

Article

Effects of Sidestep Exercise with Elastic Bands on Multidirectional Speed Abilities and Navicular Drop in Young Male Football Players: A Randomized Cross-Over Trial

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Abstract: The current study aimed to assess the effect of including the lateral-step or sidestep exercise with elastic bands on multidirectional speed abilities (linear, change of direction, and curve sprinting) and navicular drop and to know the impact of navicular drop changes on multidirectional sprinting changes in young male football players. Thirty-two young male football players (age: 14.7 ± 0.82) were randomly divided into group A ($n = 16$) or group B ($n = 16$). Using a crossover design trial (ABBA), a group performed three sets of six repetitions per side in the lateral-step exercise with elastic bands attached in a low vector, three days per week, plus their regular training sessions, while the other continued with their regular football training sessions during the first 3 weeks, changing the role during the next 3 weeks of the intervention. Pre-intervention and three and six weeks after the beginning of the intervention, a navicular drop test, a 10 m linear sprint test, a multiple change of direction test (V-cut), and a curvilinear sprinting test were assessed. The sidestep exercise with elastic bands significantly improved the ability to sprint multidirectionally in only three weeks of training ($p < 0.05$, $n^2 = 0.56$ to 0.74), and there was a trend in the impact of multidirectional sprinting performance through those changes reported in the navicular drop test ($r = -0.23$ to 0.45).

Keywords: strength activation; change of direction; curve sprint; sprint



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1. Introduction

The movement of a footballer during a football match is characterized by multidirectional actions [1], which are usually grouped into linear sprints, curvilinear sprints, change of direction, and turns [2,3]. However, it is difficult to classify the movement of a footballer in a single action. For example, a professional footballer performs a change of direction (COD) at a very high entry speed (~ 5.5 m/s) [4,5], and this entry speed is determined by their ability to sprint in line [6]. Therefore, high-speed multidirectional movements are very frequent during a football match ($\sim 70\%$) [4,5] and are considered decisive in goal situations [7]. Recently, it has been reported that high-speed running actions in La Liga (Spanish top division) are mostly curve sprinting (91.7%) rather than linear (8.3%) [8]. In fact, the scientific literature recognized that they should be included in test batteries for the evaluation of football player performance [2,9].

Navicular drop measures excessive pronation [10], as the amount of motion at the subtalar joint can be detected indirectly by measuring the amount of motion at the navicular bone [11]. The navicular drop test measures the distance from the navicular tubercle at its bottom to the ground [12]. In this regard, reduced activation of the intrinsic foot musculature [13] or a fatigued state of the intrinsic foot musculature [14] causes an increase in the navicular drop (i.e., the medial longitudinal arch). This decrease in the positioning of the navicular of the foot influences performance, especially in COD. For example, some authors show that for individuals with flat feet, an effective correction of the alignment of the foot and the temporal parameters of the kinematics of the foot occurred while sprinting or changing direction [15]. This temporary change indicates an improved pulley mechanism thanks to the navicular height reaching its minimum value. Therefore, good intrinsic foot muscle activation seems to be crucial for better shock absorption and improving multidirectional speed abilities [16].

Using elastic bands as a training mode has been a growing trend, as they have shown similar strength and power improvements to traditional resistance training [17,18]. One of their main advantages is adapting the force vector or movement plane where the force is applied, respecting the dynamic correspondence with sports movements [19]. High-intensity action performances such as COD and curve-sprinting abilities mainly depend on applying force in a lateral position [2]. As we have seen in non-published pilot studies, a lateral-step movement using a lateral and low force vector through an elastic band increases the intrinsic foot muscle activation measured through electromyography. However, no study in the literature has analyzed the effect of a lateral-step exercise using elastic bands on multidirectional sprinting abilities. Thus, the main aims of the current study were (1) to assess the effect of including the lateral-step or sidestep exercise with elastic bands on multidirectional speed abilities (linear, COD, and curve sprinting) and navicular drop, and (2) to know the impact of navicular drop changes on multidirectional sprinting changes in young male football players.

