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Publication date
2023
Document Version
Final published version

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ISBN: 978-94-6419-797-6
Cover: Ilse Modder | www.ilsemodder.nl
Lay-out: Ilse Modder | www.ilsemodder.nl
Print: Gildeprint Enschede | www.gildeprint.nl

Sustainable Cleft Care Through Simulation-Based Education

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. ir. P.P.C.C Verbeek
ten overstaan van een door het College voor Promoties ingestelde commissie,
in het openbaar te verdedigen in de Agnietenkapel
op woensdag 31 mei 2023, te 13.00 uur

door Rami Said Kantar
geboren te Toorak Gardens

Promotiecommissie

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Faculteit der Geneeskunde

- Dedication -

Thank you for molding my mind and soul into what they are today

To Maria, Jenny, Karim, Salah, Rima and Aida, for loving me unconditionally
and for being my sources of virtue

To Drs. Breugem, Rodriguez, Hamdan, Don Griot, Flores,
Kavic, Slezak, Fuleihan, Habib, Tannous, and Boustany for your mentorship
and never-ending support

Table of Contents

Chapter 1

Introduction and Aim

This chapter will provide a brief overview regarding cleft lip and/or palate anomalies, the role and models of international foundation-based cleft care delivery in low to middle income countries, as well as the evolution of simulation-based education and training in cleft surgery. This will be followed by an outline highlighting the chapters and aim of thesis.

Cleft Lip and Palate

Clefts of the lip and/or palate are estimated to affect 1 in every 500 to 700 live births with variable global incidence rates and epidemiological nuances. [1,2] In low to middle income countries, the annual incidence of congenital clefts of the lip and/or palate is estimated to be 250,000. [3] These craniofacial anomalies arise as a result of impaired normal embryological development of the lip and palate between the 4th and 12th weeks of gestation, and can occur in combination or in an isolated fashion. [4] Moreover, the severity of the cleft lip and/or palate anomaly is dependent on the timing and degree of disruption of normal embryological development. [4] Clefts of the lip and/or palate are classified as syndromic when they occur as part of clinical syndromes, or non-syndromic. [4] Non-syndromic forms of cleft lip and/or palate are more common and account for almost 70% of all cases. [4-7] The etiology of cleft lip and/or palate remains poorly defined and involves a complex interplay between genetic and environmental factors, with a number of identified candidate genes and risk factors. [4,8,9] Some of the proposed environmental risk factors for cleft lip and/or palate include maternal smoking, maternal alcohol consumption, maternal pregestational and gestational diabetes, advanced maternal age, maternal zinc or folate deficiency, in addition to exposure to a number of teratogens including retinoic acid, valproic acid and phenytoin. [4,10-17]

The timing of surgical correction of cleft lip and/or palate is dependent on patient characteristics, anesthetic risks, associated congenital anomalies, as well as surgeon preference. [4] When appropriate, there is agreement among cleft lip and/or palate surgeons and prominent cleft associations that repair of the lip should be performed within the first year of life, preferably around 10-12 weeks of age, while repair of the palate should preferably be performed before 18 months of age. [4,18,19] Delayed correction of cleft lip and palate anomalies may be associated with an increased risk of morbidity and mortality due to malnutrition and respiratory complications. [4,19] These risks are due to functional deficiencies that result from the aberrant oropharyngeal anatomy that is associated with cleft lip and/or palate. [4,19-21] Patients with cleft lip and/or palate are at risk for malnutrition and regurgitation of feeds due to feeding difficulties, which may be associated with aspiration, as well as aspiration-associated pneumonitis and pneumonia. [4,19,22,23] Patients with cleft lip

and/or palate also frequently face speech and hearing difficulties with recurrent otitis and potential hearing loss, which may persist following correction of the cleft lip and/or palate. [4,19,24,25] Moreover, patients with cleft lip and/or palate often require significant orthodontic treatment prior to and following correction of the cleft deformity. [4,19,26,27] Malocclusion requiring orthodontic interventions and/or orthognathic surgery is also frequently required following cleft lip and/or palate repair as a result of maxillofacial growth restriction. [4,19,26,27] Lastly, clefts of the lip and/or palate and resultant craniofacial differences are associated with substantial psychosocial ramifications that affect patients and their families, including patient well being, quality of life, self-esteem, psychological stress, social function, school function, and family function. [28,29] A number of surgical techniques have been described for correction of clefts of the lip and/or palate with no substantial evidence demonstrating the superiority of one technique as compared to others. [30-32] The details and nuances of these techniques are beyond the scope of this thesis.

Models of Foundation-Based Cleft Care Delivery in Low to Middle Income Countries

Surgical initiatives and interventions aimed at low to middle income countries have been shown to be cost-effective and are playing a growing role within the global health movement. [33] Plastic and reconstructive surgery initiatives, and more specifically cleft surgery initiatives, have also been shown to be economically sustainable, cost-effective, and can avert significant patient disability in these countries. [34,35] In fact, the median cost-effectiveness ratio of cleft lip or palate repair has been estimated to be $47.74 per disability adjusted life year (DALY). [33] Nevertheless, a significant unmet cleft lip and/or palate surgical burden exists in low to middle income countries. This unmet burden, combined with the significant impact of cleft surgery on patient quality of life and craniofacial aesthetic and functional outcomes, as well as the relatively basic infrastructure that is required for cleft lip and/or palate surgical procedures, have made cleft lip and/or palate surgery in low to middle income countries an appealing focus of foundation-based initiatives over the last several decades. [36-39] These initiatives have varied significantly in their scope, delivery models, as well as geographic locations. [40-42] (**Figure 1 and Figure 2**)

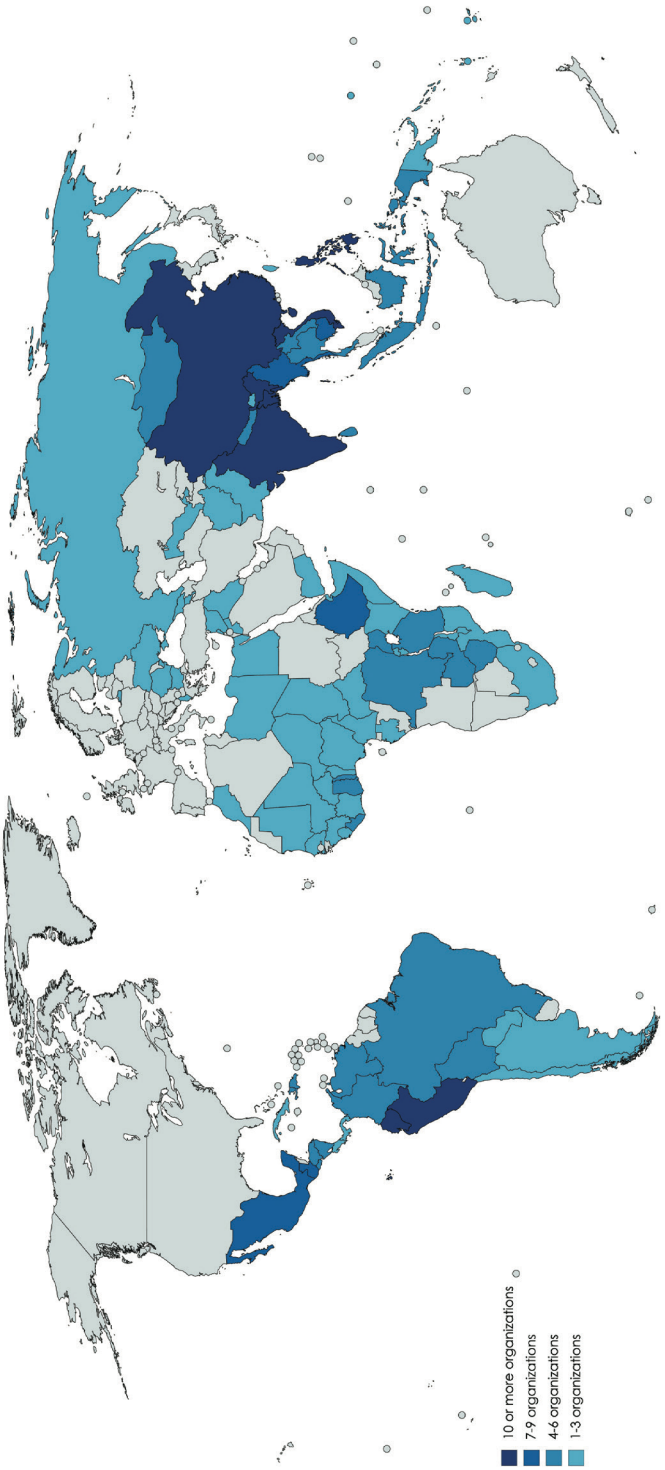

Figure 1. Number of cleft foundations per country.

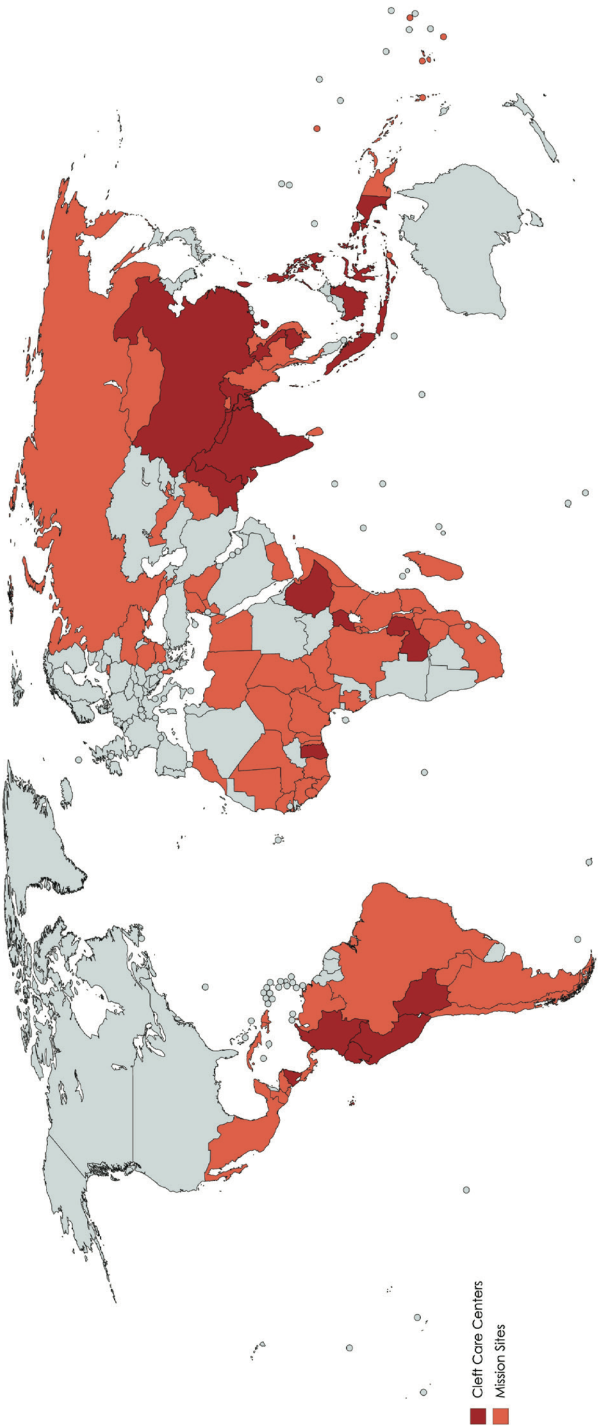

Figure 2. Distribution of cleft care centers and mission sites.

Cleft care initiatives by international foundations have broadly been classified as vertical, horizontal or diagonal based on the model of cleft care delivery. [43] Vertical interventions are best illustrated by traditional surgical mission trips, where cleft care providers and teams with their medical equipment and supplies travel to geographical locations with inadequate access to care. While these initiatives can provide cleft care, surgical expertise, as well as medical supplies and equipment to areas with a large unmet surgical burden, they have frequently been condemned for focusing on patient volume as opposed to quality of care, interfering with the healthcare infrastructure of host countries, significant expenses associated with their implementation, as well as lack of sustainability. [41,42,44-46]

Horizontal cleft care initiatives do not involve sending cleft care providers overseas, and are mostly focused on collaborating with healthcare authorities, providers, and key stakeholders in countries with an unmet cleft care burden, with the ultimate goal of building capacity and implementing sustainable interventions. [40,47,48] While these interventions have been praised for their potential to achieve cleft care self-sufficiency in their target locations, they have often been criticized for requiring a significant amount of time to instill change, and for failing to provide care in geographical areas that are completely devoid of surgical expertise and resources. [48]

Lastly, diagonal cleft care initiatives consist of a hybrid of vertical surgical missions combined with horizontal interventions aimed at building capacity and transitioning towards cleft care autonomy in areas of need. [43,48]

Simulation-Based Education and Training in Cleft Surgery

Traditional surgical training programs have been based on intensive operative exposure and progressive acquisition of responsibility in the care of surgical patients. [49] Current surgical trainees are facing significant educational challenges resulting from patient requests to limit trainee participation in their care, growing resident supervision, mounting nonclinical duties, in addition to stricter work-hour limitations. [50] These challenges facing surgical trainee progression to clinical autonomy and intraoperative exposure have driven stakeholders in surgical education and surgical training programs to comprehensively evaluate and develop resources that can complement surgical training. [51] Consequently, surgical simulation and simulation-based educational platforms and resources have emerged as potential solutions to challenges facing surgical training.

Simulation in surgery and simulation-based education have become an integral component of residency curricula in general surgery training programs through fundamentals of laparoscopic surgery and fundamentals of endoscopic surgery

training, with comparable educational initiatives emerging in other surgical subspecialties. [51-53]

Animal and cadaveric models permit surgical trainees to rehearse and simulate procedures in a high fidelity setting but are frequently associated with significant financial costs and may not be readily available to all surgical trainees. [54] This is further compounded and accentuated by the limited amount of time that is available to surgical residents, making easily accessible and readily available educational resources such as digital simulators and hands-on mannequins more convenient for procedural knowledge and skills acquisition. Similar trends have been observed in plastic and reconstructive surgery, where increasing weight has been placed on simulation-based resources and tools for trainee education. [54] These simulation-based educational opportunities in the field of plastic and reconstructive surgery, including cleft surgery, have encompassed a broad range from hands-on educational experiences to computer-aided three-dimensional simulators, and have predominantly been well received by surgical trainees and practicing surgeons. [54-58] Cleft lip and palate surgery is technically challenging and demands meticulous attention to the restoration of both form and function, in order to achieve optimal patient outcomes. Achieving proficiency in surgically correcting clefts of the lip and palate relies on extensive surgical training and expertise. Traditionally, cleft surgery training relied on reviewing relevant literature, manuscripts, textbooks, lectures, and surgical knowledge and skills acquisition in the operating room. More recently, in line with evolving trends in surgical education within the various surgical subspecialties, digital and haptic cleft surgery simulators have been developed and proposed as potential solutions for challenges facing cleft surgery training. [54] These educational tools in cleft surgery can have significant ramifications on training surgeons in the developed world as described, but even more profoundly in developing countries where lack of surgical expertise in cleft lip and palate surgery contributes significantly to the unmet burden of these conditions on patients and the local healthcare infrastructure. [44,59]

Aim and Outline of the Thesis

Simulation has emerged over the last several decades as an essential component of surgical education, including cleft lip and palate surgery. Cleft deformities of the lip and palate affect nearly one in 500-700 births, and can lead to increased morbidity and mortality due to malnutrition and respiratory complications if untreated. Nevertheless, significant global disparities in access to timely and appropriate care still exist. The relatively basic infrastructure required to surgically correct these deformities and large unmet disease burden, have resulted in a significant number of foundation-based cleft care initiatives focused towards developing countries.

Educating surgeons in low to middle income countries should be a primary goal of these initiatives, and can potentially be achieved through simulation-based training. With these issues in mind, the focus of this thesis will be on the application of simulation-based cleft surgery training and education in the outreach setting through capacity building, foundation-driven initiatives.

In **Chapter 2**, we analyze the global distribution of cleft lip and/or palate, and provide updated estimates regarding the global burden and prevalence of the disease, as well as highlight the countries that have the highest burden and prevalence.

Currently available and described cleft surgery simulators are reviewed in **Chapter 3**. The aim of this chapter is to comprehensively appraise and evaluate cleft surgery simulators that have been described to date, their role within a simulation-based educational strategy, report the costs associated with their use, and present data supporting or refuting their utility.

In **Chapter 4**, we evaluate the potential benefits of simulation-based cleft surgery learning in plastic surgery resident education through a prospective, randomized, blinded trial completed in a high income country. Plastic surgery residents were randomized to a digital simulator or textbook demonstrating unilateral cleft lip repair. Knowledge of surgical steps, procedural confidence, markings performance on a three-dimensional (3D) stone model, and surgical performance using a hands-on/high-fidelity three-dimensional haptic model were evaluated pre and post exposure to either educational tool.

In **Chapter 5**, we evaluate the application and reproducibility of simulation-based cleft surgery education in low-middle income countries, analyze how well it is received by cleft practitioners, as well as the impact of these educational initiatives on the clinical practice of practitioners who attend them.

We describe the first hybrid educational simulation-based comprehensive education cleft care workshop in **Chapter 6**, evaluate workshop impact on participants, and compare outcomes based on in-person versus virtual attendance.

In **Chapter 7**, we analyze the perceptions of participants and faculty members in our simulation-based workshops about the most important barriers facing comprehensive cleft care delivery in developing countries, what they believe are the most important interventions to deliver comprehensive cleft care in developing countries, and whether their perspectives are concordant or conflicting.

In **Chapter 8**, we evaluate the impact of geographic and demogaphic factors on perceived barriers to comprehensive cleft care delivery in developing countries.

Lastly, we discuss our findings and future perspectives in **Chapter 9**, and suggest future research endeavors facing the field of simulation-based cleft surgery training and education, with an emphasis on the outreach setting, and summarize our findings in **Chapter 10**.

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Chapter 2

Burden And Prevalence Of Orofacial Clefts

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Chapter based on the manuscript "Global Prevalence and Burden of Orofacial Clefts: A Systematic Analysis for The Global Burden of Disease Study 2019", submitted to The Journal of Craniofacial Surgery, under review, 2022

Abstract

Introduction

Congenital orofacial clefts are leading congenital anomalies. Despite guidelines recommending early surgical correction, a global backlog of untreated patients persists. This backlog combined with the relatively basic infrastructure required for cleft procedures, have made orofacial clefts an attractive target for global cleft care initiatives.

Objective

Provide updated estimates of the global prevalence and burden of orofacial clefts, stratify these estimates by geographic regions, sociodemographic index, and highlight the countries that are most affected by orofacial clefts, to provide a guide for future global cleft care initiatives.

Results

The most recent global burden of orofacial clefts was estimated to be 529,758.92 DALYs (95% UI: 362,492.88 – 798,419.69 DALYs), while the global prevalence of orofacial clefts was estimated to be 4.6 million (95% UI: 3.8 – 5.7 million). There is an inverse relationship between sociodemographic index and burden of orofacial clefts. Sub-Saharan Africa, Middle East/North Africa, and South Asia are the regions carrying the most significant burden of orofacial clefts.

Conclusion

Global geographic, socioeconomic and demographic disparities in burden and prevalence of orofacial clefts persist, despite a global decrease over the last few decades. The aim of this study is to provide updated estimates of the global burden and prevalence of orofacial clefts. We hope this will serve as a guide to direct future investments, resources, and initiatives from individuals and organizations engaged in global cleft care delivery, with the goal of building sustainable cleft care capacity where it is needed the most.

Introduction

Congenital orofacial clefts are leading congenital anomalies (Massenburg et al., 2021). Guidelines suggest that for patients with these anomalies, the cleft lip should ideally be repaired within the first year of life, while clefts of the palate if present should be corrected by 18 months of age (American Cleft Palate-Craniofacial Association, 1993). If untreated, these anomalies have been associated with increased morbidity and mortality (Shkoukani et al., 2013). Nevertheless, a significant backlog of untreated patients with variable geographical distribution persists (Massenburg et al., 2021).

This significant backlog of untreated patients coupled with the relatively basic infrastructure that is typically required for the surgical correction of orofacial clefts, have made orofacial cleft care in low to middle-income countries an attractive aim for international clinical initiatives (Kantar et al., 2019). These international cleft care initiatives have meaningfully contributed to alleviating the burden associated with orofacial clefts, and have varied widely in breadth of clinical care, models of care delivery, sustainability and geographical distribution (Kantar et al., 2019).

A recent study has demonstrated that there is a persistent negative strong association between the size of the global surgical workforce and burden of orofacial clefts, suggesting that reinforcing the global surgical workforce will help in alleviating the global burden of orofacial clefts (Massenburg et al., 2021). In this study, we utilize updated Global Burden of Disease data to model and highlight the global prevalence and burden rates of orofacial clefts. We hope this updated analysis serves as a guide for future global cleft care initiatives.

Methods

Overview

The Global Burden of Disease (GBD) Study spearheaded by the Institute for Health Metrics and Evaluation (IHME) is the most comprehensive study evaluating the trends, distribution, and impact of diseases and injuries around the world (GBD 2019 Diseases and Injuries Collaborators, 2020). In the most recent update to the study, GBD 2019, the prevalence, trends, and impact of 369 diseases and injuries in 204 countries and territories are systematically analyzed (GBD 2019 Diseases and Injuries Collaborators, 2020). The detailed methodology of the study has been previously published and is extensively described elsewhere (GBD 2019 Diseases and Injuries Collaborators, 2020).

Measures of Interest

In this study, the measures of interest include disability-adjusted life years (DALYs) as a surrogate for orofacial clefts burden, and prevalence. DALYs are computed through the sum of Years of Life Lost (YLLs) and Years of Healthy Life Lost due to Disability (YLDs) (GBD 2019 Diseases and Injuries Collaborators, 2020). YLDs are computed as a product of the disability weight, ranging from 0 for perfect health to 1 for death, and the prevalence of a disease (GBD 2019 Diseases and Injuries Collaborators, 2020). The disability weights associated with orofacial clefts have been previously reported (GBD 2019 Diseases and Injuries Collaborators, 2020; Massenburg et al., 2021). Orofacial cleft burden and prevalence are reported per 100,000 in this study. All measures are reported with uncertainty intervals (UI) ranging from 2.5% to 97.5% (GBD 2019 Diseases and Injuries Collaborators, 2020).

Case Definition

In the GBD 2019 study, orofacial clefts include isolated cleft lip or palate, and combined cleft lip and palate (GBD 2019 Diseases and Injuries Collaborators, 2020). Craniofacial clefts that do not include the oropharynx are not included in this disease definition (GBD 2019 Diseases and Injuries Collaborators, 2020). The GBD 2019 study also includes corresponding ICD-10 codes and considers disfigurement levels and treatment sequelae (GBD 2019 Diseases and Injuries Collaborators, 2020).

Socio-Demographic Index Analysis

The GBD 2019 study utilized Socio-Demographic Index (SDI) as an indicator of economic and social conditions affecting health outcomes in different locations (GBD 2019 Diseases and Injuries Collaborators, 2020). The SDI represents the geometric mean of 0 to 1 indices of total fertility rate for individuals younger than 25 years, mean education for those 15 years and older, and lag-distributed income per capita (GBD 2019 Diseases and Injuries Collaborators, 2020).

Geographical Distribution

Global rates of orofacial clefts burden and prevalence are reported. In addition, orofacial clefts burden is reported according to SDI, and World Bank regions (GBD 2019 Diseases and Injuries Collaborators, 2020). We also report the countries with the highest burden and prevalence rates for orofacial clefts.

Results

In 2019, the global burden of orofacial clefts was estimated to be 529,758.92 DALYs (95% UI: 362,492.88 – 798,419.69 DALYs), while the global prevalence of orofacial clefts was estimated to be 4.6 million (95% UI: 3.8 – 5.7 million). (**Figure 1** and **Figure 2**)

The global rate per 100,000 of DALYs was estimated to be 6.85 (95% UI: 4.68 – 10.32). (**Table 1**) The highest burden of orofacial clefts was noted in Sub-Saharan Africa (13.11 DALYs per 100,000; 95% UI: 6.26 – 28.42 DALYs per 100,000), followed by South Asia (10.84 DALYs per 100,000; 95% UI: 6.87 – 16.33 DALYs per 100,000), Middle East/North Africa (6.81 DALYs per 100,000: 95% UI: 4.59 – 9.61 DALYs per 100,000), East Asia/Pacific (4.37 DALYs per 100,000; 95% UI: 3.28 – 5.84 DALYs per 100,000), Latin American/Caribbean (3.26 DALYs per 100,000; 95% UI: 2.47 – 4.26 DALYs per 100,000), Europe/Central Asia (2.37 DALYs per 100,000; 95% UI: 1.6 – 3.32 DALYs per 100,000), and North America (0.96 DALYs per 100,000; 95% UI: 0.61 – 1.39 DALYs per 100,000). (**Table 1**) There was a negative correlation between disease burden and SDI. The highest burden of orofacial clefts was reported in low SDI countries (15.06 DALYs per 100,000; 95% UI: 7.84 – 30.75 DALYs per 100,000), followed by low-middle SDI countries (9.18 DALYs per 100,000; 95% UI: 6.27 – 13.67 DALYs per 100,000), middle SDI countries (5.21 DALYs per 100,000; 95% UI: 3.76 – 6.99 DALYs per 100,000), high-middle SDI countries (3.69 DALYs per 100,000; 95% UI: 2.66 – 5.04 DALYs per 100,000), and high SDI countries (1.97 DALYs per 100,000; 95% UI: 1.25 – 2.90 DALYs per 100,000). (**Table 1**) A gender-based stratified analysis of global burden of orofacial clefts per geographic area and SDI is also included in **Table 1**.

The global prevalence rate per 100,000 was estimated to be 59.68 (95% UI: 48.63 – 73.32 per 100,000). (**Table 1**) The highest prevalence of orofacial clefts was noted in South Asia (107.55 per 100,000; 95% UI: 86.98 – 133.27 per 100,000), followed by Middle East/North Africa (90.10 per 100,000; 95% UI: 73.09 – 110.72 per 100,000), Sub-Saharan Africa (52.15 per 100,000; 95% UI: 42.59 – 63.97 per 100,000), East Asia/Pacific (45.47 per 100,000; 95% UI: 37.12 – 55.51 per 100,000), Europe/Central Asia (32.40 per 100,000; 95% UI: 26.22 – 39.72 per 100,000), Latin America/Caribbean (29.62 per 100,000; 95% UI: 24.32 – 36.05 per 100,000), and North America (13.98 per 100,000; 95% UI: 11.29 – 17.15 per 100,000). (**Table 1**) The highest prevalence of orofacial clefts was noted in low-middle SDI countries (83.12 per 100,000; 95% UI: 67.47 – 102.47 per 100,000), followed by low SDI countries (71.22 per 100,000; 95% UI: 57.88 – 87.52 per 100,000), middle SDI countries (58.32 per 100,000; 95% UI: 47.67 – 71.56 per 100,000), high-middle SDI countries (44.62 per 100,000; 36.23 – 54.83 per 100,000), and high SDI countries (30.51 per 100,000; 95% UI: 24.85 – 36.96 per 100,000). (**Table 1**) A gender-based

stratified analysis of global prevalence of orofacial clefts per geographic area and SDI is also included in **Table 1**.

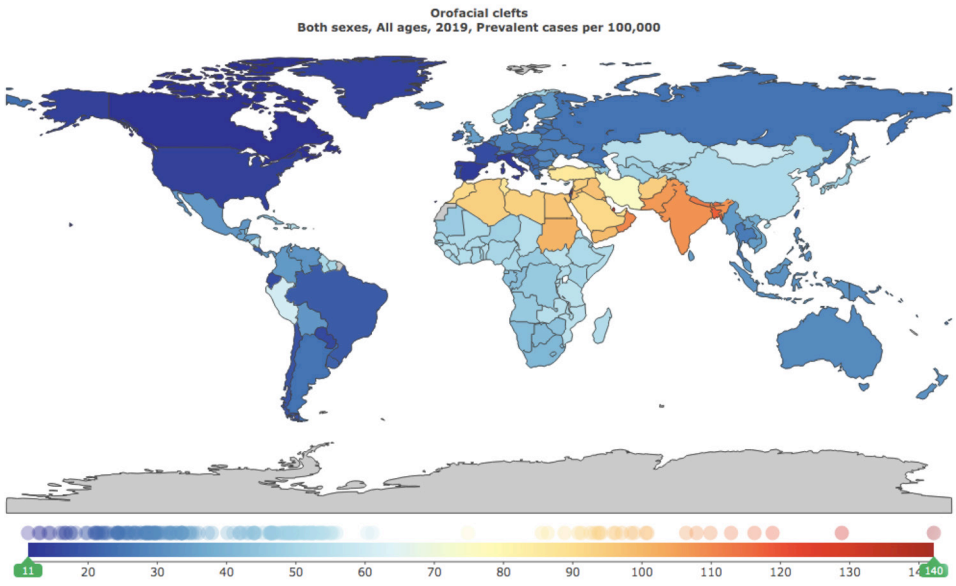

Figure 1. Global prevalence rates of orofacial clefts.

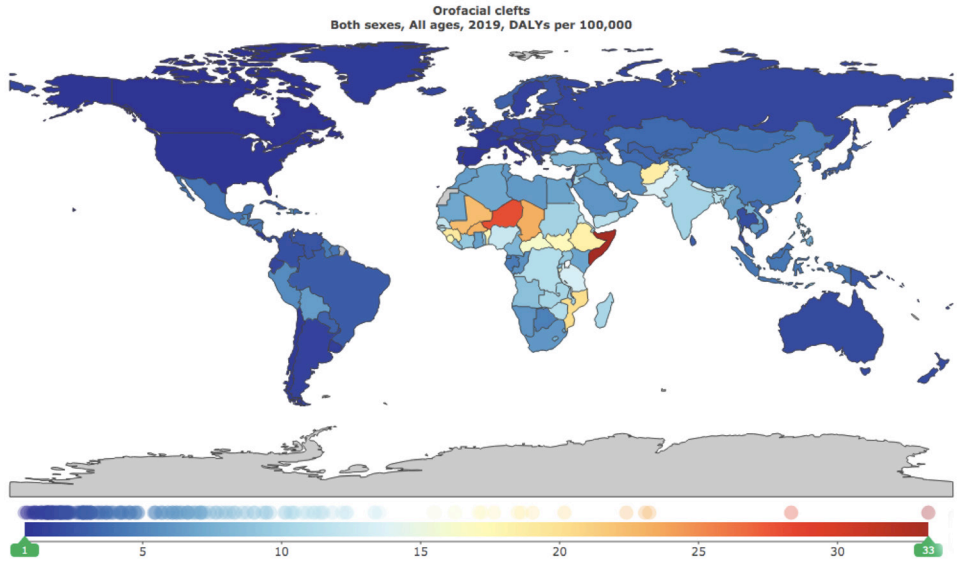

Figure 2. Global burden rates of orofacial clefts.

Table 1. Global Burden and Prevalence Rates of Orofacial Clefts, 2019.

	2019 DALYs per 100,000 Population (UI)			2019 Prevalence per 100,000 Population (UI)		
Region	**All**	**Male**	**Female**	**All**	**Male**	**Female**
Global	6.85 (4.68 – 10.32)	7.04 (4.70 – 11.97)	6.66 (4.36 – 11.02)	59.68 (48.63 – 73.32)	62.09 (50 .67 – 76.26)	57.25 (46.47 – 70.49)
East Asia/Pacific	4.37 (3.28 – 5.84)	4.32 (3.15 – 5.74)	4.42 (3.28 – 5.99)	45.47 (37.12 – 55.51)	42.89 (34.87 – 52.76)	48.09 (39.32 – 58.54)
South Asia	10.84 (6.87 – 16.33)	11.34 (6.40 – 17.69)	10.31 (6.56 – 15.99)	107.55 (86.98 – 133.27)	112.35 (90.62 – 139.29)	102.55 (82.51 – 127.30)
Europe/Central Asia	2.37 (1.60 – 3.32)	2.56 (1.73 – 3.60)	2.19 (1.42 – 3.10)	32.40 (26.22 – 39.72)	33.87 (27.49 – 41.41)	31.01 (25.07 – 37.72)
Middle East/North Africa	6.81 (4.59 – 9.61)	6.88 (4.45 – 10.03)	6.73 (4.66 – 9.40)	90.10 (73.09 – 110.72)	100.57 (81.27 – 123.26)	78.61 (63.04 – 96.91)
Sub-Saharan Africa	13.11 (6.26 – 28.42)	13.11 (6.20 – 34.29)	13.11 (5.78 – 37.00)	52.15 (42.59 – 63.97)	55.64 (45.52 – 68.33)	48.76 (39.64 – 59.75)
Latin America/Caribbean	3.26 (2.47 – 4.26)	3.60 (2.70 – 4.69)	2.94 (2.21 – 3.93)	29.62 (24.32 – 36.05)	32.05 (26.39 – 38.98)	27.29 (22.37 – 33.19)
North America	0.96 (0.61 – 1.39)	1.03 (0.67 – 1.51)	0.88 (0.56 – 1.29)	13.98 (11.29 – 17.15)	15.00 (12.12 – 18.40)	13.00 (10.47 – 15.95)
Low SDI	15.06 (7.84 – 30.75)	14.96 (7.54 – 37.46)	15.15 (7.30 – 39.16)	71.22 (57.88 – 87.52)	75.83 (61.58 – 93.02)	66.58 (53.97 – 81.60)
Low-Middle SDI	9.18 (6.27 – 13.67)	9.67 (5.89 – 14.92)	8.68 (5.86 – 13.20)	83.12 (67.47 – 102.47)	87.50 (70.86 – 107.92)	78.69 (63.46 – 96.74)
Middle SDI	5.21 (3.76 – 6.99)	5.40 (3.79 – 7.33)	5.02 (3.64 – 6.83)	58.34 (47.67 – 71.56)	59.79 (48.62 – 73.32)	56.88 (46.48 – 69.62)
High-Middle SDI	3.69 (2.66 – 5.04)	3.80 (2.72 – 5.15)	3.59 (2.56 – 4.97)	44.62 (36.23 – 54.83)	45.36 (36.76 – 55.76)	43.87 (35.58 – 54.11)
High SDI	1.97 (1.25 – 2.90)	2.05 (1.30 – 2.99)	1.90 (1.20 – 2.78)	30.51 (24.85 – 36.96)	31.35 (25.54 – 37.82)	29.67 (24.03 – 36.13)
Countries with Highest Rates of DALYs and Prevalence per 100,000 Population	**Somalia:** 33.27 (6.64 – 140.75) **Niger:** 28.33 (5.89 – 106.62) **Chad:** 23.23 (6.26 – 79.91) **Burkina Faso:** 23.08 (6.17 – 79.99) **Mali:** 22.40 (5.95 – 75.15) **Mozambique:** 20.17 (6.94 – 56.62) **Guinea:** 19.03 (6.46 – 53.06) **Afghanistan:** 18.64 (8.88 – 45.21) **Ethiopia:** 18.49 (6.20 – 48.92) **Sierra Leone:** 17.64 (6.07 - 48.15) **Benin:** 17.21 (6.38 – 46.80) **South Sudan:** 17.10 (6.34 – 45.52) **Central Africa:** 16.23 (6.08 – 42.71) **Burundi:** 15.49 (5.90 – 45.91) **Pakistan:** 13.51 (7.54 – 23.78)			**Palestine:** 142.15 (115.46 – 174.51) **Qatar:** 128.85 (102.42 – 159.03) **Bangladesh:** 118.85 (94.54 – 147.68) **Bhutan:** 116.25 (92.98 – 145.47) **Nepal:** 112.86 (90.49 – 139.64) **Oman:** 109.88 (87.93 – 134.31) **India:** 107.88 (87.21 – 133.64) **Pakistan:** 106.39 (85.28 – 131.43) **Kuwait:** 100.78 (80.02 – 124.90) **Sudan:** 100.53 (81.30 – 124.74) **Yemen:** 98.87 (79.12 – 120.64) **Jordan:** 98.39 (78.63 – 122.64) **Iraq:** 97.10 (78.03 – 120.01) **Egypt:** 96.21 (77.19 – 118.66) **Lebanon:** 95.89 (76.78 – 118.37)		

DALYs: disability-adjusted life-years; UI: uncertainty interval; SDI: Socio-Demographic Index

We also analyzed the global burden and prevalence of orofacial clefts per country. The highest burden of orofacial clefts was noted in Somalia (33.27 DALYs per 100,000; 95% UI: 6.64 – 140.75 DALYs per 100,000), followed by Niger (28.33 DALYs per 100,000; 95% UI: 5.89 – 106.62 DALYs per 100,000), Chad (23.23 DALYs per 100,000; 95% UI: 6.26 – 79.91 DALYs per 100,000), Burkina Faso (23.08 DALYs per 100,000; 95% UI: 6.17 – 79.99 DALYs per 100,000), Mali (22.40 DALYs per 100,000; 95% UI: 5.95 – 75.15 DALYs per 100,000), Mozambique (20.17 DALYs per 100,000; 95% UI: 6.94 – 56.62 DALYs per 100,000), Guinea (19.03 DALYs per 100,000; 95% UI: 6.46 – 53.06 DALYs per 100,000), Afghanistan (18.64 DALYs per 100,000; 95% UI: 8.88 – 45.21 DALYs per 100,000), Ethiopia (18.49 DALYs per 100,000; 95% UI: 6.20 – 48.92 DALYs per 100,000), Sierra Leone (17.64 DALYs per 100,000; 95% UI: 6.07 – 48.15 DALYs per 100,000), Benin (17.21 DALYs per 100,000; 95% UI: 6.38 – 46.80 DALYs per 100,000), South Sudan (17.10 DALYs per 100,000; 95% UI: 6.34 – 45.52 DALYs per 100,000), Central Africa (16.23 DALYs per 100,000; 95% UI: 6.08 – 42.71 DALYs per 100,000), Burundi (15.39 DALYs per 100,000; 95% UI: 5.90 – 45.91 DALYs per 100,000), and Pakistan (13.51 DALYs per 100,000; 95% UI: 7.54 – 23.78 DALYs per 100,000). (**Table 1**)

The highest prevalence of orofacial clefts was noted in Palestine (142.15 per 100,000; 95% UI: 115.46 – 174.51 per 100,000), followed by Qatar (128.85 per 100,000; 95% UI: 102.42 – 159.03 per 100,000), Bangladesh (118.85 per 100,000; 95% UI: 94.54 – 147.68 per 100,000), Bhutan (116.25 per 100,000; 95% UI: 92.98 – 145.47 per 100,000), Nepal (112.86 per 100,000; 95% UI: 90.49 – 139.64 per 100,000), Oman (109.88 per 100,000; 95% UI: 87.93 – 134.31 per 100,000), India (107.88 per 100,000; 95% UI: 87.21 – 133.64 per 100,000), Pakistan (106.39 per 100,000; 95% UI: 85.28 – 131.43 per 100,000), Kuwait (100.78 per 100,000; 95% UI: 80.02 – 124.90 per 100,000), Sudan (100.53 per 100,000; 95% UI: 81.30 – 124.74 per 100,000), Yemen (98.87 per 100,000; 95% UI: 79.12 – 120.64 per 100,000), Jordan (98.39 per 100,000; 95% UI: 78.63 – 122.64 per 100,000), Iraq (97.10 per 100,000; 95% UI: 78.03 – 120.01 per 100,000), Egypt (96.21 per 100,000; 95% UI: 77.19 – 118.66 per 100,000), and Lebanon (95.89 per 100,000; 95% UI: 76.78 – 118.37 per 100,000). (**Table 1**).

