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Neurosurgical training in the Caribbean

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1. Introduction

The Caribbean has a rich and diverse landscape, culture and people. It consists of primarily English-speaking islands, but also includes French, Spanish, Dutch and other multilingual countries. Although these nations all fall under this one umbrella of the Caribbean, their economic resources, education systems and healthcare advancements differ widely. This was the importance of highlighting the Gini coefficient within our results. This is a measure of wealth distribution within a country, with values approaching 1 (100%) being an indicator of great disparity (Sitthiyot and Holasut, 2020). The majority of Caribbean countries historically fell under the designation of developing nations based on a human development index, but other economic status classifications have been provided (United Nations Statistic Division (organisation), 2022; The World Bank, 2022). Under this new designation, Caribbean nations range from low-middle income to high income economic statuses.

The importance of timely access to medical health care has been discussed greatly, along with its effect on a population. The neurological surgery specialty focuses on traumatic, oncological, vascular and other pathological conditions affecting both the central and peripheral nervous systems. Of which, traumatic brain injury and spine damage from road traffic accidents, assaults and fall injury may be overwhelmingly underestimated. This presents a source of great disability and mortality if not managed appropriately (Griswold et al., 2020; Rubiano et al., 2015). Traumatic neurosurgical cases in low- and middle-income countries represent 74% of the neurosurgical load, compared to 52% globally (Meara and Greenberg, 2015). The neurosurgical specialty provides life-altering surgical management in both emergency and elective circumstances. Unfortunately, access to this surgical specialty is not readily available to all.

Neurosurgery graduate training programs provide a source of trained professionals in the field that can alter the delivery of the surgical care infrastructure (Meara et al., 2015). It has the ability to mold the future of neurosurgery in the Caribbean. Here, we aim to identify the opportunities for neurosurgery graduate training in the Caribbean and how this affects its workforce.

2. Methods

2.1. Data collection

An outline of the Caribbean countries within our study population was defined. Data was collected on all the countries located within the geographical borders of the Caribbean, inclusive of countries that form part of the Caribbean community and common market (CARICOM). Thereafter we conducted a search via PubMed using the key words "neurosurgery", "education", "residency", "training", "graduate" in combination with all the different countries in the Caribbean and also the collective term "Caribbean". We also did a Google search (Google Inc., Mountain View, California, USA) with the same key words, adding "medical schools" to collect relevant gray literature. We focused on English articles, however if no information was found on a specific country, an additional search was performed in the native language of the respective country (French, Spanish or Dutch). Information not found

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through a digital search would be confirmed by known contacts in the region. The information of the countries was recorded and assessed on a data collection form.

3. Results

Thirty-two (32) countries in the Caribbean were added to our sample population (Fig. 1). The population, income status and gross domestic product (GDP) has been depicted in Table 1. Eighteen (Kanmounye et al., 2021) of these countries have permanently situated consulting neurosurgeon(s) at the time this study was undertaken. Leaving an estimated 44% of Caribbean countries without permanent neurosurgeons. Visiting neurosurgeons or virtually consulting neurosurgeons have not been considered here as this information is not readily available and is hence difficult to estimate. Additionally, although visiting neurosurgeons are a critical aspect of neurosurgery in the Caribbean, this does not provide a true picture of the full-time neurosurgical workforce (see Fig. 2).

Medical schools are available in almost every country (81%) except for Turks and Caicos, the Virgin Islands (British and United States), Statia, Martinique and Saint Martin (Fig. 3). Most of the available medical schools are offshore (77.8%), that is, a typically private medical school that serves non-local applicants. These offshore medical schools have an American medical accreditation system and take approximately 4 years for completion. Only a few countries have solely local or regional government established or funded medical schools (12.5%), namely Suriname, Haiti, Guadeloupe, and Trinidad and Tobago. The other countries have the benefit of both offshore and local medical schools. The University of the West Indies have 3 medical school campuses established in the Caribbean, located in Barbados, Jamaica and Trinidad and Tobago. The duration of medical school in regional countries vary from 4 to 6 years.

