Title

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Journal

Laryngoscope Investigative Otolaryngology, 10(1)

ISSN

2378-8038

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Publication Date

2025-02-01

DOI

10.1002/lio2.70078

Peer reviewed

Laryngoscope
Investigative Otolaryngology

ORIGINAL RESEARCH OPEN ACCESS

Essential Equipment for Baseline Otolaryngology-Head and Neck Surgery Care: A Global Cross-Sectional Survey

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Received: 7 October 2024 | **Revised:** 29 December 2024 | **Accepted:** 1 January 2025

Funding: The authors received no specific funding for this work.

Keywords: equipment | global surgery | health disparities | infrastructure | low-resource

ABSTRACT

Objective: Availability of surgical equipment and access to essential clinical services remains an important barrier to surgical care delivery, particularly in low- and middle-income countries (LMICs). This study aims to characterize the relative availability of essential equipment for otolaryngology-head and neck surgery (OHNS) care across World Bank income groups.

Methods: We conducted a cross-sectional survey on otolaryngologists' perceptions on the availability of surgical equipment and ancillary services in their respective practice settings per a 5-point Likert scale ranging from never to always available. The study was disseminated online via professional societies, personal contacts, and social media. Eligible participants included otolaryngologists from 194 WHO-recognized countries, which were grouped by World Bank income group classification and WHO region.

Results: The study involved 146 otolaryngologists, 69 (47%) from high-income countries (HICs), and 77 (53%) from LMICs. LMIC respondents were predominantly from the African and South-East Asian regions, which comprised 48% and 7.8% of all LMIC respondents, respectively. Results revealed significant differences in the availability of otologic, rhinologic, and endoscopic airway equipment between HICs and LMICs. Differences existed among commonly used equipment such as tympanomastoidectomy equipment and rigid bronchoscopy, to subspecialized equipment such as functional endoscopic sinus surgery equipment and cochlear implants ($p < 0.05$ each).

Conclusions: The study highlighted key disparities in the availability of essential equipment for baseline OHNS care, especially for pediatric airway and otologic conditions. These results can be used to guide investment and advocacy efforts to improve specialty-specific surgical infrastructure relative to the global burden of OHNS diseases in low-resource settings.

Level of Evidence: 3

Tarika Srinivasan and Alexander Cherches are co-first authors.

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For affiliations refer to page 10.

1 | Introduction

Specialized equipment and infrastructure are key elements for providing global surgical care. Anesthetic, surgical, and ancillary medical services are essential for treatment of operable conditions, which comprise 28%–32% of the total global burden of disease [1, 2]. Surgery has been under-prioritized within global health efforts due to the perceived high cost of surgical infrastructure and complexity of surgical care delivery [3]. Otolaryngology-head and neck surgery (OHNS) conditions are particularly understudied with respect to global surgical care delivery, despite OHNS conditions representing a significant burden of disease [4]. Hearing loss affects 1.6 billion people and is the third largest cause of disability globally [5]. Otitis media, one of the most common preventable causes of hearing loss in children, has an estimated incidence of 471–709 million cases per year [6], with sequelae of chronic otitis media often requiring surgical intervention. Head and neck cancers account for 5.7% of global cancer-related mortality, in which low- and middle-income countries (LMICs) face significantly higher mortality burden and economic loss compared to high-income countries (HICs) [7]. Finally, OHNS also comprises emergent care of life-threatening conditions, such as foreign body removal and craniomaxillofacial trauma. Investment in surgical infrastructure is particularly important in subspecialities like OHNS, which heavily rely on specialized equipment for otologic, rhinologic, and airway procedures.

Per World Health Organization (WHO) cost-effectiveness criteria, surgical investment in LMICs can be considered cost-effective and even very cost-effective [8]. Several validated tools [9–11] for evaluation of surgical capacity for trauma and emergent conditions have revealed significant shortages of surgical equipment in several countries in sub-Saharan Africa [12–16], Asia [17–20], and Central and South America [21–23]. These findings underscore the need for government engagement in enhancing surgical capacity and infrastructure. Recently, professional organizations have advanced surgical equipment appraisal to include specialty-specific equipment for anesthesiology and pediatric surgical care [24, 25].

The Global OHNS Initiative is an international consortium of OHNS clinical providers, trainees, and researchers dedicated to universal access to high-quality, safe, timely, and affordable OHNS care. The Initiative previously used Delphi methodology to identify a consensus of priority OHNS conditions and procedures that national health systems should be capable of managing [26, 27]. These findings were used to derive an expert-driven list of the minimal equipment necessary for the medical and surgical care of these priority conditions [28]. By expanding the scope of current surgical capacity assessments to include OHNS care, this essential equipment list may facilitate the identification of gaps in policy and enable targeted allocation of investments to strengthen health systems.

The Global OHNS Initiative has recently developed a series of multinational surveys to OHNS providers to generate primary data on the status of surgical infrastructure and barriers to care encountered in OHNS practice worldwide. The "Infrastructure" sub-study described here aims to characterize the perceived availability of OHNS equipment and infrastructure across regions and income groups. We hope to identify key areas of prioritization for policy and advocacy efforts aimed at improving OHNS care in LMICs.

2 | Methods

2.1 | Survey Tool

The survey was developed through collaborative meetings involving OHNS researchers from the Global OHNS Initiative and experts in survey design and biostatistics, representing diverse perspectives from multiple countries (Survey Tool in Appendix S1). This survey was translated into the six official United Nations languages and administered via the Research Electronic Data Capture (REDCap) database, taking approximately 10 min to complete. Otolaryngologists were asked to respond to questions about infrastructure, barriers to OHNS care, and the cost of OHNS care in their country of practice and practice setting. The following discussion focuses only on the infrastructure and equipment subsection of the survey.

Eligible participants were otolaryngologists from the 194 WHO member states and Taiwan. As detailed in a previous publication, we applied an international consensus-driven definition of "otolaryngologist" to mean a "doctor with a medical degree who has undergone specialized or accredited training in managing conditions of the ear, nose, and throat and head and neck. This definition does not include trainees" [29].

2.2 | Data Collection

Survey consent and content were administered using the REDCap database [30]. To maximize outreach, a three-pronged approach was used for survey dissemination. First, survey links were sent to international and national professional OHNS societies. Professional OHNS societies were identified either via membership among the authors and other members of the Global OHNS Initiative, or via web search. Professional societies with active email addresses listed for contact were sent no more than three emails requesting distribution of the survey to their society membership; the means of internal dissemination was left to the purview of each society respectively. Such recruitment emails were sent to 11 global societies and 106 national or regional OHNS societies (Figure S1). Second, Global OHNS Initiative representatives in each World Bank region utilized snowball sampling to personally invite participation from otolaryngologists in their region. These representatives were instructed to contact each potential participant no more than three times. Third, targeted social media posts including the survey link were shared via X Corp (formerly known as Twitter Inc.) three times, a month interspersed between posts. Survey recruitment occurred from October 2022 through June 2023.

