



Research article

The drivers of migration of Ghanaian radiographers to high-income countries

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ABSTRACT

Background: The brain drain of Ghanaian radiographers is a growing concern for the Ghana Health Service and patient care in the country. Unfortunately, this is affecting the quality of radiology services in Ghana. This study investigated the determinants of radiographers' brain drain from Ghana and identified potential mitigating factors.

Methods: A cross-sectional survey was conducted using a semi-structured questionnaire which was administered online to Ghanaian radiographers. The questionnaire gathered data on push and pull factors that influenced brain drain. Statistical analysis was performed using SPSS version 29.

Results: A total of 128 radiographers participated in the study. The findings indicated that 92.2 % of Ghanaian radiographers expressed intentions to work abroad. The estimated means and standard deviations on a five-point Likert Scale demonstrated that poor salary (4.47 ± 0.1) and poor working conditions (4.17 ± 1.1) were the main push factors, while improved living conditions (4.62 ± 0.9) and better health infrastructure (4.55 ± 0.9) were the influential pull/attractive factors. Although there are variations in participants' demographics, comparative analyses of push and pull factors indicated that respondents did not significantly differ in their migration decisions intentions ($p < 0.05$). To mitigate brain drain, respondents emphasised the need for better salaries (97.7 %) and comprehensive health insurance for radiographers and their families (92.2 %) among other factors.

Conclusion: This study highlights the multifaceted factors that drive Ghanaian radiographers abroad and their consequences on the healthcare system. A comprehensive strategy encompassing financial incentives, career development, improved working conditions, and personal satisfaction was identified as a mitigating approach to addressing these challenges. Implementation of these recommendations by policymakers is necessary to create an environment that retains and empowers radiographers and ultimately enhances patient care and healthcare advancement in Ghana.

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1. Introduction

The term brain drain is the emigration or migration of highly trained or qualified people from a particular country [1]. This is especially evident in the health industry, where professionals such as radiographers, audiologists, physiotherapists, doctors, nurses, midwives, etc., from low-income countries (LIC), migrate to pursue better opportunities in high-income countries (HIC) [2].

Kadel & Bhandari [1] and Serour [3] emphasised that the migration of healthcare workers has been driven by a variety of circumstances. Low salaries, professional misemployment, insufficient development possibilities, political instability, and historical linkages to more developed countries all contribute to this trend [1,3]. They referred to the factors which have the potential to drive people away from their countries as the push factors [1,3]. A Ghanaian study found that bad working conditions, low pay, a lack of professional advancement, and political meddling were push factors that drove healthcare workers to seek opportunities abroad [4]. They further stressed that attractive conditions in HIC, such as better salaries, conditions of work, social infrastructure, political stability and acceptance among others, pull most skilled workers. These attractive factors are called the pull factors [4].

Misau et al. [5] and Castelli [6] found short- and long-term repercussions of the healthcare brain drain included decreased healthcare quality, reduced training skills, less healthcare innovation, and poor patient experience and outcome [7], which negatively and significantly affected the quality of life (QoL) of a large population in LICs. Thus, inadequate, ill-trained, unfairly distributed as well as ill-motivated health workers including radiographers would obviously struggle with the achievement of Universal Health Coverage (UHC) and Sustainable Development Goals (SDGs) [6].

A recent study [8] by the WHO further demonstrated that the shortage and uneven distribution of health workers in the African Region remained significantly challenging in achieving universal access to health services. Consequently, it emphasised the importance of significantly increased investment in the healthcare workforce (HWF) in line with contextual evidence and rising health demands. Unfortunately, the phenomenon of brain drain, particularly among radiography workers, has accelerated in the past year, resulting in the migration of radiographers from Africa to more HICs. Recent data and observations suggest an increase in the human capital flight of radiographers from Africa entrenching the shortage and uneven distribution of health workers in the African Region [8].

In Ghana, the population of radiographers is low. A national radiographer-population ratio of 1:100,000 has been noted based on national statistics. Despite this, the observed levels of migration of both highly skilled clinical and academic radiographers to HICs have increased drastically. It is estimated that at least one radiographer leaves the country every 1–2 weeks. The factors influencing this migration are believed to be multifaceted. However, the comparatively lower professional bargaining power of radiographers compared to other healthcare professionals, such as medical doctors, chiefly makes it challenging for their service-related issues to be addressed promptly, thereby contributing to their migration from the country. This ongoing trend of migration of radiographers from the Ghana healthcare system perpetuates a cycle where new graduates with inadequate clinical experience enter the industry essentially to replace departing experienced professionals, resulting in limited workforce growth. Compounding the issue, some newly graduated radiographers choose not to work in rural areas. This has left some radiology departments without many experienced radiographers, placing significant stress on the remaining few. This presents a likely potential to facilitate the emergence of unqualified radiographers or promote quackery.

While the healthcare industry depends on qualified educational institutions to train more radiographers, it is concerning that some qualified radiographers working in academia have also made decisions to migrate to HICs. Moreover, a significant number of radiographers who received government scholarships to study abroad and were expected to return to Ghana have chosen not to do so.

Adding to this challenge, unaccredited institutions lacking the necessary radiography academics attempt to exploit the situation by running unproved programmes. This practice has the risk of producing substandard professionals and should be curtailed, as better solutions exist.

These issues collectively highlight the urgency of addressing the brain drain phenomenon. As radiographers in Ghana work across all the various levels of the healthcare system, from primary to tertiary healthcare, including private and public sectors, failure to address workforce shortages could significantly impact healthcare delivery and impede the achievement of universal access to health services. It could also have far-reaching consequences for patient experience and healthcare management. The consequences could also affect the broader African healthcare landscape. Therefore, this study aims to investigate the drivers of brain drain, with a particular emphasis on the push, pull, and mitigating factors from the perspective of Ghanaian radiographers. Shedding light on the reasons behind the brain drain of Ghanaian radiographers is anticipated to offer valuable guidance for policy formulation and probably identify mitigating strategies to support the retention of a skilled and stable radiography workforce within the country.

