Original Article

Elite triathlete performance related to age

CARLOS VILLAROEL[1], RIGOBERTO MORA[2], GILBERTO C. GONZÁLEZ-PARRA[3] ✉

[1]Departamento de Educación Física, Universidad de los Andes, Mérida, Venezuela

[2]Dirección de Deportes, Universidad de los Andes, Mérida, Venezuela

[3]Grupo de Matemática Multidisciplinar, Facultad de Ingeniería, Universidad de los Andes, Mérida, Venezuela

ABSTRACT

Villaroel C, Mora R, González-Parra GC. Elite triathlete performance related to age. *J. Hum. Sport Exerc.* Vol. 6, No. 2, pp. 363-373, 2011. Triathlon is considered an endurance sport composed by the individual disciplines of swimming, cycling and running. The level of elite triathlon improves every year and the studies of several factors that help to improve the performance of triathletes who compete at Olympic, World Series, European, Pan-American, Commonwealth and others important events are increasing. It has been suggested that triathlon performance decline with age. However, it has also been suggested that experience is an important variable related to performance in sports and especially in crucial events. It is the aim of this research to measure and analyze the correlation between performance and age in international male elite triathletes that have participated in World Cups, Championships Series and World Championships Series from years 2007, 2008, 2009 and 2010. We found that in several cases there is a positive correlation between age and performance. Additionally, we found that the mean age of the top ten finishers in Olympic Games triathlon was higher than in the other triathlons. All these results suggest that experience is important in most relevant international elite triathlon events. **Key words:** PERFORMANCE, AGE, OLYMPIC TRIATHLON DISTANCE, WORLD CHAMPIONSHIPS SERIES.

INTRODUCTION

Over the last decade, the participation of triathletes in events has increased. Additionally, although triathlon is one of the youngest sports there is a huge quantity of new triathletes. Since this sport is relatively new there are several issues that need to be explored in order to improve performance (Bentley et al., 2008; Cejuela et al., 2007; Gonzalez-Parra, 2008). Triathlon is part of the Olympic program since Sydney 2000 and every year appears new studies to improve performance in order to obtain medals at Olympic, World Series, European, Pan-American, Commonwealth and others Games.

Mathematical models to describe the relationship between performance and age in athletes have been presented (Baker et al., 2003; Diaz et al., 2009; Moore, 1975; Tanaka & Seals, 2003, 2008). It has been shown that there is a small decline in performance for athletes between 30 and 50 years of age, followed by a more pronounced decline in performance from 50 to 60 years and a significant alteration from 70 years (Bernard et al., 2010). However, the study of the optimum age for performance in world elite triathlon has not been addressed because there must be an optimal age, if the development of maximum performance depends on years of experience in training and genetic capabilities.

It has been observed that the alteration of performance with age is different between running and swimming and seems specific to the exercise task characteristics (Tanaka & Seals, 2003, 2008). Studies focusing on factors affecting performance during a triathlon have clearly identified differences with single performance (Bentley et al., 2002; Bernard et al., 2007; Hausswirth & Lehenaff, 2001). Therefore is justifiable that the best performance could be different than those reported in swimming, cycling or running.

It has been suggested that triathlon performance decline with age. However, it has also been suggested that experience is an important variable related to performance in sports and especially in crucial events. It is the aim of this research to measure and analyze the correlation between age and performance in international male elite triathletes that participated in World Cups, Championships Series and World Championships Series from years 2007, 2008, 2009 and 2010. We don't expect any correlation since the range of ages vary from 18 to 38 years old and it is expected similar performance.

MATERIALS AND METHODS

The Olympic distance triathlon results of World Cups, Championships Series and World Championships Series from years 2007, 2008, 2009, 2010 were chosen in this study. Database is composed by the age of male competitors and the result obtained in each event. Age was measured using years as units. On the other hand, performance is measured by the final position in the triathlon event.

In order to check correlations between age and results of the male elite triathletes we performed Pearson's product moment correlations. For all statistics, a significance level of $P < 0.05$ was preset. In order to perform statistical analysis we rely on the statistical program for social sciences version 16.0 (SPSS 16.0). Additionally, we select the mean age of the first 10 elite male triathletes of Athens and Beijing Olympic Games and compare with the ones of the 2007, 2008 2009 and 2010 seasons. The choice of the top ten athletes has been used in different studies (Leyk et al., 2007).

