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Effects of 8-weeks of stable vs unstable surface destabilizing training on shot outcome in elite golfers

Efectos de 8 semanas de entrenamiento desestabilizador en superficies estables vs inestables sobre el resultado de los golpes en golfistas de élite

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Abstract. Purpose: This research aimed to compare the effect of two intervention programs using stable or unstable surfaces on speed and hitting distance in golf stroke/swing. Methods: Twenty-five elite golfers (19.20 ± 1.77 years, height = 181.12 ± 4 cm, body mass = 75.35 ± 5.83; kg, BMI = 22.71 ± 1.76 kg.m2, handicap: 2.49 ± 2.56) were randomly assigned to two different 8-week training programs based on unstable surface (n = 12) or stable surface training (n=13). Measurements of carry distance and club head speed were performed using the Trackman Golf® system, with each participant executing five swings and obtaining the average and best distance. Results: No significant changes ($p< 0.05$) in the club head speed or carry distance were found after the intervention in the stable surface or the unstable surface training group. Conclusions: The proposed intervention using instability surfaces does not provide any additional benefit to training on stable surfaces in the specific performance of the stroke in elite golfers.
Keywords: Stability, golf, trackman-golf, lumbopelvic, unstable surface, stable surface.

Resumen. Objetivo: Esta investigación tuvo como objetivo comparar el efecto de dos programas de intervención que utilizan superficies estables o inestables sobre la velocidad y la distancia de golpeo en el golpeo/swing de golf. Métodos: Veinticinco golfistas de élite (19,20 ± 1,77 años, altura = 181,12 ± 4 cm, peso corporal = 75,35 ± 5,83; kg, IMC = 22,71 ± 1,76 kg.m2, hándicap: 2,49 ± 2,56) fueron asignados aleatoriamente a dos programas de entrenamiento diferentes de 8 semanas de duración basados en superficies inestables (n = 12) o en superficies estables (n = 13). Las mediciones de la distancia de golpeo y la velocidad de la cabeza del palo se realizaron con el sistema Trackman Golf®, ejecutando cada participante cinco swings y obteniendo la media y la mejor distancia. Resultados: No se encontraron cambios significativos ($p< 0,05$) en la velocidad de la cabeza del palo ni en la distancia de golpeo después de la intervención en el grupo de entrenamiento en superficie estable o en el de superficie inestable. Conclusiones: La intervención propuesta utilizando superficies de inestabilidad no aporta ningún beneficio adicional al entrenamiento en superficies estables en el rendimiento específico del golpe en golfistas de élite.
Palabras clave: Estabilidad, golf, trackman-golf, lumbopélvico, superficie inestable, superficie estable.

Introduction

Golf is a sport based on technical and psychological skills (Fletcher & Hartwell, 2004). Among the specific skills, two types of strokes should be highlighted; The drive used to cover the largest possible distance from the starting tee is decisive for the game strategy's success (Thompson, Cobb, & Blackwell, 2007). In fact, due to the speed and distance reached with the drive, it is recognized as one of the most valuable shots in golf performance (Hume, Keogh, & Reid, 2005), to such an extent that the distance reached in this stroke is correlated with the average result in elite golfers (r = -0.24 a -0.50), determining differences in the competitive outcome (G. D. Wells, Elmi, & Thomas, 2009). The second shot is the swing (SW), based on the trunk's coordination and hands with the club, generating a dynamic movement while controlling the club head's direction and speed (Leadbetter, 1990). It is suggested that long-distance hitting ability is a determining factor in elite golf (Hellstrom, 2009). Various investigations have reported that specifically club head speed (CHS) and carry distance (CAR) are parameters marked by the technical ability in the SW, and besides, by the ability to activate the muscles involved in the movement efficiently (Alvarez, Sedano, Cuadrado, & Redondo, 2012). As a result, there is a transmission of forces in the SW between the muscular areas of the lower limb

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and the upper limb due to the kinetics generated in the five phases of this shot (address, backswing, downswing, impact, and follow-through) (Hellstrom, 2009).

