 Championships (42 females and 65 males) were determined with the use of a digital

7 synchronized video analysis system. A total of 5 cameras were placed on various positions of

8 the running circuit (4 laps of 2.42 km). Running speed and an index of running speed

9 variability ($IRSV_{race}$) were subsequently calculated over each section or running split.

10 **Results:** Mean running speed over the first 1272 m of lap1 was 0.76 $km.h^{-1}$ (+4.4%) and 1.00

11 $km.h^{-1}$ (+5.6%) faster than the mean running speed over the same section during the three last

12 laps, for females and males, respectively ($p < 0.001$). A significant inverse correlation was

13 observed between RS_{race} and $IRSV_{race}$ for all triathletes (females r = -0.41, $p = 0.009$; males r

14 = -0.65, $p = 0.002$; and whole population -0.76, $p = 0.001$). Females demonstrated higher

15 $IRSV_{race}$ compared with men (6.1 ± 0.5 $km.h^{-1}$ and 4.0 ± 1.4 $km.h^{-1}$, for females and males,

16 respectively, $p = 0.001$) due to greater decrease in running speed over uphill sections.

17 **Conclusions:** Pacing during the run appears to play a key role in high-level triathlon

18 performance. Elite triathletes should reduce their initial running speed during international

19 competitions, even if high level of motivation and direct opponents may lead them to adopt an

20 aggressive strategy.

21 **Keywords:** race analysis, speed variability, performance level, gender comparison.

INTRODUCTION

It has been well established that the distribution of work within an exercise event may have a considerable impact on overall performance (for review see Abbiss and Laursen[1]). Tucker[2] proposed that energy expenditure is regulated throughout an exercise task in order to delay the deleterious effects of fatigue and achieve the best possible performance outcomes. In triathlon, understanding and improving the influence of pacing on performance seems particularly relevant for the run portion of the event. Indeed, recent studies conducted during ITU World Cup (i.e. short distance) triathlon competitions have reported high correlation between finish position and running performance in both genders (r-value 0.71 to 0.99, $p < 0.01$).[3,4,5] Such high correlations with overall ranking were not evident in either swimming (r = 0.36 to 0.52) or cycling (r < 0.74).[3,4,5] In this context, recent field-based research has found that triathletes tended to progressively reduce speed (i.e. positive pacing strategy) throughout the run phase of ITU World Cup races.[3,4,5] For instance, during the 2001 and 2002 Lausanne World Cups most athletes ran faster over the first kilometre than the majority of other run sections, while residual effects of prior cycling were the highest[3,4]. Similarly, Le Meur et al[5] showed that all of the 136 triathletes competing in the 2007 Beijing ITU World Cup event adopted a positive pacing strategy through the running phase of the event. During this race, the first of the four laps was run 10.0% faster than the three remaining laps[5]. This pattern of energy expenditure contradicts current recommendations to adopt an even pacing strategy (*i.e.* constant pace) for endurance events (see Abbiss and Laursen[1]). From this point of view, some authors have identified pacing strategy during running as a possible factor of progress for elite triathletes.[4,5]

Hausswirth et al[6] showed that, for highly-trained triathletes, performance during a 10-km running leg of a triathlon was improved if athletes performed the first kilometre 5%

47   slower than their average 10-km pace. In this study, a 20 sec-variation in running time over

48   the first kilometre (210 s *vs.*190 s, *i.e.* 17 km.h^{-1} *vs.* 19 km.h^{-1}) led to an improvement of 150

49   ± 21s over the entire 10-km run. It is likely that the lowered intensity at the start of the run

50   reduced the early development of fatigue and thus improved overall performance when

51   compared with the overly aggressive fast start pacing strategies self-selected by the triathletes.

52   The reason highly-trained triathletes self-selected such aggressive pacing strategies is unclear.

53   However, it has been shown that one's perceived exertion may be a major factor influencing

54   running speed regulation[2,7]. Further, exertion or effort may be significantly influenced by both

55   external (i.e. race dynamics or environmental conditions)[2,7,8] and internal (i.e. motivational)

56   factors[2,7]. These findings suggested that pacing strategy is partially determined by the specific

57   emotion arousal associated with competition. In this perspective, Baron et al[7] hypothesized

58   that athletes occasionally follow pacing patterns that seem unreasonably aggressive compared

59   with those of prerace performances, potentially because of the motivation provided by

60   competition. Considering the discrepancy between the results from Hausswirth et al[6] and the

61   spontaneous fast running start systematically adopted by elite triathletes during world cup

62   races[3,4,5], further investigations are required to assess the benefit of a less aggressive strategy

63   in the particular context of major international mass-start competitions. Since pacing

64   strategies are based on robust cultural representations[9] and taking into consideration the small

65   differences in performance determining a competition outcome (often < 1% between top 10

66   triathletes in World Cup competitions), information concerning the best way to extend the

67   limited energetic sources available to the triathlete is of considerable value.

