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Risk of autochthonous human schistosomiasis transmission in Italy

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SUMMARY

Introduction: Schistosoma (S.) haematobium is a widespread tropical helminthic zoonosis. Schistosomiasis was endemic in some foci in Southern Europe until the sixties of the last century. Autochthonous transmission of human schistosomiasis was first reported in the French island of Corsica in 2014, and the schistosome responsible for this emergence was also linked to partial hybridisation between *S. haematobium* and the bovine schistosome species *S. bovis*. Transmission has recently been retrospectively confirmed in southern Spain as well.

Risk of introduction of schistosomiasis to Italy: The distance between southern Corsica and northern Sardinia is 12 km. The freshwater snail Bulinus (B.) truncatus, one of the intermediate mollusc hosts of S. haematobium, is known to be endemic in some regions of southern Europe, including Corsica, Spain, and Portugal, where it transmits the zoonotic *S. bovis*. *B. truncatus* appears still to be endemic in Sardinia and possibly also in Sicily. Furthermore, schistosomiasis of ungulates caused by *S. bovis*, transmitted by the same vector snail, also appears to be endemic in Sardinia. Migrant populations and returnees to Italy have been found to be infested with schistosomes, and tourism to local freshwater bodies is increasing.

Discussion and conclusions: There is a considerable potential risk of autochthonous schistosomiasis being introduced to Italy. Therefore, surveillance has to be intensified to prevent the establishment of an autochthonous transmission cycle of human schistosomiasis in Italy. Systematic screening strategies for individuals who have been possibly exposed to endemic areas need to be established. Curative treatment of identified cases is mandatory. Praziquantel, the drug of choice, needs to be readily available throughout Italy.
Malacological surveillance of snail populations focusing on potential transmission sites is recommended. A one-health approach is recommended to verify the actual epidemiological situation of autochthonous *S. bovis* infestation and, thereby, to investigate the risk of establishing a zoonotic reservoir. Clinicians should be aware that, in some circumstances, schistosomiasis may occur in individuals who have never travelled to known endemic areas before.

Keywords: schistosomiasis, *Schistosoma haematobium*, urinary schistosomiasis, genital schistosomiasis, *Schistosoma bovis, Bulinus truncatus, Planorbarius metidjensis*, zoonosis.

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INTRODUCTION

Schistosoma (*S.*) *haematobium* was endemic in some foci in southern Europe, such as Portugal and Greece, until the 1960s of the last century [1, 2]. Autochthonous transmission of human schistosomiasis was first reported in the French island of Corsica in 2014, and the schistosome responsible

for this emergence was identified as a hybrid between S. *haematobium* and *S. bovis* [3, 4]. Until now, we do not know whether this hybridization is ancient or still ongoing. The ongoing transmission was confirmed to occur in southeastern Corsica, specifically in the Cavu River and the Solenzara River [5, 10-12].

Italy, in particular, Sardinia, has a comparable climate to Corsica. The distance between the two islands is 12 km. The freshwater snail Bulinus truncatus, a vector of S. haematobium, is endemic in some regions of southern Europe, including Corsica, Spain, and Portugal, where it transmits the zoonotic *Schistosoma bovis* [13-19]. In Italy, specifically in Sardinia and Sicily, Bulinus truncatus remains endemic [20]. Furthermore, schistosomiasis in ungulates, caused by Schistosoma bovis, which is endemic in Sardinia, is transmitted by the same vector snail [21, 22]. However, no recent official data are available regarding the presence of *Bulinus truncatus* in Sardinia. Anecdotal evidence, such as photographs shared by users on an online forum dedicated to Mediterranean biodiversity, suggests that *Bulinus truncatus* is still present on the island [23]. This forum is used by naturalists and amateur biologists who often share geo-referenced photographs of local fauna, including mollusks. Therefore, we aim to evaluate the risk of autochthonous transmission of human schistosomiasis in Italy, with a particular focus on Sardinia, by analyzing environmental, parasitological, and epidemiological data. We conducted a narrative review, synthesizing peer-reviewed publications, historical records, surveillance data, and supporting grey literature, including unpublished data and expert field observations. We also considered ecological factors, host–vector–parasite interactions, and socio-demographic trends relevant to schistosomiasis transmission dynamics in southern Europe.