For this reason, physical fitness is an integral component in the preparation of an elite golfer (professionals and amateurs with a handicap <5). As the author mentioned above indicates, central stability and peripheral muscle strength are correlated with golf performance (Hellstrom, 2009).This stability is essential for the transmission of forces and improved sports performance (Anderson & Behm, 2005; McGill, 2001). In fact, unstable surfaces and Core training are currently objects of study in other sports modalities and populations (Waleska Reyes-Ferrada, Paula Plaza, Daniel Jerez-Mayorga, Luis Chirosa-Rios, & Peñailillo, 2021; Yessenia Norambuena et al., 2021). Therefore, strength training is a relevant component for improving the different skills required for hitting, together with the incorporation of plyometrics and combined flexibility and mobility training (Alex Ehlert, 2020). However, the literature is scarce regarding incorporating unstable surfaces in these programs (Thompson et al., 2007). Even so, this methodology is regularly present in the programs of both amateur and professional athletes (Carrasco, 2016). In this regard, higher strength gains have been recorded in traditional exercises (e.g., Squat) in protocols with stable platforms (SST), compared to unstable (UST) (Kohler, Flanagan, & Whiting, 2010; Norwood, Anderson, Gaetz, & Twist, 2007; Saeterbakken & Fimland, 2013; Sharrock, Cropper, Mostad, Johnson, & Malone, 2011). However, all these investigations reported improvements in the activation of the lumbopelvic muscles in UST protocols, except for one investigation where the results were similar (Saeterbakken & Fimland, 2013). Research of pooled results shows that training on instability surfaces can attenuate physiological adaptations (Cressey, West, Tiberio, Kraemer, & Maresh, 2007), mainly reducing the ability to generate force and power (Behm & Anderson, 2006; Chulvi-Medrano et al., 2010). Also, the disturbances generated by training on unstable surfaces do not affect untrained people in the same magnitude as in highly trained athletes, generating fewer effects in this population (Wahl & Behm, 2008). Little is known about the use of unstable surfaces in golf training. It was reported that the use of instability sandals allowed to slightly reduce back pain without negatively affecting performance (Nigg, Davis, Lindsay, & Emery, 2009). Therefore, our objective was to verify the effects of unstable surface training on SW performance variables.

Objectives

Our research had a double goal: a) to check if training with unstable platforms offers an advantage by helping the player to achieve a greater distance travelled by the ball, b) if the speed of the ball is higher when a training program with this additional stimulus is applied. The initial hypothesis was that the use of unstable surfaces does not benefit over SST in elite golfers' specific swing performance, helping the player achieve higher distances (m) and speeds (km/h).

Methods

Trial Design

A randomized control trial was carried out, comparing the UST program's application with an SST program in elite golf players during eight weeks of the preseason period. Ball speed (km/h) and distance travelled (m) were measured in two pre and post evaluations using the Trackman golf® system. Each group went through a one-week familiarization period with every protocol. During the eight weeks of the intervention, all the players continued with regular technical routines, four days per week, plus one day devoted to playing a complete round (18 holes). At the end of the eight weeks, a recovery phase was implemented, with technical training and no specific physical fitness sessions. Figure 1 shows the organization of the described training schedule.

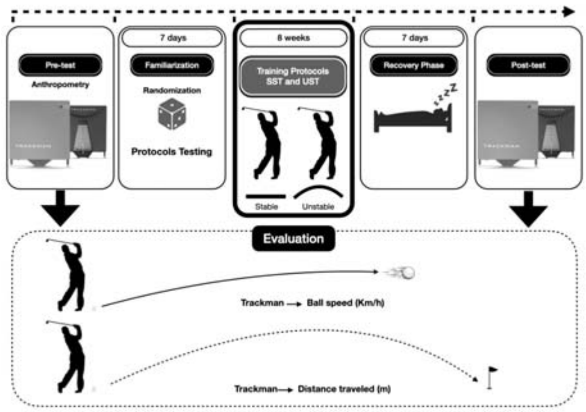


Figure 1. Intervention program.