2.3 | Statistical Analysis

Responses that were incomplete, had duplicate identifying information, or did not include a country of practice were removed

from the analysis pool (Figure S1). Countries were categorized by WHO region (African Region, Region of the Americas, South-East Asia Region, European Region, Eastern Mediterranean Region, and Western Pacific Region) and fiscal year 2023 World Bank Country and Lending Groups classification (low-, lower-middle, upper-middle, and high-income countries). Country population was obtained from World Bank estimates, except for Taiwan and Niue which were obtained from the Central Intelligence Agency World Factbook [31, 32].

A dichotomous variable denoting World Bank income group (HIC, LMIC) was used to create stratified demographic tables. Chi-squared tests were conducted to compare HICs to LMICs across discrete characteristics (i.e., gender, WHO region, facility level, rural/urban practice setting, and public/private/NGO practice setting). T-tests were applied to assess differences in averages of continuous variables (i.e., age) between HICs and LMICs. Chi-squared tests were used to assess the distribution of responses for 5-point Likert survey questions between HICs and LMICs (Survey Tool, Appendix 1). Two-sided p-values were employed; statistical significance was defined as $p < 0.05$ for all analyses. All statistical analyses were performed using R version 4.2.3.

2.4 | Ethical Approval

This study was approved by the Mass General Brigham Institutional Review Board (Protocol 2021P000076). Informed consent was collected from all participants via REDCap as the first step of survey administration [30].

3 | Results

One hundred forty-six otolaryngologists, 69 from HICs and 77 from LMICs, participated (Figure 1). All six WHO regions and various practice settings were represented. Respondents had a mean age of 45 years and 68% were male (Table 1). Respondents from the African and South-East Asian regions, in which most countries are LMICs, comprised 48% and 7.8% of all LMIC respondents, respectively (Table 1, $p < 0.001$). The Western Pacific region represented 36% of all HIC respondents due to a high response rate from Australia (Figure 1). The other three WHO regions were represented by respondents from both HICs and LMICs. Across both HIC and LMIC strata, there was no significant difference in facility level, urbanicity, or clinical practice setting among respondents. Notably, private practice settings

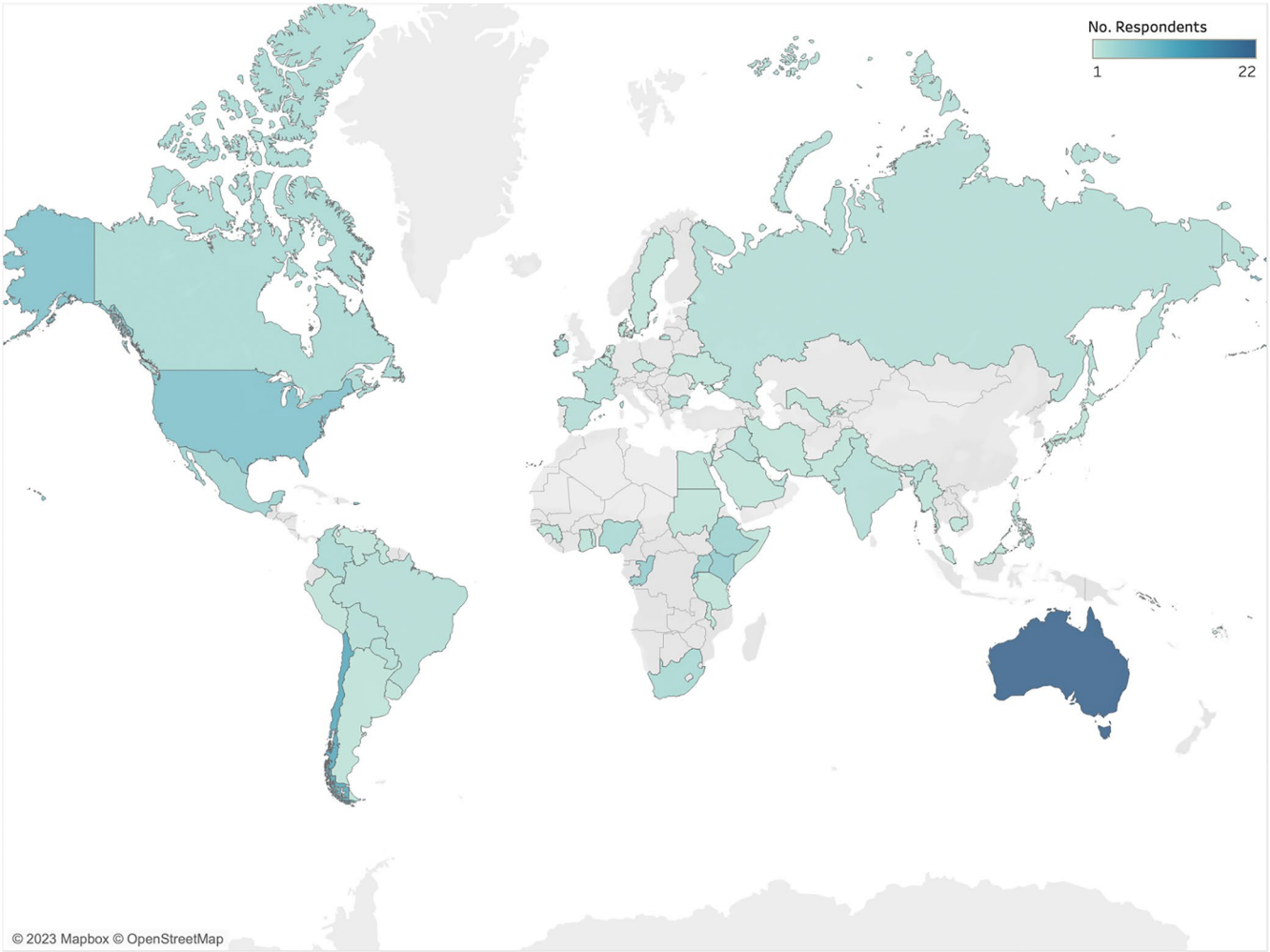

FIGURE 1 | Heatmap of number of responses received from each country.

TABLE 1 | Demographic survey responses by World Bank income groups: High-income countries (HICs) vs. low- and middle-income countries (LMICs).

Country income group				
Characteristic	***N***	**HIC, *N* = 69 (47%)**	**LMIC, *N* = 77 (53%)**	***p***
Age	144	45 (38, 58)	45 (36, 52)	0.091
Gender	146			0.648
Male		45 (65%)	54 (70%)	
Female		24 (35%)	23 (30%)	
Other		0 (0%)	0 (0%)	
Region	146			< 0.001*
Americas		27 (39%)	16 (21%)	
Africa		0 (0%)	37 (48%)	
Western Pacific		25 (36%)	7 (9.1%)	
Europe		13 (19%)	6 (7.8%)	
Eastern Mediterranean		4 (5.8%)	5 (6.5%)	
South-East Asia		0 (0%)	6 (7.8%)	
Facility level	145			0.183
3		37 (54%)	52 (68%)	
2		21 (30%)	15 (20%)	
1		11 (16%)	9 (12%)	
Urbanicity-Rurality	144			0.305
Urban		50 (72%)	46 (61%)	
Urban and rural		18 (26%)	26 (35%)	
Rural		1 (1.4%)	3 (4.0%)	
Practice setting	145			0.375
Public		52 (75%)	50 (66%)	
Private		16 (23%)	23 (30%)	
NGO		1 (1.4%)	3 (3.9%)	

*$p < 0.05$.

represented 23% of responses from HICs and 30% of responses from LMICs (Table 1, $p = 0.375$).

