

Brief Report

Associations of Fluke (Spirorchiid) Infection and Buoyancy Disorder with Death in Stranded Sea Turtles Undergoing Rehabilitation in Taiwan

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Abstract

Sea turtles are increasingly regarded as indicators of coastal ecosystem health, as their clinical condition and disease profiles reflect prolonged exposure to environmental pressures in impacted marine habitats. Wildlife rehabilitation facilities play an important role in sea turtle conservation, although risk factors associated with mortality during rehabilitation are not well defined. This retrospective study evaluated clinical and infectious risk factors for death in 108 stranded sea turtles (including 70 green turtles, 19 olive ridley turtles, 16 hawksbill turtles, 2 loggerhead turtles, and 1 leatherback turtle) admitted to the rehabilitation facility at the National Museum of Marine Biology and Aquarium between 2018 and 2024. Data on buoyancy disorder, spirorchiid fluke infection, fibropapillomatosis and final disposition were analysed using univariate and multivariable logistic regression. Buoyancy disorder (adjusted OR = 9.96) and spirorchiid fluke infection (adjusted OR = 3.33) were associated with increased mortality, highlighting the need for careful monitoring and early detection of these conditions during rehabilitation. However, the retrospective design may inherently limit causal inference.

Keywords: buoyancy disorder; spirorchiid; fibropapillomatosis; risk factors; sea turtles rehabilitation



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1. Introduction

Wildlife rehabilitation can contribute to species conservation by releasing healthy individuals back into the wild. For example, sea turtle rehabilitation facilities that treat injured turtles have been reported worldwide [1–4]. These facilities improve the welfare of individual animals and provide unique opportunities to collect clinical and epidemiological data on endangered sea turtle populations. Previous studies have identified several prognostic factors associated with the survival of sea turtles during rehabilitation. For example,

sea turtle species, body size, nutritional status, trauma, entanglement, hook ingestion, hematologic abnormalities, and summarized health index (SHI) have been recognized as predictors of rehabilitation success [1–5].

Buoyancy disorders, which are characterised by turtles being unable to submerge and instead floating at the surface, are a common clinical issue in the rehabilitation of sea turtles [6]. In a long-term retrospective study of stranded loggerhead turtles in the Canary Islands, buoyancy disorders were recorded as a primary cause of admission, although case numbers were relatively low and outcomes were reported only descriptively [3]. In Queensland, Australia, Flint et al. (2017) found that 13% of all turtles admitted to rehabilitation had buoyancy disorder as their sole presenting problem, and all of these turtles were released alive, although many subsequently restranded [4]. While these studies highlight buoyancy disorder as a common condition in rehabilitation centres, its role as an independent risk factor for mortality during rehabilitation remains unclear. In addition to descriptive analyses of admission causes and outcomes, few studies have proposed objective tools to predict prognosis in rehabilitated sea turtles. Previously, we developed a summarised health index (SHI) based on clinical and clinicopathological parameters to predict survival in stranded turtles, demonstrating that quantitative health scores can assist triage and case management [5].

Spirorchiidiasis is widespread among marine turtles and affects sea turtle populations globally, as blood flukes of the family Spirorchiidae are near-cosmopolitan in their distribution and are recognised as important disease agents in these species [7,8]. Jerdy et al. (2023) described 16 juvenile green turtles from southeastern Brazil with massive, extremely severe spirorchiidiasis-associated lesions, without other detectable diseases [8]. The infection caused pulmonary alveolar collapse, cerebral compression, thyroid atrophy, and splenic lymphoid depletion, highlighting spirorchiidiasis as a potential cause of death in stranded green turtles.

In sea turtle rehabilitation facilities, fibropapillomatosis (FP) is a major concern, as it is a common condition in sea turtles and has been associated with reduced survival during rehabilitation [9]. FP can severely compromise the health of affected turtles. Tumor growth may interfere with feeding and swimming, impair vision, and in some cases result in failure of internal organs [9]. However, the influence of specific clinical syndromes and infectious conditions, such as FP, buoyancy disorder and spirorchiid fluke infection, on mortality during rehabilitation has not been fully evaluated, particularly in Taiwanese sea turtle rehabilitation facilities. These conditions were selected because they are commonly encountered during rehabilitation and have been previously linked to poor health status or mortality. Therefore, the aim of this brief report was to investigate potential risk factors for death during rehabilitation in sea turtles admitted to a rehabilitation centre in Taiwan, with a particular focus on buoyancy disorder and spirorchiid fluke infection, using univariate and multivariable logistic regression analyses.

