

Research Article

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Characterization of dairy sheep farms in the Serra da Estrela PDO region

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Abstract: Sheep farming plays a key role in the sustainability of the most depressed rural regions of Portugal, particularly in the Serra da Estrela region, and is recognized as an important source of income for many local farmers. Thus, the management of local sheep breeds in the region has over generations given rise to its most emblematic product: Serra da Estrela cheese, with Protected Designation of Origin (PDO). This study aims to briefly describe the sheep farms producing certified milk in the Serra da Estrela region. To this end, a survey form was drawn up and applied to 75 farms, randomly selected, from the defined geographical area of Serra da Estrela, from June to August 2020. The results show that the producers, mostly male, have an average age close to 51 years. On average, the herd size is equal to or greater than 100 animals and the daily milk production per animal varies between 0.47 and 1.0 L. The price of milk paid to the producer is, on average, at 1.25 Euros/L. Both the average herd size and the lactation length are higher than those described by others. The average daily milk production in most of these farms is in accordance with the standard average value related by other authors.

Keywords: sheep farming, Serra da Estrela, cheese, PDO region, Portugal

1 Introduction

Livestock activity is particularly relevant in the economic structure of Portugal, playing a key role in the sustainability of rural economies [1], particularly in the Serra da

Estrela region, located in central mainland Portugal, where dairy sheep farming and cheese production are important sources of income for many farms [2,3].

Serra da Estrela Protected Designation of Origin (PDO) cheese is one of the main endogenous products in the region and is also the result of a way of life which is part of the ecosystem, gradually developed and adapted to local conditions over the generations [4]. In this sense, the PDO regulation ensures the preservation of the region's heritage and cultural identity, allowing the settlement of local populations through the use of family labor [5].

The certified milk for the manufacture of Serra da Estrela PDO cheese must be exclusively extracted from two local breeds of sheep, Bordaleira Serra da Estrela (BSE) and Churra Mondegueira (CM), which must be part of livestock farms located within the limits of the specific geographical region (Figure 1), which includes the districts of Castelo Branco, Coimbra, Guarda, and Viseu [6]. It covers a total area of 3,140 km² [2,3]. As open-air rearing is the most common technique, only extensive or semi-extensive production systems are permitted. Pastures are mainly composed of grasses and leguminous plants, which can withstand cold, acidity, and low soil fertility [7]. Currently, most of the farmers resort to the improvement of natural pasture areas with the introduction of new species and the use of forage crops to store food for periods of increased shortages. Farmers can also use compound feed and animal feed as a last resort during the critical stages of the production period [8]. The fodder crops most regularly used are essentially as follows: oats, rye, maize, fodder sorghum, and marsh grass or yearly ryegrass [7].

BSE sheep is the largest representative breed in the specific geographical region, usually raised in small areas and in herds of different sizes [9]. According to the latest data, 215 farmers and 18,603 BSE sheep are currently registered [10].

In the past decades, the number of dairy farms supplying certified milk and the production of Serra da Estrela PDO cheese have undergone some variations, and in recent years it had shown an increasing trend (Figure 2) [11]. Actually, there are 125 farmers licensed

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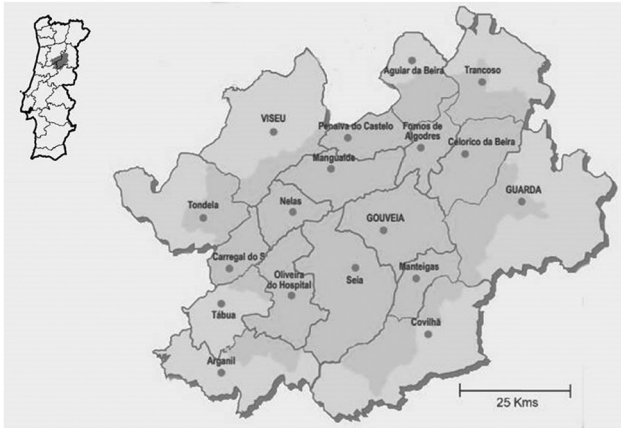


Figure 1: Specific geographical area of Serra da Estrela PDO.

to sell milk intended for the manufacture of Serra da Estrela PDO cheese.

