

Comparison between running performance in time trials on track and treadmill

Comparação entre desempenhos de corrida time trial realizados em pista e esteira

Cecília Segabinazi Peserico¹
Fabiana Andrade Machado¹

Abstract – Few studies have investigated the influence of test environment (field vs. laboratory) on pacing strategy and on physiological variables measured during endurance running performance tests. The objective of this study was therefore to compare the behavior of mean velocity (MV), pacing strategy, heart rate (HR) and rating of perceived exertion (RPE) during one-hour running time trials conducted on an athletics track with the behavior of the same variables during one-hour running time trials conducted on a treadmill. Eighteen male recreational runners (25.4 ± 3.3 years) performed two one-hour time trials; the first running on a treadmill and the second on a 400 m athletics track. Rating of perceived exertion and HR were recorded every 10 minutes and MV was calculated every 15 minutes for analysis of pacing strategy (0-15min; 15-30min; 30-45min; and 45-60min). These performance variables were compared using Student's *t* test for paired samples. Figures for MV, HR and RPE measured at different points during the trials were compared using two-factor ANOVA for repeated measures, followed by Bonferroni's *post hoc* test. A significance level of $P < 0.05$ was adopted for all analyses. Mean velocity was higher for the trials on the running track ($12.2 \pm 0.8 \text{ km}\cdot\text{h}^{-1}$) than for the trials on the treadmill ($11.8 \pm 0.8 \text{ km}\cdot\text{h}^{-1}$). Additionally, there were also differences between the two test environments for mean and maximum heart rate, and in terms of pacing strategy. On the basis of these differences, it can be concluded that performance was influenced by the environment in which the one-hour time trials were conducted.

Key words: Athletic performance; Environment; Running.

Resumo – Poucos estudos verificaram a influência do ambiente de teste (campo e laboratório) sobre o ritmo de corrida e variáveis fisiológicas obtidas durante o desempenho em corrida de endurance. Portanto, o objetivo deste estudo foi comparar o comportamento da velocidade média (VM), ritmo de corrida, frequência cardíaca (FC) e percepção subjetiva de esforço (PSE) obtidas durante os desempenhos de corrida em provas time trial de uma hora realizados em pista de atletismo e em esteira. Dezoito homens corredores recreacionais ($25,4 \pm 3,3$ anos) realizaram duas performances de uma hora de corrida: uma em esteira e outra em pista de atletismo de 400 m. A PSE e a FC foram registradas a cada 10 minutos, e a VM a cada 15 minutos para a determinação do ritmo de corrida. As variáveis relacionadas aos desempenhos foram comparadas pelo teste *t* de Student para amostras pareadas. Os valores de VM, FC e PSE obtidos durante diferentes momentos das provas foram comparados pela Anova de dois fatores para medidas repetidas seguido do *post hoc* de Bonferroni. Para todas as análises, foi adotado nível de significância de $P < 0,05$. A VM da prova realizada em pista ($12,2 \pm 0,8 \text{ km}\cdot\text{h}^{-1}$) foi superior à prova em esteira ($11,8 \pm 0,8 \text{ km}\cdot\text{h}^{-1}$). Além disso, foram encontradas diferenças entre os dois desempenhos para os valores de frequência cardíaca média e máxima, e para o ritmo de corrida. A partir dessas diferenças, conclui-se que os desempenhos foram influenciados pelo ambiente onde as provas de uma hora foram realizadas.

Palavras-chave: Corrida; Desempenho atlético; Meio ambiente.

1 Universidade Estadual de Maringá. Programa de Pós Graduação Associado em Educação Física UEM/UEL. Maringá, PR. Brasil.

Received: 21 June 2013
Accepted: 11 February 2014



Licence
Creative Commons

INTRODUCTION

Long distance (endurance) runners' performance is usually evaluated in time trials, in which participants either attempt to cover a fixed distance in the shortest time possible or attempt to cover the greatest distance possible in a fixed time¹. Assessing runners allows researchers and trainers to simulate sporting performance and/or investigate elements related to performance in a controlled manner, making it possible to choose certain variables and use them to monitor athletes' progress, with the objective of setting targets for performance improvements².

In this context, many studies have employed a one-hour test to assess performance in endurance running because it is representative of a range of the different competitions in which long distance runners compete, and because it is a test that has demonstrated a high degree of reproducibility for assessment of endurance runners³⁻⁶.