Discussion

Clefts of the lip and palate are the most common orofacial congenital anomalies (Massenburg et al., 2021). Despite guidelines strongly recommending that clefts of the lip should be repaired within the first year of life and that clefts of the palate should be treated by 18 months of age, a significant backlog of untreated patients around the globe persists (American Cleft Palate-Craniofacial Association, 1993;

Massenburg et al., 2021). This is significant given that untreated clefts of the lip and/or palate have been associated with increased patient morbidity and even mortality (Shkoukani et al., 2013). Consequently, a significant number of international cleft care organizations have attempted to address this persisting backlog of untreated patients through global initiatives that have varied considerably in scope, sustainability, longevity, geographical distribution, and model of cleft care delivery (Kantar et al., 2019). Recently, Massenburg et al. have demonstrated that there is a strong significant negative association between the global burden of orofacial clefts and the surgical workforce, suggesting that reinforcing the global surgical workforce in geographical areas that still suffer from a high burden of orofacial clefts, can help in addressing the backlog of untreated patients in those areas (Massenburg et al., 2021).

In this study, we evaluated updated data from the GBD 2019 study in order to assess the global prevalence and burden of orofacial clefts with the hope that this updated analysis can serve as a guide for organizations and individuals engaged and involved in global cleft care delivery. Our analysis here offers the most up to date estimates of the global burden and prevalence of orofacial clefts compared to previous analyses (Massenburg et al., 2021). Our results underline global burden and prevalence of orofacial clefts, as well as prevalence and burden stratified by country, World Bank region, SDI, and we highlighted countries with the highest prevalence and burden rates around the world. The goal of this analysis was to assist countries, international organizations, funding agencies, and policy makers involved in global cleft care, to plan initiatives and channel resources accordingly towards countries and regions carrying the highest prevalence and burden of the disease.

Our updated analysis of the GBD 2019 study demonstrates that the estimated global prevalence (4.6 million; 95% UI: 3.8 – 5.7 million vs. 10.8 million; 95% UI: 9.9 – 11.7 million), prevalence rate (59.68 per 100,000; 95% UI: 48.63 – 73.32 per 100,000 vs. 141.56 per 100,000; 95% UI: 130.17 – 152.53 per 100,000), burden (529,758.92 DALYs; 95% UI: 362,492.88 – 798,419.69 DALYs vs. 652,084 DALYs; 95% UI: 411,089 – 1,107,193 DALYs), and burden rate (6.85 DALYs per 100,000; 95% UI: 4.68 – 10.32 DALYs per 100,000) have decreased since 2017, highlighting that current strategies in place to address the global backlog of untreated patients with orofacial clefts have been effective to some extent (Massenburg et al., 2021). This is also consistent with the previously observed trend that the global burden of orofacial clefts has decreased significantly over the last few decades (Massenburg et al., 2021). Nevertheless, our study redemonstrates that geographical and socioeconomic disparities in the global burden and prevalence of orofacial clefts persist. Our study unfortunately shows that there is an inverse relationship between SDI and burden of orofacial clefts, and that Sub-Saharan Africa, Middle

East/North Africa, and South Asia were the regions carrying the most significant burden of orofacial clefts. Addressing the persistent burden of orofacial clefts in these regions is particularly challenging given that a significant number of countries in them are impacted by a combination of low SDI, lack of appropriate resources and infrastructure, in addition to ongoing geopolitical instability and conflicts (Massenburg et al., 2021). These findings highlight that organizations and individuals that are heavily engaged in global cleft care delivery should focus their initiatives and resources on these countries and regions. This should be done in a collaborative fashion with local authorities and governments, in order to better understand challenges facing the local population, the context in which the burden of orofacial clefts persists, and to ensure that efforts translate into longitudinal, sustainable and capacity building initiatives.

A major limitation of our study is our inability to determine through the GBD study methodology details regarding the orofacial clefts. This prevents us from stratifying our analysis by type and severity of cleft. Additionally, our study does not necessarily capture all the burden and sequelae associated with orofacial clefts, some of which may persist even after surgical correction including psychosocial considerations, as well as dental, nutritional, speech, and other craniofacial considerations. Moreover, data in countries with low SDI and regions that carried most of the burden of orofacial clefts in our study typically lack comprehensive healthcare data which renders generating more accurate estimates of disease burden and prevalence more challenging. Another limitation of our study is that we report national average rates, which can potentially mask underlying variations between states and different geographic locations, and fail to highlight areas that are more affected by the disease. Nevertheless, this manuscript supplements previously published data from the GBD study and provides the most current estimates of global prevalence and burden of orofacial clefts.

Conclusion

Global geographic, socioeconomic and demographic disparities in burden and prevalence of orofacial clefts persist, despite a global decrease over the last few decades. This study supplements existing data on orofacial clefts and provides the most up-to-date estimates on the global burden and prevalence of orofacial clefts, their regional and sociodemographic distributions, as well as the countries that are most afflicted by this condition. The aim of this study is to hopefully guide and direct future investments, resources, and initiatives from individuals and organizations invested in global cleft care delivery, with the goal of building sustainable cleft care capacity where it is needed the most.

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Chapter 3

Cleft Surgery Simulation

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Chapter based on The Manuscript "Simulation In Cleft Surgery" published in Plastic and Reconstructive Surgery Global Open, 2019; 7(9):e2438

Abstract

Background

A number of digital and haptic simulators have been developed to address challenges facing cleft surgery education. However, to date, a comprehensive review of available simulators has yet to be performed. Our goal is to appraise cleft surgery simulators that have been described to date, their role within a simulation-based educational strategy, the costs associated with their use, and data supporting or refuting their utility.

Methods

The following PubMed literature search strategies were used: "Cleft AND Simulation," "Cleft Surgery AND Simulation," "Cleft Lip AND Simulation," "Cleft Palate AND Simulation." Only English language articles up to May 1, 2019, were included. Simulation phases of learning were classified based on our previously proposed model for simulation training.

Results

A total of 22 articles were included in this study. Within identified articles, 11 (50%) were strictly descriptive of simulator features, whereas the remaining 11 (50%) evaluated specific outcomes pertinent to the use of cleft surgery simulators. The 22 included articles described 16 cleft surgery simulators. Out of these 16 cleft surgery simulators, 7 (43.8%) were high fidelity haptic simulators, 5 (31.2%) were low fidelity haptic simulators, and 4 (25.0%) were digital simulators. The cost to simulator user ranged from freely available up to $300.

Conclusions

Cleft surgery simulators vary considerably in their features, purpose, cost, availability, and scientific evidence in support of their use. Future multi-institutional collaborative initiatives should focus on demonstrating the efficacy of current cleft simulators and developing standardized assessment scales.

Introduction

Traditional models of surgical training have relied on extensive operative exposure and an apprenticeship model of gradual responsibility. [1] In the current academic landscape, resident surgical education is challenged by strict work-hour limitations, growing non-clinical duties, increasing resident supervision, and patient requests to limit resident participation in their care. [2] In light of the impact of these factors on resident operative exposure and progression to surgical autonomy, training programs and leaders in surgical education have extensively evaluated resources to supplement surgical residency training, and ensure that trainees graduate as competent, safe, independent surgeons. [2,3] As a result, simulation based educational tools and platforms have materialized as potential solutions to address current challenges facing resident surgical education. Moreover, simulation-based training has become an essential component of the residency curriculum in general surgery through fundamentals of laparoscopic surgery (FLS) and fundamentals of endoscopic surgery (FES) training, with similar initiatives in other surgical specialties. [3-5]

While animal and cadaveric models allow surgical trainees to practice surgical procedures in a high fidelity environment, they are often associated with significant costs and may not be readily accessible. [6] These limitations are further compounded by the restricted educational time that is available to surgical residents, making readily available educational tools such as hands-on mannequins and digital simulators more attractive for procedural learning. These trends in surgical education have not spared plastic and reconstructive surgery training, which has resulted in growing emphasis placed on simulation for resident education. [6] Simulation based educational opportunities in plastic and reconstructive surgery have ranged from hands-on experiences to computer-aided three-dimensional simulators, and have generally been well received by trainees and practicing surgeons. [6-10]

Clefts of the lip and/or palate affect 1 in every 500-700 live births with a variable global incidence, and lead to an increased risk of morbidity and mortality if untreated. [11,12] Cleft surgery is technically complex and requires detailed attention to restore form and function in order to achieve optimal patient outcomes. Achieving proficiency in cleft surgery relies on extensive surgical training and expertise. Traditional cleft surgery training has relied on primary literature, textbooks, lectures, as well as surgical knowledge and skills acquired in the operating room. More recently, digital as well as haptic cleft surgery simulators have been developed and proposed as potential solutions for challenges facing cleft surgery education, consistent with the shift in focus of surgical education needs. [6] However, a comprehensive review of available cleft surgery simulators has yet

to be performed. Through this manuscript, our goal is to appraise cleft surgery simulators that have been described to date, evaluate their role within a simulation based educational strategy, report the costs associated with their use, as well as present data supporting or refuting their utility.

Methods

For this review, the following PubMed literature search strategies were used: "Cleft AND Simulation", "Cleft Surgery AND Simulation", "Cleft Lip AND Simulation", "Cleft Palate AND Simulation". Only English language articles up to May 1st 2019 were included. The references in articles identified through this search strategy were also reviewed. Inclusion and exclusion of articles relied on the definition of healthcare simulation by Gaba, which defines simulation as a "technique to replace or amplify real experiences with guided experiences, often immersive in nature that evokes or replicates substantial aspects of the real world in a fully interactive manner". [13] Digital and haptic simulators were included in our study.

The following data were extracted from articles that were included in our review: simulator purpose, simulator manufacturing, simulator cost, phase of learning addressed by the simulator, and if applicable, study design, outcomes evaluated, and study findings. Simulation phases of learning were classified based on a previously proposed model for simulation training by Diaz-Siso et al. that integrates phases of simulation training and stages of motor skills acquisition. (**Table 1**) The model organizes the simulation training process along three phases: 1) Skills, 2) Procedure), and 3) Team training. Each of these phases is further classified into three stages of motor learning: A) Cognition, B) Association, and C) Automaticity. We classified haptic simulators as "High Fidelity" if they included multiple tissue layers emulating anatomical properties of different structures of the lip and palate (skin, mucosa, muscle, etc…), while any other haptic simulators identified were classified as "Low Fidelity".

Table 1. Intergrative Model of Phases of Simulation Training and Stages of Motor Learning

	Phase of Simulation Training		
Stage of Motor Learning	**1.Skills**	**2.Procedure**	**3.Team Training**
A.Cognition	1A: Skills cognition	2A: Procedure cognition	3A: Team training cognition
B.Association	1B: Skills association	2B: Procedure association	3B: Team training association
C.Automaticity	1C: Skills automaticity	2C: Procedure automaticity	3C: Team training automaticity

Results

Our search methodology yielded 22 articles describing 16 cleft surgery simulators that were included in this study. Out of these 16 cleft surgery simulators, 7 (43.8%) were high fidelity haptic simulators (**Table 2**), 5 (31.2%) were low fidelity haptic simulators (**Table 3**), and 4 (25.0%) were digital simulators (**Table 4**). There were 6 (37.5%) simulators designed for cleft lip repair and markings, 2 (12.5%) simulators designed for cleft lip repair, 4 (25.0%) simulators designed for cleft palate repair and markings, 3 (18.8%) simulators designed for Furlow cleft palate repair and markings, and 1 (6.2%) simulator designed for learning cleft lip and palate anatomy, as well as cleft lip and palate repair, and markings.

The cost of simulators ranged from freely available up to $300 (**Table 2**, **Table 3**, and **Table 4**). Out of the 16 identified simulators, 11 (68.8%) targeted phases 2B (procedure association) and 2C (procedure automaticity) of simulation training, 2 (12.5%) targeted phase 2B (procedure association), 1 (6.2%) targeted phase 2A (procedure cognition), 1 (6.2%) targeted phases 1A (skills cognition) and 2A (procedure cognition), and 1 (6.2%) targeted phases 1B (skills association) and 2B (skills automaticity).

Within identified articles, 11 (50%) were strictly descriptive of simulator features while the remaining 11 (50%) evaluated specific outcomes pertinent to the use of cleft surgery simulators. [14-24] Within these 11 studies, 4 (36.4%) described only proof of concept findings or participant-reported outcomes including satisfaction with the simulator, or perceived improvement in surgical confidence and surgical knowledge. [14,15,19,20] Only two studies relied on raters and cleft specific scales to evaluate participant surgical performance or markings performance. [16,23] Within studies reporting outcomes, the largest included 35 participants and was the only prospective randomized blinded study. [23] The study designs, outcomes evaluated, and main findings of the studies that were included in our review are highlighted in **Table 2**, **Table 3**, and **Table 4**. Examples of a digital cleft surgery and high fidelity cleft lip surgery simulators are shown in **Figure 1** and **Figure 2** respectively.

Table 2. High Fidelity Haptic Simulators

First Author	Year	Simulator Purpose	Simulator Manufacturing	Simulator Cost	Simulation Phase of Learning	Study Design	Outcomes Evaluated	Study Findings
Zheng	2015	Cleft lip repair and markings	CAD/CAM and silicone material	<$50	2B and 2C	N/A	N/A	N/A
Podolsky	2017	Cleft palate repair and markings	CAD/CAM, 3D-printed material, and silicone material	$250–300	2B and 2C	Evaluation of plastic surgery residents (n = 2), fellows (n = 11), and attending (n = 6) performing cleft palate repair using the simulator	Satisfaction with the anatomical accuracy of the simulator and its effectiveness as a teaching tool, participant perceived surgical confidence, and knowledge gained from the simulator	Participants agreed that the simulator is anatomically accurate, effective as a teaching tool, and had increased perceived surgical confidence and knowledge after using it
Podolsky	2017					Evaluate feasibility of performing robotic cleft palate repair using the simulator	Feasibility of performing robotic cleft palate repair using the simulator	Robotic cleft palate repair using the simulator is possible
Podolsky	2018					Evaluation of plastic surgery residents (n = 4), fellows (n = 2), and attendings (n = 2) performing cleft palate repair using the simulator	Surgical performance using the CLOSATS scale, end-product scale, and global rating scale	High inter-rater reliability for the CLOSATS and global rating scales. CLOSATS successfully stratified performance based on experience level. Logarithmic modeling suggested that 6.3 sessions are required to reach the minimum performance standard
Cheng	2018					Evaluation of plastic surgery residents (n = 9) and fellows (n = 1) performing cleft palate repair using the simulator	Procedural confidence and knowledge	Improved procedural confidence and knowledge among participants
Ghanem	2019					Hand motion tracking of plastic surgery residents (n = 2), fellows (n = 2), and attendings (n = 2) performing cleft palate repair using the simulator	Surgical time, number of hand movements, and path length to complete the procedure	Residents required the most time, number of hand movements, and path length to complete the procedure. Number of hand movements was closely matched between fellows and attendings, but overall total path length was shorter for the attendings. Estimated number of simulation sessions to reach within 5% and 1% of attending level were 25 and 113, respectively
Ueda	2017	Cleft lip repair and markings	CAD–CAM, 3D-printing, and polyurethane	N/A	2B and 2C	N/A	N/A	N/A
Cote	2018	Cleft palate repair and markings	CAD/CAM, 3D-printing using PLA for hard palate and silicone for soft palate and tissues	$7.31	2B and 2C	Comparison of residents and physicians in an academic medical center (n = 6) and international (n = 6) settings	Participant-reported likeness to human tissue, ability to manipulate and suture tissue, and surgical skills improvement	Both groups reported high likeness to human tissue, ability to manipulate and suture tissue, and surgical skills improvement. More improvement in surgical skills in residents

(*Continued*)

Table 2. Continued.

First Author	Year	Simulator Purpose	Simulator Manufacturing	Simulator Cost	Simulation Phase of Learning	Study Design	Outcomes Evaluated	Study Findings
Reighard	2018	Cleft lip repair and markings	CAD/CAM, 3D printing using polylactic acid for skeletal components, and silicone for soft tissues	$11.43 for reusable mold and $4.59 for consumables	2B and 2C	Evaluation of attendings performing cleft lip repair using the simulator (n = 5)	Participant-reported satisfaction with physical attributes of simulator, realism of experience, value of simulator, relevance to practice, ability to perform tasks, and global rating of simulator	High satisfaction with the simulator for all outcomes evaluated
Rogers-Vizena	2018	Cleft lip repair and markings	Silicone and synthetic polymer cartridge in a rigid nylon base	$220	2B and 2C	Evaluation of attendings performing cleft lip repair using the simulator (n = 3)	Simulator surface anatomy changes between surgeons and compared with surface anatomy changes in patients	Similar surface anatomy changes between surgeons and compared with real patients
Podolsky	2018	Cleft lip repair and markings	CAD/CAM, 3D-printed material, and silicone material	$250–300	2B and 2C	N/A	N/A	N/A

3D, three dimensional; CAD, computer-assisted design; CAM, computer-assisted manufacturing; CLOSATS, Cleft Palate Objective Structured Assessment of Technical Skills; N/A, not applicable; PLA, polylactic acid.

Table 3. Low Fidelity Haptic Simulators.

First Author	Year	Simulator Purpose	Simulator Manufacturing	Simulator Cost	Simulation Phase of Learning	Study Design	Outcomes Evaluated	Study Findings
Matthews	1997	Furlow cleft palate repair and markings	Cardboard or Styrofoam for hard palate and latex for soft palate	Negligible	2C	N/A	N/A	N/A
Vadodaria	2007	Cleft palate repair and markings	Plastic, latex, and foam	Negligible	2C	N/A	N/A	N/A
Nagy	2008	Furlow cleft palate repair and markings	Plaster, rubber, ink pad, alginate, disposable water cup, rubber dam, and rubber band	Negligible	2C	N/A	N/A	N/A
Senturk	2013	Cleft palate repair and markings	Sponge and foam	Negligible	2C	N/A	N/A	N/A
Liu	2014	Furlow cleft palate repair and markings	Sticky note	Negligible	2B	N/A	N/A	N/A

N/A, not applicable.

Table 4. Digital Simulators

First Author	Year	Simulator Purpose	Simulator Manufacturing	Simulator Cost	Simulation Phase of Learning	Study Design	Outcomes Evaluated	Study Findings
Tanaka	2001	Cleft lip repair	Software based	N/A	2B	N/A	N/A	N/A
Cutting	2002	Cleft lip and palate anatomy, markings and repair	Software based	Free	1A and 2A	N/A	N/A	N/A
Kantar	2018					Evaluation of simulator analytics	Global reach, simulator use, users reached, and user satisfaction with the simulator	Within 5 years of launch, simulator had been accessed in 136 countries, for a simulator screen time of 1,676 hours. Most users were surgeons or surgical trainees, and found the simulator to be useful as an educational tool
Plana	2019					Evaluation of medical students randomized to digital simulator (n = 18) or textbook (n = 17)	Cleft lip markings performance using 10-point scale, and participant-reported satisfaction with each educational tool	Students in the digital group performed better
Montgomery	2003	Cleft lip markings and repair	Software based	N/A	1B and 2B	Comparison of nonmedical individuals (n = 6) to plastic surgery residents (n = 6)	Cleft lip markings performance using software-generated score	Both groups improved with repeated attempts and plastic surgery residents improved quicker
Kobayashi	2006	Cleft lip repair	Software based	N/A	2A	N/A	N/A	N/A

N/A, not applicable.

Figure 1. Example of digital cleft surgery simulator.

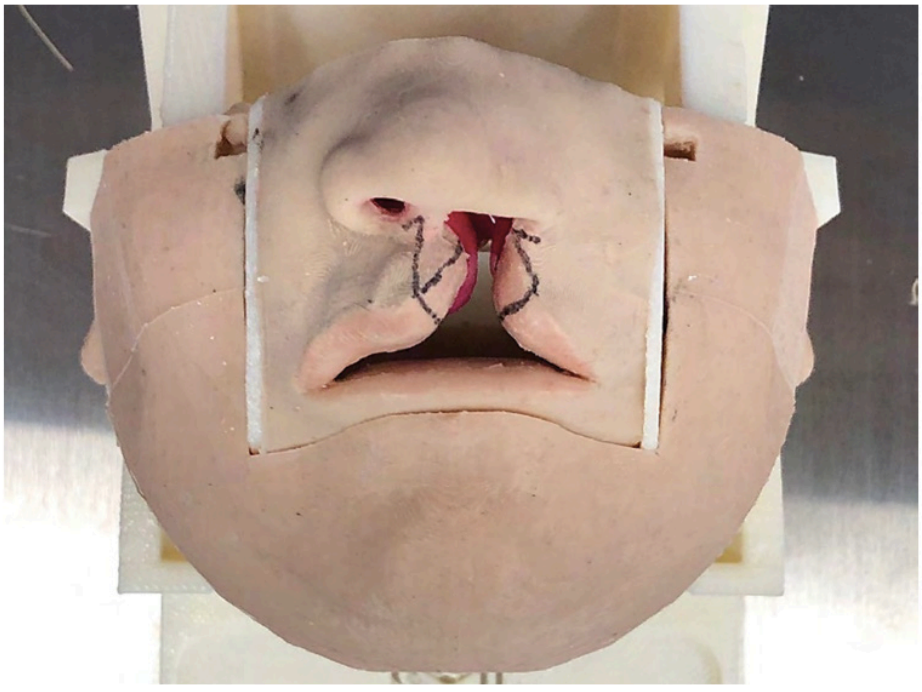

Figure 2. Example of high fidelity haptic cleft lip simulator. The high-lighted markings are not a standard component of this haptic simulator and have been drawn to demonstrate cleft lip repair markings for the extende Mohler technique.

Discussion

Simulation based training was popularized by its role in civilian as well as military pilot and astronaut training. [25] Since then, this teaching modality has been widely adopted for medical and surgical training through mannequin-based, haptic, and digital simulated clinical scenarios. [3] Within surgical specialties, general surgery demonstrated early adoption of simulation based training, with its formalized integration into surgical curricula, most notably through laparoscopic training programs such as FLS in the late 1990s. [26] In plastic and reconstructive surgery, there is growing interest in simulation based resident education, with the emergence of a number of simulation based haptic and digital educational tools. [6-9] A similar trend has been observed in cleft surgery, where a number of digital and haptic cleft lip and/or palate educational simulators have been described. [14-24,27-38] Our group has previously proposed a simulation based training strategy that integrates the three stages of motor skills acquisition (cognition, association, and automaticity) described by Fitts and Posner, with the three phases of simulation training (skills, procedures, and team training) described by *Rosen* et al. through the American College of Surgeons/Association of Program Directors in Surgery Skills Curriculum. [6,39-41] This simulation based educational strategy includes nine stages through which trainees can progress from the novice level to operative autonomy. [6] The goal of this study is to perform a comprehensive review of described cleft surgery simulators, evaluate which phase of simulation based learning they target, appraise their characteristics including cost and manufacturing, and assess data associated with their use.

Our review identified a significant number of described cleft surgery educational digital as well as haptic simulators. These simulators displayed significant variability in level of fidelity and characteristics. Moreover, the majority of identified simulators targeted procedure association and automaticity phases of simulation based cleft surgery training. While these findings highlight encouraging growing enthusiasm and efforts in the field of cleft surgery education, they also underscore a critical need for collaboration between different cleft surgery simulation teams. Current patterns of simulator development are suggestive of divergent and silo-based, rather than coordinated and synchronized educational efforts. Collaborations between different teams can allow a thorough assessment of the educational needs of current surgical trainees, and the development of complementary simulation based educational tools targeting all phases of cleft surgery education. This would also allow researchers to build on existing models to develop higher-fidelity and cheaper simulators as opposed to going through all phases of simulator development. Such collaborative efforts would allow leaders in surgical education to develop comprehensive, standardized, needs-based, simulation-driven educational

curricula in cleft surgery. Moreover, these collaborative efforts could also serve to unify research initiatives driven by different simulation teams, and overcome a significant limitation of simulation based research; limited sample size and study power. Within studies including research participants, the largest study was a prospective randomized blinded trial in which 35 participants were recruited to test the effectiveness of digital simulation in teaching cleft lip surgical markings compared to textbook. [23] Collaborative multi-institutional studies would increase sample size and study power by providing a larger pool of participants, as well as validate results obtained at the institutional level, through testing at multiple sites and across more heterogeneous cohorts.

Strict work-hour limitations, increasing resident supervision, patient requests to limit resident participation in their care, and growing non-clinical duties are challenging resident surgical education in developed countries. [2] In developing countries, surgical expertise is often lacking which can jeopardize patient access to safe surgical care. [42] Simulation based training can potentially address some of these challenges in various surgical specialties, including cleft surgery, by allowing surgical trainees in developed countries to compensate for limited operative exposure, and providing training to surgical trainees in developing countries. For educational tools, including cleft surgery simulators, to be successful at achieving their intended goal, they need to be readily available and easily accessible to surgical trainees. Moreover, these simulators also need to be affordable in order to ensure that they are reaching their intended surgical audience irrespective of demographic, social, or economic factors. Our review of the literature shows that the reported cost of cleft surgery simulators for users, has ranged from freely available with digital simulators, up to $300 with high fidelity haptic simulators. [14,22] Ongoing efforts are underway to reduce the cost of high fidelity haptic cleft surgery simulators to ensure their wide-scale distribution, particularly in low resource settings. [21] These include creating disposable cartridges of cleft lip and/or palate defects for surgical training that fit into a reusable base, as well as adopting rapid prototype manufacturing techniques for simulator production. [14,21,32] It is also important to highlight that cleft surgery simulators that are free and widely available to users can only be sustainable through strong collaborations and partnerships between invested stakeholders in cleft surgery education from the academic, philanthropic, and industry sectors. [6,22] These partnerships and success stories in cleft surgery education should serve as roadmaps for educational simulator development.

Our review of the literature demonstrated that only half of the studies that were included, evaluated specific outcomes pertinent to the use of cleft surgery simulators (**Table 2**, **Table 3** and **Table 4**). Moreover, the level of evidence of these studies was variable, with only one reported prospective randomized blinded trial.

[23] Nevertheless, all studies reported encouraging and positive outcomes associated with simulator use, including reaching a significant global surgical audience, high participant reported satisfaction with simulator use, improved surgical confidence and surgical knowledge, improved cleft lip markings performance, as well as better surgical performance and efficiency. [14-24,27-38] Assessment of these outcomes was mostly performed using modified versions of existing scales, with only two reported cleft surgery specific scales including the Cleft Palate Objective Structured Assessment of Technical Skills (CLOSATS) scale for cleft palate repair performance, and a 10-point scale developed for evaluation of extended Mohler unilateral cleft lip repair markings performance. [16,23] Future efforts in cleft surgery simulation should focus on developing, testing, and validating cleft lip and cleft palate repair specific scales through multi-institutional collaborative efforts, in order to support the efficacy of current simulation based cleft surgery educational tools and guide future development. Standardized and validated cleft specific scales can also allow better assessment of trainee performance, identify opportunities for improvement, as well as guide remedial efforts if necessary.

Conclusion

Surgical simulation can potentially address significant challenges facing surgical trainees around the world. In cleft lip and palate surgery, significant emphasis has been placed on developing digital as well as high fidelity and low fidelity haptic surgical simulators. Cleft surgery simulators vary considerably in their features, purpose, cost, and availability. The level of evidence supporting the use of these simulators has also varied widely, but results are favorable. These promising efforts in cleft surgery simulation should be coupled with future multi-institutional collaborative initiatives that are focused on demonstrating the efficacy of current cleft simulators and refining them. This will also require the development, testing, and validation of cleft lip and palate specific assessment scales that can be used to report standardized trainee performance results, identify opportunities for improvement, as well as guide remedial efforts. Standardized data in support of the educational utility of cleft surgery simulators can provide key stakeholders in surgical education with the necessary evidence for investing in these simulators and spearheading their development.

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Chapter 4

Impact of Cleft Surgery Simulation on Procedural Confidence, Knowledge, and Skills Acquisition

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Chapter based on The Manuscript "Knowledge and Skills Acquisition by Plastic Surgery Residents through Digital Simulation Training: A Prospective, Randomized, Blinded Trial", Published in Plastic and Reconstructive Surgery, 2020, 145(1):184e-192e

Oral Presentation at The American Association of Plastic Surgeons (AAPS) 98th Annual Meeting, Baltimore, Maryland, U.S.A, 2019

Abstract

Introduction

Simulation is a standard component of residency training in many surgical subspecialties, yet its impact on knowledge and skills acquisition in plastic surgery training remains poorly defined. We evaluated the potential benefits of simulation-based cleft surgery learning in plastic surgery resident education through a prospective, randomized, blinded trial.

Methods

Thirteen plastic surgery residents were randomized to a digital simulator or textbook demonstrating unilateral cleft lip (UCL) repair. The following parameters were evaluated before (pre-intervention) and after (post-intervention) randomization: knowledge of surgical steps, procedural confidence, markings performance on a three-dimensional (3D) stone model, and surgical performance using a hands-on/high-fidelity 3D haptic model. Participant satisfaction with either educational tool was also assessed. Two expert reviewers blindly graded markings and surgical performance. Intra-class correlation coefficients (ICC) were calculated. Wilcoxon signed-rank and Mann-Whitney U tests were used.

Results

Interrater reliability was strong for pre-intervention and post-intervention grading of markings (ICC=0.97; $p<0.001$ and ICC=0.96; $p<0.001$) and surgical (ICC=0.76; $p=0.01$ and ICC=0.85; $p=0.001$) performance. Post-intervention surgical knowledge (40.3±4.4 vs. 33.5±3.7; $p=0.03$), procedural confidence (24.0±7.0 vs. 14.7±2.3; $p=0.03$), markings performance (8.0±2.5 vs. 2.9±3.1; $p=0.03$), and surgical performance (20.3±3.6 vs. 15.3±3.1; $p=0.04$) significantly improved in the digital simulation group compared to pre-intervention, but not in the textbook group. All participants were more satisfied with the digital simulator as an educational tool (27.7±2.5 vs. 14.4±4.4; $p<0.001$).

Conclusions

We present evidence suggesting that digital cognitive simulators lead to significant improvement in surgical knowledge, procedural confidence, markings performance, as well as surgical performance.

Introduction

Surgical education is facing significant challenges resulting from strict work hour limitations, diminishing resident autonomy and increasing documentation time. [1] These factors have limited operative time and exposure for surgical trainees, and have driven them to seek educational tools that allow them to acquire complex surgical knowledge in an efficient and independent manner. As a result, simulation-based training has recently emerged as a potential solution to address these shortcomings within different surgical specialties, and offers trainees the opportunity to prepare for common clinical scenarios and surgical procedures without jeopardizing patient safety.[2]

Congenital clefts of the lip and/or palate affect almost 1 in every 500 to 700 live births, and lead to significant morbidity and mortality if untreated. [3-5] Cleft surgery is technically challenging and demands detailed attention to form and function for optimal patient outcomes. Extensive surgical training and expertise are therefore required prior to mastering the repair of cleft deformities. Traditional plastic surgery training resources rely on articles, textbooks, lectures, as well as knowledge and skills acquired in the operating room. More recently, in line with the overall shifting landscape in surgical education, digital as well as hands on cleft surgery simulators have been developed and proposed as potential solutions for challenges facing knowledge and skills acquisition by plastic surgery trainees. [6-10]

We have previously described an online and freely available digital cleft surgery simulator, as well as its noteworthy global reach, and effectiveness in teaching medical students cleft surgery markings. [6,11,12] However, the impact of digital simulation on plastic surgery skills acquisition in residents remains unknown. Furthermore, while numerous cleft surgery simulators have been described, an educational strategy encompassing digital and haptic simulation for the purposes of cleft surgery knowledge and skills acquisition in plastic surgery residents is lacking. With these needs in mind, the goal of this study was to evaluate the impact of a cognitive cleft surgery digital simulator on surgical skills acquisition through a prospective, randomized, blinded comparison to textbook, and propose a comprehensive simulation-based approach to cleft surgery education.

Methods

Study Participants and Design

Plastic surgery residents (N = 13) from postgraduate years (PGY) 1 to 4 prior to their craniofacial surgery rotation in PGY 5 were recruited to participate in our study. The study design is outlined in **Figure 1** and the overall testing time for each

participant was approximately 3 hours.

Participants were randomized to one of two interventions: digital simulation (n = 6) or textbook (n = 7). Development of the digital simulator through collaboration between academic plastic surgeons including the senior author (RLF), a philanthropic organization (Smile Train), and a biotechnology company (Biodigital Inc.) has previously been described in detail. [6,12] The simulator is interactive, web-based, freely available at www.cleftsim.org, and details pertinent surgical anatomy of cleft deformities, surgical markings, as well as the cardinal procedures in cleft surgery through animation and intraoperative video footage with voice-over narration (**Figure 2**). [6,12] The textbook chapter used in this study was also written by the senior author (RLF) and details the anatomy of the cleft deformity, surgical markings and step-by-step process of performing a unilateral cleft lip repair. [13]

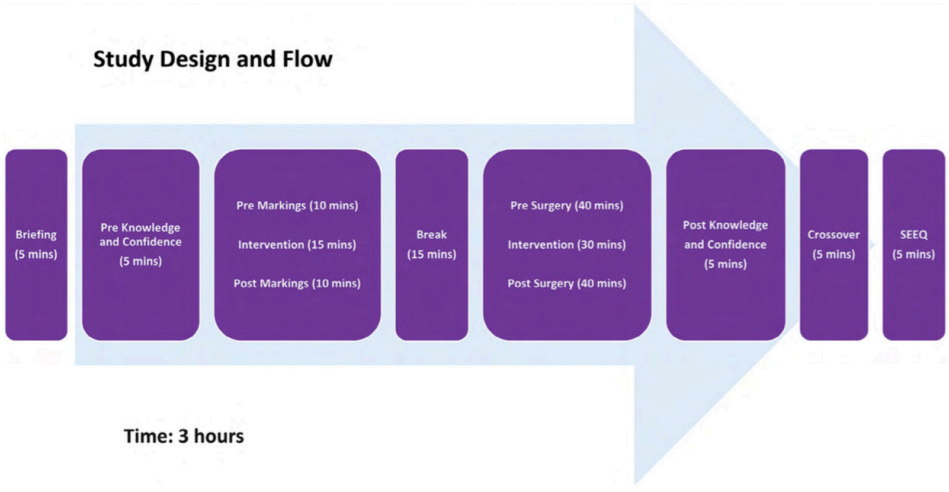

Figure 1. Study design and flow.
Pre, preinterventions; *Post*, postinterventionl; *SEEQ*, Student Evaluation of Educational Quality

The procedure evaluated in this study was the extended Mohler unilateral cleft lip repair. [14] Participants were initially briefed about the study and demographic data were collected. Pre-intervention participant knowledge of the surgical steps and procedural confidence were assessed, followed by pre-intervention assessment of markings performance using a three-dimensional cleft lip stone model (**Figure 3**). Participants were then given 15 minutes to study the markings using the simulator or textbook, and their markings performance was then reevaluated. Similarly, participants' pre-intervention surgical performance was assessed, followed by 30 minutes of study time with the simulator or textbook and reevaluation of surgical performance post-intervention. The exposure time to the educational resource was identical in both

study arms for standardization purposes, and to emulate learning conditions that modern trainees are facing: a fixed amount of time is available to learn a growing body of knowledge. The surgical procedures were performed on a high fidelity, commercially available, unilateral cleft lip three-dimensional (3D) haptic model (*Simulare Medical*, Toronto, Canada) and were video-recorded (**Figure 3**) adapting previously described techniques. [8,15] Video footage was recorded using a smartphone mounted on a table handle. The recordings were focused on the surgical field and did not include audio to prevent resident identification by the raters (**Figure 3**). Standardized instrument sets were provided to all study participants, and 2 research fellows assisted participants during the procedure (**Figure 3**). Post-intervention knowledge of the surgical steps and procedural confidence were then assessed. The participants were then exposed to the alternative study intervention arm educational tool, and their satisfaction with the digital simulator and textbook as educational tools was evaluated.

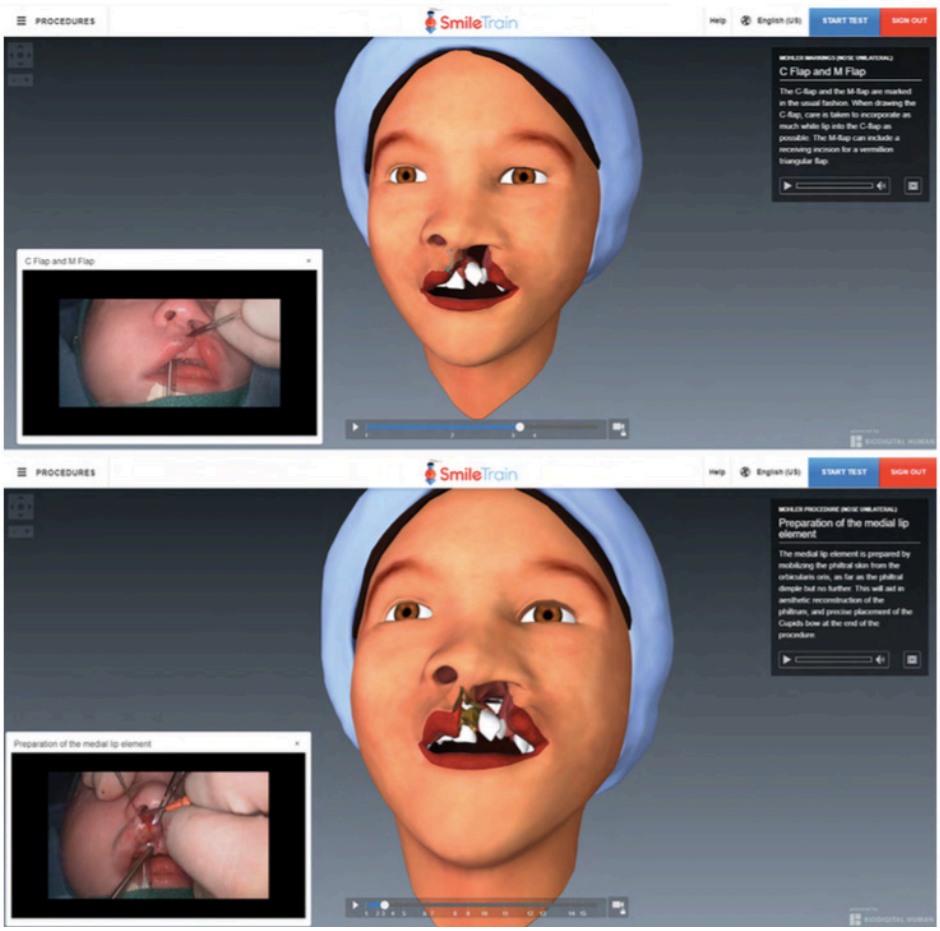

Figure 2. Digital simulator extended Mohler unilateral cleft lip markings (*above*) and repair (below) modules.

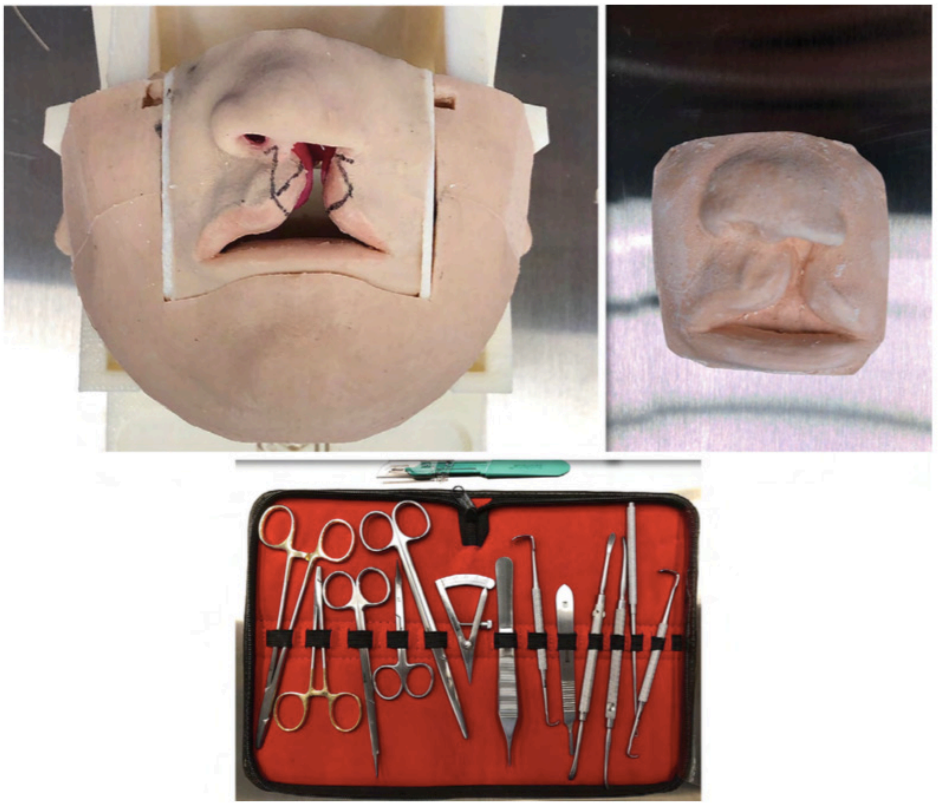

Figure 3. Unilateral cleft lip haptic model (*above, left*), stone model (*above, right*), and surgical instruments (*below*).

