

A scoping review of pre-hospital emergency care research in South Africa

Enrico Dippenaar^{1,2,*}, Edwin Marr¹

¹Emergency Medicine Research Group, Anglia Ruskin University, Chelmsford, United Kingdom

²Division of Emergency Medicine, University of Cape Town



ARTICLE INFORMATION

Received: 21 July 2021

Revision received: 15 September 2021

Accepted: 16 September 2021

Keywords:

Pre-hospital emergency care
Emergency Medical Services
Research



This open access article is distributed under Creative Commons licence CC-BY-NC 4.0

ISSN:2709-3786

*Corresponding author: enrico.dippenaar@aru.ac.uk, ARU Chelmsford, Bishop Hall Lane, Chelmsford, CM11SQ, United Kingdom

ABSTRACT

Background: Pre-hospital emergency care is a relatively new research area in South Africa. To date, little research has been conducted to chart the existing work undertaken in this field. A scoping review was conducted of the current research landscape, including as much material, both published papers and unpublished dissertations and theses, as possible.

Methods: Several journal databases and the South African National Electronic Theses and Dissertation Portal were searched with no date limits imposed. The search and inclusion criteria were limited to pre-hospital emergency care in South Africa. Literature was selected and screened according to the PRISMA framework and data extracted based on relevant and themed categories.

Results: The search resulted in 1076 published articles and 293 dissertations/theses. An additional 11 papers were identified and three dissertations/theses. Ultimately, 123 papers and 96 dissertations/theses were included. Eleven non-research papers were found relevant to the topic and included as additional information.

Conclusion: There has been substantial growth in pre-hospital emergency care research in South Africa since the 2010s. The published articles and dissertations/theses included in this review covered a range of topics, with relatively little overlap. Various methodologies, data collection designs and participants were used in the research process. However, there was a noticeable disparity when it came to geographical areas, with the Western Cape, Gauteng, and research taking place across South Africa featuring prominently, while other provinces were the subject of little or no research.

Dippenaar E, Marr E. A scoping review of pre-hospital emergency care research in South Africa. *South African Journal of Pre-hospital Emergency Care*. 2021; 2(2):11-23. doi:10.24213/2-2-4750

BACKGROUND

The aim of this review was to identify what existing research has been undertaken in the field of pre-hospital emergency care in South Africa. Mould-Millman et al. define out-of-hospital as 'the full spectrum of emergency care that occurs outside healthcare facilities'.¹ In terms of emergency care, this covers 'recognition of the emergency, bystander-initiated care, access to pre-hospital emergency care services, pre-hospital care deliv-

ery, emergency transportation, emergency centre care and definitive care'.¹ These classifications are useful, as similar broad definitions were relied upon for this review.

To date, the amount of research conducted within the South African pre-hospital emergency care context has been minimal. This is largely due to the youthfulness of both the research discipline and the modern pre-hospital care system

in South Africa. As MacFarlane, van Loggerenberg, and Kloek write, since the democratisation of South Africa in the 1990s, 'pre-hospital care has moved from isolated fire departments providing basic medical assistance, to a complex, sophisticated system of ground and air response covering the whole country to varying degrees'.² No review has been undertaken to fully capture the landscape of research conducted within this setting. With this in mind, a review was commissioned by the Emergency Care Society of South Africa to highlight and understand the current state of pre-hospital emergency care research across the country. By collating as much research material as possible and describing its features, a database can be compiled to aid future scholars and policymakers identify what work has been completed, where gaps exist, and what agendas should be supported within pre-hospital emergency care research in South Africa.

DESIGN AND METHODS

Study Design

A scoping review design was used to collate as much material as possible. The review was registered with the Open Science Framework (Reference: osf.io/8qpyu), and the standard Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure was followed to guide the review process. This method was used to search for and capture the broadest range of literature possible, both published papers and unpublished dissertations/theses.

Database Searches

The search was conducted in May 2021 using the databases CINAHL, Medline, Web of Science, Embase, PubMed Central, Scopus, and Science Direct to gather published research articles and abstracts. In addition, the South African National Electronic Theses and Dissertations Portal (National ETD Portal) was also searched to gather unpublished doctoral and master's projects. The search strategy was designed to be repeatable, covering all the selected databases with only minor variations to cater for individual database requirements (most notably for Science Direct, which is limited to eight Boolean operators per row, and Embase, which does not support quotation marks). The search string below describes the combination of words used that formed the backbone of the search.

TITLE (Pre-hospital OR Prehospital OR "Pre-Hospital Setting" OR "Out-of-hospital" OR OOH OR Ambulance OR Paramedic OR "Emergency Medical Technician" OR EMT OR "Emergency

Medical Service" OR EMS OR Helicopter OR HEMS OR "Emergency Health Services" OR "Emergency Medicine" OR "First Aid" OR Health OR Resuscitation OR "Urgent Care" OR "Critical Care" OR Treatment OR "Acute Care" OR "Life Support" OR Trauma OR Medical OR Transport OR Care) AND ABSTRACT ("South Africa" OR "South African" OR "Limpopo" OR "Mpumalanga" OR "Gauteng" OR "North West" OR "Free State" OR "Eastern Cape" OR "Kwazulu-Natal" OR "Northern Cape" OR "Western Cape"), AND ABSTRACT (Pre-hospital OR Prehospital OR "Pre-Hospital Setting" OR "Out-of-hospital" OR OOH OR Ambulance OR Paramedic OR "Emergency Medical Technician" OR EMT OR "Emergency Medical Service" OR EMS OR Helicopter OR HEMS OR "Emergency Health Services" OR "Emergency Medicine").

