

The State of Pediatric Research in Hawai'i: A Comparative Bibliometric Analysis

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Abstract

The current state of pediatric research in Hawai'i was analyzed using bibliometric methods. The Web of Science bibliometric database was used to retrieve 989 Hawai'i records, which were compared with 264 064 records from the United States (US). Hawai'i was compared to the country as a whole in terms of total output of research, article types, top journals, co-authorship, and subject areas. The research was also analyzed in 2 time periods, 1980–1999 and 2000–2019. It was found that the total Hawai'i pediatric research output has not kept pace with the US output. However, it was found that Hawai'i had a greater share of Asia-Pacific co-authorship. Subspecialty areas of study also differed between Hawai'i and the US, and have changed over time from a predominance of infectious diseases and immunology research to a focus on emergency medicine and orthopedics. Neonatology research has increased locally as it has nationally. Hawai'i authors tend to publish a greater percentage of full-length original research articles in the top pediatric journals compared to US authors as a whole. The set of institutions publishing pediatric research in Hawai'i has diversified over time. This analysis of the pediatric research in Hawai'i can be used by researchers, funders, and policy makers to direct future research efforts to improve the health of children in Hawai'i.

Keywords

Bibliometrics, Hawai'i, pediatrics

Introduction

In the last 40 years, there have been many groundbreaking advances in child health including immunizations that prevent meningitis, neonatal care that saves premature babies, and life-saving advances in oncology treatments. None of this would be possible without pediatric research and the funding that drives it. Consequently, understanding pediatric research itself, the corpus of knowledge produced by researchers and physicians, is also an important undertaking. It can provide stakeholders with information that can further advance pediatric research and child health.

Understanding research at a state level is also critical especially if the children in that state may not be well represented by research produced on a national or global scale, or if different diseases may be more common in one state compared to another, as seen with some infectious diseases. Arguably, both of these statements are true in the state of Hawai'i where the demographics and some of the tropical diseases which occur are different than the continental US. Understanding pediatric research in Hawai'i is, therefore, not only an interesting endeavor, but one that can further advance the health of children in Hawai'i. This study takes a bibliometric approach and describes

the current state of published pediatric literature produced by Hawai'i authors, compared both to earlier time periods and to the US more broadly.

Bibliometrics is the application of mathematical and statistical methods to books and other communications, including journal articles.¹ It has been used across science and medicine, including the field of pediatrics. Recently, Quinn, et al, published in *Pediatrics* a bibliometric analysis of the top 100 cited articles in pediatrics since 1945 and also explored trends in the pediatric literature.² A similar effort was published by Chhapola, et al, looking at journals, authors, and disciplines among the top 100 cited articles in pediatrics.³ These previous works looked at citation classics across the field, but did not provide a detailed view of the pediatric literature in particular regions. This study aims to fill that gap with a focus on Hawai'i's pediatric literature with the aim of providing insights into the strengths and challenges of Hawai'i's pediatric research community.

Instead of focusing on a randomly chosen number of “top-cited articles” the focus of this study was on trends over time to answer the question of what the current state of Hawai'i literature is compared to the recent past. It was hypothesized that Hawai'i's research in pediatrics would generally mirror the US output in terms of the trends over time as well as in the types of articles that were being published. However, it was also hypothesized that Hawai'i would have a larger share of Asia-Pacific pediatric research, compared to the US in general, given our geography in the Pacific Ocean. And finally, it was hypothesized that due to the unique population of Hawai'i's children compared to the US census as well as the role Hawai'i plays in global tourism, there would be differences in the subspecialty areas of research study as compared to the US as a whole.

This study may prove to be of importance to local research funding organizations and policy makers who wish to rectify gaps in the local research coverage, identify means of supporting additional scholarship, or explore avenues of future research for which there may be an unexplored niche.

Methods

Hawai'i Pediatric Research Dataset

Records were retrieved from Clarivate Analytics Web of Science bibliographic database published between 1980 and 2019. All records with an author affiliation with the state “HI”, and in a

journal with a Web of Science Subject Category of “pediatrics”, were retrieved. A total of 989 records were analyzed. This dataset was split into 2 time periods, 1980–1999 and 2000–2019, with 407 records and 582 records in each group, respectively.

US Pediatric Research Dataset

Records were retrieved from Clarivate Analytics Web of Science bibliographic database published between 1980 and 2019. All records with author affiliation with the country “USA” and in a journal with a Web of Science Subject Category of “pediatrics” were retrieved. A total of 264 064 records were analyzed. This dataset was split into 2 time periods, 1980–1999 and 2000–2019, with 98 577 and 165 487 records in each group respectively.

