Obesity Facts

Research Article

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Bibliometric and Correlation Analysis of Bariatric Surgery Researches in Asia-Pacific from 2000 to 2021

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Abstract
Introduction: Bariatric surgery has grown in popularity over the past two decades, especially in the Asia-Pacific. Correspondingly, researchers' interest in this field has also increased. This study aims to perform a bibliometric analysis of publications from Asia-Pacific represented by the International Federation for the Surgery of Obesity and Metabolic Disorders Asia-Pacific Chapter (IFSO-APC) and investigate the relevant factors that might affect the publications. ***Methods:*** The search terms for bariatric surgery were searched in Web of Science focusing on the period 2000–2021. Bibliometric analysis was performed after screening the search results. Univariate and multivariate regression analyses were performed on the number of publications and corresponding indicators obtained from official agencies. ***Results:*** A total of 9,547 publications in IFSO-APC were retrieved, of which China had the largest number with 2,782 publications. Authors and journals with major contributions were listed. The authors' or affiliations' cooperation networks mainly were limited to domestic. "Bariatric surgery" was the most frequent keyword with 2,063 times and also the largest cluster. "Morbid obesity" was the strongest citation bursts. Multivariate analysis found that the number of publications in each country/region was associated with body mass index ≥25 kg/m^2, gross domestic product, and total population. ***Conclusion:*** Generally, Asia-Pacific represented by IFSO-APC scientific publications on bariatric surgery has grown significantly in the last two decades, but cooperation between countries/regions should be strengthened. "Morbid obesity" is the focus and frontier of research in this field.

Introduction

Obesity has gained tremendous attention over the past two decades. According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health [1]. Describing to the global epidemic survey, in 2016, more than 1.9 billion adults over 18 were living with overweight, accounting for 39% of the worldwide population. More

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than 650 million were living with obesity, accounting for 13% of the global population [1]. The Asia-Pacific has nearly half of the world's population, and the incidence of obesity or obesity-related diseases in the region has increased rapidly [2]. Obesity has numerous adverse effects on health and may induce a series of metabolic syndromes such as cardiovascular disease, diabetes, dyslipidemia, endocrine system disorder, and fatty liver [3, 4].

Moreover, the economic burden of obesity is causing global concern [5, 6]. In the management of obesity or obesity-related comorbidities, bariatric surgery gains promising outcomes [7–9]. Over the past two decades, as the prevalence of people living with overweight and obesity has increased, more and more people have sought help with bariatric surgery, with bariatric surgery gaining immense growth in the Asia-Pacific region. Therefore, it is essential to analyze the publications related to bariatric surgery to study the research basis and research frontiers in the Asia-Pacific region.

As a tool to map and identify published records, bibliometric analysis has been widely considered an alternative way to evaluate the topics and keywords in library and information science [10]. Bibliometric methods can also assess the most relevant publications, authors, affiliations or countries/regions in a specific field. It also allows the description of scientific co-cited networks by analyzing the relationships between academic journal citations [11]. Bibliometric analysis can help us explore the research basis and research frontier in a specific field, which is conducive to quickly understanding the development of this field, and proposing future research directions.

Bariatric surgery is booming in the Asia-Pacific regions, and researchers' interest in the region is rapidly increasing. However, data on scientific productions and their evolution of bariatric surgery from this region are limited, and factors that may correlate with scientific productions are poorly understood. This study aims to report the scientific productions and time evolution of bariatric surgery in the Asia-Pacific region from 2000 to 2021, and also analyzed the relationship between indicators that may be related to scientific productions, such as the prevalence of people living with overweight and obesity, diet, physical activity, scientific research and education, economy and population.

Methods

Data Source

The scientific publications in this study were obtained from the Web of Science Core Collection database (WoS, Thomson Reuters, USA) and searched on February 9, 2022. The search terms "bariatric surgery," "weight loss surgery," "metabolic surgery," "obesity surgery," and "bariatric procedure" were combined with Boolean operator "OR". We further restricted publication years from 2000 to 2021, and restricted document types to "Articles" and "Review Articles," and no language restrictions. The International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) is a federation composed of national associations of bariatric surgeons and integrated health professionals, which contributes to patients suffering from obesity. In this study, we referred to IFSO Asia-Pacific Chapter (IFSO-APC) members [12] to represent the Asia-Pacific region, because bariatric surgery in the Asia-Pacific was almost carried out in IFSO-APC. Based on the above search strategy, the "AND" in the boolean operation was added to search for the scientific productions of IFSO-APC countries/regions, respectively. After deduplication of productions, we finally obtained a total of 9,547 articles.