Screening

After conducting the search, results were exported from the main seven databases into a bibliographic software application (RefWorks, ProQuest LLC, USA) and an initial, automated duplicate screening was undertaken. The results were then transferred to the Rayyan platform (Rayyan, Rayyan Systems Inc., USA), where additional duplicate screening could take place. In Rayyan, the principal investigator screened the articles, focusing on titles and abstracts of relevance to the search criteria, with primary inclusion being all research conducted in the South African pre-hospital emergency care context. Papers not covering the pre-hospital setting were excluded, as well as articles that did not focus on emergency care. Articles researching exclusively outside South Africa were also excluded, although articles exploring South Africa alongside other countries were included. However, no limits on the date of publication were imposed, enabling a wider scope within this research environment. For the dissertations/theses, these results were manually copied into a spreadsheet because the National ETD Portal does not support automatic exporting. Once duplicates were identified and removed by hand, the principal investigator applied the same inclusion criteria that were used for the published research papers. Both articles and dissertations/theses underwent a second screening by the co-investigator to ensure only the relevant material was considered for final inclusion. Several non-research articles were identified through the search, and based on their relevance to South African pre-hospital emergency care, they were separated from the main inclusion but will be additionally described.

Data Extraction and Analysis

Research outputs were not screened for their quality, but presented in a manner that would depict the scope of the current research environment rather than offering evaluations; therefore, this step in the review process was omitted. Key data points were extracted from the material to describe when the research was published and the dissertations/theses conducted, where the research was located within South Africa, the most common methods and data collection designs, the

main participants, and the main topics covered. These parameters were extracted into a spreadsheet (click here to download, also linked from the article website page) by the principal investigator and checked for consistency and completeness by the co-investigator. The range of research topics was vast and, using a thematic method, topics were categorised under the headings of Call Centre Operations, Education, Epidemiology, Experience/Perspectives/Understanding, Intervention, Clinical Knowledge/Skill, Personnel, Response/Transport, and System.

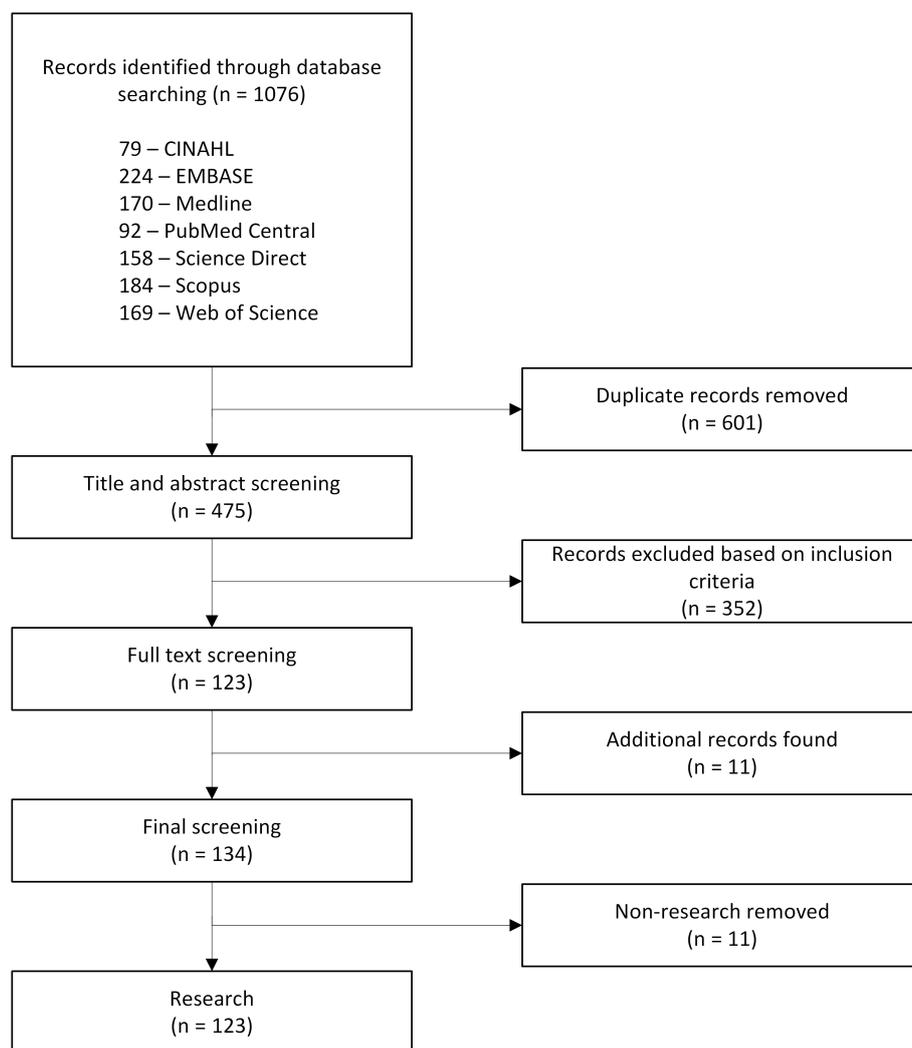


Figure 1: PRISMA Flow Diagram for Database Search and Article Screening

RESULTS

In total, 1076 articles and abstracts were found by searching databases (Figure 1). Of these, 601 duplicates were removed (n = 475). A further 352 papers were removed by the inclusion criteria (n = 123). An additional 11 records were then identified and added through a combination of specialist and personal knowledge. This left a total of 134 articles

and abstracts. Of this number, 11 were identified as non-research and 123 as research. For the dissertations/theses, 293 records were found through the NTD Portal (Figure 2). Of these, 43 were identified as duplicates and subsequently removed (n = 250). A further 157 dissertations were removed based on the inclusion criteria (n = 93). To this number, three additional academic research projects were

added through the same combination of specialist and personal knowledge, resulting in a total of 96 dissertations/theses.

