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The barriers and opportunities to support the early career academics and professionals in human factors/ergonomics - revisiting reflections from IEA2015, IEA2018 & IEA2021

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Abstract.
BACKGROUND: The Early-Career Community (ECC) comprises researchers, practitioners, and professionals in their "early-career" stages in the Human Factors/Ergonomics (HFE) profession. Early-career HFE professionals are essential to both current industry decision making and future growth of our profession.
OBJECTIVE: This paper provides detailed insights into the barriers and suggestions to support engagement with ECC within the International Ergonomics Association (IEA) and its Federated Societies.
METHODS: This report integrates key findings from the formal and informal discussions that occurred with diverse groups of stakeholders ($n > 100$) at IEA2015, IEA2018 and IEA2021 guided by the participatory inquiry paradigm, cooperative action-inquiry and participatory ergonomics approaches.
RESULTS: Barriers to support ECC include: a lack of employment opportunities, poor general awareness and integration of HFE in existing university-courses, financial constraints, inclusivity challenges and a lack of Influence in decision-making. While some of the more systemic challenges are context-specific and cannot be overcome, ECCs suggested that: the IEA and its Federated Societies include ECC members as part of their boards; a Standing Committee for the ECCs be established as part of the IEA; make use of social-media more effectively to engage the ECC. More mentorship, networking, knowledge sharing, training and education, combined with financial-support will ensure that the ECC can participate.
CONCLUSION: ECC members experience complex and dynamic challenges that affect their development and involvement in the broader HFE profession. It is therefore critical that appropriate, global, national and local strategies are developed to continue to support and develop the ECC to ensure the continued growth of and demand for HFE.

Keywords: Early career researchers, early career practitioners, International Ergonomics Association (IEA); Ergonomics, human factors

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1. Introduction

There has been and continues to be a need to increase the demand for and show the value of high-quality Human Factors and Ergonomics [HFE] [1–4]. To meet these needs, Dul and colleagues [1] argue that an important strategic step is to "strengthen the application of high-quality HFE by promoting the education of HFE specialists, by ensuring high-quality standards of HFE applications and HFE specialists, and by promoting HFE research excellence at universities and other organisations" [1 p377]. A central group of stakeholders that will (and needs to) contribute to both goals are those who fall in the "early career" category that occupy positions within academic institutions or who have gone into HFE or related practice. Early career researchers (ECRs) and early career professionals (ECPs) (who constitute what are referred to in this article as the Early Career Community [ECC]) are critically important, not only as current actors but also as future decision-makers that attend to the growth and support of the HFE profession. This includes (but is not limited to) their roles as professors integrating HFE in the educational curricula; principal investigators to identify and solve complex HFE problems; emerging researchers to support and the extend the brain pool of HFE; integrators of HFE into the design of the system to optimize the performance and safety metrics; future reviewers and editors of Ergonomics journals and organisers of future symposia or meetings. Mentoring and developing the ECC is therefore critical to the future of the discipline.

However, there is extensive evidence outside of HFE that early-career professionals face a myriad of challenges that may affect their continued involvement in their discipline: a lack of job opportunities; job instability or insecurity; poor or insufficient mentorship; no network with other researchers or professionals; barriers around the degree of inclusiveness in a system; financial stress and lack of funding (in the case of researchers) [5–7]. Failure to support the growth of these actors may lead to a "brain drain" from not only the active membership in the IEA and its Federated Societies but also the discipline [8, 9]. Brain drain is a term coined in the early 1950 s by the British Royal Society to describe an outflow of highly skilled individuals, such as scientists, technologists etc., in search of better opportunities [10]. Brain drain is a growing concern across various domains in science, technology, engineering, and mathematics (STEM) [11, 12]. The current experiences in STEM research may provide transferable learning insights for HFE. Increasingly, resource limitations and other structural barriers appear to negatively influence innovative creativity and research participation in early career stages. Today's scientists (ECRs) lack the resources required to produce the preliminary data necessary to secure the funding grant to undertake major research projects. Hence, the number of principal investigators under the age of 36 has fallen to 3% today [13]. Packalen and Bhattacharya [14] analyzed 20 million peer-reviewed journal publications from the past 70 years and found that ECRs are more likely to study more innovative topics and use more 'out of the box' approaches to analyzing these newer problems. Max Plank and Charles Darwin also argued that ECRs were open to newer ideas in comparison to their senior colleagues [15]. A survey of 280 post-doctoral researchers by Hardy and colleagues [16] reveals there are structural limitations rather than personal limitations that prevent ECRs from achieving long-term research careers. ECC members, specifically ECRs, are changing careers even though they like what they are doing because they are not receiving support in research and academic positions. Christian and colleagues [11] surveyed 658 post-doctoral researchers in STEM, where 78.3% of the respondents had considered a major career change in the past five years. Of these, 41.9% were very satisfied with their current workplace and were only considering the move due to financial and growth reasons. Given these limitations, many ECRs in STEM are considering a major career change.