Assessment Tools, Scales, and Grading

Knowledge of surgical steps of the procedure was evaluated through ordering 10 essential and sequential steps as described in the digital simulator at www.cleftsim.org and textbook (**Supplementary 1**). [13] These 10 steps were identified, ordered and clarified by consensus agreement by three expert craniofacial surgeons with active practices in cleft care. The rank was then scored from 0 to 45. The score is generated by subtracting the number of inversions, defined as the number of pair of steps that are out of order with respect to one another, from the total number of correct pairs if all steps are ranked correctly. [16] The total number of correct pairs for 10 steps is 45. Procedural confidence was assessed using a modified version of the psychometrically validated tool for measuring resident self-confidence during surgical learning developed by Geoffrion et al., with a maximum attainable score of 50 (**Supplementary 2**). [17] A modified version of this tool has previously been adapted successfully to cleft palate repair. [18] Markings performance was evaluated using the scale we described in a previous study, with a maximum score of 10

(**Supplementary 3**). [12] Surgical performance was assessed using a modified version of the Objective Structured Assessment of Technical Skill (OSATS) scale, a validated tool for evaluating the technical skills of surgical trainees, with a maximum score of 20 (**Supplementary 4**). [19] The items evaluated through OSATS include: respect for tissue, time and motion, instrument handling, knowledge of instruments, flow of operation, use of assistants, and knowledge of the specific procedure. The modified version accounts for blinded rating of video recordings in which knowledge of instruments, use of assistants, and knowledge of the specific procedure may not be appropriately evaluated given the absence of audio. [20] Participant satisfaction with the digital simulator and textbook as educational tools was evaluated using a modified survey based on the Student Evaluation of Educational Quality (SEEQ) survey, a validated tool for measuring higher education student satisfaction (**Supplementary 5**). [21] SEEQ evaluates whether an educational tool is stimulating, increases participant interest, allows the participant to learn the subject matter, is clear, is an effective means of teaching, and if participants would recommend it to others. Grading of the markings performance and surgical performance were performed in a blinded fashion by two expert craniofacial surgeons.

Data Analysis

Interrater reliability between graders was evaluated using intra-class correlation coefficients (ICC). Strong agreement as defined in this study indicated good (ICC ranging from 0.75 to 0.9) or excellent (ICC more than 0.9) interrater reliability. [22] Ordinal data were treated similar to continuous data based on previous statistical demonstrations. [23] Descriptive statistics are reported as mean ± standard deviation where applicable, and the median is also reported. Given that normal distribution could not be assumed, nonparametric testing was used for comparison between groups (including SEEQ survey results). Mann-Whitney U and Wilcoxon signed-rank tests were used for comparison between groups and for pre/post intervention comparisons within groups, respectively. Statistical significance was reached for $p < 0.05$. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS, IBM Corp, v 23, Armonk, NY).

Results

Demographic data of study participants are reported in **Table 1**.

Table 1. Participant Demographic Characteristics

Variables (n = 13)	All (%)	Simulation (%)	Textbook (%)	p
Mean age ± SD, yr	28.5 ± 2.1	28.8 ± 1.9	28.3 ± 2.4	0.66
Mean no. of cleft procedures ± SD	1.2 ± 2.8	1.4 ± 3.1	1.0 ± 2.4	0.57
Sex				
Male	10 (76.9)	4 (66.7)	6 (85.7)	
Female	3 (23.1)	2 (33.3)	1 (14.3)	0.56
PGY				
1	3 (23.1)	1 (16.7)	2 (28.6)	
2	3 (23.1)	2 (33.3)	1 (14.3)	
3	3 (23.1)	1 (16.7)	2 (28.6)	
4	4 (30.8)	2 (33.3)	2 (28.6)	0.82

PGY, postgraduate year.
*n = 13.

Post-intervention surgical knowledge (36.5 ± 5.6 vs. 32.6 ± 2.8, p = 0.02), procedural confidence (19.9 ± 7.1 vs. 15.1 ± 3.6, p = 0.01), and markings performance (5.8 ± 3.1 vs. 3.3 ± 2.8, p = 0.04) improved significantly in all participants compared to pre-intervention (**Table 2**). Post-intervention surgical performance was better than pre-intervention surgical performance in all participants (10.8 ± 2.8 vs. 9.0 ± 2.6, p = 0.18), but the improvement failed to reach statistical significance (**Table 2**). When stratified by intervention arm, our analysis showed that compared to pre-intervention, post-intervention surgical knowledge (40.3 ± 4.4 vs. 33.5 ± 3.7, p = 0.03), procedural confidence (24.0 ± 7.0 vs. 14.7 ± 2.3, p = 0.03), markings performance (8.0 ± 2.5 vs. 2.9 ± 3.1, p = 0.03), and surgical performance (12.3 ± 2.5 vs. 8.2 ± 2.3, p = 0.04) improved significantly in the digital simulation group (**Table 2**). Compared to pre-intervention, post-intervention surgical knowledge (33.1 ± 4.4 vs. 31.9 ± 1.6, p = 0.39), procedural confidence (16.4 ± 5.3 vs. 15.4 ± 4.5, p = 0.44), markings performance (4.0 ± 2.4 vs. 3.6 ± 2.8, p = 0.55), and surgical performance (9.6 ± 2.4 vs. 9.8 ± 2.8, p = 0.79) did not show significant improvement in the textbook group (**Table 2**).

Table 2. Participant Surgical Knowledge, Procedural Confidence, Markings, and Surgical Performance

	Preintervention			Postintervention			
Variables (n = 13)	**Mean ± SD**	**Median**	**Q1–Q3 (IQR)**	**Mean ± SD**	**Median**	**Q1–Q3 (IQR)**	***p***
Surgical knowledge (maximum score, 45)							
All participants (n = 13)	32.6 ± 2.8	32.0	31.0–34.5 (3.5)	36.5 ± 5.6	34.0	33.0–42.0 (8.0)	0.02*
Digital simulation (n = 6)	33.5 ± 3.7	33.5	31.5–36.5 (5.0)	40.3 ± 4.4	42.0	35.5–43.5 (8.0)	0.03*
Textbook (n = 7)	31.9 ± 1.6	32.0	31.0–32.0 (1.0)	33.1 ± 4.4	33.0	32.0–34.0 (2.0)	0.39
Procedural confidence (maximum score = 50)							
All participants (n = 13)	15.1 ± 3.6	14.0	12.0–18.5 (6.5)	19.9 ± 7.1	20.0	13.5–25.0 (11.5)	0.01*
Digital simulation (n = 6)	14.7 ± 2.3	14.0	13.5–16.0 (2.5)	24.0 ± 7.0	23.5	18.8–28.5 (9.7)	0.03*
Textbook (n = 7)	15.4 ± 4.5	16.0	11.0–19.0 (8.0)	16.4 ± 5.3	14.0	13.0–21.0 (8.0)	0.44
Markings performance (maximum score = 10)							
All participants (n = 13)	3.3 ± 2.8	2.0	1.0–6.3 (5.3)	5.8 ± 3.1	5.0	2.8–8.8 (6.0)	0.04*
Digital simulation (n = 6)	2.9 ± 3.1	1.5	0.8–6.1 (5.3)	8.0 ± 2.5	8.8	7.1–9.3 (2.2)	0.03*
Textbook (n = 7)	3.6 ± 2.8	3.0	1.0–7.0 (6.0)	4.0 ± 2.4	4.0	2.0–5.0 (3.0)	0.55
Surgical performance (maximum score = 20)							
All participants (n = 13)	9.0 ± 2.6	10.0	14.0–19.3 (5.3)	10.8 ± 2.8	10.5	15.5–22.3 (6.8)	0.18
Digital simulation (n = 6)	8.2 ± 2.3	8.8	12.8–18.3 (5.5)	12.3 ± 2.5	12.0	16.4–23.1 (6.7)	0.04*
Textbook (n = 7)	9.8 ± 2.8	10.5	17.5–20.0 (2.5)	9.6 ± 2.4	9.0	15.0–17.5 (2.5)	0.79

IQR, interquartile range.
*Statistically significant.

Interrater reliability testing demonstrated strong agreement between the two raters for pre-intervention markings performance assessment (ICC = 0.97; 95% CI: 0.89 – 0.99; $p < 0.001$) as well as surgical performance assessment (ICC = 0.76; 95% CI: 0.24 – 0.93; $p = 0.01$) (**Table 3**). Strong interrater reliability was also demonstrated for post-intervention markings performance assessment (ICC = 0.96; 95% CI: 0.87 – 0.99; $p < 0.001$) and surgical performance assessment (ICC = 0.85, 95% CI: 0.51 – 0.95; $p = 0.001$) (**Table 3**).

Table 3. Interrater Reliability

	Preintervention		Postintervention	
Variables*	**ICC**	**95% CI**	**ICC**	**95% CI**
Markings*	0.97	0.89–0.99	0.96	0.87–0.99
Surgery*	0.83	0.45–0.95	0.81	0.37–0.94

ICC, intraclass correlation coefficient.
*n = 13.

SEEQ survey results significantly favored the digital simulator compared to textbook (**Figure 4**). Participants reported that when compared to textbook, digital simulation was more stimulating (4.69 ± 0.48 vs. 2.15 ± 0.80; $p < 0.001$), increased their interest in the subject more (4.62 ± 0.51 vs. 2.23 ± 1.17; $p < 0.001$), allowed better learning of the subject matter (4.62 ± 0.65 vs. 2.31 ± 1.03; $p < 0.001$), had greater clarity (4.23 ± 0.73 vs. 2.62 ± 1.19; $p < 0.001$), and was a more effective means of teaching surgical skills (4.77 ± 0.44 vs. 2.54 ± 0.78; $p < 0.001$). Participants were also more likely to recommend the digital simulator over the textbook (4.77 ± 0.44 vs. 2.54 ± 1.05; $p < 0.001$).

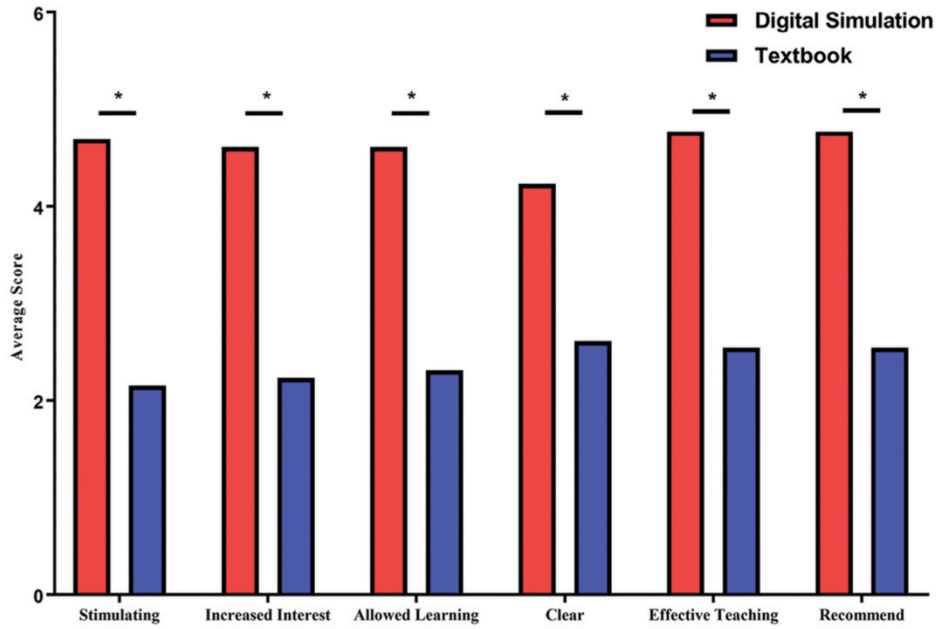

Figure 4. Student Evaluation of Educational Quality survey results.
*Statisically significant ($p < 0.05$).

Discussion

Simulation has recently emerged as an effective resource to address the challenges facing modern surgical education and trainees. [24] Internet-based, multimedia, digital simulators offer trainees immediate access to 3-dimensional anatomic and surgical information, and can facilitate the acquisition of complex surgical knowledge efficiently when presented through an interactive, user-friendly, and freely available platform. [11] Hands on simulators on the other hand, offer surgical residents the opportunity to rehearse specific clinical scenarios and procedures in real time without compromising patient safety and outcomes. While the effectiveness of procedural cognition digital simulators in surgical knowledge acquisition has been demonstrated, their impact on surgical skills acquisition in plastic surgery remains to be explored. [12] Moreover, we have recently witnessed a significant rise in the development of both digital and haptic simulators in plastic surgery, yet a comprehensive simulation-based educational strategy encompassing both surgical knowledge and skills acquisition phases of learning has yet to be determined. [7-11,25] In this study, we demonstrate that our cognitive cleft digital simulator leads to significantly improved surgical knowledge, confidence and skills in plastic surgery residents as compared to textbook, through a prospective

randomized blinded trial. We also highlight the value of using various available simulators targeting different phases of surgical learning in the development of a comprehensive simulation-based educational strategy for plastic surgery residents.

Cleft surgery is particularly challenging among surgical subspecialties due to the complexity of the 3-dimensional anatomy and surgical procedure. This has led academic leaders, surgical educators, and invested stakeholders in cleft surgery education to search for methods to teach surgical trainees the craft of cleft surgery in an efficient manner, while ensuring that patient safety and outcomes remain unaffected. As a result, numerous cleft surgery specific simulators were developed in an attempt to prepare surgical residents for subsequent operative exposure, with variable amount of supporting evidence regarding their educational utility. A high-fidelity cleft palate haptic model was shown to be anatomically accurate, and was found to be a valuable training tool by surgical trainees, leading to significant improvement in procedural knowledge and confidence. [7,18] Similarly, the cleft lip haptic model used in this study was also found to be anatomically accurate and realistic by surgeons and surgical trainees. [8] Moreover, a 3D analysis of another cleft lip haptic model demonstrated surface changes and anthropometric movements that are comparable to nasolabial movements during real cleft lip repairs on patients. [9] We have recently described the development of a digital cleft surgery simulator, and have demonstrated that within 5 years of its launch, it had been accessed in 136 countries encompassing more than 95% of the global population with an estimated screen time of more than 16,000 hours. [6] Importantly, the simulator was mostly accessed by surgeons or surgical trainees, was found to be useful for cleft surgery education by most users, and was significantly superior in teaching unilateral cleft lip markings when compared to textbook through prospective randomized blinded trial. [6] However, despite the growing presence of these cleft simulators and others in plastic surgery, their impact on resident surgical skills acquisition remained unclear.

To our knowledge, the study described here is the first in the plastic surgery literature to offer evidence supporting that knowledge acquired through digital cognitive simulators leads to a significant improvement in surgical skills acquisition. Participants exposed to digital simulation modules describing the extended Mohler unilateral cleft lip repair in our study, demonstrated significant superior improvement in surgical knowledge, procedural confidence, markings performance and surgical performance when compared to participants exposed to textbook. Furthermore, both participants exposed to digital simulation and textbook were significantly more satisfied with the digital simulator as a tool for cleft surgery education. Our study is also the first to explore the use of both digital and haptic simulation for plastic surgery resident education. Combined usage of different available surgical simulators has the potential of laying the foundations

for a comprehensive simulation-based educational curriculum that capitalizes on the strengths of each type of simulator, in order to target knowledge as well as surgical skills acquisition phases of motor learning, with the ultimate goal of achieving surgical proficiency and automaticity through repetition. [11] Future studies are needed such strategies and their effectiveness in plastic surgery resident education.

While the results of this prospective randomized blinded trial support that cleft surgery knowledge acquisition through digital simulation translates into improved surgical skills, several limitations are noteworthy. While the OSATS scale is a validated tool for evaluating the technical skills of surgical trainees, it is not specific to unilateral cleft lip repair and the tool does not identify specific areas of improvement or deficit. Such information could hypothetically guide remedial efforts during simulation exercises, but is unfortunately not available given the nature of the OSATS scale and its emphasis on global surgical performance. Furthermore, while the high fidelity of the haptic model used in this study has previously been substantiated, replicating the complex 3D anatomical features of a unilateral cleft lip deformity and associated tissue layers remains challenging, and the model used here does not capture all of these features in an identical manner. This could hypothetically introduce a bias in one or several of the surgical steps performed during the simulated cleft lip repair. Moreover, it is worth highlighting that while surgical knowledge was evaluated based on a specific order of steps, this does not imply that the specified order of steps is the only correct way to perform a cleft lip repair. We relied on the order that was described in both the digital simulator module and textbook, both of which were developed by the same author (RLF) in an attempt to standardize the assessment as much as possible. A potential bias in our study may be due to the recruitment of all participants from our institution and their potential exposure to the educational materials used in our study prior to the trial. These educational materials however, are not part of the formal didactic curriculum and we hope to be able to validate the results of our study through a multi-institutional study. While the number of participants in our study is consistent with similar and previously published studies on the effects of simulation training on procedural skills acquisition, the limited sample size is certainly a major limitation. [7,8] While we found statistically significant differences in the simulation group, we do acknowledge that the power of the study is limited by the limited sample size. This limitation also impacts achieving homogenous intervention arms, despite our best attempts by including only residents from PGY 1 to PGY 4 prior to their craniofacial surgery rotation in PGY 5, and randomizing participants. Ideally, future studies on surgical simulation with greater power would entail multicenter prospective trials, which could potentially allow us to stratify our analysis by level of training and evaluate the impact of our

interventions on junior as well as senior residents, as well as determine the impact of simulation on the learning curve in cleft surgery through repeated testing at different time points. This could potentially help us evaluate which residents are indeed ready for a clinical case versus those who are not. This study is focused on evaluating surgical knowledge, procedural confidence, markings performance and surgical performance for the extended Mohler unilateral cleft lip repair specifically, which prevents us from generalizing our findings to other unilateral cleft lip repair techniques, cleft procedures, or other plastic surgery procedures however these are topics of future study.

Conclusion

We provide evidence that cleft surgery knowledge acquisition from a cognitive digital simulator translates into improved surgical performance through a prospective randomized blinded comparison to textbook, and propose a comprehensive simulation-based approach to cleft surgery education. The digital simulator also led to a significant improvement in surgical knowledge, procedural confidence, markings performance, and was well received as an educational tool.

Supplemental Contents

Supplemental Content 1

Surgical Steps

1- M flap and C flap dissection

2- Downward rotation of the cupids bow

3- Preparation of the medial lip element

4- Elevation of the L-flap

5- Sulcus and pyriform aperture incision

6- Inset of L-flap

7- Preparation lateral lip element

8- Closure of oral mucosa

9- Repair alar base and muscle

10- Closure of upper lip skin

Supplemental Content 2

Cleft Lip Procedural Confidence Assessment Tool

1. How confident are you overall in performing a cleft lip repair?				
1 Not at all	2	3 Confident	4	5 Very confident
2. Do you get anxious about performing a cleft lip repair?				
1 Constantly anxious	2	3 Occasionally anxious	4	5 Not anxious at all
3. What is your surgical skill level performing a cleft lip repair?				
1 I feel like I have none whatsoever	2	3 Average, as required of a resident my level	4	5 Well above average
4. How confident are you in your understanding of cleft lip anatomy?				
1 Very uncomfortable	2	3 Average	4	5 Very comfortable
5. How comfortable are you independently planning and marking a cleft lip repair?				
1 Very uncomfortable	2	3 Average	4	5 Very comfortable
6. How comfortable are you independently executing (dissect, suture) a cleft lip repair?				
1 Very uncomfortable	2	3 Average	4	5 Very comfortable
7. Do you feel comfortable operating intraorally in an infant?				
1 Very uncomfortable	2	3 Average	4	5 Very comfortable
8. Based on your training to date, how comfortable are you independently performing a cleft lip repair?				
1 Very uncomfortable	2	3 Average	4	5 Very comfortable
9. Do you worry when you are performing a cleft lip repair?				
1 Constantly worry that something is going to go wrong, or I will not operate at the required level	2	3 Occasionally worry	4	5 I feel completely calm and do not worry at all
10. Based on your current performance, would you prefer to avoid cleft lip repairs altogether?*				
1 Certainly	2	3 Occasionally	4	5 No, I would do it anytime

Supplemental Content 3

Marking Grading: Ten Point Scale

- ❑ Cupid's bow points marked
- ❑ Cupid's bow points marked correctly
- ❑ Back cut marked on medial lip
- ❑ Height of back cut on columella
- ❑ Base of back cut on superior border of philtral line; non cleft side
- ❑ M-flap/C-flap border drawn correctly
- ❑ Medial M-flap border drawn correctly
- ❑ Horizontal line from lateral lip to alar base
- ❑ Lateral L-flap border on lateral lip
- ❑ Inferior L-flap border on vermillion

Supplemental Content 4

GLOBAL RATING SCALE OF OPERATIVE PERFORMANCE

Please circle the number corresponding to the candidate's performance in each category, irrespective of training level

Respect for Tissue :				
1 Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments	2	3 Careful handling of tissue but occasionally caused inadvertent damage	4	5 Consistently handled tissue appropriately with minimal damage
Time and Motion :				
1 Many unnecessary moves	2	3 Efficient time/motion but some unneccessary moves	4	5 Clear economy of movement and maximum efficiency
Instrument Handling :				
1 Repeatedly makes tentative or awkward moves with instruments by inappropriate use of instruments	2	3 Competent use of instruments but occasionally appeard stiff or awkward	4	5 Fluid moves with instruments and no awkwardness
Knowledge of Instruments :				
1 Frequently asked for wrong instrument or used inappropriate instrument	2	3 Knew names of most instruments and used appropriate instrument	4	5 Obviously familiar with the instruments and their names
Flow of Operation :				
1 Frequently stopped operating and seemed unsure of next move	2	3 Demonstrated some forward planning with reasonable progression of procedure	4	5 Obviously planned course of operation with effortless flow from one move to the next
Use of Assistants :				
1 Consistently placed assistants poorly or failed to use assistants	2	3 Appropriate use of assistants most of time	4	5 Strategically used assistants to the best advantage at all time
Knowledge of Specific Procedure :				
1 Deficient knowledge. Needed specific instruction at most steps	2	3 Knew all important steps of operation	4	5 Demonstrated familiarity with all aspects of operation

Supplemental Content 5

Volunteer Educational Assessment Form

DIGITAL ANIMATION SURVEY

Participant Study Number - _____

Please Circle a Score for Each Category

The Digital Animation was Stimulating

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Digital Animation Increased my Interest in this Subject

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Digital Animation Allowed me to Learn the Subject Matter

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Digital Animation was Clear

1	2	3	4	5
Strongly Disagree				Strongly Agree

Digital Animations are an Effective Means of Teaching Surgical Skills

1	2	3	4	5
Strongly Disagree				Strongly Agree

I Would Recommend the Digital Animation to Others Learning this Skill

1	2	3	4	5
Strongly Disagree				Strongly Agree

Volunteer Educational Assessment Form

SURGICAL TEXT SURVEY

Participant Study Number - _____

Please Circle a Score for Each Category

The Surgical Text was Stimulating

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Surgical Text Increased my Interest in this Subject

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Surgical Text Allowed me to Learn the Subject Matter

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Surgical Text was Clear

1	2	3	4	5
Strongly Disagree				Strongly Agree

Surgical Textbooks are an Effective Means of Teaching Surgical Skills

1	2	3	4	5
Strongly Disagree				Strongly Agree

I Would Recommend the Surgical Textbook to Others Learning this Skill

1	2	3	4	5
Strongly Disagree				Strongly Agree

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Chapter 5

Sustainable Cleft Care Through Simulation-Based Education

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Chapter based on The Manuscript "Simulation-Based Comprehensive Cleft Care Workshops: A Reproducible Model For Sustainable Education" Published in The Cleft Palate-Craniofacial Journal, 2020, 57(10):1238-1246

Oral Presentation at The American Cleft Palate-Craniofacial Association (ACPA) 78th Annual Meeting, Virtual Format, 2021

Abstract

Objective
Evaluate simulation-based comprehensive cleft care workshops as a reproducible model for education with sustained impact.

Design
Cross-sectional survey based evaluation.

Setting
Simulation-based comprehensive cleft care workshop.

Participants
Total of 180 participants.

Interventions
Three-day simulation-based comprehensive cleft care workshop.

Main Outcome Measures
Number of workshop participants stratified by specialty, satisfaction with the workshop, satisfaction with simulation-based workshops as educational tools, impact on cleft surgery procedural confidence, short-term impact on clinical practice, medium-term impact on clinical practice.

Results
The workshop included 180 participants from five continents. The response rate was 54.5%, with participants reporting high satisfaction with all aspects of the workshop and with simulation-based workshops as educational tools. Participants reported a significant improvement in cleft lip (33.3 ± 5.7 vs. 25.7 ± 7.6; $p < 0.001$) and palate (32.4 ± 7.1 vs. 23.7 ± 6.6; $p < 0.001$) surgery procedural confidence following the simulation sessions. Participants also reported a positive short-term and medium-term impact on their clinical practices.

Conclusion
Simulation-based comprehensive cleft care workshops are well received by participants, lead to improved cleft surgery procedural confidence, and have a sustained positive impact on participants' clinical practices. Future efforts should focus on evaluating and quantifying this perceived positive impact, as well reproducing these efforts in other areas of need.

Introduction

It is estimated that the incidence of congenital cleft lip and/or palate in developing countries exceeds 100,000 per year. [1] Nearly one in 500-700 births are affected with cleft lip and/or palate, with significant fluctuations in disease epidemiology around the globe. [2] If patients with cleft lip and/or palate are not treated in a timely fashion, they are at an increased risk of morbidity as a result of significant functional deficits, malnutrition, aspiration and respiratory tract infections. [2] Consequently, it is recommended that affected patients have the cleft lip repaired within the first year of life, and if present, the cleft palate repaired before 18 months of age. [3]

There are numerous barriers to equitable access for comprehensive cleft care around the world. These barriers can broadly be attributed to lack of appropriate expertise or financial resources and are more profound in developing regions of Latin America, Africa and Asia. [1] Foundation-driven surgical initiatives targeting these regions have attempted to alleviate the significant burden of cleft lip and/or palate care by addressing the significant backlog of untreated patients in these societies. [1] While these initiatives have provided considerable surgical expertise and resources to areas that are devoid of them, their ability to promote long-term sustainable cleft care and contribute to building surgical capacity have been called into question. [1]

Simulation-based training has emerged as an essential component of medical and surgical education over the last decade in developed countries in light of growing work hour limitations, increasing trainee supervision, and the ever-growing trend towards sub-specialization, all of which have limited trainee hands-on clinical exposure. [4] Similar trends have been observed within the field of cleft surgery, where a significant number of simulators have been described. [5] Nevertheless, financial and logistical constraints have limited the application of cleft surgery simulation in developing countries. However, we have previously described the first simulation-based comprehensive cleft care workshop in the Middle East – North Africa region, and demonstrated that it was well received by participants. [6] In the current study, we sought to validate our previous findings, demonstrate their reproducibility in Latin America, and evaluate educational simulation-based comprehensive cleft care workshops as a model for sustainable care in regions where significant barriers to comprehensive cleft care exist.

Methods

Simulation-Based Comprehensive Cleft Care Workshop Organization And Design

Global Smile Foundation is a non-governmental, non-profit foundation based in Norwood, Massachusetts, U.S.A. The mission of the foundation is to provide high quality, free, comprehensive cleft care to individuals born with cleft lip and/or palate. The vision of the foundation is a world where all children and individuals born with these craniofacial differences can thrive and realize their full potential. Volunteers with Global Smile Foundation have been providing comprehensive cleft care for over 33 years in Latin America, Africa, Asia, and the Middle East. Services provided encompass the entire spectrum of cleft care, including surgical, dental, speech, nursing, psychosocial and nutritional services among others. In line with our commitment to providing sustainable cleft care and building healthcare capacity in areas of need, we recently strengthened our educational efforts and organized the first simulation-based comprehensive cleft care workshop in the Middle East – North Africa region in April 2018. [6]

The workshop was well attended and well received by participants who unanimously reported that they would recommend it to others and participate again in a similar activity. [6] With these points in mind, we sought to reproduce this effort in Latin America, where significant unmet cleft care needs exist. [1] Relying on strong collaborations between Global Smile Foundation, other cleft care non-profit foundations, stakeholders from the biomedical industry sector, and international academic leaders in cleft care, we were able to hold our second simulation-based comprehensive cleft care workshop in Lima, Peru from October 16 to 18, 2019. As previously described, the workshop included multidisciplinary didactic lectures of relevance to all cleft practitioners, covering surgical, speech, nursing, anesthetic, pediatric, psychosocial, as well as dental considerations and team-based approaches in cleft care (**www.cleftworkshop.org**) (**Figure 1**). [6] Additionally, breakout sessions included hands-on simulations of cleft lip and cleft palate repairs using high-fidelity cleft lip and palate simulators (*Simulare Medical*, Toronto, Canada), with one experienced surgical faculty member per four simulation session participants. (**Figure 1**) The 1 to 4 faculty to simulation session participant ratio, allowed personalized feedback to participants based on their performance on the simulators, with repetition when necessary. Participants in the cleft lip (N = 50) and cleft palate (N = 43) surgery simulation sessions were provided with standardized instruments and headlights.

Figure 1. Workshop didactic lecture (*top*) and simulation session (*bottom*).

Data Collection

Participants were encouraged to complete satisfaction forms at the conclusion of the workshop as previously described. [6] Data collected included participants' age, gender, country of origin, specialty, professional position, years in current position, as well as whether participants work with a cleft team in their country. Participants were also asked if they would recommend the 2019 Lima comprehensive cleft care workshop to colleagues and whether they would participate again in a similar activity. Participant satisfaction with the 2019 Lima workshop was evaluated based on five parameters: content, design, instructors, results, and delivery, as previously described. [6] Each parameter had a maximum Likert scale score of 10. Additionally, participants were asked what they considered the most significant obstacle facing cleft care in their countries to be, and what they considered the most important intervention to overcome obstacles facing cleft care in their countries.

Participant satisfaction with simulation-based comprehensive cleft care workshops as an educational method for learning about cleft care was also evaluated using a modified version of the Student Evaluation of Educational Quality (SEEQ) survey, a validated tool for measuring higher education student satisfaction (**Supplementary Content 1**). [7,8] The SEEQ survey evaluates whether an educational tool is stimulating, increases participant interest, allows the participant to learn the subject matter, is clear, is an effective means of teaching, and whether participants would recommend it to others. Each of the parameters in the SEEQ survey has a maximum score of 5.

We also evaluated participants' perceptions of the impact of the workshop on their clinical practices. Participants were asked if the workshop improved their competence, performance, outcomes, and clinical care, and whether it changed their practice (**Supplementary Content 2**). Each of these parameters was graded over a maximum score of 5. Overall impact on practice was graded as a total over 25 by combining all of these parameters. Short-term impact on clinical practice as perceived by the participants was assessed at the end of the workshop, whereas medium-term impact on practice was evaluated by collecting data from participants up to 6 months following the workshop.

Procedural confidence was evaluated using a modified version of the psychometrically validated tool for measuring self-confidence during surgical learning developed by Geoffrion et al. [8,9] This included 8 items, each graded on a 5-point Likert scale, for a total maximum score of 40, which was calculated by combining all individual item scores (**Supplementary Content 3**). Procedural confidence with cleft lip and cleft palate surgery was evaluated prior to, as well as following the cleft lip and palate simulation sessions.

Data Analysis

Descriptive statistics were generated for all collected data. We used parametric testing including the paired sample t-test based on the central limit theorem and assumption of normal distribution for analyses involving a sample size of more than 30. Data analyses were performed using the Statistical Package for the Social Sciences (SPSS, V. 23.0, IBM Corp., Armonk, New York).

Results

The total number of participants in the workshop was 180 including 98 (54.4%) surgeons, 34 (18.9%) dentists, 33 (18.3%) speech and language pathologists, and 15 (8.4%) other cleft practitioners. Twenty-nine countries of origin were represented by workshop participants and faculty/staff. These included Afghanistan, Argentina, Australia, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Ecuador, El Salvador, Estonia, Guatemala, Honduras, India, Italy, Mexico, Paraguay, Peru, Romania, Russia, Saudi Arabia, Serbia, South Africa, Switzerland, Turkey, the United Kingdom, Uruguay, and the United States of America (**Figure 2**).

The response rate was 54.4% with 98 participants completing our workshop satisfaction survey. The majority of respondents were aged 30 years or older (83.7%) and were surgeons (66.3%), followed by dentists (14.3%), speech and language pathologists (11.2%), and other cleft care practitioners (5.1%). Most respondents were independent cleft care practitioners (64.3%) followed by trainees or students (7.1%), and the majority reported having been in their current positions for 5 years or more (43.9%) and working within a cleft team in their countries (70.4%) (**Table 1**).

The majority of respondents reported that they would recommend the 2019 Lima workshop to their colleagues (91.0%), and that they would participate in similar activities again (90.0%). Respondents also reported a high degree of satisfaction with the 2019 Lima workshop content (9.11 ± 1.30), design (8.84 ± 1.41), instructors (9.32 ± 1.22), results (8.91 ± 1.43), and delivery (8.73 ± 1.42) (**Table 1**).

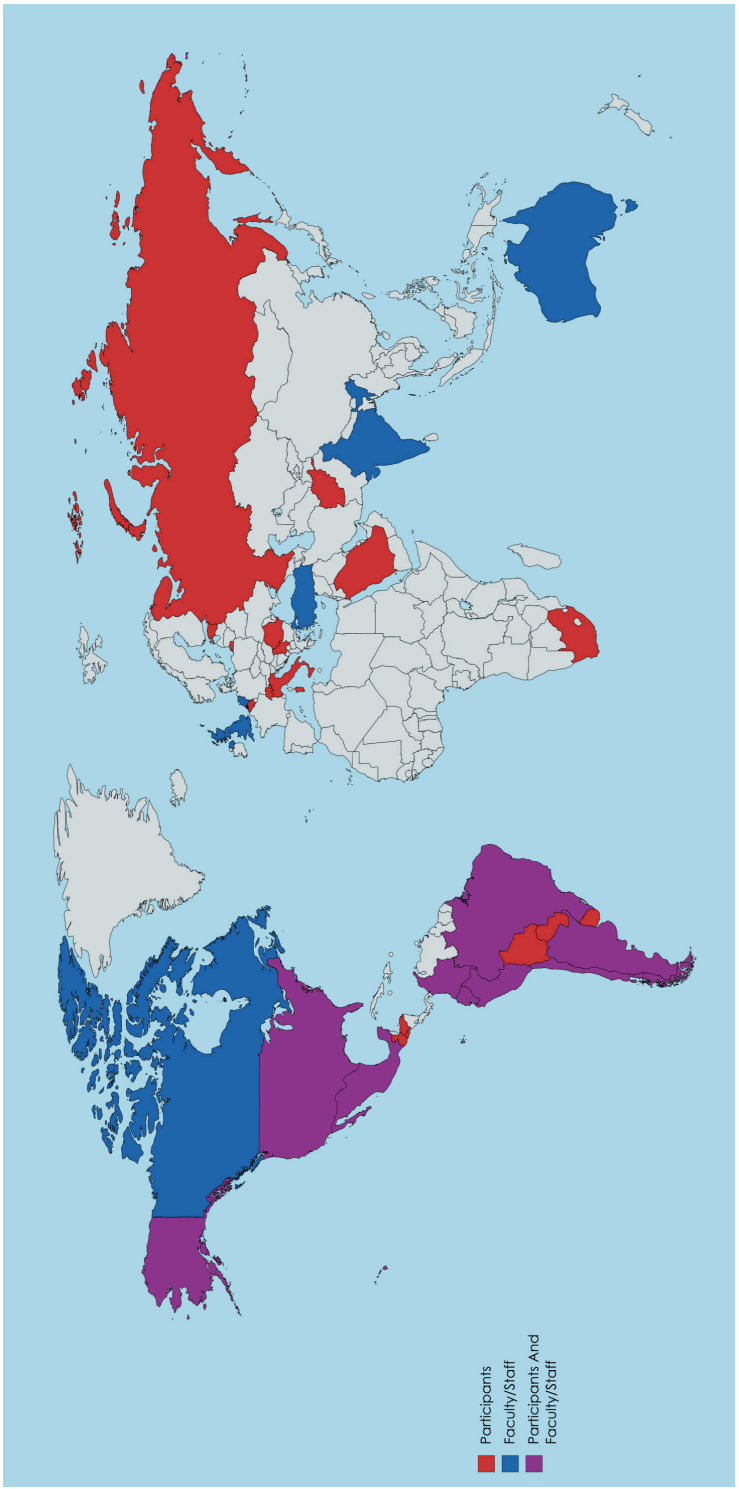

Figure 2. Workshop participants, faculty, and staff countries of origin.

Table 1. Workshop Participants Demographic Characteristics And Satisfaction With The 2019 Lima Comprehensive Cleft Care Workshop

Participant Data (N = 98)		
Age n (%)	< 30	7 (7.1)
	≥ 30	82 (83.7)
Gender n (%)	Male	44 (44.9)
	Female	49 (50.0)
Specialty n (%)	Speech and Language Pathologist	11 (11.2)
	Surgeon	65 (66.3)
	Dentist	14 (14.3)
	Other	5 (5.1)
Position n (%)	Independent Practitioner	63 (64.3)
	Trainee/Student	7 (7.1)
	Other	12 (12.2)
Years in Position n (%)	< 5	32 (32.7)
	≥ 5	43 (43.9)
Work With Cleft Team n (%)	Yes	69 (70.4)
	No	7 (7.1)
Recommend Workshop n (%)	Yes	89 (91.0)
	No	2 (2.0)
Participate Again n (%)	Yes	88 (90.0)
	No	3 (3.1)
Satisfaction with Content (mean ± SD, Max: 10)		9.1 ± 1.3
Satisfaction with Design (mean ± SD; Max: 10)		8.8 ± 1.4
Satisfaction with Instructors (mean ± SD; Max: 10)		9.3 ± 1.2
Satisfaction with Results (mean ± SD; Max: 10)		8.9 ± 1.4
Satisfaction with Delivery (mean ± SD; Max: 10)		8.7 ± 1.4

SD indicates standard deviation; Max, maximum; CCCW, comprehensive cleft care workshop. Missing data were not excluded when calculating percentages for each variable.

When asked about the biggest obstacle facing cleft care in their countries, the most frequent answer was financial challenges (24.5%), followed by the absence of multidisciplinary cleft teams (20.4%), poor training (9.2%), absence of cleft centers (5.1%), patient travel distance (4.1%), and the lack of awareness about cleft lip and/or palate (4.1%) (**Figure 3**). When asked about the most important intervention to improve cleft care in their countries, the most frequent answer was establishing multidisciplinary cleft teams (23.5%), followed by financial support (16.3%), better training (10.2%), establishing cleft centers (9.2%), and raising awareness about cleft lip and/or palate (5.1%) (**Figure 3**).