Participants

Twenty-five male golfers participated in the present study (19.20 ± 1.77 years, height = 181.12 ± 4 cm, body mass = 75.35 ± 5.83; kg, BMI = 22, 71 ± 1.76 kg.m^2, handicap = 2.49 ± 2.56). All the players were members of the University of Malaga (UMA) golf program. The inclusion criteria were being over 18 years old, handicap (2.5), more than one year of experience in strength training, and 80% of attendance to the intervention program's activities (Table 1). All of them agreed to carry out their respective training protocols without performing any other physical activity during the eight weeks. Participants were aware of the experiment's possible risks and signed an informed consent form acknowledging their willingness to participate. The research protocol was reviewed and approved by the Ethics Committee of the EADE-University of Wales Trinity Saint David (Málaga, Spain) with reference number: (EADECAFYD2020-1). All the procedures were implemented following the Declaration of Helsinki's ethical guidelines and its later amendments (WMO, 2013). Participants who reported osteoarticular problems, mainly in the hip and knee, were excluded, and those who reported any problem that prevented them from carrying out the program were excluded. All those who reported having used doping substances (e.g., anabolic-androgenic steroids or beta-blockers) during the last two years or consumed any dietary supplement during the program's implementation were also excluded from participation to avoid confounding variables. The age ranges were established between 18 and 24 years old. All participants were randomized using the website www.randomizer.org and assigned to the SST group (n = 13) or the UST group (n = 12) as reflected in Figure 2, CONSORT diagram, where participants' enrolment is described.

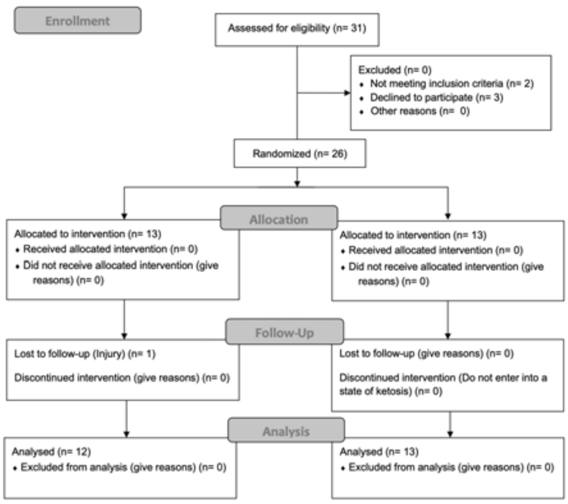


Figure 2. CONSORT diagram.

Intervention procedures

Pre-test

Anthropometry

Anthropometric measures were collected seven days before the start of the training protocols and before the pre-test evaluations. Body mass was measured using a digital scale (Tanita RD-545, Tokyo, Japan), and a fixed stadiometer (SECA 220, Hamburg, Germany) was used to determine participants' height.

Assessment with the Trackman Golf® system

At the end of the anthropometric measurements, a warm-up based on the protocol of (J. Wells, Mitchell, Charalambous, & Fletcher, 2018) consisting of 5 minutes of a leg cycle ergometer exercise followed by dynamic stretching, clock lunges, overhead squats, gluteal bridges, scapula wall slides, thoracic rotations, internal and external hip rotations and vertical and horizontal arm swings was performed. For both the pre and post evaluations, the participants were informed not to consume foods or stimulating drinks (e.g., caffeine) at least 3-4 hours before the evaluations and were instructed to have at least 8 hours of sleep before data collection. After warming up, the software and the Trackman GolfÒ system (version 3EÒ, Copenhague, Dinamarca) were adjusted, selecting the «normalization» hitting mode. This way, the trajectory and depth of the hit under different atmospheric conditions could be differentiated, including the ball material. Game conditions were selected in the software (20º centigrade, 0 meters of altitude, absence of wind and Premium ball), using the same criterion in the pre and post to guarantee that all the participants hit under the same conditions both moments.

Under outdoor conditions, five strokes of each participant were recorded, with a rest time between each stroke of 40 seconds. Thus, the meters reached from the CAR were measured (obtaining the distance in a straight line from where the ball was hit and where the point that reflects the same elevation is crossed) and the linear speed of the geometric centre of the head of the club just before the first contact with the ball (CHS).

Familiarisation session

Three specific sessions where the participants carried out the corresponding protocols under the supervision of two experienced researchers. Sessions were tailored not to interrupt the regular technical-tactical schedule of the participants.

Exercise protocol

During the eight weeks that the experiment lasted, the weekly training schedule organisation consisted of four days of technical-tactical work. The corresponding protocols, SST or UST, were incorporated. On Wednesdays and Sundays, the athletes rested, and on Saturdays, a complete round of 18 holes was played. This programming is expressed in figure 3.