While many of these may be driven by discipline or context-specific factors, one way to support this group with some of these challenges is through facilitating networking opportunities through professional societies, which Bickel [17 p92] argues is critical for **"building bridges to the next generation."** The International Ergonomics Association (IEA) and its networks, Federated and affiliated societies thus play an important role in creating networking opportunities to allow ECC members to seek the latest expertise, advice, mentoring, guidance and opportunities to grow their careers and, at the same time, garner further support for the society which will ultimately benefit the discipline [17, 18]. While most HFE societies recognize the integral contributions individuals belonging to the ECC make to HFE communities, there continues to be a need to improve engagements with and the support of individuals belonging to the ECC [19]. While it is difficult to

understand the barriers faced by young professionals in the field of HFE around the world, the triennial IEA Congresses offer a unique opportunity to listen to this group about their perceived barriers and suggestions to improve how the IEA and its internal stakeholders can better support them [20]. Therefore, the aim of this paper is to make a first attempt at drawing attention to barriers and opportunities outlined by this important cohort of future Human Factors and Ergonomics experts, following formal and informal discussions with attendees at the IEA triennial world congresses in 2015, 2018 and 2021 (hereafter referred to as IEA2015, IEA2018 and IEA2021). Further, to provide a summarized 'call to action' that provides a plan to address these barriers and the uptake of the aforementioned suggestions.

2. Methods

The current research engaged cooperative action inquiry [21–25], guided by the Participatory Inquiry Paradigm [21]. Cooperative action inquiry is an iterative approach to investigating and catalyzing systems change [23, 24]. Within action inquiry, local experts and other appropriate key stakeholders undertake iterative inquiries and considered actions to investigate and transform systems participation [21, 23, 24, 26, 27]. Action inquiry applied to HFE can also be considered a form of participatory ergonomics [28]. Participatory ergonomics integrates local knowledge experts in collaborative and iterative systems investigation to dynamically, interactively, and iteratively propel systems change [29–33]. In the current research, early-career HFE academics and practitioners, and HFE students participated in discussion with other HFE key stakeholders on various contexts. These contexts included: IEA, IEA and its executive committees, Federated Societies, and IEA congress. ECC members and students were primary local experts, given they have contemporaneous experiential knowledge as users of the system. The proportion of ECRs was higher than ECPs, as the presence of academics is higher than practitioners at IEA congresses [34].

Aligned with action inquiry approaches, the current research is characterized by pragmatic and iterative engagement of various research methods [23, 24, 27]. Inquiry and considered actions within the current research informed one another, including the direction of subsequent methods [23, 24, 26, 27]. In 2014, a mixed-methods online research survey was conducted with all IEA Federated Societies to investigate societies' experiences of student and ECC engagement [19]. With a response rate of 65% [35], this survey was analyzed using reflexive thematic analysis [36] and inferential statistics [37]. Findings from this survey were not only presented at IEA2015 [19, 35] but also informed the IEA2015 Congress schedule of events specifically focused on students. Events during the IEA2015 congress included meetings between students, early career academics and practitioners, local HFE experts and other key stakeholders to discuss current and future needs. These include but are not limited to student (and ECC) social events, informal discussions throughout the congress and special sessions e.g. 3-minute thesis (3MT) etc. [38]. Records of outcomes from IEA2015 were captured via photographs (i.e., photovoice) [39], and note-taking (i.e., participatory fieldnotes) [23, 24, 40, 41]. IEA2015 provided detailed perspectives on the needs of the ECCs. In fact, one of the biggest outcomes was the recognition of ECCs and how they and their needs are different from students [38]. Despite this recognition of the ECC community needs (35), unfortunately, the IEA2018 congress offered even fewer opportunities for ECC members to participate (20).

IEA2018 held an informal session where global ECC members and students ($n > 45$) were given a chance to voice their current challenges and their future. These were captured again through photovoice and participatory fieldnotes [22, 23, 39–41]. Additional consultation with students and ECC members was also undertaken at the IEA2018 Congress through informal discussions during leisure activities (e.g. lunch/dinners). A follow-up informal email survey of HFE ECCs and students who attended the IEA2018 Congress was distributed after the completion of the Congress. These findings were then thematically analyzed, and reported in a position paper lodged with IEA on supporting early career professionals and students within IEA and its Federated Societies [20].

The feedback gained from IEA2015 and IEA2018 formed the primary basis for the inclusion of an ECC member in the organizing committee for IEA2021. This led to the creation of the biggest ECC/student-focused programming at an IEA congress [34], with events including two formal ECC and student competitions, special sessions on gaining advice from seasoned HFE experts (with $n > 35$ participants) and a social event (with ~150 registered participants) [42].