This study is part of the Program for the Enhancement of the PDO Cheese Row in the Centro Region and aims to characterize sheep farms producing certified milk in the PDO Serra da Estrela region based on the collected data by a survey form inherent to each farm, namely the farmers profile, livestock management, milk production, or trade issues. The understanding of production conditions of sheep farms aims to contribute to the elaboration and development of actions or programs that aim to improve the conditions for the management of local breeds in the region.

2 Material and methods

2.1 Survey form

The present work is based on a sample of sheep farmers, to whom an interview survey form was applied on their dynamics in the milk and cheese production sector.

A survey form adapted from Monteiro et al. [12] was developed and structured in six sections with questions regarding the farmer, the farm, the flock, sanitary and food management, and the milk and lamb commercialization. Before the application of survey form, its suitability for the study objectives was tested through the small-scale application of the preliminary version in view of the final adjustments to ensure the success of the research.

2.2 Population

According to the Portuguese Society of Animal Genetic Resources [10], 17,617 females and 986 males are currently enrolled in the Sheep Breed Genealogical Book of the Serra da Estrela Ovine Breed. The number of farmers rises to 215. As for the CM native sheep, there are 2,264 females (1,909 females in pure line) and 99 males registered in its Genealogical Book, belonging to 37 farmers.

2.3 Sampling

The sheep farms were randomly selected from the municipalities of Celorico da Beira ($40^{\circ}38'N$; $7^{\circ}23'W$), Fornos de Algodres ($40^{\circ}37'N$; $7^{\circ}32'W$), Gouveia ($40^{\circ}29'N$; $7^{\circ}35'W$), Mangualde ($40^{\circ}36'N$; $7^{\circ}45'W$), Nelas ($40^{\circ}31'N$; $7^{\circ}51'W$), Oliveira do Hospital ($40^{\circ}21'N$; $7^{\circ}51'W$), Penalva do Castelo ($40^{\circ}40'N$; $7^{\circ}41'W$), Seia ($40^{\circ}25'N$; $7^{\circ}42'W$), and Tábua ($40^{\circ}21'N$; $8^{\circ}1'W$), belonging to the districts of Coimbra, Guarda, and Viseu. All sampled farms are part of a semi-extensive grazing regime, using natural, semi-natural, and/or sown pastures. Overall, according to the

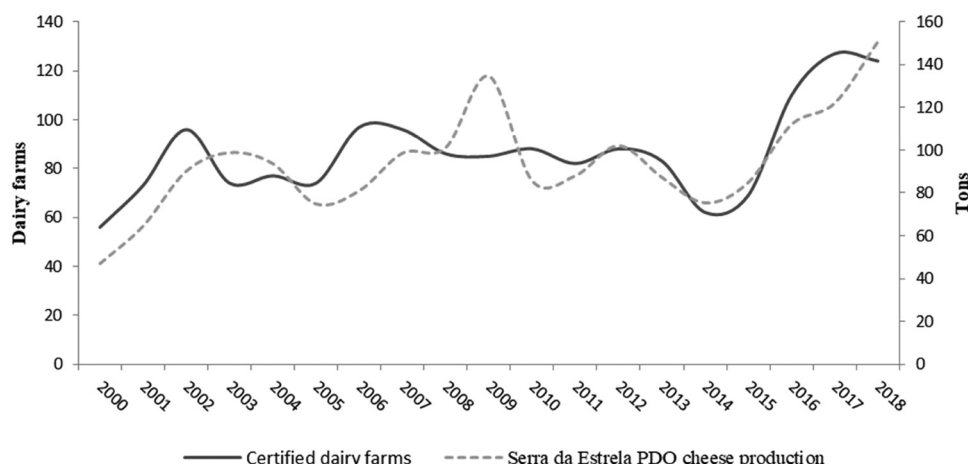


Figure 2: Number of certified dairy farms and production (tons) of Serra da Estrela PDO cheese (2000–2018). Source: [11].

last agricultural census carried out in Portugal [13], the surface of permanent pastures and meadows, as well as the forage crops and temporary meadows in the PDO region exceeded 21,000 ha. The average surface of farms for small ruminant was around 5 ha across the region.

A total of 75 farmers ($N = 75$) of BSE and CM sheep, whose milk is exclusively sold for the manufacture of Serra da Estrela PDO cheese, were interviewed. The visits made to each farm and interviews with the breeders were carried out during the months of June, July, and August 2020.