With regard to test environments, time trials can be conducted in the field (athletics track) or in laboratories (treadmill). Studies that have investigated differences in running patterns between the two have found differences between trials conducted on a track or treadmill in relation to biomechanical aspects, maximum velocity attained and perceived velocity⁷⁻¹⁰. Nummela et al.⁹ and Morin and Seve⁸ analyzed maximal sprint tests conducted on treadmill or track and found that maximum velocity attained was statistically higher on the track than on the treadmill. However, a large proportion of published studies have assessed performance in short duration tests, i.e. sprints, and there has so far been little study of the difference between performance in endurance time trials conducted in the field and in the laboratory.

Another important aspect to be taken into account when assessing performance in endurance tests is the pace or race strategy adopted by the runner. Studies that have analyzed pacing strategy and the behavior of physiological variables during endurance running have found that the best strategy that would make best performance possible is not established¹¹⁻¹³. Additionally, factors such as the capacity of energy systems, the runner's experience, duration of the trial and environmental conditions all have an effect on the choice of pacing strategy^{12,14}. However, no studies have investigated the influence of test environment (field or laboratory) on pacing strategy and on the behavior of physiological variables recorded during endurance running.

The objective of this study was therefore to compare the behavior of mean velocity (MV), pacing strategy, heart rate (HR) and rating of perceived exertion (RPE) during one-hour time trials run on an athletics track and on a treadmill. Our hypothesis is that the MV for the trial performed on the track will be greater than for the treadmill trial and that pacing strategy and the behavior of HR and RPE will be influenced by test environment.

METHODOLOGICAL PROCEDURES

Participants

Eighteen male recreational endurance runners volunteered to take part in the study. They had experience of local and/or regional 10 km competitions and were on a systematic training program (age 25.4 ± 3.3 years; height 178.0 ± 0.7 cm; body mass 76.2 ± 8.6 kg; body mass index (BMI) 24.1 ± 2.3 kg·m⁻² and body fat percentage (%G) 13.9 ± 3.0 %). They had started running an average of 3.8 ± 3.3 years previously, were training an average of 3.2 ± 1.1 days week⁻¹, covering an average distance of 26.9 ± 16.6 km·week⁻¹. Additionally, 15 of the 18 volunteers trained in open areas such as parks and streets. Before any experimental procedures were conducted, participants signed free and informed consent forms and the research project was approved in advance by the Research Ethics Committee at the Universidade Estadual de Maringá, under protocol number 719/2010.

Experimental Design

The volunteers were already accustomed to conducting trials both on treadmills and on running tracks. They undertook two performance tests in the form of one-hour time trials, the first running on an automatic programmable ergometric treadmill (INBRAMED Super ATL, Porto Alegre – Brazil) and the second on a 400 m outdoor athletics track. The sequence of trials was dictated by the availability of venues. An interval of one week was left between tests. Participants were instructed to present for the tests in a well-hydrated state and to continue eating their usual diet, eating breakfast as normal before all tests, and to abstain from consuming alcohol or caffeine for 24 hours before assessments. Participants were also asked to suspend their training routines during the test period. All assessments were conducted in the mornings with the objective of maintaining similar experimental conditions throughout. Additionally, treadmill trials were conducted in an air-conditioned laboratory (with temperature set at 20°C to 24°C and relative humidity between 50 and 60%), while track trials were conducted at temperatures ranging from 16°C to 26°C, with humidity ranging from 60 to 80%.

Performance of one-hour time trials (track and treadmill)

Both one-hour time trials were preceded by a five-minute warm-up period, at 6 km·h⁻¹ on the treadmill and as participants preferred on the track. For both types of trial, participants were requested to attempt to run as far as possible in one hour and the total distance achieved was recorded. The overall MV for each trial was calculated by dividing the total distance covered by the trial duration. Additionally, partial MVs were calculated for each 15 minutes in order to profile their pacing strategy at four points during the trial (0-15min; 15-30min; 30-45min; 45-60min). Before the tests, participants were familiarized with the Borg 0-20 scoring scale¹⁵ used to determine their rating of perceived exertion (RPE) during the trials. Additionally, heart rate was monitored throughout all trials using a heart rate monitor (Polar RS800).

