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Advancing ocean sustainability through better science integration: perspectives of Early Career Ocean Professionals

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As the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) approaches halfway, inclusive input on progress and innovative approaches to achieving ocean sustainability is timely and necessary. Input from the leaders of tomorrow—today's Early Career Ocean Professionals (ECOPs)—brings important generational perspectives on delivering marine science that can inform and contribute to achieving future ocean sustainability. ECOP perspectives may also offer novel insights on informing solutions to ocean-related challenges. Here, we articulate ECOP perspectives on priority recommendations for addressing current gaps and opportunities in ocean science in the context of the "Ocean Decade". These recommendations include: (1) a culture shift toward more active and transparent data sharing; (2) valuing and connecting different knowledge systems; and (3) achieving effective knowledge-sharing across disciplines and jurisdictions. We outline how all actors in ocean research, across different disciplines and institutions, can implement these changes, and where relevant, demonstrate unique roles ECOPs can play in this process. We propose that the implementation of these recommendations, by all actors in ocean science, along with greater inclusion and transfer of diverse knowledge, will support efforts to achieve the goals of the Ocean Decade, and ensure ocean sustainability for generations to come.

Introduction

The ocean and its coasts are under threat from a multitude of stressors across the globe. Declines in the extents of coastal habitats range from 19% (seagrass) (Dunic et al., 2021) to 85% (oyster reefs) (Beck et al., 2011) and are expected to be exacerbated by the impacts of climate change (IPCC Climate Change, 2022). Further, marine-built structures have already replaced >50% of natural habitat in urbanized coastal environments (Floerl et al., 2021) and their footprint is expected to grow (Bugnot et al., 2021). Marine habitat degradation and loss results in declines in biodiversity that will further influence the resource stability and quality on which humans and marine ecosystems rely (Worm et al., 2006). There is an urgent need to reverse these declines and protect marine habitats for ocean sustainability.

The need to restore and protect marine habitats is reflected in the declaration of the Ocean Decade, the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). The Ocean Decade seeks to "stimulate ocean science and knowledge generation to reverse the decline of the state of the ocean system and catalyse new opportunities for sustainable development of this massive marine ecosystem" (The United Nations Decade of Ocean Science for Sustainable Development 2021–2030, 2024). To date, many ambitious solutions to achieve this goal have been proposed, including the IUCN Great Blue Wall Initiative, large-scale restoration projects and socio-ecological initiatives to inspire connection to and protection of marine systems (Ocean Decade: Decade Actions). Individual countries have also published strategic documents outlining how they aim to achieve goals and challenges of the Ocean Decade, such as the United Kingdom's *Marine Management Organisation 2030 Strategic Plan* (Marine Management Organisation, 2023), the United States' *National Strategy for a Sustainable Ocean Economy* (Ocean Policy Committee, 2024) and Australia's *Sustainable Oceans and Coasts National Strategy 2021-2030* (Future Earth Australia, 2021). However, facilitating these actions will require an increasing focus on capacity building, knowledge sharing, and cooperation across diverse groups and geographies (Ocean Decade Conference Barcelona Statement, 2024), particularly those who typically have been under-represented in global discussions to date, including people from least developed countries, people with disabilities, Indigenous peoples, and Early Career Ocean Professionals (ECOPs).

An ECOP is defined as anyone who identifies as being early in their career (≤10 years of professional experience) in any field related to the ocean. In the context of the Ocean Decade, ECOPs are recognized as having a key role in the design and execution of inclusive ocean knowledge needed to achieve ocean sustainability by 2030 and beyond (Satterthwaite et al., 2022; Brodie et al., 2022) (Box 1). Today's ECOPs represent current and future ocean leaders. Empowering this cohort and future generations to connect, coordinate, and share their unique voice is key to imagining and implementing the innovative and inclusive ocean solutions we need for "the ocean we want" (Satterthwaite et al., 2022).

Here, we seek to offer an ECOP perspective on approaches to implementing and achieving the vision and mission of the Ocean Decade (Future Earth Australia, 2021). Specifically, we highlight enablers of engaging ECOPs and other professionals to

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BOX 1 The unique role of Early Career Ocean Professionals (ECOPs) in developing and communicating ocean science.