The Caribbean has only 4 (12.5%) countries with local neurosurgery training programs, being Trinidad and Tobago, Jamaica, Cuba and Dominican Republic (Fig. 4). In Puerto Rico, there was a neurosurgical postgraduate program, however their accreditation was lost this year (De Jesus, 2022). Furthermore, in 2018 it was published that Haiti created a self-sustainable neurosurgery program due to their extreme lack of neurosurgeons (Shah et al., 2018). However, to our knowledge, it is not yet operational.

Currently, Trinidad and Tobago has 4 neurosurgery residents (6-year program), and Jamaica has approximately 10–12 neurosurgery residents (6-year program). For Cuba and Dominican Republic, the estimation of neurosurgery residents is not readily accessible, due to the multiple programs they have available and the variability in the quantity of residents entering the program annually. The duration of training programs in both countries are approximately 4–5 years (Ministerio de Salud Publica, 2019; Riverón, 2013). There is no regional consensus on these training programs, nor is there a Caribbean regional examination, based on our research.

Fig. 1. Countries in the Caribbean community.

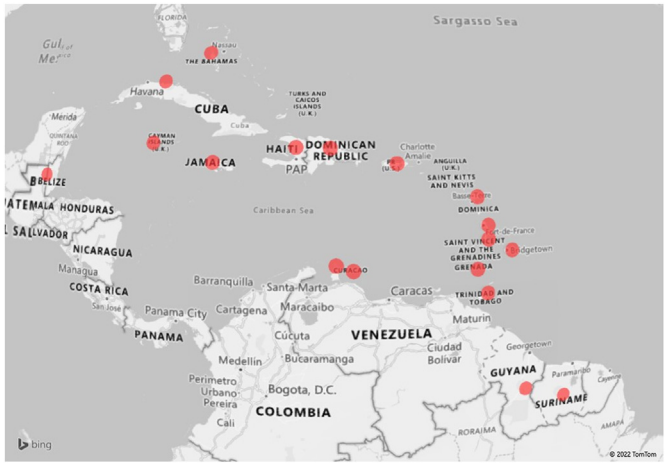

Fig. 2. Countries with permanent consulting neurosurgery.

Other countries that do not have a local neurosurgical program, either send eligible candidates to academic hospitals abroad, or eventually contract young neurosurgeons after residency from other countries. With respect to the former, the academic hospitals abroad may or may not be affiliated with that local hospital. For example, the neurosurgeons from the Dutch Caribbean have all been trained in the Netherlands. Currently, there is one neurosurgery resident (a local physician) from the Dutch Antilles that is being trained in an affiliated academic hospital in the Netherlands to eventually join the neurosurgery faculty in Curaçao (Dos Santos Rubio and Merkies, 2021). On the contrary, Grenada (a former British colony) has a Cuban neurosurgeon.

4. Discussion

4.1. Neurosurgical training capacity in the Caribbean

The Caribbean is a collective term for countries with varied colonial backgrounds, political viewpoints and healthcare systems. Over the years several unifying bodies have been developed such as the Organisation of Eastern Caribbean States (OECS), to provide support and facilitate growth in the region (Organisaton of Eastern Caribbean States, 2020). Neurosurgical graduate training in the Caribbean is essential to filling the deficit in the region, especially in countries where no neurosurgeon is available (Meara et al., 2015). Countries with a graduate program have a direct source of future neurosurgeons to supply the need in that place. Among the extensive list of countries in this Caribbean database, we have identified four (Griswold et al., 2020) countries with active neurosurgery training programs. That represents only 13% of countries in our database.