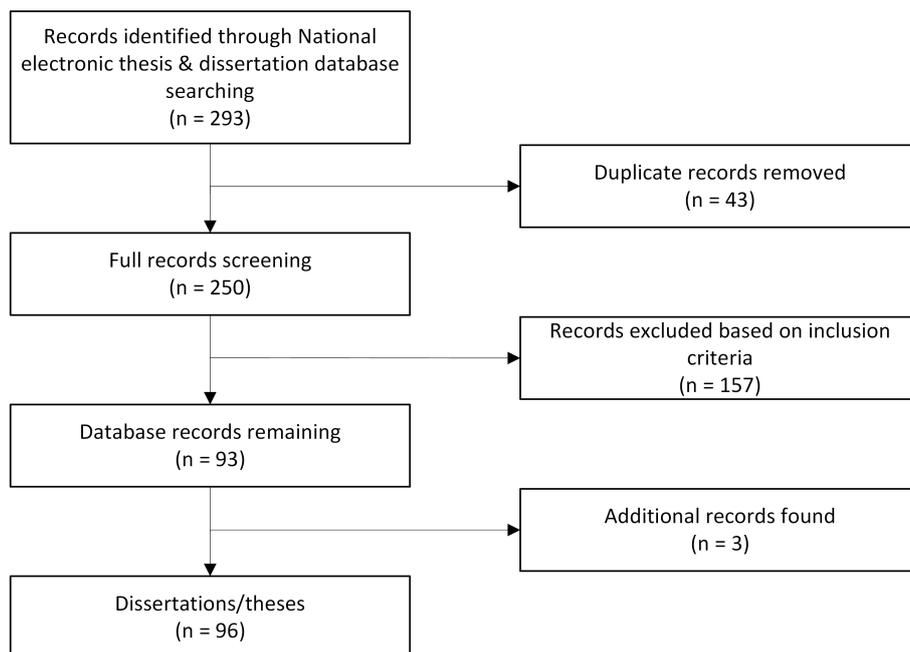


Figure 2: PRISMA Flow Diagram for Dissertations and Theses Search and Screening

Years

The oldest article included in this review was published in 1992, with a further three published in the 1990s (Figure 3). Seven papers were published in the 2000s before a rapid increase across the 2010s, with 76 articles published between 2010 and 2019. In the current decade, 36 articles were published in 2020 and 2021 (up until May 2021, when this search was undertaken). To date, 2020 signalled the apex of publications, with 24 papers published that year.

The oldest dissertation/thesis included in this review dates from 1988. A further two dissertations/theses were completed in 1994 and 1999. Fifteen projects were completed in the 2000s and 73 in the 2010s, demonstrating the same meteoric rise of academic research projects between 2010 and 2019 observable from the articles. For the dissertations/theses, the greatest number was completed in 2015, namely 11. An additional five projects were finished in 2020, but no projects were completed and indexed in 2021 at the time of searching.

Provinces

From the published articles, the most popular area to undertake research was the Western Cape, with 40 papers (32.5%) focusing on this province (Table 1). In second place was the 'Across South Africa' category, with 34 articles (27.6%) conducting re-

search in multiple provinces. Articles where the author(s) did not disclose the location were also included within this group. Gauteng also featured prominently with 28 articles (22.8%). At the other end of the spectrum, KwaZulu-Natal, the Eastern Cape, the Free State, and the North West had only eight, five, four, and three articles, respectively (6.5%, 4.1%, 3.3%, and 2.4%). Mpumalanga had only one (0.8%), while Limpopo and the Northern Cape did not have any papers presenting research exclusively within their boundaries.

For the dissertations/theses, the largest set of research, 29 projects (30.2%), took place across South Africa or the area was not disclosed. The Western Cape and Gauteng were again in the top three, with 28 and 23 (29.2% and 24.0%) projects, respectively. For the dissertations/theses, there was a notable increase in research into KwaZulu-Natal compared to the published articles, with 11 academic research projects (11.5%) researching this province. One project took place in the North West and two in the Eastern Cape (1.0% and 2.1%). Two projects also took place in Limpopo (2.1%), a province missing entirely from the published papers. However, in contrast to the articles, no dissertation/thesis undertook research exclusively in the Free State or Mpumalanga. The Northern Cape continued to be unrepresented.

Methods

Of the published papers, 77 used quantitative methods (62.6%) (Table 1). This was substantially more than the papers using qualitative or

mixed/multiple methods at 21 and 25, respectively (17.1% and 20.3%). A similar trend was observable in the dissertations/theses, with 44 (45.8%) using quantitative versus 26 each for qualitative and mixed/multiple methods (27.1%).