2. Materials & Methods

2.1. Participants

Thirty-two young male football players (age: 14.7 ± 0.82 y; height: 171.3 ± 8.89 cm; body mass: 58.3 ± 9.73 kg) voluntarily participated in this study. All players belong to the same football club. Players were asked not to perform strenuous exercise the day before each testing session and to consume their last meal (caffeine-free) at least 3 h before the scheduled testing time. The sample size was estimated a priori using G*Power (G*Power 3.1.9.6, Heinrich Heine-Universität Düsseldorf). Twenty-eight players were predicted to detect moderate differences ($f = 0.25$) for an ANOVA 3×2 for repeated measurements at 80% power and an alpha of 0.05 with a correlation among repeated measurements of 0.5. All players participated, on average, in 3 football training sessions (120 min each) and one official match per week. Their training experience is 8.2 ± 1.1 y, their experience in competitive play is 7.7 ± 1.5 y, and the specific positions they play are 5 fullbacks, 6 central defenders, 7 midfielders, 4 wingers, 4 playmakers, and 6 strikers. Players were excluded from the study if they had suffered a lower-limb injury in the past 2 months before the pretest, if they did not attend at least 80% of training sessions, if they did not complete all the assessment sessions, or if an injury occurred during a scheduled practice or competition that caused absence from the next training session or match. The study was conducted according to the Declaration of Helsinki (2013), and the protocol was fully approved by the Virgen Macarena y Virgen del Rocio University Hospitals ethics committee (0398-N-17) before recruitment. Their parents/guardians were informed of the study's procedures

and potential risks/benefits, and they signed a written informed consent before starting the investigation.

2.2. Experimental Approach to the Problem

Using a controlled, randomized, crossover design trial (ABBA), a group of trained young male football players (U-14 to U-16) were randomly allocated (<https://www.randomizer.org/> (accessed on 30 December 2024)) in two groups. They were recruited to voluntarily participate in the current study from 18th December to 9th March. We did not include a washout period between the two experimental phases. Eligible players were randomized in a 1:1 allocation to group A (n = 16) or group B (n = 16). Group A was the experimental group, and group B was the control group during the first 3 weeks; group A was the control group, and group B was the experimental group during the last 3 weeks (6 weeks in total, see Figure 1). Players were familiarized with the testing procedures and exercises two weeks before starting the intervention. During the next 3 weeks, one group performed the experimental training protocol three days per week plus their regular training sessions, while the other one continued with their regular football training sessions. While the experimental group performed their activation, the group that did not perform it played games of rondo (piggy in the middle) involving 6 attackers and 2 defenders. After the first 3 weeks, the experimental role was inverted. One week before, three weeks after the beginning of the intervention, and after six weeks, a navicular drop test, a 10 m linear sprint test, a multiple COD test (V-cut), and a curvilinear sprinting test were assessed.

