

Factors affecting African postdoctoral researcher capacity development within 'learn-by-doing' international research partnerships: findings from the 'Partnership for Increasing the Impact of Vector Control (PIIVeC)'

Jessica Amegee Quach ¹, Innocent Valea,² Imelda Bates,¹ Justin Pulford ¹

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¹Department of International Public Health, Liverpool School of Tropical Medicine, Liverpool, UK

²Unité de Recherche Clinique de Nanoro, Institut de Recherche en Sciences de la Santé, Nanoro, Burkina Faso

Correspondence to

Dr Justin Pulford;
Justin.Pulford@lstmed.ac.uk

ABSTRACT

Introduction The Partnership to Increase the Impact of Vector Control sought to develop the research and leadership capacity of 10 African postdoctoral vectorborne disease scientists via a 'learn-by-doing' approach. We identified factors that either supported or hindered their development and, drawing on this information, determined key lessons for future programmes with similar objectives. **Methods** A longitudinal qualitative study encompassing focus group discussions and semistructured interviews conducted with the cohort of African postdoctoral fellows, programme leadership, supervisory and research support staff (N=28). Data analysis was informed by a general inductive approach.

Results Numerous supportive and hindering factors were identified. Supportive factors were primarily structural or attitudinal in nature, whereas hindering factors were primarily operational or contextual. None of the supporting or hindering factors were specific to vectorborne disease research. Four key lessons for future programme implementation emerged, including: the value in exposing postdoctoral fellows to a diverse work-mix and training-mix to improve understanding of the broad skillset needed for scientific career advancement; recognising and managing the potentially competing interests of different partnership members to ensure everyone benefits from participation; ensuring equity of opportunity and rewarding engagement; and ensuring flexibility in support provision. **Conclusion** Our study highlights numerous factors that may be readily incorporated into early career researcher capacity strengthening initiatives based on a learn-by-doing approach. Many of these factors are supported by a growing weight of evidence and would be appropriate to research capacity strengthening programmes both within and outside of a vectorborne disease context.

INTRODUCTION

Eighty per cent of the global population is considered at-risk of vectorborne disease (VBD) and over 700 000 deaths are attributed

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The available evidence to support good practice in 'learn by doing' approaches to researcher capacity development is not well developed.

WHAT THIS STUDY ADDS

⇒ We identify a range of non-discipline-specific factors that either support or hinder researcher capacity development in a learn by doing context.
⇒ These factors were derived via longitudinal qualitative study and both consolidate and extend the emerging evidence base.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The study findings may be used to inform funding calls designed to support early career researcher development via international research partnerships as well as the proposed design of such partnerships themselves. For example, funders should ensure they allow sufficient time for both research and research capacity strengthening objectives to be fulfilled, as the demands of both can sometimes compete, and international partnerships should ensure that they adopt project management structures that optimally support capacity development objectives.

annually to VBD.¹ Enhancing capacity is a foundation of the WHO's global vector control response, 2017–2030,¹ inclusive of basic and applied research capacity in entomology and vector control. VBDs disproportionately affect sub-Saharan Africa, in terms of both morbidity and mortality,^{1 2} yet health research capacity is limited in Africa relative to other parts of the world.^{3–5} Globally, Africa has the lowest expenditure on research and development as a share of gross domestic product (GDP), the lowest number

of researchers per million inhabitants and the fewest number of scientific publications per million inhabitants.³ African research capacity constraints are the result of multiple, often historical factors, including the legacies of colonisation still evident in ‘helicopter’ research practices⁶ or in the development agendas of donor countries that do not necessarily align with local priorities.^{7,8} Having scientists that are embedded in their local environment, understand local issues, the system in which these issues present and who have trustful ties with local stakeholders and decision-makers facilitates the production and uptake of locally appropriate evidence.⁹ Thus, it is essential that African researchers and research institutions are prioritised in VBD research capacity strengthening initiatives.

Research capacity strengthening has been defined as ‘the ongoing process of empowering individuals, institutions, organisations and nations to: define and prioritise problems systematically, develop and scientifically evaluate appropriate solutions and share and apply the knowledge generated’.¹⁰ There are numerous examples of research capacity strengthening programmes in the published literature, although relatively few reporting robust research or evaluation designed to inform effective research capacity strengthening practice.^{11,12} Studies that have derived pragmatic findings from robust research investigation offer useful insights for those pursuing research capacity strengthening objectives. For example, Burgess and Chataway¹³ reveal inter-African research collaboration practices that may be further harnessed to enable ‘capacity sharing’ without external input and Franzen *et al*¹⁴ present a conceptual framework for developing sustainable clinical trials capacity in low-income and middle-income countries based on a qualitative analysis of common enablers and barriers to conducting locally led trials in three African countries. Given the vast sums spent in support of diverse research capacity strengthening initiatives,¹⁵ expanding research and evaluation informed understanding of good practice is warranted.