Data Analysis

For all datasets and time periods, the data fields for subject category, journal, document type, and author country affiliation were analyzed. Subject category labels were taken from the Web of Science Subject Categories assigned to journals in Clarivate’s Web of Science database. Top journals were based on the total number of records in each journal name. Document type was drawn from Web of Science’s type field, with the article type defined as “Reports of research on original works.” For comparisons across multiple categories, the top 5 highest categories in each region and time period were used, and the binary log ratios of the proportions were calculated as US proportion compared to Hawai‘i proportion, such that a value of “1” indicates that the US proportion is twice that of Hawai‘i, and “-1” indicates that the Hawai‘i value is twice that of the US. Journal names were checked for name changes in Web of Science and where applicable, the documents for such journals were combined. For author country analysis, all countries other than the US were defined as international, and all countries with names categorized in the United Nations geographic regions of East Asia, Southeast Asia, and Oceania were categorized as Asia-Pacific.⁴

Institutions were drawn from the Web of Science author organization field and Hawai‘i-based institutions were manually identified and name variations were combined. Institutions with low counts were combined into private, non-profit, and community health center categories based on comparison with publicly available information.

Results

Growth of Hawai‘i Pediatric Research Over Time

The number of pediatric documents in Web of Science published each year between 1980 and 2019 with either Hawai‘i or US authors is shown in Figure 1. There is a general trend of increasing publications over time in both groups, with adjustments on shorter timescales seen in years such as 2001 and 2004. Hawai‘i

pediatric publications tracks the US pattern closely until around 2010, when the US pediatric research output continues to increase while Hawai‘i pediatric publications remain relatively steady. The same general trend, but with a smaller degree of difference, is seen when examining only the full-length research articles in each region. Examining the change in the average number of items by decade, the US increases by 60% and 51% of total records and articles respectively from 2000–2009 to 2010–2019, while Hawai‘i increases by 4% and 36% in the same categories and time periods.

Publication Types of Hawai‘i Pediatric Research

The document types of Hawai‘i and US pediatric research are compared in Figure 2. Documents in Web of Science are classified as number of types, but this study examined those classified as full-length research articles, the other types being documents such as news, letters, editorials, or reviews. As shown in Figure 2, both Hawai‘i and US pediatric research was comprised of about 50% articles in the 1980–1999 period. This increased in both regions in the 2000–2019 period, but the proportion of Hawai‘i pediatric research articles increased to a greater extent, to 68.7% compared to 58% in the US.

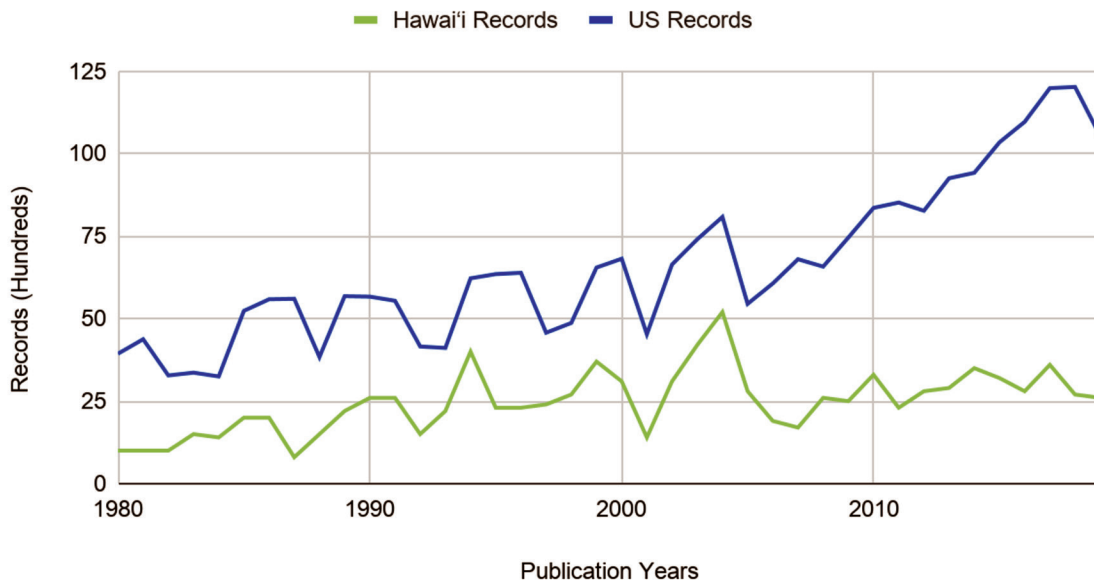
Journals by Publication Count in Hawai‘i Pediatric Research

The 5 journals with the highest proportion and counts of documents in each region and time period are shown in Table 1. Since the same journal could appear in more than one period, this table includes 10 journals in total. The combined proportion of the 5 journals with the highest record counts in each region and time period is shown in Figure 3. There is a clear trend in both regions towards increased diversity of publications outside of a few journals over time, with Hawai‘i showing more diversity than the US in the 2000–2019 time period. It is important to note that these are the highest journals by publication count, and that this study did not look at citation counts or journal impact factors, which is another method of ranking top journals, but was not used here.

