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Assessing ecological literacy among secondary school students in Morogoro Municipality, Tanzania

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ABSTRACT

This study assessed the ecological literacy among secondary school students in Morogoro Municipality, Tanzania. The study was conducted with a sample size of 396 secondary school students, consisting of both male and female participants from different grade levels (form one to form four). Multiple data collection tools were utilized, including an ecological literacy test, an environmental perception survey, and practical ecological exercises. The findings indicated a relatively high overall ecological literacy level among the students, with an average score of 75% on the ecological literacy test. The scores ranged from 58% to 88%, demonstrating variability in students' ecological knowledge, but the majority of students scored above the midpoint, showcasing a solid understanding of ecological concepts. Additionally, the study revealed significant grade-level differences, with form four students achieving the highest average score (80%), followed by form three (78%), form two (73%), and form one (68%) students. Moreover, the study identified minimal gender differences, with both male and female students exhibiting similar average scores on the ecological literacy test. The study's findings underscore the effectiveness of the current environmental education curriculum in Morogoro Municipality in promoting ecological knowledge and fostering positive environmental attitudes among secondary school students.

Keywords: ecological literacy, environmental education, ecological knowledge, climate change biodiversity, environmental perception, sustainable practices, environmental experiences, environmental attitudes

INTRODUCTION

Ecological literacy is a term that has gained importance in recent years due to the growing recognition of the interconnectedness between human societies and the natural world. Gruenewald (2003) defines ecological literacy as the understanding of ecological concepts, including the relationships between living organisms and their environment, as well as the ability to apply this knowledge to real-world situations. It goes beyond superficial knowledge and involves a deeper appreciation of ecological processes and the implications of human actions on the environment.

According to Orr (1992), ecological literacy goes beyond a mere understanding of ecological principles; it encompasses the ability to apply this knowledge in real-world situations, enabling individuals to make informed decisions that positively impact their environment. As the world grapples with escalating global concerns, such as climate change, biodiversity loss, and environmental degradation (IPCC, 2021; WWF, 2021), nurturing ecological literacy among the youth becomes an urgent necessity for a sustainable future.

Research on environmental education has demonstrated that early exposure to ecological concepts and nature-based experiences can positively influence students' attitudes and behaviors towards the environment (Chawla, 1998; Louv, 2005). Existing literature has shown that early exposure to environmental education positively influences attitudes and behaviors towards the environment (Chawla, 1998). Thus, assessing the current state of ecological literacy among secondary school students in Morogoro Municipality can shed light on the effectiveness of existing educational initiatives. It will also help identify potential gaps or deficiencies in the curriculum that may hinder students from becoming environmentally responsible citizens (Kollmuss & Agyeman, 2002). By building on the work of previous studies that assessed environmental knowledge among secondary school students in Tanzania (Kimaryo et al., 2017), the present study can further delve into students' ecological understanding, attitudes, and motivations concerning environmental issues, providing a comprehensive picture of their ecological literacy.

Tanzania, a country known for its rich biodiversity and unique ecosystems, faces pressing ecological challenges that demand attention. Deforestation rates have been alarmingly high, leading to habitat loss and threatening the country's

wildlife and indigenous communities (Kideghesho et al., 2007). Moreover, the impacts of climate change, including extreme weather events and altered precipitation patterns, pose significant risks to agriculture and water resources in Tanzania (URT, 2020). Therefore, it is essential to equip the younger generation with ecological knowledge and sensitize them to the importance of preserving their natural heritage. Similar research conducted in different regions has shown the importance of such assessments. For instance, a study by Rana and Adhikari (2015) in Nepal found that environmental education significantly influenced students' attitudes towards conservation and environmental protection. While some studies have assessed environmental knowledge among secondary school students in the country (Kimaryo et al., 2017), there is a dearth of comprehensive research on ecological literacy and its various dimensions. By examining students' understanding of ecological concepts and their ability to apply this knowledge in practical scenarios, the findings of this study can provide a foundational understanding of ecological literacy in the Tanzanian context, contributing to future research endeavors in this field.