68

69   The aim of the present study was to determine relationships between running pacing

70   strategy and running performance during an international level triathlon competition. As

71   pacing strategy may affect running performance during a triathlon competition, we analysed if

72   the best male and female runners exhibited differences in running speed distribution over the

73   10-km triathlon run.

74

75   **MATERIAL AND METHODS**

76

77   **Participants**

78   Sixty-five male and forty-two female elite triathletes were involved in the present

79   study. The experimental methodology was performed in accordance with the Declaration of

80   Helsinki.

81

82   **Procedures**

83   Performance of each participant was examined during the running section of an

84   international triathlon competition (European Triathlon Championships, Netherlands, Holten,

85   July 5th, 2009). The running leg consisted of four 2.42 km hilly-laps (total of 9.68 km). Each

86   lap contained a change in altitude of 18 m which was condensed in a 335 m hill at a 3%

87   gradient. Since the remainder of the course contained no sections with a grade greater than $\pm$

88   0.5 %, no downhill sections were identified. Little wind (mean < 2 m.s^{-1}, data obtained from

89   Royal Netherlands Meteorological Institute) was observed over the circuit during the

90   competition day.

91

92   In order to ascertain performance times over the course, a video analysis system

93   recording at a frequency of 25 Hz (Sony HDR-CX12 AVHD) was synchronized with the

94   official timing system (Omega, Swatch Group, Swiss). The video analysis system included

95   five digital cameras located at the beginning of the run (i.e. exit of bike transition: 0), 283,

96   937, 1272 and 1829 m. Distances between these points were measured using both a measuring

97 wheel (Debrunner, Givisiez, art. 851.236) and a global positioning system, with an accuracy

98 of 2 - 3 m (GPS, Garmin GPSRAP 60CSx, Garmin Europe, United Kingdom).

99

100 **Data processing**

101   The elapsed time (s) for the entire run circuit, each lap and each section (i.e. uphill and

102 flat sections) were determined for each athlete using the race timing system and video data.

103 Running speed of each athlete (RS, $km.h^{-1}$) was determined via a subsequent video analysis

104 (Pro suite version 5.0, Dartfish®, Fribourg, Swiss) over the following sections: 0-283 m flat,

105 283-937 m flat, 937-1272 m uphill, 1272-1829 m flat and 1829-2420 m flat. In order to

106 perform comparisons of running speed over laps and sections of the course, data were

107 subsequently pooled over each of the four laps, and for flat (RS_{flat}, 2085 m per lap) and uphill

108 sections (RS_{uphill}, 335 m per lap), independently.

109

110   The difference in running speed between flat and uphill sections ($\Delta_{F/U}$, %) was

111 calculated for each athlete using the following equation:

112

$$\Delta F/U, \% = \frac{\text{Mean running speed over flat sections} - \text{Mean running over uphill sections}}{\text{Mean running speed over flat sections}}$$

113

114   In order to further examine the pacing strategy selected by athletes, an index of

115 running speed variability over the entire run ($IRSV_{race}$, $km.h^{-1}$) was calculated using the

116 following equation:

$$IRVS_{race} = \frac{\sum_{n=1}^{20}(RSsection(n) - \text{Mean RS}) * \text{Time over section (n)}}{\text{Total running time}}$$

117

118   Variability in running speed during each lap ($IRSV_{lap}$, km.h^{-1}), and over flat ($IRSV_{flat}$,

119   km.h^{-1}) and uphill ($IRSV_{uphill}$, km.h^{-1}) sections were also determined independently, as defined

120   by the equations below:

121

$$IRVS_{lap} = \frac{\sum_{n=1}^{5}(RSsection(n) - \text{Mean RS (lap)}) * \text{Time over section (n)}}{\text{Lap running time}}$$

122

$$IRVS_{flat} = \frac{\sum_{n=1}^{16}\big(RSsection(n) - \text{Mean RS (flat)}\big) * \text{Time over flat section (n)}}{\text{Total running time over flat sections}}$$

123

$$IRVS_{uphill} = \frac{\sum_{n=1}^{4}\big(RSsection(n) - \text{Mean RS (uphill)}\big) * \text{Time over uphill section (n)}}{\text{Total running time over uphill sections}}$$

124

125

126 **Statistical analysis**

127   Three females and nine males did not finish the race and were excluded from the

128   analysis. All statistical analysis was conducted using (Origin 8.0$^{®}$, OriginLab, Northampton,

129   MA, USA). Data are expressed as mean ± standard deviation (SD), unless otherwise stated.

130   The influence of running sections (i.e. uphill and flat) and laps on running velocity, $IRSV_{lap}$

131   and $\Delta_{F/U}$ were analyzed using a one-way repeated measures ANOVA. A one-way ANOVA

132   was used to determine the effects of gender on $\Delta_{F/U}$, $IRSV_{race}$, $IRSV_{flat}$ and $IRSV_{uphill}$. Where

133   significant effect was observed, a Tukey's post-hoc test was conducted to further delineate

134   differences between running sections (i.e. uphill and flat) and laps. A Pearson's product

135   moment correlation was used to determine the relationship between $IRSV_{race}$ and the average

136   running speed over the entire run circuit. The equation of the linear function representing *f(x):*

137   IRVS = a * RS + b was calculated for the whole population, females and males

138   independently, when considering the whole run and each lap. For analysis, significance was

139   accepted at $p < 0.05$.