The values of HR and RPE were recorded every 10 minutes. In treadmill trials, RPE was measured without pauses, whereas on the track RPE was recorded when participants passed points chosen by the evaluator, which were spaced approximately 10 minutes apart in time. Mean heart rate (HR_{mean}) was calculated as the mean of HR values recorded and maximum heart rate (HR_{max}) was the highest rate recorded at any point during the trial. The RPE value recorded at the end of the trial was taken as final RPE (RPE_{final}).

The information given to participants during the trials was limited in order to reduce the influence of any other variables on results^{1,3}. During the track time trial, participants were only informed of the time that had passed every 5 minutes, by the researcher, while the treadmill provided participants with visual feedback consisting of time and velocity, with inclination set at 1%¹⁶. Before the tests, participants had been taught how to control the velocity of the treadmill. Each trial was initiated with the treadmill velocity set at 8 km·h⁻¹ and thereafter participants self-selected their pace until the end of the trial. Mineral water was provided *ad libitum* in cups throughout both types of trial, so that runners could hydrate themselves as they are used to doing in long-distance races.

Statistical analysis

Data were expressed as mean \pm standard deviation (SD); normality of data was verified using the Shapiro-Wilk test. Variables related to performance on track and treadmill were compared using Student's *t* test for paired samples. Results for MV, HR and RPE recorded at different points during the track and treadmill trials were compared using two-factor ANOVA for repeated measures followed by the Bonferroni *post hoc* test for multiple comparisons. The assumption of sphericity was verified using the Mauchly test and when violated the degrees of freedom were corrected using Greenhouse-Geisser sphericity estimates. Analyses were conducted with the aid of the *Statistical Package for the Social Sciences* version 17.0 (SPSS). For all analyses, a significance level of $P < 0.05$ was adopted.

RESULTS

Table 1 lists the results for variables related to performance in the one-hour time trials on treadmill and track. The MV for the treadmill trial was statistically slower than the MV for the track trial ($P = 0.001$). Additionally, values of HR_{med} (bpm) and HR_{max} (bpm) were statistically different between the two trial types ($P = 0.016$ and 0.030 , respectively). There was no difference in RPE_{final} (6-20) between the two types of test ($P > 0.05$).

Pacing strategy was analyzed by calculating MV every 15 minutes, i.e. for 0-15min, 15-30min, 30-45min and 45-60min. Two-factor ANOVA for repeated measures detected a main effect on mean velocities calculated every 15 minutes from the test environment ($P = 0.001$) and from stage of time trial (time elapsed) ($P = 0.021$). The figures shown in Table 2 demonstrate that there was a difference between treadmill and track trials

in terms of mean velocity during the first quarter (0-15min) of the trials. Additionally, during the treadmill time trial, the pacing strategy was to increase MV progressively, whereas on the track the behavior of MV was constant. Furthermore, there was also an interaction between test environment and stage of time trial (time elapsed) ($P < 0.001$).

Table 1. Comparisons between results for one-hour time trials on treadmill and running track. (n=18)

	Treadmill	Track
MV (km·h ⁻¹)	11.8 ± 0.8	12.2 ± 0.8*
HR _{mean} (bpm)	175 ± 7.8	178 ± 7.5*
HR _{max} (bpm)	188 ± 7.1	184 ± 8.1*
RPE _{final} (6-20)	19 ± 0.8	19 ± 1.1

MV, mean velocity; HR_{mean}, average heart rate; HR_{max}, maximum heart rate; RPE_{final}, maximum rating of perceived exertion; * $P < 0.05$ compared to the treadmill trials.

Table 2. Mean velocities (MV), calculated for 15-minute intervals, during the one-hour time trials on treadmill and track (n=18).

	0-15 min	15-30 min	30-45 min	45-60 min
MV Treadmill (km·h ⁻¹)	10.9 ± 1.0	11.8 ± 1.0 ^a	11.9 ± 0.8 ^a	12.5 ± 0.9 ^a
MV Track (km·h ⁻¹)	12.6 ± 1.0*	12.2 ± 0.9	11.9 ± 0.9	12.1 ± 1.0

* Difference ($P < 0.05$) between track and treadmill. ^a Difference ($P < 0.05$) with relationship to 0-15 min of treadmill trial.