Subject Categories of Hawai‘i Pediatric Research

The subject categories that most commonly appear with pediatric research was next analyzed. The proportions and counts of each of the top 5 subject categories (a total of 11 unique subjects) from the 4 different groups are shown in Table 2. The log ratio comparisons of the early (top) and late (bottom) periods are shown in Figure 4. There is a clear change in research subjects in Hawai‘i between the early and late periods from a focus on immunology and infectious diseases in the 1980-1999 period to a focus on orthopedics and emergency medicine in the 2000–2019 period. There are other trends in the US subjects, such as increasing research in oncology and obstetrics and gynecology that are also reflected in the Hawai‘i research.

(a) Hawai'i Records and US Records



(b) Hawai'i Articles and US Articles

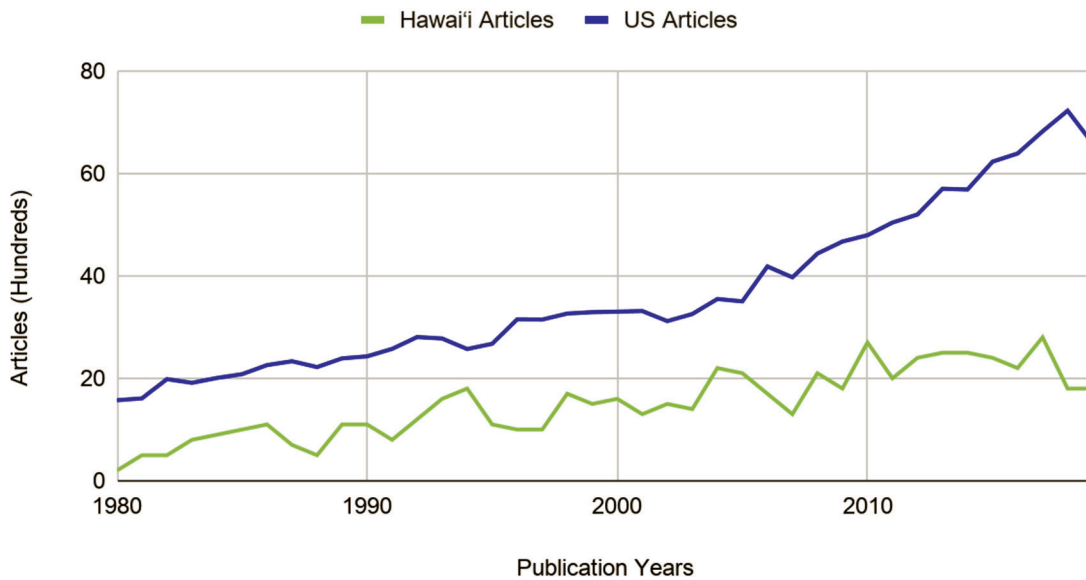


Figure 1. Number of Pediatric Journal Records and Full-Length Articles Published in the Web of Science –Hawai'i and the US, 1980–2019
The figure shows the number of pediatric journal records (a) and full-length articles (b) published in Web of Science over time, comparing those with Hawai'i authors to those with US authors.