2. Methods

2.1. Study design and sample size

The study was conducted on a population of Ghanaian radiographers using a survey in Ghana. Out of approximately 709 radiographers in Ghana, according to the records of the Allied Health Professions Council (AHPC), an estimated sample size of 128, based on Bartlett et al.'s formula [9], was deemed appropriate for concluding this study. It included all consenting licensed diagnostic and therapy radiographers in Ghana, while excluding non-consenting radiographers and student radiographers.

2.2. Data collection tool

A questionnaire was developed by blending self-designed questions with some others adapted from a previously validated survey by Poku et al. [10], in a related research context. These questions were tailored to align with the research goals and objectives, resulting in a structured comprehensive questionnaire comprising closed-ended questions (Appendix A). The demographics (Section A: Demographics) gathered information on age, sex, educational level, current radiography role and more, while radiographers' intention to migrate (Section B), aimed at exploring participants' knowledge of radiographers' migration, including intentions to practice abroad, migration methods, and the possibility of returning to Ghana. The push and pull factors associated with radiographers' migration, focused on economical, social, political, professional, and health system factors (Section C). This section utilised a 5-point Likert scale to collect data.

Section D (Implications of radiographers' migration on the radiography profession in Ghana), examined effects like personnel shortages, burnout, increased workloads, and negative patient health outcomes. Section E (Mitigating factors of radiographers' brain drain), aimed to identify immediate measures to encourage radiographers to remain in Ghana, including competitive salaries, favourable working conditions, and career advancement opportunities.

The study was piloted with five subjects, similar to those in the main study to assess the questionnaire's validity and clarity. Necessary language editing changes were implemented following the pilot study.

3. Data collection procedure

The Ghana Society of Radiographers (GSR) is the professional body of Ghana's diagnostic, therapeutic, and sonographic radiographers. The GSR gave permission to use its members for the study by issuing a clearance letter of approval. Participants provided informed consent either through a section within the questionnaires. These were administered online via the GSR WhatsApp platforms where participants completed Google Forms. This method ensured that the majority of the radiographers were aware of the study and had a chance to participate. All data collected were kept on Google Drive and backed up on another device.

3.1. Ethical considerations

In accordance with the Helsinki Protocol, ethical clearance for the study was approved by the Ethics and Protocol Review Committee of the University of Ghana School of Biomedical & Allied Health Sciences (SBAHS/AA/RAD/21847/2022–2023). Permission

Table 1

Demographic statistics of the respondents.

Demographic variable	Category	Frequency n (%)
Age (years)	<30	74 (57.8)
	30–40	34 (26.6)
	Over 40	20 (15.6)
Gender	Male	89 (69.5)
	Female	39 (30.5)
Marital status	Married	39 (30.5)
	Single	89 (69.5)
Duration of professional practice (years)	<5	77 (60.2)
	5–10	22 (17.2)
	11–15	16 (12.5)
	16–20	7 (5.5)
	21–25	3 (2.3)
	>26	3 (2.3)
Highest educational status	Diploma	7 (5.5)
	BSc	109 (85.2)
	MSc/MPhil	11 (8.8)
	PhD	1 (0.8)
Field of radiography practice	Diagnostic	119 (93.0)
	Therapy	9 (7.0)
Current radiography role	Academic radiographers	2 (1.6)
	Clinical academics (practice and teaching)	8 (6.3)
	Clinical radiographers	115 (89.8)
	Radiology managers	2 (1.6)
	Research radiographers	1 (0.8)
	Organisational set-up	CHAG facility
	Government facility	60 (46.9)
	Military facility	2 (1.6)
	Government private partnership facility	1 (0.8)
	Private facility	45 (35.2)
	Quasi-government	19 (14.8)

Key: BSc: Bachelor of Science; MSc: Master of Science; MPhil: Master of Philosophy; PhD: Doctor of Philosophy; CHAG: Christian Health Association of Ghana.

was also obtained from the GSR to engage its members in the study. The participants were informed about the nature of the research and provided informed consent via completion of the questionnaires. Participants were assured of confidentiality, anonymity, and the right to withdraw from the study at any time. Personal information was not recorded to protect anonymity.

3.2. Data analysis

The data were analysed using SPSS for Windows version 29 (Armonk, NY: IBM Corp). Descriptive and inferential statistics were used, with charts, graphs, and tables employed for descriptive analysis. T-tests and One-Way ANOVA analyses were utilised to compare demographic variables within groups concerning push and pull factors, depending on the data type. T-test was employed to compare two variable groups, such as gender, marital status, radiography field of practice, and those below 30 and above 30 years, while One-Way ANOVA was used to compare three or more variable groups, such as years of practice and the highest educational levels. The statistical significance level was established at $p < 0.05$.

4. Results

The demographics and socioeconomic characteristics are summarised in Table 1. A total of 128 radiographers participated in the study, with ages ranging from 22 to 54 years and a mean \pm standard deviation (SD) of 30.5 ± 7.2 years. The majority were under 30 years old ($n = 74$; 57.8%), while those over 40 years were in the minority ($n = 20$; 15.6%). More males ($n = 89$; 69.5%) than females ($n = 39$; 30.5%) took part, and the majority were single ($n = 89$; 69.5%). In terms of experience, the majority had practiced for 5–10 years ($n = 22$; 17.2%), with a significant number having practiced for less than 5 years ($n = 17$; 13.2%). Regarding qualifications, the majority held undergraduate qualifications (Diploma: $n = 7$, 5.5%; BSc degree: $n = 109$; 85.2%), while postgraduate degree holders were fewer (MSc/MPhil: $n = 11$, 8.8%; PhD: $n = 1$, 0.8%). Diagnostic radiographers dominated ($n = 119$; 93.0%) compared to therapy radiographers ($n = 9$; 7.0%). Most practiced as clinical radiographers ($n = 115$; 89.8%) in government facilities ($n = 60$; 46.9%), with only two in Christian Health Association of Ghana (CHAG) ($n = 1$; 0.8%) and government-private partnerships ($n = 1$; 0.8%) hospitals.