Significant differences in availability were noted among equipment used for general OHNS examination, otologic, and head and neck surgery (Figure 2, Table 2). Most endoscopic equipment, including endoscopic airway and rhinologic equipment, is displayed separately (Figure 2, Table 3), given that use of this equipment requires the infrastructure of a light tower and visual display system. Among essential equipment needed for general OHNS care and examination, the availability of procedural microscopes and flexible endoscopes differed significantly in HICs versus LMICs ($p = 0.008$ and $p < 0.001$, respectively). Twenty-one percent (16/76) and 3.9% (3/76) of LMIC respondents stated that flexible endoscopes were "never" or "rarely" available, compared to only 5.8% (4/69) of HIC respondents (Table 2). Availability for most other general OHNS equipment was similar between HICs and LMICs, except for point-of-care ultrasound, facial nerve monitoring, and bipolar diathermy (Figure S1).

There were several differences in the availability of otologic equipment between HICs and LMICs. Access to otologic drills and burrs, otoendoscopes, and tympanomastoidectomy sets was significantly different among HIC and LMIC respondents (Table 2, $p < 0.001$, $p = 0.001$, $p = 0.001$). This equipment was "never" or "rarely" available to 25%–35% of LMIC respondents, while the majority of HIC respondents denoted this equipment as "always" available (Table 2). The difference in cochlear implant (CI) availability was also significant, with CIs "never" or "rarely" available to 66.1% of LMIC respondents compared to 35% of HIC respondents (Table 2, $p < 0.001$).

Among essential equipment for head and neck surgery, there was a significant difference in the availability of neck dissection tools between HICs and LMICs (Table 2, $p = 0.016$). The difference in the availability of tracheostomy tubes and adenotonsillectomy equipment was not found to be significant (Table 2). Availability of additional advanced head and neck and microvascular surgical equipment is described in Figure S1.

For adult airway examination, there was no difference in the availability of the rigid lens endoscope (Hopkins rod), rigid bronchoscope, and ancillary bronchoscopic equipment; however, LMIC respondents reported lower access ($p = 0.045$) to direct laryngoscopy (DL) and biopsy equipment compared to HIC counterparts (Table 3). Only 7.2% (5/69) of HIC respondents reported direct laryngoscopy equipment as "never" or "rarely" available, compared with 23.3% (18/76) of LMIC respondents (Table 3). Though not a significant difference between groups, adult rigid bronchoscopes were "never" or "rarely" available to 18.9% of HIC respondents and 31% of LMIC respondents (Table 3).

Pediatric airway equipment exhibited statistically significant differences in availability compared to corresponding adult airway equipment. HICs and LMICs had significant differences in the availability of pediatric rigid lens endoscopes (Hopkins rod), ancillary bronchoscopic equipment, and DL and biopsy sets ($p = 0.004$, 0.028, and 0.018, respectively). Pediatric rigid bronchoscopes were "never" (27%) or "rarely"

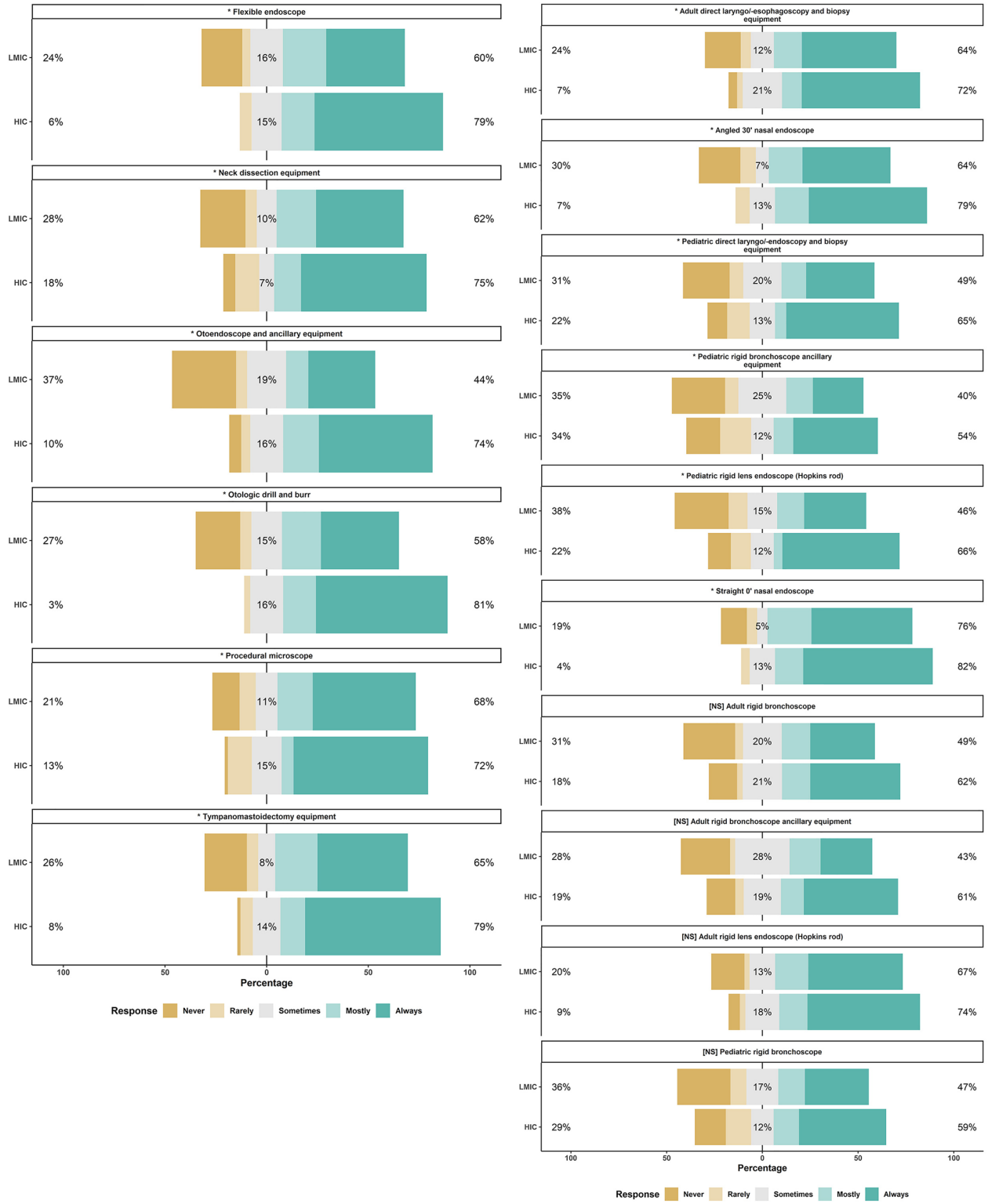

FIGURE 2 | Visual depiction of highest-priority essential OHNS equipment in high-income countries versus low- and middle-income countries. * denotes significant difference between groups. [NS] denotes no significant difference between groups.

