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Pushing the Boundaries for Evidenced-Based Practice: Can Online Training Enhance Andrology Research Capacity Worldwide? An Exploration of the Barriers and Enablers - The Global Andrology Forum

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Purpose: This is the first study to design and assess a research capacity building (RCB) specifically tailored for clinical and non-clinical andrology practitioners worldwide. We appraised: 1) the barriers and enablers to research among these practitioners; 2) attendees' satisfaction with the webinar; and 3) research knowledge acquisition as a result of the webinar (before/after quiz).

Materials and Methods: A online RCB webinar was designed, comprising two presentations in research design and systematic review/meta-analysis (SR/MA). An online survey using validated published questionnaires assessed the three above-stated objectives. Paired t-test compared the means of the pre- and post-webinar scores. Subgroup analysis was performed on the participants' professional background, sex, and number of years in practice.

Results: A total of 237 participants attended the webinar, of which 184 completed the survey and are included in the current analysis. Male participants were about double the females and 60.9% were from Asian countries. The most common research enablers were to publish scientific papers (14.8%) and to develop research (14.7%) or new skills (12.7%). The most common barriers were the lack of training in research (12.4%), training in research software (11.8%), and time for research (11.8%). Satisfaction with the webinar was considerably high (86.3%–88.4%) for the different features of the webinar. Compared to the pre-webinar knowledge level, there were significant improvements in participants' research knowledge acquisition after the webinar in terms of the total score for the quiz (13.7±4.31 *vs.* 21.5±4.7), as well as the scores for the study design (7.12±2.37 *vs.* 11.5±2.69) and SR/MA sessions (6.63±2.63 *vs.* 9.93±2.49) ($p<0.001$ for each).

Conclusions: Clinical and non-clinical andrology webinar attendees recognized the importance of research and exhibited a range of research skills, knowledge and experience. There were significant improvements in the participants' knowledge and understanding of the components of scientific research. We propose an RCB model that can be implemented and further modeled by organizations with similar academic research goals.

Keywords: Andrology; Capacity building; Research activities; Scholarly publishing; Surveys and questionnaires; Workforce

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INTRODUCTION

Research capacity building (RCB) within the healthcare professions is a challenge globally [1]. For decades, there have been calls for the importance of developing clinician-academics to play critical roles in clinical research and translational medicine. Building sustainable capacity to generate research is critical for developing research excellence and improving health outcomes [2]. High-quality evidence is essential for planning, decision-making, policy and practice [3,4]. Hence, the research literacy of healthcare professionals (HCP) needs to be enhanced in order to bridge the gap between evidence and practice.

RCB aims "to augment the ability to carry out research or achieve objectives in the field of research over the long term, with aspects of social change as an ultimate outcome" [5]. It is a "process of individual and institutional development which leads to higher levels of skills and greater ability to perform useful research" [6], whereby individuals and organizations build a better ability to undertake research [7].

Building capacity to undertake health research is a priority [8-10]. HCP do not lack the desire to conduct research, however, there are difficulties and barriers to overcome if ambitions are to be achieved [11,12]. Thus, despite the numerous benefits of research to patients, professionals, and organizations, <0.1% of the allied health professions are engaged in clinical academic roles [13].

Online delivery of RCB sessions has been recognized. In the USA, a research curriculum delivered online for undergraduate medical students provided evidence of the usefulness of online delivery in increasing research literacy and stimulating interest and motivation for future engagement in research [14]. Similarly, an innovative online student-centered mentorship program for andrology research was effective in achieving its goals of improving scientific writing [15]. Likewise in Canada, online delivery of research skills for faculty development provided opportunities for physicians to attend learning sessions and network with experts while remaining in their communities [16].

Notwithstanding, the literature reveals gaps in what is already known. First, a body of literature assessed online RCB models for biomedical undergraduates, graduate students, residents, rural physicians, and health professionals [17-19]. However, there are very sparse examples of RCB delivered online that are specifically tailored for physicians and allied practitioners working in the field of andrology. An example not specific to andrology but for the related field of sexual/reproductive health services from a public health perspective, is a blended learning course to strengthen HCP capacity in research methods [20]. Secondly, most online RCB programs are intended for participants within a country *e.g.*, USA or Canada [14,21,22]. Many fewer examples exist of RCB online delivery models aimed at regional audiences. An online blended skills capacity building was conducted for health care services and research *via* a consortium for capacity building in sickle disease management/research in sub-Saharan Africa [23]. Similarly, virtual interactive training sessions were undertaken for improving the capacity for implementation and dissemination of research in the Eastern Mediterranean region [24]. To the best of our knowledge, we are not aware of RCB online delivery models intended for a global audience.