THE LIFE CYCLE OF SCHISTOSOMES

The life cycle of schistosomiasis involves a definitive mammalian host and an intermediate vector mollusc. The definitive human host becomes infested in freshwater bodies when the swimming larvae, called furcocercariae, actively penetrate the intact skin. Subsequent stages include juvenile schistosomula, which circulate in the human blood vessels until they reach the portal vessels in the liver. Here, female and male mate and swim as a worm pair via the splanchnic and intestinal vessels until they reach the intestinal capillaries or, via the plexus haemorrhoidarius, the capillaries of the bladder. Here, the female worms lay ova which are excreted with urine and/or the feces of the host. When the eggs are excreted into a freshwater body, ciliated larvae called miracidia hatch from the egg and swim towards a snail vector. The larvae actively penetrate the snail, undergo several multiplication stages, and develop into furcocercariae, which are subsequently released from the snail and swim towards the definitive host.

FACTORS FOR THE ESTABLISHMENT OF AN AUTOCHTHONOUS HUMAN SCHISTOSOMIASIS TRANSMISSION

Factors required for the establishment of an autochthonous Human schistosomiasis transmission include

- The infested definitive mammalian host.
- The excretion of ova into a freshwater body.
- The existence of specific vector snails in the freshwater body.
- The exposure of the human host to the freshwater body.
- The capacity of vector snails and schistosomes to overwinter.

• Migrants infested with S. haematobium have been identified through screening in Italy, including the island of Sardinia [13, 24]. Bovines were found infested by *S. bovis* in Torpè village, with two of three infested by *S. bovis,* and in Ballao village, two of two infested by *S. bovis* [15, 25, 26]. In the villages of Posada, Budoni, Irgoli, Tortoli, and Bari Sardo, none of the 21 bovines and the 15 ovines analyzed were found infested by *S. bovis*. The presence of both *S. haematobium* arriving from outside Sardinia and of an autochthonous *S. bovis* gives the possibility of reproducing the same scheme as in Corsica, with a hybrid form of schistosome in Sardinia.

Tourists and expatriates from endemic areas are also at risk of schistosomiasis in Europe and Italy [27-29]. Although they represent a smaller proportion of schistosomiasis cases diagnosed in Europe and have different clinical presentations (often acute schistosomiasis), they remain a potential res-

ervoir of infestation, as demonstrated by the outbreak in Corsica, also due to the ease of movement within the European continent [30].

• Excretion of eggs (from urine and/or feces) into freshwater bodies could happen in Sardinia, from humans, from ruminants, but also rodents as it is the case in South Benin [31, 32].

• *Bulinus truncatus,* the freshwater snail, is most probably present in Sardinia. The latest scientific report was published in 2012 [33]. On an internet blog, a photo of a Bulinus snail was taken in 2007. Another conceivable vector snail, *Planorbarius meditjensis,* formerly implicated in the transmission of schistosomiasis in Portugal, Spain, and Morocco but absent from Corsica, would also need to be looked for in Sardinia [14, 15].
Indirect confirmation of the possibility of a permanent autochthonous life cycle is the presence of local *Schistosoma bovis* endemicity in local domestic animals such as bovines and ovines, because the same vector snails transmit the latter schistosome species. *S. bovis* was collected from bovines in the South-East part of Sardinia (Ballao village) [25, 26, 34, 35]. Two experimental studies of the cercarial shedding rhythm of *S. bovis* showed that (i) the Sardinian population emerged from its *Bulinus truncatus* snail host significantly earlier than the Sudanese and Spanish populations, supporting the existence of genetic variability of the emergence rhythms and (ii) that the cercarial emission is situated early in the morning (peak at 8 am). The chronotype of *S. bovis* in Sardinia indicates that, at the time (1986), S. bovis was not interacting with S. haematobium (indeed, when both schistosomes interact, the cercarial emission pattern exhibits at least two peaks) [31, 32].