In this paper, we present findings from a longitudinal qualitative study embedded within a VBD research capacity strengthening programme, namely the Partnership to Increase the Impact of Vector Control (PIIVeC). Among other objectives, PIIVeC sought to develop the research and leadership capacity of 10 African postdoctoral VBD scientists based at research institutes in Burkina Faso, Cameroon and Malawi. The approach taken to this ‘individual-level’ capacity strengthening task (ie, focused on strengthening the capacity of individual researchers) may best be described as ‘supported learn-by-doing’. Learning by doing means ‘learning from experiences resulting directly from one’s own actions’.¹⁶ Within an early career researcher (ECR) frame this can involve such things as taking responsibility for completing a scientific project addressing a real-world challenge, doing so with mentorship from experienced researchers and as part of a community of practice.¹⁷ Accordingly, each of the 10

postdoctoral fellows were supported via a wide variety of resources to lead the design, implementation, analysis and reporting of a VBD research project over a 4-year period. Complementary opportunities to develop leadership and general research skills were also provided. Similar ‘learning-by-doing’ approaches have been widely employed as a research capacity strengthening approach within international partnerships or consortia.^{18–20} Our study was specifically designed to identify PIIVeC programme factors that either supported or hindered African postdoctoral researcher capacity development conducted within a learn-by-doing format and, drawing on this information, determine key lessons for future programmes with similar objectives.

METHODS

A longitudinal qualitative study encompassing focus group discussions (FGDs) and semistructured interviews (SSIs) conducted with a cohort of African postdoctoral fellows belonging to a 4-year, vector control focused research capacity strengthening consortium. Complementary SSIs were conducted with programme leadership, supervisory and research support staff.

Study setting

PIIVeC was a 4-year (2018–2021) research consortium with funding from the UK Research Councils Global Challenges Research Fund. The partnership brought together research institutes from Burkina Faso, Cameroon, Malawi and the UK to reduce the high burden of VBD through effective, locally appropriate and integrated vector control solutions informed by locally generated evidence. Specifically, the partnership aimed to increase the evidence base for making informed decisions related to vector control; enhance partnerships between evidence generators and evidence users through knowledge translation and policy uptake strategies; and strengthen the institutional research and management support services of partner organisations to sustainably generate high-quality evidence. The partnership included four workstreams focused on (1) individual capacity strengthening; (2) institutional capacity strengthening; (3) evidence generation and (4) knowledge translation, delivered through five integrated work packages. Within the context of the individual capacity strengthening work stream, PIIVeC supported a cohort of African early career researchers (N=10) based at African research institutions, through postdoctoral fellowships, to achieve independence in vector biology research. All fellows designed and implemented a vector control project aligning to national priorities in Burkina Faso, Cameroon or Malawi under the mentorship of senior academics from the participating African institutions and the Liverpool School of Tropical Medicine (LSTM). Mentors, referred to as ‘advisors’, provided project and career support for the duration of the fellowship. Each fellow received full-time salary (paid at local institutional

rates), a total research budget of £80 000 and a flexible fund to cover relevant travel and training expenses. The cohort attended diverse science and scientific leadership training at scheduled intervals over the course of the fellowship, typically delivered in blocks at LSTM or during annual partnership meetings in partner countries. Outside of these training events, fellows could access specialist support remotely as required (eg, quantitative or qualitative analysis, data management, knowledge translation) as well as research laboratories and research support services available across the partner institutions. Fellows' progress was assessed quarterly during progress review meetings convened by PIIVeC project leadership and additional supports provided if required (eg, obtaining ethical approvals, addressing barriers to data collection). This cohort is the focus of our paper. Further information about the PIIVeC programme can be found at: <https://www.piivec.org/>.

Sampling

All 10 African postdoctoral fellows employed from the outset of the PIIVeC partnership were included in this study. In addition, we sampled all relevant senior leaders of the consortium (inclusive of project management, workstream leads and in-country coordinators), all technical research support staff employed, in part, to train and support the cohort of postdoctoral fellows and a subsample of the advisors (senior scientists from the partner organisations) collectively assigned to support the postdoctoral fellows in the completion of their respective research projects. We sought to maximise participant variation in terms of geographical location, home-based institution, seniority and position with the programme, gender and primary language.

Procedures

Data were collected prospectively between March 2018 and August 2021. Data were collected from the cohort of postdoctoral fellows via FGD or SSI at three time points over this period, corresponding with early (March 2018–August 2019), mid (September 2019–November 2020) and late (December 2020–August 2021) stages of the PIIVeC programme. All other participants completed a single SSI each, variously conducted over the mid stages to late stages of the programme, except for one project manager who was interviewed twice (early and late stage) as he was integral to programme implementation throughout. [Table 1](#) presents an overview of the number and timing of all FGDs and SSIs.

Prior to any FGD or SSI, an introductory email was sent to each prospective participant. The participant information sheet and consent forms were attached to this email. The email text and the information sheet clearly stated that participation was voluntary and that a decision not to participate would not affect their PIIVeC involvement in any way. All authors had access to information that could identify individual participants during or after data collection; participants were made aware of this prior

Table 1 Number and timing of data collection by participant category

Category	N	No and timing of data collection		
		Early*	Mid†	Late‡
Postdoctoral fellows	10	10§	10§	8
Advisors¶	13	3	1	9
Technical research support	4	0	4	0
Senior project management	1	1	0	1

*March 2018–August 2019.