Given these knowledge gaps, the present study aimed to assess the impact of an RCB webinar tailored for andrologists worldwide and delivered online. The specific objectives were to: 1) appraise the attainment of research knowledge pertaining to study design and systematic reviews/meta-analysis; 2) assess attendees' satisfaction with the webinar; and 3) explore the barriers and enablers to RCB among this group of practitioners.

MATERIALS AND METHODS

1. Setting: Global Andrology Forum

Global Andrology Forum (GAF) is an international online working collaborative for andrological research since December 2020. Its vision is to build a global partnership of clinicians and researchers to stimulate scientific distinction in andrology. The forum brings together senior and junior clinicians and researchers from across the world to promote high-quality andrology research. GAF includes 550 members from 77 countries comprising andrologists, urologists, uro-andrologists, gynecologists, embryologists, reproductive endocrinologists, and biomedical researchers with high dedication and commitment. GAF's website (https://www.globalandrologyforum.com) harbors information on andrology topics, collections of previous educational events, publications, as well as topical ideas, novel find-

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ings, and clinical questions.

GAF's vision/mission statements, management team, evolution and development, as well as a full description of its activities in terms of educational webinars, hybrid scientific meetings, online research projects, online global surveys, and scientific publications have been detailed elsewhere [25]. In summary, the aim is to promote a culture where research is the norm, rather than the exception; and to identify existing pockets of andrology research expertise globally that can constitute a base for future capacity development efforts.

2. Event: research skills webinar - basic tools for research

The webinar described in this paper was designed as an online RCB in research design and systematic review/meta-analysis. It comprised two presentations (60 minutes each) carefully developed for GAF's specific audience. The GAF team undertook external and internal consultations with educational design and subject-matter experts. The webinar utilized synchronous (instructor-led) content and was delivered by two experienced urology and andrology professors. Participant interaction and engagement were maintained by real-time question and answer sessions for each of the presentations.

Table 1 depicts the content of each of the two presentations. It aimed at enhancing knowledge, defined as "participants' textbook understanding of research concepts and their ability to recall the information" [26]. A "Certificate of Attendance" was given to all attendees upon completion of the pre- and post-webinar multiple choice questions (MCQ) quiz, and a "Certificate of Research Training" was provided to those who completed the MCQ pre-test and then scored >75% correct answers in the post-webinar MCQ quiz.

Table 1. Scientific content of the webinar's sessions

Session	Content/goals
Research design	To recognize: - Different types of observational and interventional medical studies - System of grading of different study designs based on the Oxford classification of evidence-based medicine - Appropriately choose the study design suitable for the research question - Practically apply the results of different study designs in clinical practice
SR/MA	To identify: - What a SR is - What a MA is - Impact of SR/MA in the scientific literature - How to conduct SR/MA according to the PRISMA checklist

SR: systematic review, MA: meta-analysis, PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses.

3. Ethics, study design, sample, and procedures

The current study was approved by GAF's internal review board (IR-02-23-101). The current study comprised an online before-after cross-sectional survey conducted during the months of January–February 2023 to assess the study objectives. Several e-mails and WhatsApp announcements of this free webinar and its goals were sent to all GAF members (n=550), of which 237 members expressed a desire to attend the webinar and registered for it. All registered attendees received e-mails with detailed information about the webinar, as well as the background and objectives of the current study, time required to complete the questionnaire (~20–30 minutes), the voluntary nature of participation, anonymity, and privacy of data. Participants were informed that by completing the online survey, they consent to partake in the study. We employed the Google Forms software as the platform for the survey. The questionnaire was provided in English language as it is GAF's official language, and all members are fluent in English. Code numbers ensured that attendees could participate only once in the study. To maximize participation, several e-mail reminders were sent to the registered participants. The present analyses included the responses of 184 attendees.

4. Data collection: questionnaire

A range of general demographic and professional data was collected including age, sex, country, professional background, healthcare practice setting, years in practice, reason(s) for wishing to attend the webinar, any prior formal research training, any prior research experience, and level of satisfaction with previous research experiences. Three related questionnaires were employed in this study (Supplement File 1).

1) Enablers and barriers survey

In order to understand how andrology researchers perceive the enablers and barriers to RCB, the current

study drew on validated published tools that examined, in the context of HCPs or health students, the enablers that empower and inspire individuals to become research active; or alternatively, the barriers and impediments that hinder such development. Hence, the questionnaire items we employed were adopted from published studies that addressed *e.g.*, the enablers and barriers to developing a clinical academic career [27]; the motivators, enablers, and barriers to building allied health research capacity [11]; the exploration of barriers and enablers to gaining of knowledge and skills whilst critically appraising research papers [28]; and, the barriers, enablers, and motivations for participation in research [29].