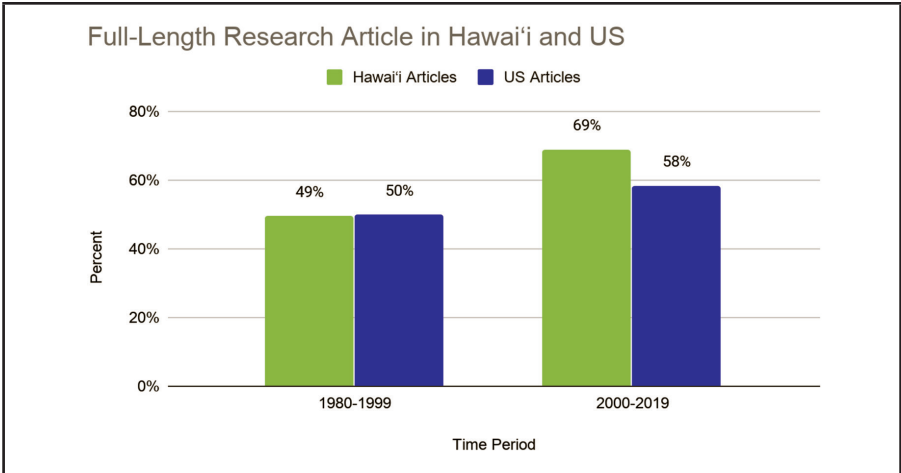


Figure 2. Full-Length Research Articles in the Web of Science – Hawai'i and the US, 1980–2019
 The figure shows a comparison of the number of records in Web of Science with the article document type, which denotes a full-length research article as opposed to review or editorial material. The percentage of total records is shown in the vertical axis, and 2 time periods are compared, 1980–1999 and 2000–2019 for both Hawai'i and US authorships.

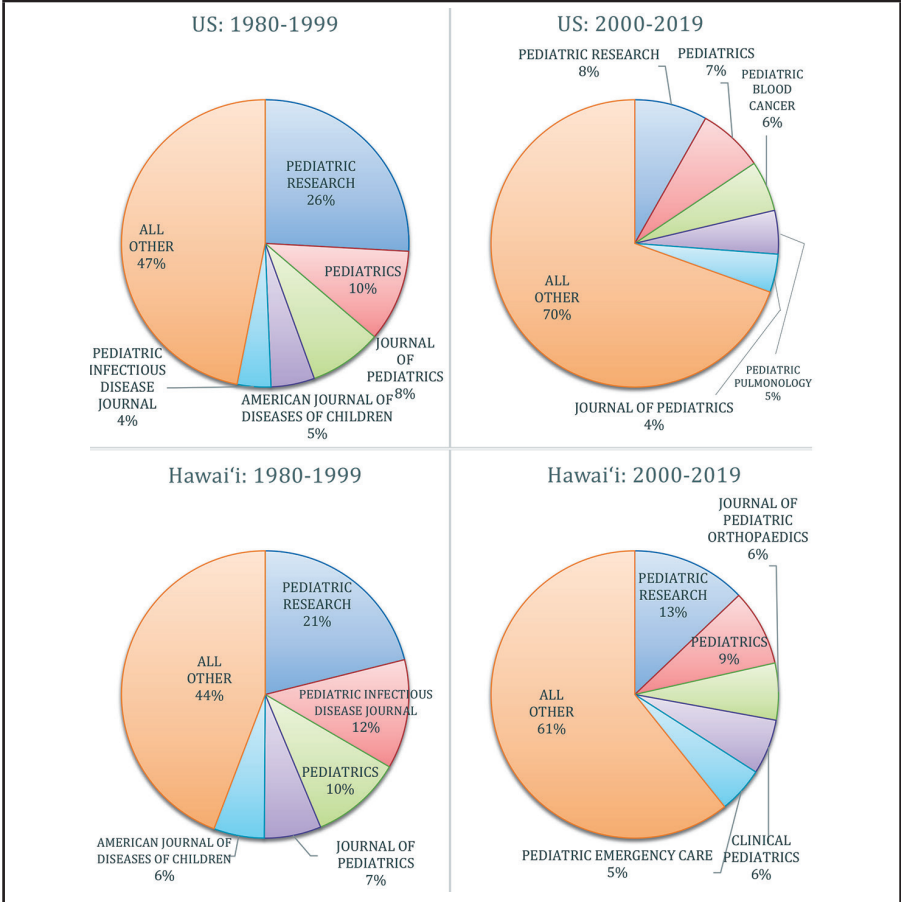


Figure 3. Five Most Published Journals in Each Time Period and Region – Hawai'i and the US, 1980–1999 and 2000–2019
 This figure shows the distribution of the 5 journals with the highest number of published records from each time period in the US and Hawai'i.