Current and future role of ECOPs

ECOPs can play a major role in developing the science that informs policy and putting science into practice, and many already do through their research and communicating results (e.g., Brodie et al., 2022). ECOPs are the next generation of ocean leaders, who can already begin to collaborate and enhance knowledge sharing (i.e., across disciplinary boundaries) and contribute to developing much-needed innovative solutions to pressing problems in the marine and coastal context (Satterthwaite et al., 2022; Lim et al., 2017; Raatikainen et al., 2021). ECOPs demonstrate a unique willingness to learn, adapt and collaborate to cross socio-ecological boundaries and seek sustainable, equitable and just outcomes (Strand et al., 2022). Importantly, as the future leaders in ocean science, culture shifts that are implemented by this group, especially in the way that science and knowledge are shared, can influence future generations of researchers.

Engaging ECOPs in ocean science

Guidance on how to best engage ECOPs in imagining and creating solutions for a sustainable ocean future is needed. Recent work and perspectives, led by ECOPs and emerging ocean leaders, have highlighted several pathways and frameworks for engaging ECOPs to have greater research impact, including in the context of the Ocean Decade (Satterthwaite et al., 2022), polar research (Brasier et al., 2020), transdisciplinary fisheries research (Nyboer et al., 2023), ocean data sharing (Levine et al., 2020), building trans-disciplinarity to transform ocean governance (Strand et al., 2022), amongst others. Beyond ocean science, ECOPs in the broad field of ecosystem services research have also called for the need for data access and knowledge transfer, funding and capability training to overcome disparities in opportunity, especially between researchers based in the Global South vs. the Global North (Wang et al., 2024). The suggested pathways to engage ECOPs have often centered around fostering and strengthening collaboration, such as through developing communities of practice (Levine et al., 2020), peer-to-peer networking or mentoring opportunities (Nyboer et al., 2023) and building horizontal partnerships with non-academic collaborators (Strand et al., 2022).

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achieve a sustainable ocean future, rather than on the barriers or challenges faced by ECOPs, which are well-established in the literature (*sensu*) (Brasier et al., 2020; Osiecka et al., 2022; Rölfer et al., 2022; Wang et al., 2024) (Box 1). In doing so, we emphasize how these enabling actions for ECOPs, when implemented by all professionals and institutions, can contribute to a broader cultural shift in ocean science—benefitting future generations of researchers, practitioners, policymakers and communities working to achieve ocean sustainability.

The ECOP perspective articulated in this piece represents a cohort of ECOPs based in Australia. We offer these perspectives because we appreciate our role and responsibilities as ECOPs—and as future ocean leaders—to shape ocean sustainability by 2030 and beyond. Although we are Australian-based ECOPs, we originate from diverse geographical backgrounds and represent a range of professions and practices, including local government, industry, and research. Our respective expertise reflects many fields, including interdisciplinary research, fisheries and aquaculture science, marine and coastal ecology, spatial science, and restoration and management practice. This collaborative paper evolved from an ECOP workshop we participated in, in the Gold Coast, Australia in 2024, focused on the *Future Earth Australia Sustainable Oceans and Coasts National Strategy 2021–2030* (Future Earth Australia, 2021). The workshop aimed to collate and articulate diverse ECOP perspectives on the key gaps and priorities of the

national strategy document. Below, is a synthesis of outcomes from that workshop in the form of three recommendations we present as key to achieving the vision and mission of the Ocean Decade.

Key recommendations to help achieve the Ocean Decade's vision and missions

We envisage culture changes, knowledge sharing and brokering, and integration of different knowledge systems as central to achieving ocean sustainability, by helping people to better connect with the ocean. For each recommendation, we provide a brief explanation of background context and identify example actions that ocean professionals and institutions (including ECOPs) can take to support these recommendations in practice. Importantly, these recommendations should be actioned in parallel or in a coordinated manner to achieve a sustainable ocean future (Figure 1).