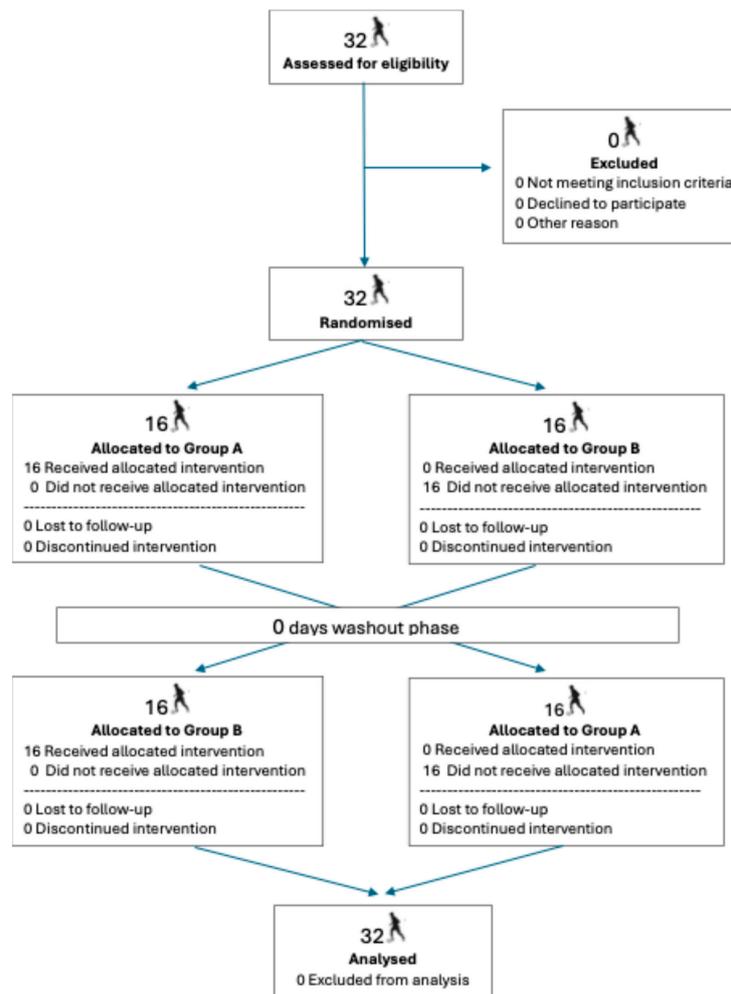


Figure 1. Flow diagram.

2.3. Procedures

Players performed two familiarization sessions with the lateral-step (i.e., lateral-lunge) exercise (see Figure 2) and linear and multidirectional sprinting tests. Tests were performed on the first day of the week, at least 48 h from the last game, and at the same time of day (6:30 p.m.). The order was as follows: the navicular drop test, the 10 m linear sprint test, the curvilinear sprint test (left and right), and the V-cut test. Before testing, all players executed a regular warm-up, including 5 min of mobility, low-intensity jogging (5 m), dynamic stretches, and moderate- to high-intensity activities, such as high knees, butt kicks, cariocas, accelerations, decelerations, linear sprints, and COD (5 min). Players performed a specific warm-up before each test (two repetitions at moderate and maximum intensities). The rest interval between tests and repetitions was 3 min.



Figure 2. Lateral-step exercise with elastic band through a low vector.

2.3.1. Training Intervention

Players performed three weekly additional training sessions used as an activation activity before each football training session, always in the afternoon (6:30 p.m.), involving 20 min combined with the previous warm-up (similar to the above-described protocol). For the first three weeks, group A performed three sets of 6 repetitions per side with 2 min between sets intervals in the lateral-step exercise with an elastic band (Sanctband, Super Loop Purple; 4.76 mm thick \times 25.4 mm wide \times 1000 mm long; 13.61 KGF; Sanct Japan Co., Ltd., Perak, Malaysia) attached to the waist with a belt and in a low vector anchored to the floor (see Figure 2). Group B continued with its regular football training sessions. After 3 weeks, group A players did not execute the experimental protocol, while group B players performed the training protocol during the next 3 weeks.

2.3.2. Navicular Drop Test

Brody's method was used to assess navicular drop, as proposed by Adhikari et al., 2018 [12]. The distance from the position of the navicular bone of the foot to the ground was measured in a sitting position (i.e., unloading) by passively placing the foot in a neutral

position with a 90° angle at the hip, knee, and ankle, and in a standing position (i.e., loading). The tester repeated the measurement three times and recorded the average value of these measurements [17]. A Vernier TM height caliper (Mitutoyo American Corporation, Mitutoyo, Aurora, IL, USA) was used to calculate the navicular drop; the main scale of this simulator is graduated in centimeters, that is, divided in tenths (millimeters). The Vernier divides the millimeters into fifty (1/50), marking each 0.02 mm (two hundredths of a millimeter). The difference between the height of the navicular drop at rest (unloading) and the height of the navicular drop under loading was used [1,12]. A decrease in this value was interpreted as a smaller drop of the navicular bone under loading and, therefore, a maintenance of the plantar arch by the intrinsic musculature of the foot. The measurement was carried out on the right (NDR) and left (NDL) legs by the same evaluator in all participants. Previous studies revealed strong intratester reliability (ICC 2.1 = 95) and precision of measurement (SEM = 0.73 mm) [1].

2.3.3. The 10 m Speed Test

Running speed was evaluated by a player's 10 m sprint time. Time was recorded with photoelectric cells (Witty; Microgate). The front foot was placed 0.5 m before the first timing gate while adopting a 2-point staggered stance. Timing gates were placed at 0.75 m height and 1.5 m distance between each other. It was performed twice, separated by at least 2 min of passive recovery. The best time was used for statistical analysis.

2.3.4. Curve Sprint Test

Running curve speed was evaluated by 17 m sprint times covering the arch of the area. The front foot was placed 1 m before the first timing gate, following the line of the arch of the area. Timing gates were placed at 0.75 m height and 1.5 m distance between each other. It was performed twice on each side, separated by at least 2 min of passive recovery. The best time was used for statistical analysis.