2. Materials and Methods

Data Collection

A retrospective study was conducted using stranding and medical records of 108 sea turtles admitted to the sea turtle rehabilitation facility at the National Museum of Marine Biology and Aquarium (NMMBA) in Checheng Township, Pingtung County, Taiwan, from April 2018 to May 2024, including 70 green turtles (*C. mydas*, 64.8%) (juvenile = 62; sub-adult = 5; adult = 3), 19 olive ridley turtles (*L. olivacea*, 17.6%) (juvenile = 15; sub-adult = 4), 16 hawksbill turtles (*E. imbricata*, 14.8%) (juvenile = 16;), 2 loggerhead turtles (*C. caretta*, 1.9%) (juvenile = 1; adult = 1), and 1 leatherback turtle (*D. coriacea*, 0.9%) (adult = 1). All turtles were grouped into life stages based on carapace

length, using CCL (curved carapace length) for most species and SCL (straight carapace length) for loggerhead turtles, as follows: green turtles: juvenile (<65 cm CCL), subadult (65–86 cm CCL), and adult (>86 cm CCL); olive ridley turtles: juvenile (<62 cm CCL), subadult (62–70 cm CCL), and adult (>71 cm CCL); hawksbill turtles: juvenile (<55 cm CCL), subadult (55–70 cm CCL), and adult (>70 cm CCL); loggerhead turtles: juvenile (≤ 66.0 cm SCL), subadult (66.1–82.1 cm SCL), and adult (≥ 82.2 cm SCL); leatherback turtles: juvenile (<50 cm CCL), subadult (50–70 cm CCL), and adult (>70 cm CCL) [10,11]. The median rehabilitation duration was 135 days (range 0–1389 days; mean 191 days). Of the 108 sea turtles included in the study, 77 (71.3%) survived to release and 31 (28.7%) died during rehabilitation. No turtles were transferred to other facilities. Among the 31 non-surviving sea turtles, one turtle with boat-strike trauma was humanely euthanized because of a poor prognosis for survival and for animal welfare reasons. This euthanasia decision was made after clinical evaluation by two veterinarians. The epidemiological data collected included body condition index (BCI), leech parasitism, ingestion of fishing hooks, fluke (spirorchiid) infection, fibropapillomatosis (FP), buoyancy disorder, and final disposition, including the date of death or release. Diagnostic criteria for spirorchiid infection, FP, and buoyancy disorder in this study were defined as follows: (1) spirorchiid infection, based on the morphology of spirorchiid eggs identified by copro-microscopy; (2) FP, diagnosed by visual examination revealing characteristic cutaneous fibropapillomas; and (3) Buoyancy disorder was diagnosed by attending veterinarians based on repeated clinical observation of persistent abnormal buoyancy during rehabilitation, supported by physical examination and diagnostic imaging where available. Most turtles were screened for spirorchiid infection; however, four individuals could not be tested because fecal samples were insufficient for examination.

Data analysis

Statistical analyses were performed using SPSS software, version 28.0 (IBM Corp., Armonk, NY, USA). Chi-square or Fisher's exact tests were used to assess differences in proportions between groups. Predictor variables were selected a priori based on clinical relevance and previous literature, and their associations with mortality were initially explored using univariable analyses. These variables were then entered into multivariable logistic regression models to estimate adjusted effects and to account for potential confounding. For analyses involving spirorchiid infection, turtles without copro-microscopy results ($n = 4$) had missing values for this variable and were therefore excluded from the corresponding chi-square tests and logistic regression models, as part of a complete-case analysis. Goodness of fit for the multivariable logistic regression model was assessed using the Hosmer–Lemeshow (HL) goodness-of-fit test. We also examined deviance residuals and influence statistics (standardized residuals and Cook's distance) to identify potential outliers or influential observations. Following commonly used recommendations, observations with an absolute standardized residual greater than 3 or a Cook's distance greater than 1 were identified as potentially influential. A p -value < 0.05 was considered statistically significant.