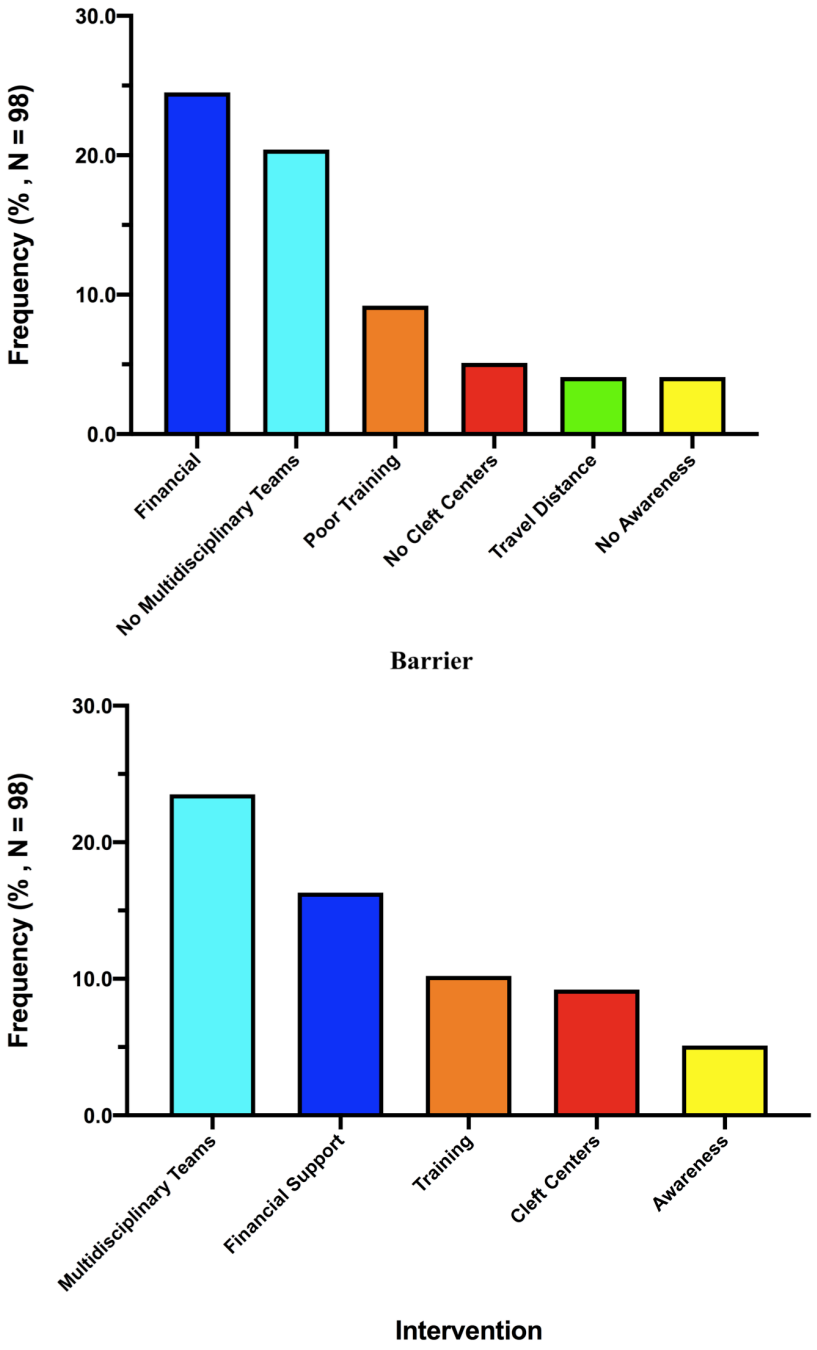

Figure 3. Greatest barrier to cleft care in workshop participants' countries (*top*) and intervention to improve cleft care in workshop participants' countries (*bottom*) as perceived by workshop participants.

Participants demonstrated a high level of satisfaction with simulation-based comprehensive cleft care workshops as an educational method for learning about cleft care, and reported that they were stimulating (4.47 ± 0.73), increased interest in the subject matter (4.57 ± 0.63), allowed for better learning (4.45 ± 0.73), were clear (4.41 ± 0.74), were effective in teaching (4.42 ± 0.75), and they were likely to recommend them to others (4.58 ± 0.67) (**Figure 4**).

Respondents also reported that they thought the 2019 Lima workshop will positively impact their clinical practices at the end of the workshop, including competence (4.28 ± 0.79), performance (4.25 ± 0.90), outcomes (4.27 ± 0.77), and clinical care (4.30 ± 0.86), as well as that it will change their practice (4.00 ± 0.98) (**Figure 4**). This impression amongst participants was positive and sustained over medium-term follow-up, with no significant difference in overall impact on practice reported by participants at the end of the workshop versus up to 6 months following the workshop (21.1 ± 3.7 vs. 20.7 ± 3.8; $p = 0.1$) (**Figure 4**).

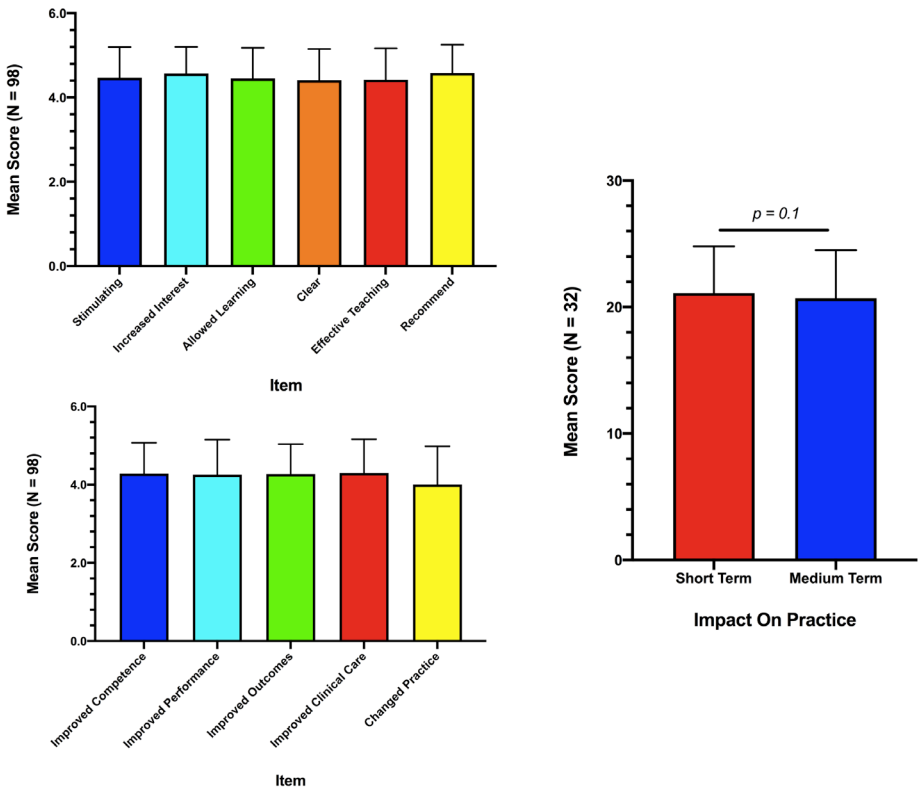

Figure 4. Participants' SEEQ survey results regarding simulation-based comprehensive cleft care workshops as an educational method to learn about cleft care (*top left*), short-term workshop impact on practice as perceived by participants (*bottom left*), and comparison of short-term and medium-term overall workshop impact on practice as perceived by participants (*right*).

Importantly, participants reported that their procedural confidence significantly improved following the hands-on simulation-based sessions. This was applicable for both participants in the cleft lip surgery (33.27 ± 5.67 post-simulation versus 25.72 ± 7.60 pre-simulation; $p < 0.001$; N = 50) (**Figure 5**) and cleft palate surgery (32.42 ± 7.07 post-simulation versus 23.72 ± 6.63 pre-simulation; $p < 0.001$; N = 43) (**Figure 5**) simulation sessions.

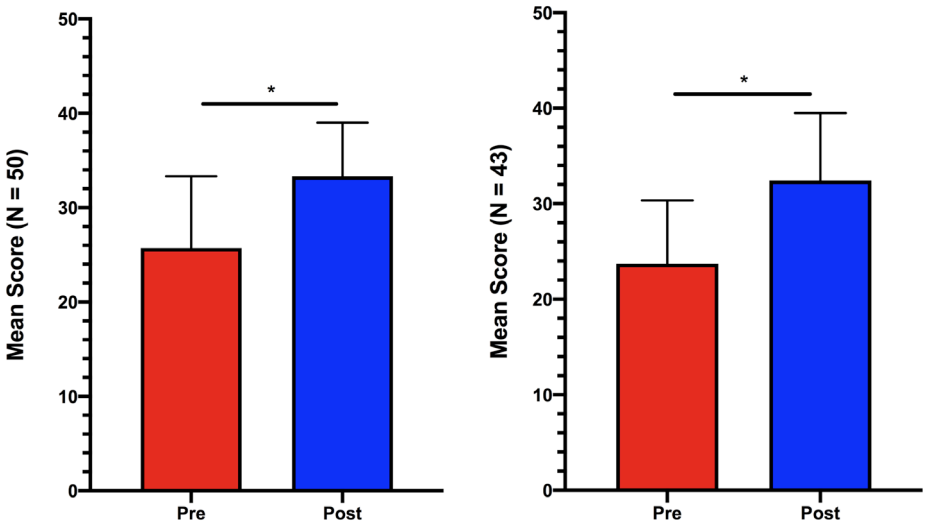

Figure 5. Cleft lip (*left*) and palate (*right*) simulation sessions impact on procedural confidence.

Discussion

When patients affected with cleft lip and/or palate are not treated in a timely fashion, they are at a significantly increased risk of morbidity including malnutrition, speech and functional deficits, aspiration, recurrent respiratory tract infections, as well as mortality. [1] Nevertheless, significant disparities in access to cleft care persist around the globe, and are more pronounced in developing countries in Asia, Latin America, Africa, and the Middle East. [1,10] One of the significant barriers to comprehensive cleft care in these regions is the lack of qualified cleft practitioners and expertise, which is further compounded by the lack of financial resources. [10] Over the last decade, simulation-based training has emerged as an essential component of surgical education in light of increasing trainee supervision, growing work hour limitations, and the evolving trend towards subspecialization, all of

which have limited trainee hands-on operative exposure. [4] This has also been the trend within the field of cleft surgery, where a significant number of simulators have been described. [5] However, logistical and financial limitations have prevented the application of simulation-based cleft surgery training in developing countries. We have previously described the first simulation-based comprehensive cleft care workshop in the Middle East – North Africa region, and demonstrated that it was well received by participants. [6] In this manuscript, we sought to demonstrate the reproducibility of our previous workshop and findings in Latin America, with the purpose of highlighting the potential role of simulation-based comprehensive cleft care workshops as a reproducible model for education with sustained impact in regions where significant barriers to comprehensive cleft care exist. In an attempt to do so, we evaluated participant satisfaction with the workshop, participant satisfaction with simulation-based workshops as a teaching tool for learning about comprehensive cleft care, workshop short-term and medium-term impact on participant practice, as well as workshop impact on participant cleft lip and palate procedural confidence.

Simulation-based training in cleft surgery has gained significant momentum over the last decade, with the development and widespread dissemination of a significant number of digital and haptic educational simulators. [5] This momentum was catapulted by the significant logistical challenges facing surgical education that were previously mentioned, which have led surgical educators to pursue alternatives to intraoperative exposure for training surgical residents. [4,5,11,12] Importantly, data suggest that trainees prefer using simulation-based educational tools more than traditional textbooks. [13] Similarly, early data evaluating simulation-based educational resources in cleft surgery seem to be favorable. [5] High-fidelity haptic as well as digital cleft surgery simulators created in developed countries have been shown to provide trainees with realistic surgical experiences leading to improved procedural knowledge, confidence, skills, and overall performance. [8,14-16] However, financial and logistical restraints have prevented the widespread use, availability, or adoption of these educational resources in developing countries. Nevertheless, previous experience suggests that these resources carry significant potential in addressing global disparities in cleft surgery education when made freely available, as recently demonstrated by an online cleft surgery simulator reaching surgeons and trainees in more than 130 countries, for a total screen time of nearly 1,700 hours. [17] With these factors in mind, we have previously organized the first simulation-based comprehensive cleft care workshop in the Middle-East/North Africa region in 2018, with participants reporting an overall positive experience. All participants reported that they would participate again in a similar workshop and recommend it to colleagues. This highlights the potential of these workshops in promoting sustainable cleft care in areas of need through

capacity building and education. [6] The results reported in this manuscript reinforce the potential role of our simulation-based comprehensive cleft care workshop as reproducible model for comprehensive cleft surgery education, with participants continuing to report an overwhelming satisfaction with the workshop.

The Lancet Commission on Global Surgery has significantly improved our understanding of current global surgical deficits and enlightened the international surgical community on potential avenues to alleviate them. [18] Among these, surgical education is vital to strengthening and revitalizing the surgical workforce in low to middle income countries, where disparities in care are most pronounced. [18] Key stakeholders in this effort are numerous, including non-governmental organizations which, "outside of acute crisis situations, should have a training component hardwired into their programs to ensure the durability of their effect". [18] Importantly, non-governmental organizations, including cleft surgery non-profit foundations, should provide "responsible training" whereby their educational efforts are tailored to the context in which they are delivered. [18] The Commission on Global Surgery has also emphasized the importance of competency-based training, which focuses more on the acquisition of context-appropriate skills and knowledge rather than on the passage of time. In this setting, the use of simulation-based training is a method to develop and ensure competency is not at the expense of quality of patient care. [18]

Relying on these guiding principles and our substantial experience in providing comprehensive cleft care to underserved patients around the world, we launched our simulation-based workshops in 2018. [6] While our participants' positive feedback following our first workshop was reassuring, we wanted to confirm that we were indeed delivering a transformative education to our participants. With this issue in mind, we collected data in our second workshop about its impact on participant cleft surgery procedural confidence, as well as short-term and medium-term impact on clinical practice. To our knowledge, this study is the first in the literature to provide evidence that implementation of a simulation-based comprehensive cleft care workshop leads to significantly improved procedural confidence as well as a sustained positive impact on clinical practice, reinforcing its role as a cleft care capacity-building tool in areas of need.

Our study provides significant insight into the potential role of simulation-based education in building sustainable cleft care in developing countries and areas of need. However, many questions remain unanswered and are at the forefront of our future research and educational endeavors. While we demonstrate that simulation-based exercises lead to significant improvement in participant cleft surgery procedural confidence, we need to determine how this is translating at the clinical level in terms of patient outcomes. Similarly, while participants reported a positive impact on their clinical practices, including clinical performance and

patient outcomes, we need to better quantify and delineate these benefits. Most importantly, financial challenges remain significant barriers to widespread implementation of simulation-based educational initiatives in developing countries, and the importance of strong collaborations among key stakeholders in cleft surgery education can't be emphasized enough in order to disseminate this educational model in developing countries. With these issues in mind, we hope to keep refining and making our workshops more accessible to meet the needs of our trainees, help alleviate disparities in cleft care around the world, and contribute effectively to sustainable cleft care in developing countries.

Conclusion

Simulation-based comprehensive cleft care workshops offer a reproducible model for building sustainable cleft care capacity in areas of need. Such educational initiatives are well received by trainees, lead to a significant improvement in cleft surgery procedural confidence, and have a sustained positive impact on clinical practice. Key players in global cleft surgery should continue to collaborate to make these initiatives more widely available in order to alleviate disparities that exist in cleft care around the world through education.

Supplemental Contents

Supplemental Content 1

Surgeon Satisfaction With Workshop

Please Circle a Score for Each Category

The Workshop was Stimulating

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Workshop Increased my Interest in this Subject

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Workshop Allowed me to Learn the Subject Matter

1	2	3	4	5
Strongly Disagree				Strongly Agree

The Workshop was Clear

1	2	3	4	5
Strongly Disagree				Strongly Agree

Cleft Surgery Workshops are an Effective Means of Teaching Surgical Skills

1	2	3	4	5
Strongly Disagree				Strongly Agree

I Would Recommend the Workshop to Others Learning About Cleft Surgery

1	2	3	4	5
Strongly Disagree				Strongly Agree

Supplemental Content 2

Please rate your current performance performing a cleft lip/palate repair.

1. How confident are you overall in performing a cleft lip/palate repair?

1	2	3	4	5
Not at all		Confident		Very confident, level of attending surgeon

2. What is your surgical skill level performing a cleft lip/palate repair?

1	2	3	4	5
I feel like I have none whatsoever		Average, as required of a resident my level		Well above average, rarely encountered in a resident of my level

3. Do you worry about performing a cleft lip/palate repair?

1	2	3	4	5
Constantly worry that something is going to go wrong, or I will not operate at the required level		Occasionally worry		I feel completely calm and do not worry at all

4. Would you get anxious about performing a cleft lip/palate repair?

1	2	3	4	5
Constantly anxious		Occasionally anxious		Not anxious at all

5. Based on your current performance, would you prefer to avoid doing cleft lip/palate repairs altogether?

1	2	3	4	5
Certainly		Occasionally		No, I would do it anytime

6. How comfortable are you independently planning and marking a cleft lip/palate repair?

1	2	3	4	5
Very uncomfortable		Average		Very comfortable, level of attending surgeon

7. How comfortable are you independently executing (incise, dissect, suture) a cleft lip/palate repair?

1	2	3	4	5
Very uncomfortable		Average		Very comfortable, level of attending surgeon

8. Based on your training to date, how comfortable are you independently performing a cleft lip/palate repair?

1	2	3	4	5
Very uncomfortable		Average		Very comfortable, level of attending surgeon

Supplemental Content 3

Workshop Impact on Practice

Please Circle a Score for Each Category

My Competence Will/Has Improve/Improved as a Result of the Workshop

1	2	3	4	5
Strongly Disagree				Strongly Agree

Please Explain:

My Performance Will/Has Improve/Improved as a Result of the Workshop

1	2	3	4	5
Strongly Disagree				Strongly Agree

Please Explain:

Patient Outcomes Will/Have Improve/Improved as a Result of the Workshop

1	2	3	4	5
Strongly Disagree				Strongly Agree

Please Explain:

Clinical Care in my Practice Will/Has Improve/Improved as a Result of the Workshop

1	2	3	4	5
Strongly Disagree				Strongly Agree

Please Explain:

I Will/Have Change/Changed my Clinical Practice as a Result of the Workshop

1	2	3	4	5
Strongly Disagree				Strongly Agree

Please Explain:

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Chapter 6

The First Hybrid Educational Simulation-Based Comprehensive Cleft Care Workshop

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Chapter Based on The Manuscript "The First Hybrid International Educational Comprehensive Cleft Care Workshop" Submitted to The Cleft Palate-Craniofacial Journal, 2022

Abstract

Objective
Describe the first hybrid global simulation-based comprehensive cleft care workshop, evaluate workshop impact on participants, and compare participant experiences based on in-person versus virtual attendance.

Design
Cross-sectional survey based evaluation.

Setting
International hybrid educational comprehensive cleft care workshop.

Participants
Total of 489 participants.

Interventions
Three-day simulation-based hybrid comprehensive cleft care workshop.

Main Outcome Measures
Participant demographic and specialty data, perceived barriers and interventions needed for global comprehensive cleft care delivery, participant workshop satisfaction and perceived short-term impact on practice stratified by in person versus virtual attendance.

Results
The workshop included 489 participants from five continents. The survey response rate was 39.9%. Participants perceived financial factors (30.3%) and improvement in training (39.8%) to be the biggest barrier and intervention respectively, facing and required for comprehensive cleft care delivery in low to middle income countries. All participants reported a high level of satisfaction with the workshop and a strong positive perceived short-term impact on their practice. Importantly, while this was true for both in person and virtual attendees, in person attendees reported a significantly higher satisfaction with the workshop (28.63 ± 3.08 vs. 27.63 ± 3.93; $p = 0.04$) and perceived impact on their clinical practice (22.37 ± 3.42 vs. 21.02 ± 3.45 $p = 0.01$).

Conclusion
Hybrid simulation-based educational comprehensive cleft care workshops are overall well received by participants and have a positive perceived impact on participant clinical practices. In person attendance is associated with significantly

higher satisfaction and perceived impact on practice suggesting that the hybrid rather than purely virtual model is the way forward. Future efforts will focus on making in person and virtual attendance more comparable.

Introduction

Clefts of the lip and/or palate (CLP) affect around one in every 500-700 live births (Shkoukani et al., 2013). If untreated, these congenital facial differences are associated with an increased risk of psychological distress, orofacial functional deficits, malnutrition, respiratory tract complications, and negative socioeconomic consequences. (Shkoukani et al., 2013). As a result, guidelines recommend that clefts of the lip should be repaired within the first year of life, and when/if present, clefts of the palate should be corrected before 18 months of age (American Cleft Palate-Craniofacial Association, 1993.) Nevertheless, a significant backlog of untreated patients persists around the world as a result of multiple barriers facing comprehensive cleft care delivery, including lack of access to high-quality cleft care education and training. (Kantar et al., 2019a)

We have previously described that international simulation-based educational comprehensive cleft care workshops can serve as a successful tool for building cleft care capacity in areas that it need it the most through education and training. (Kantar et al., 2019b; Kantar et al. 2020) We highlighted how these workshops can promote international cleft care collaborations by bringing international authorities in cleft care and learners together. (Kantar et al., 2019b; Kantar et al. 2020) Confirming our predictions, participants reported that one of the major barriers facing comprehensive cleft care delivery in low to middle income countries was lack of access to high quality education and training. (Kantar et al., 2019b; Kantar et al. 2020) We also showed that these workshops are overall well received by participants attending them. (Kantar et al., 2019b; Kantar et al. 2020) More importantly, participants attending these workshops also reported a significant impact on their practice that is sustained over prolonged period of time. (Kantar et al. 2020)

The COVID-19 pandemic amplified existing barriers facing international comprehensive cleft care delivery (Breugem et al. 2020). Limited travel, mandated lockdowns and quarantines, have significantly hindered international cleft clinical care delivery, as well as major educational initiatives and national/international cleft care meetings. This was applicable to the third version of our comprehensive cleft care workshops which was supposed to be held in India, but was ultimately held in virtual format in order to ensure the safety of our learners, staff, and faculty members. With the peak of the pandemic behind us and anticipated recurrent waves of disease variants in sight, international cleft care initiatives must learn how to

adapt to a new reality (Breugem et al. 2020). With these issues in mind, we held our fourth international educational comprehensive cleft care workshop in Istanbul, Turkey, in hybrid format. Participants had the opportunity to attend the workshop in person with heightened safety precautions, or attend virtually. In this study, we describe this first hybrid international educational simulation-based comprehensive cleft care workshop, analyze its impact on participants, and compare this impact between participants who attended in person versus those who attended virtually.

Methods

Hybrid Comprehensive Cleft Care Workshop Organization And Design

Global Smile Foundation (GSF) is a non-profit organization based in Norwood, Massachusetts, USA. The vision of the foundation is a world where all children and individuals born with CLP can thrive and reach their full potential. The mission of the foundation is to provide high quality, free, comprehensive clinical cleft care to individuals born with CLP. The clinical care provided by the foundation is supplemented with research and educational initiatives aimed at building cleft care capacity in areas around the world that need it the most. GSF volunteers and members have been providing the full spectrum of comprehensive cleft care for more than 3 decades in Latin America, Africa, Asia, and the Middle East. Since 2018, we have strengthened our educational efforts by organizing annual simulation-based comprehensive cleft care workshops around the world (Kantar et al., 2019b; Kantar et al. 2020).

Our workshops have been reproduced successfully and have been well attended and received (Kantar et al., 2019b; Kantar et al. 2020). Participants in our workshops have consistently reported a high level of satisfaction, and have also reported improved procedural confidence as well as a sustained impact on their practice at the conclusion of the workshops (Kantar et al., 2019b; Kantar et al. 2020). The third version of our workshop had to be held in virtual format as a result of the COVID-19 pandemic. With the peak of the pandemic behind us and with anticipated recurrent variant waves, we sought to organize our fourth workshop in hybrid format where participants could attend in person under heightened safety precautions or virtually.

In collaboration with Smile Train (New York City, USA), other key stakeholders in international cleft care delivery, and international authorities in cleft care, we held our fourth simulation-based international educational comprehensive cleft care workshop in Istanbul, Turkey from October 6 to 18, 2021 in hybrid format. All in person participants were required to provide proof of vaccination against COVID-19 and a recent negative test. Heightened precautions against COVID-19 were also taken

during the workshop including but not limited to masks, distancing, and appropriate hygiene measures. Similar to previous workshops, the educational program was of relevance to cleft care providers from all specialties (**www.cleftworkshop.org**) (Kantar et al., 2019b; Kantar et al. 2020). The educational program included didactic lectures, discussion panels, as well as breakout sessions including hands-on simulations of cleft lip and palate surgery using high-fidelity simulators (*Simulare Medical*, Smile Train, New York City), facial nerve block sessions, speech and language pathology (SLP) hands-on sessions and others (**Figure 1**).

Figure 1. Workshop simulation sessions (*top*) and didactic lectures session (*bottom*).

Data Collection

Data collection was performed through surveys distributed electronically to the participants at the conclusion of the workshop. Collected data included participants' age, gender, specialty, country of origin, years in current position, professional position, in person versus virtual attendance, as well as whether participants worked with a cleft team in their countries. Participants were also asked if they would participate again in a similar workshop. Participants were also asked what they considered the most significant barrier facing comprehensive cleft care delivery in their countries was, and what they considered was the most important intervention to overcome barriers facing comprehensive cleft care delivery in their countries.

Satisfaction of the participants with the workshop as an educational method for learning about cleft care was also evaluated using a modified version of the Student Evaluation of Educational Quality (SEEQ) survey, a validated tool for measuring higher education student satisfaction as previously described (Marsh, 1982; Kantar et al. 2020). The SEEQ survey evaluates whether an educational tool is stimulating, increases participant interest, allows the participant to learn the subject matter, is clear, is an effective means of teaching, and whether participants would recommend it to others. Each of the parameters in the SEEQ survey has a maximum score of 5, for a total maximum score of 30.

We also evaluated participants' perceptions of the impact of the workshop on their clinical practice as previously described (Kantar et al. 2020). Participants were asked if they thought the workshop would improve their competence, performance, outcomes, clinical care, and whether it will change their practice. Each of these parameters was graded over a maximum score of 5. Overall impact on practice was graded as a total over 25 by combining all of these parameters.

Participants' satisfaction with the workshop and their perceptions of the impact of the workshop on their practice were compared between participants attending the workshop in person and those attending virtually.

Data Analysis

Descriptive statistics were generated for all collected data. We used parametric testing including independent sample t-test based on the central limit theorem and assumption of normal distribution for analyses involving a sample size of more than 30. Data analyses were performed using the Statistical Package for the Social Sciences (SPSS, V. 23.0, IBM Corp., Armonk, New York).

Results

The total number of participants in the workshop was 489 with an average age of 40.1 ± 7.2 years. The majority of participants were female (51.1%). Workshop participants, faculty, and staff hailed from 70 countries from 5 continents (**Figure 2**).

The response rate was 39.9% with 195 participants completing our workshop satisfaction survey, including 103 participants who attended in person (52.8%) and 92 participants who attended virtually (47.2). The majority of respondents were surgeons (50.8%) followed by dentists (21.0%), speech and language pathologists (20.5%), and other cleft care practitioners (7.7%). Most respondents were independent cleft care practitioners (64.1%) followed by trainees or students (19.0%), and the majority reported having been in their current positions for 5 years or more (53.8%) and working within a cleft team in their countries (83.1%) (**Table 1**). The majority also reported that they would participate again in a similar workshop (96.4%) (**Table 1**).

Table 1. Comprehensive Cleft Care Workshop All Participants and Post Workshop Survey Respondents Data

All Participants Data (N = 489)		
Age in Years, mean ± SD	40.1 ± 7.2	
Gender, n (%)	Male	155 (48.9)
	Female	162 (51.1)
Survey Respondents Data (N = 195)		
Attendance Format, n (%)	In Person	103 (52.8)
	Virtual	92 (47.2)
Specialty, n (%)	Surgery	99 (50.8)
	Dentistry	41 (21.0)
	Speech and Language Pathology	40 (20.5)
	Other	15 (7.7)
Position, n (%)	Independent Practitioner	125 (64.1)
	Trainee/Student	37 (19.0)
	Other	33 (16.9)
Years in Position, n (%)	< 5	90 (46.2)
	≥ 5	105 (53.8)
Work With Cleft Team, n (%)	Yes	162 (83.1)
	No	33 (16.9)
Participate Again, n (%)	Yes	188 (96.4)
	No	7 (3.6)

Abbreviations: SD, standard deviation. Percentages do not include missing data where applicable.

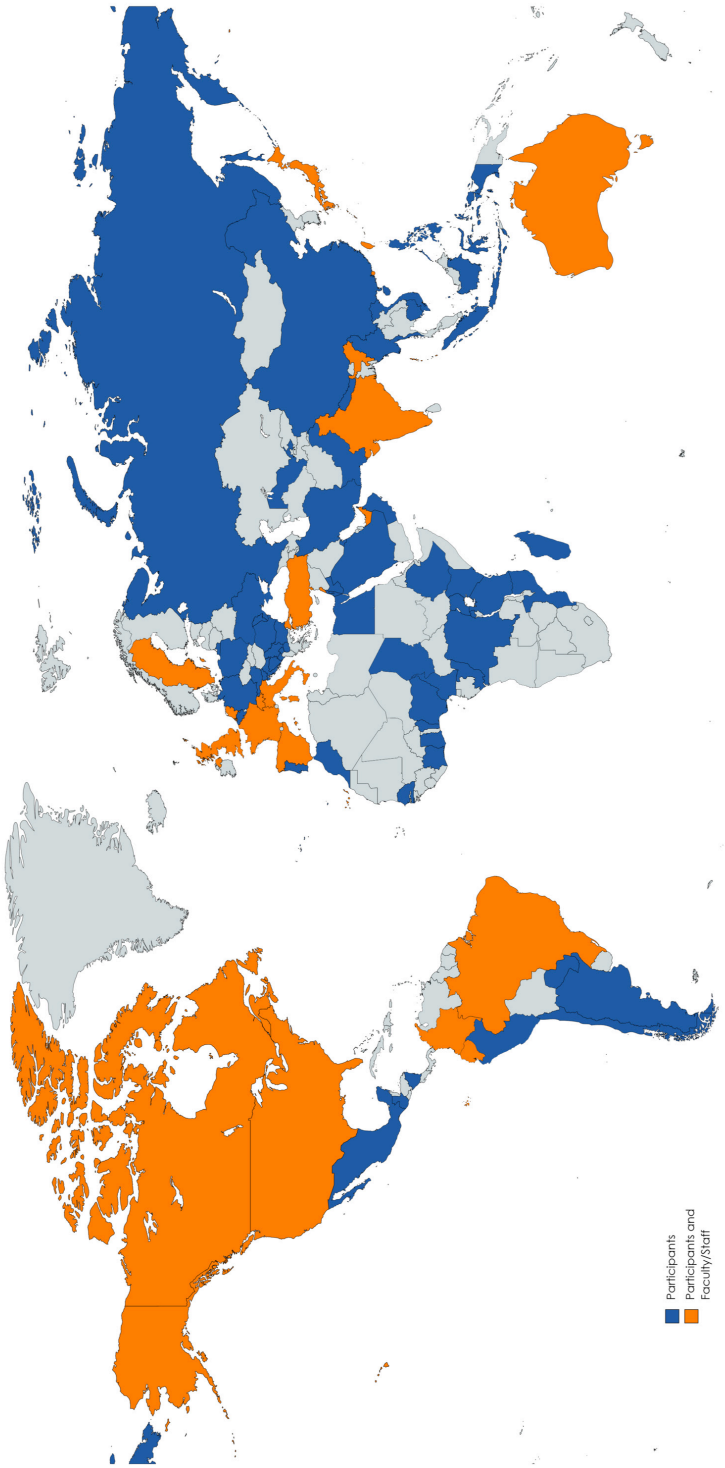

Figure 2. Workshop participants, faculty, and staff countries of origin. Orange: Participants; Blue: Participants and Faculty/Staff.

When asked about the biggest barrier facing comprehensive cleft care delivery in their countries, the most frequent answer was financial challenges (30.3%), followed by the absence of multidisciplinary cleft teams (21.1%), patient travel distance (17.4%), poor training (15.6%), lack of awareness about cleft lip and/or palate (8.3%), and the absence of cleft centers (7.3%) (**Figure 3**). When asked about the most important intervention for comprehensive cleft care delivery in their countries, the most frequent answer was better training (39.8%), establishing multidisciplinary cleft teams (18.4%), followed by financial support (17.3%), establishing cleft centers (15.3%), and raising awareness about cleft lip and/or palate (9.2%) (**Figure 3**).

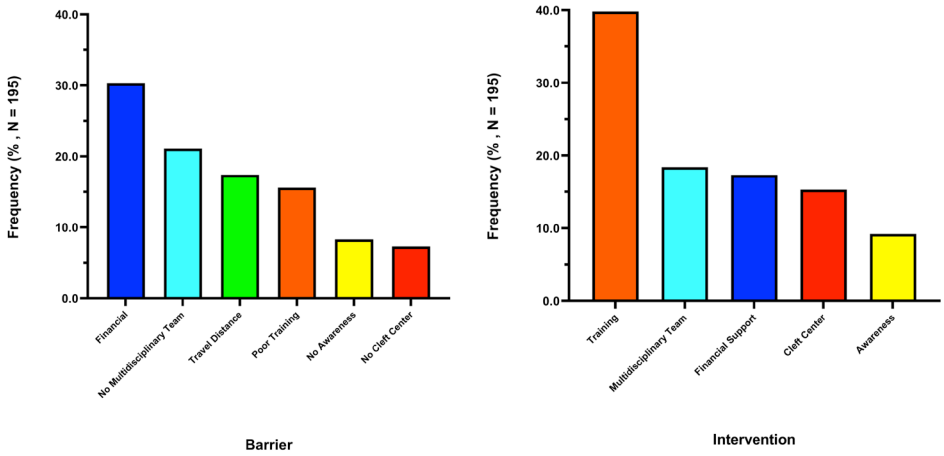

Figure 3. Greatest barrier to comprehensive cleft care delivery (*left*) and most important intervention to improve comprehensive cleft care delivery (*right*) as perceived by workshop participants.

Participants demonstrated a high level of satisfaction with the workshop as an educational method for learning about cleft care (28.16 ± 3.53), and reported that it was stimulating (4.66 ± 0.71), increased interest in the subject matter (4.70 ± 0.70), allowed for better learning (4.67 ± 0.70), was clear (4.64 ± 0.72), was effective in teaching (4.70 ± 0.68), and they were likely to recommend it to others (4.78 ± 0.61) (**Figure 4**). In person participants reported a significantly higher overall satisfaction with the workshop compared to virtual participants (28.63 ± 3.08 vs. 27.63 ± 3.93; p = 0.04) (**Figure 4**). In person participants also reported that the workshop allowed for significantly better learning (4.79 ± 0.55 vs. 4.54 ± 0.82; p = 0.02) and was significantly clearer (4.77 ± 0.58 vs. 4.50 ± 0.83; p = 0.01) compared to virtual participants (**Figure 4**).

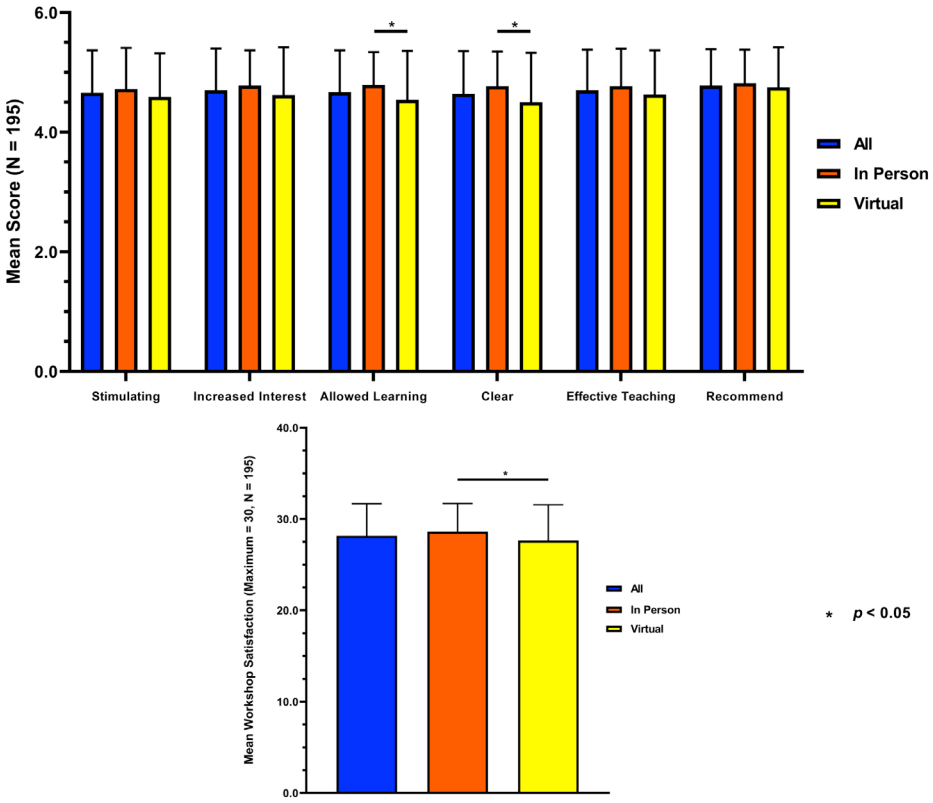

Figure 4. All participants, in person participants, and virtual participants workshop satisfaction based on SEEQ survey sub-items (*top*) and total (*bottom*) scores.

Respondents also reported that they thought the workshop will positively impact their clinical practice at the end of the workshop, including competence (4.45 ± 0.81), performance (4.45 ± 0.81), outcomes (4.41 ± 0.80), and clinical care (4.42 ± 0.79), as well as that it will change their practice (4.01 ± 0.97) (**Figure 5**). In person participants reported a significantly stronger perceived impact on their clinical practice compared to virtual participants (22.37 ± 3.42 vs. 21.02 ± 3.45; $p = 0.01$). In person participants also reported that the workshop had a significantly stronger impact on their clinical competence (4.58 ± 0.76 vs. 4.29 ± 0.85; $p = 0.01$), performance (4.59 ± 0.76 vs. 4.29 ± 0.85; $p = 0.01$), outcomes (4.57 ± 0.78 vs. 4.23 ± 0.80; $p < 0.01$) and clinical care (4.55 ± 0.74 vs. 4.27 ± 0.81; $p = 0.01$) compared to virtual participants (**Figure 5**).

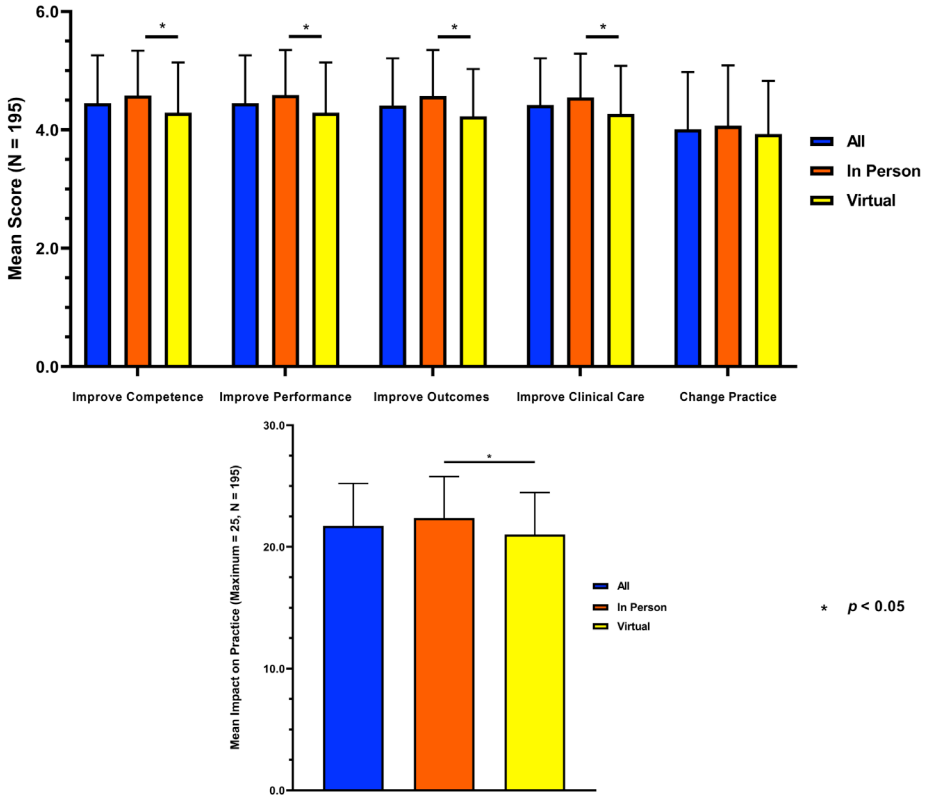

Figure 5. All participants, in person participants, and virtual participants perceived impact on clinical practice based on survey sub-items (*top*) and total (*bottom*) scores.