Recommendation 1: culture shift to active and transparent data sharing

We are in an era of big data. Open and reproducible data practices can accelerate scientific discovery and impact, improve accountability and transparency, detect tipping points and thresholds, improve precision and generalisability of results, and thereby inform better decision-making across sectors (Stewart Lowndes et al., 2017; Tulloch et al., 2018). Scientific data sharing, of both quantitative and qualitative data, across organizations and sectors is crucial for observing and understanding ocean processes, as it supports reproducible assessments and increases efficiency and knowledge synthesis through re-use of existing datasets. While actions outlined in this section may be more obvious for sharing quantitative data, sharing qualitative data (e.g., collected via interviews, focus group approaches, etc.) is also necessary to advance ocean sustainability research and practice. Qualitative data provides the nuance and insights necessary to contextualize quantitative data, and thus can help to better inform relevant and actionable approaches to achieving ocean sustainability. Further, the benefits of sharing and synthesizing quantitative and qualitative data can only be achieved where that use is ethical (Alexander et al., 2020).

Improved policies, guidelines and training for data sharing

Current barriers to data sharing in academia include a lack of recognition in the form of citations and fear of missing out on novel publications or data misuse (Fecher et al., 2015; Tenopir et al., 2015); industry is limited by concerns about competitive advantage and privacy issues (Pan et al., 2023; TNFD Global, Taskforce on Nature-related Financial Disclosures, 2023). Preparing data for sharing can be challenging due to time constraints and/or a lack of knowledge on best-practice handling for streamlined

standardization (Pearlman et al., 2019; Pendleton et al., 2019). Though open science platforms demonstrate that considerable progress has been made (e.g., Australian Ocean Data Network; Southern Ocean Observation System), and principles for effective data sharing have been characterized (FAIR: Findable, Accessible, Interoperable, and Reusable) (Tanhua et al., 2019), mere platform availability is insufficient for FAIR data sharing, which also requires standardized data and metadata.

Research institutions, government and industry can play a key role in data management processes by providing sufficient training, tools and technical support for the long-term storage and sharing of data at multiple levels. For example, data librarians could train researchers in FAIR data preparation and sharing, and library-mandated archiving in institutional repositories can assist in the uptake of data deposition and sharing (Milewska et al., 2022). The different types and sizes of datasets, however, is likely to require more discipline-specific expertise. This could be achieved through programs (e.g., modeled on Data Champions from the University of Cambridge, UK), where specialist volunteers or ECOPs advise their colleagues on data management (Savage and Cadwallader, 2019). Together, these efforts will help ensure that valuable ocean data collection is not unnecessarily doubling research efforts and that the appropriate data, gathered at various scales (e.g., citizen science), can be reused and interpreted. For ECOPs who are still establishing their careers, more widespread publishing of open data, with institutional and technological support to ensure FAIR principles are followed, offers an opportunity to secure more collaborative, equitable, and inclusive ocean science, with reproducible research and novel re-use of existing datasets (Tanhua et al., 2019; Fredston and Lowndes, 2024).

Standardized data availability requirements

In recent years, many scientific publishers have adopted policies that require, at minimum, data availability statements, yet author compliance is often unenforced (Federer et al., 2018; Tedersoo et al., 2021) and data sharing is not mandated by all journals. Publishing of data is rewarded in terms of standard academic incentives, including funding and citations, but barriers remain (Piwowar et al., 2007; Christensen et al., 2019). We propose that reward-based approaches such as cheaper publishing fees could further incentivise data sharing. Redefining existing publication metrics to value and reward data sharing would also incentivise and support this transition. Finally, journals should provide clearer guidance and regulation of data sharing to ensure that reusability standards and FAIR data principles are followed. ECOPs can already help drive change in open ocean science and more equitable and inclusive outcomes, by ensuring their data and code is openly accessible.

Inclusive and transparent multi-sectoral data sharing agreements

Industry and government also have a role to play in ensuring open data practices. They can adopt data sharing agreements especially for initiatives that use public funds and proposals involving public consultations. In doing so, data sharing across

FIGURE 1
Connecting people and ocean science is key to achieving the Ocean Decade's missions and goals. Systemic changes to the way knowledge is shared and valued will be possible through the inclusion of Early Career Ocean Professionals (ECOPs). All ocean professionals share responsibility to achieve the goals of the Ocean Decade, but ECOPs can play a role now and into the future by generating and sharing knowledge across sectors, communities and organizations. Together, these changes will lead us toward more sustainable ocean management and decision-making for a sustainable ocean future.

sectors could more readily promote innovation and relationship-building across sectors regardless of career stage (Box 1). This not only enhances cross-disciplinary expertise, but also helps to improve inclusivity and diversity in these relationships and provides ECOPs with opportunities to build their own projects and partnerships. ECOPs can advocate for this change through cross-disciplinary placements (see Recommendation 3) or by lobbying research supervisors to develop data sharing agreements with potential collaborators moving forward.