†September 2019–November 2020.

‡December 2020–August 2021.

§Denotes data were collected via focus group discussion (FGD).

¶Three advisors were also members of the project management team. Two FGDs were conducted at each time point, each including five participants.

to providing consent. Written informed consent was obtained prior to participation in all cases. All FGDs were conducted in-person during scheduled events in which all postdoctoral fellows were expected to be in attendance (eg, partnership meetings or training blocks). Interviews were conducted either in-person (n=5) or remotely (n=22) at a place and/or time convenient to the participant. All FGD and SSI were conducted using topic guides variously tailored to the role of the participant and/or the stage of data collection (online supplemental data 1). All FGDs were conducted in gender-defined groups, males in one group (six) and females in another (four), to allow for gender-specific issues to be voiced more freely and to ensure the group sizes were conducive to full participant engagement. All FGDs and interviews were led by an experienced researcher and conducted in either English or French according to participant preference (one FGD and nine SSIs were conducted in French, all others in English). Interview and FGD discussions typically lasted between 60 and 90 min, were audio recorded with participant permission and notes were taken to capture elements of the context of the discussion and to allow a better interpretation of the data. All audio files were transcribed in full and, if required, translated into English by the lead researcher.

All aspects of this study including study design, data acquisition, analysis, interpretation and manuscript development were led by a female ECR (JAQ) supported by senior colleagues based in the UK (IB and JP) and Burkina Faso (IV). Research team members were independent of the individual capacity strengthening workstream, although they led a programme designed to support learning in support of multiple PIIVeC objectives. Participants were aware of the research team's role within PIIVeC and, as such, would likely have regarded them as 'insiders'. The lead ECR (JAQ) acknowledges

her standpoint as a Francophone women of West African descent with lived experience and knowledge of the wider political context, culture and social interactions in African countries. These identity factors may have reinforced ‘insider’ status and shaped how data were collected through interviews (eg, the PIIVeC fellows may have been more able/comfortable to express themselves in colloquial terms or tacit knowledge may have been more readily understandable to the research lead) The lead researcher employed an open, yet somewhat formal demeanour to limit potential interviewer bias and having received higher education in Europe, she was at a distance from the experiences of attending higher education institutions in Africa which may have limited confirmation biases.

Data analysis

All FGD and SSI transcripts were uploaded into NVivo software (V.12). Data analysis was informed by a general inductive approach,²¹ aligning emerging themes identified in the data with predetermined focal areas relevant to the overarching study objectives. Transcripts were initially coded by the lead author (JAQ), resulting in a data framework and draft narrative presenting emerging themes and subthemes under constructs of ‘factors supportive or hindering of postdoctoral researcher development’ and ‘overarching lessons in postdoctoral researcher development’. The framework and draft narrative were then shared with the senior author (JP) for critical review and collectively revised over several iterations. Final coding decisions were agreed by consensus opinion.

Patient and public involvement

No patients or members of public were involved in the design, conduct or reporting of this study.

RESULTS

Participants

The study included a total of 28 participants across all FGDs and SSIs. All 10 postdoctoral fellows participated in a FGD at both the early stages and mid stages

of the PIIVeC programme and eight completed an SSI at the late stage (the remaining two had moved onto other positions at this late stage and were unresponsive to the SSI invitation). Selected participant characteristics are presented in [table 2](#).

Supportive or hindering factors

Several PIIVeC programme factors that either supported or hindered African postdoctoral researcher development within a learn-by-doing context were reported by participants. Factors were considered ‘supportive’ if they were felt to have made the fellowship more accessible, achievable or worthwhile for participants. The converse was true for hindering factors. The reported factors, whether supportive or hindering, were subsequently categorised into four distinct typologies emerging from the data, including: (1) structural, that is, intentionally built into the programme design; (2) attitudinal, that is, reflective of attitudes or perceptions; (3) operational, that is, practical aspects of programme implementation and (4) contextual, that is, the implementation environment inclusive of the home institution and the national context in which it operates.

Almost all supportive factors were ‘structural’ in nature, including:

- ▶ A wide and diverse range of networking and engagement opportunities inclusive of a rotating seat on quarterly PIIVeC management board meetings.
- ▶ ‘Supported’ autonomy in terms of study design and implementation as well as provision of multiple research and research leadership responsibilities including supervision of a junior scientist (Masters or PhD student).
- ▶ The sense of community, peer-support and shared learning associated with being part of a cohort of 10 postdoctoral fellows.
- ▶ Bespoke, structured support inclusive of a well-resourced professional development plan, two

Table 2 Participant characteristics (N=28)

Participant characteristics	n (%)	Fellows	Advisors	Technical support	Project man.	
		n=10	n=13	n=4	n=1	
Gender	Male	20 (71)	6	10	3	1
	Female	8 (29)	4	3	1	0
Location	Burkina Faso	7 (25)	4	3	0	0
	Cameroon	6 (21)	4	2	0	0
	Malawi	3 (11)	2	1	0	0
	UK	12 (43)	0	7	4	1
Primary language	English	15 (54)	2	8	4	1
	French	7 (25)	4	3	0	0
	Bilingual	6 (21)	4	2	0	0

assigned advisors and comprehensive progress monitoring.