Collectively, the enabler items tapped information on how participants viewed a range of issues as empowering to be research active. Sample items included *e.g.*, 'to develop research skills', 'to develop new skills', 'career advancement', 'research written into role description', 'research encouraged by managers', 'colleagues doing research', 'links to universities', 'forms part of postgraduate study', 'study or research scholarships', 'to be awarded research funds and grants', 'problem identified that needs changing', 'desire to prove a theory or hunch', 'to publish scientific papers', and 'to increase my h-index'. Respondents could tick as many items as applied to them (Supplement File 1).

Likewise, taken together, the barrier items drew information on how participants viewed a range of intrinsic and extrinsic issues as impediments to being research active. Sample items included *e.g.*, 'not interested in research', 'do not appreciate the role of research', 'other work roles take priority', 'lack of time for research', 'other personal commitments', 'lack of skills for research', 'lack of training on software for research', 'lack of training in research', 'lack of a coordinated approach to research', 'lack of library/internet access', 'intimidated by research language', 'intimidated by fear of getting it wrong', 'lack of administrative support', and 'lack of funds for research'. Respondents could tick as many items as applied to them (Supplement File 1).

2) Satisfaction survey

Attendees were asked to rate their satisfaction with the webinar using a 6-point Likert scale response format (0=least favorable response, 5=most favorable response). The items were adopted from the Workshop Survey Template which offers a template of 10 customizable questions which can be asked to the attendees after or before conducting a workshop [30].

Sample items included: "Considering your complete experience at our webinar, how likely would you recommend us to a friend or colleague?" (0=very unlikely, 5=very likely). Attendees also rated the speakers that delivered the webinar in terms of their presentations' overall content, identified topics, duration of the session, topic coverage and relevance, as well as their level of preparedness. Furthermore, respondents rated the webinar's content in terms of the overall topic, whether the webinar's objective was well-defined, and the quality of the content (0=lowest response, 5=highest response) (Supplement File 2).

3) Research knowledge survey: pre-post webinar quiz

The pre- and post-webinar quiz measured participants' research knowledge. Attendees responded to questions on the specific scientific content of the webinar in MCQ and True/False response formats. These items included 14 questions in the first session (study design), and 13 in the second session (systematic reviews/meta-analysis) formulated by the two professors that delivered the sessions. The items are detailed in Supplement File 3. Participants completed these quiz questions twice: before the webinar (pre-test) and then again after the delivery of the two webinar sessions (post-test).

5. Statistical analysis

Data are described as mean±standard deviation. for continuous variables and percentages in each category for nominal variables. Comparisons of means for pre- and post-test scores were done using paired t-test, and a two-way repeated measure ANOVA with pairwise comparisons was performed to detect overall interaction between subgroups. Subgroup analysis was undertaken by participants' professional background (clinical *vs.* non-clinical), sex, or number of years in practice. The Holm method adjusted the p-values for multiple comparisons. Statistical analysis was undertaken using R Programming Environment (v 4.1.2), with p-values <0.05 considered statistically significant.

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RESULTS

1. Sample characteristics

A total of 237 GAF members registered for the webinar, of which 184 completed the pre-test survey (pre-test 77.6% response rate) and 174 completed the post-test survey (post-test 73.4% response rate). Participants represented 46 countries across five continents.

Table 2 shows that the most common age group was 30–39 years old. The number of males was nearly double that of females, and a large proportion of participants (60.9%) were from Asian countries.

The three most common professional backgrounds of attendees were urologists (28.3%), embryologist/laboratory andrologist (20.1%), clinical andrologists and researchers (each 17.4%) together comprising the majority of the sample (83.2%) (Table 3). Most participants practiced in public settings (64.7%), and slightly more than half reported >5 years of experience (59.2%). Roughly more than half (56.4%) of the participants had prior research training, the majority (84.8%) reported some previous research experience, and about half (56.5%) reported positive satisfaction with previous research experiences.

2. Enablers and barriers to research

Table 4 shows that in terms of enablers, across the sample, respondents felt that the most common three enablers were to publish scientific papers (14.8%) and to develop research (14.7%) or new skills (12.7%). The individual enablers did not differ by participants' professional background, sex, or number of years in practice. However, the total number of enablers was significantly associated with the number of years in practice, where those with more years in practice reported significantly fewer enablers.