V-cut test. In the V-cut test, players performed a 25 m sprint with 4 CODs of 45° and 5 m each. The front foot was placed 0.5 m before the first timing gate while adopting a 2-point staggered stance. Timing gates were placed at 0.75 m height and 1.5 m distance between each other (Witty; Microgate). For the trial to be valid, players had to pass the line, drawing on the floor with one foot completely at every turn. If the trial was considered a failure, a new trial was allowed. Two valid trials were performed, separated by at least 2 min of passive recovery. The best time was used for statistical analysis.

2.4. Statistical Analysis

All statistical analyses were performed using SPSS (version 25; IBM, New York, NY, USA) and Microsoft Excel (version 2016; Microsoft Corp., Redmond, WA, USA). Normality was assessed using the Shapiro–Wilk test, which showed all variables as normally distributed. A 3 (1, 2, and 3 time-points) × 2 (group A and group B) repeated-measures ANOVA was developed to determine the effects of the intervention period through a crossover design. If the ANOVA was significant ($p < 0.05$) (time, group, group–time interaction, or time–group interaction), a Bonferroni's correction to post-hoc comparisons was conducted. Eta-squared values were used to establish the magnitude difference. Threshold values for η^2 statistics were >0.01 (small), >0.06 (medium), and >0.14 (large). Within-group changes were calculated through effect size (ES) as follows: mean, pre-mean, and mid/pooled SD. Threshold values for *Cohen's d* ES statistics were >0.2 (small), >0.5 (moderate), and >0.8 (large) [14]. In those variables where the time × group interaction was significant ($p < 0.05$) at time-point 1, an ANCOVA using the pre-test or time-point 2 value as a covariable was used to assess the changes at time-point 2 and time-point 3, respectively. The magnitude of the correlation (r (90% CL) between variables' changes was assessed with the

following thresholds: ≤ 0.1 = trivial; $>0.1-0.3$ = small; $>0.3-0.5$ = moderate; $>0.5-0.7$ = large; $>0.7-0.9$ = very large; and $>0.9-1.0$ = almost perfect [20]. If the 90% confidence interval (CI) overlapped with small positive and negative values, the magnitude of the correlation was deemed unclear; otherwise, the magnitude was deemed to be the observed magnitude [20].

3. Results

Table 1 shows between-group and between-time-point differences. A significantly ($p < 0.05$) greater performance was found in both groups (i.e., group effect) in NDR ($n^2 = 0.41$, $p = 0.001$), curve sprinting to the right (CSR) ($n^2 = 0.12$, $p = 0.049$) and to the left (CSL) ($n^2 = 0.43$, $p < 0.001$), and the V-cut test ($n^2 = 0.24$, $p = 0.004$). A significantly ($p < 0.05$) greater performance was found at all time-points (i.e., time effect) in 10 m ($n^2 = 0.56$, $p < 0.001$), CSR ($n^2 = 0.74$, $p < 0.001$), CSL ($n^2 = 0.52$, $p < 0.001$), and V-cut ($n^2 = 0.57$, $p < 0.001$). A significantly greater performance ($p < 0.05$) was found in both groups at different time-points (i.e., group x time interaction) in 10 m, CSR, CSL, and V-cut, while NDR and NDL only reported significance ($p < 0.05$) in group A. Specifically, post-hoc comparisons showed significant differences ($p < 0.05$) between time-point 1 and 2 and between time-points 1 and 3 in all variables except for NDL (1 v 3) in group A. Group B achieved significant differences ($p < 0.05$) between time-points 1 and 3 and 2 and 3 in 10 m ($p = 0.010$ and 0.009), CSR ($p < 0.001$), CSL ($p = 0.002$ and 0.010), and V-cut ($p < 0.001$).

Table 1. Within- and between-group comparison after the 3-week lateral step with elastic bands intervention. Values represent the mean (SD).