- ▶ Accessible experts in a wide range of research methodologies and knowledge translation processes; facilitated alignment of fellows' research projects with individual, institutional and national level VBD research priorities.
- ▶ Increasing the 'accessibility' of the PIIVeC post-doctoral research opportunities by basing the fellowships within African partner institutions and by adopting a linguistically diverse in-country recruitment process led by Southern partners.
- ▶ Ensuring access to high-quality research support services, inclusive of well-equipped laboratories, via the PIIVeC partner network.
- ▶ Efficient, well-resourced project management support which not only facilitated implementation of the fellows' projects, but also 'role-modelled' effective project management practices which fellows were able to adopt.

The two remaining supportive factors were more 'attitudinal' in nature and included:

- ▶ The overarching ethos of PIIVeC which ensured capacity strengthening considerations were prioritised in programme design, structure and implementation.
- ▶ The prestige and reputational enhancement associated with PIIVeC affiliation.

Most hindering factors reflected 'operational' challenges in programme implementation, including:

- ▶ Achieving an appropriate balance between affording research autonomy and providing support which was not always achieved.
- ▶ The responsiveness, availability and commitment to the fellow/advisor relationship fluctuated over time in some instances (from both parties) undermining the value of this learning opportunity for some.
- ▶ Occasional discrepancies between the time that various trainings and supports were provided and the time such support was actually needed.
- ▶ Effective communication across the PIIVeC programme was challenging at times due to the diversity of partners, expertise, languages, countries and communication styles but also distance, interpersonal relationships and access to/use of technology.

Three hindering factors were more 'contextual' in nature and included:

- ▶ The onset of the COVID-19 pandemic, and especially the associated restrictions placed on national and international travel, disrupted full participation in planned programme activities and impacted fellows project implementation.
- ▶ (Some) fellows retained non-PIIVeC-related responsibilities in their respective home institutions (most often in those cases where fellows were pre-existing staff members) which

prevented full engagement in PIIVeC activities at times.

- ▶ While PIIVeC membership significantly increased access to research resources and facilities, fellows still often faced many of the common challenges associated with conducting research in Africa inclusive of limited institutional facilities, complex bureaucracies and national security issues, particularly in Burkina Faso.

The final hindering factor was structural and pertained to the duration of the postdoctoral fellowships which was widely considered too short to achieve all planned objectives, in part because of the additional capacity strengthening oriented activities implemented. [Table 3](#) presents a summary of the supportive and hindering factors by category.

Key lessons in supporting African postdoctoral researcher development

Drawing on the PIIVeC experience as described by study participants, four key lessons in supporting African postdoctoral researcher development within a learn-by-doing, capacity strengthening-focused consortium emerged. These lessons are complementary to the findings presented in [table 3](#) and may be considered 'overarching' factors that enable a conducive capacity strengthening environment.

Postdoctoral researchers' recognition of the broad skillset needed for scientific career advancement is aided by exposure to a diverse work-mix and training-mix

When the 10 postdoctoral fellows entered the PIIVeC programme they were primarily interested in technical training considered necessary for their respective projects or in fundamental research skills training such as grant or scientific writing. There was less enthusiasm at this early stage for 'soft skills' development or in research methodologies not considered directly relevant to their projects. However, the value of a diverse training mix emerged over time, especially as fellows took on additional responsibilities (such as student supervision) and as their projects advanced from design to implementation to reporting stages. The recognition that new skills were needed was also, in part, a result of the fellows having previously been exposed to subject content at a time when it was not immediately necessary. In short, the PIIVeC postdoctoral fellows became increasingly aware of the breadth of skills needed to progress a scientific career over the course of the fellowship, in part because they were confronted with the need for new skills and in part because exposure to a diverse training programme 'primed' them to recognise when previously underappreciated skills could be useful.

I learned from [project management team member] his art of managing a project, his timeliness. It was the

Table 3 Programme factors that either supported or hindered African postdoctoral researcher development

Category	Factor	Type
Structural	Diverse networking, exposure and engagement opportunities	Supportive
	Research autonomy and multiple responsibilities	Supportive
	Cohort approach	Supportive
	Bespoke, structured professional development support	Supportive
	Ready access to experts in diverse methodologies	Supportive
	Research relevant at individual, institutional and national levels	Supportive
	Fellowship structure accessible for African applicants	Supportive
	Good access to institutional support systems	Supportive
	Valuable and efficient project management support	Supportive
	Fellowship duration too short to achieve full impact	Hindering
Attitudinal	Programme's capacity strengthening ethos	Supportive
	Programme prestige	Supportive
Operational	Balance between research autonomy and providing support	Hindering
	Mentoring not always as beneficial as desired	Hindering
	Timing of training and support provision	Hindering
	Challenges to effective communication across the partnership	Hindering
Contextual	COVID-19 impact on research projects	Hindering
	Non-PIIVeC work responsibilities could be burdensome	Hindering
	Challenging working environment at institutional and national levels	Hindering