As shown in Fig. 1, the majority ($n = 118$; 92.2%) expressed their intention to migrate to HICs, while a minority ($n = 10$; 7.8%) did not. A cross-tabulation of demographic characteristics regarding radiographers' intentions to practice in HICs is presented in Table 2.

Table 3 and Fig. 2 present the radiographers' intended modes of migration and their preferred destinations, respectively. The study found that the majority preferred the direct application route ($n = 94$, 79.7%), while some opted for agency assistance ($n = 14$, 10.9%). A small number ($n = 4$, 3.1%) preferred to migrate through marriage. From Fig. 2, it is evident that most radiographers expressed a preference to work in the United Kingdom ($n = 51$), Canada ($n = 24$), the United States ($n = 23$), and Australia ($n = 8$). A few individuals indicated a desire to work in other countries, including Switzerland ($n = 1$), and Israel ($n = 1$).

The factors influencing radiographers' intentions to migrate for professional opportunities were categorised as push and pull factors. These factors were assessed using a 5-point Likert scale (1–5, with 5 being the highest). In terms of the push factors (Table 4), economic factors, particularly low salaries (mean = 4.77 ± 1.96) and poor living conditions (mean = 4.38 ± 0.97) were the primary drivers for radiographers seeking opportunities abroad. Within the health system, unfavourable working conditions (mean = 4.17 ± 1.06), inadequate infrastructure (mean = 4.06 ± 1.10), and insufficient equipment (mean = 4.04 ± 1.01) were factors radiographers considered as driving factors to migrate abroad. Concerning professional practice, low satisfaction (mean = 4.00 ± 1.01), under-utilisation of skills (mean = 3.90 ± 1.109), and perceived power differences with physicians (mean = 3.69 ± 1.23) were influencing their decisions. Socially, the desire for life aspirations (mean = 4.22 ± 0.9) and life changes (mean = 4.16 ± 0.9) were key motivators. Regarding political factors, governmental mismanagement (mean = 4.07 ± 1.10) and safety concerns (mean = 3.38 ± 1.24) were playing significant roles in their decisions.

In terms of the pull factors (Table 5), the radiographers' motivations to work in other countries were multifaceted. Better living conditions (mean = 4.62 ± 0.85) and higher salaries (mean = 4.59 ± 0.86) were significantly emphasized as primary economic incentives, while the appeal for better health infrastructure (mean = 4.55 ± 0.87) and assurance of adequate equipment and supplies (mean = 4.53 ± 0.83) were the main drivers to immigrate within the health system.

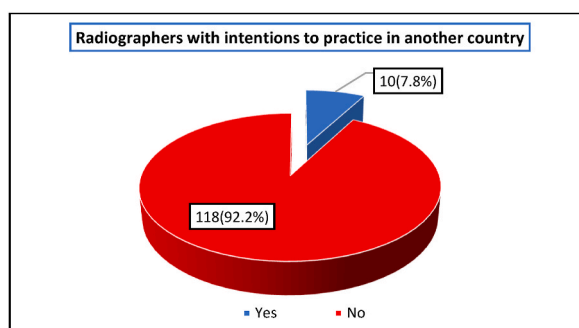


Fig. 1. Radiographers with intentions to practice in another country.

Table 2
Demographic of radiographers intending to practice in other countries.

Demographic variable	Category	No (n)	Yes (n)
Age	<30 years	3	71
	30 to <40 years	5	29
	40 and more	2	18
Gender	Male	4	85
	Female	6	33
Marital status	Married	6	33
	Single	4	85
Length of professional radiography practice (yrs)	<5	2	75
	5–10	2	1
	11–15	2	14
	16–20	1	6
	21–25	0	3
	>26	3	19
Highest educational status	BSc degree	9	100
	Diploma	1	6
	MSc/MPhil	0	11
	PhD	0	1
Field of radiography practice	Diagnostic	10	109
	Therapy	0	9
Current radiography role	Academic radiographer	0	2
	Clinical academic (practice and teaching)	1	7
	Clinical radiographer	8	107
	Radiology manager	1	1
	Research radiographer	0	1
Organisational set-up	CHAG facility	0	1
	Government facility	3	57
	Military facility	0	2
	Government private partnership facility	0	1
	Private facility	4	41
	Quasi-government	3	16

Key: BSc: Bachelor of Science; MSc: Master of Science; MPhil: Master of Philosophy; PhD: Doctor of Philosophy; CHAG: Christian Health Association of Ghana.

Table 3
Means of reaching the preferred destination.

Means	Frequency	Percentage (%)
Direct application	94	73.4
Invitation	6	4.7
Agency	14	10.9
Marriage	4	3.1
Not certain	10	7.8

On the professional front, they expressed a strong desire for career advancement and training opportunities (mean = 4.47 ± 0.87), the potential to gain more clinical experience (mean = 4.41 ± 0.95), and the promise of higher professional satisfaction (mean = 4.41 ± 0.89) as motivating factors for migration. Socially, radiographers were driven by the prospect of a better quality of life (mean = 4.3 ± 0.88) and the curiosity to experience a different working environment (mean = 3.93 ± 1.04). In terms of political factors, the effectiveness of governmental management (mean = 4.09 ± 1.09) and the stability of political transitions (mean = 3.69 ± 1.11) influenced their decisions.