| Journal ^b | Hawai'i 1980–1999 % (Records) | Hawai'i 2000–2019 % (Records) | US 1980–1999 % (Records) | US 2000–2019 % (Records) |
|--|----------------------------------|----------------------------------|-----------------------------|-----------------------------|
| Pediatric Research | 21.1 (86) | 12.9 (75) | 25.9 (25502) | 8.2 (13515) |
| Pediatrics | 10.3 (42) | 8.6 (50) | 10.4 (10206) | 7.4 (12176) |
| Journal of Pediatrics | 6.4 (26) | 4.8 (28) | 8.2 (8109) | 4.3 (7162) |
| American Journal Of Diseases Of Children (JAMA Pediatrics) | 5.7 (23) | 2.9 (17) | 4.9 (4788) | 1.5 (2487) |
| Pediatric Infectious Disease Journal | 12.3 (50) | 3.1 (18) | 3.8 (3715) | 2.1 (3466) |
| Pediatric Blood Cancer (Medical And Pediatric Oncology) | 2.2 (9) | 3.3 (19) | 1.5 (1450) | 5.7 (9468) |
| Pediatric Pulmonology | 2.5 (9) | 1.0 (6) | 1.0 (962) | 4.9 (8190) |
| Journal of Pediatric Orthopaedics | 3.4 (14) | 6.4 (37) | 1.6 (1557) | 1.5 (2555) |
| Clinical Pediatrics | 4.2 (17) | 6.2 (36) | 2.5 (2434) | 1.9 (3183) |
| Pediatric Emergency Care | 1.2 (5) | 5.2 (30) | 0.8 (774) | 1.8 (3051) |
| All Other Journals | 30.7 (126) | 45.7 (266) | 39.6 (39080) | 60.6 (100234) |

^a US Numbers indicate the percentage (%) of the total number of records in that time period for that group.

^b The journals listed in this table were chosen for being in the top 5 journals by proportion for each of the 4 groups. Journals with name changes over time were identified manually and their values combined.

| Subject Category ^b | Hawai'i 1980–1999 % (Records) | Hawai'i 2000–2019 % (Records) | US 1980–1999 % (Records) | US 2000–2019 % (Records) |
|-------------------------------|----------------------------------|----------------------------------|-----------------------------|-----------------------------|
| Psychology developmental | 9.3 (38) | 7.0 (41) | 8.6 (8517) | 8.1 (13429) |
| Surgery | 2.5 (10) | 5.2 (30) | 4.6 (4500) | 5.6 (9246) |
| Obstetrics gynecology | 3.2 (13) | 7.6 (44) | 4.4 (4323) | 6.9 (11431) |
| Psychiatry | 6.1 (25) | 4.1 (24) | 4.4 (4310) | 4.1 (6723) |
| Clinical neurology | 1.2 (5) | 1.7 (10) | 4.1 (4053) | 6.1 (10012) |
| Oncology | 2.9 (12) | 5.0 (29) | 2.9 (2836) | 7.2 (11862) |
| Hematology | 0.7 (3) | 4.6 (27) | 1.4 (1386) | 7.0 (11590) |
| Immunology | 12.3 (50) | 3.1 (18) | 4.0 (3948) | 2.4 (4020) |
| Infectious diseases | 12.3 (50) | 3.3 (19) | 3.9 (3877) | 2.4 (4024) |
| Orthopedics | 3.4 (14) | 7.4 (43) | 1.6 (1605) | 1.9 (3083) |
| Emergency medicine | 1.2 (5) | 5.2 (30) | 0.8 (774) | 1.8 (3051) |

^a Values represent the percentage (%) of records in that group that are labeled with the specific subject category.

^b The 11 subject categories are included based on being in the top 5 categories of the groups.