The only regional tertiary medical faculty in the Caribbean is the University of the West Indies. This institution has various campuses on different islands and serves as a hub for many locals across the region (University of The West Indies, 2022; Browne and Shen, 2017). There are currently active neurosurgical graduate training programs affiliated with the university in two islands, Jamaica and Trinidad and Tobago. The graduate training program in Trinidad and Tobago has been recently established over the last 5 years, with its first graduating students occurring within the near future. On the other hand, Jamaica has a long recognized training program over decades, producing several neurosurgeons in the region (Fletcher et al., 2003). Contrastingly, where these two islands may have one neurosurgery training program, Cuba has multiple active training programs. A direct source of neurosurgeons to maintain the neurosurgical workforce on that island.

Table 1
Overview of Caribbean nations included within sample population, with corresponding income status, GDP per capita, GINI index and population.

Country	Income status	GDP per capita US$ (2021)	GINI INDEX (%) (2020)	Population
Antigua & Barbuda	High	14,900.80	_	98,728
Bahamas	High	28,239.40	91.4	396,914
Barbados	High	17,033.90	80.4	287,708
Belize	Upper middle	4,420.50	83.4	404,915
Dominica	Upper middle	7560	_	72,172
Grenada	Upper middle	9928.6	_	113,015
Guyana	Upper middle	9374.8	76.5	790,329
Haiti	Lower middle	1814.7	85.2	11,541,683
Jamaica	Upper middle	4586.7	82	2,973,462
Montserrat[a]	Upper middle	12017	–	5,000
St Lucia	Upper middle	9571	51.2 (2016)	184,401
St Kitts & Nevis	High	18,230.10	_	53,546
St Vincent & the Grenadines	Upper middle	7996.6	_	111,269
Suriname	Upper middle	4836.3	87.1	591,798
Trinidad & Tobago	High	15,243.10	78	1,403,374
Curaçao	High	16,109.9 (2020)	[a]28.1 (2021)	152,369
Aruba	High	23,384.3 (2020)	_	107,195
Saba	High	24,300 (2019)	_	1, 918
Statia	High	38,400 (2019)	_	3, 142
Bonaire	High	27,000 (2019)	_	21, 745
Sint Maarten	High	28,988.30	_	42,846
Guadeloupe	High	[b]24,350 (Euro, 2018)	[a]32.4 (2021) France	400,002 (2020)
Martinique	High	[b]24,110 (Euro, 2018)	[a]32.4 (2021) France	374,912 (2020)
Saint Martin	High	21,459.3 (2014)	_	39,239
Turks and Caicos	High	24,047.10	_	39,226
Dominican Republic	Upper middle	8,603.80	39.6(2020)/ [a]43.7 (2021)	10,953,714
Cuba	Upper middle	9,477.9 (2020)	_	11,317,498
French Guiana	High	[b]14,879 (Euro, 2018)	[a] 32.4 (2021)	294,071
Cayman Islands	High	85,346.8 (2020)	_	66,498
Puerto Rico	High	31,429.90	_	3,263,584
British Virgin Islands	High	85,346.80	_	30,423
US Virgin Islands	High	39,552.2 (2020)	_	105,870

GINI INDEX: French Caribbean 73.8, Dutch Caribbean 69.1, British Caribbean 80.8.
French Caribbean (Guadeloupe, Martinique, Saint Barthélemy, Saint Martin, and Saint Pierre and Miquelon).
Dutch Caribbean (Aruba, Bonaire, Sint Eustatius and Saba, Curacao, and St Maarten).
British Caribbean (Anguilla, Antigua and Barbuda, British Virgin Islands, Cayman Islands, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines and Turks and Caicos Islands).
[a] *Global Wealth Data book 2021* (Leidinger et al., 2018).
[b] *French bureau of statistics*.