	Pre-		Mid-		Post-	
	A	B	A	B	A	B
NDR (cm)	0.08 (0.02)	0.09 (0.02)	0.04 (0.03) *	0.10 (0.04)	0.04 (0.04) *	0.10 (0.05)
NDL (cm)	0.07 (0.02)	0.07 (0.03)	0.05 (0.03) *	0.07 (0.04)	0.05 (0.03)	0.06 (0.05)
10 m (s)	1.86 (0.09)	1.86 (0.11)	1.77 (0.09) *	1.84 (0.11)	1.77 (0.09) *	1.81 (0.09) *#
CSR (s)	2.66 (0.19)	2.54 (0.12)	2.61 (0.17) *	2.52 (0.14)	2.59 (0.17) *	2.47 (0.11) *#^
CSL (s)	2.83 (0.18)	2.58 (0.11)	2.78 (0.17) *	2.56 (0.11)	2.77 (0.19) *	2.52 (0.09) *#^
V-cut (s)	7.44 (0.43)	6.98 (0.44)	7.29 (0.39) *	6.94 (0.41)	7.29 (0.35) *	6.81 (0.39) *#^

Note: NDR: navicular drop with right leg; NDL: navicular drop with left leg; CSR: curve sprinting to the right; CSL: curve sprinting to the left; V-cut: 25 m sprint with four changes of direction of 45° and 5 m each. * $p < 0.05$ compared to pre-. # $p < 0.05$ compared to mid-. ^ $p < 0.05$ vs. group A using the mid-intervention value as a covariate.

A significant between-group difference ($p < 0.05$) (i.e., time x group interaction) was reported at time-point 1 in NDR ($n^2 = 0.14$), CSR ($n^2 = 0.13$), CSL ($n^2 = 0.43$), and V-cut ($n^2 = 0.24$) in favor of group B, except for NDR. As such, NDR showed a significant difference at time-point 2 ($p < 0.001$, $n^2 = 0.35$) in favor of group A. On the other hand, group B showed a significantly better performance in CSR ($p < 0.013$, $n^2 = 0.19$), CSL ($p < 0.047$, $n^2 = 0.13$), and V-cut ($p < 0.001$, $n^2 = 0.46$) at time-point 3.

Small to moderate relationships ($r = -0.23$ to 0.45) were found between those relative changes in the navicular drop test (both sides) and the multidirectional sprinting test changes. When those relationships were individually grouped and analyzed, navicular drop improvements in both the right and left were largely ($r = 0.53$ to 0.54) related to curve sprinting to the left side enhancements in group A between the pre- and mid-test.

4. Discussion

The main aim of the current study was (1) to assess the effect of including the lateral-step or sidestep exercise with elastic bands on multidirectional speed abilities (linear, COD, and curve sprinting) and navicular drop, and (2) to know the impact of navicular drop

changes on multidirectional sprinting changes in young male football players. The main findings were (1) the sidestep exercise with elastic bands significantly improved the ability to sprint multidirectionally in only three weeks of training, and (2) there was a trend in the impact of multidirectional sprinting performance through those changes reported in the navicular drop test.

One of the most important findings was the curve sprinting and COD speed (i.e., V-cut test) improvements (ES = 0.28 to 0.40) through a short elastic band intervention based on the lateral-step exercise. Previous studies [4,18,21–24] have found COD and linear sprinting improvements (ES = –0.07 to 1.79) after using different training methods. Firstly, the device overloading the movement seems to be the most important variable in developing multidirectional adaptations in football players. In this regard, those who have used an inertial rotational device [4,24] have achieved greater improvements (ES = 1.22 to 1.79) in comparison to the rest of the studies. Some authors [24,25] argue that the COD improvement might be closely related to the musculoskeletal system's capacity to tolerate eccentric loads in the braking phase before COD. Secondly, the force vector, or movement plane, is another important variable supporting the current adaptations. Specifically, those studies where football players have applied force in the specific force vector [4,24] have reported greater improvements compared to those who did not, as occurred in the current study.

If we focus on the elastic bands used, the only study where the specific force vector is stressed (i.e., medial–lateral) is the current study. Other studies [18,21] have added elastic bands to traditional exercises like squats and deadlifts, focusing on the vertical axis, showing substantial [21] (ES: 0.81 to 0.82) or no improvements [18]. It is interesting to note that, as no force vector is replicated during the execution of previous studies, training-load adaptations every week designed to overload, through elastic bands, 20% of the maximal capacity of the player (which was measured every week before starting) might be an important factor. Despite the previous differences in the force vector and exercises used, one study [21] showed greater enhancements (ES = 0.81 to 0.82 vs. 0.28 to 0.40) than ours. Such differences might be due to some variables like the number of training weeks (3 weeks vs. 4 weeks), player age (U-16 vs. U-18), the tests used (V-cut and curve sprinting vs. the zig-zag test), or the devices used (elastic bands vs. bars + elastic bands).