RESULTS

A total of 48 triathlon competition of World Cups, Championships Series and World Championships Series from years 2008, 2009, 2010 were used to analyze the relationship between age and performance. Since, Championships Series and World Championships Series may be considered as higher level than World Cups we compute correlations between age and performance for each event separately. However, it is important to remark that Championships Series and World Championships Series start from year 2009. Therefore, World Cups form years 2007 and 2008 can be considered as the same level of these Championships Series. Additionally, we analyze the mean age of top ten male triathletes of Olympic Games 2004 and 2008. The descriptive characteristics of the triathlon competitions under investigation are shown in Table 1 and 2. As it can be seen not all competitions repeat every year. Most of the competitions events correspond to World Cups since Championship Series started in 2009 and World Championships Series started in 2010 as a substitute of the previous Series. Most of the competitions correspond to Europe in first place, America in second place, Asia in third place, Oceania fourth and Africa fifth.

Table 1. *Descriptive characteristics of the World Cups competitions under investigation.*

WORLD CUP 2007	WORLD CUP 2008	WORLD CUP 2009	WORLD CUP 2010
MOOLOOLA	MOOLOOLABA	MOOLOOLABA	MOOLOOLABA
ISHIGAKI	NEW PLYMOUTH	ISHIGAKI	MONTERREY
LISBON	ISHIGAKI	HY-VEE	ISHIGAKI
RICHARDS	TONGYEONG	TISZAUJVAROS	HY-VEE
MADRID	RICHARDS BAY	HUATULCO	HOLTEN
VANCOUVER	MADRID		TISZAUJVAROS
DES MOINES	HY-VEE		
EDMONTON	HAMBURG		
KITZBUHEL	TISZAUJVAROS,		
SALFORD	KITZBUHEL		
TISZAUJVAROS	LORIENT		
BEIJING	HUATULCO		
RHODES			
CANCUN			
EILAT			

Table 2. *Descriptive characteristics of Championship Series, World Championship Series and Olympic Games competitions under investigation.*

CHAMPIONSHIP SERIES 2009	WORLD CHAMPIONSHIP SERIES 2010	OLYMPIC GAMES
TONGYEONG	LONDON	SIDNEY 2000
MADRID	KITZBUEHEL	ATHENS 2004
WASHINGTON,		BEIJING 2008
KITZBUEHEL HAMBURG LONDON		
YOKOHAMA GOLD COAST		

In order to analyze the relationship between performance and age we apply several general regression models and Pearson's test for each triathlon event considered. The results when the correlation has a significance level P<0.05 are shown in Table 3. It can be observed that the higher correlations between age and performance have been obtained in Yokohama 2009 World Series Yokohama and Moololaba 2010 World Cup. Further data from the next years will help to prove hypothesis and clarify the relationships between age and performance if there are not many changes in World Series competition levels due to prize money or qualifying requirements.

Table 3. *Relationship of final position and age for triathletes using Pearson's correlation test (*Significance level P<0.05 and ** P<0.01).*

Triathlon Events	Pearson's Correlation
TISZAUJVAROS 2008	-0.320*
NEW PLYMOUTH 2008	-0.299*
TISZAUJVAROS 2009	-0.339**
YOKOHAMA 2009	-0.460**
TONGYEONG 2009	-0.299*
MOOLOOLABA 2010	-0.421*
HOLTEN 2010	-0.330*