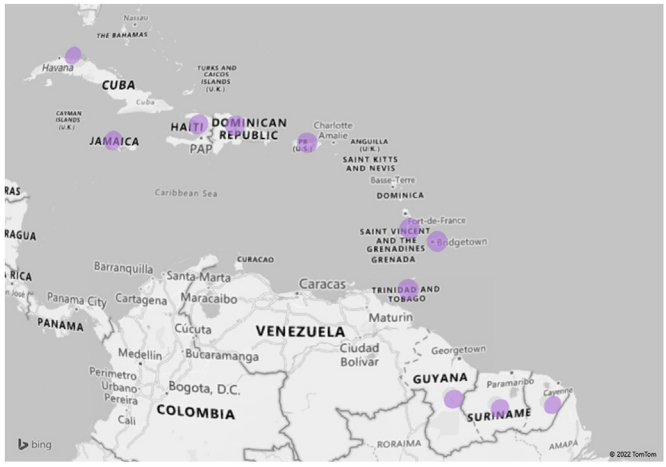

Fig. 3. Countries with regional medical schools.

Fig. 4. Countries with local neurosurgical training programs.

4.2. Challenges

Browne et al. identified economic challenges as a major hurdle in the establishment of tertiary education in the Caribbean (Browne and Shen, 2017). This is a contrasting concept, given that more than half of the countries in this study have attained a high-income economic status based on data from the World bank (The World Bank, 2022). Economic stability and the diversion of funds towards the progression of education and the healthcare system are major factors to be analysed. Perhaps, this may be as a result of not recognizing the need for more graduate programs and its impact on the health of a nation. A similar study performed in Africa demonstrated that 40.7% of these nations had established neurosurgery graduate training programs. However, inadequacies in the neurosurgical workforce were still a factor in this region (Dada et al., 2021). Obstacles determined to be critical to advancement included lack of resources and the geospatial accessibility (Dada et al., 2021).

Neurosurgical workforce density is defined as the number of neurosurgeons per population (Kanmounye et al., 2021). It is estimated that within low- and middle-income countries, 1 neurosurgeon for every 212, 000 persons will and should suffice for neurotrauma care (Corley et al., 2019). Our study population comprises over 46 million people. Under this purview, the estimated workforce density was one neurosurgeon for every 111,000 persons. However, we must bear in mind that the Caribbean consists of several countries with non-adjacent borders and its population density varies greatly per country. We cannot "copy and paste" a standard neurosurgical workforce calculation for this region, as

it does not apply. The United States and Europe have a neurosurgical workforce of 1 per 67,000 and 1 per 100,000 respectively, and these regions still find themselves with a shortage of neurosurgeons (Reulen et al., 2009; Rosman et al., 2013). Figures less than 1 neurotrauma surgeon per 212,000 persons, along with the maldistribution of the neurosurgeons have a considerable effect on patient outcome (Meara et al., 2015; Corley et al., 2019). Within the Caribbean community, this estimated neurosurgeon impact is being met, the concern lies with the distribution of these neurosurgical specialists, with the highest concentration being situated in Cuba, at 58% of the total Caribbean neurosurgery workforce (Table 2).

It has been postulated that 3.5 million persons (22%) within CARICOM, the English-speaking Caribbean community, do not have access to timely neurosurgical management (Rolle et al., 2021).We believe that the inadequate accessibility of neurosurgical graduate training is a direct contributing factor to this. However, only redistributing neurosurgeons or creating more training programs will not suffice. There are other factors that need to be addressed. Due to the delicate nature of central nervous system pathology, neurosurgery is considered a highly complex profession where morbidity and mortality can be substantial. Additional resources have been developed over the years to ensure safe surgeries and post-surgical care. This makes contemporary neurosurgery a very costly profession. Furthermore, to be able to train neurosurgical residents and ensure that they receive enough "hands-on" surgical time, the country would need a diverse, continuous and sufficient supply of surgical cases to generate a general neurosurgeon. This is not always possible, so some countries send eligible candidates abroad for education with the risk of them never returning after completing their residency.