Discussion

Patients with CLP are at an increased risk for malnutrition, orofacial functional deficits, respiratory complications, psychological distress, and negative socioeconomic consequences if they are not treated surgically early in life (Shkoukani 2013). Despite guidelines recommending repair of the cleft lip within the first year of life and correction of the cleft palate if present by 18 months of age, a significant global backlog of untreated patients persists, particularly in low to middle income countries (American Cleft Palate-Craniofacial Association, 1993; Massenburg et al., 2016). An important barrier to comprehensive cleft care delivery in these countries is the paucity of cleft care expertise and poor training, compounded by the limited resources to address these deficiencies (Massenburg et al., 2016; Kantar et al., 2019b; Kantar et al. 2020). Global Smile Foundation has been providing comprehensive clinical cleft care around the globe for more than three

decades (Kantar et al., 2019b; Kantar et al. 2020). To strengthen our educational initiatives and in line with our vision to build cleft care capacity in areas around the globe that need it, we launched our simulation-based comprehensive cleft care workshops in 2018 in collaboration with key international stakeholders in cleft care (Kantar et al., 2019b; Kantar et al. 2020). We have previously described how our workshops have had an overwhelmingly positive impact on participants including a high level of satisfaction with the workshop content, a significantly positive perceived impact on cleft surgery procedural confidence, as well as a strong positive impact on clinical practice that was sustained for a prolonged period of time following attendance of the workshops (Kantar et al., 2019b; Kantar et al. 2020).

The COVID-19 pandemic significantly affected cleft care provision around the world including clinical activities, as well as educational initiatives, local, national, and international cleft care meetings (Breugem et al., 2020). This included our third comprehensive cleft care workshop which was supposed to be held in person in India in 2020, but was ultimately held in virtual format for the safety of our participants, speakers and staff. Development of the COVID-19 vaccines and implementation of large-scale vaccination campaigns, have enabled some return to normalcy and have allowed less stringent travel restrictions (Breugem et al., 2020). However, with expected recurrent waves of disease variants in sight, international cleft care stakeholders must adapt to continue to provide comprehensive cleft care to areas of the world that need it the most (Breugem et al., 2020). All of these factors encouraged us to organize our fourth international educational comprehensive cleft care workshop in hybrid format in Istanbul, Turkey recently under heightened COVID-19 precautions. This allowed participants who were vaccinated against COVID-19 and can demonstrate a recent negative COVID-19 test to attend the workshop in person, while others who were not, or did not feel safe to attend in person had the option to attend the workshop virtually. In this study, we compared workshop satisfaction and perceived impact on clinical practice between participants who attended the workshop in person and those who attended virtually. While all participants reported a high degree of satisfaction with the workshop and a strong positive perceived impact on their clinical practice, participants who attended the workshop in person reported a significantly higher level of satisfaction with the workshop and a stronger perceived impact on their clinical practice compared to those who attended virtually. To our knowledge, the workshop described here constitutes the first simulation-based international educational comprehensive cleft care workshop, and this study is the first to analyze educational differences between in person and virtual cleft care learners.

Our study provides proof of concept that hybrid international educational comprehensive cleft care workshops can be carried out successfully in a safe

fashion, and provide learners with high quality educational content that positively meets their expectations and has a significant perceived impact on their clinical practice. However, we also identified significant differences in these outcomes between learners who attended the workshop in person and those who attended it virtually. We hypothesize that while virtual learners reported strong satisfaction with the workshop content and perceived impact on their practice, in person learners had a significantly more positive experience due to the ability to participate in the simulation and hands on sessions offered for the different specialties. While these are not completely unexpected findings we believe that they are extremely significant, as they highlight a major current and anticipated future challenge that all key stakeholders in international cleft care delivery and education will have to face, adapt to, and overcome. We foresee that future cleft care and other educational workshops and meetings will predominantly be held in hybrid format, allowing learners who do not feel safe traveling long distances or internationally, to still benefit from the educational content that is being offered. The challenge for teams organizing these educational initiatives will be to find innovative methods to deliver all aspects of their educational content to in person as well as virtual learners alike. The COVID-19 pandemic has significantly accelerated the widespread adoption of remote digital education, as well as the development of tools, technologies, and platforms that are required for its effective delivery (Naciri et al., 2021). Augmented reality has previously been shown to be successful and effective in transferring cleft surgery knowledge and procedural skills to overseas learners through an augmented reality-based, hands on remote educational curriculum (Vyas et al., 2020). Harnessing these emerging technologies and tools will certainly be explored extensively for our future workshops, with the hope of delivering all of our educational content, including the simulation and hands on sessions to virtual and in person learners in a comparable fashion.

There are multiple limitations to this study as well as challenges facing the organization of future international, educational, simulation-based comprehensive cleft care workshops. While we have demonstrated that our workshops are well received by learners, lead to significantly increased procedural confidence, and have a sustained strong perceived positive impact on their clinical practice, our future efforts should and will focus on analyzing how this is affecting patient clinical outcomes. We will also continue to collaborate with key international stakeholders in comprehensive cleft care provision and education to make our initiatives as widely available as possible for learners around the world. This is especially important in low to middle income countries where financial resources and logistical challenges to widespread implementation and dissemination of these initiatives are particularly challenging. Expected recurrent waves of COVID-19 will also challenge organization and implementation of our future workshops, which

we hope to mitigate by adopting a hybrid format for all of our future educational initiatives and focusing on leveraging new digital technologies to deliver our educational content effectively to virtual learners. With these considerations in mind, we hope to keep improving our workshops to make them as widely accessible by learners as possible, in order to help alleviate global cleft care disparities and contribute to building cleft care capacity in areas around the world that need it the most.

Conclusion

We describe the first international, simulation-based, educational comprehensive cleft care workshop held in a hybrid format. Our results suggest that while the workshop was well received by all participants, in person learners reported a significantly higher level of satisfaction with the workshop and a stronger perceived impact on their clinical practice. This highlights a significant challenge that all international cleft care educational initiatives will face moving forward. Future efforts will focus on leveraging emerging technologies, tools, and digital platforms to deliver our educational content to in person and virtual learners in a comparable fashion

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Chapter 7

Perceived Barriers To Comprehensive Cleft Care Delivery In Developing Countries

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Chapter Based on The Manuscript "Perceived Barriers To Comprehensive Cleft Care Delivery: Results From A Capacity-Building Educational Initiative And Implications" Published in Annals of Plastic Surgery, 2021, 87(2):194-198

Abstract

Introduction

We analyzed the perceptions of participants and faculty members in simulation-based comprehensive cleft care workshops regarding comprehensive cleft care delivery in developing countries.

Methods

Data were collected from participants and faculty members in two simulation-based comprehensive cleft care workshops organized by Global Smile Foundation. We collected demographic data and surveyed what they believed was the most significant barrier to comprehensive cleft care delivery, and the most important intervention to deliver comprehensive cleft care in developing countries. We also compared participant and faculty responses.

Results

The total number of participants and faculty members was 313 from 44 countries. The response rate was 57.8%. The majority reported that the most significant barrier facing the delivery of comprehensive cleft care in developing countries was financial (35.0%), followed by the absence of multidisciplinary cleft teams (30.8%). The majority reported that the most important intervention to deliver comprehensive cleft care was creating multidisciplinary cleft teams (32.2%), followed by providing cleft training (22.6%). We found no significant differences in what participants and faculty perceived as the greatest barrier to comprehensive cleft care delivery (p=0.46), or most important intervention to deliver comprehensive cleft care in developing countries (p=0.38).

Conclusion

Our study provides an appraisal of barriers facing comprehensive cleft care delivery and interventions required to overcome these barriers in developing countries. Future studies will be critical to validate or refute our findings, as well as determine country-specific roadmaps for delivering comprehensive cleft care to those who need it the most.

Introduction

Close to 1 in every 500-700 live births are affected by congenital cleft lip and/or palate. [1] Moreover, it is estimated that the annual incidence of cleft lip and/or palate in developing countries is around 250,000 per year. [2] If these facial differences are not surgically corrected in a timely fashion, patients are at a significantly increased risk for substantial comorbidities including speech and functional deficits, aspiration and recurrent respiratory tract infection, malnutrition, as well as mortality. [1] Given these potential consequences, repair of the cleft lip is recommended within the first year of life, and if present, repair of the cleft palate is recommended prior to 18 months of age. [3]

Despite overwhelming consensus regarding the importance of timely surgical correction of cleft lip and/or palate, a significant number of patients reach adulthood without undergoing surgery, or may not have their cleft lip and/or palate repaired at all. [4] Barriers to cleft care are numerous ranging from financial to logistical challenges among others, and are more pronounced in developing countries where healthcare infrastructures are more fragile and are not equipped to support the significant backlog of untreated patients. [5] This large unmet surgical burden, coupled with the dramatic impact on quality of life and the relatively basic resources that are associated with cleft lip and/or palate repair, have made cleft surgery an attractive target for humanitarian initiatives to developing countries. [4]

Cleft care provided through these humanitarian initiatives has varied significantly in terms of geographic locations, methods of healthcare delivery, sustainability, services provided, timespan and other factors. [4] To provide sustainable cleft care, these humanitarian initiatives need to clearly delineate barriers to care as perceived by local communities in order to guide their efforts and ensure that they are concordant with local needs. [5] In 2018 and 2019, we organized simulation-based comprehensive cleft care workshops in areas of need as part of our organizational educational efforts and commitment to building cleft care capacity in these areas. [6,7] In this study, we analyze the perceptions of participants and faculty members in these workshops about the most important barriers to comprehensive cleft care in developing countries, what they believe are the most important interventions to deliver comprehensive cleft care in developing countries, and whether their perspectives are concordant or conflicting.

Methods

Simulation-Based Comprehensive Cleft Care Workshop Logistics And Organization

Global Smile Foundation is a non-profit, non-governmental organization that is based in Norwood, Massachusetts, The United States of America. The goals and mission of the organization are to deliver free, comprehensive, high-quality cleft care to underserved patients with cleft lip and/or palate. The vision of Global Smile Foundation is to allow these individuals to reach their full potential in their societies without any limitations resulting from their facial differences. Services provided by the organization encompass all aspects of cleft care including surgical, speech, dental, psychosocial, nursing, and nutritional services. Global Smile Foundation physicians, staff and volunteers have been dedicated to providing these services and comprehensive cleft care to patients in the Middle East, Asia, Africa, as well as Latin America for more than three decades.

In line with our commitment to providing multidisciplinary cleft care along with building surgical capacity and self-sustainability in areas of need, we recently expanded our educational efforts significantly by launching simulation-based comprehensive cleft care workshops in these areas. The first workshop was held in The Middle East/North Africa region in Beirut, Lebanon from April 25th to April 27th 2018. The Middle East and North Africa regions have recently been subject to significant political turmoil resulting in substantial demographic shifts along with resultant stressors on healthcare delivery, including cleft care delivery, which has led to significant delays in treating patients with cleft lip and/or palate. [6,8-11] The second simulation-based comprehensive cleft care workshop was held in Latin America in Lima, Peru from October 16th to October 18th 2019. Similarly to Asia, The Middle East, and Africa, significant multifactorial disparities in cleft care delivery and a growing backlog of untreated exist in Latin America. [5,7,12]

The organization of these capacity-building educational initiatives relied on strong collaborations with other cleft care organizations, local and international healthcare institutions, academic authorities in cleft surgery from around the world, as well as invested partners from the biomedical industry sector. The simulation-based comprehensive cleft care workshops received endorsement from key societies including The American Cleft Palate-Craniofacial Association. [6] The workshops included traditional didactic lectures of relevance to all cleft practitioners covering surgical, anesthetic, speech, psychosocial, pediatric, dental, and other considerations in cleft care delivery. The didactic lectures were coupled with specialty-specific breakdown sessions with more focused programs, including surgical breakout sessions with simulation-based sessions of cleft lip and palate surgery relying on high-fidelity cleft lip and palate haptic simulators (*Simulare*

Medical, Toronto, Canada). Simulation sessions included live video demonstrations by workshop faculty, as well as opportunities for close surgical feedback and guidance (**www.cleftworkshop.org**).

Data Collection

Data were collected from participants at the end of the workshops through anonymous questionnaires. Data collected from participants consisted of age, sex, country of origin, professional position, specialty, and years in current position. Most importantly, participants were asked what they believed was the most significant barrier to comprehensive cleft care delivery in developing countries, and what they perceived was the most important intervention to deliver comprehensive cleft care in developing countries.

To evaluate whether our educational initiative was meeting the goals, aspirations, and needs of participants, we investigated whether perceptions regarding the greatest barriers facing comprehensive cleft care delivery and interventions needed to deliver comprehensive cleft care in developing countries, were concordant or discordant between workshop faculty and participants. Similar to data collected from participants, faculty members were asked what they believed was the most significant barrier facing comprehensive cleft care delivery in developing countries, and what they perceived was the most important intervention to deliver comprehensive cleft care in developing countries. Data regarding faculty members' age, sex, country of origin, professional position, specialty and years in current position were also collected through electronic anonymous questionnaires.

Data Analysis

Descriptive statistics were generated for all collected data. Chi-squared testing was used to compare categorical variables and perform our stratified analysis comparing participants' and faculty responses. Data analyses were performed using the Statistical Package for the Social Sciences (SPSS, V. 23.0, IBM Corp., Armonk, New York).

Results

The total number of participants and faculty members in the two workshops was 313, including 273 participants (87.2%) and 40 (12.7%) faculty members. Participants included 135 (43.1%) surgeons or surgical trainees, 79 (25.2%) speech and language pathologists, 34 (10.9%) dentists, and 25 (8.0%) from other specialties. Faculty members included 25 (8.0%) surgeons, 5 (1.6%) dentists, 4 (1.3%) speech and language pathologists, and 6 (1.9%) from other specialties.

The workshop participants and faculty members represented 44 countries. These included Afghanistan, Argentina, Australia, Bahrain, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Ecuador, Egypt, El Salvador, Estonia, Guatemala, Honduras, India, Iraq, Italy, Ivory Coast, Jordan, Kuwait, Lebanon, Libya, Madagascar, Mexico, Morocco, Nigeria, Paraguay, Peru, Romania, Russia, Saudi Arabia, Serbia, South Africa, Sudan, Switzerland, Syria, Tunisia, Turkey, The Netherlands, The United Arab Emirates, The United Kingdom, Uruguay, and The United States of America (**Figure 1**).

The overall response rate was 57.8%, with 181 participants and faculty members responding to our surveys. The response rate among participants was 52.0%, with 142 responding out of 273. The response rate among faculty members was 97.5%, with 39 responding out of 40. Among participants, the majority were females (60.6%) and were aged 30 years or older (83.7%). The most common specialty of participants was surgery (56.1%), followed by speech and language pathology (25.9%), dentistry (10.1%), and other specialties (7.9%). The majority of participants reported being in their current positions for 5 or more years (59.1%). Within faculty members, the majority were males (55.3%) and were aged 30 years or older (97.1%). The most common specialty of faculty members was surgery (61.5%), followed by dentistry (12.8%), speech and language pathology (10.3%), and other specialties (15.4%). All faculty members reported being in their current positions for 5 or more years (100%) (**Table 1**).

Table 1. Workshop Participants And Faculty Demographic Characteristics

Variables (N = 181)		**Participants (n = 142)**	**Faculty (n = 39)**
Age n (%)	< 30	28 (21.2)	1 (2.9)
	≥ 30	104 (83.7)	34 (97.1)
Sex n (%)	Male	54 (39.4)	21 (55.3)
	Female	83 (60.6)	17 (44.7)
Specialty n (%)	Speech and Language Pathologist	36 (25.9)	4 (10.3)
	Surgeon	78 (56.1)	24 (61.5)
	Dentist	14 (10.1)	5 (12.8)
	Other	11 (7.9)	6 (15.4)
Years in Position n (%)	< 5	47 (40.9)	0 (0)
	≥ 5	68 (59.1)	39 (100)

Percentages indicate percentages within available responses, excluding missing data.

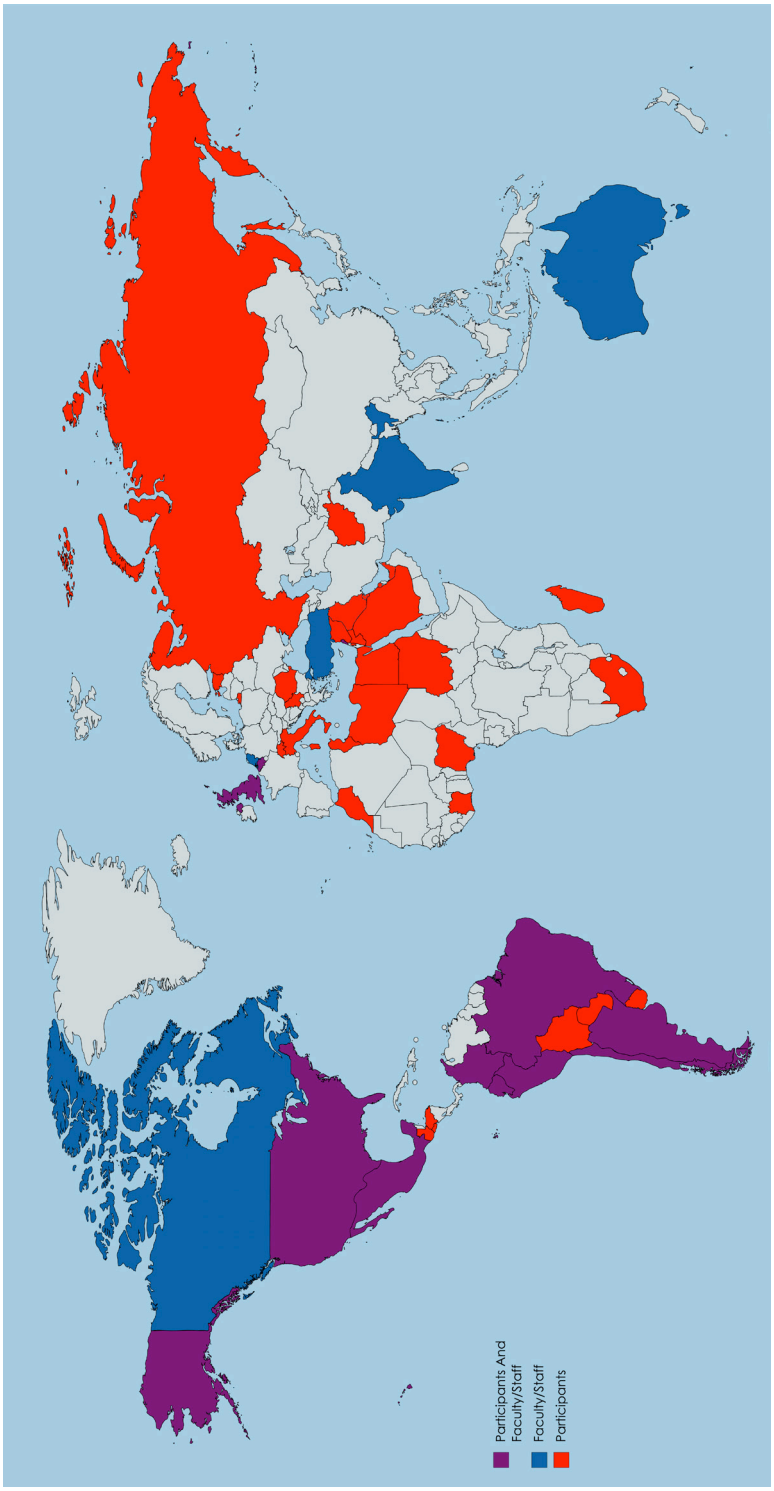

Figure 1. Workshops participants and faculty countries of origin

Among all respondents, participants and faculty members, the majority reported the most significant barrier facing the delivery of comprehensive cleft care in developing countries was financial (35.0%), followed by the absence of multidisciplinary cleft teams (30.8%), poor training (16.1%), the absence of cleft centers (9.8%), patient travel (4.2%), and the absence of awareness regarding congenital cleft lip and/or palate (4.2%) (**Figure 2**).

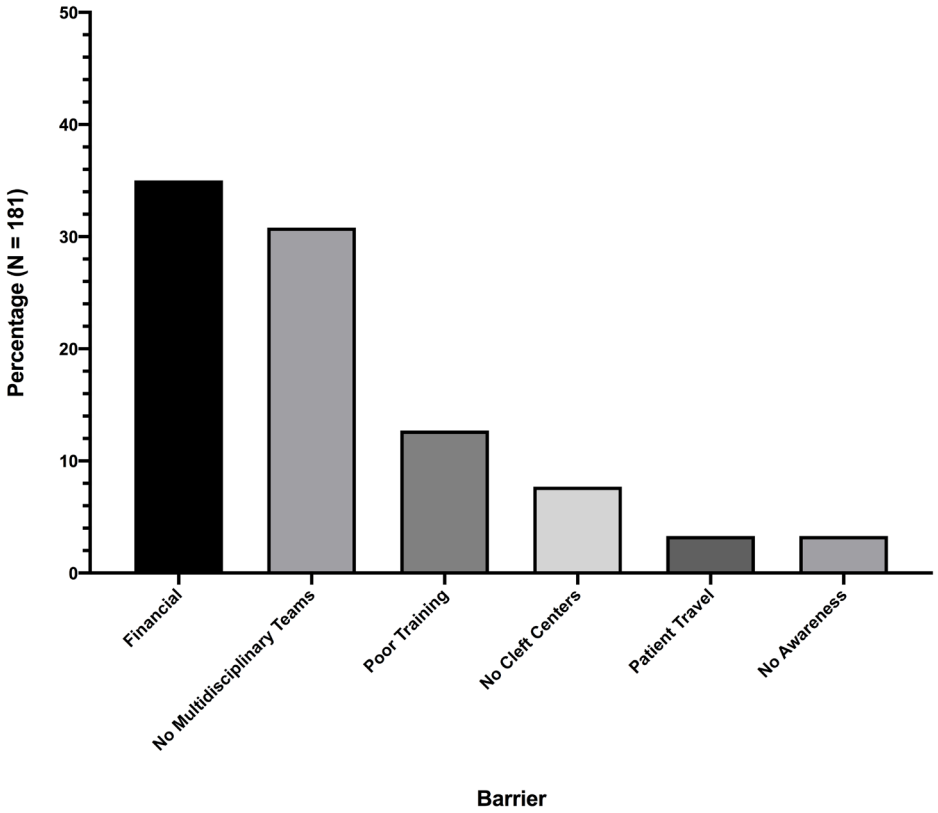

Figure 2. Greatest barrier to comprehensive cleft care delivery in developing countries perceived by workshops participants and faculty.

The majority reported that the most important intervention to deliver comprehensive cleft care in developing countries was creating multidisciplinary cleft teams (32.2%), followed by providing cleft training (22.6%), financial support (20.5%), creating cleft centers (17.1%), and raising awareness regarding congenital cleft lip and/or palate (7.5%) (**Figure 3**).

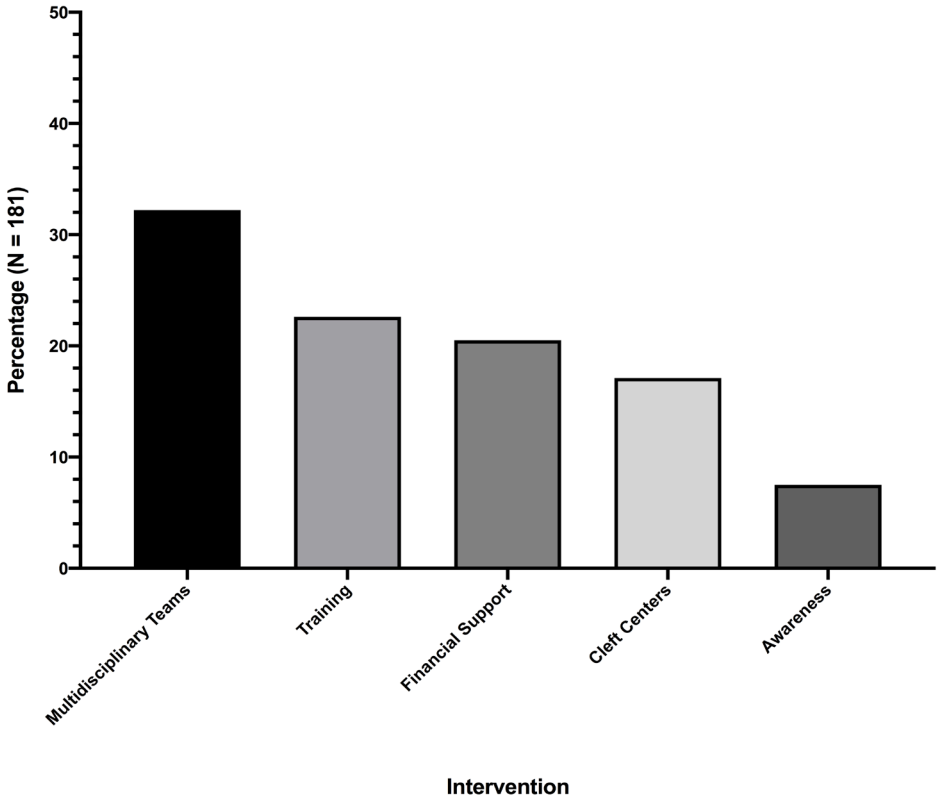

Figure 3. Most important intervention to deliver comprehensive cleft care in developing countries perceived by workshops participants and faculty.

We then stratified our analysis to compare perceptions between participants and faculty members, and found no significant differences in what they perceived as the greatest barrier to comprehensive cleft care delivery in developing countries (p = 0.46), or what they considered was the most important intervention to deliver comprehensive cleft care in developing countries (p = 0.38) (**Tables 2 and 3**).

Table 2. Stratified Analysis Of Greatest Perceived Barrier To Comprehensive Cleft Care Delivery

Barrier	Participants (n = 142)	Faculty (n = 39)	*p-value*
Financial	35 (33.7)	15 (38.5)	0.46
Poor Training	17 (16.3)	6 (15.4)	
Travel Distance	5 (4.8)	1 (2.6)	
No Multidisciplinary Teams	33 (31.7)	11 (28.2)	
No Cleft Centers	8 (7.7)	6 (15.4)	
No Awareness	6 (5.8)	0 (0)	

Percentages indicate percentages within available responses, excluding missing data.

Table 3. Stratified Analysis Of Most Important Intervention To Deliver Comprehensive Cleft Care

Barrier	Participants (n = 142)	Faculty (n = 39)	*p-value*
Financial Support	19 (17.8)	11 (28.2)	0.38
Training	26 (24.3)	7 (17.9)	
Awareness	10 (9.3)	1 (2.6)	
Multidisciplinary Teams	35 (32.7)	12 (30.8)	
Cleft Centers	17 (15.9)	8 (20.5)	

Percentages indicate percentages within available responses, excluding missing data.

Discussion

Timely surgical correction of clefts of the lip and/or palate is critical to avoid patient morbidity arising from speech deficits, recurrent respiratory tract infections, and malnutrition. [1] One in 500-700 live births are affected by congenital cleft lip and/or palate and 250,000 cases are reported annually in developing countries, highlighting the potential impact of this condition on patients, families and their societies if untreated. [1,2] Nevertheless, a substantial number of patients affected with cleft lip and/or palate do not have access to surgical treatment and may reach adulthood without undergoing surgery. [4] Factors preventing access to comprehensive cleft care are multi-faceted, ranging from logistical to financial challenges among others, and are most palpable in developing countries where deficient healthcare infrastructures coupled with poor surgical capacity lead to a significant backlog of untreated patients. [5] This unmet burden has led to the exponential growth of humanitarian cleft care initiatives targeting developing countries. [4] Importantly, while these initiatives have varied considerably in their scope and geographical distribution, a thorough evaluation of barriers to comprehensive cleft care as perceived by communities receiving these services is lacking. Our non-profit organization Global Smile Foundation has been providing free comprehensive cleft care services to patients in the Middle East, Asia, Africa, as well as Latin America for more than three decades. [6] Since 2018, we have held

simulation-based comprehensive cleft care workshops in areas of need as part of our organizational educational efforts. [6,7] In this study, we sought to evaluate the most important barriers facing comprehensive cleft care delivery and the most important interventions to deliver comprehensive cleft care in developing countries, as perceived by workshop participants and faculty members. Importantly, we evaluated whether their perceptions are concordant or discordant.

Identifying barriers to care is critical to achieving healthcare equity. More specifically, these barriers are defined as the obstacles to providing the standard of care for cleft lip and/or palate, including timely surgical treatment through a comprehensive team-based approach. [3] In this study, these barriers were affirmed by comprehensive cleft care workshop participants and faculty members who represented diverse geographic and training backgrounds with an acceptable response rate of 57.8%. The most significant perceived barrier facing delivery of comprehensive cleft care in developing countries was financial (35.0%). This was followed by the absence of multidisciplinary cleft teams (30.8%), poor training (16.1%), the absence of cleft centers (9.8%), patient travel (4.2%), and the absence of awareness regarding congenital cleft lip and/or palate (4.2%). Massenburg et al. similarly identified patient travel costs, lack of patient awareness, and lack of financial support as the most commonly reported barriers to providing cleft surgery. [5] The relative importance of these factors depended on geographic location of care and was observed to decline over time as barriers were addressed, with the exception of patient travel cost. The lesser importance of patient travel cost in this study highlights a potential shift in perceived barriers to cleft surgery over the last six years. Nonetheless, the pragmatic aspects of access to care, such as attending appointments and cost, remain important factors to caregivers and providers alike. [13,14] This is not unique to cleft care, but instead an identified barrier to surgical care in low and middle-income countries. [15]

Importantly, the question asked in this study was not limited to perceived barriers to surgical care, which has been previously explored, but instead to comprehensive cleft care as a whole. [5,16] The most important intervention to comprehensive cleft care delivery therefore was creating multidisciplinary cleft teams (32.2%). This acknowledges the significance of a team-based approach to cleft care, and its potential to collectively overcome barriers to care. This standard to provide multidisciplinary team care can and should be achieved for all patients. [3,4,17] This begins with implementing educational initiatives that provide cleft training, such as the cleft care workshops attended by this survey's respondents, among others implemented worldwide. [4,6,7] Interestingly, creating multidisciplinary teams and providing cleft training were prioritized by survey respondents as the most important interventions to deliver comprehensive cleft care, meanwhile, financial factors were the most important perceived barrier. Though this may be influenced

by the cohort of respondents from an educational workshop, the importance of multidisciplinary teams and educational initiatives should not be undermined. The concordance of responses observed between workshop participants and faculty supports the identified perceived barriers to comprehensive cleft care and the most important interventions to deliver such care. These results can help guide comprehensive cleft care efforts in developing countries.

The simulation-based comprehensive cleft care workshop is one such intervention that aims to address these perceived barriers. According to identified barriers, the ideal workshop is affordable, includes multidisciplinary teams, offers interactive training opportunities, and strategizes ways to raise awareness in respective countries. Simulation fosters an intimate setting for hands-on intellectual exchange and real-time feedback. The high-fidelity simulators provide a realistic learning experience that has previously been shown to significantly improve surgical trainees' cleft surgery knowledge, confidence, technical skills, and overall performance. [18-21] Comprehensive cleft care workshops require strong collaborative efforts, meticulous planning, and context-dependent curricular development taught by expert faculty. Topics must be relevant to the geographic location of the workshop and accessible to local cleft care teams and providers. The global impact of these initiatives remains to be determined, but with the successful implementation of two workshops thus far, perceived barriers to care and greatest factors for improvement are projected to evolve. Continued workshop evaluation and quality assurance will be important for program success and sustainability.

Our study provides significant insight into perceived barriers facing comprehensive cleft care delivery and interventions required to deliver comprehensive cleft care in developing countries, but unfortunately leaves many questions unanswered, many of which are at the forefront of our current research and educational initiatives. We acknowledge that barriers facing comprehensive cleft care delivery are not uniform in all developing countries and that context-appropriate and specific interventions need to be developed for each country and/or community facing these challenges. Future surveys will be designed to explore more specific aspects of these issues. Similarly, our results shed light on barriers to comprehensive cleft care delivery and interventions to address these challenges as perceived by cleft practitioners in general, but do not allow us to draw specialty-specific conclusions. Addressing these issues in future investigations will be critical to understanding and developing country-specific roadmaps for comprehensive cleft care delivery that align the purpose of delivered resources with actual host country needs. Investing in these specific needs will certainly pave the road for sustainable, long-term benefits instead of short-term interventions that still constitute the majority of international surgical initiatives targeting developing countries. [2]

Conclusion

The results we report in this study provide a preliminary appraisal of barriers facing comprehensive cleft care delivery and interventions required to overcome these barriers in developing countries, as perceived by participants in a capacity-building educational initiative driven by a non-profit cleft care organization dedicated to providing free comprehensive cleft care in areas of need. Future studies with the potential to combine data from our experience and the experience of sister organizations dedicated to the same mission will be critical to validate or refute our findings, as well as determine country and community-specific roadmaps for delivering comprehensive cleft care to those who need it the most.

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Chapter 8

Impact of Geographic And Demographic Factors On Comprehensive Cleft Care Delivery In Developing Countries

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Chapter Based on The Manuscript "Comprehensive Cleft Care Delivery In Developing Countries: Impact of Geographic and Demographic Factors" Published in The Journal of Craniofacial Surgery, 2021, 32(6):2041-2044

Abstract

Introduction

We analyzed the insights of participants and faculty members of Global Smile Foundation (GSF)'s Comprehensive Cleft Care Workshops (CCCWs) concerning the barriers and interventions to multidisciplinary cleft care delivery, after stratification based on demographic and geographic factors.

Methods

During two simulation-based CCCWs organized by GSF, participants and faculty members filled a survey. Surveys included demographic and geographic data and investigated the most relevant barrier to multidisciplinary cleft care and the most significant intervention to deliver comprehensive cleft care in outreach settings, as perceived by participants.

Results

The total response rate was 57.8%. Respondents reported that the greatest barrier to comprehensive cleft care was financial, and the most relevant intervention to deliver multidisciplinary cleft care was building multidisciplinary teams. Stratification by age, gender and geographical area showed no statistical difference in reporting that the greatest barrier to cleft care was financial. However, lack of multidisciplinary teams was the most important barrier according to respondents with less than 5 years of experience ($p=0.03$). Stratification by gender, years in practice, specialty and geographical area showed no statistical difference, with building multidisciplinary teams reported as the most significant intervention. However, increased training was reported as the main intervention to cleft care for those aged less than 30 years old ($p=0.04$).

Conclusion

Our study delivers an assessment for barriers facing multidisciplinary cleft care delivery and interventions required to improve cleft care delivery. We are hoping that stratification by demographic and geographic factors will help us delineate community-specific road maps to refine cleft care delivery.

Introduction

Orofacial clefts comprise a spectrum of congenital deformities, most commonly presenting as congenital clefts of the lip and/or the palate (CLP). In the United States, the estimated prevalence of CLP is 1 in 690 births, affecting around 7,000 newborns each year.[1,2] In addition to nutritional and respiratory challenges, CLP may inflict significant economic and psychosocial constraints on patients and their families.[3] Timely surgical correction is therefore crucial; it is recommended to repair the cleft lip within the first 12 months of age, and to close the cleft palate before the age of 18 months.[4]

Despite the urgent need for surgical repair, a plethora of patients with CLP are deprived from appropriate cleft care and reach the later stages of life without undergoing surgery, particularly in Low- and Middle-Income Countries (LMICs).[4,5] Barriers to multidisciplinary cleft care in LMICs are numerous and diverse, ranging from financial and psychosocial to logistical and administrative challenges.[6,7,8,9] The culmination of these challenges in resource-limited countries have resulted in many patients suffering from the consequences of delayed treatment, which has pushed cleft care practitioners worldwide to establish cleft care initiatives targeting LMICs.[4,5] These initiatives have been implemented primarily through the establishment of short-term medical missions to underserved countries by groups of surgeons and multidisciplinary practitioners.[10,11] Nevertheless, cleft care delivery is not standard across LMICs and varies based on geographic, demographic, and a multitude of other factors, highlighting the pressing need for cleft care teams to identify community-specific barriers to care, in a bid to better optimize and tailor care according to patient and communities' local needs.[4,5]

In 2018 and 2019, the Global Smile Foundation (GSF) held Simulation-based Comprehensive Cleft Care Workshops (CCCW) in resource-restricted areas, in line with its commitment to provide sustainable multidisciplinary cleft care and expand its educational reach.[11,12] We have previously analyzed the perceptions of both participants and faculty members in these workshops regarding the biggest barriers to cleft care in LMICs, as well as the most important potential interventions required to enhance the quality of cleft care in those countries.[7] The majority reported that the most significant barrier was financial, followed by the absence of multidisciplinary cleft teams, while the most significant intervention was creating multidisciplinary cleft teams, with concordance of responses between participants and faculty members.[7] We acknowledge however that barriers facing cleft care are not standard across LMICs and may vary between different practitioners based on demographic and geographic factors. In this study, we investigate how these demographic and geographic factors affect perceived barriers facing cleft care in our quest to delineate community-specific road maps to refine cleft care delivery.

Methods

Global Smile Foundation International Comprehensive Cleft Care Workshops (CCCW)

Global Smile Foundation (GSF), a non-profit and non-governmental organization, focuses on establishing Multidisciplinary Cleft Care programs in LMICs. Its main headquarter is based in Norwood, Massachusetts, United States of America. GSF is dedicated to delivering high quality and free comprehensive cleft care to patients with CLP, mainly in underserved and resource-limited areas of the world. GSF team members and volunteers provide the full breadth of cleft care services including surgical, dental, orthodontic, psychosocial, and speech therapy. For over three decades, GSF volunteers have participated in outreach surgical missions to Latin America, Africa, Asia, and the Middle East, performing more than 2,000 cleft procedures in the last decade alone. GSF adopts the diagonal model of cleft care delivery that helps build long-term local cleft care centers with the aim of developing, optimizing, and making comprehensive cleft care delivery in LMICs more sustainable. It also provides fellowship training programs to surgeons interested in cleft care, and hosts yearly International Comprehensive Cleft Care Workshops (CCCW) as part of its educational services.

The first international CCCW took place in the Middle East/North Africa (MENA) region in Beirut, Lebanon in 2018, a region that has been ravaged by conflicts and sociopolitical unrest, resulting in significant turmoil and instability within the local healthcare system.[12,14-17] The second international CCCW took place in Latin America, specifically in Lima, Peru in 2019 where significant challenges and disparities in comprehensive cleft care delivery are also significant.[6,13,18] Our third international CCCW was initially scheduled to take place in India, but was ultimately held in a virtual format in light of the COVID-19 pandemic.

The educational content of the workshops was delivered by world-acclaimed and esteemed cleft care practitioners, covering the full spectrum of comprehensive cleft care delivery. Simulation-based sessions for CLP repair using high-fidelity haptic simulators (*Simulare Medical*, Toronto, Canada) have been the hallmark of the GSF workshops, coupled with focused, specialty-driven sessions.[13] The development of these educational initiatives is a result of strong teamwork and resilient cooperation with other cleft care foundations, healthcare facilities, as well as invested stakeholders from the biomedical industry sector.[7]

Data Collection

At the end of the two in-person international CCCWs, participants and faculty were asked to complete an anonymous survey. Participants and faculty members were asked what they thought was the greatest obstacle facing comprehensive cleft care

in their country of residence, as well as the most significant intervention needed to enhance the delivery of comprehensive cleft care. Collected data included age, sex, country of residence, specialty, and years spent in current position. Data entries were mutually exclusive between both workshops. The questionnaire included a combination of multiple choice and open-ended questions.[7]

Data Analysis

All data were treated confidentially. Descriptive statistics were generated. Chi-squared testing was used to compare categorical variables. Data Stratification was performed based on age, gender, specialty, years in practice, and respondents' geographical area of origin. Data analyses were performed using the Statistical package for the Social Sciences (SPSS, V. 23.0, IBM Corp., Armonk, New York).