As for the barriers to research, the most common three were the lack of training in research (12.4%) or training in research software (11.8%), and lack of time for research (11.8%). The individual barriers did not differ by participants' professional background or sex. However, some individual barriers were significantly related to the number of years in practice, where attendees with more years in practice viewed the lack of

Table 2. Demographic characteristics of the sample

Characteristic	n (%)
Age (y)	
20–29	24 (13.0)
30–39	88 (47.8)
40–49	56 (30.4)
50–59	10 (5.4)
60–69	3 (1.6)
>70	3 (1.6)
Sex	
Male	126 (68.5)
Female	58 (31.5)

Table 3. Professional characteristics of the sample

Characteristic	n (%)
Professional background	
Urologist	52 (28.3)
Embryologist/laboratory andrologist	37 (20.1)
Clinical andrologist	32 (17.4)
Researcher	32 (17.4)
Gynecologist	18 (9.8)
General practitioner/primary care	5 (2.7)
Student	3 (1.6)
Academic	2 (1.1)
Endocrinologist	1 (0.5)
Nutritionist	1 (0.5)
Otorhinolaryngologist	1 (0.5)
Clinical	97 (52.7)
Non-clinical	87 (47.3)
Health care practice setting	
Public	119 (64.7)
Private	65 (35.3)
Years in practice (y)	
>5	109 (59.2)
≤5	75 (40.8)
Reason(s) for attending the webinar	
Interesting topics	171 (55.3)
Required for current job	61 (19.7)
Required for future job application	58 (18.8)
Other	19 (6.1)
Prior formal research training	
Yes	97 (56.4)
No	75 (43.6)
Previous research experience	
Yes	156 (84.8)
No	28 (15.2)
Satisfaction with previous research experiences	
Positive	104 (56.5)
Neutral	64 (34.8)
Negative	7 (3.8)
Not applicable	9 (4.9)

Table 4. Enablers and barriers to research

Characteristic	Total sample (n=184)	Professional background			Sex			Years in practice		
		Clinical (n=97)	Non-clinical (n=87)	p-value	Male (n=126)	Female (n=58)	p-value	≤5 (n=75)	>5 (n=109)	p-value
Enablers				0.5			0.9			0.3
Career advancement	115 (11.8)	58 (11.2)	57 (12.4)		70 (10.9)	45 (13.6)		51 (11.7)	64 (11.9)	
Colleagues doing research	31 (3.18)	19 (3.68)	12 (2.62)		23 (3.58)	8 (2.41)		15 (3.45)	16 (2.96)	
Desire to prove a theory or hunch	44 (4.51)	24 (4.64)	20 (4.37)		28 (4.35)	16 (4.82)		17 (3.91)	27 (5)	
Forms part of postgraduate study	32 (3.28)	23 (4.45)	9 (1.97)		20 (3.11)	12 (3.61)		20 (4.6)	12 (2.22)	
Am faced with problem that needs research to change	31 (3.18)	17 (3.29)	14 (3.06)		23 (3.58)	8 (2.41)		12 (2.76)	19 (3.52)	
Links to universities	57 (5.85)	30 (5.8)	27 (5.9)		41 (6.38)	16 (4.82)		30 (6.9)	27 (5)	
Research encouraged by managers	26 (2.67)	16 (3.09)	10 (2.18)		16 (2.49)	10 (3.01)		13 (2.99)	13 (2.41)	
Research written into role description	42 (4.31)	26 (5.03)	16 (3.49)		29 (4.51)	13 (3.92)		17 (3.91)	25 (4.63)	
Study or research scholarships	50 (5.13)	25 (4.84)	25 (5.46)		35 (5.44)	15 (4.52)		30 (6.9)	20 (3.7)	
To be able to apply for research funds and grants	63 (6.46)	26 (5.03)	37 (8.08)		37 (5.75)	26 (7.83)		28 (6.44)	35 (6.48)	
To develop new skills	124 (12.7)	61 (11.8)	63 (13.8)		77 (12)	47 (14.2)		58 (13.3)	66 (12.2)	
To develop research skills	143 (14.7)	77 (14.9)	66 (14.4)		98 (15.2)	45 (13.6)		61 (14)	82 (15.2)	
To increase my h-index	70 (7.18)	38 (7.35)	32 (6.99)		48 (7.47)	22 (6.63)		26 (5.98)	44 (8.15)	
To publish scientific papers	144 (14.8)	76 (14.7)	68 (14.8)		96 (14.9)	48 (14.5)		56 (12.9)	88 (16.3)	
Others	3 (0.31)	1 (0.19)	2 (0.44)		2 (0.31)	1 (0.3)		1 (0.23)	2 (0.37)	
Total number of enablers	5.9±2.71	5.33±2.97	5.26±2.51	0.9	5.12±2.74	5.72±2.78	0.2	5.8±2.89	4.95±2.62	0.04*
Range of enablers				0.3			0.2			0.04*
<3	53 (28.8)	32 (33)	21 (24.1)		41 (32.5)	12 (20.7)		14 (18.7)	39 (35.8)	
4–6	86 (46.7)	41 (42.3)	45 (51.7)		55 (43.7)	31 (53.4)		41 (54.7)	45 (41.3)	
>6	45 (24.5)	24 (24.7)	21 (24.1)		30 (23.8)	15 (25.9)		20 (26.7)	25 (22.9)	