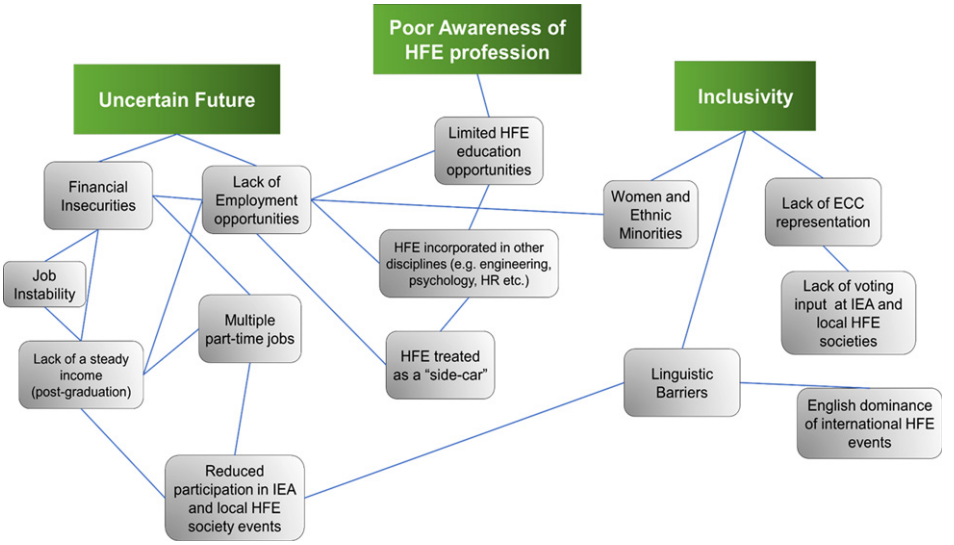

Fig. 1. Illustrates the different themes and related subthemes (codes) of the barriers faced by ECC members in the world of HFE. Three emergent themes include: 'uncertain future' for the ECC, the challenges emanating from 'poor awareness of the HFE profession' and challenges around 'inclusivity'.

Feedback from these sessions and informal discussions were captured via field notes [40, 41].

Three congresses later and after gaining input from the aforementioned HFE community members ($n > 100$) – data captured via field notes and phonovoice from IEA2015, IEA2018, IEA2021, were analyzed using thematic analysis [43]. The analysis was done using the following steps outlined by Vaismoradi and colleagues [44].

- In the **Initialization** phase, data was thoroughly read and meaningful units were highlighted through coding and reflective notes.
- **Construction** - In the second phase, the codes were classified into different categories and compared to delineate themes. A potential theme was formed when on multiple occasions a group of codes repeated in a patterned way. The codes were compared to establish linkages between codes.
- In the **Rectification and Verification** phase, the researchers distanced themselves from the data for ~1 week to increase their sensitivity and to spot/fix inconsistencies with the data analysis. This included recording and changing themes. Further, themes were checked against established knowledge (e.g. published research).
- **Finalization** – In the last phase, a narration/storyline was developed that describes how themes are interconnected. This led to the creation of 'barriers'. The 'suggestions' to support ECC members were developed through brainstorming and critical analysis of the barriers by the IEA's "Communications and Public Relations" (CPR) Standing committee members. Further, documented 'suggestions' from the field notes were also taken into account.

3. Results and discussion

3.1. Barriers faced by ECC members

The following sections discuss the identified barriers to supporting engagement with members of the ECC within the IEA and its Federated Societies. Broadly, the data revealed three emergent themes that included an 'uncertain future' for the ECC, the challenges emanating from 'poor awareness of the HFE profession' and challenges around 'inclusivity'. These broad themes and related subthemes (codes) are illustrated in Fig. 1. The linkages between subthemes were established using the method of Vaismoradi and colleagues [44]. Further, during discussions, multiple participants would provide further insights by building off statements from other participants (e.g. Participant A would say "the biggest concern is the job instability", to which Participant B would say "... that's why I must work multiple jobs"). The authors established further linkages from existing literature and through their own experience.

Further discussion on barriers and its linkages are discussed below.

3.1.1. Poor awareness of HFE and limited educational opportunities

The major barrier highlighted consistently by ECCs across various interactions is the continued *lack of awareness and understanding of what HFE is and what its benefits are* - a finding that aligns with the concerns outlined by Dul and colleagues [1] and more recently by Oakmen and colleagues [45]. Linked to this was a common complaint that many colleges and universities do not offer many HFE-specific courses [46] or that HFE is often incorporated into other disciplines, such as psychology or engineering [45], without the necessary detail of what characterizes it as a systems discipline that is human/user-centred and design-driven [1]. HFE is thus often treated as a "side-car" [47], and must be positioned through mutual efforts with educational institutes and HFE professionals, as a profession to improve business operations and worker health. Thus, the lack of awareness combined with *limited educational opportunities* may be inhibiting the development of new ECC members within the profession, while also affecting the overall growth of HFE.

3.1.2. Uncertain futures

3.1.2.1. Lack of employment opportunities A lack of employment opportunities has been identified as a particular challenge for ECC members who wish to pursue an HFE-related career within academia or in practice. The following discusses broader context insights based on extant literature specifically for those in academic settings.

Successfully entering a career in academia and research is the desirable outcome for many who successfully complete a PhD or equivalent Doctoral qualification [48]. Steadily increasing numbers of successful PhD completions has been reported globally across the past two decades [49–52]. For example, the number of successful PhD completions in Australia since 2000 has risen from 4,000 to 10,000 annually [49]. Canada has observed a similar trend across the sample 20-year span, with the number of PhD graduates increased from 3,723 to nearly 8,000 [51]. Unfortunately, the number of academic employment positions appears to have remained relatively the same [50]. Further, it is currently unknown how much of the burden early career academics experience regarding the global economic downturn from COVID-19. Anecdotally, heavy redundancies experienced in Australian academia since 2020 have aligned with reduced opportunities for new research positions traditionally offered to newly qualified PhDs. Further, given the mismatch between high numbers of newly qualified PhDs and limited academic appointment opportunities, it is perhaps unsurprising that ECRs focusing on HFE share difficulties securing full-time academic roles.