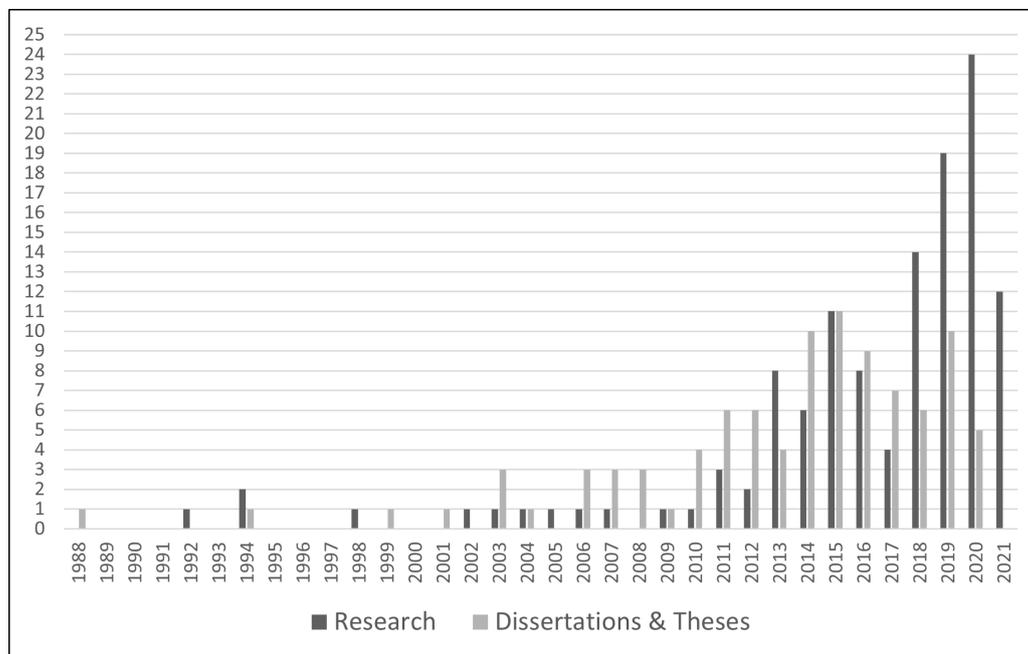


Figure 3: Publication Numbers for Research and Dissertations/Theses per Year

Design

The most popular design for the published papers was database/chart reviews, with 42 articles using this method either in isolation or in conjunction with another design (Table 2). This was followed closely by questionnaires, utilised by 40 articles. In third place was ‘other’, with 23 papers. This category consisted of a variety of designs that were not used frequently enough to justify standing alone. This included audits, case studies, cohort studies, commentaries, computer modelling, consensus, content analyses, documents, guideline developments, implementation studies, observations, lab analyses, legal analyses, literature reviews, physical assessments, geospatial analyses, quality improvements, quasi-experimental studies, randomised control trials, vignettes, recommendations, reports, and simulations. Of the remaining published articles, 18 used interviews and seven utilised Delphi studies. Turning to the dissertations/theses, questionnaires featured most prominently, with 37 projects using this design. This was followed in joint second place by database/chart reviews and interviews, used by 27 academic research projects each. Eighteen used other designs, while focus groups and Delphi studies were used by 16 and five projects, respectively.

Participants

The top three most studied groups within the published papers were emergency medical service (EMS) personnel, services, and patients, with 31, 26, and 17 articles focusing on these participants (25.2%, 21.1%, and 13.8%) (Table 1). A double-digit number of articles were also written about advanced life support (ALS) providers and a mixture of experts, with 12 and 11, respectively (9.8% and 8.9%). None of the published papers centred on educators/students or physicians, while there was one paper each on emergency care practitioner (ECP) students/ALS providers, intermediate life support (ILS) providers, physicians/nurses, and nurses (0.8%).

For the dissertations/theses, EMS personnel and services also took the top two spots for participants with 25 and 18 projects, respectively (26.0% and 18.8%). However, ALS providers and patients were reversed when it came to the academic research projects, with 15 written on the former and nine on the latter (15.6% and 9.4%). Nine dissertations/theses were also designed around a mixture of experts (9.4%), leading to a very similar top five for both the published articles and the dissertations/theses. No academic research project was conducted using physicians/nurses, or ECP

students/ALS providers, although two projects (2.1%) focused on educators/students, a demographic missing from the published papers.

Dissertations and Theses Translating into Research Articles

In total, 27 master's and doctoral candidates published articles emanating from their research. Only

Non-research

Eleven additional papers were included under non-research and were published between 1990 and 2019. Seven of these were categorised under System, with the remaining three covering Personnel, Education, and Response/Transport. All took place across South Africa, and all 11 were commentaries, although five were in conjunction with other designs, including literature reviews, reports, and consensus. Two articles discussed trauma sys-

tems, one charted the history of helicopter emergency medical services (HEMS), and one explored emergency medicine and pre-hospital care in democratic South Africa. One paper covered violence towards EMS staff, one discussed EMS systems in South Africa, and one paper explored clinical practice guidelines. The remaining three discussed integrated approaches to out-of-hospital emergency care, emergency care education, and barriers to accessing out-of-hospital treatment.

tems, one charted the history of helicopter emergency medical services (HEMS), and one explored emergency medicine and pre-hospital care in democratic South Africa. One paper covered violence towards EMS staff, one discussed EMS systems in South Africa, and one paper explored clinical practice guidelines. The remaining three discussed integrated approaches to out-of-hospital emergency care, emergency care education, and barriers to accessing out-of-hospital treatment.

DISCUSSION

After the literature review, key themes were identified from the published papers and dissertations/theses, and the material was grouped into nine categories. Due to the vast spread of topics and the limited number of papers per topic, it was not possible to delineate or collate the research based on topic alone, which led to the use of categories instead. A full record of topics can be viewed in the Supplementary Material. The nine categories are: Call Centre Operations, Clinical Knowledge/Skill, Education, Epidemiology, Experience/Perspective/Understanding, Intervention, Personnel, Response/Transport, and System. Call Centre Operations was the smallest of these groups, featuring nine research articles (7.3%) and six dissertations/theses (6.3%). The largest category for the published papers was Response/Transport with 23 articles (18.7%), followed by Education and Experience/Perspective/Understanding with 17 each (13.8%). For the dissertations/theses, Personnel was the biggest category with 17 projects (17.7%), followed by Education and Experience/Perspective/Understanding, with 14 each (14.6%). The remainder of the articles and academic research projects were spread fairly evenly between the other categories. The main topics of the papers included in each of these classifications are discussed below.