In the linear regression analysis, the prevalence of people living with overweight or obesity among adults, diet plans or related policies, insufficient physical activity prevalence or related policies were searched from WHO [13] and the World Bank [14]. Data for medical doctors, health, education, research and development (R&D) was collected from WHO [13] and UNESCO Institute for Statistics [15]. Economic and demographic data came from the United Nations [16] and International Monetary Fund [17]. All indicators used the most recent data.

Two independent reviewers extracted all data. A third reviewer compared the two data, discussed the disagreement, and finally reached an agreement.

Bibliometric Methods

CiteSpace (version 5.8.R3) and Bibliometrix (version 3.1.4) were utilized for bibliometric visualization analysis. The publications' annual productions, research hotspots and frontiers analysis (keyword co-occurrence network, clusters, timeline view, and occurrences burst history) were conducted by CiteSpace. The publications' authors, journals sources, and co-occurrence analysis (authors, affiliations, countries/regions, and three-fields plot) were performed by Bibliometrix. Generally, the visualization networks apply the size of nodes and the thickness of links to indicate importance [18]. The larger the node size, the higher the number or frequency, and the change of the color of the nodes represents the scientific development or different clusters every year. Thicker links indicate higher partnerships, and the color of the links denotes the years of citation. Microsoft Excel 2016 was also used to classify the data.

Statistical Analysis

Statistical analysis was performed utilizing IBM SPSS Statistics (version 24). A linear univariate regression analysis was used to summarize the relationship between the total number of publications and other indicators in each country/region, such as people living with overweight or obesity prevalence, diet plans or related policies (existence of tax on sugar-sweetened beverages, existence of national policies on trans-fatty acid elimination, existence of national policies on saturated fatty acids), insufficient physical activity prevalence or related policies (implementation of physical activity public awareness program, existence of operational policy/strategy/action plan to reduce physical inactivity), medical care, education, R&D, economy and population. To improve the fit of the model, the variables with a p value of less than 0.1 in univariate regression analysis were screened for inclusion in multivariate regression analysis (backward selection method). p values less than 0.05 were considered statistically significant.