Table 3 lists the results recorded for HR and RPE every 10 minutes during the one-hour time trials on treadmill and track. Two-factor ANOVA for repeated measures demonstrated that both the environment in which trials were conducted ($P = 0.016$) and stage of time trial (time elapsed) ($P < 0.001$) had a main effect on HR recorded every 10 minutes and also showed that there was an interaction ($P < 0.001$) between the two independent factors. The RPE scores were also affected by test environment ($P = 0.005$) and stage of time trial ($P < 0.001$), and these factors also exhibited an interaction ($P = 0.013$). Additionally, it was observed that HR was statistically different between track and treadmill at the 10th minute, while RPE was different at the 40th. Furthermore, in the treadmill trials HR increased constantly over time and RPE exhibited the same behavior in both types of trial.

Table 3. Results for heart rate (HR) and rating of perceived exertion (RPE) recorded every 10 minutes during one-hour time trials on treadmill and track (n=18).

	Time (min)					
	10	20	30	40	50	60
HR (bpm)						
Treadmill	160 ± 12.7	169 ± 11.0 ^a	174 ± 8.9 ^a	178 ± 8.3 ^{a,b}	182 ± 6.7 ^{a,d}	188 ± 7.1 ^{a,e}
Track	174 ± 9.2*	176 ± 8.9	177 ± 9.1	180 ± 8.1	181 ± 7.5	183 ± 8.7
RPE (6-20)						
Treadmill	8 ± 1.8	11 ± 2.0 ^a	12 ± 1.8 ^{a,b}	14 ± 1.9 ^{a,c}	17 ± 1.8 ^{a,d}	19 ± 0.8 ^{a,e}
Track	9 ± 1.4	11 ± 1.4 ^a	13 ± 1.7 ^{a,b}	15 ± 2.0 ^{a,c}	18 ± 1.6 ^{a,d}	19 ± 1.0 ^{a,e}

* Difference ($P < 0.05$) between track and treadmill; ^a difference ($P < 0.05$) with relation to 10 min point of same trial; ^b difference ($P < 0.05$) in relation to 20 min point of same trial; ^c difference ($P < 0.05$) in relation to 30 min point of same trial; ^d difference ($P < 0.05$) in relation to 40 min point of same trial; and difference ($P < 0.05$) in relation to 50 min point of same trial.

DISCUSSION

The objective of the present study was to compare the behavior of mean velocity (MV), pacing strategy, heart rate (HR) and rating of perceived exertion (RPE) during one-hour running time trials conducted either on an athletics track or on a treadmill. The principal finding of this study was that performance was influenced by the environment in which time trials were conducted, since MV for the trial conducted on track was faster than MV for the treadmill trial. Additionally, runners exhibited differences in the variables HR_{mean} , HR_{max} , and pacing strategy when tested on track, compared to the trials conducted on the treadmill.

These differences observed between one-hour time trial performance (track and treadmill) add weight to the results of other studies which have compared short-duration and high-intensity running (sprinting) and found that performance on a treadmill was slower than performance on a running track^{8,9}. In the light of this, some studies have suggested that the fact that the test environment appears more monotonous and less attractive in a laboratory may result in worse performance in treadmill tests^{9,10}. Additionally, Milgrom et al.¹⁷ claim that whereas running on a treadmill involves repetition of the same body kinematics, running on a track involves frequent changes of direction, rhythm and stride, which makes running on the track more motivating than running on a treadmill. Specifically with relation to our study, it is possible that the fact that the runners investigated here are more familiar with the track than the treadmill, since they train in open spaces, may have influenced the results.

Another important element that may have had an influence on our findings is the difference in perceived running velocity when being tested on a treadmill or on a track^{7,18}. In a study conducted by Kong et al.⁷, participants first ran on a track at their preferred velocity (self-selected) and then immediately afterwards attempted to reproduce the same velocity on a treadmill for three minutes, blinded to the velocity shown on the display. The results showed that average velocity was 27.1% slower and that the need for greater balance and coordination, fear of falling off and increased demands on attention and vision may all be related to the perception of higher velocity on a treadmill.

In addition to MV, both HR_{max} and HR_{mean} were also statistically different between trials conducted in the two different test environments. The fact that HR_{max} was greater for the treadmill trials may be because the participants increased in their pace at the end of the test, often described as a sprint finish. Studies involving one-hour time trials on a treadmill with constant visual feedback of time elapsed have shown that there is a tendency for runners to distribute their energy reserves along the 60-minute run in such a way as to be able to increase velocity, i.e. to sprint, during the final minutes of the trial^{3,19}.