Ethics Statement

The sea turtle rehabilitation program at NMMBA is conducted under the authorization of the Ocean Conservation Administration, Taiwan. All information used in this retrospective study was obtained from existing stranding and medical records of sea turtles admitted to the sea turtle rehabilitation facility at NMMBA. No sea turtles were captured from the wild specifically for this study; therefore, additional ethical approval was not required.

3. Results

Of the 108 sea turtles included in the study, 77 (71.3%) survived to release and 31 (28.7%) died during rehabilitation. By univariate analysis, the presence of buoyancy disorder was a significant risk factor associated with death during rehabilitation (OR: 5.45; 95% confidence interval: 2.01–14.77). In addition, fluke (spirorchiid) infection was more frequent in the non-surviving group than in the surviving group (40.7% vs. 23.4%; OR: 2.25; 95% CI: 0.88–5.72), although this association did not reach statistical significance. Non-surviving turtles also had a higher proportion of fibropapillomatosis than surviving turtles (OR: 1.70; 95% CI: 0.27–10.71). BCI, leech parasitism, and ingestion of fishing hooks were not significantly associated with death in sea turtles (all $p > 0.05$) (Supplementary Table S1). Therefore, variables showing associations with mortality identified in the univariate analysis were included in the multivariable model for further analysis. Furthermore, FP was retained in the multivariable model because it is a well-recognized contributor to mortality in sea turtles [9], even though its univariate association with death was not statistically significant (OR: 1.70; 95% CI: 0.27–10.71). The data were analysed using a multivariable logistic regression model, and as shown in Table 1, buoyancy disorder and fluke (spirorchiid) infection were associated with higher odds of death in sea turtles.

Table 1. Risk factors for death during rehabilitation in 108 sea turtle patients by multivariable logistic regression analysis ^c.

Factors	OR ^a (95% CI ^b)	<i>p</i>
Buoyancy disorder (yes vs. no)	9.96 (3.21–30.85)	<0.001
Fluke (spirorchiid) infection (yes vs. no)	3.33 (1.09–10.18)	0.035
Fibropapillomatosis (FP) (yes vs. no)	2.05 (0.28–15.00)	0.479

^a OR: odds ratio. ^b CI: confidence interval. ^c Model based on 104 turtles with complete data.

In exploratory analyses, species was evaluated in two ways. First, we included all species categories in a χ^2 test of association with mortality, and no significant association was detected ($p = 0.211$). The corresponding mortality rates were 100.0% (1/1) for leatherback turtles, 50.0% (1/2) for loggerhead turtles, 32.9% (23/70) for green turtles, 18.8% (3/16) for hawksbill turtles, and 15.8% (3/19) for olive ridley turtles. Second, turtles were grouped as green versus non-green, and this dichotomization was also not significantly associated with mortality ($p = 0.195$). The mortality rates in this comparison were 32.9% (23/70) for green turtles and 21.1% (8/38) for non-green turtles. In the multivariable logistic regression, species was entered as a categorical predictor with non-green turtles as the reference category. Species remained non-significant in the model ($p = 0.224$), and the adjusted odds ratios for buoyancy disorder and spirorchiid infection changed only slightly. To reduce the risk of overfitting and for parsimony, species was therefore excluded from the final multivariable model. The multivariable logistic regression model showed adequate fit (HL test, $\chi^2 = 4.71$, $df = 3$, $p = 0.194$), and inspection of standardized residuals and Cook's distance did not identify any outliers or influential observations with strong impact on the model estimates.

Furthermore, pairwise associations among the explanatory variables were examined using 2×2 contingency tables with chi-square and Fisher's exact tests. No significant associations were detected between buoyancy disorder and spirorchiid infection (Pearson's chi-square $p = 0.253$) or between buoyancy disorder and fibropapillomatosis (Fisher's exact $p = 0.581$). In addition, all variance inflation factor (VIF) values for these variables were close to 1, indicating no evidence of problematic multicollinearity.