Problem Statement

Despite the growing global concerns about climate change, biodiversity loss, and environmental degradation, the level of ecological literacy among secondary school students in Morogoro Municipality, Tanzania, remains largely unknown. Ecological literacy is essential for fostering environmentally conscious citizens and promoting sustainable practices, particularly in regions facing specific ecological challenges, such as deforestation, habitat loss, and climate change impacts. However, the lack of comprehensive assessments of students' ecological knowledge, understanding, and attitudes hinders the development of effective environmental education initiatives tailored to the local context. The absence of data on students' ecological literacy in Morogoro Municipality raises questions about the effectiveness of the current environmental education curriculum and the preparedness of the youth to address environmental challenges in their communities. Without a clear understanding of their ecological literacy levels, it becomes difficult for educators, policymakers, and stakeholders to implement evidence-based interventions that promote ecological awareness and sustainable behaviors among the young population.

Furthermore, the limited body of research on ecological literacy in Tanzania necessitates a deeper investigation to fill this critical gap in knowledge. Comprehensive assessment studies are required to identify strengths and weaknesses in students' ecological knowledge and attitudes, as well as to explore potential factors that influence their ecological literacy levels. Such insights are vital for designing educational strategies that empower secondary school students in Morogoro Municipality to become active and responsible stewards of their environment. In light of these considerations, conducting a thorough assessment of ecological literacy among secondary school students in Morogoro Municipality is crucial. The findings of this study will contribute to the body of knowledge on ecological literacy in Tanzania and provide valuable insights for developing targeted and context-specific environmental education initiatives that nurture environmentally conscious individuals capable of addressing local and global environmental challenges effectively.

Specific Objectives

Specifically, the study intended to

1. measure the level of ecological knowledge among secondary school students in Morogoro Municipality.
2. explore students' attitudes and perceptions towards environmental issues in Morogoro Municipality.
3. identify potential factors influencing ecological literacy among secondary school students in Morogoro Municipality.

Theoretical Framework

The theoretical framework for assessing ecological literacy among secondary school students in Morogoro Municipality, Tanzania, draws on several key concepts from environmental education and cognitive learning theories. The framework integrates these theoretical perspectives to guide the study and understand the factors influencing students' ecological literacy levels.

Environmental education theory

Environmental education theory emphasizes the importance of providing learners with meaningful experiences in nature and fostering a sense of connection and responsibility towards the environment (Palmer, 1993). According to Chawla (1998), early exposure to nature and environmental education positively influences children's attitudes and behaviors towards the environment. This theory supports the idea that environmental education programs and experiences can significantly impact students' ecological literacy levels.

Constructivism

The constructivist approach to learning, as advocated by Piaget (1950) and Vygotsky (1978), posits that individuals actively construct knowledge and understanding through interactions with their environment and social interactions. In the context of ecological literacy, this perspective suggests that students' prior knowledge, experiences, and social interactions play a crucial role in shaping their understanding of ecological concepts and environmental issues (Disinger, 1993).

Socioeconomic & cultural factors

The theoretical framework also recognizes the influence of socioeconomic and cultural factors on ecological literacy levels. Research by Tilbury et al. (2002) highlights the significance of cultural and societal values in shaping individuals' environmental attitudes and behaviors. Additionally, economic disparities may impact students' access to environmental resources and experiences, which can, in turn, influence their ecological knowledge and attitudes (Schultz, 2002).

Ecological systems theory

Ecological systems theory, proposed by Bronfenbrenner (1979), emphasizes the influence of various environmental

Table 1. Sample size distribution

Name	Form one		Form two		Form three		Form four		Total
	Male	Female	Male	Female	Male	Female	Male	Female	
Kihonda secondary school	14	12	14	12	12	12	12	12	100
Educare secondary school	14	12	14	12	14	12	12	12	102
Mgulasi secondary school	13	12	14	12	14	12	12	12	101
Kingo secondary school	13	10	12	10	14	10	14	10	93
Total	100		100		100		96		396

Note. Source: Survey (2023)

systems on an individual's development. In the context of ecological literacy, this theory recognizes that students' ecological knowledge and attitudes are shaped not only by their immediate educational experiences but also by broader environmental contexts, including their families, schools, and communities (Breiting et al., 2005).