Subject Ratios: US/Hawai'i

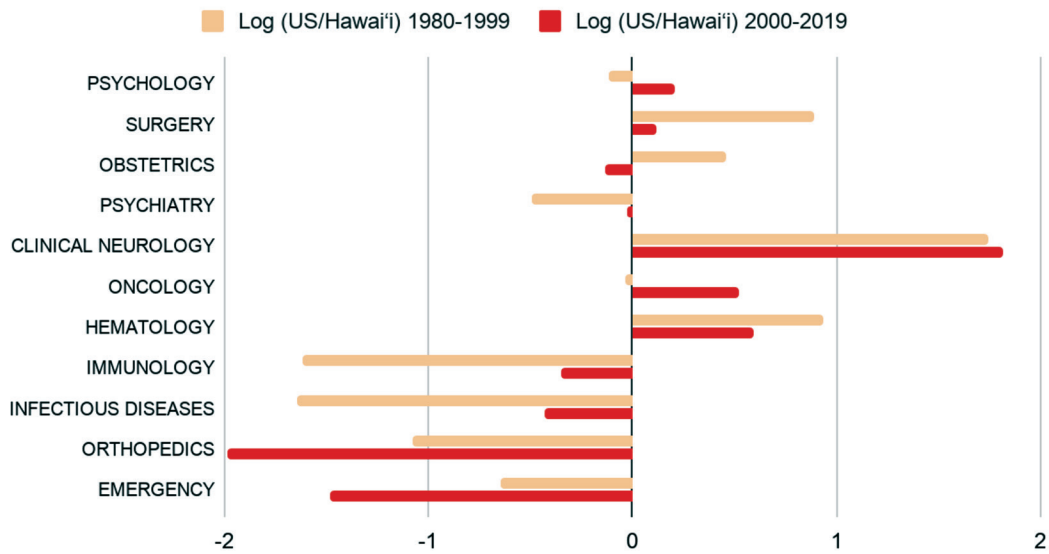


Figure 4. Relative Ratio of Web of Science Subject Categories Published by Authors in Hawai'i and the US, 1980–1999 and 2000–2019
 The figure shows the relative ratio of Web of Science Subject Categories comparing records published by US versus Hawai'i authors in 1980–1999 and 2000–2019. The binary log ratio is shown between the percentage of each subject area, where “1” indicates that the US percentage is twice the Hawai'i percentage and “-1” indicates the opposite.

Country Co-authorship Ratios: US/Hawai'i

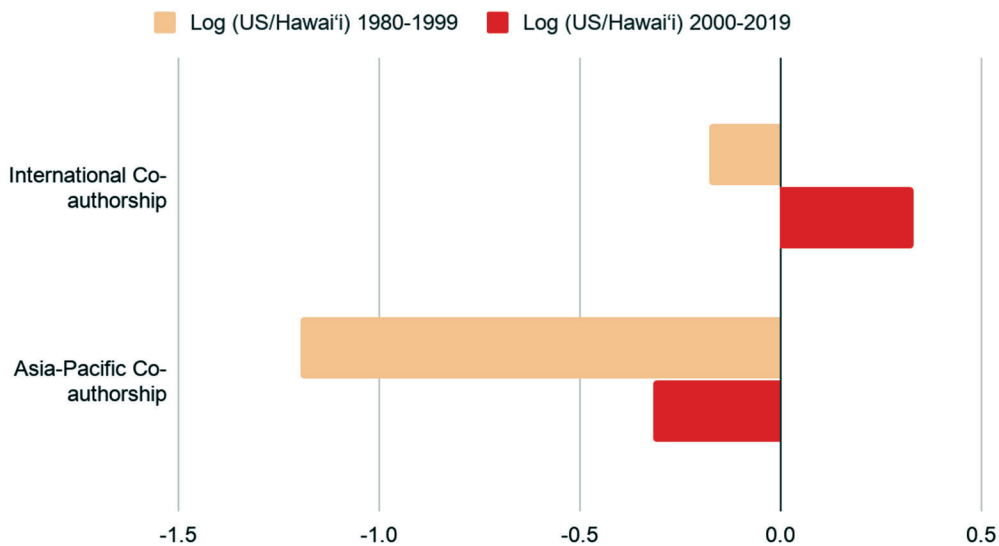


Figure 5. Relative Ratio of International and Asia-Pacific Co-authorship in Pediatric Journal Records – Hawai'i and the US, 1980–1999 and 2000–2019
 The figure shows the relative ratio of international and Asia-Pacific co-authorship in pediatric records from Hawai'i and the US in 1980-1999 and 2000-2019. The binary log ratio is plotted, where a value of “1” indicates twice the percentage of US records in that time period, and a value of “-1” indicates twice the percentage of Hawai'i records compared to US.

| Type of co-authorship | Hawai'i 1980–1999 % (Records) | Hawai'i 2000–2019 % (Records) | US 1980–1999 % (Records) | US 2000–2019 % (Records) |
|----------------------------|----------------------------------|----------------------------------|-----------------------------|-----------------------------|
| International ^a | 6.9 (28) | 18.4 (107) | 6.1 (6013) | 23.2 (38393) |
| Asia-Pacific ^b | 1.7 (7) | 5.0 (26) | 0.8 (788) | 4.0 (6619) |

^a International records contained at least 1 co-author from a country other than the US.

^b Asia-Pacific records contained at least 1 co-author from a country listed in the United Nations subregions of East Asia, Southeast Asia, or Oceania.