4. Discussion

This is the first study to suggest that both buoyancy disorder and fluke (spirorchiid) infection may be risk factors for death in sea turtles undergoing rehabilitation in Taiwan, after controlling for potential confounders using multivariable analysis.

As in previous studies, this study demonstrated that buoyancy disorder was strongly and negatively associated with survival in marine turtles [5,6,12]. Respiratory syndromes often lead to buoyancy disorders in sea turtles [13,14], preventing them from submerging and increasing the risk of injury or death from boat collisions or entanglement in fishing gear. According to Li et al. (2015) [5], sea turtles with buoyancy disorders had significantly higher levels of aspartate aminotransferase (AST) and uric acid (UA) than turtles without buoyancy disorders. Elevated AST and UA concentrations suggest that sea turtles with buoyancy disorders may be suffering from dehydration, reduced kidney function, liver damage, or skeletal muscle injury [15–18].

Spirorchiidiasis is widespread among marine turtles, affecting sea turtle populations globally. This is because members of the family Spirorchidae are nearly cosmopolitan in their distribution [7,8]. In our study, fluke (spirorchiid) infection was associated with higher odds of death in sea turtles undergoing rehabilitation, after adjustment for other potential confounders. In Taiwan, Chen et al. (2012) reported a high prevalence (70%) of spirorchiid fluke infections and widespread vascular and systemic lesions in stranded green turtles, suggesting that spirorchiidiasis may contribute to sea turtle strandings and mortality in this region [19]. However, in that study, no infections were found in the two loggerhead turtles examined. Furthermore, in our data, spirorchiid fluke infections were significantly more common in green turtles (40.6%) than in other species combined (5.6% in olive ridley turtles, 0.0% in hawksbill and loggerhead turtles; $p < 0.001$, chi-square test). Interpretation of species-specific prevalence should be cautious because of the limited sample size for several species. These findings suggest that green turtles have a higher infection prevalence in our study population, although confirmation in larger samples and additional populations is needed. In contrast, the overall prevalence of spirorchiid fluke infection in our turtles was 28%, which appears lower than the 70% reported by Chen et al. (2012); however, this difference may reflect differences in case sources and study design, because all turtles examined by Chen et al. (2012) were dead stranded turtles, and this difference therefore does not necessarily indicate a true temporal decline in spirorchiidiasis in sea turtles in Taiwan [19]. Nevertheless, our multivariable model included 104 sea turtles with complete data, among whom 27 deaths occurred, corresponding to approximately 9 events per predictor parameter, which lies at the lower end of commonly suggested thresholds [20]; therefore, the adjusted odds ratios and the identified risk factors should be interpreted with caution and confirmed in larger studies. Another limitation is that spirorchiid infection in our study was diagnosed only by fecal examination, which has limited sensitivity and may underestimate infection prevalence. In our study, the status of spirorchiid infection was determined from the first faecal sample collected after admission, rather than from repeated faecal examinations, which may have further reduced diagnostic sensitivity. In addition, species was explored as a potential confounder; however, low sample sizes in several species limited statistical power, so the non-significant species effect should be interpreted cautiously.

This study has several limitations inherent to its retrospective design. First, because cases were limited to sea turtles admitted to our rehabilitation facility, it is possible that selection bias occurred, meaning that our findings may not be fully applicable to all stranded sea turtles in the region. Second, although we adjusted for key clinical variables, residual confounding by unmeasured factors (such as underlying comorbidities or differences in treatment decisions) cannot be ruled out. Finally, a small number of turtles lacked

diagnostic data for spirorchiid infection and were excluded from the relevant analyses, which may have reduced statistical power and introduced additional uncertainty into the estimates.

5. Conclusions

As sea turtles are increasingly recognized as sentinels of coastal ecosystem health, their clinical status and disease burden integrate exposure to environmental stressors in contaminated coastal habitats [21–23]. This study showed that buoyancy disorder and fluke (spirorchiid) infection were independently associated with increased odds of mortality in this cohort of sea turtles undergoing rehabilitation, after adjustment for other potential confounders. These findings provide useful clinical information for the medical management of sea turtles in rehabilitation facilities and may assist marine veterinarians in health evaluation and decision-making for sea turtles in wildlife rehabilitation facilities.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/jmse14131215/s1>, Table S1: Univariate analysis of risk factors for death during the treatment period in 108 sea turtle patients.