For a smaller island with limited resources, it might not be feasible to invest in local complete neurosurgical care. In that case, there would be a need to invest in a timely surgical referral service. With neurosurgery, timing is critical, especially in the scope of neurotrauma. This requires a large financial and logistical investment which is not available in some countries. Furthermore, we must consider the role of solo neurosurgeon on an island with a population up to 212,000 persons. This translates into work hours exceeding labour laws, with one specialist trying to excel in every aspect of the profession, which is arduous. Thus, still requiring patient referrals to other countries for surgeries, or inviting visiting neurosurgeons to operate locally. Such a case is demonstrated on the island of Curaçao with a population over 150,000 persons, with one neurosurgeon, who also receives external referrals from other countries. This is an especially demanding career.

4.3. *Reimagining neurosurgical care delivery*

Solutions to adjust the deficit and inadequacies of neurosurgical training and its workforce can seem too grand. However, it principally requires the identification of the need and the areas highly affected. In countries where neurosurgical programs are not present, professional qualification titles and training is outsourced regionally and internationally, mostly making use of that country's colonial heritage. The most prominent countries include Jamaica, Cuba, the Netherlands and the United Kingdom. Without permanent neurosurgeons, connections have been established with visiting neurosurgeons, both local and internationally. Additionally, patients are transferred to other countries where one is available (Dos Santos Rubio and Merkies, 2021; Garland, 2021; Observer. Teen continues fighting for, 2022). This faces its own challenges to both surgeons and patients. These options provide a short-term fix on the larger scale.

4.4. *Recommendations (Dada et al., 2021; Leidinger et al., 2018)*

- ●Identify and define the met and unmet neurosurgical burden within different territories within the Caribbean.
- ●Expand the number of neurosurgical programs in training deserts such as Haiti.
- ●Provide adequate compensation and professional resources to local physicians to pursue in demand surgical specialties.
- ●Utilize technology to enhance training and care delivery, for example remote coaching and telemedicine.
- ●Increase collaboration with international partners to sustain and advance neurosurgical standards of care.
- ●Establish trust and partnerships between Caribbean countries. This will enhance local collaborations and educational opportunities in different languages to build regional solidarity.

Table 2
Overview of neurosurgeons per inhabitant per country.

Countries with Consulting Neurosurgery	Population	Neurosurgeons *	Inhabitants per Neurosurgeon
Guadeloupe	400,002	8	50,000
Saint Lucia	184,401	3	61,467
Martinique	374,912	6	62,485
Cayman Islands	66,498	1	66,498
The Bahamas	396,914	4	99,229
Aruba	107,195	1	107,195
Grenada	113,015	1	113,015
Cuba	11,317,498	241	46,961
Puerto Rico	3,263,584	27	120,873
Trinidad and Tobago	1,403,374	11	127,579
Belize	404,915	3	134,972
Dominican Republic	10,953,714	77	142,256
Barbados	287,708	2	143,854
Jamaica	2,973,462	20	148,673
Curaçao	152,369	1	152,369
Suriname	591,798	2	295,899
Guyana	790,329	1	790,329
Haiti	11,541,683	5	2,308,337

NB: The majority of data was reused from a previous project led by author E.dSR. Publication of that manuscript is still pending. Part of the data is an estimation on the basis of a survey done within the Caribbean. Part was retrieved from digital information or personal communications with various faculty within countries of interest.

5. Strength points and limitations

This study has several strong points. We retrieved data from published reports as well as personal communications to ensure a comprehensive evaluation of the situation in the Caribbean region. Data on the studied countries included many key indicators of the economic and financial status including income status, GDP per capita (2021), and Gini index. Nonetheless, the study has a few limitations; for example, some countries have limited published data and their electronic information was not readily available in the English language.

6. Conclusion

Only 13% of countries within our Caribbean study population have active neurosurgery training programs. This study expands the literature by providing new data about the neurosurgical training programs in the Caribbean region, which has received less attention in the literature. This article highlights the unmet needs to leverage the neurosurgical training programs in the Caribbean to meet the recommended neurosurgical workforce density, as needed for the region. One of the key recommendations to bridge the geographical divide and maldistribution of the neurosurgical workforce is fostering solidarity among nations.

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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