In Figure 1 different regressions for the elite men results of the New Plymouth 2008 World Cup can be observed. The best fit is by means of the quadratic regression (R^2=0.257). The quadratic and linear regressions in this case suggest that with more age a better position is obtained. In Figure 2 different regressions for the elite men results of the Tiszaujvaros 2008 World Cup are shown. The best fit is by means of the quadratic regression (R^2=0.123). The linear regression in this case also suggests that with more age a better position is obtained. In Figure 3 different regressions for the elite men results of the Tiszaujvaros 2009 World Cup are presented. The best fitting is by means of the inverse (R^2=0.123) and the quadratic regression (R^2=0.120). As in the previous results, the linear regression suggests that with more age a better position is obtained.
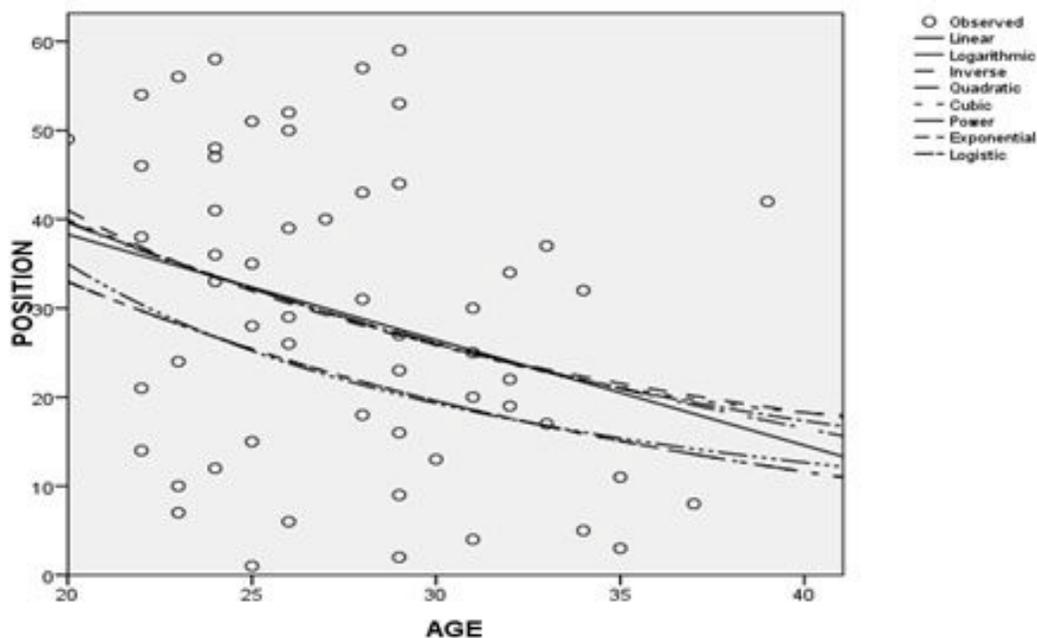