Call Centre Operations

Nine of the published papers covered Call Centre Operations. Of these, three explored triage, one covered acute myocardial infarction (AMI) calls,

and one covered stroke assessment. There was a further paper each covering the appropriateness of HEMS call-outs and EMS responses more generally. One covered call location matching, and one covered language barriers. There were also six dissertations/theses carried out in this category. Buma's,³ Laatz's,⁴ and Newton's⁵ research into AMI calls, HEMS activation, and the appropriateness of EMS responses all featured here as master's dissertations. In addition to these, one project explored the interaction between caller and dispatch, one researched call centre complaints, and one covered Afrikaans telephonic descriptors of cardiac arrest. Regarding the published articles, five took place in the Western Cape, while the remaining four were divided between Gauteng, KwaZulu-Natal, and across South Africa. Three dissertations/theses were conducted in the Western Cape, with one each in KwaZulu-Natal, Gauteng, and across South Africa. Research in this category used a mixture of methodologies and designs, although database/chart reviews were the most popular for both the papers and academic research projects.

Clinical Knowledge and Skill

Of the ten published papers in this category, two covered triage and two covered paediatrics (one exploring paediatric weight estimates and one paediatric emergency care). One analysed acute pain assessments, one researched acute psychiatric emergencies, and one covered cardiopulmonary resuscitation (CPR) quality. The remaining three explored airflow, with one article on peak flow meters, one on rapid sequence intubation, and one

Table 1: Publication Numbers for Province, Method, Category and Participants

<i>Description</i>	Research n (%)	Dissertations/Theses n (%)
Province		
Across South Africa	34 (27.6)	29 (30.2)
Eastern Cape	5 (4.1)	2 (2.1)
Free State	4 (3.3)	
Gauteng	28 (22.8)	23 (24.0)
KwaZulu-Natal	8 (6.5)	11 (11.4)
Limpopo		2 (2.1)
Mpumalanga	1 (0.8)	
North West	3 (2.4)	1 (1.0)
Northern Cape		
Western Cape	40 (32.5)	28 (29.2)
Method		
Mixed/Multiple	25 (20.3)	26 (27.1)
Qualitative	21 (17.1)	26 (27.1)
Quantitative	77 (62.6)	44 (45.8)
Category		
Call Centre Operations	9 (7.3)	6 (6.2)
Education	17 (13.8)	14 (14.6)
Epidemiology	12 (9.8)	10 (10.4)
Experience/Perspective/Understanding	17 (13.8)	14 (14.6)
Intervention	12 (9.8)	6 (6.2)
Clinical Knowledge/Skill	10 (8.1)	9 (9.4)
Personnel	12 (9.8)	17 (17.7)
Response/Transport	23 (18.7)	11 (11.5)
System	11 (8.9)	9 (9.4)
Participants		
ALS Providers	12 (9.8)	15 (15.6)
Call Centre Personnel	7 (5.7)	1(1.1)
Community	3 (2.5)	5 (5.2)
ECP Providers	4 (3.3)	2 (2.1)
ECP Students	8 (6.5)	3 (3.1)
ECP Students/ALS Providers	1 (0.8)	
Educators/Students		2 (2.1)
EMS Personnel	31 (25.2)	25 (26.0)
Expert Mixture	11 (8.9)	9 (9.4)
ILS Providers	1 (0.8)	3 (3.1)
Nurses	1 (0.8)	3 (3.1)
Patients	17 (13.8)	9 (9.4)
Physicians		1 (1.1)
Physicians/Nurses	1 (0.8)	
Services	26 (21.1)	18 (18.7)

ALS = Advanced Life Support, ECP = Emergency Care Practitioner, ILS = Intermediate Life Support

on waveform capnography. There were nine dissertations/theses in this category, and three were later published as articles mentioned above. One was Lourens's⁶ doctoral thesis exploring acute pain, and the remaining two were Veronese's⁷ and Wylie's⁸ master's projects into CPR quality and waveform capnography. The remaining projects covered suicide transport decision-making, first

aid and BLS for early childhood development practitioners, 12-lead electrocardiogram (ECG) interpretation and thrombolytics, ambulance infection control, bystander CPR knowledge, and pre-hospital trauma care. Of the published papers, three took place in the Western Cape and a further three in Gauteng, two covered the Free State, and another two were conducted across South Africa.

Table 2: Publication Numbers for Most Used Data Collection Designs

<i>Description</i>	Research	Dissertations/Theses
Data Collection Designs		
Database/Chart Review	42	27
Delphi	7	5
Focus Groups	11	16
Interviews	18	27
Questionnaires	40	37
Other	23	18

Three of the nine dissertations/theses took place in the Western Cape, two were in Limpopo, one in KwaZulu-Natal, and a further three were conducted across South Africa. All except one published paper and academic research project used questionnaires, and all but one used a quantitative methodology.

Education

Education was the topic of 17 published papers, with five covering simulation and three researching trauma training. Two papers discussed academic success, one covered continuing professional development (CPD) non-compliance, one explored peer-assisted learning, one explored FOAMed, and one scrutinised online learning in relation to HEMS and traumatic brain injury (TBI) care. Of the remaining articles, one covered nursing placement in the pre-hospital environment, one explored hostile environments for emergency staff, and one charted the similarities and differences between emergency care technician (ECT) and bachelor of emergency medical care (BEMC) qualifications. Of the dissertations and theses, 14 covered education, with Heyns,⁹ Sobuwa,¹⁰ Steyn,¹¹ Van Wyk,¹² and Vincent-Lambert¹³ going on to publish their research into nursing placements, academic success, FOAMed, and technical versus degree education. Of the remaining academic research projects, one covered motor vehicle accidents, one explored prior learning and training, one analysed modules covering critical care, and one discussed the identity and attributes of EMS students. One project explored students' practical experience, one researched HEMS simulation-based learning, one covered CPD needs for ALS providers, one explored students' experiences with paediatrics, and one researched student satisfaction with simulation. Articles and dissertations/theses took place across South Africa, with the Western Cape and Gauteng again featuring prominently. Studies in this category used a wide variety of methods and designs, although quantitative methodologies remained dominant.