Both our observations and reports from the volunteers who took part in our study suggest that the fact that they were able to see both their velocity

and elapsed time throughout the test when running on the treadmill, but were only informed of elapsed time every five minutes when running on track, may have made them more cautious when deciding at which point to increase the treadmill velocity, which they generally left until the end of the trial. On this basis, one limitation of this study is the fact that participants were only able to monitor elapsed time constantly when running on the treadmill, which in turn may have had an influence on their different behavior at the end of the two types of trial.

It was observed that HR_{mean} was greater when time trials were run on the track, primarily because of the greater intensity of track trials (in terms of MV). Additionally, temperature appears to have influenced the behavior of HR during the trials, since, in contrast to the treadmill trials which were conducted under temperature-controlled laboratory conditions, when running on the track participants were exposed to the sun and to heat, which may have physiologically altered their HR response, accentuating cardiovascular drift, and increased their HR further still as a consequence²⁰.

Another important finding was that the pacing strategy, analyzed in terms of mean velocity at different points during the one-hour time trial, differed between treadmill and track. When running on a treadmill, the participants adopted a pacing strategy that was progressive throughout the trial. A similar strategy has been described by Schabort et al.⁶, who conducted a study with eight trained runners (27 years old and $VO_{2\text{max}}$ of $66 \text{ mL}\cdot\text{kg}^{-1} \text{ min}^{-1}$) who performed one-hour time trials on a treadmill and showed that MV increased over the first 30 minutes, then stabilized at that intensity until the 50th minute, before once more increasing progressively up to the end of the trial. In contrast, Rollo et al.³ conducted one-hour time trials on a treadmill with 10 experienced runners (32 years old and $VO_{2\text{max}}$ of $61 \text{ mL}\cdot\text{kg}^{-1} \text{ min}^{-1}$), observing a constant pacing strategy in which MV remained similar from the second to the 59th minute of the test. The pacing strategy adopted by the participants in the present study when running on the athletics track was different to the strategy they employed on the treadmill, and fits the pattern that Abbis and Laursen¹² have described as a parabolic strategy. In other words, one in which the start of the time trial is run at high velocity, followed by a progressive decrease during the run, followed by an increase in velocity towards the end. This strategy has been observed in studies analyzing pacing strategy in recreational runners and also among competitors in top-level 10 km races^{13,21}.

It therefore appears that factors related to the environment in which trials are conducted may affect the choice of pacing strategy adopted in performance tests. However, it is also possible that other factors may have had an effect on the different pacing strategies adopted by the participants. These factors include the constant visual feedback of velocity and elapsed time which was only available during the treadmill trial and the failure to randomize conditions, i.e., the fact that the trials on the track were conducted after the treadmill trials, possibly leading to familiarization with the time trial test format.

With regard to the results of the analysis of HR and RPE, measured every 10 minutes during the trials, it was demonstrated that only HR at the 10th minute and RPE at the 40th minute were statistically different between track and treadmill. It was also observed that over the course of the time trials RPE increased significantly irrespective of test environment and HR increased significantly during treadmill trials. The few studies that have analyzed these variables during endurance runs have also found significant increases between the start and end of the test^{11,13}.

Finally, certain limitations of this study should be borne in mind, including the failure to randomize the order of trials, the constant visual feedback of velocity and elapsed time only available during treadmill trials; the fact that wind speed was not measured during track tests; the minor differences in temperature and humidity between test environments; and the differences in warm-up protocols before the two types of trial.

CONCLUSIONS

Concluding, the differences observed between one-hour time trials conducted on treadmill or on the running track in terms of MV, HR_{med}, HR_{max} and pacing strategy show that the test environment (in the field or in a laboratory) had an influence on the results. In general, the variables measured during the running performance tests conducted here, such as trial MV and HR (particularly HR_{max}), are parameters used to control and prescribe training intensity, which in turn shows that the fact that these variables exhibit different responses in different test environments implies that changing environment will change the prescription and, consequently, lead to different physiological adaptations. Therefore, once it is known that MV and HR may differ between tests conducted on the track or on treadmills, when coaches and athletes are choosing the environment in which they will conduct tests, they must take into account both their objectives and the environments in which the athletes train.