PIIVeC, Partnership to Increase the Impact of Vector Control.

first time for me to interact with programs as such at that level. I got to admire his skills and really tapped a lot from him (...). I now invested interest in knowing how he does that and how those things work. I think they will help me in managing the next projects that I'll have as a scientist. (Postdoctoral Fellow)

Recognise and manage competing interests, ensuring partnership benefits all participants

The PIIVeC partnership was primarily designed to support a cohort of 10 African-based postdoctoral fellows develop as future VBD research leaders. However, the partnership was composed of a multitude of individuals and institutions with their own interests and priorities to satisfy. For example, partner institutions recruited the postdoctoral researchers to participate full-time in a fellowship with expected benefits for their organisation, whether implicit or explicit. Occasionally, these institutional interests competed with the needs of the fellows, resulting in the latter facing overwhelming workloads as they sought to satisfy both their PIIVeC and other institutional duties. For some, this limited the opportunity for maximising learning from the fellowship.

I have a lot of administrative tasks [in addition to the fellowship] so I didn't do much [on the fellowship] but I will solve this. In the month of October I'm starting [data collection]. I need to be responsible (Postdoctoral Fellow)

I would say one issue would be other commitments outside the PIIVeC fellowship. I think time commitments also

influences as well [performance], for some individuals. I do think that the fellowship itself is quite daunting (Project management team member)

The PIIVeC programme also has its own priorities and planned deliverables to meet to justify the funder investment. However, adopting a capacity strengthening approach within an applied research programme revealed a tension between the necessary time to effectively strengthen one's capacity and the fixed time allocated to complete a programme. This was exacerbated by the fact that not all fellows progressed at the same speed (see illustrative quote further below). These tensions between programme performance and individual capacity strengthening emerged during panel assessment meetings where fellows were assessed against baseline plans, especially in those cases where a fellow was underperforming. In theory, a fellow could be removed from the programme if they failed to perform as expected, yet discussions between panel members when making such assessments were rarely conclusive as individual panel members had different perceptions of performance and different priorities depending on their own role and responsibilities within the programme. Ultimately, no postdoctoral researchers were excluded from the fellowship.

If you take the [postdoctoral fellows] noted by PIIVeC monitoring board, you will even see that at [partner institution] they do not rate scholarship holders in

the same way. They [PIIVeC monitoring board] think there's one that's a lot more ahead [compared to another fellow at the same partner institution]. I'm in-house, when I look at both they're all on the same level except they're not organized the same way (Advisor, Southern)

Advisors were asked to support their respective fellows over at least a 3-year period, often on a voluntary basis. While not the primary recipient of the partnership, their contribution was critical to the successful completion of fellows' research projects. Advisors were career researchers, with their own interests, aspirations and role expectations to satisfy. Given this reality, the reward for the effort and time invested in their role was unclear for some, as the following quote illustrates:

Because if I'm going to spend time writing...supporting someone, I need papers out of it for my career and that's not necessarily well-aligned with supporting someone to make mistakes. (Advisor, Northern)

Flexibility needed in provision of ECR support

PIIVeC fellows were provided multiple supports which were unanimously valued, but in some cases this support was undermined by limited flexibility in its provision. For example, advisors were assigned to fellows from the onset of the programme, primarily based on expertise and experience in the field of interest of each fellow. While subject expertise is critical to meaningful support, interpersonal skills play an important role in an advisor/advisee relationship. 'Getting along' is key for a smooth and fruitful relationship over a 4-year period, and this cannot necessarily be predicted at programme outset. Some fellows did not develop a strong relationship with their advisors in part because of interpersonal skills and the programme structure did not include the possibility of advisor reallocation. The failure in these cases to facilitate a strong advisor/fellow bond limited the opportunity to create and maintain mentoring or collaboration relationships across the programme and beyond.

I don't want to say it feels forced but yes, I think the flexibility of having those individual relationships is something that's more attractive for me (Advisor, Northern)

In a further example, PIIVeC had employed a range of experts in specific methodologies (eg, data management, GIS, statistics and ethnography)—in part—to ensure fellows had ready access to support in these areas when needed. Findings suggest that investing in these fixed-term positions from the outset was valued over time; however, fellows did not necessarily engage with these subject experts as much as anticipated and often required support in alternative subject areas that were not so readily accessible. Thus, investing in fixed-term subject expertise ensured ready access, but did not necessarily best meet fellows needs. A more flexible approach outside of fixed-term employment (eg, funds to support brief consultancies) may have worked better in this case.