Hardy and colleagues [16] surveyed 284 post-doctoral researchers to explore their experiences and expectations of work. The researchers found that most of the surveyed post-doctoral researchers intended to pursue ongoing and fulltime academic roles, including being a principal investigator (PI) on funded research. Further, Christian and colleagues [11] found that post-doctoral researchers often work beyond their allocated 38–40 hours a week, often reflecting desires to transition into ongoing and full-time academic roles such as PIs. Further, Christian and colleagues [11] found that 30% of post-doctoral researchers were 6–10 years post-PhD, and 21% were 10 years or more beyond successfully attaining their PhD qualification. These findings indicate that even at the post-doctoral career level, may researchers lack smooth and certain career trajectories, with these findings aligning with findings in studies outside of HFE [5, 7].

3.1.2.2. Job and financial pressure Linked to the challenge of job precarity, many ECC members outlined how the need for increased work engagement due to work insecurity often creates barriers to participation in local HFE society events. Specifically, the HFE ECC members report that time limitations caused by their position precarity often prevent participation in organizational committees and sometimes in event attendance. Further, a lack of fiscal resource access continues to be a barrier to HFE event attendance. For example, while conference attendance fees may be covered by universities for ongoing academic staff, many HFE ECC members in temporary post-doctoral appointments noted not having the same access to resources.

3.1.3. Inclusivity

HFE ECC members from culturally and linguistically diverse (CALD) backgrounds have shared that the English dominance of international HFE events creates barriers to their participation and engagement. For example, at the IEA2015 Congress social networking was recognised as more challenging

for students and early career professionals whose primary language was not English [19, 20]. Similar concerns were raised during the IEA2018 and IEA2021 Congresses. An important issue raised during the IEA2021 congress under the theme of inclusiveness (or a lack thereof) were the continued challenges faced by those from ethnic minorities and women. This aligns with previous findings outside of HFE [6] but ties into broader debates and calls from within the HFE discipline to consider issues of equity, diversity and inclusion when designing systems [53–55].

3.1.3.1. Lack of representation and inclusion in decision-making. An important concern outlined was that ECC members often do not have the same influence on decision-making at societal and IEA levels as HFE members at later career stages, given that in most cases, there are no avenues for them to voice their needs or interests or to become part of boards at Federated Society or the IEA level. For example, after the IEA2018 Congress, lack of voting input at society and IEA levels was identified as a barrier to ECC members and students directly affecting change [20].

3.2. Opportunities to support ECC development

In line with the participatory approach adopted by HFE, a number of suggestions emerged during the various IEA meetings and are summarised here. Given that these suggestions offer opportunities that can be situated at different levels (macro – IEA or global level; meso – at Federated Society level and micro level – institutional level). Here, a nested hierarchy of systems model is proposed that summarises some of the key opportunities of how different stakeholders can support the ECC looking for a future in HFE. Additionally, this section will highlight some of the ways in which the IEA has already responded to these suggestions.

3.2.1. A Standing committee for the early career professional and academics

The needs of the HFE ECC members have been identified in recent congresses [1, 20, 34], but without a standing committee at IEA to advocate and drive these needs, they are often not catered for. As a result, each IEA Congress must essentially 'start from scratch' with the early career/student planning. In response to this, the recently elected IEA President has, in collaboration with the other executives formed an ECC subcommittee that forms part of the "*Communications and Public Relations*" *(CPR)* Standing committee, which is currently formulating a strategic plan around how to address some of the needs and suggestions outlined in this paper. The creation of this committee will serve as a knowledge "bank" of the needs for future committees (as part of the IEA and the IEA Congresses) - a knowledge bank informed by diverse stakeholder perspectives. Future strategic actions to support the engagement of the ECC members can be undertaken by this committee around the design of events and opportunities that are centred on ECC development. This representation will hopefully also ensure that the ECC and students are given the opportunity to volunteer and get involved in the organisation of events or the activities of committees like the Communications and Public Relations standing committee for the IEA which in turn will ensure continuity and institutional memory.

3.2.2. Better use of social media to promote HFE and share resources

Across the various meetings, there was and continues to be a call for an increased presence and interactions on social media by the IEA and its Federated Societies. Social media platforms provide opportunities for global outreach and engagement with ECC members. These digital forms of communication may also break down resource barriers (e.g. travel costs etc.) to allow ECCs from all over the world to connect, interact and form networks. The use of social media and digital platforms further plays an important role in knowledge generation and sharing, the promotion of effective communication and participation in research or debates online [56]. Furthermore, a better presence on social media, by the IEA, its societies and other groups (such as the IEA's Technical Committees) will help to enhance the understanding of HFE, its approaches and its benefits which may in turn feed into creating more demand for HFE in the eyes of the public, other key external stakeholders and decision-makers, which Dul and colleagues [1] refer to as dominant stakeholders who are system experts and decision-makers. In response to this, the IEA, as part of the CPR standing committee, has started to use LinkedIn, Facebook and Twitter more frequently to promote the activities of the IEA and of its technical committees and Federated Societies.