A comparative analysis of variables concerning groups, in terms of all the push factors together and pull factors together (Table 6), indicated that respondents from different backgrounds did not significantly differ in how these factors affected their migration decisions.

Nonetheless, more participants ($n = 89$; 69.5 %) expressed intentions of returning to Ghana after working in other countries compared to those ($n = 39$; 30.5 %) without such intentions (Fig. 3).

Interestingly, the challenges resulting from the migration of radiographers were known to the participants. Specifically, the majority of radiographers agreed that migration would result in a shortage in the workforce ($n = 115$; 89.8 %), increased workload ($n = 107$; 83.6 %), decreased quality of healthcare ($n = 101$; 78.9 %), and burnout among remaining staff ($n = 98$; 76.6 %). Prolonged hospital stays ($n = 59$; 46.1 %), increased mortality ($n = 55$; 43 %), and higher costs associated with training new radiographers ($n = 65$; 50.8 %) were regarded as implications with a lesser impact on radiography practice in the destination country (Fig. 4).

However, they suggested ways in which brain drain among radiographers could be mitigated. These measures, as shown in Fig. 5, include better salaries (like the introduction of the 13th salary) ($n = 125$; 97.7 %), comprehensive free health insurance for radiographers and their immediate family members ($n = 118$; 92.2 %), and nurturing a sense of patriotism and national pride ($n = 110$; 85.9

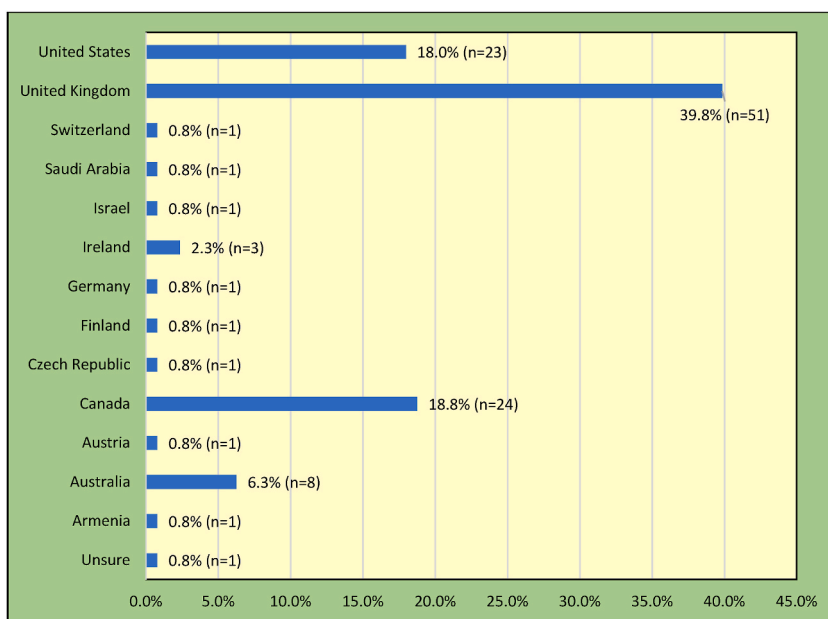


Fig. 2. Most preferred destinations of immigrating radiographers.

Table 4

Push factors of radiographers' migration.

Push factors	Mean	SD	Range of scores	Rank
Economic factors				
Poor salaries	4.47	0.96	1–5	1st
Poor living conditions	4.38	0.97	1–5	2nd
Devaluation of the country's currency	4.31	1.06	1–5	3rd
Poor economic policies and taxes	4.23	1.05	1–5	4th
Health system factors				
Poor working conditions	4.17	1.06	1–5	1st
Poor health infrastructure	4.06	1.10	1–5	2nd
Inadequate equipment and supplies	4.04	1.01	1–5	3rd
Poor management and supervision	3.89	1.12	1–5	4th
Work overload	3.71	1.20	1–5	5th
Professional factors				
Low professional satisfaction	4.00	1.01	1–5	1st
Underutilization of skills	3.90	1.09	1–5	2nd
Lack of training opportunities	3.74	1.16	1–5	3rd
Lack of promotion opportunities	3.70	1.16	1–5	4th
Perceived power difference between physicians and radiographers	3.69	1.23	1–5	5th
Social factors				
Desire to fulfil self-aspirations	4.22	0.88	1–5	1st
The desire for life change	4.16	0.87	1–5	2nd
The desire for life adventure	3.93	1.05	1–5	3rd
Corruption in everyday life in the country	3.88	1.09	1–5	4th
Political Factors				
Governmental mismanagement	4.07	1.10	1–5	1st
Safety and security reasons	3.38	1.24	1–5	2nd
Influence of colonial connections	3.15	1.20	1–5	3rd
Influence of bilateral agreements	3.15	1.15	1–5	4th

Key: SD: standard deviation.

Table 5
The pull factors of radiographers' migration.