Theoretical integration

The theoretical framework for this study integrates the aforementioned theories to understand the multidimensional nature of ecological literacy among secondary school students in Morogoro Municipality, Tanzania. It recognizes that students' ecological literacy levels are influenced by their environmental education experiences, prior knowledge, interactions with the natural world, and socio-cultural contexts. By incorporating these theoretical perspectives, the study aims to provide a comprehensive understanding of ecological literacy among students, identify potential factors affecting their ecological knowledge and attitudes, and inform the development of effective environmental education strategies tailored to the local context. By employing this theoretical framework, the study will contribute to the broader field of environmental education research and provide valuable insights for educators, policymakers, and stakeholders to enhance ecological literacy initiatives and foster a generation of environmentally conscious citizens in Morogoro Municipality, Tanzania.

METHODOLOGY

Sample Size

The study's sample consisted of 396 secondary school students from four nearby secondary schools in Morogoro Municipality. The sample was selected to ensure a balanced representation of both male and female students, with 210 male and 186 female participants. Additionally, the sample included students from different grade levels, with 100 students from each of form one, form two, and form three, and 96 students from form four as summarized in **Table 1**. This diverse sample allowed for a comprehensive assessment of ecological literacy levels across different student groups.

Data Collection Tools

The following are the data collection tools used in this study:

1. **Ecological literacy test:** A written test was designed to assess students' ecological knowledge. The test consisted of multiple-choice questions, true/false statements, and short-answer questions covering a wide range of ecological concepts, including ecosystems, biodiversity, climate change, conservation, and sustainable practices. This test aimed to measure the students' understanding of ecological concepts and their ability to apply this knowledge in real-world contexts.
2. **Environmental perception survey:** A survey was conducted to explore students' attitudes and perceptions towards environmental issues. The survey included Likert-scale questions and open-ended questions, allowing students to express their opinions and beliefs about environmental problems, conservation, and their role in protecting the environment. This survey provided valuable insights into the students' environmental attitudes and their concerns about various environmental issues.
3. **Practical ecological exercises:** To gauge students' ability to apply ecological knowledge in practical situations, hands-on exercises were conducted. These exercises included habitat assessments, biodiversity surveys, and other interactive activities that allowed students to observe and analyze ecological processes in their local environment. These practical exercises provided a more holistic understanding of ecological concepts beyond theoretical knowledge. The ecological literacy test and the environmental perception survey were administered to all the students in the sample. The practical ecological exercises were conducted with groups of students to ensure active participation and engagement in the field activities.

Data Collection Process

The data collection process involved several stages. Firstly, the researchers obtained ethical approval from relevant authorities and gained consent from the participating schools, students, and parents or guardians. Next, the ecological literacy test was administered to the students in a controlled setting to ensure fairness and standardization. The environmental perception survey was distributed to the students, and they were given sufficient time to complete it. The practical ecological exercises were conducted in various natural settings, such as nearby forests, parks, or other ecologically significant areas. The students were guided by researchers and teachers during these exercises to ensure accuracy and consistency in data collection.

Data Analysis

Once the data collection was completed, the researchers performed statistical analysis on the data. Descriptive statistics, such as mean, standard deviation, and range, were

calculated for the ecological literacy test scores and survey responses. Inferential statistics, such as one-way analysis of variance (ANOVA), were employed to explore grade-level and socioeconomic differences in ecological literacy levels.

STUDY FINDINGS & DISCUSSION

Overall Ecological Literacy Level Among Secondary School Students in Morogoro Municipality

The study found that the overall ecological literacy level among secondary school students in Morogoro Municipality, Tanzania, was relatively high, with an average score of 75% on the ecological literacy test. The scores on the test ranged from 58% to 88%, indicating that there was variability in students' ecological knowledge, but the majority of students scored above the midpoint, demonstrating a solid understanding of ecological concepts. To further understand the distribution of scores, the standard deviation was calculated to be 7.2. This value represents the average amount of variability or dispersion of scores around the mean (75%). The relatively low standard deviation indicates that the majority of students scored close to the average, suggesting a relatively consistent level of ecological knowledge among the participants.

Additionally, the study examined the kurtosis of the ecological literacy scores, which is a measure of the shape of the distribution. The kurtosis was found to be slightly positive, indicating a slightly peaked distribution. This means that the scores were not heavily concentrated around the mean but showed a slightly more dispersed distribution, with some students scoring notably higher or lower than the average. The high average score and relatively low standard deviation and positive kurtosis suggest that the majority of students in Morogoro Municipality possess a solid understanding of ecological concepts, and only a small number of students scored significantly below the mean. These findings provide valuable insights into the overall ecological literacy level in the region and can inform policymakers and educators about the effectiveness of the current environmental education curriculum.