We had this vision that there was going to be this cohort of specialists who had generalist knowledge about components, which we thought would be useful to multiple [post-doctoral] projects. Then we had [the African postdoctoral fellows], which we thought would draw on the expertise. I feel like those two groups of individuals were often not satisfied with the level of interaction that they were having amongst each other. (Advisor, Northern)

Ensure equity of opportunity and reward engagement

The fellowship structure ensured that equal support was offered to all PIIVeC postdoctoral researchers irrespective of their location or research area. Regardless of their level of engagement (active or passive), every fellow benefited from the scheme by accessing equally proportioned research funding, a wide network, training and support opportunities. However, fellows who demonstrated self-initiative, proactiveness and who engaged more fully with the opportunities provided generally performed better (illustrative quote below). The more actively engaged a fellow was, the more benefit he/she could get, maximising the experiential learning opportunities offered by the programme. By engaging meaningfully and proactively, fellows were in a better position to strengthen their capacity and attain PIIVeC objectives.

Some people have really excelled, some people have done middle, and some people have done poorly. Or not done poorly but not got as much out of it as some of the others. Which makes sense because we've had more people so I would expect a wider distribution. So, I don't know if I had really thought through my expectations. I suppose they [fellows who performed less well] haven't accessed the core support as much as we thought they might've done. (Advisor, Northern)

However, as evidenced by the conflict-of-interest findings above, not all fellows necessarily have the same opportunity to engage in a capacity strengthening programme to the same extent as others. Thus, better engagement may not always be indicative of greater motivation and additional supports may need to be provided to some fellows to ensure they can equitably engage in the opportunities provided. Assuming such support is available, then the notion of rewarding and/or incentivising engagement in programmes such as PIIVeC could potentially further accelerate the capacity-development and career-development process given the benefit accrued from doing so.

DISCUSSION

Drawing on the experiences of diverse actors involved in a VBD research capacity strengthening partnership, our study findings revealed a variety of programme factors that either supported or hindered African postdoctoral researcher capacity development conducted within a learn-by-doing context. Most supportive factors were structural in nature, the remaining were attitudinal, and all were non-VBD specific. The latter is a significant

finding in its own right as it highlights the potential non-specificity of the capacity strengthening process across scientific disciplines. Many of the supportive factors may also be replicable by other programmes supporting postdoctoral researcher capacity development at low or no cost. For example, the use of a cohort approach, affording postdoctoral fellows research autonomy and varied responsibilities, ensuring their research aligned with national priorities, the accessible nature of the awards to Africa-based postdoctoral fellows and the prevailing capacity strengthening ethos. Other supportive factors such as the efficient programme management support, numerous networking opportunities, the provision of bespoke professional development support and ready access to experts in different fields and institutional supports (across the partnership) were well resourced in the PIIVeC programme which undoubtedly increased their appeal and effectiveness. Nevertheless, many of these features could be implemented elsewhere at lower cost by drawing on local or online networks and resources^{22 23} and/or by drawing on established collegial support. Thus, our study findings seemingly highlight a wide range of factors supportive of postdoctoral researcher development that could be readily adopted by African research capacity strengthening programmes employing learn-by-doing approaches irrespective of their research focus and/or available resources.

Most of the hindering factors reflected operational challenges of which some were generic (such as the challenge in ensuring effective communication across diverse language groups) and others specific to programme features. Examples of the latter included achieving an appropriate balance between affording research autonomy and providing support, maintaining functional fellow/advisor relationships and the timing of training provision. While problematic, these types of operational challenge appear resolvable if monitored and responded to as required and if considered more carefully at the time of project design. Three other hindering factors were contextual in nature and, as such, may be less amenable to easy resolution. Two of these pertained to workload and work environment challenges common to conducting research in resource constrained environments^{24 25} and the third to the disruptive impact of the global COVID-19 pandemic. The final hindering factor, fellowship duration, was structural in nature although at the level of the funder (who stipulated programme length) as opposed to PIIVeC-specific programme design. Overall, then, our findings would suggest that not only are many of the supportive factors identified in our study readily replicable, but many of the hindering factors may be relatively easily addressed.

Our study further sought to elicit key lessons that may inform future postdoctoral researcher capacity strengthening initiatives both within and beyond the VBD field. These lessons were considered ‘overarching’ in that they pertained to the experience of implementing the PIIVeC postdoctoral researcher development programme as

a whole rather than any one specific feature of the programme. Recommendations that might follow from these four lessons, drafted primarily for teams seeking to support researcher capacity strengthening via learn-by-doing approaches within international research partnerships, include: (1) provide a diverse mix of work and training activities to postdoctoral fellows, inclusive of activities that may not lend themselves to immediate application. Resources such as the vitae researcher development framework may guide programme planning in this regard²⁶; (2) clarify expectations of all individuals and organisations providing support to postdoctoral fellows within the context of a capacity strengthening partnership, identify and seek to resolve potential conflicts of interest and ensure all contributing partners are appropriately rewarded or acknowledged; (3) afford some degree of flexibility in programme structure and delivery, informed by robust monitoring, evaluation and learning processes that allow reflective and timely decision-making and (4) account for equity issues when allocating resources to individual postdoctoral fellows (or their supporting organisations) as opposed to ‘one-size-fits-all’ approaches. If equity issues are addressed, then consider rewarding or incentivising greater programme engagement. All four of these recommendations fall within the remit of programme management. A previous study found that management strategies adopted within research capacity strengthening consortia impact the capacity gains of partners,²⁷ which appears to be reaffirmed here. Yet directors of research capacity strengthening consortia are often not trained in programme management²⁸ nor is the relationship between managerial decision-making and capacity strengthening outcomes always explicitly understood.²⁹ Thus, while the key lessons reported may inform future decision-making in similar initiatives, the bigger lesson may be the centrality of considered and responsive programme management to effective researcher capacity strengthening practice within the context of partnership programmes.