Recommendation 2: value different knowledge systems

The ocean and ocean science are perceived and experienced through diverse worldviews, and some worldview systems typically dominate discourse and decision-making. These existing power dynamics inhibit the measures of equity needed to truly achieve ocean sustainability (Spalding et al., 2023). A sustainable ocean future is only possible where diverse

values are reflected in the management and use of the ocean through governance.

Modern ocean governance has tended to reflect more capitalistic and Western worldviews that view the ocean for its extractive and use values, and consider different issues in isolation (Decker Sparks and Sliva, 2019; Pascual et al., 2023), though alternative worldviews are increasingly being recognized. For example, Indigenous worldviews recognize the interconnectedness of land, sea, and people, and the ocean as a holistic, relational system that is inherently connected and interdependent (Vigliano Relva and Jung, 2021). Such worldviews also consider different ocean values that may prioritize relational and intrinsic values focused on socio-cultural 'benefits', rather than monetary or biophysical benefits (Parsons et al., 2021; Isaac et al., 2024). Therefore, broadening the number of voices and "agendas," and welcoming different viewpoints in sustainability decisions (Chambers et al., 2022) are imperative to achieving Ocean Decade goals.

Elevate local and traditional knowledge

To effectively value Indigenous knowledge and perspectives in research and policy, Indigenous voices need to be elevated in academia, policy and decision-making, shifting the status quo to learning *from* Indigenous people rather than learning *about* them. A move away from tokenistic inclusion to genuine partnerships should apply when engaging with Indigenous peoples (Saunders et al., 2024). Closer collaboration with Indigenous peoples and the development of training programs for ocean professionals are essential. The "Closing the Gap" target in Australia aims for 70% of Indigenous Australians aged 25–34 to have a tertiary qualification by 2031 (National Indigenous Australians Agency, 2023). In Canada, an increase in First Nations peoples earning tertiary degrees followed years of advocating for universities to ensure more "respectful, relevant, reciprocal and responsible" engagement and education (Kirkness and Barnhardt, 2001; Melvin, 2023). Elevating these types of approaches and supporting future Indigenous graduates to pursue postgraduate studies should increase the number of Indigenous ECOPs.

ECOPs are more likely than their senior counterparts to receive formal education embedded with Indigenous and diverse perspectives, which have been increasingly included in classrooms and higher education curricula (Zidny et al., 2020; da Silva et al., 2024). Current ECOPs can thus help foster more inclusive and culturally sensitive approaches to collaborative science initiatives and respectful engagement with Indigenous communities. Still, all actors must play a role in enabling Indigenous rights, perspectives, and governance structures to contribute and shape ocean science, policy and conservation strategies, and promote shared learning and true collaboration between traditional knowledge systems and Western science.

Better representation of the people connected to the ocean, respecting their needs, priorities and worldviews, and accepting the differences and imbalances in governance to work toward a just and sustainable ocean future will help change how diverse values are included in governance. Bridging the gap between Indigenous and Western practices ensures that decisions are not just statistically valid but also ecologically, socially and culturally sound (Kenter

et al., 2019). By valuing and incorporating Indigenous perspectives, we can better safeguard biodiversity, enhance ecosystem services, and honor the wisdom of these cultures.

Recommendation 3: effective knowledge-sharing across disciplines and jurisdictions

Decision-makers require knowledge to address socio-ecological challenges. However, true examples of collaboration and co-design at the science–policy interface (*sensu*) (van den Hove, 2007), a social process encompassing positive relations between scientists and other actors, including planners, managers and practitioners, which enriches decision-making in policy processes, are rare (Maas et al., 2022). Scientists from all disciplines should welcome opportunities to share how science is conducted and communicated. However, scientists often do not understand decision-makers' information needs or how their science is used to inform policy and decision-making (von Winterfeldt, 2013). Similarly, policy-makers rarely understand the uncertainties and imperfect nature of science (Sutherland et al., 2013), and are often unaware of unutilised knowledge bases that could be used to address their key challenges.