Pull Factors	Mean	SD	Score range	Rank
Economic factors				
Better living conditions	4.62	0.85	1–5	1st
Better salaries	4.59	0.86	1–5	2nd
Value in the country's currency	4.46	0.97	1–5	3rd
Better insurance policies	4.44	0.99	1–5	4th
Demand for labour	4.24	0.96	1–5	5th
Health system factors				
Better health infrastructure	4.55	0.87	1–5	1st
Adequate equipment and supplies	4.53	0.83	1–5	2nd
Better working conditions	4.51	0.84	1–5	3rd
Proper management and supervision	4.4	0.98	1–5	4th
Active recruitment overseas	4.16	1.07	1–5	5th
Professional factors				
Several career advancements and training opportunities	4.47	0.87	1–5	1st
Opportunities for better clinical experience	4.41	0.95	1–5	2nd
High professional satisfaction	4.41	0.89	1–5	3rd
Opportunity for professional networking	4.36	0.94	1–5	4th
Opportunity for research	4.28	0.99	1–5	5th
Desire for foreign professional qualification	4.26	0.96	1–5	6th
Promotions at work	4.09	1.04	1–5	7th
Social factors				
Offer of a better quality of life	4.30	0.88	1–5	1st
Desire to experience different working environment	3.93	1.04	1–5	2nd
Access to social networks	3.84	1.08	1–5	3rd
Desire to gain foreign citizenship	3.3	1.13	1–5	4th
To join family and friends	2.92	1.17	1–5	5th
Identity acceptance	2.73	1.23	1–5	6th
Religious acceptance	2.67	1.14	1–5	7th
Political Factors				
Effective governmental management	4.09	1.09	1–5	1st
Smooth political transitions	3.69	1.11	1–5	2nd
Peaceful coexistence of political parties	3.55	1.14	1–5	3rd
Safety and security reasons	3.51	1.27	1–5	4th

Key: SD: standard deviation.

Table 6
Comparison of variables with groups concerning push factors together and pull factors together.

Variables	Push factors			Pull factors		
	a cumulative mean, SD and p-values					
	Mean	SD	p-value	Mean	SD	p-value
Male	3.927	0.575	0.589	4.136	0.529	0.364
Female	3.991	0.700		4.032	0.726	
Married	3.834	0.774	0.25	4.047	0.586	0.846
Single	3.996	0.606		4.071	0.709	
<30 years	3.980	0.641	0.516	4.065	0.750	0.984
30+ years	3.901	0.695		4.062	0.553	
Diagnostic	3.930	0.677	0.138	4.056	0.676	0.630
Therapy	4.166	0.401		4.165	0.630	
<5 years	3.9775	0.6475	0.169	4.0799	0.7514	0.865
5–10 years	4.009	0.597		4.116	0.599	
11–15 years	3.596	0.788		3.941	0.483	
16–20 years	4.296	0.415		4.200	0.491	
21–25 years	4.103	0.460		3.947	0.210	
>26 years	3.600	1.074		3.710	0.668	
BSc degree	3.9399	0.6369	0.177	4.0593	0.6935	0.843
Diploma	3.627	1.193		4.033	0.676	
MSc/MPhil	4.122	0.361		4.070	0.467	
PhD	5.000	0.000		4.000	0.000	

a Cumulative mean, SD and p-values are for economic, health systems, professional, social, and political factors.

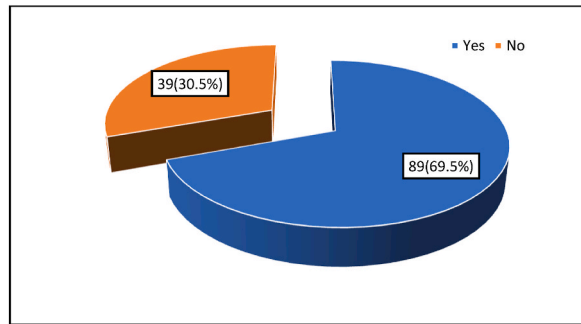


Fig. 3. Intentions to return to the country after migration.

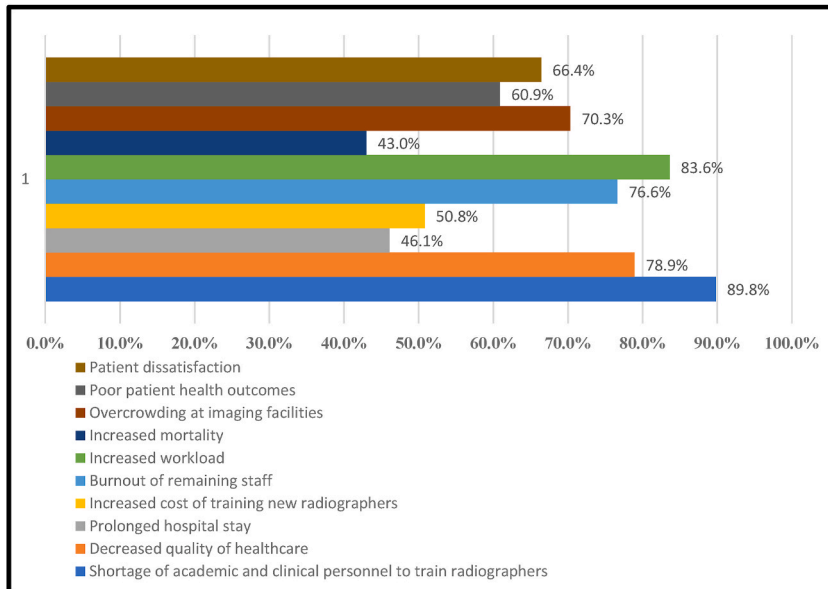


Fig. 4. Implications of radiographers' migration on the radiography profession.

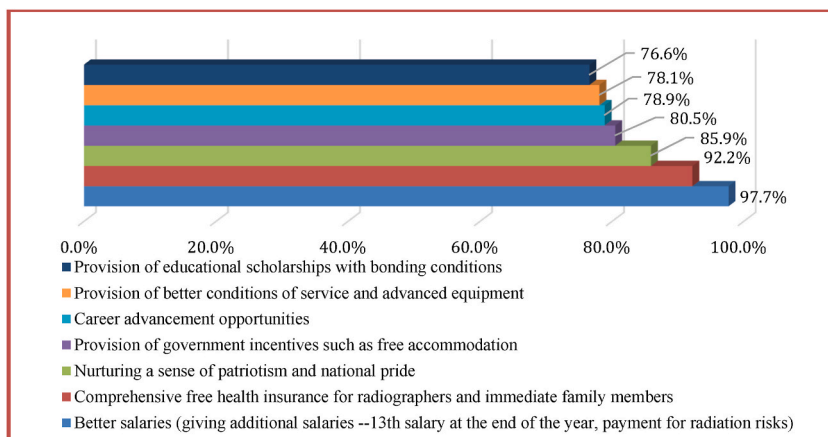


Fig. 5. Perception of Ghanaian radiographers on measures that can be implemented to mitigate the brain drain and enhance retention.