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Table 4. Continued

Characteristic	Total sample (n=184)	Professional background			Sex			Years in practice		
		Clinical (n=97)	Non-clinical (n=87)	p-value	Male (n=126)	Female (n=58)	p-value	≤5 (n=75)	>5 (n=109)	p-value
Barriers				0.8			0.2			0.005*
Don't appreciate the role of research	3 (0.43)	2 (0.53)	1 (0.3)		3 (0.63)	0 (0)		2 (0.63)	1 (0.26)	
Intimidated by fear of getting it wrong	23 (3.27)	13 (3.48)	10 (3.04)		15 (3.16)	8 (3.51)		12 (3.79)	11 (2.85)	
Intimidated by research language	14 (1.99)	8 (2.14)	6 (1.82)		8 (1.68)	6 (2.63)		8 (2.52)	6 (1.55)	
Lack of a coordinated approach to research	60 (8.53)	32 (8.56)	28 (8.51)		39 (8.21)	21 (9.21)		32 (10.1)	28 (7.25)	
Lack of administrative support	59 (8.39)	30 (8.02)	29 (8.81)		35 (7.37)	24 (10.5)		28 (8.83)	31 (8.03)	
Lack of funds for research	101 (14.4)	47 (12.6)	54 (16.4)		66 (13.9)	35 (15.4)		45 (14.2)	56 (14.5)	
Lack of library/internet access	27 (3.84)	12 (3.21)	15 (4.56)		14 (2.95)	13 (5.7)		16 (5.05)	11 (2.85)	
Lack of skills for research	66 (9.39)	34 (9.09)	32 (9.73)		48 (10.1)	18 (7.89)		34 (10.7)	32 (8.29)	
Lack of time for research	83 (11.8)	50 (13.4)	33 (10)		64 (13.5)	19 (8.33)		26 (8.2)	57 (14.8)	
Lack of training in research	87 (12.4)	46 (12.3)	41 (12.5)		56 (11.8)	31 (13.6)		43 (13.6)	44 (11.4)	
Lack of training on software for research	83 (11.8)	50 (13.4)	33 (10)		60 (12.6)	23 (10.1)		42 (13.2)	41 (10.6)	
Other personal commitments	27 (3.84)	16 (4.28)	11 (3.34)		22 (4.63)	5 (2.19)		6 (1.89)	21 (5.44)	
Other work roles take priority	63 (8.96)	32 (8.56)	31 (9.42)		42 (8.84)	21 (9.21)		18 (5.68)	45 (11.7)	
Others	7 (1)	2 (0.53)	5 (1.52)		3 (0.63)	4 (1.75)		5 (1.58)	2 (0.52)	
Total number of barriers	3.82±2.05	3.86±2.03	3.78±2.09	0.8	3.77±2.05	3.93±2.06	0.6	4.23±2.16	3.54±1.93	0.03*
Range of barriers				0.6			0.4			0.1
≤3	89 (48.4)	50 (51.5)	39 (44.8)		65 (51.6)	24 (41.4)		31 (41.3)	58 (53.2)	
4–6	75 (40.8)	36 (37.1)	39 (44.8)		48 (38.1)	27 (46.6)		32 (42.7)	43 (39.4)	
>6	20 (10.9)	11 (11.3)	9 (10.3)		13 (10.3)	7 (12.1)		12 (16)	8 (7.34)	

Values are presented as number (%) or mean±standard deviation.
*Indicate statistical significance.

time for research as the most common barrier (14.8%), whereas participants with fewer years in practice felt that their lack of training in research was the most common barrier (13.6%). Likewise, the number of years in practice was significantly associated with the total number of barriers reported, where those with more years in practice reported significantly fewer barriers.

3. Satisfaction with the research skills webinar

An overwhelming 98.2% were likely to recommend GAF to a friend or colleague based on their experience at the webinar (Table 5). Likewise, satisfaction with the webinar was generally very high, ranging between 86.3%–88.4% for different individual features related to the content, aspects of the sessions or ratings of the speakers.

4. Knowledge level before and after the webinar

Table 6 shows the respondents' knowledge level before and after the webinar. Across the whole sample, there were significant improvements in the participants' research knowledge in terms of the total score for the entire webinar, as well as for the individual sessions of study design and systematic review/meta-analysis ($p<0.001$ for each).