(8.2%) available to 35.2% of LMIC respondents; similarly, 35.8% of LMIC respondents denoted that ancillary equipment for pediatric rigid bronchoscopy was "never" (29%) or rarely (6.8%) available. Notably, HIC respondents denoted that equipment for pediatric rigid bronchoscopy was "never" or "rarely" available to a higher degree than most other equipment, namely 30% for rigid bronchoscopes and 35% for ancillary equipment (Table 3). Thus, the availability of pediatric rigid bronchoscopes between HICs and LMICs was not statistically different (Table 3, $p = 0.408$).

TABLE 2 | Survey responses on availability of essential equipment for OHNS care by World Bank income groups: High-income countries (HICs) vs. low- and middle-income countries (LMICs).

Country income group				
Equipment availability	***N***	**HIC, *N* = 69 (47%)**	**LMIC, *N* = 77 (53%)**	***p***
Procedural microscope	145			0.008*
Never		1 (1.4%)	10 (13%)	
Rarely		8 (12%)	6 (7.9%)	
Sometimes		10 (14%)	8 (11%)	
Mostly		4 (5.8%)	14 (18%)	
Always		46 (67%)	38 (50%)	
Flexible endoscope	145			< 0.001*
Never		0 (0%)	16 (21%)	
Rarely		4 (5.8%)	3 (3.9%)	
Sometimes		10 (14%)	12 (16%)	
Mostly		11 (16%)	16 (21%)	
Always		44 (64%)	29 (38%)	
Otologic drill and burr	143			< 0.001*
Never		0 (0%)	16 (22%)	
Rarely		2 (2.9%)	4 (5.4%)	
Sometimes		11 (16%)	11 (15%)	
Mostly		11 (16%)	14 (19%)	
Always		45 (65%)	29 (39%)	
Otoendoscope and ancillary equipment	143			0.001*
Never		4 (5.8%)	23 (31%)	
Rarely		3 (4.3%)	4 (5.4%)	
Sometimes		11 (16%)	14 (19%)	
Mostly		12 (17%)	8 (11%)	
Always		39 (57%)	25 (34%)	
Tympanomastoidectomy equipment	144			0.001*
Never		1 (1.5%)	16 (22%)	
Rarely		4 (6.0%)	4 (5.5%)	
Sometimes		9 (13%)	6 (8.2%)	
Mostly		8 (12%)	15 (21%)	
Always		45 (67%)	32 (44%)	
Cochlear implant	142			< 0.001*
Never		17 (25%)	43 (58%)	
Rarely		7 (10%)	6 (8.1%)	
Sometimes		6 (8.8%)	8 (11%)	
Mostly		10 (15%)	5 (6.8%)	
Always		28 (41%)	12 (16%)	

(Continues)

TABLE 2 | (Continued)

Country income group				
Equipment availability	***N***	**HIC, *N* = 69 (47%)**	**LMIC, *N* = 77 (53%)**	***p***
Neck dissection equipment	142			0.016*
Never		4 (5.8%)	16 (22%)	
Rarely		8 (12%)	4 (5.5%)	
Sometimes		5 (7.2%)	7 (9.6%)	
Mostly		9 (13%)	15 (21%)	
Always		43 (62%)	31 (42%)	
Tracheostomy tubes	143			0.200
Never		1 (1.4%)	6 (8.1%)	
Rarely		9 (13%)	8 (11%)	
Sometimes		7 (10%)	10 (14%)	
Mostly		14 (20%)	20 (27%)	
Always		38 (55%)	30 (41%)	
Adenotonsillectomy equipment	142			0.262
Never		0 (0%)	1 (1.4%)	
Rarely		7 (10%)	5 (6.8%)	
Sometimes		7 (10%)	2 (2.7%)	
Mostly		8 (12%)	8 (11%)	
Always		46 (68%)	58 (78%)	

*$p < 0.05$.

HIC and LMIC respondents reported disparate availability of all rhinologic/functional endoscopic sinus surgery (FESS) equipment (Figure S1). The availability of straight 0° nasal endoscopes, angled 30° nasal endoscopes, and FESS ancillary equipment in LMICs varied considerably (Table 3). Tables 2 and 3 represent a selection of those equipment with statistically significant differences in availability between income groups or of highest importance to baseline OHNS care. Results on the availability of additional surgical equipment and ancillary services are included in Tables S1 and S2.

4 | Discussion

This study is the first to characterize access to OHNS equipment globally. Our results highlight inadequate access to essential surgical equipment among otolaryngologists in LMICs. The most significant differences in equipment availability between income groups were found in otologic, rhinologic, and endoscopic equipment. We identify a few overarching reasons for these equipment disparities. First, equipment tailored for use on particular anatomic regions is often priced higher than equipment used for general surgical care. Therefore, the costs of specialty-specific equipment, such as otologic, rhinologic, and laryngologic equipment, may prohibit investment in resource-constrained settings. Second, many National Surgical, Obstetric, and Anesthesia Plans have identified maternal health and emergency surgery as areas of highest priority for investment [33, 34]. We argue that OHNS equipment deserves higher prioritization for policy and financing given the high impact of OHNS conditions on patient quality of life and the global burden of disease [4–7]. Third, some equipment disparities may be attributed to differing regional priorities based on relative disease morbidity and mortality [35]. For example, FESS equipment, despite its significant impact on quality of life [36, 37], may not be considered a priority for investment due to its expense and primary use for non-emergent conditions [26]. Our results reveal a need to improve access to particular OHNS equipment crucial for addressing prevalent, high-priority conditions, especially in LMICs.

4.1 | Otologic Equipment

Prior Delphi consensus studies of general and pediatric otolaryngologists have identified otitis media, mastoiditis, and related otologic disease processes to be among the top 10 highest-priority OHNS conditions [26, 27]. The global incidence of complications of suppurative otitis media is heavily skewed toward LMICs [6, 38]. Of these complications, preventable hearing loss, affecting approximately 20.4 million children worldwide, is of particular concern for pediatric patients due to long-term effects on language acquisition, cognitive development, and educational attainment [5, 6, 39]. Otologic drills and tympanomastoidectomy equipment, which are frequently used to address these preventable conditions, were never or rarely available to

TABLE 3 | Survey responses on availability of essential endoscopic equipment for OHNS care by World Bank income groups: High-income countries (HICs) vs. low- and middle-income countries (LMICs).