140

141

142   **RESULTS**

143

144   **Overall performance.** The mean finish times for the entire event were 121 ± 4 min and $108 \pm$

145   3 min, for females and males, respectively.

146

147   **Running speed.** Mean time and speed over the running section were 37 min 32 ± 3 min (15.6

148   ± 1.0 km.h^{-1}) for females and 33 min 30 ± 2 min (17.4 ± 1.1 km.h^{-1}) for males respectively.

149   Running speed values are presented in Table 1. Mean running speed over the first 1272 m of

150   lap1 was 0.76 km.h^{-1} (+4.4%) and 1.00 km.h^{-1} (+5.6%) faster than the mean running speed

151   over the same section during the last three laps, for both females and males, respectively ($p <$

152   0.001). A similar result was found when considering the whole circuit (+0.6 km.h^{-1} and +3.7

153   % for females and +0.8 km.h^{-1} and +4.3% for males, respectively, $p < 0.0001$) or flat sections

154   (+0.5 km.h^{-1} and +2.7% for females and +0.7 km.h^{-1} and +4.0% for males, respectively, $p <$

155   0.0001) and uphills independently (+1.2 km.h^{-1} and +8.6% for females and +1.0 km.h^{-1} and

156   +5.9% for males, respectively, $p < 0.0001$) (Table 1). The speed (km.h^{-1}) at each point of the

157   running leg is depicted in Fig. 1. Thirty seven of the 95 finishers (12 females and 25 males)

158   demonstrated an increase of at least 5% over the run section prior to the finish line (*i.e.* lap4),

159   compared to the same section during lap3. For 11 of them (3 females and 8 males), this

160   increase reached more than 10%.

161

162   The mean running speed for each section (i.e. uphill and flat) of the course and the average

163    $\Delta_{F/U}$ per lap are presented in Table 1. Females demonstrated higher $\Delta_{F/U}$ than males over each

164   lap ($p < 0.0001$, Table 1). $\Delta_{F/U}$ increased significantly after lap1 in females ($p < 0.0001$),

165   however remained stable until lap3 for males ($p = 0.99$, $p = 0.04$, $p = 0.001$ between lap1, and

166   lap2, lap3, lap4, respectively, Table 1).

167

168   **Running speed variability.** A significant inverse correlation was observed between RS_{race}

169   and $IRSV_{race}$ for all triathletes (r = -0.41, $p = 0.009$, r = -0.65, $p = 0.002$, -0.76, $p = 0.001$, for

170   females, males and the whole population, respectively, Fig. 2). Similarly, an inverse

171   correlation was observed when considering each lap independently (r = -0.61, -0.75, -0.57 and

172   -0.57, for lap1, lap2, lap3 and lap4, respectively, when considering the whole population, $p <$

173   0.001). Females demonstrated higher $IRSV_{race}$ than males (6.1 $\pm$ 0.5 km.h^{-1} and 4.0 $\pm$ 1.4

174   km.h^{-1}, for females and males, respectively, $p = 0.001$, Fig. 2). $IRSV_{lap}$ increased immediately

175   after lap1 for females (+23.8%, +24.6% and +31.6% for lap2, lap3 and lap4, when compared

176   with lap1, respectively, $p < 0.001$, Fig. 3), while no significant difference was reported until

177   lap4 for males (+6.8% with $p = 0.88$, +21.9% with $p = 0.07$, +46.6% with $p = 0.004$, for lap2,

178   lap3 and lap4, when compared with lap1, respectively, Fig. 3). The linear function

179   representing $IRSV_{race} = a * RS_{race} + b$ demonstrated a greater heterogeneity of running speed

180   variability for males than for females because a greater slope (absolute value) was reported

181   for males than for females [|a| = 0.22 [0.05 to 0.38; mean (95% confidence interval)], and |a| =

182   0.79 (0.53 to 1.04) for women and men, respectively, Fig. 2].