Furthermore, it is possible that when the stretch-shortening cycle or the transition between the eccentric and concentric phases is enhanced, COD ability has more chances to achieve improvements irrespective of the device or force vector used. As such, a previous study [23] focused explicitly on COD tests (0%, 12.5%, and 50% of body mass) on adolescent football players. Interestingly, the 12.5% load exclusively achieved significant improvements (ES = 0.25 to 0.45), similar to those found in the current study. Thus, it seems that both the device and the force vector used may develop greater adaptations in multidirectional ability. However, studies comparing a combination of devices and movement speeds exposed might be needed to elucidate the most appropriate method.

So far, we have only analyzed the way of resisting the exercise as a possible cause of the improvement without considering the possible impact of the exercise on improving parameters related to COD performance. Tanaka et al., 2019 [26] and Okamura et al., 2020 [15] associated a decrease in the navicular drop with an improvement in the ability to accelerate and decelerate the intrinsic musculature of the foot, relating this to greater shock absorption and better performance in tasks related to COD. In our study, a simple pre-training activation exercise based on a lateral step resisted with an elastic band has decreased our athletes' navicular drop in just 3 weeks of training, being one of the possible causes of the improvement in their performance in multidirectional ability. Our study shows a general decrease in the navicular drop. However, it only reaches significant values for one of the experimental groups and their dominant foot (i.e., the right foot). As indicated

by Tanaka et al., 2019 [26], the action of the longitudinal median arch of the foot improves the navicular drop. In our case, these are favored by the choice of training exercise. The lateral step favors the deceleration–acceleration phase of the movement; all the foot pressure falls on the median arch of the foot and the longitudinal line that joins the first toe with the heel. This would also be favored during the squat performance if the foot accelerates until it is supported on the forefoot or if it is jumped with [21]. We hypothesized that, by using a diagonal resistance axis and causing a lateral movement of the body, we would have a more significant impact on the modification factors of the navicular drop. Despite the theoretical framework, small to moderate relationships were found between navicular drop and performance changes. However, when those relationships were individually grouped and analyzed, navicular drops in both right and left improvements were largely ($r = 0.53$ to 0.54) related to curve sprinting to the left side enhancements in group A between the pre- and mid-test, that is, after the intervention period in said group. Thus, more longitudinal studies are needed to verify the correlation between the decrease in the navicular drop and the improvement in the change of direction using individualized training loads.

It is essential to acknowledge some limitations in the present study. Specifically, there is a lack of GPS to monitor the training load daily. This does not allow us to verify whether the training load has been the same for all the players who participated in this study. However, all participants had an identical temporal exposure to football training, using similar space/time structures during this period. Lastly, with the absence of washout time between intervention periods, it is reasonable to hypothesize that the initial intervention may have influenced the group that subsequently served as the control.

5. Conclusions

A 3-week intervention program based on executing the resisted lateral-step exercise with elastic bands as a pre-activation to the pitch session showed improvements in curve sprinting and change-of-direction performance. The impact of navicular drop on multidirectional sprinting performance is a positive trend, though more studies are needed to support it robustly.

6. Practical Applications

The current results provide a fascinating overview that includes an easily implemented exercise within practice routines to prepare your players for training and to improve multidirectional abilities. All clubs can access such material to improve the quality of activations and increase the feedforward mechanism on any pitch with the specific football shoes used during games and training.

Author Contributions: The individuals contribution to this paper were as follows: conceptualization, J.L.N.-G., O.G.-S. and F.J.N.; methodology, J.L.N.-G., F.J.N., O.G.-S. and F.H.A.; formal analysis, O.G.-S.; investigation, J.L.N.-G. and M.J.G.; resources, F.J.N., O.G.-S. and F.H.A.; data curation, J.L.N.-G. and M.J.G.; writing—original draft preparation, J.L.N.-G.; writing—review and editing, J.L.N.-G., F.J.N., O.G.-S. and F.H.A.; supervision, F.J.N. and O.G.-S.; project administration, F.J.N. and O.G.-S. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was approved by the Virgen Macarena y Virgen del Rocio University Hospitals ethics committee (0398-N-17) and was conducted in accordance with the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to privacy restrictions.

Conflicts of Interest: The authors declare no conflicts of interest.

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