%). The majority of radiographers considered these measures as the most effective in stemming brain drain and enhancing retention. The provision of educational scholarships with bonding conditions was also acknowledged by 76.6 % of the participants.

5. Discussion

5.1. Intentions to migrate

The study found that the majority of participants (92.2 %) intended to practice abroad, particularly, in the United Kingdom, Canada, United States and Australia as primary destinations of interest.

The scarcity of skilled radiographers within their borders has led some of these nations to actively seek professionals from around the world, creating ample opportunities for international practitioners [11,12]. The allure of working in regions with a pronounced demand for radiography expertise is evident. Moreover, these countries have established efficient pathways for foreign radiographers, offering a smoother transition and reducing bureaucratic hurdles. These pull factors appeal to those seeking international careers [13, 14].

A census conducted by the Society of Radiographers [15] in a workforce study in 2021 revealed that 92 % of the 62 respondents reported vacant diagnostic radiography workforce posts, indicating a significant deficiency of radiographers in the United Kingdom [15]. A follow-up study published in 2022 also showed that 89 % of the 52 respondents across the country reported vacant diagnostic radiography workforce posts. It is suggested that there is an average vacancy rate across providers of 10.5 % [16]. In the USA, the American Society of Radiologic Technologists (ASRT) [17] also recorded an 'all-time high' of unfilled vacancies of 18.1 % among radiographers, representing an increase of 6.2 % in 2021. These statistics suggest a pressing need for more radiographers in both the United Kingdom and the USA.

5.2. Pull and push factors

The radiographers' migration phenomenon is complex, and its drivers are related to economic and institutional factors as well as associated political factors (Jurić, 2021). Push factors are usually associated with donor countries; pull factors are identified with receiving countries. The forces behind the factors are typically identified as political, social, economic, legal, historical, cultural, and educational [18].

5.3. Push factors

This study revealed that the most influential push factors of radiographers' migration were economic and health system factors. The study reports that poor salaries, poor working conditions, low professional satisfaction, the desire to fulfil self-aspirations, and governmental mismanagement were identified as the main push factors for radiographers to migrate, categorised into economic, health system, professional, social, and political factors, respectively. Studies [10,19,20] revealed similar findings among other healthcare professions. Kadel and Bhandari [1] also discovered that the lack of career opportunities, low salaries, and poor working conditions were the main push factors of brain drain among nurses in Nepal. Dovlo [21] similarly argued that low wages were the major reason for the brain drain of health professionals.

The low professional satisfaction observed as a substantial push factor is corroborated in a study by Owusu-Ansah [22] who hypothesised that highly satisfied health professionals were less likely to emigrate than less satisfied health professionals. Moreover, Li et al. [23] also found a positive correlation between corruption, bad governmental management, and brain drain to support the finding of the impact of governmental mismanagement as a strong push factor.

5.3.1. Pull factors

Pull factors are the conditions that contribute to workers' decision to migrate, usually because of better or more favourable conditions in another location, such as opportunities for professional growth, a better work environment, higher wages, and improved personal and family safety [24]. This is consistent with this study which found better living conditions and better salaries as the most significant economic pull factors. In a Caribbean study on health worker migration PAHO [24] also reported better working or employment conditions (45 %) and better economic or financial opportunities (25 %) as the leading pull factors of migration. The rising incidence of poverty also accounted for skilled workers' migration to HICs for better opportunities and better living conditions in a study by Chimenya et al. [25].

Better health infrastructure and adequate equipment and supplies were identified in this study as the most influential *health system pull factors*. According to Ibrahim et al. [26], sub-Saharan African countries including Ghana have relatively weak and inefficient healthcare systems, while Oleribe et al. [27] also identified inadequate human resources as the major challenge faced by African healthcare systems. In particular, a shortage of health personnel leads to inefficient healthcare systems and directly serves as a driving influence on the migration of radiographers.

Opportunities for career advancements and training were also recognised in this study as the most influential *professional pull factor*. Onah et al. [20], also reported similar findings where the migration intentions of health professionals were fuelled by improved prospects for career advancement in destination countries. Yarhere et al. [28] also discovered that 65.1 % of their participants had intentions to migrate due to professional satisfaction derived from working in better systems.

For the economic and health system pull factors, the results showed that respondents who perceived better economic and health system conditions as pull factors were more likely to migrate. Consistent with this, Gustafsson et al. [29], showed that individuals intended to migrate to access better healthcare and improve their livelihoods. Meanwhile, the offer of a better quality of life (*social factor*), and proper government management (*political factor*) were also leading pull factors.

5.4. Implications of brain drain in radiography

The effects of the brain drain of radiographers on the radiography profession in Ghana are detrimental. The majority of participants (89.8 %) anticipated a shortage of academic and clinical personnel available to train radiographers. In general, a lack of qualified trainers will adversely affect the quality and effectiveness of radiography education. This, in turn, has far-reaching consequences, as 78.9 % of respondents associated a shortage in the radiography workforce with a decreased quality of healthcare services.

The ramifications are felt on multiple fronts: in particular, participants felt patient care would be compromised, evidenced by prolonged hospital stays, and poorer health outcomes. This is supported by other studies which associated brain drain with decreased quality of patient care [10,30,31]. Additionally, most participants in this study agreed that the strain on the remaining workforce would result in burnout (76.6 %), increased workload (83.6 %), and poor healthcare delivery resulting in patient dissatisfaction (66.4 %). In corroborating these findings, Afzal et al. [32] also found that many health workers who remained in the public health system had greater workloads, experienced additional occupational stress leading to burnout, and were ill-motivated.