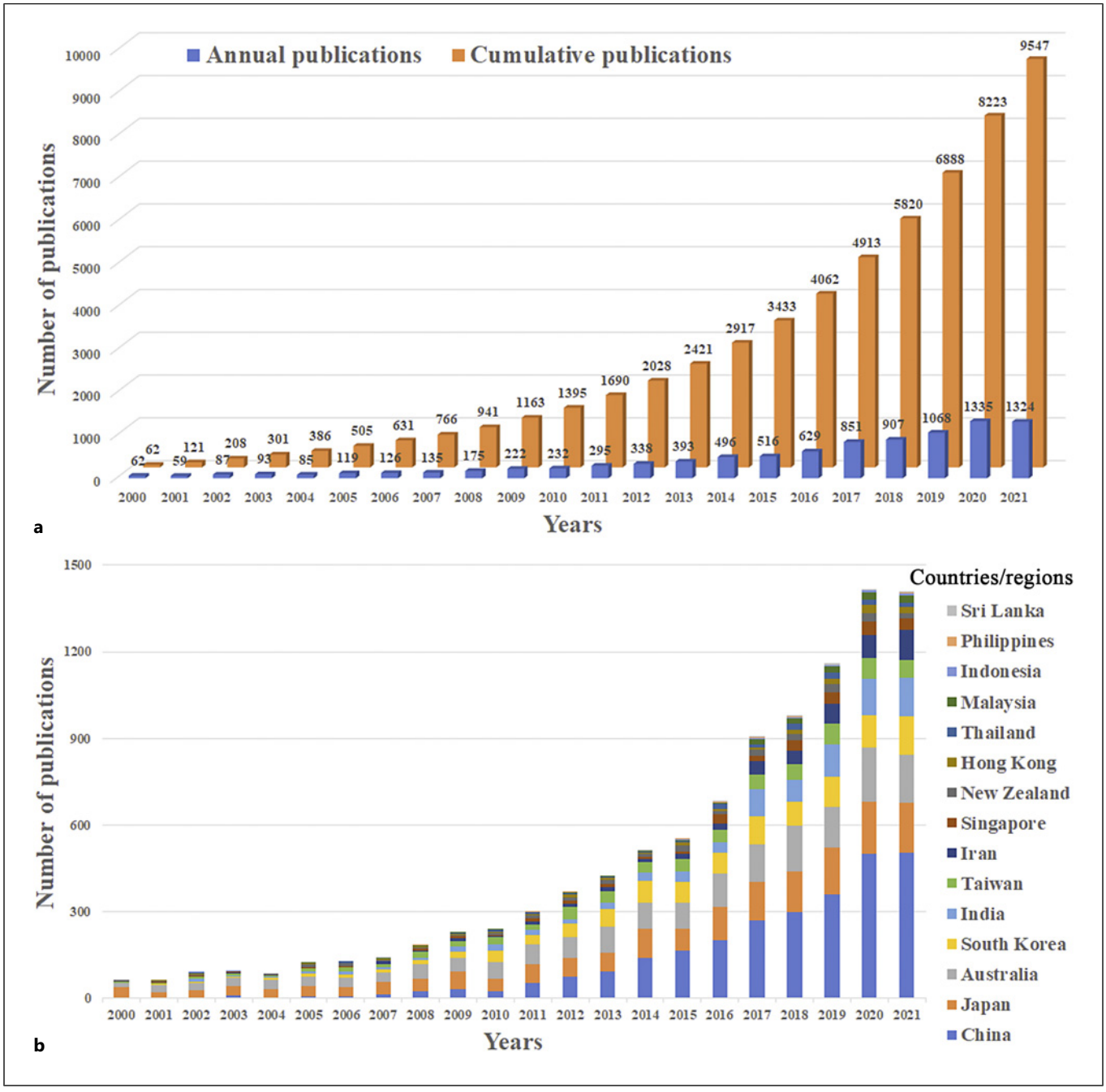

Fig. 1. Overview of IFSO-APC publications each year. **a** Annual publications and cumulative publications of IFSO-APC from 2000 to 2021. **b** Annual publications of IFSO-APC in different countries/regions.

Results

Overview of IFSO-APC Publications Each Year

Based on our literature search strategy, IFSO-APC identified 9,547 publications from 2000 to 2021, including 8,590 articles and 1,505 reviews. Figure 1a shows the development of IFSO-APC's annual publications and cumulative publications over the past two decades. The number of publications had increased 21-fold from 62 articles in 2000 to 1,324 articles in 2021. As shown in Figure 1b, in the IFSO-APC, between 2000 and 2010, Japan and Australia occupied the top two places in terms

Table 1. The top 10 most relevant authors and top 10 most local cited authors

Most relevant authors				Most local cited authors		
Rank	Authors	Publications	H index[a]	Rank	Authors	Local citations[b]
1	Lee WJ	155	42	1	Lee WJ	1,994
2	Dixon JB	131	56	2	Dixon JB	1,464
3	Wang Y	112	15	3	O'Brien PE	1,342
4	O'Brien PE	103	51	4	Lee YC	1,111
5	Lee YC	83	30	5	Chen SC	955
6	Lee JH	76	20	6	Ser KH	947
7	Huang CK	67	24	7	Chen JC	752
8	Li Y	67	13	8	Chong K	707
9	Kim JH	66	18	9	Kasama K	505
10	Liu Y	66	10	10	Wang W	492

H index[a]: Author local impact by H index, calculated from our collection of datasets. Local citations[b]: Data were obtained from reference lists.

of annual publications and total publications. After 2010, publications in China had developed rapidly, and publications occupied the first place every year. At present, the top three in the total number of publications were China (n = 2,782), Japan (n = 1,692) and Australia (n = 1,685). Specifically, for the last 3 years, 2019–2021, the annual publication volume is 359, 499 and 505 for China, 164, 183 and 171 for Japan, and 163, 209 and 183 for Australia, respectively.

Active Authors, Affiliations and Countries/Regions

Co-occurrence networks analysis reveals collaborative relationships between authors, affiliations, and countries/regions in publications. Table 1 shows the top 10 most relevant authors from our datasets and the top 10 most local cited authors from reference lists. Local cited references refers to all references in the literature dataset that we retrieved. The top five authors in the publications and reference lists were almost the same, indicating their contributions to the field. The number of publications and the H-index ranking of the authors were almost the same.