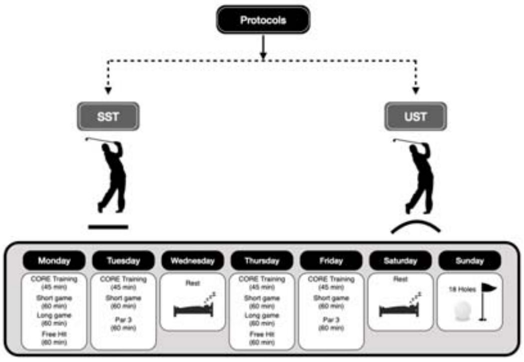
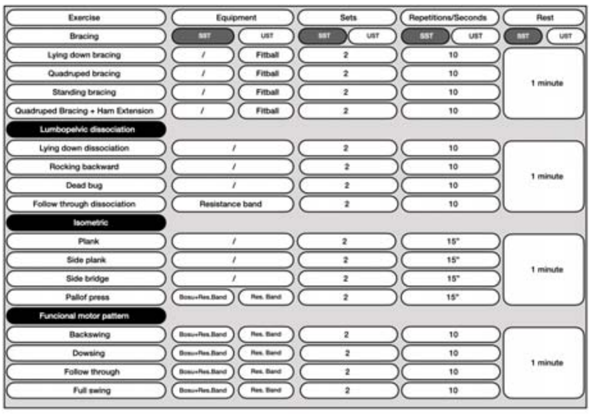


Figure 3. Weekly training schedule

The eight weeks of training consisted of lumbopelvic training, using elastic bands, and, in the case of UST, destabilising materials; BOSU or stability ball. Two series per exercise were performed, with ten repetitions and, in the isometric contraction, 15 seconds of activation. All exercises had one minute of recovery between each set. The protocols are shown in figure 4.



Exercise	Equipment		Sets	Repetitions/Seconds	Rest
Bracing	SST	UST	SST / UST	SST / UST	SST / UST
Lying down bracing	/	Fitball	2	10	1 minute
Quadruped bracing	/	Fitball	2	10	
Standing bracing	/	Fitball	2	10	
Quadruped Bracing + Ham Extension	/	Fitball	2	10	
Lumbopelvic dissociation					
Lying down dissociation	/		2	10	1 minute
Rocking backward	/		2	10	
Dead bug	/		2	10	
Follow through dissociation	Resistance band		2	10	
Isometric					
Plank	/		2	15"	1 minute
Side plank	/		2	15"	
Side bridge	/		2	15"	
Pallof press	Bosu+Res.Band	Res. Band	2	15"	
Funcional motor pattern					
Backswing	Bosu+Res.Band	Res. Band	2	10	1 minute
Dowsing	Bosu+Res.Band	Res. Band	2	10	
Follow through	Bosu+Res.Band	Res. Band	2	10	
Full swing	Bosu+Res.Band	Res. Band	2	10	

Figure 4. Training protocols

Every session, a core stability progression was programmed (Coulombe, Games, Neil, & Eberman, 2017), starting with a general core training routine, focused on bracing to generate intra-abdominal pressure. Lumbopelvic dissociation, isometry, and functional golf motor skills were subsequently practised. Following the same rationale, the UST protocol using unstable surfaces was incorporated. All sessions were supervised by two researchers experience in strength and conditioning settings.

Statistical methods

Results are expressed as mean, standard deviation, and 95% confidence intervals for the mean (95% CI). The normality of the data was contrasted with the Shapiro-Wilk test. The comparison of the baseline variables was performed with the repeated measures t-test for the intra-subject analyses of both protocols (SST and UST) considering the time factor, Pre and Post values of the CHS and CARRY variables, and obtaining the effect size (ES) between the comparisons drawn, using the Cohen's d test. For the inter-subject tests, the independent measures t-test was used to compare the CHS and CARRY variables between both protocols (SST and UST). The effect size (ES) calculated using Cohen's d test for intra-group interactions (Table 3) (Hopkins, Marshall, Batterham, & Hanin, 2009). The significance assumed for all tests was $p < 0.05$ at two tails. Statistical procedures were performed using the SPSS software (Version, 25, SPSS, IBM Corporation, Armonk, New York, USA). Graphs were plotted using GraphPad Software version 6 (GraphPad Software, California, USA).