Table 7 depicts the changes in the scores attained by the attendees in the pre- and post-quiz categorized by the webinar session and by the selected characteristics of the participants (professional background, sex, years of experience, practice setting and previous research training). As for the characteristics of the participants, research knowledge significantly improved across all the individual characteristics examined with regards to the study design (section A) and systematic review/meta-analysis (section B) sessions, as well as the total score for the entire webinar quiz (section C) ($p<0.0001$ for each). On the other hand, a few characteristics of the participants influenced knowledge acquisition. For instance, in the study design pretest, males scored significantly more than females; and participants with >5 years' experience scored higher than those with less experience. All the other participant characteristics had no effect on knowledge acquisition.

Table 5. Satisfaction with research skills webinar

Aspect	Total sample
Content of the webinar	
Overall topic	153 (88.4)
Objective of webinar was well-defined	153 (88.4)
Quality of content was excellent	153 (88.4)
Preparedness	150 (86.7)
Content was relevant to my current job profile	152 (87.9)
Rating of the speakers	
Overall content	154 (88.1)
Identified topics	153 (88.4)
Duration of the session	150 (86.3)
Topic coverage and relevance	150 (86.6)
Preparedness	151 (87.3)

Cell values represent number (%) of respondents reporting a favorable response (≥3 out of a maximum response of 5).

DISCUSSION

Research training develops confidence in knowledge translation skills [31], and when HCPs are directly involved in research, translating evidence into practice is enhanced [32,33]. RCB of the physician-scientist is crucial as these individuals can move their profession forward, given the lack of clinical investigators in practice [34,35].

However, to date, little is known about the current research culture, capacity and support for andrology teams [25]. GAF's goals and activities reinforce the development of a competent clinical and non-clinical andrology academic workforce across the globe to enhance the quality of andrology research [25]. This is timely, given that a recent report has highlighted that the reporting quality of abstracts of systematic reviews/meta-analyses in urology did not adhere to international reporting guidelines and could be improved [36]. Hence, the two webinar topics described in this paper (study design and systematic reviews/meta-analysis) were purposively selected to bridge this gap.

To the best of our knowledge, the current study is

Table 6. Comparison of participants' research knowledge level before and after the Webinar

Variable	Pre-test	Post-test	p-value
Total score	13.7±4.31	21.5±4.7	<0.001
Study design	7.12±2.37	11.5±2.69	<0.001
SR/MA	6.63±2.63	9.93±2.49	<0.001

Values are presented as mean±standard deviation.
SR: systematic review, MA: meta-analysis.
Paired t-test.

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Table 7. Changes in pre- and post-quiz by webinar session and selected participant characteristics

Knowledge domain	Knowledge level														
	Professional background			Sex			Experience (y)			Practice			Formal research training		
	Clinical (n=78)	Non-clinical (n=69)	p-value	Male (n=102)	Female (n=45)	p-value	≤5 (n=66)	>5 (n=81)	p-value	Public (n=95)	Private (n=52)	p-value	Yes (n=73)	No (n=64)	p-value
Study design[a]															
Total pre-test	7.41 (2.42)	6.78 (2.29)	0.110	7.38 (2.30)	6.51 (2.46)	0.040*	6.58 (2.28)	7.56 (2.37)	0.012*	7.26 (2.36)	6.85 (2.40)	0.310	7.37 (2.38)	7.06 (2.27)	0.443
Total post-test	11.68 (2.68)	11.35 (2.72)	0.458	11.79 (2.40)	10.91 (3.21)	0.103	11.11 (3.27)	11.86 (2.07)	0.105	11.56 (2.71)	11.46 (2.70)	0.836	11.58 (2.35)	11.56 (2.92)	0.977
p-value	<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*	
SR/MA[b]															
Total pre-test	6.96 (2.53)	6.26 (2.72)	0.107	6.80 (2.58)	6.24 (2.72)	0.236	6.62 (2.45)	6.64 (2.79)	0.962	6.65 (2.82)	6.60 (2.28)	0.895	6.96 (2.70)	6.31 (2.30)	0.136
Total post-test	10.10 (2.31)	9.72 (2.68)	0.360	10.07 (2.30)	9.60 (2.87)	0.469	9.59 (2.90)	10.20 (2.08)	0.156	9.82 (2.58)	10.12 (2.32)	0.495	10.12 (2.39)	9.84 (2.41)	0.280
p-value	<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*	
All questions[c]															
Total pre-test	14.24 (4.39)	13.04 (4.16)	0.092	14.09 (4.29)	12.76 (4.25)	0.084	13.03 (4.16)	14.21 (4.38)	0.099	13.81 (4.62)	13.44 (3.70)	0.622	14.34 (4.26)	13.20 (4.11)	0.115
Total post-test	21.79 (4.50)	21.09 (4.92)	0.364	21.87 (4.24)	20.53 (5.53)	0.153	20.73 (5.77)	22.06 (3.53)	0.103	21.39 (4.85)	21.60 (4.44)	0.800	21.70 (4.40)	21.42 (4.70)	0.722
p-value	<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*		<0.0001*	<0.0001*	