Figure 2 shows the visualization of the co-occurrence networks at three levels. Among the top 10 most relevant authors, Lee WJ, Lee YC and Huang CK cooperated closely, Dixon JB and O'brien PE cooperated closely, Wang Y, Li Y and Liu Y cooperated closely, Lee JH and Kim JH cooperated closely. In addition to this, there was an occasional collaboration between these authors, but with weak links (Fig. 2a). Similarly, Figure 2b shows the cooperation network of the top 10 most relevant affiliations, which exhibited group behavior and cooperated closely within the scope. Still, unfortunately, most of them were limited to domestic cooperation. The countries/regions collaboration map shows less cooperation inside IFSO-APC, but there was close cooperation between IFSO-APC and the United States or United Kingdom (Fig. 2c). Three-fields-plot visualizes relationships between authors, affiliations, and countries/regions (Fig. 2d). The top 10 most relevant authors were in the middle field, with affiliations and countries/regions on either side. Some authors were not limited to one affiliation, which was one of the foundations of a multi-affiliations network. Briefly, the plots visually illustrated the social cooperation structure of the publications and provided information on influential research affiliations, countries/regions and potential collaborators.

Publication Distribution of Journals and Local Cited Journals

Based on the number of journals sources from publications and local cited journals sources from reference lists, Table 2 presents the top 10 most relevant journals from datasets and the top 10 most local cited journals from reference lists. *OBESITY SURGERY* had the largest number of published papers, with a total of 907 publications, and was also cited the most in the reference lists, with 18,696 citations. *OBESITY SURGERY* was a journal in the Q2 partition of Journal Citation Reports (JCR) with an impact factor (IF) of 3.48. The second place from datasets was *SURGERY FOR OBESITY AND RELATED DISEASES*, with 252 publications. The IF was 3.71, ranking Q1 of the JCR partition, and it ranked third in the local cited sources, with a total number of 6,650 citations. Among the top 10 most local cited journals from reference lists, almost all of them were journals with high IF and top partition ranking. Across all sources, most journal categories were surgery, medicine, or metabolism.