Results

To evaluate the speed of the golf ball difference and the distance travelled after implementing the two protocols, 25 participants were assessed at two different moments, pre and post.

Table 1: Participants baseline characteristics

Characteristics	X	SD
Age (years)	19.20	1.77
Height (m)	1.81	0.05
TBW (kg)	75.35	5.83
BMI (kg×m-2)	22.71	1.76
HCP	2.49	2.56

In the intra-subject tests for the SST protocol, the results obtained in the t-test for the CHS variable were [t (12) = -2.016; p>0.05] y (*d* =0.22), y [t (12) = -2.072; p>0.05] and (*d* =0.49) for the CARRY variable, showing no significant differences in the two variables evaluated. Regarding the UST protocol, values of [t (11) = 0.395; p>0.05] and (*d* =0.06) for the CHS variable and [t (11) = 0.112; p>0.05] y (*d* =0.01) for the CARRY variable were obtained, with no statistically significant difference for the two variables evaluated. Figure 5.

Table 2. Intra-subject t-tests

Protocol	Variable	Pre X ± DE	Post X ± DE	gl	t	*P*	*d*
SST	CHS	108.27 ± 6.25	109.60 ± 5.66	12	-2.016	0.067	0.22
	CARRY	236.75 ± 13.77	243.73 ± 14.26	12	-2.072	0.061	0.49
UST	CHS	106.60 ± 5.41	106.27 ± 5.01	11	0.395	0.700	0.06
	CARRY	236.20 ± 21.02	235.89 ± 16.85	11	0.112	0.913	0.01

In the inter-subject tests for the comparison between both protocols used, values of [t (23) = 0.71; p>0,05] and (*d* =0.28) for the CHS-Pre variable and [t (23) = 1.548; p>0,05] and (*d* =0.62) in CHS-Post, showing no significant differences between protocols, for the comparison of protocols in the CARRY-Pre variable, values of [t (23) = 0.077; p>0,05] and (*d* =0.03) and for the CARRY-Post variable of [t (23) = 1.26; p>0,05] and (*d* =0.50), without significant differences in both comparisons. Means and SD in Table 3.

Table 3. Inter-subject t-test

Variable/Time	Protocol	X ± DE	gl	t	*p*	*d*
CHS-Pre	SST	108.27 ± 6.25	23	0.71	0.485	0.28
	UST	106.60 ± 5.41				
CHS-Post	SST	109.60 ± 5.66	23	1.548	0.135	0.62
	UST	106.27 ± 5.01				
CARRY-Pre	SST	236.75 ± 13.77	23	0.077	0.939	0.03
	UST	236.20 ± 21.02				
CARRY-Post	SST	243.73 ± 14.26	23	1.26	0.220	0.50
	UST	235.89 ± 16.85				

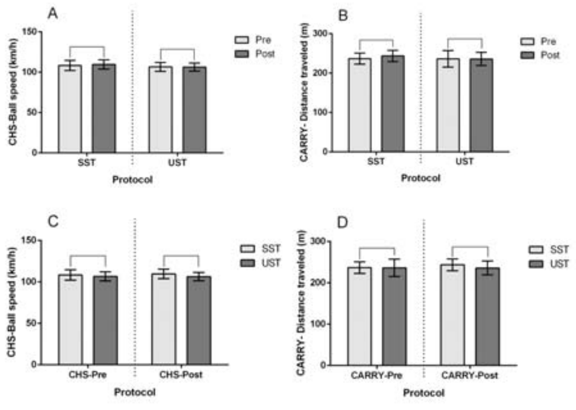


Figure 5. CHS and CARRY Results

Discussion

Our study aimed to evaluate unstable platforms' impact on the distance reached and the ball speed in advanced level golfers' stroke. The results did not show advantages in these parameters when unstable training was used for eight weeks. These results are supported by (Behm, Drinkwater, Willardson, Cowley, & Canadian Society for Exercise, 2010), where they concluded that the use of instability to train the core muscles did not thoroughly explain the improvement in sports performance. Later, the same research group found limited effects favouring UST against SST in adolescents and young adults, but without positive results in other populations in power, strength and balance (Behm, Muehlbauer, Kibele, & Granacher, 2015). However, the diversity of research and parameters of each sport makes it difficult to compare in the application of unstable platforms and skills typical of golf. The application of instability over repeated sprints, countermovement jump, and functional movement screen has been investigated on futsal players, with diverging results in the observed variables (Lago-Fuentes et al., 2018; Thompson et al., 2007; Weston, Coleman, & Spears, 2013).