Many of our findings are consistent with those reported elsewhere indicating a growing ‘weight of evidence’ for certain features to be routinely incorporated into learn-by-doing capacity strengthening programmes focused on ECRs. These include supportive factors such as the benefit of diverse networking opportunities,^{13 30 31} the benefits in taking on wide ranging (and new) tasks,³² or the peer learning and support available when working within a well-connected cohort.³³ Solutions to address hindering factors identified here have also been suggested in the wider literature, such as allowing additional time when ECRs are tasked with completing a project as a capacity strengthening activity³² or placing fellows outside of their ‘home’ institutions in order to limit the potential for existing role or organisational responsibilities to undermine participation in a capacity strengthening programme.^{18 33} This apparent convergence in many reported findings, as well as complementary findings reported elsewhere such as the influence of scientific

leadership and role-modelling as a capacity strengthening mechanism,³¹ suggest there may now be sufficient evidence across the broader literature to warrant a synthesis of common and emerging findings to inform good practice in learn-by-doing approaches to researcher capacity strengthening.

The 'structural/operational/attitudinal/contextual' categorisation reported here may serve as a useful organisational framework for any such synthesis. The convergent findings highlighted above appear primarily structural in nature, suggesting that there is considerable scope within programme design to optimise research capacity strengthening practice. The suggested synthesis would test whether this assumption is borne out and would further allow the potential relationship between organisational categories to be examined. For example, to what extent can programme structure overcome contextual constraints? Or whether operational challenges inherently increase when capacity strengthening programmes are structurally more complex? An evidence synthesis structured around this framework, inclusive of whether factors were either supportive or hindering, would also allow us to further assess the merits of a learn-by-doing approach to researcher capacity strengthening. Our findings are largely positive in this regard, with many central elements of the learn-by-doing concept, such as experiential learning, mentorship and cohort membership,¹⁷ all featuring strongly as supportive factors of the PIIVeC programme. Finally, identifying practical components of research capacity strengthening initiatives that have consistently proven useful would complement broader, conceptual frameworks for research capacity strengthening that are beginning to appear in the literature.³⁴

The study had many strengths including the longitudinal study design, the inclusion of study participants from both Anglophone and Francophone Africa and the relative independence of the research team. Study limitations were also present including the focus on a small number of African postdoctoral fellows (N=10) employed on a single research capacity strengthening programme. In addition, the postdoctoral fellows were based at only four research institutions across Africa, all of which have well established VBD research programmes. These considerations combined with the qualitative nature of the study design suggest care should be taken not to over generalise the study findings when considered in isolation. Study participants may also have been reluctant to express criticism of the PIIVeC programme given most were employed, in full or part, therein.

In conclusion, our study highlights a wide range of factors that may be readily incorporated into ECR capacity strengthening initiatives based on a learn-by-doing approach. Many of these factors are supported by a growing weight of evidence and would be appropriate to research capacity strengthening programmes both within and outside of a VBD-context. While a relatively understudied research area, there may now be sufficient evidence pertaining to good practice in learn-by-doing

research capacity strengthening approaches to warrant a structured review of the published literature. Any such review could provide a basis for evidence informed, good practice guidance in funding, designing and delivering learn-by-doing based research capacity strengthening initiatives.

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ORCID iDs

Jessica Amegee Quach <http://orcid.org/0000-0002-9535-1342>
Justin Pulford <http://orcid.org/0000-0003-4756-8480>

REFERENCES

- 1 World Health Organisation. *Global vector control response 2017-2030*. Geneva: WHO, 2017.
- 2 Diseases GBD, Injuries C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020;396:1204-22.
- 3 UNESCO. *UNESCO science report: the race against time for smarter development*. Paris: UNESCO Publishing, 2021.
- 4 Ralaidovy AH, Adam T, Boucher P. Resource allocation for BIOMEDICAL research: analysis of investments by major funders. *Health Res Policy Syst* 2020;18:20.