Values are presented as mean (standard deviation).
SR: systematic review, MA: meta-analysis.
[a]Comprised 14 questions, [b]comprised 13 questions, [c]comprised all 27 questions.
*Indicate statistical significance.

the first to design, deliver, and assess a RCB webinar designed for a worldwide audience of andrology practitioners. Our main findings were that the most common motivators for research were to publish scientific papers and to develop research abilities or new skills. Conversely, the most common barriers were the lack of training in research and research software, and lack of time for research. Satisfaction with the webinar was considerably high, reaching up to 88.4% of participants. There were significant improvements in participants' research knowledge acquisition as a result of the webinar.

In terms of the mode of delivery, others have identified barriers and solutions for developing and undertaking online learning programs. Lack of time was a barrier due to the increasing workloads of HCP. With the advent of online learning, time becomes available as the process is streamlined [37]. Such sentiments resonate with our findings where the online delivery positively impacted the attainment of research knowledge, and the high satisfaction that the andrology attendees reported reflects that the RCB webinar addressed their learning needs.

Early engagement with formal research training motivates individuals to conduct research [31]. A recent systematic review reported that research training was a key facilitator that expedited the research journey of HCPs [38]. Only 56.4% of our sample reported having prior formal research training, a low level that highlights the importance of undertaking our RCB webinar to improve research training.

Research experience was reported by 84.8% of our sample. In agreement, evidence suggests that strategies to enhance research capacity need to be guided by knowledge of clinicians' research capabilities [39]. Conversely, others who appraised research culture and capacity found that most HCP had not participated in research activities in the past year [39]. The current sample expressed high (88.4%) satisfaction with the webinar, supporting others where an online research training/mentoring program for early-career family physicians was feasible and acceptable [40].

The current study found significant post-webinar improvements in attendees' research knowledge, consistent with other RCB studies [41,42]. Such enhancements are imperative for HCP to participate in research, thus accruing benefits to the individual, organization, and society [2,43-45]. However, other models *e.g.*, medical education models focus on 'not just knowledge acquisition', but also on subsequent behavior change [46], and we undertook the post-test a few days after the webinar.

The present study found that the most common motivators for research were to publish scientific papers and to develop research abilities or new skills. This concurs with others, where the factors that impacted research capacity include a desire to stay at the "cutting edge" and a lack of exposure to research [11]. We also observed other intrinsic and extrinsic motivators that support other studies where HCPs testified being motivated to do research by intrinsic factors such as a strong interest in research [11]. Our participants also reported 'research was encouraged by their managers' as a motivator, in agreement with others where enablers for HCPs participating in a knowledge translation tele-mentoring program included organizational support and motivation [47]. Moreover, enablers that influenced HCP participation in research included positive beliefs about the consequences of research participation, and motivation for skill development [48], similar to our present findings. Across our sample, the individual enablers did not differ by participants' professional background, sex, or number of practice years.

On the other hand, the most common barriers to perform research in the current study were the lack of training in research and research software, and the lack of time for research. These findings support the idea that barriers to research were extrinsic *e.g.*, workload and lack of time [11]. Others noted that HCPs experienced barriers to research that included knowledge gaps and lack the skills to do research, competing time demands, as well as barriers related to environmental context and resources (*e.g.*, reduced funding), emotional responses of being overwhelmed, perceptions of reduced capability, poor visibility of research training opportunities, and lack of organizational support [11,38,47-50]. We observed similar barriers among our sample.

In connection with the demographic variables, in terms of sex, we found that our male attendees were nearly double the female attendees (Table 2), supporting the over-representation of males in the andrology field generally. However, we found no differences in the barriers to research by sex (Table 4). Others reported sex imbalances in several barriers to research participation, with more women feeling intimidated by research and reporting lower skills than men, that

might explain why proportionately fewer women were involved or interested in research [51]. We also found no differences in the barriers to research by professional background (clinical *vs.* non-clinical).

Researchers observed that women and nurses reported lower research skills than comparable groups [51], supporting our observation that females scored significantly less than males in the study design pre-test quiz which reflects a lower baseline research skills knowledge level (Table 7). This is critical, as females comprise more than three quarters of hospital staff, hence targeted efforts towards addressing barriers to female and nurse participation in research seem well justified [51].