Country income group				
Equipment availability	***N***	**HIC, *N* = 69 (47%)**	**LMIC, *N* = 77 (53%)**	***p***
Adult rigid lens endoscope (Hopkins rod)	145			0.275
Never		4 (5.8%)	13 (17%)	
Rarely		2 (2.9%)	2 (2.6%)	
Sometimes		12 (17%)	10 (13%)	
Mostly		10 (14%)	13 (17%)	
Always		41 (59%)	38 (50%)	
Adult rigid bronchoscope	144			0.513
Never		11 (16%)	20 (27%)	
Rarely		2 (2.9%)	3 (4.0%)	
Sometimes		14 (20%)	15 (20%)	
Mostly		10 (14%)	11 (15%)	
Always		32 (46%)	26 (35%)	
Adult rigid bronchoscope ancillary equipment	143			0.118
Never		11 (16%)	19 (25%)	
Rarely		3 (4.4%)	2 (2.7%)	
Sometimes		13 (19%)	21 (28%)	
Mostly		8 (12%)	12 (16%)	
Always		33 (49%)	21 (28%)	
Adult direct laryngo–/esophagoscopy and biopsy equipment	145			0.045*
Never		3 (4.3%)	14 (18%)	
Rarely		2 (2.9%)	4 (5.3%)	
Sometimes		14 (20%)	9 (12%)	
Mostly		7 (10%)	11 (14%)	
Always		43 (62%)	38 (50%)	
Pediatric rigid lens endoscope (Hopkins rod)	140			0.004*
Never		8 (12%)	21 (29%)	
Rarely		7 (10%)	7 (9.7%)	
Sometimes		8 (12%)	11 (15%)	
Mostly		3 (4.4%)	10 (14%)	
Always		42 (62%)	23 (32%)	
Pediatric rigid bronchoscope	142			0.408
Never		12 (17%)	20 (27%)	
Rarely		9 (13%)	6 (8.2%)	
Sometimes		8 (12%)	12 (16%)	
Mostly		9 (13%)	10 (14%)	
Always		31 (45%)	25 (34%)	
Pediatric rigid bronchoscope ancillary equipment	142			0.028*
Never		13 (19%)	21 (29%)	
Rarely		11 (16%)	5 (6.8%)	
Sometimes		8 (12%)	18 (25%)	
Mostly		7 (10%)	10 (14%)	
Always		30 (43%)	19 (26%)	
Pediatric direct laryngo–/esophagoscopy and biopsy set	139			0.018*
Never		7 (10%)	18 (25%)	
Rarely		8 (12%)	5 (7.0%)	
Sometimes		9 (13%)	14 (20%)	
Mostly		4 (5.9%)	9 (13%)	
Always		40 (59%)	25 (35%)	
Straight 0′ nasal endoscope	144			0.007*
Never		0 (0%)	10 (13%)	
Rarely		3 (4.3%)	4 (5.3%)	
Sometimes		9 (13%)	4 (5.3%)	
Mostly		10 (14%)	17 (23%)	
Always		47 (68%)	40 (53%)	
Angled 30′ nasal endoscope	144			0.001*

TABLE 3 | (Continued)

Equipment availability	N	Country income group: HIC, N = 69 (47%)	LMIC, N = 77 (53%)	p
Never		0 (0%)	16 (21%)	
Rarely		5 (7.2%)	6 (8.0%)	
Sometimes		9 (13%)	5 (6.7%)	
Mostly		12 (17%)	14 (19%)	
Always		43 (62%)	34 (45%)	
Functional endoscopic sinus surgery equipment	143			< 0.001*
Never		1 (1.4%)	12 (16%)	
Rarely		8 (12%)	4 (5.4%)	
Sometimes		10 (14%)	6 (8.1%)	
Mostly		4 (5.8%)	15 (20%)	
Always		46 (67%)	37 (50%)	

*$p < 0.05$.

approximately a third of LMIC respondents (Table 2). Access to such equipment is a crucial step to addressing prevalent otologic conditions in LMICs.

Endoscopic ear surgery is a safe and effective method for a range of middle ear pathologies [40–43]. Compared to microscopic surgical setups, endoscopic ear surgery may be substantially less expensive to set up in low-resource settings, with lower shipping costs, less bulky equipment for transportation, and shared use of existing endoscopic infrastructure across surgical departments [44]. However, access to otoendoscopes in LMICs was also constrained, with 31% of LMIC respondents stating that they "never" had access (Table 2). Consequently, investment in otoendoscopes may be a promising and cost-effective method to expand OHNS access in LMICs in rural or district hospital settings.

Finally, cochlear implants are extremely valuable interventions that may avert lifelong effects of hearing loss [45–48]. Fifty-eight percent of LMIC respondents (as well as 35% of HIC respondents) reported "never" having access to CIs (Table 2, $p < 0.001$). Our results indicate that current access to CIs is insufficient in both HICs and LMICs. Pre- and post-operative audiology and speech therapy services are critical to the success of CIs [49]; thus investment in ancillary clinical services is necessary to scale CI capacity (Table S2).

4.2 | Endoscopic Airway Equipment

Endoscopic equipment for pediatric airway surgery was identified as another major gap (Figure 2). Pediatric otolaryngologists have identified rigid and flexible bronchoscopy, esophagoscopy, and DL to be among the 10 highest-priority procedures within their subspecialty [27]. Rigid bronchoscopy can be a life-saving procedure for children who have aspirated foreign bodies, and both DL equipment and rigid lens endoscopes (Hopkins rod) may be required depending on the anatomic location of the foreign body [50, 51]. Airway foreign body removal must be performed with appropriately sized bronchoscopic and endoscopic equipment for children under 5 years [52]. Yet, pediatric endoscopic airway equipment exhibited low availability ratings among LMICs (Table 3).

Notably, both HIC and LMIC respondents endorsed limited availability of pediatric rigid bronchoscopes in their respective settings. Recent estimates show that pediatric foreign body aspiration causes 317.9 per 100,000 disability-adjusted life-years (DALYs) for children under 5 years of age and is increasing in incidence in HICs [53]. Lack of appropriate equipment, in conjunction with skill acquisition, may be a contributor to global morbidity and mortality from airway foreign bodies [50, 51]. Our findings suggest that access to equipment to manage pediatric airway foreign bodies is a critical area for investment across resource and practice settings.

4.3 | Implications

The reported equipment disparities may affect accessibility to OHNS care in multiple respects. First, our results feature a similar distribution of responses across practice settings, with private settings representing 23% and 30% of responses in HICs and LMICs, respectively (Table 1, $p = 0.375$). Even if essential equipment is present in private practice settings, costs of private facilities are often beyond the means of the general population in both HICs and LMICs [54]. Findings from the "Barriers to Care" subsection of the Global OHNS Provider Survey (publication forthcoming) and similar studies may elucidate impediments faced by patients in accessing OHNS care, including distribution of resources between private and public facilities.

Second, our results are limited to the responses of otolaryngologists and may not reflect the accessibility of equipment to other specialists in the same setting. This may be the case for head and neck surgeries and airway emergencies, which may fall under the purview of other surgical or interventional specialties. A recent study found that the OHNS workforce provides the majority of care for ear and hearing conditions, rhinologic and sinus conditions, benign laryngeal disorders, and mucosal cancers in more than 70% of countries worldwide [29]. Thus, reports from OHNS providers on lack of equipment are likely to reflect actual gaps in their respective health systems to address common OHNS conditions.