183

184   The results revealed a significant inverse correlation between $IRSV_{flat}$ and RS_{flat} for both

185   genders and the whole population (r = -0.41, $p = 0.01$, r = -0.60, $p = 0.0001$, r = -0.37 $p =$

186   0.001, for females, males and the whole population, respectively, Fig. 2). The correlation

187   between $IRSV_{uphill}$ and RS_{uphill} was significant for males ($a = -0.78$, $r = -0.44$, $p < 0.0001$) but

188   not for females ($p = 0.09$) or the whole population ($p = 0.88$). No significant effect of gender

189   was observed concerning $IRSV_{flat}$ ($p = 0.23$) and $IRSV_{uphill}$ ($p = 0.15$).

190

191   **DISCUSSION**

192

193   While all triathletes adopted a positive pacing strategy during the run leg of the 2009

194   European Triathlon Championships (*i.e.* positive-split), the present results demonstrated that

195   the best runners tended to adopt a more even paced strategy. This finding extended previous

196   results[6] collected during individual time-trial triathlons by suggesting that triathletes should

197   avoid an aggressive fast-start pacing strategy during mass-start competitions. Furthermore,

198   results of the present study also indicate that the more successful competitors during this

199   event also slowed to a lesser degree on uphill sections of the course.

200   In the present study, athletes performed the first lap of the run significantly faster than

201   the remaining three laps (Table 1). After the first lap both males and females decreased their

202   average running speed by 0.5 km.h^{-1} (*i.e.* 3.1%) and 0.7 km.h^{-1} (*i.e.* 3.9%), respectively (Table

203   1). Thereafter, the difference in mean running speed did not vary more than 0.2 km.h^{-1} over

204   the remaining laps. These results support previous research conducted during World Cup

205   triathlon events which highlighted similar systematic fast start pacing strategies during short-

206   to middle- distance competitions[3,4,5]. Nevertheless, the effectiveness of such positive pacing

207   during the running section of a triathlon event remains unclear. Indeed, it has previously been

208   shown that a fast start pacing strategy may improve, hinder or have no effect on athletic

209   performance.[1] Despite this, Hausswirth et al[6] recently showed that performing the first

210   kilometre of a simulated time-trial triathlon 5% slower than the average pace of a 10-km

211   control run resulted in significant improvements in performance, when compared a relatively

212   fast start (*i.e.* first kilometre 5% faster than the average pace of a 10-km control run). In this

213   study, Hausswirth et al[6] hypothesised that the relatively slow start may have prevented

214   development of high physiological stress early in the exercise bout thereby preventing athletes

215   from considerably slowing later in the event. Results of the present study indicate that this

216   strategy is also viable for major mass-start international triathlons, as a significant inverse

217   correlation was found between running speed variability and mean running speed over the 10-

218   km triathlon run (r = -0.76, $p < 0.0001$). This correlation was also significant when

219   considering both genders independently (r = -0.41, $p < 0.01$ and r = -0.65, $p < 0.001$ for

220   females and males, respectively). Considering that all triathletes adopted a fast running speed

221   at commencement of the run (Fig. 1), it appears that the better performers demonstrated a

222   greater ability to limit decrements in running speed throughout the later stages of the race.

223   Since all triathletes in the present study self-selected a relatively fast-starting strategy

224   and better performers were able to maintain a more even pacing strategy over the entire run, it

225   may be suggested that elite triathletes should reduce their spontaneous initial running speed in

226   order to improve overall performance. However, it should also be noted that the high intensity

227   at the beginning of the run phase may be a tactical technique adopted by triathletes in order to

228   stay in the same group/pack as their direct opponents. Conversely, Tucker et al.[9] analyzed the

229   evolution of pacing during 32 consecutive world records of the 5 km performed over the past

230   century and suggested that pacing strategy might be associated with a cultural learning

231   process. Their results revealed that since 1920, running speed variability in the 5 km world

232   record has progressively decreased. Furthermore, the pacing select by world record holders

233   has shifted from a "reverse J-shaped" strategy[1] towards a more even strategy, suggesting that

234   the pacing strategy of elite athletes' may be optimized over decades. The systematic fast start

235   adopted by triathletes during the cycle-to-run transition in competitions[3,4,5] and multi-

236   transition training sessions[10] may therefore be associated with a learnt template of

237   performance, rather than an optimal strategy. Further research is needed in order to gain a

238   greater understanding as to the influence of unconscious/physiological and

239   conscious/emotional (i.e. motivation and tactics) factors influencing pacing strategies during

240   elite athletic competition.

241   In addition to maintaining a more even pacing strategy over the entire event, the

242   results of the present study showed that top performers slowed to a lesser degree on the uphill

243   section of the course, as evidenced by a significant relationship between running speed

244   variability and performance within laps. It has previously been shown, with the use of

245   mathematical models[11,12] and actual performance trials[13], that increasing energy expenditure

246   to counter periods of high external resistance (i.e. uphill and into a headwind) and decreasing

247   expenditure when resistance is low (i.e. downhill and with a tailwind) results in meaningful

248   improvements in performance. Since energy expenditure or power output varies, this theory

249   has previously been termed a 'variable pacing strategy'[1,13] however such variation is

250   performed in an attempt to maintain an even pace/speed. As a result, the better runners in the

251   present study tended to adopt a more even pacing strategy when compared with the less

252   successful athletes. Since such strategy may be dependent of the circuit design (*i.e.* uphill and

253   downhill lengths and grades), further investigations are necessary to determine the

254   acceptability of running speed variation over hilly course.