2.4 Statistical analysis

The survey forms were coded and descriptive statistics were performed using the Statistical Package for Social Sciences (SPSS, version 25.0 for Windows).

3 Results and discussion

3.1 Sheep farmer profile

According to the surveys carried out, the range of farmers' age is quite wide (ages ranging from 24 to 72 years). In general, the interviewed farmers are not elderly people. The average age of farmers is around 51 years, with only a quarter of farmers (25%) below the age of 42.5 years. Likewise, 75% are less than 60 years old (Table 1). According to the results, we cannot consider that the farmers are actually young, nor can we consider that they are part of an extremely aging population, with the overwhelming majority still in working age.

Table 2 shows that most of the farmers are males (82.7%). In terms of educational qualifications, about half of farmers (50.7%) said they only had elementary school and the majority (82.7%) have not finished high school. The remaining farmers claim to have completed high school (9.3%) or to have higher education qualifications (8%). Only two of them (2.7%) do not know how to read or write, being over 60 years old. In general, we find a group of farmers with limited educational backgrounds whose experience in dairy sheep farming is based on the know-how and family tradition. In fact, most of the interviewed farmers (78.7%) claim to have more than 20 years of experience working in this sector (dairy sheep management). According to the interviews, sheep breeding

Table 1: Characterization of the farmers' age

	N	Mean	Min.	Max.	Std. deviation	Percentile		
						25	50	75
Age	75	51.4	24	72	11.49	42.5	51	60

and herd management are closely associated with family inheritance. Most of the farmers claimed to have family traditions in this activity: parents and, in some cases, grandparents, were also involved in sheep farming, at least temporarily. In addition to enjoying the activity they carry out, the family tradition is in fact pointed out as one of the important reasons for the decision to choose sheep farming management in this region. The great majority of farmers (76%) consider the sheep farm management as their main activity. However, the demands of this activity and the existence of other available resources make many of these farmers dedicate themselves to other activities of less importance in terms of the overall income of the farm. In addition to their herds, they cultivate cereals, fodder, vegetable gardens, and vineyards and raise other animal species, usually goats in a small number. Thus, only 5 (6.7%) of the 75 farmers stated that their main activity is based on both sheep and goat farming. There are also farmers, although in a minority number (17.3%), whose livestock farming is not the main activity.

3.2 Livestock production

Table 3 shows the results concerning to the dairy sheep management. Although on most farms the herds equal or exceed 100 heads (74%), the size of the herds per farm is extremely diverse, showing great variability ranges from 26 to 800 animals.

The average number of sheep per farm, over 100 animals, diverges from the average values cited in other works, pointing to 50–60 sheep per flock, varying according to the region [9,14,15], or to a range between 30 and 100 [10], BSE sheep breed. In a broader perspective, Portugal presented an average of 48.1 sheep per farm in 2016 [16]. On the contrary, the mortality of lambs averages 9.19 heads per farm. There is a wide variation in this value between farms [17]. Ideally, the mortality rate for lambs should remain at approximately 3%, with a maximum acceptability limit of 5% [18]. The results obtained exceed the acceptability limit previously

Table 2: Gender, qualifications, main activity, and experience of farmers

	<i>N</i>	Frequency	Percent	Cumulative percent
Gender	75			
Female		13	17.3	
Male		62	82.7	
Educational qualifications	75			
No school qualifications		2	2.7	2.7
Elementary school (first cycle)		38	50.7	53.4
Elementary school (second cycle)		9	12.0	65.4
Elementary school (third cycle)		13	17.3	82.7
High school		7	9.3	92.0
Graduation		6	8.0	100.0
Main activity	75			
Sheep farming		57	76.0	
Goat farming		0	0.0	
Both		5	6.7	
Other		13	17.3	
Years of experience related to the sheep farming	75			
0–10		6	8.0	8.0
11–15		5	6.7	14.7
16–20		5	6.7	21.3
>20		59	78.7	100.0

mentioned in the case of dairy farms. The mortality rate in adult sheep assumes some variability, related to the different production systems, which may vary between 4 and 5.5%, in the most extensive systems [19]. In this context, the calculated values seem to be in accordance with the values mentioned by the author.