Results

Overall, 273 participants (87.2%) and 40 faculty members (12.7%) representing 44 different countries attended the first 2 CCCWs. Countries included Afghanistan, Argentina, Australia, Bahrain, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Ecuador, Egypt, El Salvador, Estonia, Guatemala, Honduras, India, Iraq, Italy, Ivory Coast, Jordan, Kuwait, Lebanon, Libya, Madagascar, Mexico, Morocco, Nigeria, Paraguay, Peru, Romania, Russia, Saudi Arabia, Serbia, South Africa, Sudan, Switzerland, Syria, Tunisia, Turkey, The Netherlands, The United Arab Emirates, The United Kingdom, Uruguay, and The United States of America. **(Figure 1)** Participants and faculty member responses were mutually exclusive. Participants included 135 (43.1%) surgeons or surgical trainees, 79 (25.2%) speech and language pathologists, 34 (10.9%) dentists, and 25 (8.0%) attendees from other specialties. Faculty members included 25 (8.0%) surgeons, 5 (1.6%) dentists, 4 (1.3%) speech and language pathologists, and 6 (1.9%) from different specialties.[7]

The total response rate was 57.8 % (n=181), with the survey completed by 39 out of 40 faculty members (97.5%) and 142 out of 273 participants (52.0%). The majority of respondents were female (57.1%), 30 years or older (82.6%) and had more than 5 years of experience in their current position (69.5%). Surgery was the predominant specialty among respondents (57.3%), followed by speech and language pathology (22.5%), dentistry (10.7%), and other specialties (9.6%). Most respondents represented Latin America (47.5%), followed by the Middle East (24.3%), North America (16.0%), Europe (6.6%) and Africa (5.5%). **(Table 1)**

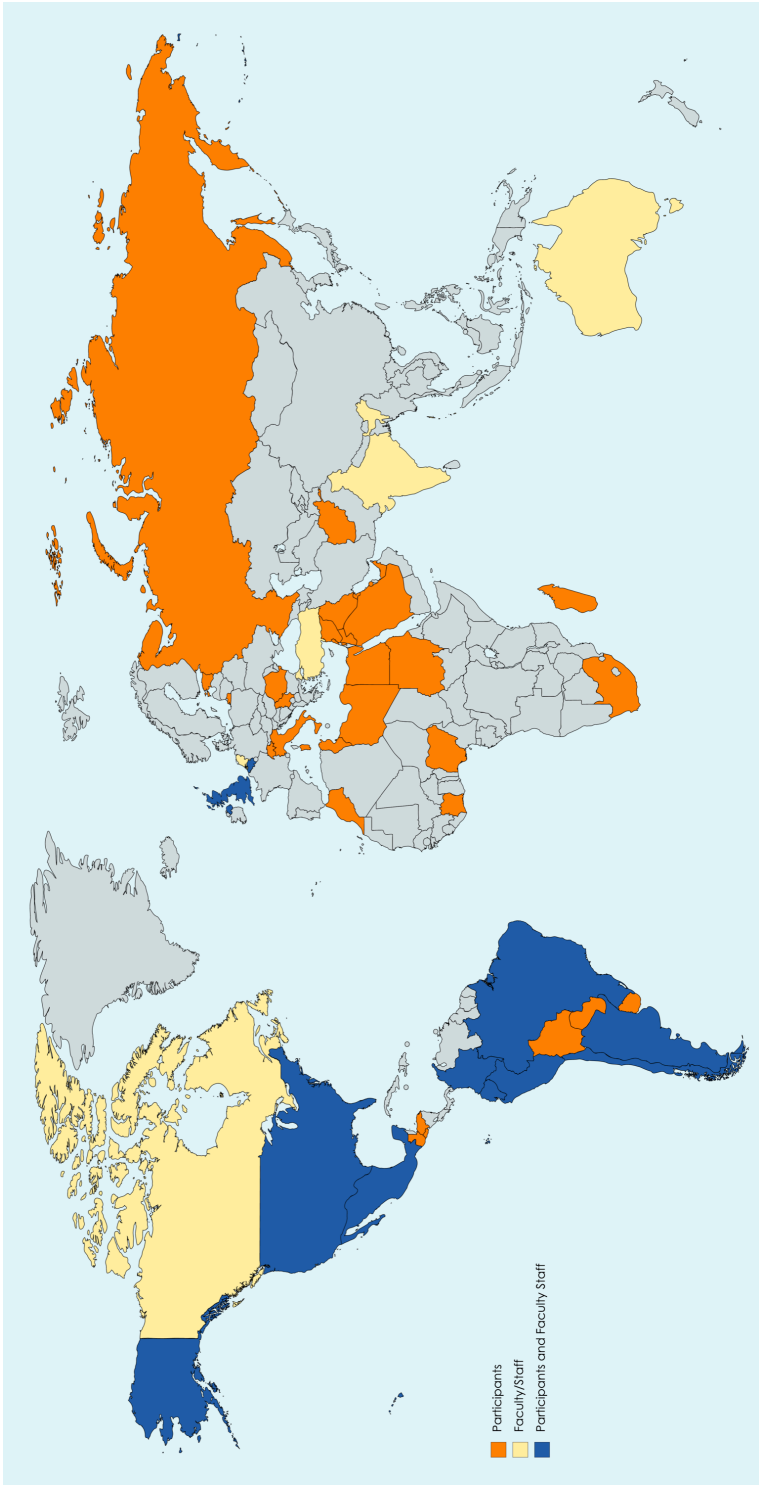

Figure 1. Workshop participants, faculty, and staff countries of origin

Table 1. Workshop Participants and Faculty Demographic and Geographic Characteristics

Variables (N = 181)		**n (%)**
Age n (%)	< 30	29 (17.4)
	≥ 30	138 (82.6)
Sex n (%)	Male	75 (42.9)
	Female	100 (57.1)
Specialty n (%)	Speech and Language Pathologist	40 (22.5)
	Surgeon	102 (57.3)
	Dentist	19 (10.7)
	Other	17 (9.6)
Years in Position n (%)	< 5	47 (30.5)
	≥ 5	68 (69.5)
Region (n%)	North America	29 (16.0)
	Latin America	86 (47.5)
	Europe	12 (6.6)
	Middle East	44 (24.3)
	Africa	10 (5.5)

Percentages indicate percentages within available responses, excluding missing data.

The majority of participants reported financial factors as the greatest barrier to comprehensive cleft care in their countries (33.7%), followed by the absence of multidisciplinary cleft teams (31.7%), poor training (16.3%), the absence of cleft centers (7.7%), the lack of awareness regarding CLP (5.8%), and patient travel distance (4.8%). Similarly, the majority of faculty members reported financial factors as the greatest barrier to comprehensive cleft care in their countries (38.5%), followed by the absence of multidisciplinary cleft teams (28.2%), poor training (15.4%), the absence of cleft centers (15.4%), patient travel distance (2.6%), and the lack of awareness regarding CLP (0%). Looking at interventions, the majority of participants reported building multidisciplinary teams as the greatest intervention to achieve comprehensive cleft care delivery in their countries (32.7%), followed by improving training (24.3%), financial support (17.8%), creating cleft centers (15.9%), and raising awareness (9.3%). Similarly, the majority of faculty members reported building multidisciplinary teams as the greatest intervention to achieve comprehensive cleft care delivery in their countries (30.8%), followed by financial support (28.2%), creating cleft centers (20.5%), improving training (17.9%), and raising awareness (2.6%). Stratified analysis of our results between faculty members and participants regarding the greatest perceived barrier facing comprehensive cleft care delivery, and the greatest perceived intervention to deliver comprehensive cleft care showed no significant difference between the two groups ($p = 0.46$ and $p = 0.38$, respectively). **(Table 2)**

Table 2. Analysis of Greatest Perceived Barrier and Intervention to Comprehensive Cleft Care Delivery Among Workshop Participants and Faculty

Variables (N = 181)	Cleft Provider n (%)		
	Participants (n = 104)	Faculty (n = 39)	*p*
Barrier			
Financial	35 (33.7)	15 (38.5)	0.46
Poor Training	17 (16.3)	6 (15.4)	
Travel Distance	5 (4.8)	1 (2.6)	
No Multidisciplinary Teams	33 (31.7)	11 (28.2)	
No Cleft Centers	8 (7.7)	6 (15.4)	
No Awareness	6 (5.8)	0 (0)	
Intervention			
Financial Support	19 (17.8)	11 (28.2)	0.38
Training	26 (24.3)	7 (17.9)	
Awareness	10 (9.3)	1 (2.6)	
Multidisciplinary Teams	35 (32.7)	12 (30.8)	
Cleft Centers	17 (15.9)	8 (20.5)	

Percentages indicate percentages within available responses, excluding missing data. P indicates p-value.

We subsequently evaluated the impact of age on faculty and participant responses, and found no significant differences between their perceived perceptions of the greatest barrier facing comprehensive cleft care delivery (p = 0.64). However, a significant difference was noted in their perception of the most important intervention needed to deliver comprehensive cleft care (p = 0.04). While the majority of respondents below 30 years of age reported better training as the most important intervention to enhance comprehensive cleft care delivery (41.7%), the majority of older respondents believed that assembling multidisciplinary teams was the most important intervention (36%). Through our stratified analysis, we did not identify significant gender differences in perceived barriers (p = 0.26) and interventions (p = 0.09) to comprehensive cleft care delivery. Stratification of our analysis by individual experience revealed statistically significant difference in regards to the biggest perceived barrier among respondents, where respondents with less than 5 years of experience in their current position reported the absence of multidisciplinary teams as the most significant barrier (54.8%), whereas financial limitations was the major barrier for those with more than 5 years of experience (p = 0.03). Individual experience did not have a significant impact on perceived perception regarding the most important intervention to deliver comprehensive cleft care. **(Table 3)**

Table 3. Analysis of Greatest Perceived Barrier and Intervention To Comprehensive Cleft Care Delivery Stratified by Age, Gender and Cleft Practitioner Experience

Variables (N = 181)	Age in years n (%)			Gender n (%)			Experience in years n (%)		
	Age < 30 (n = 20)	Age ≥ 30 (n = 113)	*p*	Male (n = 64)	Female (n = 77)	*p*	< 5 (n = 36)	≥ 5 (n = 93)	*p*
Barrier									
Financial	9 (45.0)	37 (32.7)	0.64	28 (44.4)	21 (28.0)	0.26	8 (25.8)	38 (39.2)	**0.03**
Poor Training	4 (20.0)	17 (15.0)		7 (11.1)	16 (21.3)		2 (6.5)	16 (16.5)	
Travel Distance	0 (0)	6 (5.3)		3 (4.8)	3 (4.0)		2 (6.5)	3 (3.1)	
No Multidisciplinary Teams	5 (25.0)	37 (32.7)		18 (28.6)	25 (33.3)		17 (54.8)	24 (24.7)	
No Cleft Centers	1 (5.0)	13 (11.5)		6 (9.5)	6 (8.0)		2 (6.5)	11 (11.3)	
No Awareness	1 (5.0)	3 (2.7)		1 (1.6)	4 (5.3)		0 (0)	5 (5.2)	
Intervention									
Financial Support	1 (4.2)	27 (24.3)	**0.04**	16 (25.0)	13 (16.9)	0.09	8 (22.2)	19 (20.4)	0.76
Training	10 (41.7)	19 (17.1)		12 (18.8)	19 (24.7)		7 (19.4)	21 (22.6)	
Awareness	2 (8.3)	9 (8.1)		7 (10.9)	4 (5.2)		3 (8.3)	7 (7.5)	
Multidisciplinary Teams	8 (33.3)	36 (32.4)		15 (23.4)	31 (40.3)		9 (25.0)	31 (33.3)	
Cleft Centers	3 (12.5)	20 (18.0)		14 (21.9)	10 (13.0)		9 (25.0)	15 (16.1)	

Percentages indicate percentages within available responses, excluding missing data. P indicates p-value.

Stratification of our analysis by respondent specialty did not identify statistically significant differences among participants' and faculty members' responses concerning the prime perceived barrier (p = 0.62) and intervention (p = 0.50) to comprehensive cleft care delivery. Financial limitation was the most important perceived barrier among surgeons (39.5%), dentists (37.5%) and respondents from other specialties (35.7%). Absence of multidisciplinary teams was the biggest perceived barrier among speech pathologists (32.3%). There was consensus between the different specialties regarding the most vital intervention, with 39.5% of surgeons and surgical trainees, 30.6 % of speech pathologists, 30.8% of dentists, and 43.8 % of respondents from other specialties divulging the need for multidisciplinary teams. **(Table 4)**

Table 4. Analysis of Greatest Perceived Barrier and Intervention to Comprehensive Cleft Care Delivery Stratified by Specialty

Variables (N = 181)	Specialty n (%)				
	Surgery (n = 81)	SLP (n = 31)	Dentistry (n = 16)	Other (n = 14)	*p*
Barrier					
Financial	32 (39.5)	6 (19.4)	6 (37.5)	5 (35.7)	0.62
Poor Training	8 (9.9)	9 (29.0)	3 (18.8)	3 (21.4)	
Travel Distance	4 (4.9)	0 (0)	1 (6.3)	1 (7.1)	
No Multidisciplinary Teams	27 (33.3)	10 (32.3)	4 (25.0)	3 (21.4)	
No Cleft Centers	7 (8.6)	4 (12.9)	2 (12.5)	1 (7.1)	
No Awareness	3 (3.7)	2 (6.5)	0 (0)	1 (7.1)	
Intervention					
Financial Support	21 (25.9)	3 (8.3)	2 (15.4)	4 (25.0)	0.50
Training	13 (16.0)	12 (33.3)	4 (30.8)	4 (25.0)	
Awareness	7 (8.6)	3 (8.3)	1 (7.7)	0 (0)	
Multidisciplinary Teams	25 (30.9)	11 (30.6)	4 (30.8)	7 (43.8)	
Cleft Centers	15 (18.5)	7 (19.4)	2 (15.4)	1 (6.3)	

Percentages indicate percentages within available responses, excluding missing data. P indicates p-value. SLP indicates Speech and Language Pathology.

When stratified by geographical area, financial limitations and absence of multidisciplinary teams were equally perceived as the main barriers to cleft care in North America (29.2%) and Europe (40%), financial limitations were the greatest barrier for respondents from Latin America (38.7%) and the Middle East (34.2%), whereas absence of multidisciplinary teams was the most reported barrier from Africa (55.6%). These differences did not reach statistical significance (p = 0.62). Developing multidisciplinary teams was the main intervention need for comprehensive cleft care delivery reported by respondents from North America

(34.8%), Latin America (35%), Europe (40%) and Africa (33.3%), while enhancing training was found to be the most important intervention for respondents from the Middle East (36.4%). Differences between groups were also not statistically significant (p = 0.35). **(Table 5)**

Table 5. Analysis of Greatest Perceived Barrier and Intervention to Comprehensive Cleft Care Delivery Stratified by Geographical Area

Variables (N = 181)	Geographical Area n (%)					
	North America	Latin America	Europe	Middle East	Africa	*p*
Barrier						
Financial	7 (29.2)	24 (38.7)	4 (40.0)	13 (34.2)	2 (22.2)	0.62
Poor Training	4 (16.7)	9 (14.5)	1 (10.0)	9 (23.7)	0 (0)	
Travel Distance	2 (8.3)	2 (3.2)	1 (10.0)	0 (0)	1 (11.1)	
No Multidisciplinary Teams	7 (29.2)	16 (25.8)	4 (40.0)	12 (31.6)	5 (55.6)	
No Cleft Centers	2 (8.3)	9 (14.5)	0 (0)	3 (7.9)	0 (0)	
No Awareness	2 (8.3)	2 (3.2)	0 (0)	1 (2.6)	1 (11.1)	
Intervention						
Financial Support	6 (26.1)	16 (26.7)	2 (20.0)	3 (6.8)	3 (33.3)	0.35
Training	6 (26.1)	9 (15.0)	1 (10.0)	16 (36.4)	1 (11.1)	
Awareness	0 (0)	4 (6.7)	1 (10.0	5 (11.4)	1 (11.1)	
Multidisciplinary Teams	8 (34.8)	21 (35.0)	4 (40.0)	11 (25.0)	3 (33.3)	
Cleft Centers	3 (13.0)	10 (16.7)	2 (20.0)	9 (20.5)	1 (11.1)	

Percentages indicate percentages within available responses, excluding missing data. P indicates p-value.

Discussion

Clefts of the lip and/or the palate remain one of the leading congenital defects, with varying prevalence based on geographical region and population.[19,20] If left untreated or if treatment is delayed, patients with these craniofacial differences are at increased risk of malnutrition, speech delays, recurrent infections and dental-related morbidities.[3] It is estimated that 250,000 cases are reported annually in LMICs, where several factors affect access to cleft care.[21] The lack of training, multidisciplinary teams, cleft centers and awareness about clefts of the lip and palate, as well as financial limitations and logistical challenges all constitute barriers to optimal comprehensive cleft care delivery. Despite efforts of non-profit organizations to address the unmet burden of disease and provide temporary increases in workforce and resources through outreach programs, LMICs still face limitations for cleft care delivery.[4,6] To promote the delivery of sustainable and comprehensive cleft care, GSF combines a diagonal model of cleft care delivery in outreach settings with annual simulation-based Comprehensive

Cleft Care Workshops (CCCW).[10] These workshops are held in areas of need and are scheduled to recur in the same geographical location every three years. We have previously evaluated the perceived barriers and limitations to comprehensive cleft care delivery among participants in this educational initiative and faculty.[7]

Our analysis showed that the most significant barrier facing comprehensive cleft care delivery was financial limitations, which was concordant among faculty members and attendees. Similarly, the major intervention required to deliver comprehensive cleft care was creating multidisciplinary teams, also concordant between faculty members and attendees. In this post hoc study, we sought to further stratify the results based on age, gender, specialty, years in practice and geographical area. Recognizing barriers to and addressing limitations of cleft care are essential steps in the development of sustainable cleft care worldwide.

After stratification by age, gender, specialty and geographical area, the most important reported barrier to cleft care remained financial. However, after stratification by years of experience, the majority of respondents with less than five years of experience reported the lack of multidisciplinary cleft teams as the major barrier while the majority of respondents with more than five years of experience reported financial limitations to be the main barrier to cleft care, with statistical significance. The lack of financial support remains a commonly mentioned barrier for global care, particularly in LMICs. Similarly, after stratification by gender, years of experience, specialty and geographic location, the establishment of multidisciplinary cleft teams prevailed as the most important intervention, followed by financial support. Stratification by age revealed statistically significant differences, with respondents <30 years old reporting increased training as the most significant intervention and respondents >30 years old reporting the establishment of multidisciplinary teams as most important intervention to the establishment of comprehensive cleft care. These results emphasize the need for skilled professionals, collaborating through multidisciplinary teams in order to provide the best quality and standards of care for patients with clefts of the lip and/or palate.

While attendance of educational initiatives might affect respondents' answers, consistent results after detailed stratification reinforce the identified barriers and limitations for the delivery of comprehensive cleft care. These results highlight the importance of collaboration and education to achieve sustainable as well as comprehensive worldwide cleft care, which align well with the vision of our CCCWs. Indeed, our CCCWs represent an affordable, capacity-building educational initiative that attracts leaders in cleft care from heterogenous specialties to deliver an interdisciplinary symposium over several days. Training in CCCWs incorporates simulation sessions that reinforce and strengthen the educational content, allow for real-time feedback and practice, and provide a hands-on interactive experience

for attendees.[22-25]

While we acknowledge that different providers from diverse geographical locations may have different needs that need to be addressed, we hope that this study provides the groundwork for perceived barriers and potential needed interventions for the delivery of comprehensive cleft care, and how they are impacted by geographic and demographic factors, in order to tailor future research efforts and educational initiatives. We are committed to pursue our efforts in identifying site-specific and specialty-specific disparities in our fortuitous endeavor to develop more specific and focused roadmaps for universal interdisciplinary cleft care delivery.

Conclusion

This post hoc study provides an overview of perceived barriers and needed interventions for the delivery of comprehensive cleft care, by participants and faculty members of the first two international CCCWs. These educational initiatives are driven by GSF, a non-profit organization dedicated to providing free of charge interdisciplinary cleft care for patients in need. We hope to build on these results and future research efforts by GSF and other sister organizations to recognize the local necessities and disparities in cleft care and develop strategies to address them.

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Chapter 9

Discussion and Future Perspectives

Clefts of the lip and/or palate affect approximately one in every 500 to 700 live births, and carry significant associated morbidity if not surgically corrected. [1] The impact of these congenital defects is more pronounced in developing countries where the annual incidence of cases is estimated to be around 250,000, and a significant backlog of untreated patients persists. [2]

Foundation-Driven Cleft Care In Developing Countries And Potential Impact

This unmet surgical burden in low- to middle-income countries has attracted a significant number of cleft care initiatives over the last several decades. [3] These initiatives have varied significantly in their geographic distributions, scope of services, models of cleft care delivery, and can be broadly classified as vertical, horizontal or diagonal initiatives. [3,4] Vertical initiatives are best exemplified by cleft surgery missions, where teams of cleft practitioners travel to areas of need with their equipment, provide voluntary cleft care and often donate surgical as well as medical supplies. [3] Vertical initiatives can provide cleft care in areas with limited access to healthcare resources, but have frequently been criticized for not being cost-effective, interfering with host country infrastructure, focusing on volume rather than quality of care, and lack of sustainability. [3] Horizontal initiatives have been hailed as being more sustainable, given that they target host country infrastructures and focus on collaborating with local healthcare authorities. [3] Nevertheless, they are ineffective in areas that are devoid of basic infrastructure and take a long time to instill change. [3] Diagonal initiatives combine elements of vertical and horizontal models of cleft care delivery in order to ultimately create autonomous cleft care systems in developing countries. [3] The clinical impact achieved by international cleft care initiatives in low- to middle-income countries, is associated with a significant economic impact as well. The mean number of disability-adjusted life years (DALYs) averted per patient through cleft surgery has been estimated to range from 2.67 to 9.04 per patient, with an economic gain ranging between $5,510 and $50,634 per patient. [3,5]

Global Burden And Prevalence Of Orofacial Clefts

Despite recommendations favoring surgical correction of orofacial clefts early in life and numerous international cleft care initiatives, a significant global backlog of untreated patients persists despite a decreased noted over the last few decades (**Chapter 2**). [6] In **Chapter 2**, we provided the most recent updated estimates of global

burden and prevalence of orofacial clefts, stratified our estimates by geographic regions as well as sociodemographic index, and highlighted the countries that are most affected by orofacial clefts. [6] We performed this analysis to help guide future global cleft care initiatives and hopefully direct available resources appropriately. We estimated the global prevalence of orofacial clefts to be around 4.6 million (95% UI: 3.8 – 5.7 million), while the global burden of orofacial clefts was estimated to be 529,758.92 DALYs (95% UI: 362,492.88 – 798,419.69 DALYs) (**Chapter 2**). [6] The geographic regions carrying the most significant burden of orofacial clefts were Sub-Saharan Africa, Middle East/North Africa, and South Asia, and we noted an inverse relationship between sociodemographic index and burden of orofacial clefts (**Chapter 2**). [6]

Simulation In Cleft Surgery

Non-profit organizations and international initiatives have also contributed to cleft care in developing countries through an array of educational endeavors. [3] These have included formal clinical fellowships and electives sponsored by non-profit organizations for international cleft practitioners, educational opportunities for cleft practitioners from low- to middle-income countries, as well as cleft surgery educational tools (**Chapter 3**). [3] In developed countries, surgical simulation has emerged as a potential solution to challenges facing modern surgical education including a growing number of non-clinical duties, increasing resident supervision, and strict work-hour limitations. [7] Consequently, a number of simulation-based surgical educational tools and platforms have been described in several specialties, including plastic, reconstructive, craniofacial, and cleft surgery (**Chapter 3**). [8] A recent review of such educational tools identified 16 cleft surgery simulators, including 7 (43.8%) high fidelity haptic simulators, 5 (31.2%) low fidelity haptic simulators, and 4 (25.0%) digital simulators, with costs ranging from freely available up to $300 (**Chapter 3**). [8] While identified cleft surgery simulators varied significantly in their characteristics, availability, purpose, cost, and data supporting their use, overall results regarding their utility in teaching cleft surgery were favorable (**Chapter 3**). [8] These favorable results, combined with our pursuit for developing and implementing solutions for sustainable cleft care for our patients in developing counties, have provided the major impetus for the work described in this thesis, and have driven us to investigate the use of simulation-based cleft surgery education as a conduit for achieving sustainable, capacity-building cleft care in developing countries.

Simulation-Based Cleft Surgery Education: Proof of Concept

We previously gauged how well received and effective available cleft surgery simulators were prior to implementing their use within our educational endeavors targeting developing countries. We first evaluated the global impact and utilization of a freely available internet-based educational digital cleft surgery simulator developed by the non-profit organization Smile Train, available in 5 languages: English, Chinese, Spanish, Portuguese, and French. [9] The digital simulator covers cardinal procedures in cleft lip and palate surgery including anatomy, surgical markings, detailed surgical steps, and includes high-definition intraoperative footage of real cases along with surgeon commentary. [9] Over a span of 5 years, the simulator was accessed by more than 4,000 users from 136 countries encompassing more than 95% of the global population, with an average session duration per user of 9.0 ± 7.3 minutes. [10] More importantly, when asked to evaluate the simulator, the majority of users (88%) found it to be useful as a cleft surgery educational resource. [10] The majority (58%) also found it to be specifically useful as an educational tool for teaching surgical trainees about cleft surgery. [10] These findings provided us with concrete data that cleft surgery educational simulators are well received and appraised by surgeons and surgical trainees when readily available. Moreover, these results also highlighted that stakeholders interested in reaching this target audience should support and endorse cleft surgery educational simulators.

Effectiveness of Simulation-Based Cleft Surgery Education

Despite cleft surgery educational simulators being well received by their target audience, demonstrating that they can contribute to sustainable cleft care capacity building in developing countries mandates investigating if they are effective educational tools. With this in mind, we completed the first prospective, randomized, blinded trial evaluating the impact of cleft surgery simulators on trainee surgical knowledge, procedural confidence, markings performance, as well as surgical performance (**Chapter 4**). [11] The trial enrolled plastic surgery trainees at a tertiary care academic medical center in New York City, prior to testing simulation-based cleft surgery education in developing countries. Participants were randomized to a cleft surgery digital simulator (*Smile Train*, www.cleftsim.org) or textbook and were subsequently tested on the extended Mohler unilateral cleft lip repair (**Chapter 4**). [11] Participants' surgical knowledge and procedural confidence were tested, in

addition to their markings performance using a three-dimensional cleft lip stone model, as well as their surgical performance using a commercially available high-fidelity unilateral cleft lip haptic model (*Simulare Medical*) (**Chapter 4**). [11] Trainees randomized to the simulation arm of the study, demonstrated a significant improved in surgical knowledge, procedural confidence, markings performance, and surgical performance as opposed to the trainees randomized to textbook (**Chapter 4**). [11] The encouraging data provided through this prospective randomized trial, was the impetus to translating utilization of simulation-based education in cleft surgery to developing countries, as a method to build surgical capacity in a sustainable fashion in areas that need it the most.

Application of Simulation-Based Cleft Surgery Education in Developing Countries

Simulation-based surgical curricula and tools have become widespread in developed countries, where trainee education is progressively challenged by a relentless shift towards subspecialty training, strict work hour limitations imposed by accrediting bodies, and increasing trainee supervision. [7,12,13] Nevertheless, the dissemination and implementation of these simulation-based strategies in developing countries have been significantly challenged by organizational and financial restraints. In an attempt to tackle this issue and relying on our encouraging data, we organized the first simulation-based, multidisciplinary, comprehensive, educational cleft care workshop in the Middle East/North Africa (MENA) region, a geographical region we identified as carrying one of the highest burdens of orofacial clefts (**Chapter 2**). [14] The workshop was held in Beirut, Lebanon in 2018, and included surgeons, speech and language pathologists, and nurses. [14] (The surgical curriculum included simulation-based breakout sessions focused on cleft lip and palate repair using high-fidelity cleft lip and palate haptic models (*Simulare Medical*). [14] Data collected at the conclusion of the workshop demonstrated that all participants would recommend simulation-based cleft surgery workshops to their colleagues and would participate again in similar workshops. [14] Participants were also highly satisfied with the design, content, instructors, delivery, and results of the workshop. [14]

Simulation-Based Cleft Surgery Education in Developing Countries: Reproducibility and Impact

While results from our first workshop were encouraging, providing evidence that simulation-based comprehensive cleft surgery workshops were well

received by their intended audience, we needed to demonstrate that this effect was, reproducible, sustained over time, and clinically translatable. We therefore collected data to investigate these issues in our second workshop held in Lima, Peru in 2019 (**Chapter 5**). [15] Similar to our first workshop, most participants reported that they would recommend simulation-based workshops to their colleagues, would participate again in similar workshops, and they were highly satisfied with the design, content, instructors, delivery, and results of the workshop (**Chapter 5**). [15] Using a modified version of the Student Evaluation of Educational Quality (SEEQ) survey, a validated tool for measuring student satisfaction, we also demonstrated that participants perceived simulation-based cleft surgery workshops to be stimulating, increased interest in the subject, were effective for learning, were clear, provided an effective teaching method, and they were likely to recommend them as an educational tool for cleft surgery (**Chapter 5**). [15,16] More importantly, our results provided important insight into the potential clinical impact of simulation-based cleft surgery education, as participants reported a significant improvement in their clinical competence, performance, outcomes, clinical care, as well as changing their clinical practice as a result of what they have learned (**Chapter 5**). [15] Furthermore, this clinical impact was one that was sustained over medium-term follow-up (**Chapter 5**). [15] Using a modified version of the psychometrically validated tool for measuring self-confidence during surgical learning developed by Geoffrion et al., we were also able to demonstrate for the first time, that simulation-based cleft lip and cleft palate sessions held in a developing country result in a significant improvement in procedural confidence among surgeons (**Chapter 5**). [11,15,17]

Future Perspectives

Our data provides novel, evidence-based insight that simulation-based comprehensive cleft surgery workshops are well received by trainees, and provide a reproducible model for building sustainable cleft care capacity in areas that need it, by instilling a durable clinical impact on trainees. Nevertheless, unanswered questions remain that are the focus of ongoing and future research efforts. Data collected in our studies included participant satisfaction in the workshops, satisfaction with educational quality of simulation-based workshops, participant perceived clinical impact of the workshops on them, and participant perceived impact of the workshops on their procedural confidence. We collected data through available validated scales or modified versions of validated scales whenever possible. [11,15-17] However, cleft surgery specific validated assessment scales are lacking to this date, and future research efforts should focus on developing such tools. Moreover, due to logistical restraints associated with organizing such

workshops, we were only able to collect participant perceived data as opposed to evaluating participant surgical skills. While we have previously demonstrated that simulation-based cleft surgery education leads to significantly improved markings and procedural performances among trainees in a developed country, demonstrating that these results are reproducible in developing countries will be critical. [11] Similarly, while we have previously utilized a modified version of the validated Objective Structured Assessment of Technical Skill (OSATS) Global Rating Scale, developing cleft surgery specific assessment tools for this purpose will also be very important in the future. [11]

Importantly, the COVID-19 has significantly amplified barriers facing international cleft care clinical and educational initiatives through mandated lockdowns and quarantines, as well as limited travel. This highlighted how international cleft care initiatives had to adapt to a new reality following the peak of the COVID-19 pandemic. With this issue in mind, we held our most recent global simulation-based comprehensive cleft care workshop in hybrid format, where participants had the opportunity to attend the workshop in person with heightened safety precautions or attend virtually. This provided us with the opportunity to compare participant experiences based on in-person versus virtual attendance (**Chapter 6**). [18] The workshop included 489 participants from five continents. The majority of participants reported a high level of satisfaction with the workshop and a strong positive perceived short-term impact on their practice (**Chapter 6**). [18] Importantly, while this was true for both in person and virtual attendees, in person attendees reported a significantly higher satisfaction with the workshop (28.63 ± 3.08 vs. 27.63 ± 3.93; $p = 0.04$) and perceived impact on their clinical practice (22.37 ± 3.42 vs. 21.02 ± 3.45 $p = 0.01$) (**Chapter 6**). [18] This provided us with evidence that hybrid simulation-based educational comprehensive cleft care workshops are overall well received by participants and have a positive perceived impact on participant clinical practices (**Chapter 6**). [18] This also demonstrated that in person attendance is associated with significantly higher satisfaction and perceived impact on practice, suggesting that the hybrid rather than purely virtual model is the way forward, and that future efforts will have to focus on making in person and virtual experiences more comparable, given that recurrent COVID-19 variant waves are expected (**Chapter 6**). [18]

Identifying barriers facing comprehensive cleft care delivery in developing countries is critical to achieve sustainable healthcare equity for patients with cleft lip and/or palate. [19] We evaluated perceived barriers facing comprehensive cleft care delivery in our simulation-based workshops, as well as interventions necessary to overcome these obstacles. The greatest perceived barrier facing comprehensive cleft care delivery in developing countries was financial, while the single most important intervention to deliver comprehensive cleft care was the

creation of multidisciplinary teams (**Chapter 7**). [20] This finding highlighted that despite the significant perceived challenge to comprehensive cleft care delivery imposed by financial factors, respondents believed that creating multidisciplinary teams was a more imminent intervention to deliver comprehensive cleft care than providing financial support in developing countries (**Chapter 7**). [20] Importantly, these beliefs were concordant between faculty members in our workshops and participants in them, further highlighting the potential role of our simulation-based multidisciplinary workshops in delivering comprehensive cleft care in developing countries (**Chapter 7**). [20] Future efforts will have to focus extensively on delineating roadmaps for delivering comprehensive cleft care education through workshops that are site and specialty specific; as we certainly recognize that the needs of different geographic areas, populations, and specialists are different (**Chapter 8**). [21] While our workshops have predominantly focused on simulation-based surgical education, we will continue to investigate how simulation-based teaching can be applied to all cleft providers involved in a comprehensive multidisciplinary cleft team as achieving optimal patient outcomes is highly dependent on overall team performance rather than only surgical performance. We are also investigating how best to evaluate the impact of our simulation-based cleft surgery workshops on patients ultimately treated by trainees participating in these workshops, in order to evaluate how our participants perceived improved procedural confidence and change in clinical practice is impacting and correlating with patient-reported and observed outcomes.

The versatility of simulation-based training allows it to achieve a broad spectrum of educational goals and training objectives. Simulation programs can focus on surgical skills, medical knowledge, teamwork, as well as crisis resource management, all of which are critical factors in building surgical capacity in low to middle income countries. Importantly, simulation-based resources can also be utilized in concordance with other emerging technologies such as augmented reality and artificial intelligence-based tools in order to overcome challenges that face simulation-based training. Utilizing AR for example, can help disseminate simulation-based programs globally and overcome geographical challenges that might limit their widespread implementation. Along the same lines, artificial intelligence can potentially be useful in objectively evaluating trainee surgical performance and improvement through simulation-based training programs, while allowing educators to identify key metrics and elements in surgical procedures through pattern recognition and repetition. We are currently investigating these technologies in order to address some of the challenges discussed in this thesis, tackle the persistent global gap in cleft care, and ultimately build global cleft care capacity and sustainability through simulation-based cleft surgery education.

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Chapter 10

Summary and Nederlandse Samenvatting

Summary

Clefts of the lip and/or palate affect close to one in 500-700 live births, and can result in increased patient morbidity and mortality due to poor nutrition and respiratory complications if left untreated. However, significant global disparities in access to adequate and timely cleft care persist and are more pronounced in developing countries. This unmet surgical burden, coupled with the relatively basic logistics required to repair these craniofacial conditions have prompted a significant number of foundation-based cleft care initiatives in developing countries. Providing surgical education to surgeons and trainees in developing countries is critical to build cleft care capacity. While simulation-based education has emerged as an essential component of surgical education, including cleft surgery education, in developed countries, its application in the outreach setting and developing countries has remained limited due to financial and logistical restraints. With these issues in mind, the aims of this thesis were the following:

1. Quantify the global burden and prevalence of orofacial clefts, review foundation-based cleft care initiatives in developing countries, and appraise the current state of simulation in cleft surgery education.
2. Evaluate the efficacy of simulation-based cleft surgery education and how well trainees receive it.
3. Implement simulation-based cleft surgery education in developing countries through foundation-based comprehensive cleft care workshops, and evaluate its immediate and longitudinal impact on trainees.

In **Chapter 2**, we provided the most recent updated estimates of global burden and prevalence of orofacial clefts, stratified our estimates by geographic regions as well as sociodemographic index, and highlighted the countries that are most affected by orofacial clefts. We performed this analysis to help guide future global cleft care initiatives and hopefully direct available resources appropriately. We estimated the global prevalence of orofacial clefts to be around 4.6 million (95% UI: 3.8 – 5.7 million), while the global burden of orofacial clefts was estimated to be 529,758.92 DALYs (95% UI: 362,492.88 – 798,419.69 DALYs). The geographic regions carrying the most significant burden of orofacial clefts were Sub-Saharan Africa, Middle East/North Africa, and South Asia, and we noted an inverse relationship between sociodemographic index and burden of orofacial clefts.

In **Chapter 3**, we performed a thorough review of currently available cleft surgery simulators and identified a total of 16, including 7 (43.8%) high fidelity haptic simulators, 5 (31.2%) low fidelity haptic simulators, and 4 (25.0%) digital

simulators, with costs ranging from freely available up to $300. The simulators varied significantly in their characteristics, availability, purpose, cost, and data supporting their use, but overall results regarding their utility in teaching cleft surgery were favorable.

Chapter 4 described the first prospective, randomized, blinded trial evaluating the impact of cleft surgery simulators on trainee surgical knowledge, procedural confidence, markings performance, as well as surgical performance among surgical trainees at a tertiary care academic medical center in New York City. Participants were randomized to a cleft surgery digital simulator or textbook and were subsequently tested on the extended Mohler unilateral cleft lip repair. Trainees randomized to the simulation arm of the study, demonstrated a significant improved in surgical knowledge, procedural confidence, markings performance, and surgical performance as opposed to the trainees randomized to textbook. These encouraging results prompted us to implement simulation-based cleft surgery education to developing countries as a method to build sustainable capacity in areas that needed the most.

In **Chapter 5** we report data from second simulation-based comprehensive cleft care workshop in Lima, Peru in 2019. Similar to the first workshop held in Beirut, Lebanon in 2018, most participants reported that they would recommend simulation-based workshops to their colleagues, would participate again in similar workshops, and that they were highly satisfied with the design, content, instructors, delivery, and results of the workshop. Moreover, relying on a validated tool for measuring trainee satisfaction, we also showed that participants perceived simulation-based cleft surgery workshops to be stimulating, increased interest in the subject, were effective for learning, were clear, provided an effective teaching method, and they were likely to recommend them as an educational tool for cleft surgery. Results from this workshop also provided important insight into the potential clinical impact of simulation-based cleft surgery education, given that participants reported a significant improvement in their clinical competence, performance, outcomes, clinical care, as well as changing their clinical practice as a result of what they have learned. Relying on another validated tool for measuring self-confidence during surgical learning, we were also showed for the first time that simulation-based cleft lip and cleft palate sessions held in a developing country as part of a foundation-drive comprehensive cleft care workshop, result in a significant improvement in procedural confidence among surgeons. Most importantly, the impact achieved in this workshop was sustained over a prolonged period of time.