Figure 1. *Different regressions for the elite men results of the New Plymouth 2008 World Cup. As it can be observed the regression models suggest that with more age better position is obtained.*
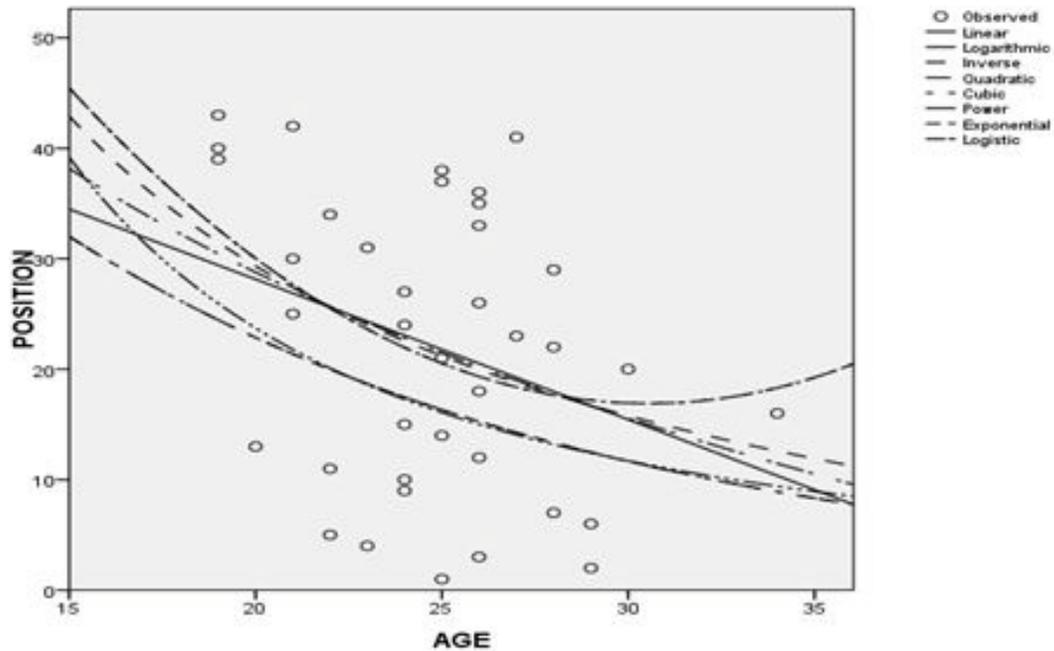
Figure 2. *Different regressions for the elite men results of the Tiszaujvaros 2008 World Cup. As it can be observed the regression models suggest that with more age better position is obtained.*
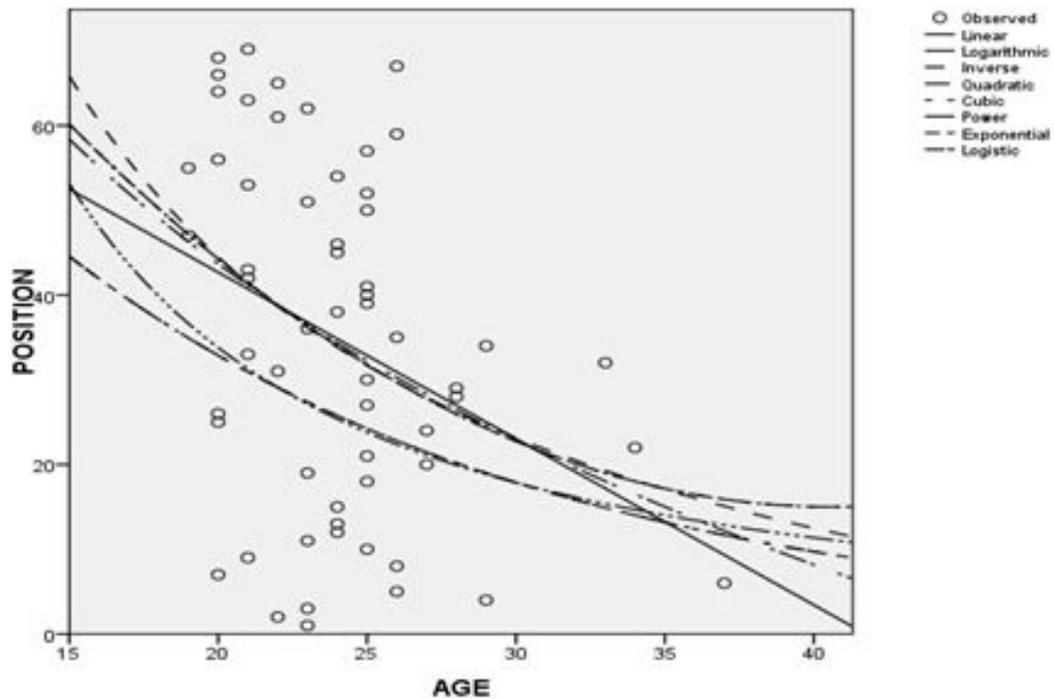

Figure 3. *Different regressions for the elite men results of the Tiszaujvaros 2009 World Cup. As it can be observed the regression models suggest that with more age better position is obtained.*