• Tourists taking baths in freshwater bodies, such as those found in Corsica, are far less common in Italy compared to Corsica. Conceivable transmission sites, however, are found, for example, in the Barbagia region of Sardinia. Several freshwater sites in Sardinia are popular for bathing and may serve as potential transmission foci (Table 1). Bulinus truncatus was found in the Barbagia region of Sardinia, in the villages of Suaredda (San Teodoro) and Ballao, as well as in the Flumendosa and Bari Sardo rivers [26]. Prevalence was, from North to South, 0.3%, 0%, 0%, 0% and 11.3% in Suaredda, Bari Sardo, Flumendosa and Ballao, respectively (Mouahid and Moné, unpublished data obtained during August 1986 in collaboration with Efisio Arru from the University of Sassari).

Table 1 - Open freshwater bodies in Sardinia as potential transmission sites of schistosomiasis.

Rivers	Fiume Tirso: it is the longest river in Sardinia, and at many points people take a bath, especially at certain thermal spots (e.g., Fordongianus).
	Flumendosa is the second-largest river in Sardinia. Along this river, there are numerous beaches. The most important is near the waterfall of Sa Stiddiosa. This is actually not a waterfall, but a water resurgence phenomenon along the rocky wall that forms the right orographic bank of the river in the locality of Sa Murta. The water trickles down the wall, creating a generous dripping.
	Fiume Coghinas: the third river of Sardinia, where numerous people also bathe in the Viddalba area. There is a beach where canoeing is also possible.
	Riu Biralotta, Rio Flumineddu, and Fiume Cedrino with "le Sorgenti Su Gologone".
Waterfalls	Cascata di Piscina de Licona, Rio Li Cossi, is a small beach which is confined on one side by the sea and on the other by the river Rio Pitrisconi, Corropus di Gergei, Cascata di Triulintas a Martis.
Lakes	Lago di Baratz, Lago Omodeo, Lago Mulargia, Lago di Gusana, Lago di Leni, and Lago Corsi.

• *Bulinus truncatus* is a snail that is known to resist the winter temperatures in Mediterranean countries, including Italy, France, Spain, and Portugal [21]. The schistosomes were thought not to be capable of overwintering inside the snails, but they can survive the winter easily inside the mammalian host. A recent study confirmed, however, that schistosomes insider snails can resist temperatures as low as 4°C [36]. Another risk factor is climate change, which is favorable to the establishment of a life cycle. There is circumstantial evidence of the influence of climate change by the observation that Napoleon's troops who returned from Egypt in 1798 with urinary schistosomiasis did not cause an outbreak of schistosomiasis in Europe, namely in Corsica [37].

Concluding, in Italy, specifically in Sardinia, a situation similar to that in Corsica may occur, where local vector snails are present and humans, whether adults or children, who may not be aware of their infestation, infest these snails, introducing the possibility of permanent autochthonous transmission of schistosomiasis. To prevent this from happening, systematic screening of migrant populations and returnees from endemic areas, as well as treatment for those who are infested, is necessary. For first-line screening of potentially exposed individuals, particularly migrants and returnees from endemic regions, urine reagent strips (e.g., hematuria dipsticks) are a rapid, low-cost, and scalable tool suitable for field use. In individuals with a positive or high-risk status, parasitological confirmation via urine filtration microscopy or serological testing (e.g., ELISA and/or immunochromatography) should be performed to confirm the diagnosis and guide treatment. Additionally, malacological surveillance of potential transmission sites is necessary to assess the snail population in these areas. Education about schistosomiasis and its chronic forms should be strengthened among healthcare workers [38]. Clinicians should be aware of the possibility that, in some circumstances, schistosomiasis may occur in individuals who have never travelled to known endemic areas. Additionally, the disease could not be detected via conventional screening and diagnostic methods when it is in its chronic stage.

Conflict of interest
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