255   Interestingly, the relative difference in running speed observed between uphill and flat

256   sections in the present study was 18.9% for females, while males slowed down by only 5.9%

257   (*P*<0.001*)*. This difference is likely to explain the higher running speed variability over the

258   whole run observed by females, compared with males (r = -0.41, *p* = 0.009 and r = -0.65, *p* =

259   0.002, respectively). The greater influence of uphill sections on running speed variability in

260   female triathletes may be linked to a lower power-to-mass ratio and thus a greater influence of

261   changes in gradient on running speed. Le Meur et al[5] recently reported that female triathletes

262 (with similar level of performance of the ones in the present race) spent relatively more time

263 than males above their maximal aerobic power in the hilly sections of the cycling circuit.

264 These authors proposed that females were disadvantaged by their lower power-to-mass ratio,

265 which was correlated with the time spent above their maximal power output in uphill sections

266 (r=-0.73, $P < 0.05$). In this perspective, the present research furthers previous research

267 collected during the cycling leg of world cup triathlon[5] by demonstrating that female

268 triathletes should focus on their aptitude for running over incline sections by improving their

269 running skills or their power-to-mass ratio.[14]

270 Interestingly, the variability in running velocity of both males and females over the

271 entire run increased significantly over the four running laps (Fig. 2). As such it appears that

272 athletes pacing strategy become significantly less even as the trial progressed. The factors

273 responsible for such increases in the variability of pace are currently unclear, however it has

274 been suggested that greater fluctuations in speed later in the event may be related to the

275 development of fatigue and associated alterations in neural drive.[15] Supporting this, it has

276 recently been found that the variability in power output during a 40 km cycling time trial may

277 be significantly greater in hot (32°C) compared with cool (17°C) climates.[15] This study

278 hypothesized that the increase in the variability of power output in conditions of high

279 physiological stress (i.e. exercise in the heat) was related to alterations in afferent feedback,

280 arousal and central drive.[15] Indeed, it has been suggested that brain continuously performs

281 subconscious calculations by comparing the physiological demands of an exercise task with

282 the athlete's physiological capacity, and the level of motivation, in order to insure that the

283 exercise can be maintained for the expected duration without any catastrophic failure in

284 physiological and emotional homeostasis[15]. As a result, triathletes in the present study may

285 have experienced difficulties to sustain a constant pace later in the run due to high negative

286 load associated with increases in perceive exertion/fatigue. Further research is warranted in

287   order to better understand the factors influencing the variability speed and energy expenditure

288   during exercise.

289   While previous field-based studies[3,4,5] have shown that triathletes adopted a systematic

290   positive pacing strategy, the high number of split times measured in the present research (*i.e.*

291   20) allowed a more accurate description of running speed evolution during the triathlon and

292   revealed that 39% of the finishers of the present race demonstrated an "end-spurt". The video

293   analysis revealed that the majority of these competitors were packed at the penultimate split

294   point (571m previous the finish line), which likely resulted in increasing intensity in the final

295   section to complete the race ahead their direct opponents. This observation confirmed that the

296   presence of other competitors influence pacing strategy by suggesting that the global positive

297   pacing systematically adopted by triathletes may shift towards a "reverse J-shaped" strategy

298   depending on race dynamics. Given the high percentage of triathletes that displayed a final

299   increase in running speed, it appears that elite triathlon performance is associated with a

300   capacity to sprint at the end of the 10-km run.

301

302   **Conclusion**

303   This study demonstrated that the running performance (and overall performance)

304   during an international triathlon is correlated with running speed variability. Top female and

305   male international triathletes demonstrated a trend to adopt a more even pace, whereas less

306   successful athletes chose an unreasonably aggressive pacing pattern over the initial phase of

307   the run resulting in a significant subsequent decrease in running speed.

308

309   **Practical applications**

310   The present research showed that elite triathletes should reduce their initial running

311   speed during international competitions, even if high level of motivation and direct opponents

312   lead them to adopt an aggressive start. In this regard, more research is required to observe the

313   way in which triathletes develop their pre-exercise strategy and which intervention could

314   influence their initial starting effort to optimize their running performance level. This study

315   also highlighted that elite triathlon performance may be associated with the capacity to sprint

316   at the end of the 10-km run and that female triathletes should focus on their aptitude for

317   running over incline sections by improving their running skills or their power-to-mass ratio.