The regressions for the elite men results of the Yokohama 2009 World Championship Series can be observed in Figure 4. The best fitting is by means of the quadratic (R^2=0.307) and the cubic regression (R^2=0.310). In Figure 5 different general regressions for the elite men results of the Tongyeong 2009 World Championship Series can be observed. The best fitting is by means of the quadratic (R^2=0.141) and the cubic regression (R^2=0.142). As before the linear regression in this case suggests that with more age better position.
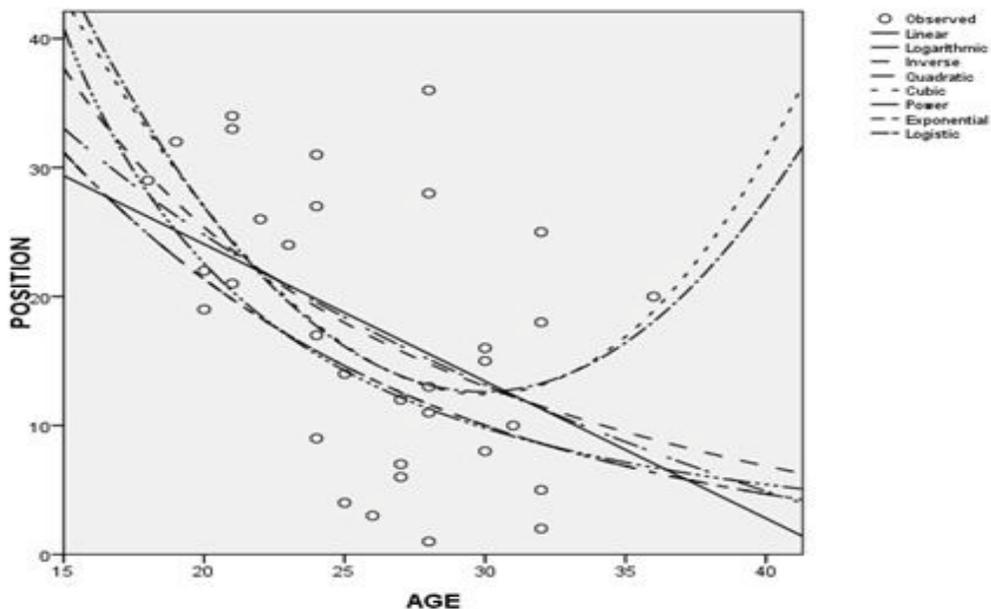

Figure 4. *Different regressions for the elite men results of the Yokohama 2009 World Championship Series.*
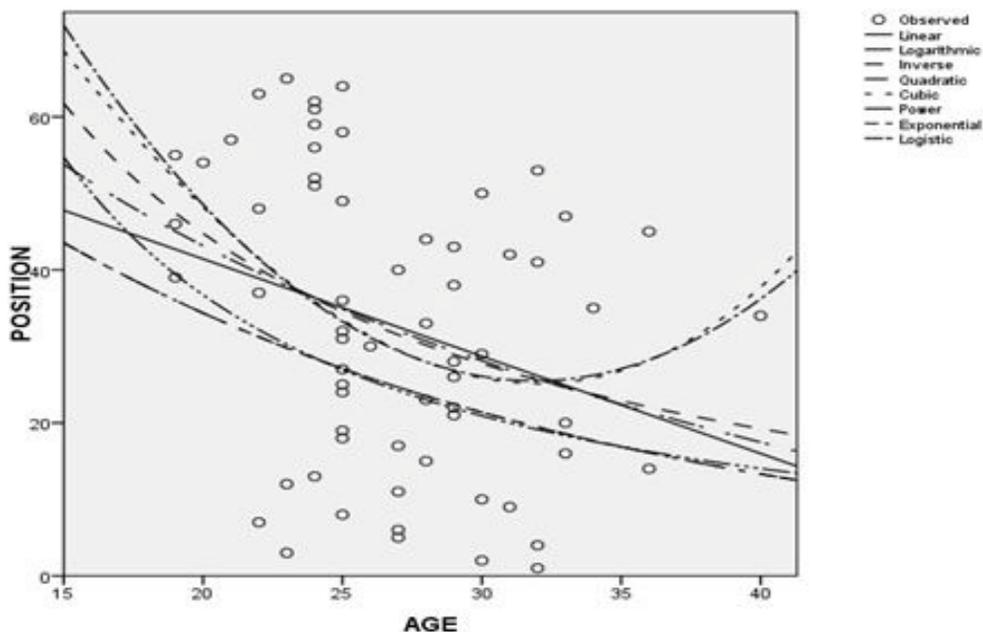

Figure 5. *Different regressions for the elite men results of the Tongyeong 2009 World Championship Series. As it can be observed with more age better position is obtained.*