Chapter 6 describes the first hybrid global, simulation-based, educational, comprehensive cleft care workshop, which was held in Istanbul, Turkey, in 2021. The workshop provided participants with the opportunity to attend in person

with heightened safety precautions or attend virtually, which allowed us to compare participant experiences based on in-person versus virtual attendance. The workshop included 489 participants from five continents. The majority of participants reported a high level of satisfaction with the workshop and a strong positive perceived short-term impact on their practice. Importantly, while this was true for both in person and virtual attendees, in person attendees reported a significantly higher satisfaction with the workshop and perceived impact on their clinical practice. This provided us with evidence that hybrid simulation-based educational comprehensive cleft care workshops are overall well received by participants and have a positive perceived impact on participant clinical practices. More importantly, this demonstrated that in person attendance is associated with significantly higher satisfaction and perceived impact on practice, suggesting that the hybrid rather than purely virtual model is the way forward, and that future efforts will have to focus on making in person and virtual experiences more comparable, given that recurrent COVID-19 variant waves are expected.

In **Chapter 7** we evaluated the perceptions of participants in our workshops regarding barriers facing comprehensive cleft care delivery, as well as interventions necessary to overcome them. The greatest perceived barrier facing comprehensive cleft care delivery in developing countries was financial, while the single most important intervention to deliver comprehensive cleft care was the creation of multidisciplinary teams. This highlighted that despite the significant perceived challenge to comprehensive cleft care delivery imposed by financial factors, participants believed that creating multidisciplinary teams was a more imminent intervention to deliver comprehensive cleft care than providing financial support in developing countries. These perceptions were concordant between faculty members in our workshops and participants in them, further highlighting the potential role of our simulation-based multidisciplinary workshops in delivery comprehensive cleft care in developing countries. **Chapter 8** describes further analysis into geographic and demographic factors affecting perceived barriers and interventions to deliver comprehensive cleft care in developing countries, in an attempt to delineate site and specialty specific nuances and needs. This will be critical to determine the needs of different geographic areas, populations, and specialists, and tailor future simulation-based comprehensive cleft care workshops according to those needs.

Nederlandse Samenvatting

Een gespleten lip en/of gehemelte (schisis) treft bijna één op de 500-700 levendgeborenen en kan, indien onbehandeld, leiden tot verhoogde morbiditeit en mortaliteit van de patiënt als gevolg van slechte voeding en respiratoire complicaties. Er zijn echter nog steeds aanzienlijke wereldwijde verschillen in de toegang tot adequate en tijdige zorg voor schisis, deze verschillen zijn meer uitgesproken in ontwikkelingslanden. Deze onvervulde chirurgische last, in combinatie met de relatief elementaire logistiek die nodig is om deze craniofaciale aandoeningen te herstellen, heeft geleid tot een aanzienlijk aantal op stichting-gebaseerde initiatieven voor schisiszorg in ontwikkelingslanden. Het geven van chirurgisch onderwijs aan chirurgen en stagiaires in ontwikkelingslanden is van cruciaal belang om de capaciteit voor schisiszorg op te bouwen. Hoewel op simulatie gebaseerd onderwijs naar voren is gekomen als een essentieel onderdeel van chirurgisch onderwijs, inclusief onderwijs voor schisis chirurgie, in ontwikkelde landen, is de toepassing ervan in de outreach-omgeving en ontwikkelingslanden beperkt gebleven als gevolg van financiële en logistieke beperkingen. Met deze kwesties in gedachten, waren de doelstellingen van dit proefschrift de volgende:

1. Het analyseren en evalueren van het huidige landschap van op funderingen gebaseerde initiatieven voor schisiszorg in ontwikkelingslanden, evenals de huidige stand van zaken in het onderwijs van schisis chirurgie.
2. De evaluatie van de doeltreffendheid van simulatie onderwijs voor schisis chirurgie en hoe goed de cursisten deze ontvangen.
3. Implementatie van simulatie onderwijs voor schisis chirurgie in ontwikkelingslanden door middel van door stichtingen geïnitieerde uitgebreide workshops over schisiszorg, en het evalueren van zowel de directe als het langetermijneffect ervan op de deelnemers.

Hoofdstuk 2 presenteert de meest recent bijgewerkte schattingen van de wereldwijde belasting en prevalentie van orofaciale schisis. Onze schattingen gestratificeerd naar geografische regio's en sociodemografische index, en markeert de landen die het meest worden getroffen door orofaciale schisis. We hebben deze analyse uitgevoerd om toekomstige wereldwijde zorginitiatieven voor schisis te helpen begeleiden en hopelijk de beschikbare middelen op de juiste manier aan te sturen. We schatten de globale prevalentie van orofaciale schiss op ongeveer 4,6 miljoen (95% UI: 3,8 – 5,7 miljoen), terwijl de globale last van schisis werd geschat op 529.758,92 DALY's (95% UI: 362.492,88 – 798.419,69 DALY's). De geografische

regio's met de meest significante last van orofaciale schisis zijn Sub-Sahara Afrika, het Midden-Oosten/Noord-Afrika en Zuid-Azië, en een omgekeerd verband was gevonden tussen de sociodemografische index en de last van orofaciale schisis.

In **Hoofdstuk 3** hebben we een grondige analyse uitgevoerd van de momenteel beschikbare simulatoren voor schisis chirurgie. We hebben er in totaal 16 geïdentificeerd, waaronder 7 (43,8%) haptische simulatoren met hoge getrouwheid, 5 (31,2%) haptische simulatoren met lage getrouwheid en 4 (25,0%) digitale simulatoren. De kosten voor de simulatoren variëren van gratis beschikbaar tot $ 300. De simulatoren varieerden aanzienlijk in hun kenmerken, beschikbaarheid, doel, kosten en gegevens die hun gebruik ondersteunden, maar de algemene resultaten met betrekking tot hun bruikbaarheid bij het onderwijzen van schisis chirurgie waren gunstig.

Hoofdstuk 4 beschrijft de eerste prospectieve, gerandomiseerde, geblindeerde studie die de impact evalueerde van simulatoren voor schisis chirurgie op de chirurgische kennis van plastisch chirurgen in opleiding, het vertrouwen in de procedure, de prestaties van markeringen, evenals de chirurgische prestaties van plastisch chirurgen in opleiding in een academisch medisch centrum voor tertiaire zorg in New York City. Deelnemers werden gerandomiseerd in een groep die de procedure met de digitale simulator bestudeerde of een groep die een leerboek voor schisis chirurgie gebruikte en werden vervolgens getest op Mohler's techniek voor de reconstructie van een uitgebreide eenzijdige lip spleet. Deelnemers die waren gerandomiseerd in de simulatie-arm groep van het onderzoek, toonden een significante verbetering in chirurgische kennis, procedureel vertrouwen, markeringsprestaties en chirurgische prestaties, in tegenstelling tot de deelnemers in de andere groep, die het leerboek gebruikte ter voorbereiding. Deze bemoedigende resultaten hebben ons ertoe aangezet om op simulatie gebaseerde opleiding voor schisis chirurgie in ontwikkelingslanden te implementeren als een methode om duurzame capaciteit op te bouwen in gebieden die het het meest nodig hadden.

In **Hoofdstuk 5** rapporteren we resultaten van de tweede op simulatie gebaseerde uitgebreide workshop voor schisiszorg in Lima, Peru in 2019. Net als bij de eerste workshop meldden de meeste deelnemers dat ze simulatie workshops zouden aanbevelen aan hun collega's, opnieuw zouden deelnemen aan vergelijkbare workshops, en dat ze zeer tevreden waren over het ontwerp, de inhoud, de instructeurs, de levering en de resultaten van de workshop. Bovendien, vertrouwend op een gevalideerde tool voor het meten van de tevredenheid van cursisten, toonden we ook aan dat deelnemers simulatie workshops voor schisis chirurgie als stimulerend beschouwden, verhoogde de interesse in het onderwerp, educatief effectief waren, duidelijk waren, een effectieve lesmethode opleverde, en ze zouden ze waarschijnlijk aanbevelen als een educatief hulpmiddel voor schisis

chirurgie. De resultaten van deze workshop verschaften ook belangrijk inzicht in de potentiële klinische impact van op simulatie onderwijs voor schisis chirurgie, aangezien deelnemers een significante verbetering rapporteerden in hun klinische competentie, prestaties, resultaten, klinische zorg, evenals verandering van hun klinische praktijk als resultaat van de opgedane kennis. Steunend op een ander gevalideerd meetinstrument voor het meten van zelfvertrouwen tijdens chirurgisch leren, hebben we ook voor het eerst aangetoond dat simulatiesessies voor lip- en gehemelte-schisis die in een ontwikkelingsland werden gehouden als onderdeel van een uitgebreide workshop voor schisiszorg en door een stichting georganiseerd werd, resulteerde in een aanzienlijke verbetering van het procedurele vertrouwen onder chirurgen. Het belangrijkste was dat de impact die tijdens deze workshop werd bereikt, gedurende een langere periode werd behouden.

Hoofdstuk 6 beschrijft de eerste hybride wereldwijde, op simulatie gebaseerde, educatieve, uitgebreide workshop voor schisiszorg, die in 2021 in Istanbul, Turkije werd gehouden. De workshop bood deelnemers de mogelijkheid om fysiek, met de inachtneming van verhoogde veiligheidsmaatregelen, of virtueel deel te nemen. Deze situatie stelde ons in de gelegenheid om de ervaringen van fysieke deelnemers te vergelijken met de virtuele aanwezige deelnemers. De workshop had 489 deelnemers uit vijf continenten. De meerderheid van de deelnemers rapporteerde een hoge mate van tevredenheid over de workshop en een sterk positief waargenomen korte termijneffect op hun praktijk. Belangrijk is dat, hoewel dit gold voor zowel de fysiek aanwezige als de virtuele deelnemers, de fysiek aanwezigen een significant hogere tevredenheid over de workshop rapporteerden en de impact op hun klinische praktijk. Dit bewijst dat de op hybride simulatie gebaseerde educatieve, uitgebreide workshops voor schisiszorg over het algemeen goed worden ontvangen door deelnemers en deze een positieve impact hebben op de klinische praktijk van de deelnemers. Wat nog belangrijker is, dit toonde aan dat fysieke aanwezigheid geassocieerd is met een aanzienlijk hogere tevredenheid en waargenomen impact op de praktijk, wat suggereert dat een hybride vorm van de workshop de weg vooruit is in plaats van een puur virtueel model, en dat toekomstige inspanningen zich zullen moeten concentreren op het vergelijkbaar maken van de fysieke aanwezigheid en de virtuele ervaringen, aangezien terugkerende golven van de COVID-19-variant kunnen worden verwacht.

In **Hoofdstuk 7** hebben we de percepties van deelnemers aan onze workshops geëvalueerd met betrekking tot belemmeringen voor uitgebreide, multidisciplinaire schisiszorgverlening, evenals interventies die nodig zijn om deze te overwinnen. De grootste waargenomen barrière voor uitgebreide schisiszorg in ontwikkelingslanden was financieel van aard, terwijl de belangrijkste interventie om uitgebreide schisiszorg te bieden de oprichting van multidisciplinaire teams was. Dit onderstreepte dat ondanks de aanzienlijke vermeende uitdaging voor

uitgebreide schisiszorgverlening opgelegd door financiële factoren, de deelnemers van mening waren dat het opzetten van multidisciplinaire teams een meer op handen zijnde interventie was om uitgebreide schisiszorg te bieden, dan het bieden van financiële steun in ontwikkelingslanden. Deze percepties kwamen overeen tussen faculteitsleden in onze workshops en de deelnemers eraan, en benadrukten de potentiële rol van onze op simulatie gebaseerde multidisciplinaire workshops bij het leveren van uitgebreide schisiszorg in ontwikkelingslanden. **Hoofdstuk 8** beschrijft een verdere analyse van geografische en demografische factoren die van invloed zijn op waargenomen barrières en interventies om uitgebreide schisiszorg te bieden in ontwikkelingslanden, in een poging om locatie- en specialiteit specifieke nuances en behoeften af te bakenen. Dit zal van cruciaal belang zijn om de behoeften van verschillende geografische gebieden, populaties en specialisten te bepalen, en toekomstige, op simulatie workshops voor schisiszorg af te stemmen op die behoeften.

Appendices

PhD Portfolio

PhD student Name Rami S. Kantar
PhD period December 2018 to May 2023
Name PhD supervisor Professor Dr. Corstiaan C. Breugem and Dr. J. Peter W. Don Griot

1. PhD training		
	Year	**Workload (Credits)**
General Courses		
Introduction to Healthcare Economics	2017	3
Issues and Approaches in Health Policy	2017	3
Managerial and Organizational Behaviour	2017	3
Accounting and Budgeting	2018	3
Biostatistics	2018	3
Governance, Healthcare Law, and Ethics	2018	1.5
Epidemiology	2018	3
Human Resources and Management	2018	1.5
Healthcare Finance	2018	3
Program Evaluation for Policymakers	2018	1.5
Environmental Challenges in Healthcare	2018	1.5
Strategic Management	2018	3
Transformation Economics	2018	1.5
Strategic Issues in Healthcare Quality	2018	1.5
Healthcare Marketing Strategies	2018	1.5
Healthcare Information Technology	2018	1.5
Entrepreneurship in Healthcare	2018	1.5
Social and Behavioural Science	2019	1.5
Master Class	2019	3
Competitive Healthcare Strategy	2019	1.5
Globalization and Healthcare	2019	1.5
Oral Presentations		
Robert Younan, Mario Haddad, Wassim Najjar, Antonio Melhem, Sara Hussein, Lucille Ridgell, Rami Kantar, Raj Vyas, Usama Hamdan. Premaxillary Setback with Posterior Vomerine Ostectomy and Bilateral Cleft Lip Repair: Case Series. American Cleft Palate-Craniofacial Association 80th annual meeting. 2023. Raleigh, NC, U.S.A.	2023	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Kantar RS, Esenlik E, Al Abyad OS, Melhem A, Younan RA, Haddad M, Keith K, Serena Kassam S, Annan B, Vijayakumar C, Picard A, Padwa BL, Sommerlad B, Raposo-Amaral CE, Forrest CR, Gillett DA, Steinbacher DM, Runyan CM, MD, Tanikawa DYS, Chong DK, Fisher DM, Mark H, Canter HI, Losee JE, Patel KG, Hartzell LD, Johnson AB, Collares MVM, Alonso N, MD, Chen PK, Tse R, Mann RJ, Prada-Madrid JR, Kobayashi S, Hussain SA, Kummer A, Sell DA, Pereira VJ, Mabry K, Gonsoulin CK, Persson M, Davies G, Sethna NF, Munoz-Pareja JC, Kuijpers-Jagtman AM, Grayson BH, Grollemund B, Garib DG, DDS, Meazzini MC, Kharbanda OP, Santiago PE, Nalabothu P, Batra P, Stieber E, Prasad D, Brewster H, Ayala R, Erbay E, OkanAkcam MO, Don Griot JPW, Vyas RM, Flores RL, Breugem CC, Hamdan US. The First Hybrid International Educational Comprehensive Cleft Care Workshop. American Society of Plastic Surgeons Annual Meeting. October 2022. Boston, MA, U.S.A.	2022	
Nader Hanna, Andrea Parker, Rami S. Kantar. Building Sustainable Global Surgical Programs Through Education. The American College of Surgeons – Trainees Making a Global Impact. August 2022. Webinar.	2022	
Usama Hamdan, Adam Johnson, Omar Al Abyad, Rami S. Kantar. Synchronous Premaxillary Setback with Posterior Vomerine Ostectomy and Complete Bilateral Cleft Lip Repair: Outcomes of Single-Stage Repair of Complete Bilateral Cleft Lip with a Severely Protruding Premaxilla. July 2022. 14th International Cleft Congress. Edinburgh, Scotland.	2022	
Omar Al Abyad, Mario Haddad, Antonio Melhem, Robert Younan, Lucille Ridgell, Rami S. Kantar, Elsa Chahine, Serena Kassam, Marie Nader, Beyhan Annan, Kristen Keith, Corstiaan Breugem, Usama Hamdan. Comprehensive Cleft Care Delivery in Developing Countries: Impact of Geographic and Demographic Factors. July 2022. 14th International Cleft Congress. Edinburgh, Scotland.	2022	
Robert Younan, Antonio Melhem, Omar Al Abyad, Mario Haddad, Lucille Ridgell, Rami S. Kantar, Elsa Chahine, C McAleer, D Franco, Beyhan Annan, Anthony Haddad, Adam Johnson, Usama Hamdan. Clinical and Economic Impact of the Global Smile Foundation Outreach Surgical Program. July 2022. 14th International Cleft Congress. Edinburgh, Scotland.	2022	
Lucille Ridgell, Omar Abyad, Antonio Melhem, Robert Younan, Mario Haddad, Elsa Chahine, Beyhan Annan, Wasila Madhoun, Holly Sprow, Rami S. Kantar, Adam Johnson, Usama Hamdan. Impact of the Covid-19 Pandemic on Volunteer Participation in Cleft Surgical Outreach Programs. July 2022. 14th International Cleft Congress. Edinburgh, Scotland.	2022	
Usama Hamdan, Omar Al Abyad, Rami S. Kantar. Secondary Cleft Lip Residual Deformities: A Classification System. July 2022. 14th International Cleft Congress. Edinburgh, Scotland.	2022	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Antonio Melhem, Omar Al-Abyad, Mario Haddad, Robert Younan, Lucille Ridgell, Elsa Chahine, Elie Ramly, Alexander Marston, Sarena Teng, Marie Nader, Serena Kassam, Rami S. Kantar, Usama Hamdan. Quality Assurance Guidelines for Mission-Based Cleft Care in Underserved Settings: An Evolving Three Decade Experience. July 2022. 14th International Cleft Congress. Edinburgh, Scotland.	2022	
Rami S. Kantar, MD, MPH. The Global Burden of Orofacial Cleft and Perceived Barriers to Comprehensive Cleft Care in Low-Middle Income Countries. Amsterdam University Medical Center Global Health Week. June 2022. Virtual Meeting.	2022	
Rami S. Kantar, MD, MPH. Global Disparities in Access to Cleft Care. American College of Surgeons Resident and Associate Society Hangout. May 2022.	2022	
Dale Podolsky, MD; Roberto L. Flores, MD; Rami S. Kantar, MD, MPH; Abel M. Smerica, MD. High Fidelity Cleft Lip/Palate Simulation Devices For Training Centers, Study Session. American Cleft Palate-Craniofacial Association 79th annual meeting. March 2022.	2022	
Robert Younan, Antonio Melhem, Omar Al Abyad, Elsa Chahine, Adam Johnson, Anthony Haddad, Caille McAleer, Denise Franco, Beyhan Annan, Rami Kantar, Usama Hamdan. The Global Smile Foundation Surgical Program: Clinical and Economic Impact in Developing Countries. American Cleft Palate-Craniofacial Association 79th annual meeting. March 2022.	2022	
Rami S. Kantar, MD, MPH. Smile Like You Mean It. The American College of Surgeons Maryland Chapter Annual Meeting Keynote Lecture. March 2022.	2022	
Rami S. Kantar, MD, MPH; Elçin Esenlik, DDS, PhD; Omar S. Al Abyad, MD; Antonio Melhem, MD; Robert A. Younan, MD; Mario Haddad, MD; Kristen Keith, RN; Serena Kassam, DMD; Beyhan Annan, MPH; J. Peter W. Don Griot, MD, PhD, Raj M. Vyas, MD; Roberto L Flores, MD; Corstiaan C. Breugem, MD, PhD; Usama S. Hamdan, MD, FICS. The First Hybrid Simulation-Based International Educational Comprehensive Cleft Care Workshop. The American College of Surgeons Maryland Chapter Annual Meeting. March 2022.	2022	
Rami S. Kantar. Smile Like You Mean It. The University of Maryland Medical System/Shock Trauma Center Department of Surgery Grand Rounds. March 2022.	2022	
Rami S. Kantar. Humanitarian Surgical Outreach at Home and Abroad: Reports of the 2021 Volunteerism and Humanitarian Award Winners. The American College of Surgeons Clinical Congress. October 2021 Virtual Meeting.	2021	
Rami S. Kantar. American College of Surgeons Board of Governors' Awards Program. The American College of Surgeons Clinical Congress. October 2021 Virtual Meeting.	2021	
Elsa M. Chahine, Beyhan Annan, Wasila Madhoun, Holly Sprow, Rami S. Kantar, Adam Johnson, Usama S. Hamdan. Impact of COVID-19 on Global Smile Foundation Surgical Outreach Programs. American Cleft Palate-Craniofacial Association 78th annual meeting. April 2021. Virtual Meeting.	2021	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Antonio Melhem, Elsa Chahine, Omar Al Abyad, Adam Johnson, Anthony G. Haddad, Caille McAleer, Denise Franco, Beyhan Annan, **Rami S. Kantar**, Usama S. Hamdan. Clinical and Economic Impact of The Global Smile Foundation Surgical Program. American Cleft Palate-Craniofacial Association 78th annual meeting. April 2021. Virtual Meeting.	2021	
Elsa M. Chahine, Elie Ramly, Antonio Melhem, Omar Al Abyad, Alexander Marston, Sarena Teng, Marie Nader, Serena Kassam, **Rami S. Kantar**, Usama S. Hamdan. Quality Assurance Guidelines for Mission-Based Cleft Care in Underserved Settings: An Evolving Three-Decade Experience. American Cleft Palate-Craniofacial Association 78th annual meeting. April 2021. Virtual Meeting.	2021	
Elsa M. Chahine,Omar Al Abyad, Antonio Melhem, Serena N. Kassam, Raj M. Vyas, Anthony G. Haddad,**Rami** S. Kantar, Usama S. Hamdan. Sustainable Cleft Care: A Comprehensive Model Based On The Global Smile Foundation Experience. American Cleft Palate-Craniofacial Association 78th annual meeting. April 2021. Virtual Meeting.	2021	
Antonio Melhem, Omar Al Abyad, Elsa Chahine, Corstiaan Breugem, Kristen Keith, Serena Kassam, Charanya Vijayakumar, Mikaela Bow, Allyson Alfonso, Elcin Esenlik, Krishna Patel Pradip Shetye, Pedro Santiago, Joseph Losee, Derek Steinbacher, Ann Kummer, Roberto Flores, Percy Rossell-Perry, Daniela Garib, Nivaldo Alonso, Robert Mann, Maria Pamplona, Carlos Giugliano, Jose Rolando Prada-Madrid, Bonnie Padwa, Cassio-Eduardo Raposo-Amaral, Brian Sommerlad, Raymond Tse, Ricardo Bennun, Marcus Collares, **Rami S. Kantar**, Usama Hamdan. Simulation-Based Comprehensive Cleft Care Workshops: A Reproducible Model for Sustainable Education. American Cleft Palate-Craniofacial Association 78th annual meeting. April 2021. Virtual Meeting.	2021	
Omar Al Abyad, Elsa Chahine, Antonio Melhem, Corstiaan Breugem, Allyson Alfonso, Kristen Keith, Serena Kassam, Beyhan Annan, Krishna Patel, Roberto Flores, **Rami S. Kantar**, Usama Hamdan. Perceived Barriers To Comprehensive Cleft Care Delivery: Results From A Capacity-Building Educational Initiative And Implications. American Cleft Palate-Craniofacial Association 78th annual meeting. April 2021. Virtual Meeting.	2021	
Allyson R. Alfonso, Elie P. Ramly, Rami S. Kantar, Zoe P. Berman, Gustave K. Diep, Chen Shen, J. Rodrigo Diaz-Siso, Oriana Cohen, Eduardo D. Rodriguez. Call to Action: Preclinical Students Benefit From a Plastic Surgery-Focused Anatomy and Skills Training Curriculum. American Society of Plastic Surgeons Meeting. October 2020. Virtual Meeting.	2020	
Allyson R. Alfonso, Zoe P. Berman, Gustave K. Diep, Elie P. Ramly, Rami S. Kantar, J. Rodrigo Diaz-Siso, So-Young Oh, Victoria Harnik, Eduardo D. Rodriguez. Facial Transplantation Modernizes The Preclinical Curriculum: A Compelling Application of Immunologic, Anatomic, and Surgical Principles. American Society of Plastic Surgeons Meeting. October 2020. Virtual Meeting.	2020	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Allyson R. Alfonso, Elie P. Ramly, Rami S. Kantar, Maxime M. Wang, Bradley S. Eisemann, David A. Staffenberg, Pradip R. Shetye, Roberto L. Flores. Defining The Burden of Cleft Care: A Systemic Review of Nasoalveolar Molding. American Society of Plastic Surgeons Meeting. October 2020. Virtual Meeting.	2019	
Bruce E. Gelb, Elie P. Ramly, Rami S. Kantar, J. Rodrigo Diaz-Siso, Allyson R. Alfonso, Eduardo D. Rodriguez. Computerized Surgical Planning in Facial Transplantation. International Society of Vascularized Composite Allotransplantation Meeting. October 2019. New Delhi, India.	2019	
Bruce E. Gelb, Michael J. Cammarata, Nicole Wake, Rami S. Kantar, Margy Maroutsis, William J. Rifkin, Alexes Hazen, Lawrence E. Brecht, G. Leslie Bernstein, J. Rodrigo Diaz-Siso, Eduardo D. Rodriguez. Quality Improvement of Donor Masks for Facial Transplantation: A Comparison of Conventional Impression and 3-Dimensional Printing Technology. International Society of Vascularized Composite Allotransplantation Meeting. October 2019. New Delhi, India.	2019	
Bruce E. Gelb, Rami S. Kantar, Daniel J. Ceradini, Jamie P. Levine, David A. Staffenberg, Pierre B. Saadeh, Roberto L. Flores, Nicole G. Sweeney, G. Leslie Bernstein, Eduardo D. Rodriguez. Vascularized Composite Allotransplantation for Central and Lower Face Ballistic Injuries. International Society of Vascularized Composite Allotransplantation Meeting. October 2019. New Delhi, India.	2019	
Hunaid Hasan, Elie Ramly, Rami Kantar, Etoile Leblanc, Eduardo Rodriguez, Farng-Yang Foo. Reinnervation in Face Transplantation: The Role of Needle Electromyography. American Association of Neuromuscular and Electrodiagnostic Medicine Annual Meeting. October 2019. Austin, TX, U.S.A.	2019	
Allyson R. Alfonso, William J. Rifkin, Rami S. Kantar, Etoile LeBlanc, J. Rodrigo Diaz-Siso, Maria I. Grigos, Eduardo D. Rodriguez. Total Eyelid Transplantation in the Setting of a Full Face Transplant: Analysis of Postoperative Periorbital Function. American Society of Plastic Surgeons Annual Meeting. September 2019. San Diego, CA, U.S.A.	2019	
Elie P. Ramly, Rami S. Kantar, J. Rodrigo Diaz-Siso, Allyson R. Alfonso, Eduardo D. Rodriguez. A Computerized Approach to Facial Transplantation: Evolution and Application in 3 Consecutive Face Transplants. American Society of Plastic Surgeons Annual Meeting. September 2019. San Diego, CA, U.S.A.	2019	
Elie P. Ramly, Jason W. Yu, Bradley S. Eisemann, Olivia W. Yue, Allyson R. Alfonso, Rami S. Kantar, David A. Staffenberg, Pradip R. Shetye, Roberto L. Flores. Clinical Course and Outcomes of Temporomandibular Joint Ankylosis in Patients With Craniofacial Microsomia. American Society of Plastic Surgeons Annual Meeting. September 2019. San Diego, CA, U.S.A.	2019	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Elie P. Ramly, Jason W. Yu, Bradley S. Eisemann, Olivia Yue, Allyson R. Alfonso, Rami S. Kantar, David A. Staffenberg, Pradip R. Shetye, Roberto L. Flores. Temporomandibular Joint Ankylosis In Patients With Craniofacial Microsomia: Causes, Recurrence And Clinical Outcomes. 18th Congress of the International Society of Craniofacial Surgery. September 2019. Paris. France.	2019	
Usama S. Hamdan, MD, Rami S. Kantar, MD. Sustainable Cleft Care Through Education: Simulation-Based Comprehensive Workshops. European Cleft Palate Craniofacial Association. June 2019. Utrecht. Netherlands.	2019	
Rami S. Kantar, MD, Allyson R. Alfonso, BS, BA, Elie P. Ramly, MD, Marina Gonchar, DMD, MS, Samantha G. Maliha, BA, Oriana Cohen, MD, J. Rodrigo Diaz-Siso, MD, Bradley S. Eisemann, MD, Pierre B. Saadeh, MD, Roberto L. Flores, MD. Simulation-Based Skills and Knowledge Acquisition by Plastic Surgery Residents: A Prospective Randomized Blinded Trial. European Cleft Palate Craniofacial Association. June 2019. Utrecht. Netherlands.	2019	
Rami S. Kantar, MD, Allyson R. Alfonso, BS, BA, Elie P. Ramly, MD, Marina Gonchar, DMD, MS, Samantha G. Maliha, BA, Oriana Cohen, MD, J. Rodrigo Diaz-Siso, MD, Bradley S. Eisemann, MD, Pierre B. Saadeh, MD, Roberto L. Flores, MD. Cleft Surgery Knowledge and Skills Acquisition by Plastic Surgery Residents: A Simulation-Based Prospective Randomized Blinded Trial. Plastic Surgery Research Council 64th annual meeting. May 2019. Baltimore, MD, U.S.A.	2019	
Rami S. Kantar, MD, Allyson R. Alfonso, BS, BA, Elie P. Ramly, MD, Marina Gonchar, DMD, MS, Samantha G. Maliha, BA, Oriana Cohen, MD, J. Rodrigo Diaz-Siso, MD, Bradley S. Eisemann, MD, Pierre B. Saadeh, MD, Roberto L. Flores, MD. Simulation-Based Knowledge and Skills Acquisition by Plastic Surgery Residents: A Prospective Randomized Blinded Trial. The American Association of Plastic Surgeons 98th annual meeting. April 2019. Baltimore, MD, U.S.A.	2019	
Bradley S. Eisemann, MD, Rami S. Kantar, MD, Elie P. Ramly, MD, Allyson R. Alfonso, BS, BA, Maxime M. Wang, BA, Roberto L. Flores, MD. Qualitative Assessment of Columella Scar Quality After Extended Mohler Unilateral Cleft Lip Repair. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Serena Kassam, DMD, Bieke Kreps, DDS, MSc, Fernando Almas, MD, DDS, Rami S. Kantar, MD, Elie P. Ramly, MD, Christopher Hughes, DMD, PhD, MS, Barry H. Grayson, DDS, Usama S. Hamdan, MD. Cleft lip and palate: Development of a dental database in an outreach setting. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Rami S. Kantar, MD, Michael J. Cammarata, BS, William J. Rifkin, BA, J. Rodrigo Diaz-Siso, MD, Usama S. Hamdan, MD, Roberto L. Flores, MD. The Impact of Foundation-Based Cleft Care in Developing Countries. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Rami S. Kantar, MD, Samantha G. Maliha, BA, Elie P. Ramly, MD, Allyson R. Alfonso, BS, BA, Bradley S. Eisemann, MD, Barry H. Grayson, DDS, Roberto L. Flores, MD. Nasolabial Aesthetics Following Cleft Lip Repair: An Objective Evaluation of Subjective Assessment. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Rami S. Kantar, MD, Marina Gonchar, DMD, MS, Samantha G. Maliha, BA, Elie P. Ramly, MD, Allyson R. Alfonso, BS, BA, Bradley S. Eisemann, MD, Pradip R. Shetye, DDS, MDS, Barry H. Grayson, DDS, Pierre B. Saadeh, MD, Roberto L. Flores, MD. Learner Satisfaction with Three-Dimensional Affordable Stone Models for Cleft Lip Markings: Results from a Prospective Study. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Allyson R. Alfonso, BS, BA, Evellyn M. DeMitchell-Rodriguez, BS, Elie P. Ramly, MD, Daphney Y. Noel, BA, Dina Levy-Lambert, BS, Maxime M. Wang, BA, Rami S. Kantar, MD, Roberto L. Flores, MD. Assessment of Patient-Oriented Online Resources Provided by American Cleft Palate-Craniofacial Association-Approved Teams. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Rami S. Kantar, MD, Michael J. Cammarata, BS, William J. Rifkin, BA, Samantha G. Maliha, BA, Scott J. Farber, MD, J. Rodrigo Diaz-Siso, MD, Roberto L. Flores, MD. Single-Stage Primary Cleft Lip and Palate Repair: Analysis of Early Complications. American Society of Plastic Surgeons Meeting. September 2018. Chicago, IL, U.S.A.	2018	
Rami S. Kantar, MD, Natalie M. Plana, BA, William J. Rifkin, BA, Joshua A. David, BS, Samantha G. Maliha, BA, J. Rodrigo Diaz-Siso, MD, Roberto L. Flores, MD. Textbook Versus Digital Simulation for Cleft Surgery Education: A Prospective, Randomized Blinded Trial. American Society of Plastic Surgeons Meeting. September 2018. Chicago, IL, U.S.A.	2018	
William J. Rifkin, BA, David A. Daar, MD, MBA, Rami S. Kantar, MD, Michael J. Cammarata, BS, Stelios C. Wilson, MD, Eduardo D. Rodriguez, MD, DDS. Predictors of Adverse Outcomes in the Management of Mandibular Fractures: An Analysis of 953 Cases. American Society of Plastic Surgeons Meeting. September 2018. Chicago, IL, U.S.A.	2018	
Amit K. Manjunath, BS, Michael J. Cammarata, BS, Rami S. Kantar, MD, William J. Rifkin, BA, Adam Jacoby, MD, Bruce E. Gelb, MD, Rodrigo Diaz-Siso, MD, Eduardo D. Rodriguez, MD, DDS. Maintenance Immunosuppression Trends in Hand and Facial VCA Transplantation. American Transplant Congress. June 2018. Seattle, WA, U.S.A.	2018	
Natalie A. O'Neill, MD; Rami S. Kantar, MD; Stephen M. Kavic, MD; Eric D. Strauch, MD. Millenial Medical Students Expect Surgical and Medical Residents to Violate Work Hour Restrictions. Surgical Education Week. May 2018. Austin, TX, U.S.A.	2018	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Rami S. Kantar, MD, William J. Rifkin, BAS, Joshua A. David, BS, Michael J. Cammarata, BS, J. Rodrigo Diaz-Siso, MD, Alyssa R. Golas, MD, Jamie P. Levine, MD, Daniel J. Ceradini, MD. Impact of Diabetes on Microsurgical Free Tissue Transfer Outcomes: Analysis of 6,030 Cases. Plastic Surgery Research Council 63rd annual meeting. May 2018. Birmingham, AL, U.S.A.	2018	
Amit K. Manjunath, BS, Laura L. Kimberly, MSW, MBE, Rami S. Kantar, MD, Michael J. Cammarata, BS, Adam Jacoby, MD, William J. Rifkin, BA, Bruce E. Gelb, MD, Rodrigo Diaz-Siso, MD, Eduardo D. Rodriguez, MD, DDS. Trends of Maintenance Immunosuppression in Hand and Facial Transplantation. Plastic Surgery Research Council 63rd annual meeting. May 2018. Birmingham, AL, U.S.A.	2018	
Rami S. Kantar, MD, William J. Rifkin, BA, Joshua A. David, BS, Michael J. Cammarata, BS, J. Rodrigo Diaz-Siso, MD, Alyssa R. Golas, MD, Jamie P. Levine, MD, Daniel J. Ceradini, MD. The Impact of Diabetes on Free Flap Outcomes: Analysis of 6,030 Patients. The American Association of Plastic Surgeons 97th annual meeting. April 2018. Seattle, WA, U.S.A.	2018	
Michael J. Cammarata, BS, Nicole Wake, MS, Rami S. Kantar, MD, Margy Maroutsis, Elise C. Schmidt, BS, William J. Rifkin, BA, G. Leslie Bernstein, MPA, Alexes Hazen, MD, J. Rodrigo Diaz-Siso, MD, Lawrence E. Brecht, DDS, Eduardo D. Rodriguez, MD, DDS. Three-Dimensional Analysis of Donor Masks for Restoration of the Face After Allograft Procurement, A Case Study. The American Association of Plastic Surgeons 97th annual meeting. April 2018. Seattle, WA, U.S.A.	2018	
J. Rodrigo Diaz-Siso, Rami Kantar, William Rifkin, Natalie Plana, Joshua David, Samantha Maliha, Roberto Flores. A Prospective, Randomized, Blinded Trial in Cleft Surgery Training: Textbook Versus Digital Simulation. American Cleft Palate-Craniofacial Association 75th annual meeting. April 2018. Pittsburgh, PA, U.S.A.	2018	
Samantha Maliha, Rami Kantar, Marina Gonchar, Vrajkumar Parikh, Roberto Flores, Etoile Leblanc. The Influence of Occlusal Severity on Velopharyngeal Competence Following Orthognathic Surgery. American Cleft Palate-Craniofacial Association 75th annual meeting. April 2018. Pittsburgh, PA, U.S.A.	2018	
Ali Khalifeh, Bryan Buckingham, Rami Kantar, Emily Reardon, Sarah Kidd-Romero, Kimberly Lumpkins, Stephen Kavic. Surgical Resident Use of Google™ and YouTube™ for OR Preparation. The 13th Annual Academic Surgical Congress. January 2018. Jacksonville, FL, U.S.A.	2018	
Eric S Wise, MD; Jessica Felton, MD; Rami S. Kantar, MD; Mark D Kligman, MD. Factors Associated with Prolonged Length of Stay after Laparoscopic Roux-en-Y Gastric Bypass: A Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBASQIP) Database Analysis. The American College of Surgeons Clinical Congress Scientific Forum. October 2017. San Diego, CA, U.S.A.	2017	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Eric Mace; Eric S. Wise; Jessica Felton; Rami Kantar; Mark Kligman. Outcomes after robotic versus laparoscopic Roux-en-Y gastric bypass: A Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program national database analysis. Tennessee Chapter of the American College of Surgeons (TNACS) annual meeting. August 2017. Nashville, TN, U.S.A	2017	
Kantar R, Morales D, Harris D, Kavic S. The ABSPITE as a Predictor of Performance on the ABSITE®. Surgical Education Week. April 2017. San Diego, CA, U.S.A.	2017	
Ramly EP, Alami R, Tamim H, **Kantar R**, Elias E, Chamseddine G, Safadi B. Concomitant Removal of Gastric Band and Gastric Bypass: Analysis of Outcomes and Complications from the ACS-NSQIP Database. American Society for Metabolic and Bariatric Surgery (ASMBS) Obesity week. November 2014. Boston, MA, U.S.A.	2014	
Ramly EP, Alami R, Tamim H, **Kantar R**, Elias E, Chamseddine G, Safadi B. Concomitant Removal of Gastric Band and Sleeve Gastrectomy: Analysis of Outcomes and Complications from the ACS-NSQIP Database. American Society for Metabolic and Bariatric Surgery (ASMBS) Obesity week. November 2014. Boston, MA, U.S.A.	2014	
Poster Presentations		
Sara Hussein, Robert Younan, Mario Haddad, Wassim Najjar, Lucille Ridgell, Beyhan Annan, Kristen Keith, Elcin Esenlik, Adam Johnson, Raj Vyas, Usama Hamdan, Rami Kantar. The First Hybrid Simulation-based Global Comprehensive Cleft Care Workshop (CCCW). American Cleft Palate-Craniofacial Association 80th annual meeting. 2023. Raleigh, NC, U.S.A.	2023	
Hossam Abdou, Ali Khalifeh, Rami Kantar, Khanjan Nagarsheth. The 5-item Modified Frailty Index Does Not Predict Postoperative Myocardial Infarction or Mortality Following Carotid Endarterectomy. The American College of Surgeons Clinical Congress. 2021. Virtual Meeting.	2021	
Jasmine Lee, Allyson R. Alfonso, Rami S. Kantar, Gustave K. Diep, Zoe P. Berman, Elie P. Ramly, David A. Daar, Jamie P. Levine, Daniel J. Ceradini. Association Of The Modified Frailty Index (mfi-5) With Postoperative Complications After Panniculectomy. The American Association of Plastic Surgeons 98th annual meeting. 2020. Chicago, IL, U.S.A.	2020	
Jasmine Lee, Allyson R. Alfonso, Rami S. Kantar, Gustave K. Diep, Zoe P. Berman, Elie P. Ramly, David A. Daar, Jamie P. Levine, Daniel J. Ceradini. Association Of The Modified Frailty Index (mfi-5) With Postoperative Complications After Panniculectomy. Plastic Surgery Research Council 65th annual meeting. 2020. Toronto, Canada	2020	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Serena Kassam, Nicholas Toomey, Emma Azurin, Elie Ramly, Rami Kantar, Adam Johnson, Mohammed Ahmed, Barry Grayson, Usama Hamdan. Developing a Sustainable Nasoalveolar Molding Program in Outreach Settings: An Eight-Year Follow-Up. American Cleft Palate-Craniofacial Association 77th annual meeting. 2020. Portland, OR, U.S.A.	2020	
Elie P. Ramly, Daniel J. Ceradini, Allyson R. Alfonso, Gustave K. Diep, Zoe P. Berman, J. Rodrigo Diaz-Siso, Rami S. Kantar, William J. Rifkin, Michael Sosin, Adam Jacoby, Shane Meehan, Leslie G. Bernstein, Roberto L. Flores, Jamie P. Levine, Pierre B. Saadeh, Bruce E. Gelb, Eduardo D. Rodriguez. Long-Term Outcomes of Full and Partial Facial Transplantaton. The American Association of Plastic Surgeons 98th annual meeting. 2020. Chicago, IL, U.S.A.	2020	
Elie P. Ramly, Daniel J. Ceradini, Allyson R. Alfonso, Gustave K. Diep, Zoe P. Berman, J. Rodrigo Diaz-Siso, Rami S. Kantar, William J. Rifkin, Michael Sosin, Adam Jacoby, Shane Meehan, Leslie G. Bernstein, Roberto L. Flores, Jamie P. Levine, Pierre B. Saadeh, Bruce E. Gelb, Eduardo D. Rodriguez. Prospective Evaluation of Long-Term Outcomes of Full and Partial Facial Transplantation. Plastic Surgery Research Council 65th annual meeting. 2020. Toronto, Canada.	2020	
Allyson R. Alfonso, Rami S. Kantar, Elie P. Ramly, Oriana Cohen, Zoe P. Berman, Gustave K. Diep, J. Rodrigo Diaz-Siso, Eduardo D. Rodriguez. Preclinical Students Benefit from a Plastic Surgery-Focused Anatomy and Skills Training Curriculum. Plastic Surgery Research Council 65th annual meeting. 2020. Toronto, Canada.	2020	
Allyson R. Alfonso, Gustave K. Diep, Jasmine Lee, Rami S. Kantar, Zoe P. Berman, Elie P. Ramly, David A. Daar, Jamie P. Levine, Daniel J. Ceradini. Evidence for Preoperative Risk Stratification of Surgically Managed Pressure Injuries Using the 5-Factor Modified Frailty Index. Plastic Surgery Research Council 65th annual meeting. 2020. Toronto, Canada.	2020	
Emma Azurin, Nicholas Toomey, Serena Kassam, Adam Johnson, Elie Ramly, Rami Kantar, Barry Grayson, Usama Hamdan. Aesthetic Outcomes of Patients With Unilateral Cleft Lip and Palate Following Nasoalveolar Molding Therapy in an Outreach Setting. American Cleft Palate-Craniofacial Association 77th annual meeting. 2020. Portland, OR, U.S.A.	2020	
Allyson Alfonso, Elie Ramly, Rami Kantar, Maxime Wang, Bradley Eisemann, David Staffenberg, Pradip Shetye, Roberto Flores. What is the Burden of Care of Nasoalveolar Molding? American Cleft Palate-Craniofacial Association 77th annual meeting. 2020. Portland, OR, U.S.A.	2020	
Elie Ramly, Jason Yu, Bradley Eisemann, Olivia Yue, Allyson Alfonso, Rami Kantar, David Staffenberg, Pradip Shetye, Roberto Flores. Clinical Course of Temporomandibular Joint Ankylosis in Pediatric Patients With Craniofacial Anomalies. American Cleft Palate-Craniofacial Association 77th annual meeting. 2020. Portland, OR, U.S.A.	2020	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Adam Jacoby, William Rifkin, Rami Kantar, Elie Ramly, Allyson Alfonso, Shane A. Meehan, Bruce E. Gelb, Samer Al-Homsi, Daniel J. Ceradini, Eduardo D. Rodriguez. Dynamics of Donor and Recipient Immunological Responses Following Vascularized Composite Allotransplantation. Plastic Surgery Research Council 65th annual meeting. 2020. Toronto, Canada.	2020	
Serena N. Kassam, Elie P. Ramly, Emma T. Azurin, Nicholas Toomey, Allyson Alfonso, Rami S. Kantar, Adam Johnson, Barry Grayson, Usama Hamdan. Outcomes of Patients With Unilateral Cleft Lip and Palate Following Nasoalveolar Molding Therapy in an Outreach Setting. Plastic Surgery Research Council 65th annual meeting. 2020. Toronto, Canada.	2020	
Serena N. Kassam, Elie P. Ramly, Emma T. Azurin, Nicholas Toomey, Allyson Alfonso, Rami S. Kantar, Adam Johnson, Barry H. Grayson, Usama Hamdan. Developing a Sustainable Nasoalveolar Molding Program in Outreach Settings: An Eight-Year Follow-Up. Plastic Surgery Research Council 65th annual meeting. 2020. Toronto, Canada.	2020	
Z-Hye Lee, Rami S. Kantar, Allyson Alfonso, Elie Ramly, Salma A. Abdou, Christodoulos Kaoutzanis, Jason Yu, Pierre B. Saadeh, Jamie P. Levine, Vishal D. Thanik. Vascularized Free Fibula Flap for Tibial Reconstruction: Institutional Experience and Systematic Review. American Society for Reconstructive Microsurgery Meeting. January 2020. Ft. Lauderdale, FL, U.S.A.	2020	
Z-Hye Lee, Elie Ramly, Allyson Alfonso, David Daar, Christodoulos Kaoutzanis, Rami S. Kantar, Vishal D. Thanik, Pierre B. Saadeh, Jamie P. Levine. Dangling Protocols in Lower Extremity Microvascular Reconstruction: A Systematic Review and Evidence-Based Clinical Recommendations. American Society for Reconstructive Microsurgery Meeting. January 2020. Ft. Lauderdale, FL, U.S.A.	2020	
Bruce E. Gelb, Rami S. Kantar, Elie P. Ramly, J. Rodrigo Diaz-Siso, Adam Jacoby, Michael Sosin, Daniel J. Ceradini, Eduardo D. Rodriguez. Preventable Nonfatal Craniofacial Injuries: Incidence and Implications for Facial Transplantation. International Society of Vascularized Composite Allotransplantation Meeting. October 2019. New Delhi, India.	2019	
Bruce E. Gelb, Evelyn M DeMitchell-Rodriguez, Helen Irving, Amy L. Friedman, Allyson R. Alfonso, Elie P. Ramly, J. Rodrigo Diaz-Siso, Rami S. Kantar, Eduardo D. Rodriguez. Towards Increased Organ Procurement Organization Involvement in Vascularized Composite Allograft Donation. International Society of Vascularized Composite Allotransplantation Meeting. October 2019. New Delhi, India.	2019	
Bruce E. Gelb, Daphney Y. Noel, Evelyn M DeMitchell-Rodriguez, Dina Levy-Lambert, Elie P. Ramly, Allyson R. Alfonso, Adam Jacoby, J. Rodrigo Diaz-Siso, Rami S. Kantar, Eduardo D. Rodriguez. Comprehensive Assessment of Face and Upper Extremity Transplantation Patient-Oriented Online Resources. International Society of Vascularized Composite Allotransplantation Meeting. October 2019. New Delhi, India.	2019	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Rami S. Kantar, MD, Elie P. Ramly, MD, Fernando Almas, MD, DDS, Krishna Patel, MD, Carolyn Rogers-Vizena, MD, Nathalie Roche, MD, Elias Zgheib, MD, Jennifer Munoz, MD, Marie Nader, MD, Ann Kummer, PhD, Roberto L. Flores, MD, John Van Aalst, MD, Usama S. Hamdan, MD. Sustainable Cleft Care Through Education: The First Simulation-Based Comprehensive Workshop in the Middle East and North Africa Region. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Olivia Y. Yue DDS, Bradley Eisemann MD, Rami Kantar, MD, Barry H. Grayson DDS, Roberto L. Flores, MD, David A. Staffenberg, MD, Joseph G. McCarthy, MD, Eduardo D. Rodriguez DDS, MD, Pradip R. Shetye DDS, MD. Surgical Outcomes of combined LeFort III and LeFort I Osteotomy: Immediate Post surgery and at One Year Follow up. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Serena Kassam, DMD, Fernando Almas, MD, DDS, Bieke Kreps DDS, MSc, Mohammad Mansoor, DDS, Rami S. Kantar, MD, Elie P. Ramly, MD, Christopher Hughes, DMD, PhD, MS, Larry Herman, DMD, MD, Barry H. Grayson, DDS, Usama S. Hamdan MD. Developing an Oral Hygiene Instruction (OHI) protocol to parallel the surgical post-operative care after cleft lip/palate surgery. American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
Elie P. Ramly, MD, Rami S. Kantar, MD, Allyson R. Alfonso, BS, BA, Bradley S. Eisemann, MD, Maxime M. Wang, BA, Roberto L. Flores, MD, Etoile Leblanc, PhD. Long Term Speech and Functional Outcomes of Bilateral Intraoral Myomucosal Flaps for Velopharyngeal Insufficiency American Cleft Palate-Craniofacial Association 76th annual meeting. April 2019. Tucson, AZ, U.S.A.	2019	
William J. Rifkin, BA, Evellyn DeMitchell-Rodriguez, BS, Rami S. Kantar, MD, J. Rodrigo Diaz-Siso, MD, John T. Stranix, MD, Daniel J. Ceradini, MD, Pierre B. Saadeh, MD. "Integrated" Plastic Surgery Residency Training: Evaluating Changes and the Current State of Plastic Surgery Programs Nationwide. The American Association of Plastic Surgeons 98th annual meeting. April 2019. Baltimore, MD, U.S.A.	2019	
Scott J. Farber, MD, Rami S. Kantar, MD, Eduardo D. Rodriguez, MD DDS. Facial Trauma Care in the Austere Environment. Special Operations Medical Association Scientific Assembly. May 2018. Charlotte, NC, U.S.A.	2018	
Rami S. Kantar, MD, William J. Rifkin, BA, Stelios C. Wilson, MD, Joshua A. David, BS, Michael J. Cammarata, BS, J. Rodrigo Diaz-Siso, MD, Alyssa R. Golas, MD, Jamie P. Levine, MD, Daniel J. Ceradini, MD. Evaluating the Impact of Diabetes and Risk Factors for Adverse Events Following Abdominal Panniculectomy. Analysis of 7,035 Patients. Plastic Surgery Research Council 63rd Annual Meeting. May 2018. Birmingham, AL, U.S.A.	2018	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
William J. Rifkin, BA, **Rami S. Kantar**, MD, Michael J. Cammarata, BS, Joshua A. David, BS, Stelios C. Wilson, MD, J. Rodrigo Diaz-Siso, MD, Alyssa R. Golas, MD, Jamie P. Levine, MD, Daniel J. Ceradini, MD. The Impact of Diabetes on Mastectomy and Breast Reconstruction Outcomes: An Analysis of 106,210 Patients. The American Association of Plastic Surgeons 97th annual meeting. April 2018. Seattle, WA, U.S.A.	2018	
Natalie M. Plana, BA, William J. Rifkin, BA, **Rami S. Kantar**, MD, Joshua A. David, BS, Samantha Mahlia, BA, J. Rodrigo Diaz-Siso, MD, Eduardo D. Rodriguez, MD, DDS, Roberto L. Flores, MD. Digital Simulation in Plastic Surgery Training: A Prospective, Randomized, Blinded Trial of a Surgical Simulator. The American Association of Plastic Surgeons 97th annual meeting. April 2018. Seattle, WA, U.S.A.	2018	
Rami Kantar, Natalie Plana, J. Rodrigo Diaz-Siso, Roberto Flores. Cleft Surgery Education Through Internet-Based Digital Simulation: A Five Year Assessment of Demographics, Utilization and Global Impact. American Cleft Palate-Craniofacial Association 75th annual meeting. April 2018. Pittsburgh, PA, U.S.A.	2018	
Fernando Almas, Valerie Cote, Rami Kantar, Elie Ramly, Usama Hamdan. Complete Bilateral Cleft Lip Repair Using Posterior Vomerine Premaxillary Setback: Safety and Outcome Evaluation. American Cleft Palate-Craniofacial Association 75th annual meeting. April 2018. Pittsburgh, PA, U.S.A.	2018	
Rami Kantar, Michael Cammarata, William Rifkin, Natalie Plana, J.Rodrigo Diaz-Siso, Roberto Flores. Challenging Convention: Assessment of Perioperative Complications Associated with Outpatient Primary Cleft Palate Surgery. American Cleft Palate-Craniofacial Association 75th annual meeting. April 2018. Pittsburgh, PA, U.S.A.	2018	
Rami Kantar, William Rifkin, Michael Cammarata, Natalie Plana, J.Rodrigo Diaz-Siso, Roberto Flores. Perioperative Complications Associated with Outpatient Versus Inpatient Primary Cleft Lip Surgery. American Cleft Palate-Craniofacial Association 75th annual meeting. April 2018. Pittsburgh, PA, U.S.A.	2018	
Ali Khalifeh, **Rami Kantar**, Bryan Buckingham, Samantha Cox, Robert Crawford, Rajabrata Sarkar, Shahab Toursavadkohi. Management of Chronic Massive Traumatic Popliteal Artery Aneurysm: A Case Series with Evolution of Treatment. Society for Vascular Surgery Vascular Annual Meeting. June 2017. San Diego, CA, U.S.A	2017	
Hessler L, Ahmad S, **Kantar R**, Kavic S. Textbook or E-book? Role of Electronic Resources in Surgical Education. The American College of Surgeons Clinical Congress Scientific Forum. October 2016. Washington, DC, U.S.A.	2016	
Haddad A, **Kantar R**, Tamim H, Taher H. Venous Thromboembolism and Preoperative Steroid Use, a Retrospective Cohort Study: Are Surgical Patients at Risk? Data from the ACS-NSQIP Database. The American Society of Hematology (ASH) 56th Annual Meeting. December 2014. San Francisco, CA, U.S.A.	2014	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Rami S. Kantar, Ghazal Lashghari, Grant K. Lewandrowski and Bakhos A. Tannous. Bioluminescence Imaging of Tumor Vascularity and Response to Anti-Angiogenic Therapy. MGH Research Fellows Research Day. May 2015. Boston, MA, U.S.A.	2015	
Rami S. Kantar, Ghazal Lashghari, Grant K. Lewandrowski and Bakhos A. Tannous. Bioluminescence Imaging of Tumor Vascularity and Response to Anti-Angiogenic Therapy. MGH Research Fellows Research Day. May 2015. Boston, MA, U.S.A.	2015	
Community Service		
Global Smile Foundation (GSF) – Junior surgeon in the comprehensive cleft surgical mission Beirut, Lebanon. Duties included assisting in surgical procedures and organizing the mission	2022	
Lebanon Mountain Trail (LMT) – Adrian Lifetime Member	2021-	
Smile Train – Volunteer – Smile Train is a non-profit organization focused on providing sustainable cleft care to patients around the world.	2021-	
Global Smile Foundation (GSF) – Junior surgeon in the comprehensive cleft surgical mission to San Salvador, El Salvador. Duties included assisting in surgical procedures and organizing the mission.	2020	
MyFace – Volunteer - MyFace is a non-profit foundation that is dedicated to transforming the lives of patients with facial differences. With a special focus on children and their families, myFace funds medical, surgical, dental, speech and psychosocial services as well as research and public awareness.	2017-2019	
GSF – Junior surgeon, mission coordinator and videographer in the comprehensive cleft surgical mission to Beirut, Lebanon. Duties included assisting in surgical procedures, taking care of the logistics and videography, and coordinating the activities of the team members.	2016	
GSF – Mission Coordinator and Photographer in the comprehensive cleft surgical mission to Beirut, Lebanon. Duties included taking care of the logistics and photography of the GSF April mission in Lebanon and coordinating the activities of the team members.	2015	
GSF – Mission Coordinator and Videographer in the comprehensive cleft surgical mission to San Salvador, El Salvador. Duties included taking care of the logistics and videography of the GSF January mission in El Salvador and coordinating the activities of the team members.	2015	
GSF – Volunteer - GSF is a non-profit organization dedicated to providing free, sustainable, high-quality comprehensive cleft care to patients in need.	2013-	
Mobile Medical Clinic for Syrian War Refugees – Primary Care Physician Duties consisted of providing medical aid to Syrian war refugees in Lebanon.	2013	
St. Jude Children's Cancer Center of Lebanon – Teacher Duties consisted of teaching patients who could not attend school on a regular basis and helping them with their homework.	2007-2008	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Leadership Positions		
The American College of Surgeons International Relations Committee - Member	2023-	
Plastic and Reconstructive Surgery Journal Resident Ambassador	2023	
Comprehensive Cleft Care Workshop (CCCW) – Organizer of the Comprehensive Cleft Care Workshop Educational in Rio De Janeiro, Brazil. The 4-day workshop by GSF included close to 400 participants and world authorities in cleft care.	2022	
Plastic Surgery Foundation (PSF) Surgeons in Humanitarian Alliance for Reconstruction, Research and Education (SHARE) – Research Committee Member	2022-	
Blog Contributor - *Inside The Match* residency and residency match guidance platform	2021-2022	
Group Advisor - The Lebanese medical student plastic and reconstructive surgery interest group	2021	
Event Organizer - Comprehensive Cleft Care Workshop (CCCW) – Organizer of the Comprehensive Cleft Care Workshop Educational in Istanbul, Turkey. The 3-day hybrid workshop by GSF included close to 500 participants and world authorities in cleft care.	2021	
Global Surgery Workgroup (GSW) Communication Lead - Resident and Associate Society (RAS) – The American College of Surgeons (ACS)	2021	
Fellow Resources Lead - ACS Associate Fellow Committee	2021	
Event Organizer - ACS – Maryland Chapter Surgery Fellowship Fair	2021	
Young Leadership Circle Board Member – Smile Train	2021	
Peer Mentor - Plastic Surgery Foundation (PSF) Surgeons in Humanitarian Alliance for Reconstruction, Research and Education (SHARE)	2021-	
Collaborator - Global Burden of Disease (GBD) study Network, Institute for Health Metrics and Evaluation (IHME), University of Washington	2021-	
Event Organizer and Moderator - Comprehensive Cleft Care Workshop (CCCW) – Organizer and Moderater the Comprehensive Cleft Care Workshop Educational Webinar in collaboration with The Sri Ramachandra Cleft and Craniofacial Center in Chennai, India. The 5-day webinar by GSF included more than 300 participants and world authorities in cleft care.	2020	
Chief Resident for Research Mentoring	2020-	
Executive Council Resident Member - ACS – Maryland Chapter	2020-	
Event Organizer and Moderator - Comprehensive Cleft Care Workshop (CCCW) – Organizer and Moderator of the largest simulation-based Comprehensive Cleft Care Educational Workshop in Latin America in Lima, Peru. The 3-day workshop by GSF included close to 200 participants and world authorities in cleft care.	2019	
Course Organizer - NYU Hansjörg Wyss Department of Plastic Surgery Upper Extremity Flap Course	2019	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
Course Organizer - NYU Hansjörg Wyss Department of Plastic Surgery Flap course	2019	
Member - GSF Institutional Review Board	2019-	
Member - Plastic Surgery Research Council (PSRC) – Education Committee	2019-	
Founder - Association of Plastic Surgeons of Lebanese Descent (APSLD) – Committee for Residents and Trainees	2019-	
Research Coordinator - Major Extremity Trauma Research Consortium (METRC): A Multi Center Prospective Observational Study of Nerve Repair and Reconstruction Associated With Major Extremity Trauma	2018-2019	
Course Organizer - NYU Hansjörg Wyss Department of Plastic Surgery Microsurgery Course	2018	
Fellowship Supervisor - NYU Hansjörg Wyss Department of Plastic Surgery Medical Student Summer Clinical Research Fellowship	2018	
Event Organizer and Moderator - Comprehensive Cleft Care Workshop (CCCW) – Organizer and Moderator of the first Comprehensive Cleft Care Educational Workshop in the Middle East/North Africa Region in Beirut, Lebanon. The 3-day workshop by GSF included close to 100 participants and world authorities in cleft care.	2018	
Member – GSF – Strategic Growth, Surgical, Education, and Research Committees	2018-	
Course Organizer - NYU Hansjörg Wyss Department of Plastic Surgery Microsurgery Course	2017	
Fellowship Supervisor - NYU Hansjörg Wyss Department of Plastic Surgery Medical Student Summer Clinical Research Fellowship	2017	
Founder and President The Massachusetts General Hospital Postdoc Association (MGPA) – Committee for International Medical Graduates	2013-2015	
Membership in Organization and Societies		
The Aesthetic Society	2022-	
American Society of Plastic Surgeons	2022-	
International College of Surgeons (ICS)	2022-	
AO Craniomaxillofacial (CMF)	2022-	
The University of Maryland/Shock Trauma Surgical Society	2022-	
RAS – ACS Global Surgery Workgroup	2021-	
ACS Associate Fellow Committee	2021-	
Plastic Surgery Foundation (PSF)	2021-	
GBD study Collaborator Network, IHME	2021-	
Columbia University Alumni Association	2019-	
Circle of Cleft Professionals	2019-	
APSLD	2017-	
PSRC	2017-	
The American Cleft Palate-Craniofacial Association (ACPA)	2017-	
Association for Academic Surgery (AAS)	2017-2018	
Resident and Associate Society – ACS	2016-	