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TABLE 1. Evolution of running speed throughout the running leg over the whole circuit, flat sections and uphill sections for female and male triathletes ($n = 39$ and $n = 56$ for females and males, respectively). * Significantly different from Lap1, $p < 0.0001$. [#] Significantly different from previous lap, $p < 0.0001$. Females demonstrated significant differences with males over each lap in running speed and relative decrease in running speed between flat and uphill sections.

| Gender	Circuit sections	Overall run	Lap1	Lap2	Lap3	Lap4
Female	Whole (km.h^{-1})	15.6 ± 1.0	16.1 ± 1.0	15.6 ± 1.0$^{*\#}$	15.4 ± 1.0*	15.5 ± 1.1*
	Flat (km.h^{-1})	16.1 ± 1.0	16.5 ± 1.0	16.1 ± 1.0$^{*\#}$	16.0 ± 1.0$^{*\#}$	16.1 ± 1.0*
	Uphill (km.h^{-1})	13.1 ± 0.9	14.0 ± 1.2	13.0 ± 0.9$^{*\#}$	12.7 ± 0.8$^{*\#}$	12.7 ± 0.8*
	Δflat/uphill (%)	18.9 ± 1.2	15.0 ± 0.5	19.2 ± 0.3$^{*\#}$	20.2 ± 0.3*	20.7 ± 0.3*
Male	Whole (km.h^{-1})	17.4 ± 1.1	18.0 ± 1.4	17.3 ± 1.2$^{*\#}$	17.1 ± 1.1$^{*\#}$	17.3 ± 1.0*
	Flat (km.h^{-1})	17.6 ± 1.1	18.1 ± 1.2	17.4 ± 1.2$^{*\#}$	17.3 ± 1.1$^{*\#}$	17.5 ± 1.1*
	Uphill (km.h^{-1})	16.6 ± 1.1	17.4 ± 1.7	16.6 ± 1.6$^{*\#}$	16.3 ± 1.2$^{*\#}$	16.2 ± 1.2*
	Δflat/uphill (%)	5.9 ± 2.5	4.4 ± 0.5	4.5 ± 0.8	6.2 ± 0.4	8.0 ± 0.4$^{*\#}$
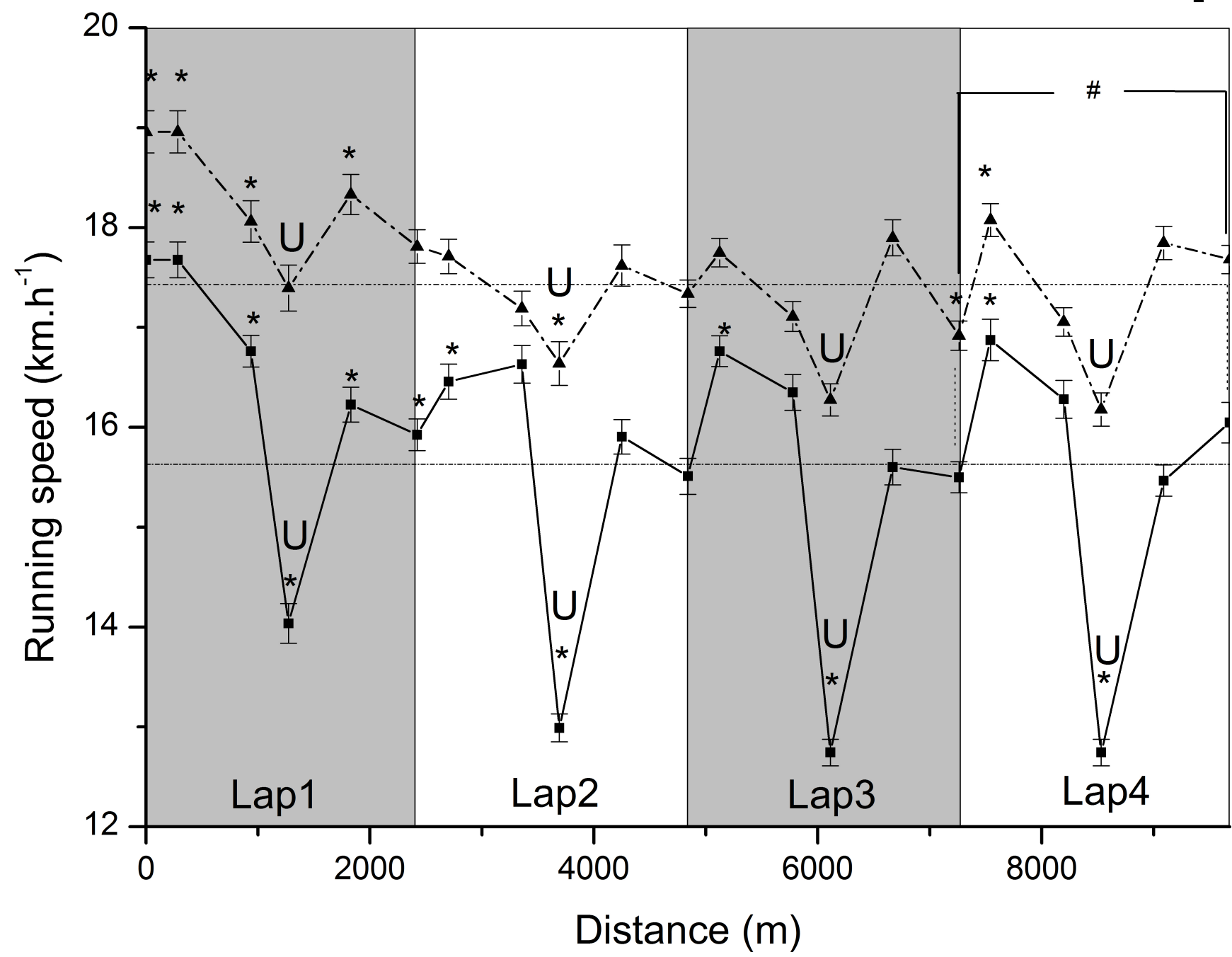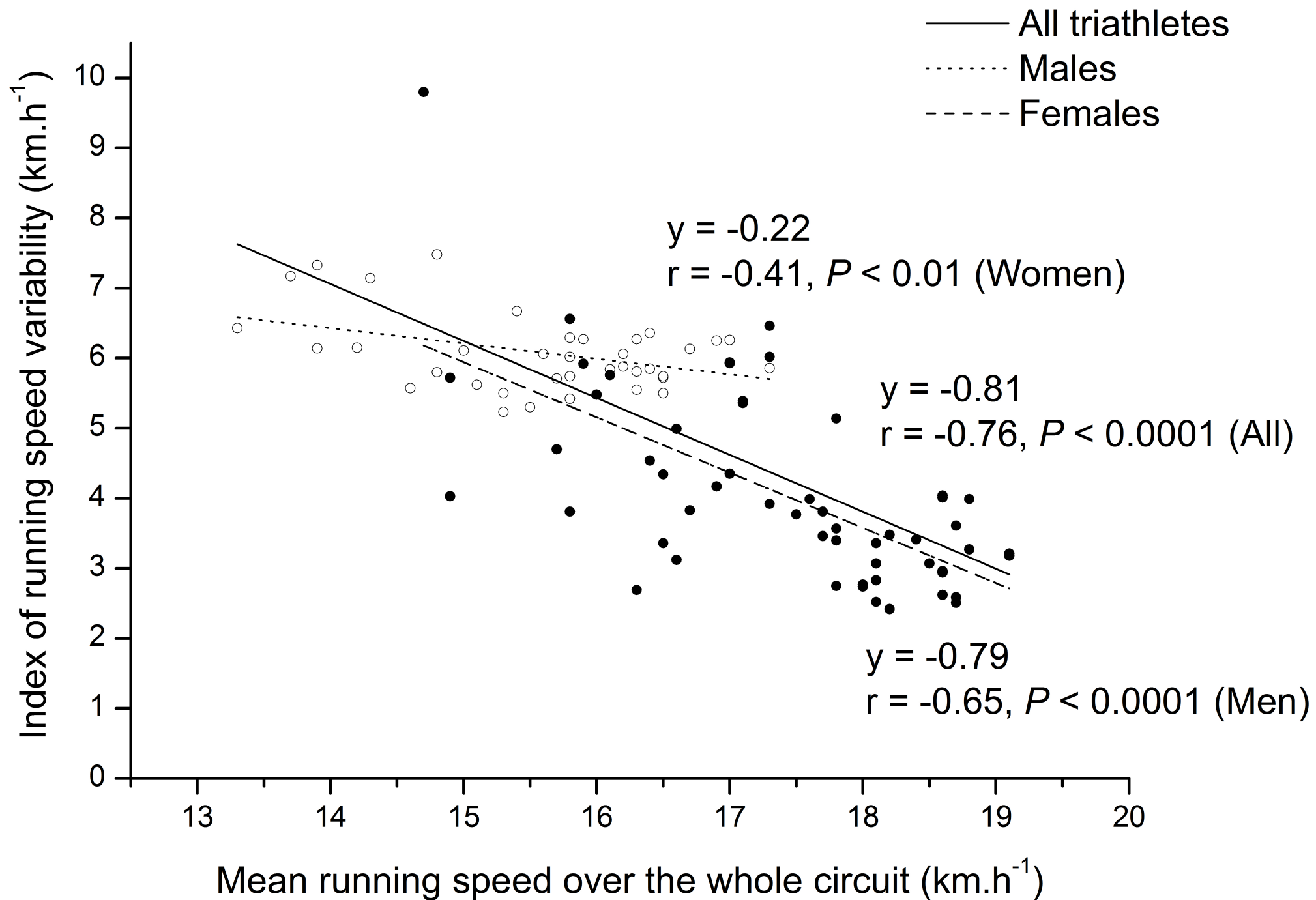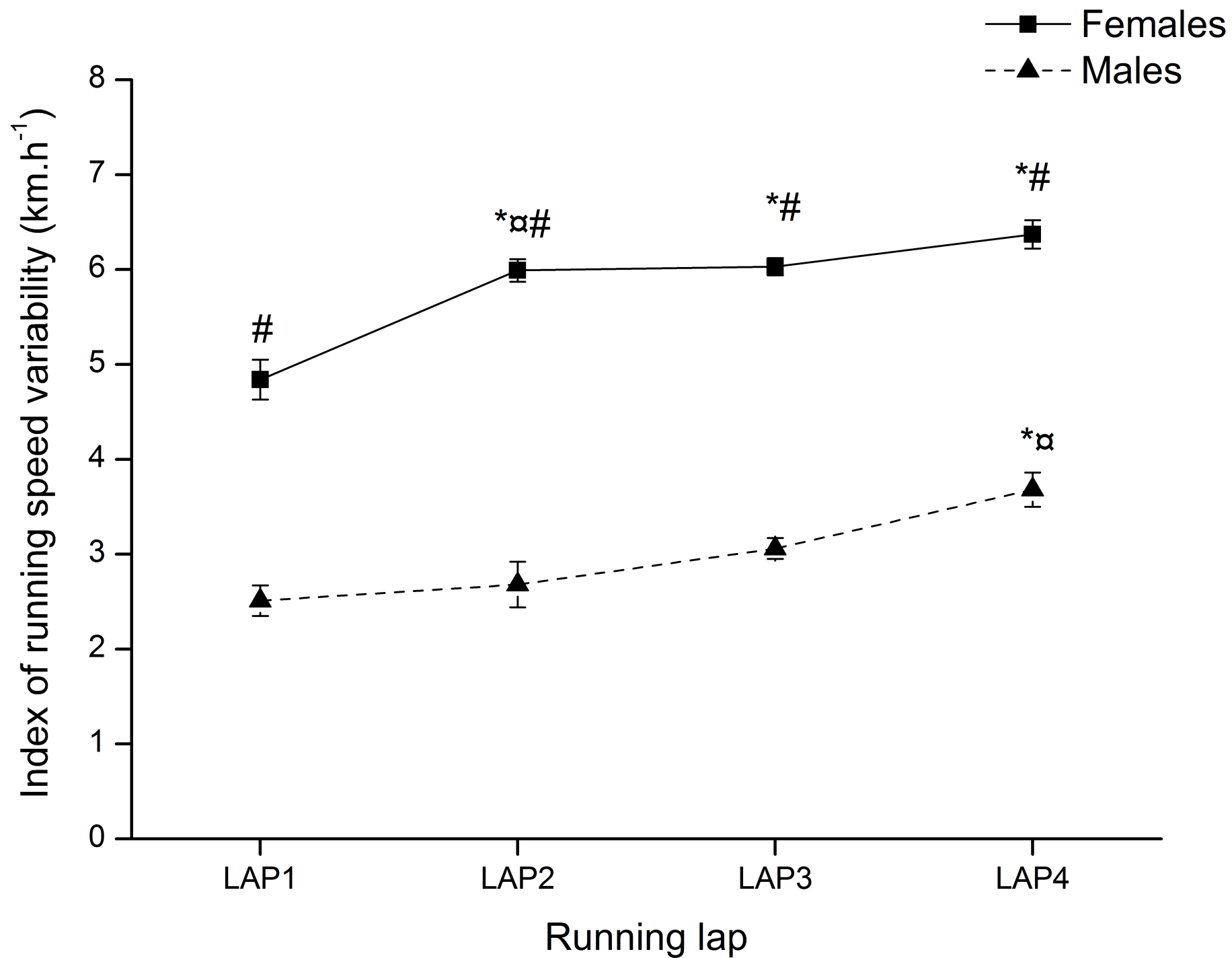
FIGURE 1. Average running speed for each of the running sections for elite female (n=39) and male triathletes (n=55) during the European Triathlon Championships. U: uphill sections (sections without any indication were flat).
* Significantly different from the mean running speed over the whole circuit.
# Significantly different from the speed over the same section during previous lap.

FIGURE 2. Index of running speed variability over the whole running section for senior males (n=55), females (n=39) and all triathletes during the European Triathlon Championships.

FIGURE 3. Average index of running speed variability for each of the four laps for elite female (n=39) and male triathletes (n=55) during the European Triathlon Championships.
* Significantly different from Lap1,
¤ Significantly different from previous lap,
Significantly from men.