Another example of this has been the IEA's initiative of providing free webinars, facilitated directly by the IEA Communications and Public Relations

standing committee or the various IEA Technical Committees. A collection of these webinars has already been uploaded on the official YouTube channel of IEA. At the time of writing, IEA's YouTube channel has about 136 subscribers [57]. With eventual subscribers, the YouTube channel's monetization option can be turned into an extra source of income for IEA. These funds may be distributed in the form of competitive grants for the ECC support.

3.2.3. Mentoring, promotion and networking opportunities

Mentoring opportunities have been identified by the ECC as desirable for supporting transition and early experiences in both industry and academic work domains. Mentoring (through various society, network or global channels) may support ECC members' ease of successfully finding work and undertaking within-work tasks. For example, ECC members working in academic contexts have identified the continued need for mentoring to support finding postdoctoral opportunities, grant writing, and stakeholder engagement, which is consistent with other research outside of HFE [6, 7]. Similarly, industry-oriented ECCs have reported that recognising the need for mentoring support to find industry-based HFE positions (that match their interests and expertise) and navigating work roles where HFE is needed but - is not necessarily recognised.

While there is still more work to be done on developing a strategic plan on best to facilitate this, the organisers of the IEA2021 congress included an interactive panel discussion entitled "*How to Kick-Start an HFE program in Academia and/or Industrial Settings*." This special session consisted of an interactive discussion with three international panellists from business and academia who had experience in undertaking ergonomic research, academic programmes, and gaining industrial partners. An 'open mic townhall' session allowed attendees to ask the experts topic-specific questions. The primary purpose of this session was to assist members of the EC community in strategically planning for success in the next stage of their careers. This kind of session will certainly form part of future Congresses.

At IEA2018 and IEA2021, ECC members from various countries have shared experiencing limitations in matched opportunities to access HFE-based mentoring. However, with increasing access to technology and strengthening global bonds within the HFE community, possibilities for an IEA-supported mentoring programme appear timely. It is also noteworthy that HFE licencing and certification processes now increasingly include mentoring (i.e., being a mentor) as a desirable activity as part of demonstrated HFE community engagement [58, 59]. It appears that IEA and Federated Society facilitated mentoring programmes may meet the needs of several parts of the HFE community.

Lastly, to facilitate more exposure for the ECC members, an "ECC Member of the Month" may be showcased in each IEA "NewsBriefs" (newsletter). This publication forms part of the IEA's Communications and Public Relations standing committee's activities and there is indeed a plan to include a section where ECC members may share their recent publications or accomplishments. The IEA NewsBriefs are sent out globally. This would provide a new platform for the ECC members to showcase their work.

3.2.4. Representation at the society level

In line with the suggestion of creating an ECC standing committee at the IEA level, the ECC members have also called for more representation on boards of the Federated Societies. Examples of ECC representation currently used within Federated Societies include having ECC representation on Society boards, including ECC members in organizing committees for events, and having special interest groups targeted at ECC needs.

While many IEA congresses and many IEA Federated Society conferences have some dedicated sessions centred on creating opportunities for students, all too often, ECC members have reported that because they fall between the bracket of student and established generalist, they often do not find their specific needs met during conference programming. Thus, the inclusion of dedicated ECC-focused programming within HFE conference events would support meeting this identified need. The IEA2021 congress organizers made strides to create an ECC-focused programme, with positive outcomes reported by ECC members [34]. The inclusion of an ECC member in the organizing committee will provide event organisers to provide input on how to design and include context-specific events aimed at supporting ECC members.

3.2.5. Financial support and experiential learning opportunities

A key barrier identified across the various interactions with the ECC were various financial constraints, which affected ECC participation in society and

IEA events. Furthermore, there were suggestions surrounding the need for more opportunities, grants and awards that are focused on attracting and recognising members from the ECC. These are elaborated on below.

3.2.5.1. Registration discounts. There continues to be a call for the need to consider supporting ECC members (and not just students) with discounts to membership of Federated Societies and events at the International and National levels. The IEA World congresses and most conferences of IEA's Federated and affiliated societies do not have discounts for the individuals belonging to ECC, but do for students and for researchers or students from the Global South [34, 60].

The cost of conference registration and attendance creates barriers to attendance for some ECC members. Options for conference registration discounts associated with ECC status would facilitate greater attendance by this sector of the HFE community. A suggestion that has emerged to overcome this barrier, is that a sliding scale approach may be appropriate for considering ECC conference discounting. Resource alternative support may also mitigate conference cost attendance for this group, such as organised free child-care or possibilities for pay-on-demand access rather than in-person attendance. In addition, the option to offer volunteer service to off-set/mitigate registration costs.

Event organisers (whether at IEA or society level) may wish to include members of the ECC in their event through volunteering roles. The IEA2021 congress had extensive volunteer opportunities for students and members of the ECC in Canada and internationally [61], with the pivot to a fully virtual congress opening up more volunteer opportunities as extensive data had to be tabulated, correlated and coded in preparation of and during the conference. The ECC members appreciated the initiative and the hope is that this type of programming becomes a 'tradition' in future IEA and other HFE conferences. Other conference volunteer examples include (but not limited to): manning the registration desk, lost and found area, social media and/or congress photographer, assembling congress 'goody' bags, printing name-tag etc. Volunteers maybe assigned to these duties for a few hours and in-return they may enjoy a registration discount.

