Reviewer's report

Title: Pacing strategy in male elite and age group 100 km ultra-marathoners

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Reviewer: Simon Angus

Reviewer's report:

A. Major Compulsory Revisions

A1. Underlying hypothesis to be tested

The brief review of the literature points directly to the fact that 'older, faster, and female' (p.4) competitors are better able to achieve even (less slow down) pacing in similar events. However, the second paragraph on p.5 which outlines the central hypothesis that the paper will test says,

"Since running performance in 100 km ultra-marathon running decreased with increasing age, we may assume that older runners (i.e. older than ~35-45 years) will faster slow down during a 100 km ultra-marathon than younger runners (i.e. younger than ~35-45 years)."

The authors seem here to confuse 'average running speed' with 'poor pacing'. To be clear, the literature finds that:

a) Older runners tend to achieve lower average running speeds over the event (lowering their relative performance); but

b) Older runners tend to achieve more even (arguably better) pacing over the event.

The authors must clarify what their hypothesis is -- are they testing the age--average speed nexus, or the age--pacing nexus? These are difference questions.

A2. Lack of control for gradient

The authors study a running race over 100km, in the out-doors, natural environment. The major analytical approach of the study is to compare an athlete's average speed in two of the four segments in the race (see B1). Indeed, the title of the paper and its ensuing language indicate that the authors wish to study the 'pacing strategy' of the athletes in the study. 'Pacing strategy' is the distribution of effective power an athlete makes over the course of a race. In running, since we do not have direct access to power (e.g. measured by a device in the shoe), we fall back to measuring the speed of the athlete as a proxy. However, the speed of the athlete, in field conditions, represents the power signal that we wish to focus on /and/ the impact of gradient and incident wind.
vectors and other environmental factors. Thus, to recover 'pacing strategy' from field data, and so compare earlier to later proxies for power of the athlete, one needs to make an attempt to 'net out' other significant factors that pollute the power signal obtained from running speed.

In this event we have segment variation in both of the gradient- and wind- vector dimensions. The authors include, in Figure 6, the altitude variation on course. We can see from here, or for example in the more detailed data obtainable from a major GSP community website [1] that the variation in the gradient is significant. Hence, we cannot really talk about 'pacing strategy' derived from speed without correcting in some way for the influence of gradient on-course.

Wind could also be a factor and would be worth exploring likewise. Yes, the course is 'out and back', but given that it traces something of a circle, the impact of the wind (if constant through the race) on each segment will vary from side, to tail, to head, to side and so on. Though, it could be argued, at ultra-marathon pace, the influence of wind is reduced relative to shorter running events.

In any case, the point remains that without correcting for gradient (and perhaps wind) I do not believe that we can say anything about small changes in average segment running speed over the course of this event.

I note that the authors point to such variations as possible reasons for pacing variation in the Discussion section, but it is my opinion that this is not really good enough. All they have really done here is to admit that the data they have presented are polluted by 'environmental' (including gradient) factors; rendering all previous conclusions which compare one average speed segment to another invalid.

The request being made here is not beyond the ability or revealed technology of the field. The authors could look at two papers which have addressed methodologically, and in example, these problems with field data. [2] [3]


B. Minor Essential Revisions

B1. Clarification of running speed data

The basis of the speed data in this paper is the time taken by an athlete to complete one of 4 segments of the race. Hence, the best that we can say about the 'speed' of any athlete is the 'average speed for segment X' (where X \in \{1..4\}). However, the authors persist in several places to use language of
instantaneous speed. e.g. in the Abstract, "Running speed at time station (TS) 2 (56.1 km) was compared to running speed at TS1 (38 km) and TS3 (76.7 km) and running speed at TS3 was compared to running speed at the finish."

All references to 'running speed at location X' should be removed and a standard system of referring to 'average running speed over a segment' should instead be used to avoid mis-interpretation.

B2. You have two 'Figure 5's.

**Level of interest:** An article of limited interest

**Quality of written English:** Acceptable

**Statistical review:** No, the manuscript does not need to be seen by a statistician.

**Declaration of competing interests:**

I declare that I have no competing interests.