The number of animals on all farms amounts to 10,323 sheep, of which 10,205 (98.7%) are of the BSE breed and 118 (1.3%) of the CM breed as shown in Table 4. Thus, considering the very weak representativeness of CM breed in this study, we will highlight only the particularities of the BSE sheep breed.

The BSE is a sheep breed with strong dairy qualities [9] which has two varieties: white and black [14]. According to the results obtained, we found that just over a

quarter of farmers (26.7%) claim that their herd consists exclusively of black and white sheep and 30.7% of the white variety. The mixed category was the most registered (45.3%), although most of the farmers affirm that white variety is in large majority in the two breeds set. According to the bibliography [15], the estimated proportion for the total herd of the BSE breed was around 90% of white sheep and 10% of black sheep. Based on the data collected for the current study, the proportion of the black variety does not correspond to the estimated proportion cited by the authors. It should also be noted that according to a study by Carolino et al. [9], it was found that the effect of the variety did not significantly influence ($P < 0.01$) the characteristics of milk production.

Table 3: Size, lambing, and mortality of the sheep flock

	<i>N</i>	Mean	Median	Mode	Min.	Max.	Std. dev.
Total livestock	75	137.6	112	100	26	800	114.49
Total females	74 ^a	134.2	109	97	25	793	113.82
Total males	74 ^a	3.7	3	2	1	11	2.06
Rearing lambs	74 ^a	22.5	18	12	0	140	20.50
Number of births	74 ^a	127.0	93	70	18	1,100	140.51
Number of dead lambs	75	9.2	8	6	0	30	6.61
Number of dead sheep	75	5.7	5	2	0	18	4.39

^a Only BSE sheep farmers.

Table 4: Breed, variety, and type of birth

	<i>N</i>	Frequency	Percent	Cumulative percent
Breed	75			
Bordaleira Serra da Estrela		74	98.7	
Churra Mondegueira		1	1.3	
Variety (BSE)	77 ^a			
Black		20	26.7	
White		23	30.7	
Mixed (black and white)		34	45.3	
Most frequent type of birth (BSE)	75			
Simple		46	61.3	61.3
Double		29	38.7	100

^a Two breeders have two distinct herds, one black and one white.

In reproductive terms, the most frequent type of birth was the simple one (61.3%), resulting in the birth of one lamb per ewe/year, the remaining ones (38.7%) being double lambings. However, according to the respondent farmers, we must emphasize that the number of lambs per lambing varies from year to year depending on environmental, genetic, and lambing order factors.

3.3 Milk production

Two daily milking is performed by all farmers. The number of sheep to be milked is, in average terms and according to most farmers (64%), at least 60 animals per farm (Table 5). All milking periods correspond to milking after weaning the lambs, usually at 1 month of age. The average daily milk per animal is 0.73 L during the lactation length, a value that is in accordance with the values mentioned to in other publications [10,14,15], although there is an oscillation in milk production between herds, with values ranging from 0.47 to 1.0 L, reflecting a great variability of milk production by the BSE sheep [9].

Furthermore, according to the information provided by the farmers for this work, the length of lactation in

animals of BSE breed had an average duration of approximately 248 days in the last year. This value is slightly higher than the reference average for BSE breed, which varies between 180 and 220 days [9,10,14]. This fact may be associated with poor scheduling of the mating seasons, which have an excessive duration, causing the birth season to become dispersed and, consequently, extend the milking period. The extension of the milking period may result in problems such as over-milking and the consequent increased probability of developing mastitis [20].

Table 6 shows that the milk produced on these farms is intended exclusively for the manufacture of Serra da Estrela PDO cheese. Only 15 (20%) of the 75 farmers claimed to be cheese makers, although two of them do not currently produce cheese, opting to sell the milk to other cheese dairies.

Of the 75 milk farms surveyed, only 15 use machine milking, although there are other farmers who have installed the milking machine but do not use it. Traditionally, milking is done by hand, although mechanical milking is also used (a faster process that allows milk to be obtained in better hygiene conditions), restricted to a few producers because of the high cost of the equipment and its use is only profitable in larger herds [21]. In this work, we found that the largest numbers are in fact associated with mechanical milking.