Continued.

1. PhD training		
	Year	**Workload (Credits)**
ACS – Maryland Chapter	2015-	
ACS	2015-	
GSF	2013-	
Worldwide Alumni Association of the American University of Beirut (WAAAUB)	2013-	
Alpha Omega Alpha Honor Medical Society	2013-	
Lebanese Medical Students' International Committee (LeMSIC)	2009-2010	
Journal Responsibilities		
Editorial Board Member – The Cleft Palate-Craniofacial Journal	2023-	
Editorial Board Member – Plastic and Reconstructive Surgery	2023-	
Associate Editor – Frontiers in Surgery, Reconstructive and Plastic Surgery Section	2022-	
Reviewer – Diagnostics	2021-	
Reviewer – Clinics and Practice	2021-	
Reviewer – Clinical Medicine	2021-	
Reviewer - Clinical, Cosmetic, and Investigational Dentistry	2021-	
Reviewer – Diagnostics	2021-	
Reviewer – Clinics and Practice	2021-	
Reviewer Board Member – Journal of Clinical Medicine	2021-	
Reviewer – Journal of Cranio-Maxillo-Facial Surgery	2021-	
Reviewer - Clinical, Cosmetic and Investigational Dentistry	2021-	
Reviewer – Nutrients	2021-	
Reviewer - Healthcare	2021-	
Reviewer - International Journal of Surgery	2021-	
Youth Editorial Board Member - Plastic and Aesthetic Research	2021-	
Reviewer - Journal of Personalized Medicine	2021-	
Reviewer - Medicina	2021-	
Reviewer - Journal of Clinical Medicine	2020-	
Reviewer - Journal of International Medical Research	2020-	
Reviewer - Clinical Case Reports	2020-	
Reviewer - BMJ Open Ophthalmology	2020-	
Reviewer - AMA Journal of Ethics	2019-	
Resident Advisory Board - Plastic and Reconstructive Surgery	2018-	
Resident Advisory Board - Plastic and Reconstructive Surgery Global Open	2018-	
Reviewer - The American Journal of Surgery	2017-	
Reviewer - The Cleft Palate-Craniofacial Journal	2017-	
Reviewer - Plastic and Reconstructive Surgery	2017-	
Reviewer - Plastic and Reconstructive Surgery Global Open	2017-	

2. Teaching	
	Year
Clinical Teaching	
Yamini Vyas: Medical Student, The University of Maryland SOM	2022
Joshua D. Etzel: General Surgery Resident, UPMC Harrisburg	2021
Christopher E. Rosson: Oral and Maxillofacial Surgery Resident, Walter Reed Medical Center	2021
Brian Shear: Orthopedic Surgery Resident, UMMS/Shock Trauma Center	2021
Abhishek Vaidya: General Surgery Resident, Western Reserve	2021
Lauren E. Levy: Medical Student, The University of Maryland SOM	2020
Kimberly Oslin: Medical Student, The University of Maryland SOM	2020
Dany Herrera: Medical Student, The University of Maryland SOM	2020
Nicole Hays: Medical Student, The University of Maryland SOM	2019
Research Mentoring	
Robert Younan, MD: Postdoctoral Research Fellow, Global Smile Foundation	2021-
Mario Haddad, MD: Postdoctoral Research Fellow, Global Smile Foundation	2021-
Antonio Melhem, MD: Postdoctoral Research Fellow, Global Smile Foundation	2019-
Omar Al Abyad, MD: Postdoctoral Research Fellow, Global Smile Foundation	2019-
Elsa M. Chahine, MD: Postdoctoral Research Fellow, Global Smile Foundation	2018-
Allyson R. Alfonso, BA, BS: Predoctoral Research Fellow, NYU Medical Student	2018-2019
William J. Rifkin, BA: Predoctoral Research Fellow, NYU Medical Student	2018-2019
Michael J. Cammarata, BS: Predoctoral Research Fellow, Eastern Virgina Medical Student	2018-2019
Samantha G. Maliha, BA: Predoctoral Research Fellow, NYU Medical Student	2018-2019
Dina Levy-Lambert, BS: Predoctoral Research Fellow, NYU Medical Student	2018
Evellyn M. DeMitchell-Rodriguez, BS: Predoctoral Research Fellow, NYU Medical Student	2018
Daphney Y. Noel, BS: Predoctoral Research Fellow, Robert Wood Johnson Medical Student	2018
Jason A. Greenfield, BA: Predoctoral Research Fellow, Washington University Medical Student	2017
Amit K. Manjunath, BS: Predoctoral Research Fellow, NYU Medical Student	2017
Alessandra E. Cabrera, BA: Predoctoral Research Fellow, New York Medical College Medical Student	2017
Lauren K. Rangel, BA: Predoctoral Research Fellow, NYU Medical Student	2017

3. Parameters of Esteem

			Year
Awards and Prizes			
Outstanding Associate Editor	Frontiers in Surgery – Reconstructive and Plastic Surgery Section		2023
Top 100 Peer Reviewers	PRS and PRS Global Open		2022
Resident Leadership Award	The UMMS/STC Surgery Residency		2022
Resident Humanism Award	The UMMS/STC Surgery Residency		2022
Best Grand Rounds Presentation	The UMMS/STC Surgery Residency	Based on Department of Surgery Grand Rounds	2022
Journal Hot Topic Video Discussion	PRS	Manuscript: "Less Operating and More Overtriage: National Trends in Interfacility Transfer of Facial Fracture Patients"	2022
Best Presentation	The American College of Surgeons (ACS) Maryland Chapter Annual Meeting	Based on Oral Presentation at Annual Meeting	2022
Top 2021 Journal Reviewer	PRS	Based on Reviews for The Journal	2022
Surgical Volunteerism Award	The American College of Surgeons (ACS) – Operation Giving Back (OGB)	Based on Surgical Volunteerism and Humanitarian Outreach	2021
Resident Humanism Award	UMMS Surgery Residency	Based on Vote from Surgery Residents	2021
Journal Cover Article	PRS	Manuscript: "Facial Transplantation: Principles and Evolving Concepts"	2021
Journal Cover Article	The Cleft Palate-Craniofacial Journal	Manuscript: "Sustainable Cleft Care: A Comprehensive Model Based on the Global Smile Foundation"	2021
Journal Feature	PRS Journal Club	Manuscript: "Congestive Heart Failure Predicts Major Complications and Increased Length of Stay in Lower Extremity Pedicled Flap Reconstruction"	2020
Journal Feature	PRS	Manuscript: "The Latest Evolution in Virtual Surgical Planning: Customized Reconstruction Plates in Free Fibula Flap Mandibular Reconstruction"	2020
Exemplary Peer Reviewer	PRS Global Open	Based on exemplary peer review for the Journal	2020

Continued.

3. Parameters of Esteem			
			Year
Journal Feature	PRS	Manuscript: "Knowledge and Skills Acquisition by Plastic Surgery Residents Through Digital Simulation Training: A Prospective Randomized Blinded Trial"	2020
Magna Cum Laude GPA	Columbia University - Master of Public Health	Based on Graduating GPA of 3.9	2019
Top 1 % Peer Reviewer in Clinical Medicine	Publons	Global Peer Review Awards	2019
Top 1 % Peer Reviewer in Cross-Field	Publons	Global Peer Review Awards	2019
Cover Article	Annals of Plastic Surgery	Manuscript: "Three-Dimensional Affordable Stone Models for Cleft Lip Markings: A Prospective Study of Learner Satisfaction"	2019
Journal Cover Article and Hot Topic Video	PRS	Manuscript: "Facial Transplantation for an Irreparable Central and Lower Face Injury: A Modernized Approach to a Classic Challenge"	2019
Journal Hot Topic Video	PRS	Manuscript: "Foundation-Based Cleft Care in Developing Countries"	2019
Exemplary Peer Reviewer	PRS Global Open	Based on exemplary peer review for the Journal	2019
Journal Hot Topic Video	PRS	Manuscript: "Abdominal Panniculectomy: Determining the Impact of Diabetes on Complications and Risk Factors for Adverse Events"	2018
Intern of The Year Award	UMMS Surgery Residency	Based on voting by UMMS Surgery Residents	2016
Resident Teaching Award	UMMS Surgery Residency	Based on voting by The University of Maryland School of Medicine Students	2016
Highest Resident ABSITE Score Award	UMMS Surgery Residency	Based on ABSITE Score	2016
Gold VA Pin	Baltimore VA Medical Center	Awarded to VA employees willing to go "above and beyond" the call of duty to be of assistance to others	2016
Honored Caregiver	UMMS Surgery Residency	Based on nomination by patients at UMMS	2016

Continued.

3. Parameters of Esteem			
			Year
Alpha Omega Alpha Honor Medical Society	The University of Maryland School of Medicine Chapter	"Based on Excellent Academic and Professional Performance and Potential for a Distinguished Career in the Medical Profession"	2015
Poster of Excellence Award	MGH Research Fellows Poster Celebration Day		2015
Top 8 Papers	American Society for Metabolic and Bariatric Surgery (ASMBS)	ACS-NSQIP Abstract Selected Amongst the Top 8 Paper Sessions and for Oral Presentation	2014
Top 15 Posters	ASMBS	ACS-NSQIP Abstract Selected Amongst the Top 15 Posters and for Oral Presentation	2014
Penrose Award Nominee	Faculty of Medicine, AUB	"Based on Scholarship, Character, Leadership and Contribution to University Life"	2013
Alpha Omega Alpha Honor Medical Society	AUB Faculty of Medicine Chapter	"Based on Excellent Academic and Professional Performance and Potential for a Distinguished Career in the Medical Profession"	2013
Dean's Honor List	Faculty of Medicine, AUB	Based on Academic Performance	2010-2013
Class Rank in Top 10%	Faculty of Medicine, AUB	Based on Academic Performance	2009-2013
"Good Standing"	Faculty of Arts and Sciences (FAS), AUB	Based on Academic Performance	2005-2008
High Distinction	French and Lebanese Baccalaureates	Based on Academic Performance	2005

4. Publications

In this thesis

1. Prevalence and Burden of Orofacial Clefts. **Kantar RS**, Hamdan US, Flores RL, Don Griot JPW, Breugem CC, Mokdad AH. Submitted, *The Journal of Craniofacial Surgery,* 2022. (Under Review).
2. Simulation in Cleft Surgery. **Kantar RS**, Alfonso AR, Ramly EP, Diaz-Siso JR, Breugem CC, Flores RL. *Plast Reconstr Surg Glob Open*. 2019 Sep 23;7(9):e2438.
3. Knowledge and Skills Acquisition by Plastic Surgery Residents Through Digital Simulation Training: A Prospective, Randomized, Blinded Trial. **Kantar RS**, Alfonso AR, Ramly EP, Cohen O, Rifkin WK, Maliha SG, Diaz-Siso JR, Eisemann BS, Saadeh PB, Flores RL. *Plast Reconstr Surg*. 2020 Jan;145(1):184e-192e.
4. Simulation-Based Comprehensive Cleft Care Workshops: A Reproducible Model for Sustainable Education. **Kantar RS**, Breugem CC, Keith K, et al. *Cleft Palate Craniofac J*. 2020 Oct;57(10):1238-1246.
5. The First Hybrid International Educational Comprehensive Cleft Care Workshop. **Kantar RS**, Esenlik E, Al Abyad OS, et al. *Cleft Palate Craniofac J*. 2022 May 9:10556656221097820.
6. Perceived Barriers to Comprehensive Cleft Care Delivery Results from a Capacity-Building Educational Initiative and Implications. **Kantar RS**, Breugem CC, Alfonso AR, Keith K, Kassam S, Annan B, Chahine EM, Wasicek PJ, Patel KG, Flores RL, Hamdan US. *Ann Plast Surg*. 2021 Aug:87(2):194-198.
7. Comprehensive Cleft Care Delivery in Developing Countries: Impact of Geographic and Demographic Factors. **Kantar RS**, Al Abyad O, Melhem A, Chahine EM, Kassam SN, Annan B, Nader MK, Keith K, Breugem CC, Hamdan US. *J Craniofac Surg*. 2021 Sep:32(6):2041-2044.

Other

1. Chaya BF, Rodriguez Colon R, Boczar D, Daar D, Brydges H, Thys E, **Kantar R**, Saadeh PB. Perioperative Medication Management in Elective Plastic Surgery Procedures. J Craniofac Surg. 2023.
2. Azevedo R, Diaz-Siso R, Alfonso AR, Ramly EP, **Kantar RS**, Berman ZP, Diep GK, Rifkin WJ, Rodriguez ED, Tsakiris M. Re-cognizing the new self: the neurocognitive plasticity of self-processing following facial transplantation. PNAS. 2023.
3. Global Burden of Disease 2021 Health Financing Collaborator Network. Global investments in pandemic preparedness and COVID-19: development assistance and domestic spending on health between 1990 and 2026. Lancet Glob Health. 2023.
4. Azevedo R, Diaz-Siso R, Alfonso AR, Ramly EP, **Kantar RS**, Berman ZP, Diep GK, Rifkin WJ, Rodriguez ED, Tsakiris M. Re-cognizing the new self: the neurocognitive plasticity of self-processing following facial transplantation. PNAS. 2023.
5. GBD 2019 Healthcare Access and Quality Collaborators. Assessing performance of the Healthcare Access and Quality Index, overall and by select age groups, for 204 countries and territories, 1990-2019: a systematic analysis from the Global Burden of Disease Study 2019. Lancet Glob Health. 2022

6. Hamdan US, Melhem AM, Haddad M, Younan RA, Padwa B, **Kantar RS**. Premaxillary Setback with Posterior Vomerine Ostectomy and Complete Bilateral Cleft Lip Repair: Report of a Case with Challenging Anatomy. Cleft Palate Craniofac J. 2022.
7. **GBD 2019 Adolescent Transport and Unintentional Injuries Collaborators.** Adolescent transport and unintentional injuries: a systemic analysis using the Global Burden of Disease Study 2019. Lancet Public Health. 2022.
8. **GBD 2019 Hepatitis B Collaborators**. Global, regional, and national burden of hepatitis B, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet Gastroenterol Hepatol. 2022.
9. **Kantar RS**, Esenlik E, Al Abyad OS, Melhem A, Younan RA, Haddad M, Keith K, Serena Kassam S, Annan B, Vijayakumar C, Picard A, Padwa BL, Sommerlad B, Raposo-Amaral CE, Forrest CR, Gillett DA, Steinbacher DM, Runyan CM, MD, Tanikawa DYS, Chong DK, Fisher DM, Mark H, Canter HI, Losee JE, Patel KG, Hartzell LD, Johnson AB, Collares MVM, Alonso N, MD, Chen PK, Tse R, Mann RJ, Prada-Madrid JR, Kobayashi S, Hussain SA, Kummer A, Sell DA, Pereira VJ, Mabry K, Gonsoulin CK, Persson M, Davies G, Sethna NF, Munoz-Pareja JC, Kuijpers-Jagtman AM, Grayson BH, Grollemund B, Garib DG, DDS, Meazzini MC, Kharbanda OP, Santiago PE, Nalabothu P, Batra P, Stieber E, Prasad D, Brewster H, Ayala R, Erbay E, OkanAkcam MO, Don Griot JPW, Vyas RM, Flores RL, Breugem CC, Hamdan US. The First Hybrid International Educational Comprehensive Cleft Care Workshop. Cleft Palate Craniofac J. 2022.
10. **Kantar RS**, Habib JR, Nassereldine H, Hoballah JJ, Mokdad AH. Surgical Care in Lebanon: Shedding Light on a Grim Situation and Urgent Plea. Lancet. 2022.
11. Phillips BT, Barreras-Espinoza JA, Bergmeister KD, Brown S, Bustos SS, Facio JA, Gallo L, **Kantar RS**, Klifto KM, Luan A, Onyejekwe GO, Gosain AK. Spotlight in Plastic Surgery: April 2022. Plast Reconstr Surg. 2022.
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Acknowledgements

Thank you for molding my mind and soul into what they are today

Our patients with cleft lip and/or palate and their families, for your humbling resilience. You are the inspiration behind this thesis.

Jenny and Salah, for your never-ending love and turning me into the man I am today.

Karim, my role model.

Maria, my rock and source of virtue.

Rima and Aida, for your affection and unparalleled generosity.

Dr. Breugem and Dr. Don Griot, for your unconditional support.

Dr. Rodriguez, for your mentorship and the opportunity of a lifetime.

Dr. Hamdan, for showing me that the joy is in the journey.

Dr. Flores, for your inspiring academic rigor.

Drs. Ceradini, Saadeh, Levine, and Staffenberg for your genuine support.

Drs. Kavic, Hanna, Diaz, Fitzpatrick, Betzold, Lumpkins, Slezak, Hoballah, Abi Saad, and Safadi for the privilege of becoming a surgeon.

Dr. Fuleihan, Dr. Habib, and SHARP faculty for teaching me the value of research.

Dr. Boustany and Dr. Tannous, for giving me a chance when I needed it the most.

Elsa, Will, Rodrigo, Allyson, Serena, Beyhan, Adam, and Kristen for helping me turn this work into a reality.

Bernard, Rayan, Maroun, Anthony, Carine, Raya, Mo, Wael, Rawad, Sima, and Marc for eternal friendships.

Ali, Phil, Dmo, Bryan, Greg, Chris, Marco, Nicole, Christina, and Sarah for that much-needed dose of wellness in residency.

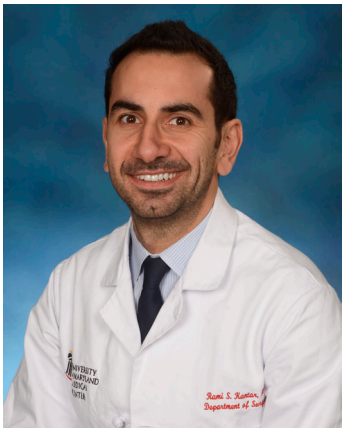
Global Smile Foundation and The Comprehensive Cleft Care Workshop Team for the support and opportunity to conduct the work described in this thesis.

Smile Train and Simulare Medical for the digital and haptic cleft surgery simulators used in our research studies described in this thesis.

Smile Train, Operation Smile, The American Cleft Palate-Craniofacial Association (ACPA), and so many other sister organizations for endorsing our educational initiatives.

Elsa M. Ronde and Jess J. Peters, for your support in pushing this thesis through the finish line.

About the Author



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