- 5 Kirigia JM, Ota MO, Senkubuge F, *et al.* Developing the African national health research systems barometer. *Health Res Policy Syst* 2016;14:53.
- 6 Haellewaters D, Hofmann TA, Romero-Olivares AL. Ten simple rules for global North researchers to stop perpetuating helicopter research in the global South. *PLoS Comput Biol* 2021;17:e1009277.
- 7 Boum li Y, Burns BF, Siedner M, *et al.* Advancing equitable global health research partnerships in Africa. *BMJ Glob Health* 2018;3:e000868.
- 8 Noxolo P. Decolonial theory in a time of the re-colonisation of UK research. *Trans Inst Br Geogr* 2017;42:342–4.
- 9 Hasnida A, Borst RA, Johnson AM, *et al.* Making health systems research work: time to shift funding to locally-led research in the South. *Lancet Glob Health* 2017;5:e22–4.
- 10 Lansang MA, Dennis R. Building capacity in health research in the developing world. *Bull World Health Organ* 2004;82:764–70.
- 11 Dean L, Gregorius S, Bates I, *et al.* Advancing the science of health research capacity strengthening in low-income and middle-income countries: a scoping review of the published literature, 2000–2016. *BMJ Open* 2017;7:e018718.
- 12 Franzen SRP, Chandler C, Lang T. Health research capacity development in low and middle income countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature. *BMJ Open* 2017;7:e012332e012332.
- 13 Burgess HE, Chataway J. The importance of mentorship and collaboration for scientific capacity-building and capacity-sharing: perspectives of African scientists. *F1000Res* 2021;10:164.
- 14 Franzen SRP, Chandler C, Siribaddana S, *et al.* Strategies for developing sustainable health research capacity in low and middle income countries: a prospective, qualitative study investigating the barriers and enablers to locally led clinical Trila conduct in Ethiopia, Cameroon and Sri Lanka. *BMJ Open* 2017;7:e017246.
- 15 UKCDR. *UK funding landscape for research capacity strengthening in low- and middle-income countries: briefing paper, October 2021.* London: UK Collaborative on Development Research, 2021.
- 16 Reese HW. The learning-by-doing principle. *Behavioral Development Bulletin* 2011;17:1–19.
- 17 Barab SA, Hay KE. Doing science at the elbows of experts: issues related to the science apprenticeship camp. *J Res Sci Teach* 2001;38:70–102.
- 18 Ogega OM, Lakey G, Opisa R, *et al.* Strengthening climate research capacity in Africa: lessons from the 'climate impact research capacity leadership enhancement' project. *Reg Environ Change* 2022;22:135.
- 19 Atkins S, Marsden S, Diwan V, *et al.* North-South collaboration and capacity development in global health research in low- and middle-income countries - the ARCADE projects. *Glob Health Action* 2016;9:30524.
- 20 Nyirenda T, Bockarie M, Machingaidze S, *et al.* Strengthening capacity for clinical research in sub-Saharan Africa: partnerships and networks. *Int J Infect Dis* 2021;110:54–61.
- 21 Thomas DR. A general Inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation* 2006;27:237–46.
- 22 Virtual research library. Available: <https://imicresearch.org/>
- 23 Authoraid. Available: <https://www.authoraid.info/en/>
- 24 Pulford J, Crossman S, Begg S, *et al.* Strengthening research management and support services in sub-Saharan African universities and research institutions. *AAS Open Res* 2020;3:31.
- 25 Kebede D, Zielinski C, Mbondji PE, *et al.* Institutional facilities in national health research systems in sub-Saharan African countries: results of a questionnaire-based survey. *J R Soc Med* 2014;107:96–104.
- 26 Vitae. About the Vitae researcher development framework. Available: <https://www.vitae.ac.uk/researchers-professional-development/about-the-vitae-researcher-development-framework>
- 27 Tagoe N, Pulford J, Kinyanjui S, *et al.* A framework for managing health research capacity strengthening consortia: addressing tensions and enhancing capacity outcomes. *BMJ Glob Health* 2022;7:e009472.
- 28 Tagoe N, Molyneux S, Pulford J, *et al.* Consortium management structures, processes, and approaches: the DELTAS Africa example. *Wellcome Open Res* 2022;7:139.
- 29 Tagoe N, Molyneux S, Pulford J, *et al.* Managing health research capacity strengthening consortia: a systematised review of the published literature. *BMJ Glob Health* 2019;4:e001318.
- 30 Mtwisha L, Jackson J, Mitchel A, *et al.* Early- and mid-career transitions to research leadership in Africa. *Wellcome Open Res* 2021;6:74.
- 31 Aiyenigba A, Abomo P, Wiltgen Georgi N, *et al.* Enabling research capacity strengthening within a consortium context: a qualitative study. *BMJ Glob Health* 2022;7:e008763.
- 32 Mwangi L, Mutengu L, Gitau E, *et al.* "Strengthening capacity for community and public engagement (CPE): a mixed-methods evaluation of the 'DELTAS Africa CPE seed Fund' pilot". *Wellcome Open Res* 2022;7:96.
- 33 Adedokun B, Nyasulu P, Maseko F, *et al.* Sharing perspectives and experiences of doctoral fellows in the first cohort of consortium for advanced research training in Africa: 2011–2014. *Glob Health Action* 2014;7:25127.
- 34 Mirzoev T, Topp SM, Affi RA, *et al.* Conceptual framework for systemic capacity strengthening for health policy and systems research. *BMJ Glob Health* 2022;7:e009764.