Insufficient OHNS workforce may potentiate the relationship with equipment and infrastructure. Africa and Southeast Asia have particularly low OHNS clinician density, with an estimated 0.18 to 1.12 OHNS clinicians per 100,000 population, respectively [29, 55]. In settings with few OHNS providers, general otolaryngologists require access to otologic and pediatric airway equipment, among other general equipment. Limited numbers of OHNS clinicians within the global

surgical workforce may result in limited allocation of hospital resources toward OHNS practice and relatively fewer voices to advocate for OHNS investment. Furthermore, the maldistribution of OHNS providers between urban and rural settings (a focus of the "Barriers to Care" subsection of our provider survey) may exacerbate disparities in equipment availability at district-level hospitals in LMICs.

4.4 | Limitations

We chose to utilize snowball sampling to maximize visibility and access of the survey beyond smaller academic OHNS communities. We attempted to increase our study's accessibility by translating the survey into the six official United Nations languages. Open recruitment tactics, including mailing list and social media distribution, precludes the calculation of a response rate, as it is unknown how many providers viewed the survey consent but declined to participate. Inability to calculate a response rate, while important to acknowledge, is a common limitation of snowball sampling methodologies.

Snowball sampling via mailing lists and social media yielded a diverse, international sample of providers, resulting in an overall large sample size and breadth of responses across countries. However, our sample varied in representation, with a few countries very frequently represented and others without any responses. Thus, analysis was conducted along a broad dichotomous variable of HIC versus LMIC status, which may limit generalizability of findings to all settings within each category.

Finally, this survey assessed providers' subjective perceptions of equipment availability rather than objective data from health facilities. Equipment availability can be assessed in a variety of ways, including hospital or clinic-level appraisals, which may provide more accurate assessments of whether equipment is present in a system. For example, surgical equipment belonging to another department in the same hospital (i.e., plastic surgery) may not be reported as "available" by OHNS clinicians per this methodology. However, this may also be a unique strength of our study, as using providers' perceptions may capture a more nuanced picture of whether equipment, even if physically present in a practice setting, is accessible for use by OHNS clinicians. Future studies may compare physician-reported availability data with more objective hospital-level assessments of equipment presence; differences between these reports may indicate other barriers to equipment usage that should be further investigated.

4.5 | Conclusion

In this multinational survey study of otolaryngologists worldwide, we provide the first global snapshot of specialty-specific surgical equipment availability for OHNS procedures. This study revealed that providers in LMICs often had inadequate access to essential otologic, rhinologic, and pediatric endoscopic airway equipment. These were identified as high-priority areas for strategic investment to equip clinicians to treat common OHNS conditions. Further work is needed to elucidate equipment availability at the local level within LMICs and to understand how the availability of essential equipment and services may influence clinician distribution. We further recommend research and policy be directed toward mitigating the glaring equipment disparities between countries. Investment in essential equipment will enable OHNS clinicians worldwide to adequately address the global burden of otolaryngologic disease, ensuring improved patient outcomes for OHNS care delivery.

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Acknowledgments

The authors would like to express their gratitude to Dr. Mahmood Bhutta for his support during the conception of this project. Thank you to Dr. Christopher Wen, Dr. Lauren Dillard, Dr. Isaie Ncogoza, Dr. Keith Potent, Keshav Shah, and Hudson Lin for their helpful comments during the development of this manuscript. Finally, our sincere thanks to the International Federation of ORL Societies for their support in survey dissemination.

Ethics Statement

This study was approved by the Mass General Brigham Institutional Review Board (Protocol 2021P000076).

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. B. C. Alkire, N. P. Raykar, M. G. Shrime, et al., "Global Access to Surgical Care: A Modelling Study," *Lancet Global Health* 3, no. 6 (2015): e316–e323, https://doi.org/10.1016/S2214-109X(15)70115-4.

2. M. G. Shrime, S. W. Bickler, B. C. Alkire, and C. Mock, "Global Burden of Surgical Disease: An Estimation From the Provider Perspective," *Lancet Global Health* 3 (2015): S8–S9, https://doi.org/10.1016/S2214-109X(14)70384-5.

3. P. E. Farmer and J. Y. Kim, "Surgery and Global Health: A View From Beyond the OR," *World Journal of Surgery* 32, no. 4 (2008): 533–536, https://doi.org/10.1007/s00268-008-9525-9.

4. R. W. Bergmark, D. A. Shaye, and M. G. Shrime, "Surgical Care and Otolaryngology in Global Health," *Otolaryngologic Clinics of North America* 51, no. 3 (2018): 501–513, https://doi.org/10.1016/j.otc.2018.01.001.

5. GBD 2019 Hearing Loss Collaborators, "Hearing Loss Prevalence and Years Lived With Disability, 1990–2019: Findings From the Global Burden of Disease Study 2019," *Lancet* 397, no. 10278 (2021): 996–1009, https://doi.org/10.1016/S0140-6736(21)00516-X.

6. L. Monasta, L. Ronfani, F. Marchetti, et al., "Burden of Disease Caused by Otitis Media: Systematic Review and Global Estimates," *PLoS One* 7, no. 4 (2012): e36226, https://doi.org/10.1371/journal.pone.0036226.

7. R. H. Patterson, V. G. Fischman, I. Wasserman, et al., "Global Burden of Head and Neck Cancer: Economic Consequences, Health, and the Role of Surgery," *Otolaryngology—Head and Neck Surgery: Official Journal of American Academy of Otolaryngology—Head and Neck Surgery* 162, no. 3 (2020): 296–303, https://doi.org/10.1177/0194599819897265.

8. C. E. Grimes, J. A. Henry, J. Maraka, N. C. Mkandawire, and M. Cotton, "Cost-Effectiveness of Surgery in Low- and Middle-Income Countries: A Systematic Review," *World Journal of Surgery* 38, no. 1 (2014): 252–263, https://doi.org/10.1007/s00268-013-2243-y.

9. H. Osen, D. Chang, S. Choo, et al., "Validation of the World Health Organization Tool for Situational Analysis to Assess Emergency and Essential Surgical Care at District Hospitals in Ghana," *World Journal of Surgery* 35, no. 3 (2011): 500–504, https://doi.org/10.1007/s00268-010-0918-1.

10. A. Markin, R. Barbero, J. J. Leow, et al., "Inter-Rater Reliability of the PIPES Tool: Validation of a Surgical Capacity Index for Use in Resource-Limited Settings," *World Journal of Surgery* 38, no. 9 (2014): 2195–2199, https://doi.org/10.1007/s00268-014-2522-2.

11. E. G. Wong, S. Gupta, D. L. Deckelbaum, et al., "The International Assessment of Capacity for Trauma (INTACT): An Index for Trauma Capacity in Low-Income Countries," *Journal of Surgical Research* 190, no. 2 (2014): 522–527, https://doi.org/10.1016/j.jss.2014.01.060.