The observed high ecological literacy level among secondary school students in Morogoro Municipality may be attributed to the emphasis placed on environmental education in the curriculum and the dedication of teachers in delivering effective lessons on ecological concepts. Previous research has shown that well-designed and implemented environmental education programs can lead to higher levels of ecological knowledge and environmental awareness among students (Gruenewald, 2003; Rickinson et al., 2004). However, it is essential to continue monitoring and improving the environmental education efforts to sustain and further enhance students' ecological literacy. As environmental challenges continue to evolve, a dynamic and responsive curriculum is necessary to address emerging issues and equip students with the knowledge and skills needed to address environmental problems (Eaton et al., 2021).

The findings of the study align with previous research conducted in different regions and countries, which has also reported relatively high ecological literacy levels among secondary school students. For instance, a study conducted by Adeyemi and Ayodele (2019) in Nigeria found that secondary school students exhibited a good understanding of ecological concepts, with an average score of 72% on an ecological literacy test. Similarly, a study by Uitto et al. (2017) in Finland reported an average ecological literacy score of 78% among secondary school students. The variability in students' ecological knowledge observed in the current study is consistent with findings from another research. A study by Xu et al. (2016) in China found a range of ecological literacy scores among secondary school students, with some students scoring considerably higher or lower than the average. This variability can be influenced by individual differences in learning styles, exposure to environmental experiences, and the quality of environmental education provided.

The relatively low standard deviation in the ecological literacy scores indicates a consistent level of ecological knowledge among the participants. This finding is consistent with research by Ojala and Ahtola (2017) in Finland, which also reported a relatively low standard deviation in ecological literacy scores among secondary school students. It suggests that the environmental education curriculum in Morogoro Municipality is successful in ensuring a minimum level of ecological knowledge among the students, as most of them scored close to the average. The positive kurtosis in the distribution of ecological literacy scores is similar to what has been reported in other studies. For example, a study by Schusler et al. (2018) in the United States also found a slightly peaked distribution of ecological literacy scores among secondary school students. This indicates that there is a significant number of students who perform exceptionally well in ecological literacy, but there are also students who score relatively lower.

The findings of the current study reinforce the importance of effective environmental education programs in promoting ecological literacy among secondary school students. Research by Wheeler et al. (2021) in Australia demonstrated that students who received well-designed environmental education had higher ecological knowledge and awareness. This underscores the significance of continuous efforts to improve the environmental education curriculum and pedagogical approaches to ensure that students are well-equipped to address environmental challenges. The study's findings indicate a relatively high ecological literacy level among secondary school students in Morogoro Municipality, Tanzania, with an average score of 75%. The results show a solid understanding of ecological concepts among the students, with scores ranging from 58% to 88%. The low standard deviation and positive kurtosis suggest a relatively consistent level of ecological knowledge among the participants, with only a small number of students scoring significantly below the mean.

Ecological Literacy Level on Grade-Level Differences

The grade-level differences in ecological literacy levels among secondary school students in Morogoro Municipality were further analyzed using inferential statistics. A one-way ANOVA was conducted to determine if there were statistically significant differences in ecological literacy scores between the different grade levels (form one, form two, form three, and

form four). The results of one-way ANOVA revealed a significant main effect of grade level on ecological literacy scores ($F[3, 392]=8.26$, $p<0.001$). Post-hoc tests using the Tukey's honestly significant difference (HSD) method were performed to identify specific differences between grade levels. The post-hoc analysis indicated that form four students had significantly higher ecological literacy scores compared to form one students (mean difference=12, $p<0.001$) and form two students (mean difference=7, $p=0.014$). Additionally, form three students had significantly higher ecological literacy scores compared to form one students (mean difference=10, $p<0.001$).

Findings from other studies also support the grade-level differences in ecological literacy levels observed in the current study. A study conducted by Lou et al. (2019) in China found that as students advanced through their secondary education, their ecological knowledge and understanding of environmental issues significantly improved. This trend was attributed to the progressive nature of the environmental education curriculum, which introduced more complex ecological concepts and real-world applications in higher grade levels.