3.2.5.2. Grants, awards and opportunities for ECC. The IEA has triennial and annual awards that support and celebrate the contributions of various parts of the HFE community. However, there are currently limited dedicated awards specifically for ECC members. ECC members working in academia have reported a desire for IEA awards to be associated with competition-based research. In recognition of this important aspect of the IEA Congress, the organisers of the IEA2021 conceived various ECC focused competitions (e.g. Patient Safety Design Competition). Such events offer the chance for networking and relationship formation across ECC members. Furthermore, these kinds of competitions should involve more established researchers and professionals, which may in turn facilitate opportunities for both informal and formal mentorship relationships to be established. Another example of how these suggestions were addressed by the IEA was the inclusion of the Pecha Kucha Student Competition (PK). PK is derived from the Japanese word for 'chit-chat' [62]. It is a concise, fast-paced method of delivering presentations. Speakers must use 20 slides that change automatically every 20 seconds. At the IEA congress, students/ECRs had the opportunity to compete to explain their complex doctoral/masters' research in 6 minutes and 40 seconds [63]. A Pecha Kucha (PK) was undertaken during the IEA2021 congress to highlight students' research work. Recommendations to undertake a competitive PK as part of the IEA2021 congress were made by ECC members after the success of the 3 Minute Thesis competition during IEA2015 [20]. Future conferences may develop similar ECC-centric competitions.

The want for IEA-supported ECC research grants stems both from the desired opportunities research grants afford and opportunities to celebrate the achievements and potential of ECC members. Similar possible fiscal awards could also support the HFE skills and engagement goals of industry-based ECC members. Experts and senior members of the HFE community highlight research gaps at IEA triennial congresses and other HFE community conferences [46, 64], but there is a lack of follow-through in terms of research grant support that can support the study of these highlighted research gaps. The ECC members are motivated to perform innovative research [14] and create opportunities for novel industry engagements [65]. IEA competitive grants and awards specific to the ECC members would allow ECC members to establish their own track records as principal investigators (PI) that may lead to gainful employment (academia and industry). In response to this, the IEA Awards committee have included, as part of their

Kingfar and Tshingua awards, the chance for the EC community to apply and be considered for these awards. This is an important step towards supporting and recognising ECC excellent and contributions to the development of HFE on a global scale.

Another suggestion was centred on creating opportunities for ECC members to have dedicated conference tracks or events. This will facilitate important opportunities for collaboration with peers of similar career-age groups and may yield longer-lasting collaborations than those with more senior academics and professionals, which supports the arguments by Bickel [17] around the important role that networking events can play in forming communities of support. Linked to this is the suggestion of providing ECC members with the chance to give keynote addresses at conferences, given that most IEA congresses and Federated Societies' conferences mostly have had end-career and mid-career professionals, and industrial leaders as keynote speakers. Platforms like these make the ECC members feel more valued in the profession. Further, this will allow end and mid-career professionals to become aware of their junior colleagues. This exposure may assist members of the ECC members gain meaningful collaborations with their international colleagues on different projects.

3.2.6. Increasing knowledge and skills in HFE through courses and webinars

An important suggestion that has emerged consistently is the need for more opportunities for ECC members to attend short courses on HFE topics, which may be created by academic institutions and promoted by the IEA and its Federated Societies. To translate this knowledge, short courses (e.g., 4 hours to a week or more) may be organized by IEA Federated and affiliated societies where students and the ECC members can enroll and attend via Zoom, WebEx, Teams or other online platforms. This will allow students and the members of the EC community who are limited by their geographical location to gain access to some of the most esteemed and prominent names in the HFE profession. This initiative may lead to the uptake of newer skills and abilities that students and ECC members may implement in their projects. Further, it may provide formal and informal pathways for engagement with the broader HFE community. Oakman and colleagues [45] provided examples of Massive Open Online Courses (MOOC) that make attempts at addressing these concerns, while Davy and colleagues [66] made reference to the BRICS (Brazil, Russia, India, China, South Africa) HFE summer school which was held prior to COVID-19. Such courses may be useful in cases where Professional Ergonomist designations/certifications (e.g. European Ergonomist [Eur.Erg.], Certified Professional Ergonomist [CPE]) require students to prove their HFE-specific education hours [58, 59]. Students from less common fields (e.g. engineering, human resources etc.) coming into HFE lack these hours. These short courses maybe used as substitutes.

While not necessarily part of the discussions at the various IEA Congresses, the advent of online webinars, accelerated by the COVID-19 pandemic, has offered an opportunity of global knowledge sharing. As part of the IEA's attempts to promote the demand for and application of high-quality HFE, the CPR committee has, in collaboration with the Science, Technical and Practice committee, facilitated a number of webinars which have attracted a global audience.

3.2.7. Increasing the need for and development of HFE Education programs

While beyond the scope of this paper, there continues to be a need for developing more high-quality HFE programs across the world as called for by Dul and colleagues [1] and Oakman and colleagues [45]. The IEA, in collaboration with its Federated Societies, has created an initial map of HFE programs around the world [67], which has been the first step towards highlighting the education programs available, while also identifying areas for possible development and growth of education programs. Furthermore, as outlined in the recent IEA Triennial report, there have been a number of engagements with various societies across the world to develop various postgraduate study programs, the most recent of which have been in Argentina, Peru, Colombia and Chile [52, 68]. There is a continued need for the IEA, through its networks, standing committees and Federated Societies, to identify further opportunities for the development of education programs in under-represented countries such as in Africa.