Table 5: Milk production and lactation length

	<i>N</i>	Mean	Median	Mode	Min.	Max.	Std. dev.
Number of sheep milked	75	74.16	60	60	25	300	43.40
Daily average milk per farm (L)	75	55.09	50	40	14	270	39.50
Daily average milk per sheep (L)	74 ^a	0.73	0.71	0.67	0.47	1	0.128
Lactation length (days)	74 ^a	247.84	255	270	120	320	32.25

^a Only BSE sheep farmers.

Table 6: Milking and cheese factory

	<i>N</i>	Frequency	Percent
Exclusive milk for cheese factories	75		
Yes		75	100.0
No		0	0.0
Own cheese factory	75		
Yes		15	20.0
No		60	80.0
Mechanical milking	75		
Yes		15	20.0
No		60	80.0

3.4 Feed management

Feed management is based on maximizing the use of resources available on each farm, including spontaneous pastures, from autumn to spring and pastures sown (e.g., oat, rye, and ryegrass), with variable floristic composition, seeking that the quality of the food meets the specific needs of the animals according to the physiological phase in which they are. The farmers use a simple rotational grazing system in which more than one pasture area is used and livestock are moved to different pasture areas during the grazing season.

According to the survey form, more than half of the farmers (56%) say that feeding the animals is based on the use of both spontaneous and sown pastures (Table 7). Only two farmers (2.7%) use the spontaneous pastures as the exclusive basis for feeding their animals. In short, farmers mostly use sown pastures combined or not with spontaneous pastures. There is also the supplementation of animals with hay and concentrated food in times of lower forage production, carried out by the most of

Table 7: Sheep feeding and supplementation

	<i>N</i>	Frequency	Percent	Cumulative percent
Pastures	75			
Spontaneous		2	2.7	2.7
Sown		31	41.3	44.0
Both		42	56.0	100.0
Fodder	75			
Produced		53	70.7	
Purchased		6	8.0	
Both		16	21.3	
Feed supplementation	75			
Yes		68	90.7	
No		7	9.3	

farmers (90.7%). Traditionally, BSE sheep were not supplemented with concentrates, although on recent years this practice has become common [22]. In times of greater feeding needs, such as the period before mating, the last third of gestation and the first stage of lactation, could be essential the use of supplementation with concentrated foods to deal with the increased production needs of the sheep [23]. The use of these feedstuffs must be authorized by the producer group and is controlled both quantitatively and qualitatively by the certification body [7].

3.5 Sanitary management

Table 8 shows some aspects related to the sanitary management of herds. All the farmers interviewed state that their herds are subject to deworming and vaccination practices, once or twice a year and to blood tests, usually once a year. The acceptance of the milk produced on their farms forces them to a stricter control according to the requirements which certification imposes. The registration of medicines administered to animals is carried out by two-thirds of the farmers (66.7%), and a

Table 8: Sheep sanity

	<i>N</i>	Frequency	Percent
Sanitary interventions	75		
Yes		75	100
No		0	0
Registration of medicines	75		
Yes		50	66.7
No		25	33.3
Medicine administration without agreement of the veterinarian	75		
Yes		52	64
No		23	36
Udder and teat evaluation for mastitis	75		
Yes		22	29.3
No		53	70.7
Disinfection of the umbilical cord of lambs	75		
Yes		26	34.7
No		49	65.3
Hoof trimming	75		
Yes		66	88
No		9	12
Footbaths	75		
Yes		50	66.7
No		25	33.3

Table 9: Price of milk and lambs

	<i>N</i>	Mean	Median	Min.	Max.	Std. dev.
Price per liter (€/L) of milk	75	1.25	1.25	0.70	1.35	0.080
Price per kilogram (€/kg) of lambs	75	3.62	3.50	3.00	4.50	0.33

proportion close to the previous one (64%) reveals do not administer medicines to animals without the agreement of the veterinarian.

The udder and teat evaluation for mastitis is not usual in most of the farms (70.7%). The frequency of this practice could prove to be positive, as the mastitis are of high damage to animal welfare and farm income – cost of treatments, slaughter, lesser lamb growth and increased mortality, less milk sold, etc. [24]. Likewise, close to two-thirds (65.3%) of farmers claim do not disinfect the umbilical cord of lambs after birth and just 26 of the 75 farmers report doing so.