In Figures 6 and 7 different regressions for the elite men results of the Moololaba and Holten 2010 World Cups can be observed. For the first one the best fit is by means of the cubic (R^2=0.211) and quadratic regression (R^2=0.206). On the other hand, for Holten 2010 World Cup the best fit is by means of the quadratic regression (R^2=0.257). As in the previous results linear regression suggests that with more age better position.
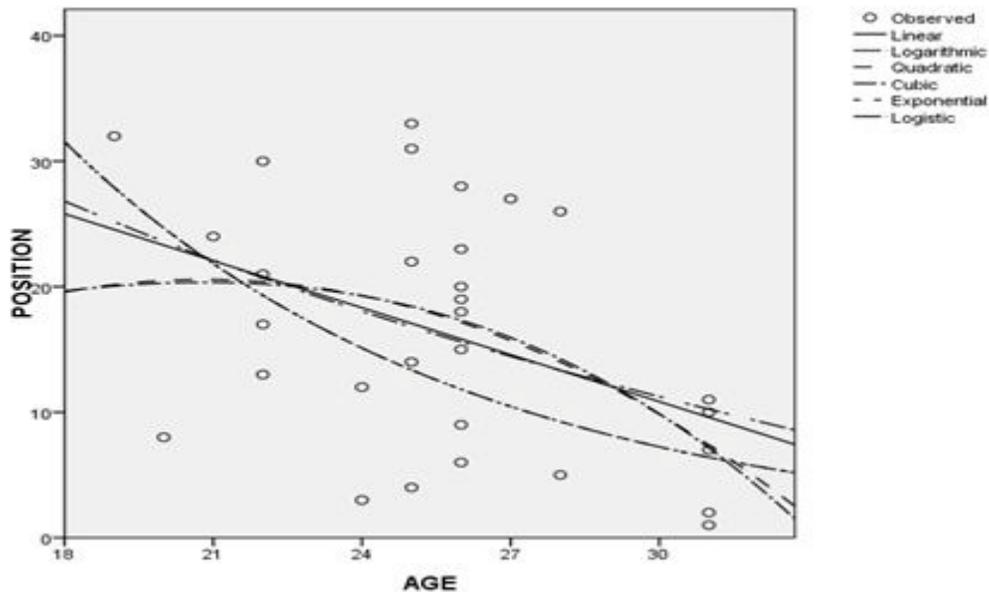

Figure 6. *Different regressions for the elite men results of the Moololaba 2010 World Cup. As it can be observed with more age better position is obtained.*
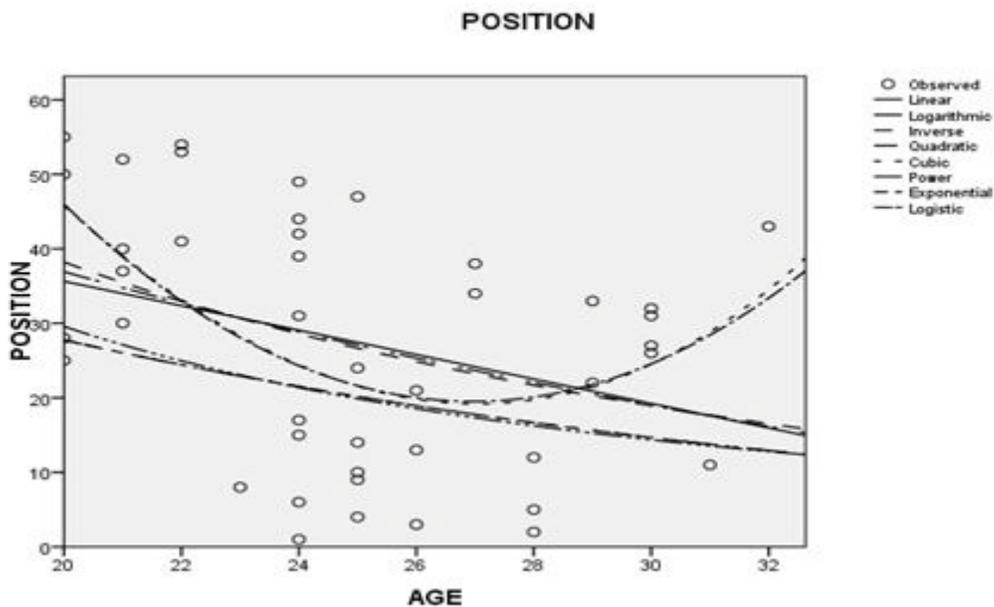
POSITION