Epidemiology

A total of 12 papers were classified as Epidemiological. Of these, two explored the burden of disease and trauma, one covered burns, and one researched the outcomes of penetrating chest trauma. Lourens's⁶ doctoral thesis (covering acute chest pain) was published and included in this category. There was one article covering traumatic deaths, one on out-of-hospital triage, and one analysing ECG telemetry and PCI-times. One paper covered hypotension and hypoxaemia in TBI, one explored the epidemiology of out-of-hospital cardiac arrest (OHCA), one covered hypothermia in trauma patients, and one explored penetrating injury surveillance.

Ten of the dissertations/theses were categorised under Epidemiology, with Zalgaonker's¹⁴ research into penetrating injury surveillance and Stassen's¹⁵ project on hypotension and hypoxaemia written first as master's theses before being published. Hodkinson's¹⁶ doctoral thesis on paediatric critical care also yielded two research papers, included in other categories. In addition to these, there were academic research projects on trauma burden, seizures, the population of EMS users, and adverse events. There was also one project on volunteer EMS, one covering mass casualty events, and one researching point-of-care blood gas. The majority of papers and dissertations/theses used database/chart reviews, and the majority of academic research projects and all articles were quantitative. Five of the 12 papers' research took place in the Western Cape, with a further three in Gauteng, one in KwaZulu-Natal, and two across South Africa. Meanwhile, seven of the ten dissertations/theses covered the Western Cape, one researched KwaZulu-Natal, and two Gauteng.

Experience, perspective and understanding

In this category, 17 papers were included. Of these, three covered handovers and handover experiences at emergency centres, one explored child abuse knowledge, one researched intercostal chest drains, and one discussed suicide transport

decision-making. Further papers covered palliative care, clinical quality and performance, neonatal inter-facility transfers, pre-hospital thrombolysis, and clinical practice guidelines. There was one article on needle stick injuries, one covering gender-based violence, and one researching behavioural emergencies. This is in addition to papers on coronary care networks, financial medicine, and the understanding of EMS capabilities.

There were 14 dissertations/theses in this category. Of this number, six were later published as articles. These included Dessena's¹⁷ work on child abuse knowledge, Dippenaar's¹⁸ project on intercostal chest drains, Gage's¹⁹ research into palliative care, Ismail's²⁰ dissertation on neonatal transportation, Naidoo's²¹ project on gender-based violence, and Stander's²² research into behavioural emergencies. Of the remaining dissertations/theses, there were projects on rapid sequence intubation, the assessment of rape survivors, critically unwell children, and intimate partner violence. Further projects covered safety in practice, clinical decision-making, domestic violence, and perspectives of EMS workers. Seven of the research papers covered Gauteng, with the remainder conducted in the Western Cape or across South Africa. In contrast, only one academic research project took place in Gauteng, with the remainder shared between the Western Cape and South Africa more broadly. The articles and dissertations/theses used a variety of methods and designs, although quantitative was once again the most popular by a sizeable margin.

Intervention

This category contained 12 published papers. Two covered rapid sequence intubation, a third explored HEMS endotracheal intubation, and a fourth discussed emergency intubation in trauma. Other articles covered intravenous (IV) therapy, morphine use, the pre-hospital cooling of burns, and on-scene discharge. One paper explored analgesia administration, one researched antibiotics, one covered quality of shock care, and one explored symptomatic hypoglycaemia. Of the dissertations/theses, six were classed as interventions, but only one was subsequently published as a paper; this was Matthews's²³ dissertation on analgesia administration. The remaining five academic research projects covered intubation success rates, advanced airway management, thrombolytic therapy for AMI, pre-hospital intubation, and ketamine for airway management in head injuries. The dissertations/theses were spread across South Africa, while the papers mostly covered the Western Cape, Gauteng, and KwaZulu-Natal.

Quantitative methods were once again dominant, and designs were varied, although the published articles preferred database/chart reviews.

Personnel

Twelve published articles were included under the Personnel category. Three of these covered retention strategies or the loss of ALS, while eight covered the mental or physical health of ALS and EMS personnel. The remaining paper covered social media and its role in sharing information. Of the dissertations/theses, 17 explored personnel. Govender's²⁴ work on the retention of paramedics led to two published articles, but this was the only dissertation in this category that led to publication. In addition to Govender's work, another two academic research projects covered the retention of paramedics. A further 13 explicitly covered the trauma, stress, and psychological impact of frontline emergency medical staff. The remaining project researched non-compliance with guidelines. Research took place across South Africa, with no single province standing out in terms of frequency. However, in this category, the qualitative approach was the most popular methodology for dissertations/theses, whereas the papers were more varied. Questionnaires and interviews were the most popular data collection methods.

Response and transport

Response and Transport were the themes of 23 of the published papers. Five covered HEMS transport, four analysed response times, and a further four covered paediatric or neonatal transportation. One article discussed inter-facility transfers, one analysed caregiver experiences, one researched the impact of mode of transport on mortality, and one covered emergency first aid responder (EFAR) programmes in South Africa. Other papers covered maternal health, transfer patterns and patient outcomes, coronary care network models, time to facility, and critical care transport scope of practice.

There were 11 dissertations/theses covering Transport and Response. Of these, Ashokcoomar's²⁵ project on inter-facility transfer, Muhlbaauer's²⁶ dissertation on HEMS transport, and Stein's²⁷ work on EMS response system performance were subsequently published as articles. Of the remaining academic research projects, three covered HEMS transport, with two of these covering the demographics of patients transported by HEMS, and one exploring malaria and HEMS transport. In addition, one project focused on emergency response times, one discussed obstetric patients, one researched inter-hospital neonatal transfer, one covered critical case time intervals, and one anal-

ysed the transport and referral of HIV/AIDS and TB patients. The majority of the published papers conducted research in the Western Cape, whereas a majority of the dissertations/theses took place in Gauteng and KwaZulu-Natal. Quantitative methods were the most popular, while database/chart reviews were the most common designs for both published articles and dissertations/theses.