3.2.8. Emailing lists

At the IEA2018 Congress, ECC members cited a lack of ongoing connection with IEA activities as a continuous barrier to global HFE community engagement. Several attendees at the informal session highlighted that their only connection with the IEA occurred during the triennial congress. In response

to this highlighted lack of ongoing connection, it was proposed that an emailing list be created to connect students and early career HFE professionals with ongoing global HFE activities such as: competitions, funding and grant opportunities, conferences, and scholarships. An email list provides a tandem way of supporting communication with ECC alongside social media. However, it should be noted that the IEA and other societies are hindered from keeping in contact using a database of emails from individuals belonging to the ECC - some country laws (especially in the European Union) prohibit emailing ECPs and ECRs unless each individual gives permission. Members of the newly formed IEA Early Career and Student Special Interest Group are currently grappling with how to set this up, while also using social media to support reaching ECC members.

3.2.9. Addressing Linguistic barriers

Given the dominance of English for many events hosted at IEA, the needs of ECC members whose primary language is not English need to also be considered. Some organizers of IEA congresses (e.g. IEA2018) have made strides to address this, where a few sessions were held where the medium of instruction for presentations and Q/A was not in English. To make sessions more inclusive, attendees may be provided with subtitle options, other language events, interpreters (e.g. sign-language), and options for presenters to speak in their own primary language with English language sub-titles etc..

3.2.10. Access to high-quality HFE journals

Most students in high-income countries (HICs) have free access to the top journals in the realm of HFE via their home institutes (universities/colleges). However, this is not the case for many students and ECC members in low and middle-income countries (LMICs). At IEA2018, student and ECC attendees from developing nations strongly voiced their concerns about the lack of free access to these journals. Two suggestions emanated from discussions with ECC members to address this.

3.2.10.1. Exclusive paid subscription rates and packages. At IEA2018, several ECC members and students (from Global South) voiced their concern about the lack of access to research papers - Not all Global South universities may be able to provide free subscriptions to major HFE journals, unlike universities from other parts. Some big publishers, such as Elsevier and Springer may be persuaded to provide exclusive discounts to IEA's student and ECC members in developing countries. Paid subscriptions are not only expensive, but they also provide access to one journal only. Discussions with these 'big' publishers can be done to promote offering exclusive packages to this community group. The overall costs of paid subscription packages may be offset if more ECC members and students participate in such programs. This would be similar to how most student unions in Canada, the US etc., are able to provide discounts on local transportation (buses, metro trains, streetcars etc.) to all the students in their universities. This may be offered directly through IEA in collaboration with the journals that it endorses perhaps. The authors do recognize that this is a really big and difficult avenue to pursue, but the reward and its impact would be great too.

4. A call to action

This paper provides important insights into the perceived barriers faced by members of the ECC group who have attended the last three IEA Congresses. In sum, these systemic barriers are similar to those reported in other disciplines, but also highlight unique areas that continue to affect ECC inclusion and development in HFE, principally because the discipline remains poorly understood. There is thus a continued need for various stakeholders (the IEA, its networks, its committees and its Federated and affiliated societies) to continue to promote, grow and demonstrate the value add of HFE to ensure that there is indeed a demand for HFE professionals and a place for the ECC in the future.

In line with the participatory approach adopted by HFE, the perceived opportunities to support the ECC members offer important, albeit at times, obvious suggestions about how the IEA and its internal stakeholders may do this better. By sharing these ideas (illustrated in Fig. 2), the authors hope to spark increased dialogue around this important issue and invite HFE professionals at all levels to share their own ideas, strategies and current practices on how to better support the development of the ECC. Additionally, careful consideration needs to be given to how to ensure that all ECC members are catered for, particularly those from previously marginalized groups including women, ethnic minorities and those with disabilities.