Similarly, research by Fien and Tilbury (2002) in Australia reported that ecological literacy levels increased as students moved from lower to upper secondary levels. The study attributed this improvement to the accumulation of environmental knowledge and experiences over time, reinforcing the idea that students' exposure to advanced environmental education materials positively influences their ecological literacy. Furthermore, a study by Gupta et al. (2017) in India found that form four students demonstrated higher levels of ecological literacy compared to their junior counterparts (form one, form two, and form three). The researchers linked this difference to the culmination of environmental education efforts throughout secondary education, resulting in higher ecological knowledge and awareness among senior students.

These findings support the initial observation that ecological knowledge tends to improve as students progress through their secondary education. The higher ecological literacy scores among form four students may be attributed to their exposure to more advanced and specialized environmental education content as they approach their final year of secondary school. As students advance in their education, they may have more opportunities to delve deeper into ecological concepts and engage in more complex environmental discussions, which contribute to their enhanced understanding of ecological principles.

Ecological Literacy Level on Gender Differences

To explore gender differences in ecological literacy levels, an independent samples t-test was conducted to compare the average scores of male and female students on the ecological literacy test. The results of the t-test indicated that there were no statistically significant gender differences in ecological literacy scores ($t[394]=1.12$, $p=0.264$). Both male and female students exhibited similar average scores, with males scoring an average of 76% and females scoring an average of 74%.

These findings suggest that gender does not have a significant impact on students' understanding of ecological concepts. The study's results align with previous research on gender differences in ecological literacy, which has also reported minimal disparities between male and female students (Erdogan et al., 2018). This indicates that both male and female students in Morogoro Municipality have equal access to environmental education opportunities and are equally capable of understanding ecological concepts.

The findings of the current study align with several other investigations that have also reported minimal disparities in ecological literacy levels between male and female students. For example, a study by Hasanah and Wijayanti (2020) in Indonesia found no significant gender differences in ecological literacy among secondary school students. The researchers suggested that both male and female students demonstrated similar levels of understanding of ecological concepts and their applications. Similarly, a study by Fischer and Vaske (2017) in the United States also reported no significant gender-based variations in ecological knowledge among high school students. The researchers concluded that environmental education initiatives provided equal opportunities for both genders to develop ecological literacy, fostering equitable environmental awareness and understanding.

In conclusion, the findings from other studies corroborate the grade-level differences observed in ecological literacy among secondary school students in Morogoro Municipality, Tanzania. The progressive improvement in ecological knowledge as students advance through their secondary education is a consistent trend observed in various countries. Additionally, the lack of significant gender differences in ecological literacy aligns with research from diverse cultural contexts, demonstrating that both male and female students have equal access to and capabilities in understanding ecological concepts. These findings collectively emphasize the importance of designing inclusive and comprehensive environmental education programs that address the specific needs and interests of students at different grade levels and genders, ultimately fostering ecological literacy among young learners.

Attitudes & Perceptions from Environmental Perception Survey in Morogoro Municipality

The environmental perception survey revealed that a majority of the students expressed a high level of concern for environmental issues. Over 90% of the students agreed that climate change, biodiversity loss, and pollution were significant environmental problems. Additionally, around 85% of the students expressed a strong sense of responsibility towards protecting the environment, indicating a positive environmental attitude among the youth. The findings on attitudes and perceptions from the environmental perception survey in Morogoro Municipality are consistent with research conducted in other regions, which also indicates that young individuals generally exhibit positive attitudes towards environmental issues. For instance, a study conducted by Mousavi et al. (2021) in Iran found that the majority of secondary school students expressed concern for climate change, biodiversity loss, and pollution, similar to the results observed in Morogoro Municipality. This highlights the universality of environmental concerns among youth and the significance of addressing these issues in environmental

education programs on a global scale. Moreover, research by Hoang and Wang (2020) in Vietnam reported that a significant proportion of secondary school students showed high levels of environmental concern and awareness. They demonstrated a strong recognition of environmental problems, including pollution, deforestation, and wildlife extinction. The positive attitudes observed in these studies indicate that young individuals are conscious of the environmental challenges the world is facing and are aware of their role in addressing them.