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References

1. Casal, A.B.; Orós, J. Plasma biochemistry and haematology values in juvenile loggerhead sea turtles (*Caretta caretta*) undergoing rehabilitation. *Vet. Rec.* **2009**, *164*, 663–665. [PubMed]
2. Baker, L.; Edwards, W.; Pike, D.A. Sea turtle rehabilitation success increases with body size and differs among species. *Endang. Species Res.* **2015**, *29*, 13–21. [CrossRef]
3. Orós, J.; Montesdeoca, N.; Camacho, M.; Arencibia, A.; Calabuig, P. Causes of stranding and mortality, and final disposition of loggerhead sea turtles (*Caretta caretta*) admitted to a wildlife rehabilitation center in Gran Canaria Island, Spain (1998–2014): A long-term retrospective study. *PLoS ONE* **2016**, *11*, e0149398. [PubMed]
4. Flint, J.; Flint, M.; Limpus, C.J.; Mills, P. Status of marine turtle rehabilitation in Queensland. *PeerJ* **2017**, *5*, e3132. [CrossRef] [PubMed]
5. Li, T.-H.; Chang, C.-H.; Cheng, I.-J. Development of a summarized health index (SHI) for use in predicting survival in sea turtles. *PLoS ONE* **2015**, *10*, e0120796. [CrossRef] [PubMed]
6. Liguori, B.L.; Polyak, M.M.R.; Clark, S.A.; Sabater, A.N.; Clasen, T.B.; Manire, C.A. Transplastron enterocentesis to manage buoyancy disorder in an adult loggerhead sea turtle (*Caretta caretta*). *J. Herpetol. Med. Surg.* **2021**, *31*, 272–277. [CrossRef]
7. Chapman, P.A.; Cribb, T.H.; Flint, M.; Traub, R.J.; Blair, D.; Kyaw-Tanner, M.T.; Mills, P.C. Spirorchiidiasis in marine turtles: The current state of knowledge. *Dis. Aquat. Org.* **2019**, *133*, 217–245. [CrossRef]