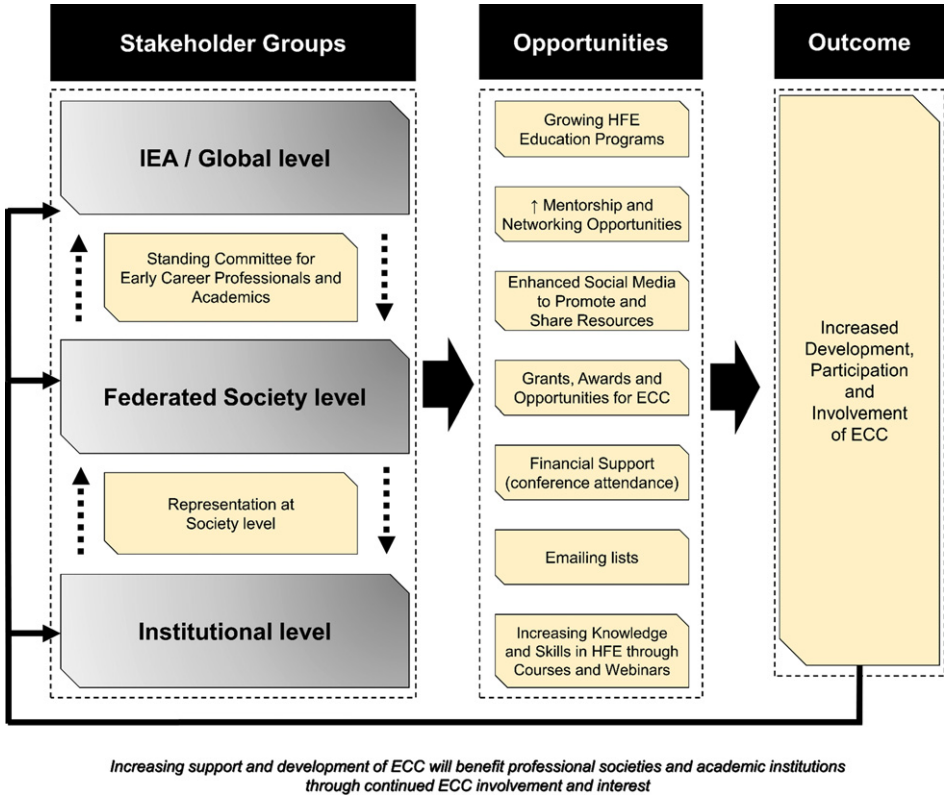

Fig. 2. A framework of proposed opportunities aimed at developing and supporting the ECC to ensure continued development and involvement of the ECC at IEA, Federated Society levels and institutional level. Through representation by ECC members at IEA and Federated Society levels, accompanied by interactions across all levels (denoted by the dash arrows) appropriate opportunities specific or relevant to the context can be leveraged and developed into programs aimed at supporting ECC from a global, local and institutional level.

5. Strengths, limitations, and future work

The current report is the culmination of the formal and informal discussions at IEA2015, IEA2018, IEA2021, and other venues. Discussions, including brainstorming sessions, were held with diverse stakeholders, including current students, early-career academic researchers, early career industry workers (e.g., ergonomists), established academics (e.g., tenured), and established HFE sector workers (e.g., industry, government). The integration of diverse stakeholders has allowed iterative integrations of various perspectives. This has allowed the practical integration of perspectives analogous to multivocality experienced during formalised research [69]. Discussions have also been informed by a previous research study that scoped student engagement across IEA Federated Societies [19]. Outcomes of discussions have included two reports, which are lodged with IEA [20, 35]. However, discussions that informed current suggestions to support ECC members were functionally pragmatic. They were not undertaken using any specific rigorous method to systematically identify barriers and facilitators. A lack of planned and systematic methods does suggest the potential for limited rigour within the current suggestions. Systems thinking approaches, search conferences, future inquiry, questionnaires, Delphi study, in-depth interviews, focus groups, and action inquiry [70–74] would be important methods to consider for future engagement in this area by allowing systematic analytical investigation of barriers and opportunities to ECC's HFE participation. These methods may also provide opportunities to explore collaborative systems transformation with diverse stakeholders.

Additionally, the generalisability of these findings is limited given that only views from participants from IEA2015, IEA2018 and IEA2021 congresses were garnered. Therefore, these findings may not be reflective of challenges faced by those who could not or did not attend the Congress. While this article focuses on both early career academics (researchers)

and early career practitioners, suggestions and barriers might be slightly skewed towards early career academics (researchers). Since the proportion of academics (researchers) is much larger than practitioners at conferences [34]. Furthermore, it was not determined what various societies may already be doing to support their ECCs, which this article will hopefully promote the discussion around.

Based on the recognised core theme, future work should integrate formal investigation on considered actions and research. The current authors also recommend the continuation of the successful informal consultation and discussion mechanisms used to maintain evolving insights into how ECC members are being supported across global communities. The scoping of experiences and brainstorming for ongoing recommendations is a major step in solving the complex problem of how to support ECC members. Further work with decision-makers across IEA and HFE communities will enrich appreciation of how actions to support ECC members can be enacted and monitored within local contexts.

6. Conclusion

Following engagements with ECC members across various IEA Congresses, it remains evident that the ECC group has and continues to face various, system and complex barriers that may continue to affect their sustained participation in professional societies and organisations involved in the discipline of HFE. The current paper provides some initial suggestions on how some of these barriers can be overcome by highlighting ideas from those who are most affected by them. It is clear that there is a need for ongoing considered actions, consultation, and research at localised, national, and global levels to better understand how ECC members in different contexts can be better supported. Current findings suggest that more direct recognition and actions to cultivate facilitators and address barriers would enrich ECC participation experiences with HFE. Perhaps just as importantly, by including ECC members more in the governance structures of HFE professional societies, the IEA and its Federated Societies will likely ensure the ongoing engagements and networking opportunities for ECC to support the broader development of the HFE profession. ECC members are an essential part of the future of professional societies and the broader discipline of HFE. A growth and support of the ECC means a growth of the HFE profession.

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Ethical approval

This study has been approved by the Human Research Ethics Committees of University of New South Wales (Approval no: HC15065), Central Queensland University (Approval no: H15/04-055), and La Trobe University (Approval no: HC15065).

Informed consent

The consent process approved by the Human Research Ethics Committees of University of New South Wales, Central Queensland University, and La Trobe University, were followed.

Conflict of interest

The authors declare that they have no conflict of interest.

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