Figure 7. *Different regressions for the elite men results of the Holten 2010 World Cup. As it can be observed with more age better position is obtained.*

It is interesting to observe that in Yokohama 2009 World Championship Series the quadratic regression suggest an optimum performance at 29.94 years old. The quadratic expression obtained for Yokohama event is $y = 0.146 x^2 - 8.743x + 143.316$, where the variables y and x correspond to the place and the age respectively. For Tongyeong 2009 World Championship Series the quadratic regression gives $y = 0.163x^2 - 10.385x + 191.107$ where the optimum place is at 31.85 years old. Additionally, in Holten 2010 World Cup it is obtained $y = 0.546x^2 - 29.4x + 416.5$ which gives an optimum place at 26.92 years old. As it can be observed these regressions are in accordance with the real results of different events.

Finally in Table 4 it is shown the mean age of top ten male triathletes at different events from seasons 2007, 2008, 2009, 2010 and Olympic Games. As it can be seen the mean age in Olympic Games is higher than in the triathlon events of the season. In addition, it is shown that the 2008 season was the one with the highest mean age as the 2008 Beijing Olympic Games triathlon event. However, since data of Championships Series and World Championships Series are few it is necessary to compile more data from the next years in order to have more confidence on these results. Furthermore, triathlete data results from World Cup Series need to be divided before and after year 2009 due to a possible change of competition level.

Table 4. *Mean age of top ten male elite triathletes in different events form seasons 2007, 2008, 2009, 2010 and Olympic Games.*

Events	Mean Age of Top Ten	Std. Deviation
ATHENS 2004	28.1	
BEIJING 2008	29.6	
2007	27.46	0.78
2008	27.53	1.48
2009	27.22	1.19
2010	26.87	1.05

DISCUSSION AND CONCLUSION

In this research we measured and analyzed the correlation between age and performance in international male elite triathletes that participated in World Cups, Championships Series and World Championships Series from years 2007, 2008, 2009 and 2010. We found that in some events performance is correlated to age positively. Additionally, we found that the mean age from top ten triathletes in Olympic Games triathlon

competitions was higher than in the regular season. All these results suggest that experience is important in most relevant international elite triathlon events. It is important to remark that previous studies have suggested a small decline in performance between 30 and 50 years (Bernard et al., 2010). The results obtained here are in good accordance with these studies since the optimum age obtained here is in the range of 26 to 32 years old.

It is important to remark that previous to the study we did not expect any correlation since the range of ages vary from 18 to 38 years old and it is expected similar performance. Among the most interesting results it is the one observed in Yokohama 2009 World Championship Series. The quadratic regression suggests an optimum performance at 29.94 years old. In addition Tongyeong 2009 World Championship Series and Holten 2010 World Cup regression results give an optimum place at 31.85 and 26.92 years old respectively. The other interesting result is that the mean age in Olympic Games is higher than in the triathlon events of the season. This result suggests that at important events the experience is a key characteristic. In addition, it was showed that the 2008 season was the one with the highest mean age as the 2008 Beijing Olympic Games triathlon event. However since 2008 the mean age is descending. In this way it may be possible that 2012 mean age could be less than the 2008 Olympic Games triathlon event. The results obtained here and other similar studies can help coaches and manager from national teams to select among several triathletes the best team for an important event such Olympic Games.

Finally it is important to remark that for each event different regression models have been obtained. One explanation is that the profile and relevance are different for each event and these variables may be related also to the performance. Thus, we expect to do future works in this line where more variables need to be taken into account. Additionally, longer competition results from World Series of the next years and London Olympic Games will help to get more insight regarding the relationship between age and performance in important events.