12. M. Kouo-Ngamby, F. N. Dissak-Delon, I. Feldhaus, C. Juillard, K. A. Stevens, and M. Ekeke-Monono, "A Cross-Sectional Survey of Emergency and Essential Surgical Care Capacity Among Hospitals With High Trauma Burden in a Central African Country," *BMC Health Services Research* 15 (2015): 478, https://doi.org/10.1186/s12913-015-1147-y.

13. T. E. Chao, M. Burdic, K. Ganjawalla, et al., "Survey of Surgery and Anesthesia Infrastructure in Ethiopia," *World Journal of Surgery* 36, no. 11 (2012): 2545–2553, https://doi.org/10.1007/s00268-012-1729-3.

14. J. A. Henry, O. Windapo, A. L. Kushner, R. S. Groen, and B. C. Nwomeh, "A Survey of Surgical Capacity in Rural Southern Nigeria: Opportunities for Change," *World Journal of Surgery* 36, no. 12 (2012): 2811–2818, https://doi.org/10.1007/s00268-012-1764-0.

15. J. A. Henry, E. Frenkel, E. Borgstein, N. Mkandawire, and C. Goddia, "Surgical and Anaesthetic Capacity of Hospitals in Malawi: Key Insights," *Health Policy and Planning* 30, no. 8 (2015): 985–994, https://doi.org/10.1093/heapol/czu102.

16. N. Elkheir, A. Sharma, M. Cherian, et al., "A Cross-Sectional Survey of Essential Surgical Capacity in Somalia," *BMJ Open* 4, no. 5 (2014): e004360, https://doi.org/10.1136/bmjopen-2013-004360.

17. M. B. Bhatia, S. C. Mohan, K. J. Blair, et al., "Surgical and Trauma Capacity Assessment in Rural Haryana, India," *Annals of Global Health* 87, no. 1 (2021): 15, https://doi.org/10.5334/aogh.3173.

18. J. Loveday, S. P. Sachdev, M. N. Cherian, et al., "Survey of Emergency and Essential Surgical, Obstetric and Anaesthetic Services Available in Bangladeshi Government Health Facilities," *World Journal of Surgery* 41, no. 7 (2017): 1743–1751, https://doi.org/10.1007/s00268-017-3918-6.

19. R. Kalhor, N. Keshavarz Mohamadi, N. Khalesi, and M. Jafari, "Situational Analysis of Essential Surgical Care Management in Iran Using the WHO Tool," *Iranian Red Crescent Medical Journal* 18, no. 5 (2016): e23075, https://doi.org/10.5812/ircmj.23075.

20. S. Contini, A. Taqdeer, M. Cherian, et al., "Emergency and Essential Surgical Services in Afghanistan: Still a Missing Challenge," *World Journal of Surgery* 34, no. 3 (2010): 473–479, https://doi.org/10.1007/s00268-010-0406-7.

21. C. Solis, P. León, N. Sanchez, et al., "Nicaraguan Surgical and Anesthesia Infrastructure: Survey of Ministry of Health Hospitals," *World Journal of Surgery* 37, no. 9 (2013): 2109–2121, https://doi.org/10.1007/s00268-013-2112-8.

22. A. Markin, R. Barbero, J. J. Leow, et al., "A Quantitative Analysis of Surgical Capacity in Santa Cruz, Bolivia," *Journal of Surgical Research* 185, no. 1 (2013): 190–197, https://doi.org/10.1016/j.jss.2013.05.051.

23. K. J. Blair, M. A. Boeck, J. L. Gallardo Barrientos, et al., "Assessment of Surgical and Trauma Capacity in Potosí, Bolivia," *Annals of Global Health* 83, no. 2 (2017): 262–273, https://doi.org/10.1016/j.aogh.2017.04.002.

24. A. W. Gelb, W. W. Morriss, W. Johnson, et al., "World Health Organization-World Federation of Societies of Anaesthesiologists (WHO-WFSA) International Standards for a Safe Practice of Anesthesia," *Anesthesia and Analgesia* 126, no. 6 (2018): 2047–2055, https://doi.org/10.1213/ANE.0000000000002927.

25. Global Initiative for Children's Surgery, "Optimal Resources for Children's Surgical Care: Executive Summary," *World Journal of Surgery* 43, no. 4 (2019): 978–980, https://doi.org/10.1007/s00268-018-04888-7.

26. S. Nuss, R. H. Patterson, G. L. Cahill, et al., "Delphi Method Consensus on Priority Global Otolaryngology-Head and Neck Surgery Conditions and Procedures," *Otolaryngology—Head and Neck Surgery: Official Journal of American Academy of Otolaryngology—Head and Neck Surgery* 167, no. 4 (2022): 669–677, https://doi.org/10.1177/01945998211073705.

27. S. Nuss, G. L. Cahill, W. Limenh, and J. Wiedermann, "Developing Consensus on Priority Pediatric Otolaryngology-Head and Neck Surgery Conditions and Procedures," *Otolaryngology—Head and Neck Surgery: Official Journal of American Academy of Otolaryngology—Head and Neck Surgery* 169, no. 2 (2023): 374–381, https://doi.org/10.1002/ohn.291.

28. T. Srinivasan, A. Cherches, A. Seguya, et al., "Essential Equipment and Services for Otolaryngology Care: A Proposal by the Global Otolaryngology-Head and Neck Surgery Initiative," *Current Opinion in Otolaryngology & Head and Neck Surgery* 31, no. 3 (2023): 194–201, https://doi.org/10.1097/MOO.0000000000000885.

29. B. Petrucci, S. Okerosi, R. H. Patterson, et al., "The Global Otolaryngology-Head and Neck Surgery Workforce," *JAMA Otolaryngol Neck Surgery* 149, no. 10 (2023): 904–911, https://doi.org/10.1001/jamaoto.2023.2339.

30. P. A. Harris, R. Taylor, R. Thielke, J. Payne, N. Gonzalez, and J. G. Conde, "Research Electronic Data Capture (REDCap)—A Metadata-Driven Methodology and Workflow Process for Providing Translational Research Informatics Support," *Journal of Biomedical Informatics* 42, no. 2 (2009): 377–381, https://doi.org/10.1016/j.jbi.2008.08.010.

31. The World Factbook, "The World Factbook," (2024), https://www.cia.gov/the-world-factbook/.

32. World Bank Country and Lending Groups, "World Bank Data Help Desk," (2024), https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

33. K. A. Sonderman, I. Citron, S. Mukhopadhyay, et al., "Framework for Developing a National Surgical, Obstetric and Anaesthesia Plan," *BJS Open* 3, no. 5 (2019): 722–732, https://doi.org/10.1002/bjs5.50190.

34. P. Truché, H. Shoman, C. L. Reddy, et al., "Globalization of National Surgical, Obstetric and Anesthesia Plans: The Critical Link Between Health Policy and Action in Global Surgery," *Globalization and Health* 16 (2020): 1, https://doi.org/10.1186/s12992-019-0531-5.