| Hawai'i organization | 1980-1999 Records | | 2000-2019 Records | |
|---|-------------------|----------------|-------------------|----------------|
| | n | % ^a | n | % ^a |
| University of Hawai'i | 217 | 53.3 | 365 | 62.5 |
| Tripler Army Medical Center | 179 | 44.0 | 122 | 20.9 |
| Kapi'olani Medical Center for Women and Children ^b | 57 | 14.0 | 102 | 17.5 |
| Shriners Hospital for Children-Honolulu | 11 | 2.7 | 23 | 3.9 |
| Kaiser Permanente Hawai'i | 11 | 2.7 | 21 | 3.6 |
| The Queen's Medical Center | 5 | 1.2 | 5 | 0.9 |
| Hawai'i State Department of Health | 4 | 1.0 | 37 | 6.3 |
| Straub Medical Center* | 2 | 0.5 | 0 | 0.0 |
| Kuakini Medical Center | 0 | 0.0 | 3 | 0.5 |
| Hawai'i Department of Education | 0 | 0.0 | 4 | 0.7 |
| Hawai'i Medical Service Association | 0 | 0.0 | 1 | 0.2 |
| Hawai'i Pacific University | 0 | 0.0 | 1 | 0.2 |
| Hawai'i Residency Program | 0 | 0.0 | 2 | 0.3 |
| Small Non-Profit | 0 | 0.0 | 21 | 3.6 |
| Private Organizations | 0 | 0.0 | 11 | 1.9 |
| Community Health Centers | 2 | 0.5 | 7 | 1.2 |

^a The columns with the percentages (%) of records do not add to 100% as records can occur in more than 1 category due to co-authorship.

^b Kapi'olani Medical Center for Women and Children and Straub Medical Center are noted as being part of the Hawai'i Pacific Health organization starting in 2001, and all records from those institutions are grouped with Kapi'olani Medical Center for Women and Children in the 2000–2019 dataset.

International Authorship of Hawai'i Pediatric Research

To test the hypothesis that Hawai'i, due to its unique geographical and cultural position in the center of the Pacific, would exhibit increased international and Asia-Pacific collaboration in pediatric research, the co-author affiliations were analyzed. The proportion and counts of documents that have either international or Asia-Pacific co-authors are shown in Table 3. There is a trend towards increasing international authorship from 1980–1999 to 2000–2019 that is seen in both Hawai'i and the US. In both periods, Hawai'i pediatrics research has a higher level of Asia-Pacific co-authorship. Figure 5 shows the log ratio comparison, showing that while the levels of international co-authorship are relatively similar for the US and Hawai'i, Asia-Pacific co-authorship is greater in Hawai'i pediatric research, though it is decreasing over time.

Institutional Affiliations of Hawai'i Pediatric Research

The organizations identified with Hawai'i pediatric records in each time period are shown in Table 4. There is an increase in the number of institutions found publishing in the later time period. Small private and non-profit institutions that were not seen in the 1980–1999 dataset make up a larger proportion of the 2000–2019 dataset. The proportion of records from the University of Hawai'i, which includes the John A. Burns School of Medicine, is also increasing. The Web of Science data does not distinguish reliably between departments within a single university, so the data looking for trends within the University of Hawai'i was not available.

Discussion

This study set out to map the state of pediatric research in Hawai‘i, both currently and in the past and, in comparison, to the rest of the US. This was accomplished by analyzing trends in publication counts, journals, disciplinary subjects, document types, and author affiliation countries. Overall, this descriptive contribution should be useful to researchers and policymakers in Hawai‘i and elsewhere to better guide research efforts. Some specific findings are highlighted below.

One finding of this study was the observation that Hawai‘i research mirrored the growth of pediatric research in the US remarkably closely until 2010 when the US publications increased more dramatically and Hawai‘i’s output leveled off. This could reflect the well-known and grave problem in Hawai‘i of a growing physician shortage.⁵ Physicians who conduct research are often practicing physicians and with this physician shortage in Hawai‘i, there may be less time dedicated for research than the greater US.

Trends in research may also be attributed to differences in funding, although a comparison of funding between the US and Hawai‘i was beyond the scope of this bibliometric analysis. However, a recent publication in *JAMA Open Network* analyzed research on Asian American, Native Hawaiian, and Pacific Islander (AA/NHPI) populations and found that “proportional increases in research dollars for AA/NHPI clinical research were not consistent with increases in the overall NIH [National Institute of Health] research budget, suggesting that underrepresentation of AA/NHPI research subgroups may be partially responsible.”⁶ Given that Hawai‘i’s population is 57.2% Asian and 26.9% Native Hawaiian and Pacific Islander, this finding could significantly impact the research output in Hawai‘i as compared to the US.⁷

Another difference between Hawai‘i and the US is in publication type. Hawai‘i authors are focused on publishing research articles rather than news, letters, editorials, or reviews as compared to the US. There has been a proliferation of new journals in recent years, and Hawai‘i publications make use of this diversity. This may also result in less research output, if Hawai‘i researchers are focused on full-length original research manuscripts in top journals.