One-third (33.3%) of the 75 farms surveyed have no footbaths. The remaining producers (66.7%) say that they have footbaths, although some of them reveal do not use it. This fact shows that there is a general concern to take a preventive and curative approach [25]. The preventive way is probably the most appropriate approach in the extensive production systems. Once the sheep will share pastures, confinement areas, etc., it is advisable to pass the entire herd through the footbath as a precaution [25]. Using footbaths, as a component in the treatment of the main foot pathologies, such as the foot-rot, is now called into question, as there does not seem to be a direct beneficial effect of its use, often resulting in increased costs for the farm [26].

Hoof trimming is an essential element of sheep production and management. In this sense, 66 farmers

(88%) perform hoof trimming to the animals in either a preventive or curative way. The farmers who claim to carry out the hoof trimming assumed it like a frequent practice.

3.6 Commercialization

The average price of milk practiced in the last season was 1.25 Euros per liter (Table 9). However, most farmers consensually claim that the price paid for milk is not yet what they desire because it is not kept up with the increased costs inherent to the farm management. It should be noted that the exceptional situation in the country regarding the outbreak of COVID-19 pandemic has affected the price of milk in the last 3 months of the campaign. In some cases the cheese industry has reduced the price from €1.25 to €0.70 to €0.80 per liter, or even giving up buying milk.

Although these breeds are primarily exploited for milk production, they also contribute to meat production. The sale of lambs is another important source of income for the farmer. Traditionally the lamb is traded to the unit and its value may change according to the average weight, age, breed, and sale season. The average price of lamb until 12 kg was €3.62 per kg, although the most frequent price was €3.50 per kg, which is below the lamb prices between 3.75 and 4.10 Euros indicated to the producer by GPP [27].

In recent years, under normal market conditions, milk and lamb outflow was not very constrained, according to all farmers (Table 10), managing to sell everything produced. The good functioning of the marketing system, according to a greater number of responses, is because of the ease flow of production, the PDO condition, the compliance with payment dates, and the organizational efficiency in milk collecting.

Table 10: Commercialization of milk and lambs

	Milk			Lamb		
	<i>N</i>	Frequency	Percent	<i>N</i>	Frequency	Percent
Milk and lambs outflow	75			75		
Yes		75	100.0		75	100.0
No		0	0.0		0	0.0
Actual customers	67 ^a			75		
Intermediaries		32	47.8		69	92.0
Private customers		0	0.0		0	0.0
Factories		35	52.2		6	8.0

^a Eight of the 75 producers have their own cheese factory and make cheese.

More than half of the farmers (52.2%) say the milk is sold directly to the cheesemakers. The other form of products outflow, for 32 of 67 farmers (47.8%), is the sale through a cooperative that intermediates the distribution of milk to one of the largest cheesemakers in the region. Farmers also use two ways for the lambs outflow: the main one is the sale to intermediaries (92%) and the direct sale to slaughterhouses, although in a minority (8%).

4 Conclusion

The results of this work show that the sheep farmers are mostly men of working age, with limited school qualifications and whose experience in dairy sheep farming is based on know-how and family tradition. Farmers with less experience in sheep farming are generally those with a higher level of education.

The average number of sheep per farm exceeds 100 animals and differs from the average values mentioned in other researches, pointing to lower average values. The white variety of the sheep BSE is the one with the largest number of animals. The mortality rate of lambs on these farms is higher than the maximum limit of acceptability described in the bibliography. However, the mortality rate of adult sheep is in accordance with the literature.

In terms of feed provided to the animals, most of the interviewed farmers resort the use of sown and spontaneous pastures in a mixed regime; however, the limited amount of pasture in the most demanding production phase leads to supplementation with compound feed during the main lactation months.

The average daily milk produced per animal at milking is in accordance with the values mentioned in other works. The acceptance of milk produced on dairy sheep farms forces farmers to stricter control in accordance with the sanitary requirements imposed by certification, particularly in terms of vaccination, deworming, and blood tests.

Finally, the average producer price of milk in the last campaigns was €1.25 per liter. However, for some dairy farmers, the price of milk was reduced in the April, May, and June 2020, as the COVID-19 pandemic situation has been spread all over the world.

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Author contributions: António Monteiro: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, and writing original draft and editing; Sérgio Santos: writing, review and editing.

Conflict of interest: The authors state no conflict of interest.

Data availability statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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