Olorunfemi et al. [33] highlighted the severe impacts of health professional emigration on healthcare services—such as a reduced workforce, increased workload, diminished quality of care, and higher mortality and morbidity rates—our current study also underscores these concerns. Specifically, 43 % of the participants expressed a belief that unmanaged migration could lead to an increase in patient mortality rates. The findings of this study agree with the work of Yan et al. [34] and Yakubu et al. [30] who also showed that a reduced workforce of health workers resulted in increased mortality and morbidity patterns arising from inaccessibility to essential healthcare services.

Furthermore, the respondents felt that scarcity of radiographers due to the migration of qualified and competent radiographers would compound the already existing challenges within imaging facilities, which can lead to overcrowding (70.3 %) and higher costs for training new radiographers (50.8 %). This study further identified that the migration of radiographers would lead to an increase of quacks and unqualified personnel, whose actions and performance of medical imaging procedures are professionally and clinically detrimental to patients and the healthcare system as a whole.

5.5. Mitigating strategies for overcoming brain drain

The findings underscore the multifaceted approaches that can be employed to address the reductions in the radiographer workforce due to migration. The survey results highlight the importance of tailored incentives in attracting and retaining skilled professionals.

Better salaries and additional incentives were indicated by an overwhelming majority (97.7 %) of the radiographers as an effective mitigating strategy to averting or minimising the migration of qualified radiography workforce. This strategy was also considered a necessary motivator to keep professionals at post. Specifically, the radiographers argued for innovative ideas such as the introduction of a 13th salary at the year's end and payment of allowances for hazard and radiation risks. The majority of the participants (92.2 %) also agreed that comprehensive health insurance coverage for radiographers and their families and ensuring their well-being were other potential mitigating factors to minimise brain drain. The recommendations of Akinwale and George [35] are also consistent with our findings that adequate and attractive pay and remuneration should be offered to the healthcare workforce in the industry. Provision of adequate remuneration, workplace incentives, strengthening healthcare systems and ensuring good economic and living conditions for radiographers can minimise brain drain and encourage radiographers to stay at post, as supported by Ramalan and Garba [36].

Fostering national pride and patriotism aimed at creating a sense of commitment to the profession within the local workforce was also recognised as a key mitigating factor to brain drain. This was affirmed by 86 % of the radiographers. Other strategies mentioned by the radiographers included enhanced government incentives like free accommodation, and educational scholarships with bonding conditions. These according to the radiographers could contribute to building a supportive environment that encourages long-term dedication to radiography. Consistent with this, Ebeye and Lee [31] also agreed that subsidised housing for health professionals could motivate them to stay at post.

Regarding the bonding strategy, this was previously implemented in Ghana to retain nurses [38]. This initiative can also be extended to radiographers; however, the government should be in a position to provide employment to them upon qualification [37]. The use of targeted scholarships and bonding has also been recommended in some studies [39,40]. In the long term, there is a need to train and improve the skills of more radiographers while mitigating brain drain. Training more radiographers for the local healthcare system and for potential export can be achieved in various ways. For instance, foreign lecturers can be involved in training more radiographers if the existing radiography lecturers are inadequate. Additionally, universities should be supported with the necessary resources to train more students, as there are many brilliant individuals who aspire to study radiography but are unable to do so due to limited admission opportunities.

Many participants agreed that the availability of career advancement opportunities and improved conditions of service coupled with advanced equipment reinforces the notion that professional growth and conducive working environments are pivotal in retaining radiographers. This study also identifies that the improvement of career development policies, the introduction of workplace safety and security measures, and the expansion of available technologies and equipment were important mitigating approaches necessary to stem the brain drain of radiographers. Participants also mentioned that providing employment opportunities for younger radiographers and eliminating quacks and quack training institutions would aid in curbing the brain drain.

Collectively, these suggestions present a comprehensive strategy for addressing radiographers' brain drain in Ghana and other countries so affected. The need to design holistic strategies encompassing financial recognition, personal and professional growth, and the creation of attractive and supportive environments is necessary to keep radiographers in service. It is hoped that this approach will

ensure a resilient and highly motivated radiography workforce capable of providing high-quality patient care.

5.6. Limitation

The sample size of the study is small, which means that any attempt to generalise the findings needs to be done with caution. Moreover, the study did not examine the specific institutions where these radiographers work; therefore, it is unclear how this could have affected the findings. Furthermore, as this study adopts a quantitative approach, its depth may be somewhat constrained. However, there are plans to delve into this topic qualitatively to gain deeper insights into the drivers of migration among Ghanaian radiographers to high-income countries.

6. Conclusion

This study provides firsthand insight on the intricate web of factors driving radiographers to migrate to HICs and the strategies that influence the retention of radiography professionals within the Ghanaian healthcare system. The findings underscore the paramount importance of creating comprehensive strategies that address both the tangible and intangible needs of these healthcare professionals. By balancing financial incentives, career growth opportunities and enhanced working conditions among other factors, retention of radiographers can be improved. Meanwhile, training more radiographers for the local healthcare system and for potential export can be achieved in various ways. Implementation of these strategies by policymakers, healthcare administrators, and stakeholders could retain and empower radiographers to excel, which in turn, could immensely contribute to the delivery of high-quality patient care and the overall advancement of healthcare systems on a global scale.

Data availability statement

The raw/processed data required to reproduce the above findings cannot be shared at this time as the data also forms part of an ongoing study.