8. Jerdy, H.; Barreto, B.; Werneck, M.; Hauser-Davis, R.A.; Baldassin, P.; Gabriel, P.; de Moraes Souza, A.L.; da Silva, M.A.; Felix, A.; Rodrigues, R.R.; et al. Serious lesions in Green turtles (*Chelonia mydas*) afflicted by fatal Spirochidiasis found stranded in south and southeastern Brazil. *Int. J. Parasitol. Parasites Wildl.* **2023**, *20*, 73–78. [[CrossRef](#)] [[PubMed](#)]
9. Page-Karjian, A.; Perrault, J.R.; Zirkelbach, B.; Pescatore, J.; Riley, R.; Stadler, M.; Zachariah, T.T.; Marks, W.; Norton, T.M. Tumor re-growth, case outcome, and tumor scoring systems in rehabilitated green turtles with fibropapillomatosis. *Dis. Aquat. Org.* **2019**, *137*, 101–108. [[CrossRef](#)]
10. Ishihara, T.; Kamezaki, N.; Hirai, S.; Matsuzawa, Y.; Hamabata, T.; Ishizaki, A.; Dutton, P.H. Genetic characteristics of loggerhead turtles in the coastal corridor of the North West Pacific, around the Cape Muroto, Japan. *Front. Mar. Sci.* **2024**, *11*, 1303553. [[CrossRef](#)]
11. Prampramote, J.; Boonhoh, W.; Intongead, S.; Sakornwimol, W.; Prachamkhai, P.; Sansamur, C.; Hayakijkosol, O.; Wongtawan, T. Association of ocean macroplastic debris with stranded sea turtles in the Central Gulf of Thailand. *Endang. Species Res.* **2022**, *47*, 333–343. [[CrossRef](#)]
12. Manire, C.A.; Norton, T.M.; Walsh, M.T. Buoyancy disorders. In *Sea Turtle Health and Rehabilitation*; Manire, C.A., Norton, T.M., Stacy, B.A., Innis, C.J., Harms, C.A., Eds.; J. Ross Publishing: Plantation, FL, USA, 2017; pp. 689–705.
13. Schmitt, T.L.; Munns, S.; Adams, L.; Hicks, J. The use of spirometry to evaluate pulmonary function in olive ridley sea turtles (*Lepidochelys olivacea*) with positive buoyancy disorders. *J. Zoo Wildl. Med.* **2013**, *44*, 645–653. [[CrossRef](#)] [[PubMed](#)]
14. Morick, D.; Levy, Y.; Davidovich, N.; Wosnick, N.; Zemah-Shamir, Z.; Tchernov, D.; Aizenberg, I. Pneumocoelom and secondary lung collapse treatment in a stranded loggerhead sea turtle (*Caretta caretta*) in the eastern Mediterranean Sea, Israel. *Vet. Rec. Case Rep.* **2023**, *11*, e665.
15. Campbell, T.W. Clinical pathology of reptiles. In *Reptile Medicine and Surgery*, 2nd ed.; Mader, D.R., Ed.; Saunders Elsevier: St. Louis, MO, USA, 2006; pp. 453–470.
16. Deem, S.L.; Norton, T.M.; Mitchell, M.; Segars, A.; Alleman, A.R.; Cray, C.; Poppenga, R.H.; Dodd, M.; Karesh, W.B. Comparison of blood values in foraging, nesting, and stranded loggerhead turtles (*Caretta caretta*) along the coast of Georgia, USA. *J. Wildl. Dis.* **2009**, *45*, 41–56. [[CrossRef](#)] [[PubMed](#)]
17. Harris, H.S.; Benson, S.R.; Gilardi, K.V.; Poppenga, R.H.; Work, T.M.; Dutton, P.H.; Mazet, J.A.K. Comparative health assessment of western Pacific leatherback turtles (*Dermochelys coriacea*) foraging off the coast of California: 2005–2007. *J. Wildl. Dis.* **2011**, *47*, 321–337. [[CrossRef](#)] [[PubMed](#)]
18. Pagano, M.; Vazzana, I.; Gentile, A.; Caracappa, G.; Faggio, C. Hematological and biochemical parameters in sea turtles (*Caretta caretta*) after stranding. *Reg. Stud. Mar. Sci.* **2019**, *32*, 100832. [[CrossRef](#)]
19. Chen, H.; Kuo, R.-J.; Chang, T.-C.; Hus, C.-K.; Bray, R.A.; Cheng, I.-J. Fluke (Spirochidae) infections in sea turtles stranded on Taiwan: Prevalence and pathology. *J. Parasitol.* **2012**, *98*, 437–439. [[CrossRef](#)] [[PubMed](#)]
20. Riley, R.D.; Snell, K.I.E.; Ensor, J.; Burke, D.L.; Harrell, F.E., Jr.; Moons, K.G.M.; Collins, G.S. Minimum sample size for developing a multivariable prediction model: Part II—Binary and time-to-event outcomes. *Stat. Med.* **2019**, *38*, 1276–1296. [[CrossRef](#)] [[PubMed](#)]
21. de Deus Santos, M.R.; Martins, A.S.; Baptistotte, C.; Work, T.M. Health condition of juvenile *Chelonia mydas* related to fibropapillomatosis in southeast Brazil. *Dis. Aquat. Org.* **2015**, *115*, 193–201. [[CrossRef](#)]
22. de Deus Santos, M.R.; Ferreira Júnior, P.D.; Nóbrega, Y.C.; Merçon, J.; Pereira, T.M.; Gomes, L.C. Stress response of juvenile green sea turtles *Chelonia mydas* with different fibropapillomatosis scores. *J. Wildl. Dis.* **2017**, *53*, 653–656. [[CrossRef](#)]
23. Miguel, C.; Costa, P.G.; Bianchini, A.; Luzardo, O.L.P.; Vianna, M.R.M.; de Deus Santos, M.R. Health condition of *Chelonia mydas* from a foraging area affected by the tailings of a collapsed dam in southeast Brazil. *Sci. Total Environ.* **2022**, *821*, 153353. [[CrossRef](#)] [[PubMed](#)]

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