At present, science is commonly provided through a linear model of research uptake where advice is conceived as a one-way communication process (Sokolovska et al., 2019) based on a dichotomy of facts (science) and values (policy) (Reichmann and Wieser, 2022)—i.e., deficit model of communication. Additionally, information generated by scientists is not always accessible to those directly funding it (see Recommendation 1) (von Winterfeldt, 2013; Oliver and Boaz, 2019). Importantly, the science-policy interface—though often generalized to include only scientists and policy-makers—is also influenced by planners, managers and practitioners who are working to implement sustainability science at a variety of local government, organizational or regional levels. Therefore, improving interactions and flow of information across disciplines by employing the use of knowledge-brokers, particularly ECOP knowledge-brokers from various professional backgrounds, can reduce the evidence-policy gap (Reichmann and Wieser, 2022).

Invest in knowledge brokers

Research institutions are a vehicle to generate knowledge, but the role of scientists in mobilizing knowledge to inform policy and decision-making is less apparent (Oliver and Boaz, 2019). ECOPs can act as knowledge-brokers—intermediaries who make knowledge exchange more effective—by bringing people to dialogue, building relations, uncovering needs, and sharing evidence and ideas (Gluckman, 2017). Knowledge-brokering involves a nuanced, cross-boundary approach that facilitates knowledge-sharing across different audiences (Karcher et al., 2024) to support sustainable ocean resource use. While investing in databases, repositories, and interfaces is imperative for ensuring relevant data informs decisions, knowledge-brokerage for sustainability requires investing in the capacity of ECOPs to grapple with the complexity of working across policy and practice so knowledge is shared more effectively in the future.

Accelerate knowledge sharing using digital technologies

Digital technologies can also boost knowledge-sharing across jurisdictions, stakeholders and organizations (e.g., videoconferencing tools to broaden reach or social media to engage citizen scientists). To meet the challenges of the future, ocean professionals will need to upscale their adoption of new digital technologies at even faster rates (Kelly et al., 2022), especially in the new era of artificial intelligence. ECOPs are well-placed to advance digital transitions within organizations. Typically, ECOPs have emerged from educational systems and social backgrounds defined by technological change and often possess high digital literacy (Jeanson et al., 2020; Björklund et al., 2023). Greater inclusion of ECOPs in ocean management is therefore likely to improve knowledge-sharing through technological innovation and accelerate ocean sustainability.

Implement more exchange and training opportunities across disciplines to enhance agility in collaborative research

The implementation of more extensive placement and exchange opportunities across all sectors (e.g., policy, industry, academic, research, etc.) and training programs would further facilitate cross-sector knowledge-sharing and ensure that ECOPs are equipped to tackle interdisciplinary problems (Satterthwaite et al., 2022). Programs that offer ECOPs opportunities to enhance cross/trans-disciplinary skills (e.g., Australian Academy of Science Policy Internship, or START program) (START International Inc., 2020) are invaluable for building well-rounded skill sets, fostering collaboration and developing sustainability leaders of the future (Lim et al., 2017). In addition to building these cross-disciplinary skill sets, ECOPs, and particularly researchers, should aim to develop skills in reflexivity to improve their own insights and learnings from participating in collaborative research and thus their own research agility (Chambers et al., 2022). Doing so can lead to a greater transformation of ocean sustainability science by more actively reflecting on contributors to success/failure and revising current practices and ways of doing things to better address needs and context. In particular, creating awareness of, and critically evaluating dominant narratives and elevating suppressed voices (see also Recommendation 2), may enable adaptive and diverse knowledge (co-)production in efforts to tackle key issues (Chambers et al., 2022). Increasing opportunities for cross/trans-disciplinary training and collaboration will contribute to achieving more holistic approaches to coastal and ocean management, integrating scientific knowledge with insights from various fields.