Acknowledgements

This research received support from the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES, Brazil.

REFERENCES

1. Laursen PB, Francis GT, Abbiss CR, Newton MJ, Nosaka K. Reliability of time-to-exhaustion versus time-trial running tests in runners. *Med Sci Sports Exerc* 2007;39(8): 1374-9.
2. Currell K, Jeukendrup AE. Validity, Reliability and Sensitivity of measures of sporting performance. *Sports Med* 2008;38(4):297-316.
3. Rollo I, Williams C, Nevill A. Repeatability of scores on a novel test of endurance running performance. *J Sports Sci* 2008;26(13):1379-86.
4. Loftin M, Sothorn M, Koss C, Tuuri G, Vanvrancken C, Kontos A, et al. Energy expenditure and influence of physiologic factors during marathon running. *J Strength Cond Res* 2007;21(4):1188-91.

5. Gamelin FX, Coquart J, Ferrari N, Vodugnon H, Matran R, Leger L, et al. Prediction of one hour performance using Constant duration tests. *J Strength Cond Res* 2006;20(4): 735-9.
6. Schabert EJ, Hopkins WG, Hawley JA. Reproducibility of self-paced treadmill performance of trained endurance runners. *Int J Sports Med* 1998;19(1):48-51.
7. Kong PW, Koh TMC, Tan WCR, Wang YS. Unmatched perception of speed when running overground and on a treadmill. *Gait Posture* 2012;36(1):46-8.
8. Morin JB, Seve P. Sprint running performance: comparison between treadmill and field conditions. *Eur J Appl Physiol* 2011;111(8):1695-703.
9. Nummela A, Hamalainen I, Rusko H. Comparison of maximal anaerobic running tests on a treadmill and track. *J Sports Sci* 2007;25(1):87-96.
10. Schache AG, Blanch PD, Rath DA, Wrigley TV, Starr R, Bennel KL. A comparison of overground and treadmill running for measuring the three-dimensional kinematics of the lumbo-pelvic-hip complex. *Clin Biomech* 2001;16(8):667-80.
11. Loftin M, Sothorn M, Tuuri G, Tompkins C, Koss C, Bonis M. Gender comparison of physiologic and perceptual responses in recreational marathon runners. *Int J Sports Physiol Perform* 2009;4(3):307-16.
12. Abbiss CR, Laursen PB. Describing and understanding pacing strategies during athletic competition. *Sports Med* 2008;38(3):239-52.
13. Bertuzzi RSM, Nakamura FY, Rossi LC, Kiss MAPD, Franchini E. Independência temporal das respostas do esforço percebido e da frequência cardíaca em relação à velocidade de corrida na simulação de uma prova de 10 km. *Rev Bras Med Esporte* 2006; 21(4):179-83.
14. Tucker R, Noakes TD. The physiological regulation of pacing strategy during exercise: a critical review. *Br J Sports Med* 2009;43(6):1-9.
15. Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 1982;14(5):377-81.
16. Jones AM, Doust JH. A 1% treadmill grade most accurately reflects the energetic cost of outdoor running. *J Sports Sci* 1996;14(4):321-7.
17. Milgrom C, Finestone A, Segev S, Olin C, Arndt T, Ekenman I. Are overground or treadmill runners more likely to sustain tibial stress fracture? *Br J Sports Med* 2003;37(2): 160-3.
18. Kong PW, Candelaria NG, Tomaka J. Perception of self-selected running speed is influenced by the treadmill but not footwear. *Sports Biomech* 2009;8(1):52-9.
19. Whitham M, Mckinney J. Effect of a carbohydrate mouthwash on running time trial performance. *J Sports Sci* 2007;25(12):1385-92.
20. Lambert MI, Mbambo ZH, Gibson SC. Heart rate during training and competition for long-distance running. *J Sports Sci* 1998;16:S85-90.
21. Thiel C, Foster C, Banzer W, Koning J. Pacing in Olympic track races: competitive tactics versus best performance strategy. *J Sports Sci* 2012;30(11):1109-15.

Corresponding author

Fabiana Andrade Machado.
Depto. de Educação Física – Bloco M
06, Sala 6.
Campus Universitário
Universidade Estadual de Maringá
Av. Colombo, 5.790
CEP 87.020-900 – Maringá, PR. Brasil.
Email: famachado_uem@hotmail.com