As for the professional background, studies found that doctors and allied health professionals more frequently reported already being or willing to be involved in research compared with nurses [52,53]. Others confirmed that nurses narrated having lower research skills than respondents from other professions [51], probably because they were unlikely to have received research training during their initial clinical training. Our attendees comprised nearly equal individuals with clinical *vs.* non-clinical professional backgrounds; and professional backgrounds (clinical *vs.* non-clinical) did not influence the pre-test scores (initial knowledge) or the post-test scores (improvements in knowledge). A point to note is that GAF's non-clinical participants are not nurses, but rather, embryologists and basic scientists, whose research motivation could be different from nurses.

In terms of experience, other studies found that research involvement was significantly associated with years of professional experience [52], congruent with our finding that participants with >5 years' experience scored higher in the study design pre-test quiz than those with less experience, hence reflecting more baseline research skills knowledge. Our sample of attendees comprised more individuals with longer years in practice (>5 years).

1. Limitations and strengths of this study

This study has its limitations. Data presented here pertains to a single webinar. Although the response rate of completing the questionnaire for those who registered to attend was high (≈75%), however <50% of the total membership of GAF actually registered to attend, hence generalizability should be cautious. We are unable to compare research capacity and skills by geographical locations due to the small number of attendees from some continents. Data about the attendees' home organization research culture/support would have been beneficial to appreciate the levels of their research experience/skills but was beyond the scope of the study. The post-test was undertaken a few days after the webinar and we are unable to forecast longer-term knowledge retention, or rate of decay. The webinar was designed to enhance knowledge, and it remains to be seen if the gaining of knowledge will progress to modify participants' attitudes to research *i.e.*, ability to put research knowledge into practice [26]. Future research should address these limitations.

Nevertheless, the current study has many strengths. It is the first to assess an RCB program intentionally designed for a worldwide audience of andrology practitioners. The study had a broad scope, appraising the attainment of research skills knowledge; assessing satisfaction with the content/delivery of the webinar; as well as exploring the barriers and enablers to RCB among members of a diverse group of andrology community of practice. Methodologically, we used published and validated questionnaires; sample size was large; attendees came from 46 countries, thus providing external validity for the findings. The high response rate of the study suggests higher data quality and accuracy, and a representative sample [54]; and the high response rate to almost all the survey questions enhance the internal validity.

2. Final thoughts

The findings of the current study provide much food for thought for andrology researchers worldwide. RCB strategies should be guided by data on clinicians' research experience and interests and focused on the development of skills to generate research. Resources and funding are needed to overcome the barriers to research generation, and RCB necessitates mentorship, training and opportunities to build abilities and assimilate confidence [4,39,55-57]. GAF strives to provide such opportunities in delivering webinars such as the one described in this paper, matching up mentors with junior researchers, and a range of other activities.

A crucial purpose of RCB is to empower practitioners to become change agents in their communities by researching relevant health issues [21]. GAF continually evaluates the application and impact of this webinar

series in improving the research practices of andrologists. Strategies that enable clinicians to assist rather than direct, research training may also lessen the upskilling time requisite for such individuals to partake in research [39]. GAF also supports activities such as literature searching, gathering and reviewing and collecting data as reported by others [39]. Future studies could examine the impact of such webinar's online delivery on attendees' research involvement and expanding research practice.

CONCLUSIONS

The current webinar has proved to be effective. Satisfaction with the webinar was considerable, and there were significant improvements in the participants' research knowledge acquisition as a result of attending the webinar. For this andrology workforce worldwide, common motivators for research were to publish scientific papers and to develop research abilities or new skills; and common barriers were the lack of training in research and research software, and lack of time for research. These motivators should be more popularized and capitalized upon to entice and motivate de novo budding researchers to begin their journey, and the barriers should be continually addressed and resolved as feasible to pave and smoothen the way for andrologists who wish to either embark or progress their research voyage. Meanwhile, some at-risk groups might require focused attention *e.g.*, females and those with less years of experience. Collectively, multipronged strategies and policies to address these issues would contribute to research-competent andrology practitioners globally, that in turn, would generate more and better evidence that will push the boundaries and improve practice.

Conflict of Interest

The authors have nothing to disclose.

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Author Contribution

Conceptualization: WEA, MA. Formal analysis: AH. Methodology: WEA, MA. Project administration: AA, RS, WZ, AS, MS. Supervision: AA. Writing – original draft: WEA, MA. Writing – review & editing: all authors.

Supplementary Materials

Supplementary materials can be found *via* https://doi.org/10.5534/wjmh.230084.

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