Discussion

This paper has articulated ECOP perspectives on actions for delivering marine science that can better inform and contribute to achieving future ocean sustainability. Specifically, we have outlined recommendations that we believe will better connect people with ocean science to support informed, inclusive and transdisciplinary decision making. Our recommendations emphasize the need for transparency, communication, knowledge-sharing and inclusiveness—and can be actioned by all actors involved in and impacted by ocean science. While we believe each of these recommendations and the associated actions are achievable, doing so will require systemic change across career levels (i.e., from early-career to senior-level professionals) and disciplines (e.g., government, research, academia, industry, communities).

Many of the recommendations and actions presented herein challenge the status quo. For example, changes to metrics, open access and funding agreements related to the scientific publishing process—as well as authentically welcoming and elevating different knowledge systems, such as those from Indigenous cultures and local communities, into ocean science and decision-making. But these are required to ensure the needs and priorities of all ocean actors are considered and to achieve sustainability, especially under a changing climate. We posit that harnessing digital opportunities and encouraging cross-disciplinary exchanges and engagement, especially for ECOPs, can help to deliver these changes in practice. We emphasize that all ECOPs, including scientists, practitioners, policy-makers, and local government employees, can play a role in these actions. Further, ECOPs may be uniquely placed to foster such change in roles as knowledge-brokers.

Marine and coastal ecosystems worldwide need urgent protection and action to ensure ocean health and sustainable ocean use into the future (Jouffray et al., 2020). Humans are increasingly connected to and dependent upon the resources provided by the ocean (Paolo et al., 2024). Global calls and agreements such as the declaration of the Ocean Decade present an opportunity for individuals, organizations and countries to come together to address these needs and take real action. To do this, all voices need to be represented.

The recommendations presented here are certainly not exhaustive and there are many other potential actions and avenues that should be pursued in efforts to achieve ocean sustainability and goals of the Ocean Decade. Rather, the recommendations presented offer prospective thinking and ECOP perspectives on enhancing current efforts to implement the vision and mission of the Ocean Decade. We hope that others can build on the recommendations outlined here, to imagine and implement much-needed change, from individual to institutional levels, toward achieving "the ocean we want" for tomorrow.

ECOPs—the future leaders of ocean science—have voices to share and roles to play in helping transform how ocean science is conducted. We encourage ECOPs to play an active role in the delivery of these recommendations—however, we caution that the responsibility to engender shifts and change in practices should be carried and delivered by all ocean actors and professionals (and institutions) to achieve ocean sustainability in the context of the Ocean Decade and beyond.

Opportunities for future engagement

Despite the potential for engagement and future leadership by ECOPs in ocean science, challenges and barriers to positioning ECOPs as contributors and innovators remain and have been well-documented. For example, the precarious nature of marine science employment and limited access to training often leave ECOPs

spread too thinly across their tasks, topics, and skillsets (Cosentino and Souviron-Priego, 2021). Further, institutional barriers to the time required for authentic engagement and co-design with actors outside of academia can discourage innovative relationship building and contributions from ECOPs (Rölfer et al., 2022). Notably, recent papers have also highlighted how these obstacles are not unique to ocean science research but scientific research more broadly (e.g., ecosystem services research) (Wang et al., 2024). Some perspectives have focused specifically on ways to engage female ECOPs within research institutions to encourage their participation in future leadership roles (Shellock et al., 2022). However, these obstacles may be overcome by the same pathways that have been identified to engage and include ECOPs.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

MV: Conceptualization, Writing – original draft, Writing – review & editing. MC: Conceptualization, Writing – original draft, Writing – review & editing. LG: Conceptualization, Writing – original draft, Writing – review & editing. RK: Conceptualization, Writing – original draft, Writing – review & editing. MLM: Conceptualization, Writing – original draft, Writing – review & editing. SB: Conceptualization, Writing – original draft, Writing – review & editing. JB: Conceptualization, Writing – original draft, Writing – review & editing. PF-M: Conceptualization, Writing – original draft, Writing – review & editing. MH: Conceptualization, Writing – original draft, Writing – review & editing. AI: Conceptualization, Writing – original draft, Writing – review & editing. CK: Conceptualization, Writing – original draft, Writing – review & editing. MMD: Conceptualization, Writing – original draft, Writing – review & editing. MMur: Conceptualization, Writing – original draft, Writing – review & editing. SP: Conceptualization, Writing – original draft, Writing – review & editing. NS: Conceptualization, Writing – original

draft, Writing – review & editing. JS: Conceptualization, Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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