System

Eleven papers were categorised under System. Of these, two covered quality indicators, two covered mass gathering events, and a further two researched clinical practice guidelines. Of the remaining articles, one explored rural ambulance services, one researched occupationally acquired communicable diseases, one covered spinal clearance, one discussed supporting systems, and one explored emergency care research priorities. Nine dissertations/theses fell under the System category. Mahomed's²⁸ dissertation on communicable diseases and Stassen's²⁹ work on coronary care networks both led to publications. Of the remaining dissertations/theses, one discussed an EMS marketing plan, one explored health literacy, one discussed IT requirements, and one discussed the role of the nurse in the pre-hospital setting. The remaining three academic research projects covered information management, the legal analysis of EMS, and disinfection protocols. All published papers and dissertations/theses in this category were geographically varied and used a wide variety of methods and designs.

LIMITATIONS

The search was designed to capture as much material as possible. Nonetheless, it is acknowledged there may be articles that fell outside the search parameters. In fact, this was proven to be the case with the 11 additional papers that were located after failing to appear in the database searches. Furthermore, only articles published in indexed journals were listed on the databases, with some pre-hospital focused journals not yet attaining that status. The ETD Portal is not perfect, and once again, the fact that additional dissertations/theses were later identified proves that some results were not captured by the search. The number of excluded papers was so large because of the inclusion of 'North West' as a province in South Africa. This was included for completeness, but due to its generic nature, it pulled up many papers in north-western regions outside of South Africa, most notably in the north-west of the UK.

In a similar way, 'EMS' is an acronym present in many other disciplines, especially agriculture and

education; the inclusion of this search term yielded many irrelevant papers that were later excluded by the search parameters. Furthermore, some papers that were conducted in South Africa but sponsored or undertaken by foreign universities appeared on the thesis repositories for those international institutions. This was the case for Stassen's 2018 doctorate, which was in the Swedish thesis repository. Without searching the databases of every country, and in some cases, every university, some of these projects will inevitably fall through the cracks. Nonetheless, there is confidence that this review has captured as much material as reasonably possible, and a broad cross-section of the current research landscape.

The limitation of manual categorisation was also identified. The categories were designated by reading the published articles and dissertations/theses. However, the research topics were so disparate, in addition to many falling on the boundaries of multiple categories, that this made it challenging to label them definitively. It is also recognised that the vast range of research topics meant that tabulation or synthesis was impossible, as the topics were too varied to explore their nuanced commonalities and differences within the parameters of this paper. Instead, this project functions as a foundational study, and it is anticipated that follow-up papers will be written focusing on specific categories, which will have the space to analyse the research topics in depth.

CONCLUSION

Pre-hospital emergency care research is a new area and growing discipline in South Africa, as demonstrated by the lack of papers before the 2000s and the drastic uptake in research since the 2010s. However, there is a notable disparity in terms of where this research was conducted. The Western Cape, Gauteng, and across South Africa featured prominently as research locations, with these areas combined accounting for 82.9% of the published papers and 83.4% of the dissertations/theses. KwaZulu-Natal also fared moderately, forming the focus of 6.5% of papers and 11.5% of dissertations/theses. However, the Eastern Cape, the Free State, Limpopo, Mpumalanga, and the North West combined were the subject of just 10.6% of published articles and only 5.2% of the dissertations/theses, while the Northern Cape did not feature at all. In terms of the research conducted, the articles and dissertations/theses were spread evenly between the nine categories, although Response/transport stood out amongst the published papers and Personnel amongst the academic research projects in terms of frequency.

The research included under each category was wide and varied, with only one or two papers or dissertations/theses typically sharing a topic. An exception was the mental and physical health of frontline life support staff, which was the topic of eight papers and 13 dissertations/theses. It was also noticeable that there was a large focus on ALS, rather than the less urgent levels of EMS care. A range of methodologies and data collection designs were used in the research process, with favour toward the quantitative approach, database/chart reviews, and questionnaires. It was observed that only a small number of dissertations/theses were eventually published as papers, with only 34.6% of projects adapted into publications. Going forward, it would be valuable to see more students publishing their academic research projects, in addition to a more equitable spread of research across the country.

ACKNOWLEDGEMENT

We appreciate the support from Anglia Ruskin University who sponsored £5000 toward the recruitment of a research assistant (EM) to assist in the completion of this review.

CONFLICTS OF INTEREST

ED is a Director of the Emergency Care Society of South Africa that commissioned this review.

AUTHOR CONTRIBUTIONS

ED initiated the review, established the search methodology, screened, and categorised publications. EM conducted the searches, managed the review process, and extracted publication details. Both ED and EM wrote and approved the manuscript.