ACKNOWLEDGEMENTS

REFERENCES

1. BAKER AB, TANG YQ, TURNER MJ. Percentage decline in masters superathlete track and field performance with aging. *Exp Aging Res*. 2003; 29:47-65. [Abstract] [Back to text]
2. BENTLEY DJ, COX GR, GREEN D, LAURSEN PB. Maximizing performance in triathlon: Applied physiological and nutritional aspects of elite and non-elite competitions. *Journal of Science and Medicine in Sport*. 2008; 11(4):407-416. doi:10.1016/j.jsams.2007.07.010 [Back to text]
3. BENTLEY DJ, MILLET GP, VLECK VE, MCNAUGHTON LR. Specific aspects of contemporary triathlon: Implications for physiological analysis and performance. *Sports Med*. 2002; 32:345-359. [Abstract] [Back to text]
4. BERNARD T, SULTANA F, LEPERS R, HAUSSWIRTH C, BRISSWALTER J. Age-Related Decline in Olympic Triathlon Performance: Effect of Locomotion Mode. *Exp Aging Res*. 2010; 36: 1, 64-78. doi:10.1080/03610730903418620 [Back to text]
5. BERNARD T, VERCRUYSSEN F, MAZURE C, GORCE P, HAUSSWIRTH C, BRISSWALTER J. Constant versus variable-intensity during cycling: Effects on subsequent running performance. *Eur J App Physiol*. 2007; 99:103-111. doi:10.1007/s00421-006-0321-7 [Back to text]

6. CEJUELA R, PÉREZ JA, VILLA JG, CORTELL JM, RODRÍGUEZ JA. Análisis de los factores de rendimiento en triatlón distancia sprint. *Journal of Human Sport and Exercise*. 2007; 2(2):1-25. doi:10.4100/jhse.2007.22.01 [Back to text]

7. DÍAZ V, GARCÍA A, PEINADO AB, ALVAREZ M, BENITO PJ, CALDERON FJ. Physiological profile of elite triathletes: a comparison between young and professional competitors. *Journal of Human Sport and Exercise*. 2009; 4(3):237-245. doi:10.4100/jhse.2009.43.05 [Back to text]

8. GONZALEZ G, DIAZ M. Optimization of swimming performance in triathlon. *Journal of Human Sport and Exercise*. 2009; 4:69-71. doi:10.4100/jhse.2009.41.08 [Back to text]

9. HAUSSWIRTH C, LEHENAFF D. Physiological demands of running during long distance runs and triathlons. *Sports Med*. 2001; 31:679-89. [Abstract] [Back to text]

10. LEYK D, ERLEY O, RIDDER D, LEURS M, RU¨THER T, WUNDERLICH M, SIEVERT A, BAUM K, ESSFELD D. Aged-related changes in marathon and half-marathon performances. *Int J Sports Med*. 2007; 28:513-517. [Abstract] [Back to text]

11. MOORE DH. A study of age group track and field records to relate age and running speed. *Nature*. 1975; 253:264-265. doi:10.1038/253264a0 [Back to text]

12. ROUBOA A, SILVA A, LEAL L, ROCHA J, ALVES F. The effect of swimmer's hand/forearm acceleration on propulsive forces generation using computational fluid dynamics. *J Biomech*. 2006; 39(7):1239-48. doi:10.1016/j.jbiomech.2005.03.012 [Back to text]

13. TANAKA H, SEALS DR. Invited Review: Dynamic exercise performance in masters athletes: Insight into effects of primary human aging on physiological functional capacity. *J Appl Physiol*. 2003; 95:2152–2162. [Full Text] [Back to text]

14. TANAKA H, SEALS DR. Endurance exercise performance in Masters athletes: Age-associated changes and underlying physiological mechanisms. *Journal of Physiology*. 2008; 586:55-63. doi:10.1113/jphysiol.2007.141879 [Back to text]

15. VLECK VE, BENTLEY DJ, MILLET GP, BÜRGI A. Pacing during an elite Olympic distance triathlon: Comparison between male and female competitors. *Journal of Science and Medicine in Sport*. 2008; 11(4):424. doi:10.1016/j.jsams.2007.01.006 [Back to text]