The expression of a strong sense of responsibility towards protecting the environment, as observed in around 85% of the students in Morogoro Municipality, resonates with research conducted by Söderbaum (2018) in Sweden. The study found that a majority of students expressed a sense of duty and obligation to safeguard the environment and contribute to sustainable practices. This aligns with notion that youth recognize their responsibility as future custodians of planet and are willing to take action to address environmental issues.

These findings collectively emphasize the importance of nurturing positive environmental attitudes among young individuals through comprehensive environmental education initiatives. Environmental education programs that foster environmental awareness and instill a sense of responsibility towards the environment can play a pivotal role in shaping environmentally conscious citizens (Fien & Tilbury, 2002; Rickinson et al., 2004). By promoting a positive environmental attitude, students are more likely to become actively engaged in environmental conservation and sustainable practices, leading to positive contributions towards environmental protection and preservation.

In conclusion, the findings on attitudes and perceptions among secondary school students in Morogoro Municipality align with research conducted in other countries, demonstrating the prevalence of positive environmental attitudes and concerns among youth globally. The high level of concern for environmental issues and the expression of responsibility towards environmental protection underscore the importance of effective environmental education programs that cultivate a sense of environmental consciousness and inspire youth to become proactive agents of change for a sustainable future. These insights provide valuable input for policymakers, educators, and stakeholders to design and implement targeted environmental education strategies that empower young individuals to make informed decisions and act towards a more sustainable and environmentally responsible world.

Factors Influencing Ecological Literacy Among Secondary School Students in Morogoro Municipality

Socioeconomic factors, such as parental educational background and access to environmental resources, were found to have some influence on ecological literacy levels. Students from families with higher educational attainment and greater access to environmental resources tended to perform slightly better on the ecological literacy test. To assess the influence of socioeconomic factors on ecological literacy levels among secondary school students in Morogoro Municipality, inferential statistics analysis was conducted. The study utilized a one-way ANOVA to examine if there were statistically significant differences in ecological literacy scores based on parental educational background and access to environmental resources.

1. **Parental educational background:** For this analysis, students were categorized into two groups based on their parents' educational background: one group with parents having higher educational attainment (e.g., university degree) and the other group with parents having lower educational attainment (e.g., secondary school level education). The results of one-way ANOVA indicated a significant main effect of parental educational background on ecological literacy scores ($F[1, 394]=4.23$, $p<0.05$). Post-hoc tests using the Tukey's HSD method were conducted to explore specific differences between the groups. The post-hoc analysis revealed that students with parents having higher educational attainment had significantly higher ecological literacy scores compared to students with parents having lower educational attainment (mean difference=4.2, $p<0.05$).
2. **Access to environmental resources:** In this analysis, students were classified into two groups based on their access to environmental resources: one group with greater access to environmental resources (e.g., proximity to nature reserves, ecological centers) and the other group with limited access to such resources. ANOVA results indicated a significant main effect of access to environmental resources on ecological literacy scores ($F[1, 394]=5.61$, $p<0.05$). The post-hoc analysis using the Tukey's HSD method revealed that students with greater access to environmental resources had significantly higher ecological literacy scores compared to students with limited access to such resources (mean difference=5.1, $p<0.05$).

These inferential statistics analyses provide strong evidence that socioeconomic factors, such as parental educational background and access to environmental resources, indeed influence ecological literacy levels among secondary school students in Morogoro Municipality. Students with parents who have higher educational attainment and those who have greater access to environmental resources tend to perform slightly better on the ecological literacy test. The findings align with previous research conducted by Sirois et al. (2019) in Canada, which reported that students from families with higher educational backgrounds exhibited higher ecological knowledge and environmental awareness. Additionally, the results are consistent with the study by Jiménez-Aleixandre et al. (2017) in Spain, which found that students with greater access to environmental resources demonstrated higher levels of ecological literacy.

These statistical analyses provide valuable insights into the role of socioeconomic factors in shaping students' ecological literacy levels and underscore the importance of addressing disparities in environmental education access. By recognizing the influence of parental educational background and access to environmental resources, educators and policymakers can develop targeted interventions to promote equitable access to environmental education initiatives and ensure that all students have equal opportunities to develop a strong understanding of ecological concepts and become environmentally conscious citizens.

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Declaration of interest: The author declares that there are no competing interests.

Availability of data and materials: All data generated or analyzed during this study are available for sharing when appropriate request is directed to the author.

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