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Ethics statement

In accordance with the Helsinki Protocol, ethical clearance for the study was approved by the Ethics and Protocol Review Committee of the University of Ghana School of Biomedical & Allied Health Sciences (SBAHS/AA/RAD/21847/2022–2023).

CRediT authorship contribution statement

Benard Ohene-Botwe: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Samuel Anim-Sampong:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration. **Shirley Naa Adjeley Quaye:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Theophilus N. Akudjedu:** Writing – review & editing, Writing – original draft, Visualization, Supervision. **William K. Antwi:** Writing – review & editing, Writing – original draft, Visualization, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX A

QUESTIONNAIRE.

THE DRIVERS OF MIGRATION OF RADIOGRAPHERS FROM AFRICA TO DEVELOPED COUNTRIES AND MITIGATING FACTORS: THE GHANA SITUATION.

This study aims to investigate the determinants of the radiographers' brain drain and mitigating factors from the perspective of radiographers in Ghana. Information provided here is strictly confidential and would be used for only academic purposes. Thank you

for your time and cooperation.

Kindly tick this box if you consent to participate in the study [].

SECTION A: Background Information.

1. Gender: Male [] Female [] Prefer not to say [] Other []
2. Highest education level: Diploma [] Degree [] MSc/M.Phil. [] Ph.D. [] Others (specify)
3. Age:
4. Marital status: Single [] Married [] Others (specify)
5. Number of working years:
6. Specialization: Diagnostic [] Therapy [] Both []
7. Organizational setup of your facility: Government [] Quasi-government [] Military [] Private []
8. Which equipment do you currently use for your daily work?:CT [] MRI [] X-ray [] Fluoroscopy [] Ultrasound [] Mammography [] Linac [] Cobalt-60 [] Nuclear medicine [] Others (specify)
9. Current radiography role: Clinical radiographer [] Research radiographer [] Academic radiographer [] Retired radiographer [] Clinical Academic radiographer [] Radiology manager []

SECTION B: Knowledge of radiographers’ migration.

10. Do you have any intention to practice in another country?Yes [] No [] If yes, which is your most preferred country to work in?
11. How would you want to go to your preferred destination?Direct application [] Through Agency [] Through Marriage [] Invitation []
12. Do you have any intention of returning to Ghana when you leave for greener pastures? Yes [] No []

SECTION C: PUSH FACTORS ASSOCIATED WITH RADIOGRAPHERS’ MIGRATION.

The following factors will “push” me to other countries to work.

KEY: Strongly Disagree -SD, Disagree -D, Neutral – N, Agree – A, and Strongly Agree – SA.

S/N	Factors	SD	D	N	A	SA
	Economic factors					
1	Poor salaries					
2	Poor living conditions					
3	Devaluation of the country’s currency					
4	Poor economic policies (taxes)					
	Health system factors					
5	Poor working conditions					
6	Work overload					
7	Poor health infrastructure					
8	Inadequate equipment and supplies					
9	Poor management and supervision					
	Professional factors					
10	Lack of training opportunities					
11	Lack of promotion opportunities					
12	Low professional satisfaction					
13	Underutilization of skills					
14	Perceived power differences between physicians and radiographers					
	Social factors					
15	The desire for life change					
16	Desire to fulfil self-aspirations					
17	Corruption in everyday life in the country					
18	The desire for life adventure					
	Political factors					
19	Lack of safety and security					
20	Governmental mismanagement					
21	Influence of colonial connections					
22	Influence of bilateral agreements					

SECTION C: PULL FACTORS ASSOCIATED WITH RADIOGRAPHERS’ MIGRATION.

The following factors will “pull” me to travel outside the country to work.

KEY: Strongly Disagree -SD, Disagree -D, Neutral – N, Agree – A, and Strongly Agree – SA.

S/N	Factors	SD	D	N	A	SA
Economic factors						
1	Better salaries					
2	Better living conditions					
3	Value in the country's currency					
4	Demand for labour					
5	Better insurance policies					
Health system factors						
6	Better working conditions					
7	Better health infrastructure					
8	Adequate equipment and supplies					
9	Proper management and supervision					
10	Active recruitment overseas					
Professional factors						
11	Several career advancement and training opportunities					
12	Promotions at work					
13	High professional satisfaction					
14	Opportunities to gain better clinical experience					
15	Opportunity for research					
16	Desire to gain a foreign professional qualification					
17	Opportunity for professional networking					
Social factors						
18	To join family/friends					
19	Desire to experience working in a different environment					
20	Offer of a better quality of life					
21	Desire to gain foreign citizenship					
22	Access to social networks					
23	Religious acceptance					
24	Identity acceptance					
Political factors						
25	Safety and security reasons					
26	Effective governmental management					
27	Smooth political transitions					
28	Peaceful coexistence of political parties					

SECTION D: IMPLICATIONS OF RADIOGRAPHERS' MIGRATION ON THE RADIOGRAPHY PROFESSION.

29. Identify the effect(s) that radiographers leaving Ghana will have on the radiography profession. (Select as many that apply)
 Shortage of academic and clinical personnel to train radiographers [] Decreased quality of healthcare delivery [] Prolonged hospital stay [] Increased cost of training new radiographers [] Burnout of remaining staff [] Increased workload [] Increased mortality [] Overcrowding at imaging facilities [] Poor patient health outcomes [] Patient dissatisfaction [] Other (Specify) ...
30. What immediate measures can be put in place to encourage radiographers to stay in GHANA? (Choose as many as apply)
 Better salaries (Giving additional salaries eg. 13th pay, payment for radiation risks) [] Provision of government incentives such as free accommodation [] Career advancement opportunities [] Provision of educational scholarships with bonding conditions [] Provision of better conditions of service and advanced equipment [] Comprehensive free health insurance for radiographers and immediate family members [] Nurturing a sense of patriotism and national pride []

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