Multiple parameters should be considered to optimize golf performance (Evans & Tuttle, 2015), but among them, we can highlight that the ability to exert explosive power requires a stable base and strong core muscles to reach a notable performance (G. D. Wells et al., 2009). It has been proposed that the use of unstable surfaces could increase core muscle recruitment and participation, potentially improving performance (Behm et al., 2015; Willardson, 2007). However, it has also been stated that the use of unstable surfaces in combination with resistance training can impair the ability to generate power and movement velocity while maintaining similar or greater core muscle activation (Behm, Colado, & Colado, 2013).

Thus, investigating the effects of unstable training on golf performance is interesting for two primary reasons. First, analyse the possible effect of these programs on performance and second, if they influence low back muscle fitness. Consequently, the present study aimed to quantify the effect of an 8-week UST training program on golf CHS and ball spin parameters, but we observed no beneficial effect of our exercise intervention on CHS.

Similar previous studies have shown that after eight weeks of functional training that included the application of instability starting from the 6th week, CHS measured by radar showed an increase (p<0.05) of 127.3 (±13.4) to 133.6 (±14.2) km/h in a sample of 18 adult males of 70.7 (±9.1) years old (Thompson et al., 2007). In a more recent scientific work, (Weston et al., 2013), propose using instability using a stability ball combined with a functional motor pattern of specific skills to favour the principle of specificity of training in a group of 36 participants. After eight weeks of training, there was an increase in CHS of 3.6%, establishing an improved range of 0.5 to 6.3%.

Perhaps the main difference between these data lies in the training experience of our sample, high-performance athletes in which the margin of improvement is very narrow and therefore, increases in multiple factors are required (Reed, Ford, Myer, & Hewett, 2012) and not just core training (Sung, Park, Kim, Kwon, & Lim, 2016). Likewise, a high level of training is a variable that can reduce the effectiveness of training on unstable surfaces (Chulvi-Medrano et al., 2010), and higher degrees of instability may be necessary to achieve better adaptations (Wahl & Behm, 2008). Buscà et al., study showed that some unstable exercises in the same population and anatomic region have a higher effect on muscle activation than others (Busca et al., 2020). For that reason, a proper selection of exercises for every training program also seems a crucial aspect.

Additionally, emphasis should be placed on the principle of specificity. According to Brandon & Pearce., a program of core stability for golf should emphasise the transverse and oblique abdominals, which undergo the most stress in providing torque for the golf swing» and perhaps our proposal should incorporate a higher volume of exercise with this orientation (Brandon & Pearce, 2009).

Although the findings apply specifically to golf, it is possible that these benefits could transfer to other sports that require substantial asymmetrical movements of the spine.

Limitations

Some limitations should be noted. Our sample size is small and specific. Concerning this aspect, and due to the subjects' training experience, the training program's length may have been short. We have not recorded specific changes in the core region, electrical activity (EMG), or performance in specific tests such as the lumbar extension test. Monitoring using super slow-motion cameras would have allowed us to monitor possible changes in the specific golf motor skill's kinematics.

Conclusions

The use of unstable platforms provides no benefit over training on stable surfaces on specific performance over distance (m) and speed (km/h) in elite junior golfers' stroke.

Practical applications

The present study questions the use of unstable surfaces for golf player improvement. These tools are commonly used among players of various levels, but so far, there is no strong evidence that their use can improve such a determinant aspect of the game as swing distance. Therefore, training on stable surfaces appears to be the most effective option at present.

Authors'contributions

Data accuracy: Manuel García-Sillero, Constantino Peruzzi
Investigation: Manuel García-Sillero, Salvador Vargas-Molina
Methodology: Manuel García-Sillero
Writing – original draft: Manuel García-Sillero, Constantino Peruzzi, Iván Chulvi-Medrano, Salvador Vargas Molina
Writing – review & editing: Manuel García-Sillero, Constantino Peruzzi, Iván Chulvi-Medrano, Javier Peña, Manuel De Diego, Salvador Vargas Molina.

Conflicts of Interest

There are no conflicts of interest declared by the authors.

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