REFERENCES

1. Mould-Millman N, Naidoo R, de Vries S, Stein C, Wallis L. Afem consensus conference, 2013. afem out-of-hospital emergency care workgroup consensus paper: advancing out-of-hospital emergency care in africa-advocacy and development. *African Journal of Emergency Medicine* 2014;4:90-5.
2. MacFarlane C, Loggerenberg C van, Kloeck W. International EMS systems in South Africa: past, present, and future. *Resuscitation* 2005;64:145-8.
3. Buma C. An analysis of the descriptors of acute myocardial infarction used by South Africans when calling for an ambulance from a national emergency call centre. Dissertation. University of Cape Town, 2019. (<http://hdl.handle.net/11427/31131>).
4. Laatz D. Developing call out criteria for South African helicopter services: A delphi study. Dissertation. University of Cape Town, 2019. (<http://hdl.handle.net/11427/29354>).
5. Newton P. An evaluation of the appropriateness of emergency medical service (EMS) responses in the eThekweni health district of KwaZulu-Natal. Dissertation. Durban University of Technology, 2014. (<http://hdl.handle.net/10321/1105>).
6. Lourens A. Developing an in-depth understanding of acute pain assessment and management in the prehospital setting in the Western Cape, South Africa, the factors influencing practice and what improvement measures could advance prehospital acute pain management. Thesis. University of Cape Town, 2020. (<http://hdl.handle.net/11427/32775>).
7. Veronese J. An assessment of theoretical knowledge and psychomotor skills of basic life support cardio-pulmonary resuscitation provision by emergency medical services in a province in South Africa. Dissertation. University of Cape Town, 2015. (<http://hdl.handle.net/11427/16524>).
8. Wylie C. Waveform capnography in the South African prehospital setting: knowledge assessment of qualified advanced life support (ALS) paramedics. Dissertation. University of Cape Town, 2016. (<http://hdl.handle.net/11427/22789>).
9. Heyns T. Core competencies of the A&E (accident and emergency) nurse in life-threatening situations in the emergency care environment in South Africa. Dissertation. University of Pretoria, 2003. (<http://upetd.up.ac.za/thesis/available/etd-09272005-095002/>).
10. Sobuwa S. A critical realist study into the emergence and absence of academic success among Bachelor of Emergency Medical Care students. Thesis. University of Cape Town, 2018. (<http://hdl.handle.net/11427/29475>).
11. Steyn J. A retrospective content analysis of the ambulance emergency assistant refresher course outcomes as covered by free open access medical education (FOAMED) resources.

- Dissertation. Stellenbosch University, 2018. (https://scholar.sun.ac.za/bitstream/handle/10019.1/103297/steyn_retrospective_2018.pdf?sequence=1&isAllowed=y).
12. Wyk S van. Evaluating the pre-hospital learning environment by students enrolled for an emergency nursing programme. Dissertation. University of Pretoria, 2013. (<http://upetd.up.ac.za/thesis/available/etd-11262012-165158/>).
 13. Vincent-Lambert C. A framework for articulation between the emergency care technician certificate and the emergency medical care professional degree. Thesis. University of the Free State, 2011. (<https://scholar.ufs.ac.za/handle/11660/7584>).
 14. Zalgaonker M. Intravenous fluid resuscitation: surveillance of penetrating injury in the pre-hospital environment. Dissertation. Cape Peninsula University of Technology, 2018. (<http://hdl.handle.net/20.500.11838/2738>).
 15. Stassen W. The prevalence of hypotension and hypoxaemia in the prehospital setting of traumatic brain injury in Johannesburg, Gauteng. Dissertation. University of Cape Town, 2013. (<http://hdl.handle.net/11427/2875>).
 16. Stassen W. Developing a patient-centred care pathway for paediatric critical care in the Western Cape. Thesis. University of Cape Town, 2015. (<http://hdl.handle.net/11427/17259>).
 17. Dessena B. A study to determine perceived and actual knowledge of Cape Town emergency medical care providers with regard to child abuse. Dissertation. University of Cape Town, 2015. (<http://hdl.handle.net/11427/15158>).
 18. Dippenaar E. Identifying the role of pre-hospital intercostal chest drains in South Africa. Dissertation. University of Cape Town, 2013. (<http://hdl.handle.net/11427/2859>).
 19. Gage C. The thoughts and opinions of advanced life support providers in the South African private emergency medical services sector concerning pre-hospital palliative care. Dissertation. University of Cape Town, 2019. (<http://hdl.handle.net/11427/32216>).
 20. Ismail E. Preparedness of Western Cape ALS providers to provide clinical stabilisation and intensive care for neonates during the patient journey. Dissertation. Durban University of Technology, 2017. (<http://hdl.handle.net/10321/3188>).
 21. Naidoo N. Gender-based violence: strengthening the role and scope of prehospital emergency care by promoting theory, policy and clinical praxis. Thesis. University of Cape Town, 2017. (<http://hdl.handle.net/11427/27395>).
 22. Stander C. Prehospital emergency care provider's understanding of their responsibilities towards a mental health care user, during a behavioural emergency. Dissertation. University of Cape Town, 2019. (<http://hdl.handle.net/11427/31266>).
 23. Mathews R. A description of practices of analgesia administration by advanced life support paramedics in the City of Cape Town. Dissertation. University of Cape Town, 2015. (<http://hdl.handle.net/11427/21187>).
 24. Govender P. The development of a framework to retain migrating South African undergraduate advanced life support paramedics. Dissertation. Durban University of Technology, 2010. (<http://hdl.handle.net/10321/599>).
 25. Ashokcoomar P. An analysis of inter-healthcare facility transfer of neonates within the eThekweni Health District of KwaZulu-Natal. Dissertation. Durban University of Technology, 2012. (<http://hdl.handle.net/10321/809>).
 26. Muhlbauer D. An analysis of patients transported by a private helicopter emergency service within South Africa. Dissertation. Durban University of Technology, 2015. (<http://hdl.handle.net/10321/1326>).
 27. Stein C. Emergency medical service response system performance in an urban South African setting: a computer simulation model. Thesis. University of Cape Town, 2014. (<http://hdl.handle.net/11427/9523>).
 28. Mahomed O. A review of the communicable diseases and infection control policy for emergency medical services in the pre-hospital environment in the public health sector in South Africa - 2005. Dissertation. University of KwaZulu-Natal, 2006. (<http://hdl.handle.net/10413/2382>).

29. Stassen W. Coronary care networks in the resource-limited setting: systems of care in South Africa. Thesis. Karolinska Institutet/University of Stellenbosch, 2018. (<https://openarchive.ki.se/xmlui/handle/10616/46322>).