Another finding of further interest is the focus of research in Hawai‘i, different than the US, and has changed over time. The predominance of infectious diseases and immunology articles in the 1980s to 2000 is thought provoking. This focus may reflect a combination of various factors, including the availability of productive and prolific researchers, epidemiological disease trends of local infectious diseases, and/or the effect of a local niche of studying diseases that affect AA/NHPI populations such as Kawasaki disease or rheumatic fever.^{8,9}

The more recent local focus on orthopedics and emergency medicine research is also of interest. Again, the presence of prolific researchers may in part be responsible. This shift may also represent the unique geography of Hawai‘i as an island state, with interest in emergency topics such as drownings or other marine-related injuries.¹⁰

In Web of Science, the pediatric subspecialty of neonatology falls under the “obstetrics and gynecology” subheadings due to publications in perinatal journals. In Hawai‘i and in the US, neonatology research has increased. The paper by Quinn, et al, on the top 100 cited articles in pediatrics identified neonatology as the second most cited subspecialty. This likely reflects this field’s recent development, proliferation, and technological advances, with modern neonatology evolving rapidly from the 1960s, as compared to the historical development of other pediatric subspecialties.¹¹

International co-authorship was used as an indicator of global research impact in this study. It was found that collaborations with global partners between US and Hawai‘i authors has increased over time. Indeed, the hypothesis that Hawai‘i has a unique connection to the Asia-Pacific region was confirmed. This is a notable finding given the state university’s stated mission “with its unique geographic location bridging East and West, Mānoa serves as a portal to an exceptional educational experience while striving to improve quality of life in the region through collaborative partnerships that support innovations in education, health care, social development, culture and arts, earth, space, and ocean sciences, sustainable land management, and technological advancement.”¹² Additionally, the state medical school’s mission “to teach and train high-quality physicians, biomedical scientists, and allied health workers for Hawai‘i and the Pacific.”¹³ Arguably, these missions are being met.^{12,13}

Hawai‘i authors institutional affiliations were analyzed to determine the origins of Hawai‘i research papers. The majority of authors listed their affiliation with the University of Hawai‘i. Limitations of Web of Science data prevent further breakdown of author affiliations into departments, schools, or centers of origin. Author affiliation with Tripler Army Medical Center was the next highest institution, though this has decreased from the pre-2000 era. Over the years of the study, institutions also changed. Thus, in the later dataset, Hawai‘i Pacific Health is listed by some authors while other authors chose to cite its affiliated medical centers, such as Kapi‘olani Medical Center for Women and Children or Straub Medical Center. To be sure, Hawai‘i Pacific Health is the parent entity for both Kapi‘olani and Straub. Further, it is interesting to note that 86% of all Hawai‘i Pacific Health records were affiliated with Kapi‘olani. Non-profit research entities have emerged in the dataset after 2000, but overall comprise a small proportion of author affiliations. This is also true of several for-profit entities, such as private subspecialty offices. The state’s health department has

also become a common author affiliation designation in the later dataset. Finally, there was only 1 record of author affiliation with a university other than the University of Hawai‘i (ie, Hawai‘i Pacific University).

While this study’s methodology would be inappropriate for evaluative purposes, the data may be of value to policy makers and research funding institutions to better understand the origins, trends, affiliations, and focus of research activities in Hawai‘i. It may also serve to invigorate research collaborations and partnerships, as researchers recognize the broader landscape of pediatric research in Hawai‘i as well as the identify of potential collaborators.

The limitations of this study include the analysis of international impact, which was based entirely on the identification of co-authorship. A citation analysis was not performed. This could be the focus of a later study, involving a random sample of the 264 064 US pediatric articles and comparing them to Hawai‘i data. Additionally, subject categories in the Web of Science do not allow for further delineation of research areas that may be critical to fully understanding local research. For instance, to better understand trends in infectious diseases research, it would be important to identify which conditions, such as angiostrongyliasis, leptospirosis, or Kawasaki disease are being studied. As such, a future study could be performed utilizing corpus analysis to compare the frequency of terms used in one body of research with another. Another limitation of bibliometrics research is that it looks only at published literature. A deeper understanding of pediatric research in Hawai‘i may result from interviews and surveys of the physician scientists. This could be an avenue of future research. The bibliometric methods of the study could also be expanded, for example, by considering citations in the analysis of top journals and articles. Finally, the author affiliation analysis could be more robust if each individual paper were obtained and a more granular author affiliation was identified (eg, by department within John A. Burns School of Medicine).

Finally, a recommendation from this study is to support the exploration and expansion of future funding for pediatric research in Hawai‘i, especially focused on the AA/NHPI population, appreciating the importance of addressing health disparities in these vulnerable populations. Other medical disciplines in Hawai‘i and other states in the US may benefit from similar analyses to broaden their understanding of the research landscape in their areas.

Conflict of Interest

None of the authors identify any conflict of interest.

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