35. C. N. Mock, P. Donkor, A. Gawande, D. T. Jamison, M. E. Kruk, and H. T. Debas, "Essential Surgery: Key Messages From Disease Control Priorities, 3rd Edition," *Lancet* 385, no. 9983 (2015): 2209–2219, https://doi.org/10.1016/S0140-6736(15)60091-5.

36. P. V. Vlastarakos, M. Fetta, J. V. Segas, P. Maragoudakis, and T. P. Nikolopoulos, "Functional Endoscopic Sinus Surgery Improves Sinus-Related Symptoms and Quality of Life in Children With Chronic Rhinosinusitis: A Systematic Analysis and Meta-Analysis of Published Interventional Studies," *Clinical Pediatrics (Phila)* 52, no. 12 (2013): 1091–1097, https://doi.org/10.1177/0009922813506489.

37. S. Algahtani, A. Alhajlah, A. I. Abuharb, et al., "Outcomes of Functional Endoscopic Sinus Surgery in Chronic Rhinosinusitis: A Systematic Review and Meta-Analysis," *Cureus* 16, no. 2 (2024): e53952, https://doi.org/10.7759/cureus.53952.

38. M. Khairkar, P. Deshmukh, H. Maity, and V. Deotale, "Chronic Suppurative Otitis Media: A Comprehensive Review of Epidemiology, Pathogenesis, Microbiology, and Complications," *Cureus* 15, no. 8 (2023): e43729, https://doi.org/10.7759/cureus.43729.

39. J. E. C. Lieu, M. Kenna, S. Anne, and L. Davidson, "Hearing Loss in Children," *Journal of the American Medical Association* 324, no. 21 (2020): 2195, https://doi.org/10.1001/jama.2020.17647.

40. J. E. Choi, W. S. Kang, J. D. Lee, et al., "Outcomes of Endoscopic Congenital Cholesteatoma Removal in South Korea," *JAMA Otolaryngology Head & Neck Surgery* 149, no. 3 (2023): 231–238, https://doi.org/10.1001/jamaoto.2022.4660.

41. C. M. Jenks, P. L. Purcell, G. Federici, et al., "Transcanal Endoscopic Ear Surgery for Congenital Cholesteatoma: A Multi-Institutional Series," *Otolaryngology—Head and Neck Surgery: Official Journal of American Academy of Otolaryngology—Head and Neck Surgery* 167, no. 3 (2022): 537–544, https://doi.org/10.1177/01945998211067502.

42. S. Manna, V. F. Kaul, M. L. Gray, and G. B. Wanna, "Endoscopic Versus Microscopic Middle Ear Surgery: A Meta-Analysis of Outcomes Following Tympanoplasty and Stapes Surgery," *Otology & Neurotology* 40, no. 8 (2019): 983–993, https://doi.org/10.1097/MAO.0000000000002353.

43. S. Ho, P. Patel, D. Ballard, R. Rosenfeld, and S. Chandrasekhar, "Systematic Review and Meta-Analysis of Endoscopic vs Microscopic Stapes Surgery for Stapes Fixation," *Otolaryngology—Head and Neck Surgery: Official Journal of American Academy of Otolaryngology—Head and Neck Surgery* 165, no. 5 (2021): 626–635, https://doi.org/10.1177/0194599821990669.

44. R. Thompson, G. Basura, T. F. Din, and A. Jayawardena, "A Step Towards Achieving Sustainable Otologic Surgery in Low-Resource Settings: A Cost Comparison Between Shipping an Otologic Versus Microscopic Surgical Setup," *Audiology Research* 12, no. 4 (2022): 388–392, https://doi.org/10.3390/audiolres12040039.

45. T. R. McRackan, M. Bauschard, J. L. Hatch, et al., "Meta-Analysis of Quality-Of-Life Improvement After Cochlear Implantation and Associations With Speech Recognition Abilities," *Laryngoscope* 128, no. 4 (2018): 982–990, https://doi.org/10.1002/lary.26738.

46. O. M. Neve, J. A. Boerman, W. B. van den Hout, J. J. Briaire, P. P. G. van Benthem, and J. H. M. Frijns, "Cost-Benefit Analysis of Cochlear Implants: A Societal Perspective," *Ear and Hearing* 42, no. 5 (2021): 1338–1350, https://doi.org/10.1097/AUD.0000000000001021.

47. S. D. Sharma, S. L. Cushing, B. C. Papsin, and K. A. Gordon, "Hearing and Speech Benefits of Cochlear Implantation in Children: A Review of the Literature," *International Journal of Pediatric Otorhinolaryngology* 133 (2020): 109984, https://doi.org/10.1016/j.ijporl.2020.109984.

48. M. G. Crowson, Y. R. Semenov, D. L. Tucci, and J. K. Niparko, "Quality of Life and Cost-Effectiveness of Cochlear Implants: A Narrative Review," *Audiology & Neuro-Otology* 22, no. 4–5 (2017): 236–258, https://doi.org/10.1159/000481767.

49. A. D. Warner-Czyz, J. T. Roland, D. Thomas, K. Uhler, and L. Zombek, "American Cochlear Implant Alliance Task Force Guidelines for Determining Cochlear Implant Candidacy in Children," *Ear and Hearing* 43, no. 2 (2022): 268–282, https://doi.org/10.1097/AUD.0000000000001087.

50. S. Cohen, H. Pine, and A. Drake, "Use of Rigid and Flexible Bronchoscopy Among Pediatric Otolaryngologists," *Archives of Otolaryngology–Head & Neck Surgery* 127, no. 5 (2001): 505–509, https://doi.org/10.1001/archotol.127.5.505.

51. A. M. Salih, M. Alfaki, and D. M. Alam-Elhuda, "Airway Foreign Bodies: A Critical Review for a Common Pediatric Emergency," *World Journal of Emergency Medicine* 7, no. 1 (2016): 5–12, https://doi.org/10.5847/wjem.j.1920-8642.2016.01.001.

52. S. E. Ambrose and N. P. Raol, "Pediatric Airway Foreign Body," *Operative Techniques in Otolaryngology-Head and Neck Surgery* 28, no. 4 (2017): 265–269, https://doi.org/10.1016/j.otot.2017.08.012.

53. Y. Wu, X. Zhang, Z. Lin, et al., "Changes in the Global Burden of Foreign Body Aspiration Among Under-5 Children From 1990 to 2019," *Frontiers in Pediatrics* 11 (2023): 1235308, https://doi.org/10.3389/fped.2023.1235308.

54. M. Mackintosh, A. Channon, A. Karan, S. Selvaraj, E. Cavagnero, and H. Zhao, "What Is the Private Sector? Understanding Private Provision in the Health Systems of Low-Income and Middle-Income Countries," *Lancet* 388, no. 10044 (2016): 596–605, https://doi.org/10.1016/S0140-6736(16)00342-1.

55. K. Kamenov, R. Martinez, T. Kunjumen, and S. Chadha, "Ear and Hearing Care Workforce: Current Status and Its Implications," *Ear and Hearing* 42, no. 2 (2021): 249–257, https://doi.org/10.1097/AUD.0000000000001007.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.