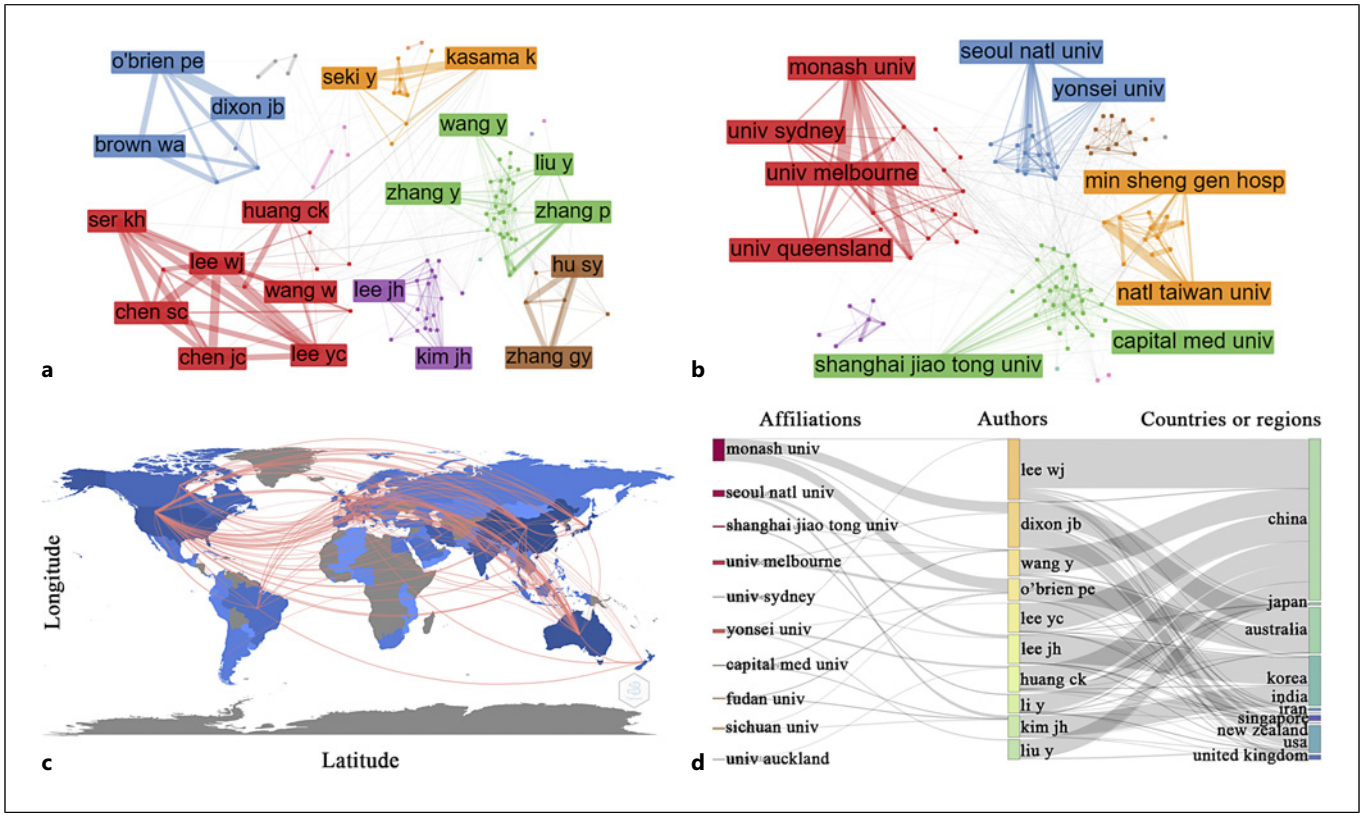

Fig. 2. The social cooperation structure of the publications. A network of co-occurrence collaborations among authors (**a**), affiliations (**b**), and countries/regions (**c**). Different colors indicate different collaborative clusters of authors (**a**) or affiliations (**b**). **d** Three-fields-plot of authors, affiliations, and countries/regions. The thickness and size of the lines imply the tightness of the collaboration.

Co-Occurrence Network and Cluster Analysis of Keywords

All keywords were extracted from author keywords of publications, and CiteSpace was used for keywords co-occurrence network and cluster analysis. The parameters that produced each stable network were time slicing (from 2000 to 2021, years per slice = 1), text processing (all selected), node types (keyword), links (default), selection criteria (top 50), pruning (pathfinder, pruning sliced networks), and visualization (cluster view -static, show merged network). As shown in Figure 3a, in the synthesized keywords co-occurrence network, N = 539, E = 1,971, D = 0.0136, meant that there were a total of 539 keywords, which were composed of 1,971 links, and the density was 0.0136. Color bars indicate when publications keywords appeared or when keywords were first linked in co-occurrences. The size of the nodes means the frequency of the keywords. The most five frequent keywords were "bariatric surgery" (2,063), "surgery" (1,261), "weight loss" (1,228), "obesity" (1,197), "body mass index" (789), which identified the main research themes. Subsequently, cluster analysis was performed on 539 keywords, and log-likelihood ratio (LLR) was used to optimize the cluster labels [19]. The modularity Q of the cluster was 0.5295, which indicated a significant clustering structure (Q>0.3), and the weighted mean silhouette (S) was 0.7919, suggesting a good degree of homogeneity (S>0.7) [20, 21]. Figure 3b shows ten large clusters, with different colors indicating different clusters. Cluster analysis could assist researchers in obtaining the direction of current research quickly.

Timeline View after Keywords Clustering

The timeline view reflects the evolution of the observed parameters at different times. Figure 4 shows a timeline view of the top 10 cluster labels after cluster analysis (modularity Q = 0.5294, mean silhouette = 0.7669) for keywords in publications. The time evolution process is represented from left to right, and the clusters are represented from large to small from top to bottom. The

Table 2. The top 10 most relevant journals and top 10 most local cited journals

Most relevant sources					Most local cited sources				
Rank	Journals	Publi-cations	IF[a]	Quartile	Rank	Journals	Fre-quently[b]	IF	Quartile
1	Obesity Surgery	907	3.48	Q2	1	Obesity Surgery	18,696	3.48	Q2
2	Surgery for Obesity and Related Diseases	252	3.71	Q1	2	Annals of Surgery	7,007	13.79	Q1
3	Nutrition Metabolism and Cardiovascular Diseases	193	4.67	Q2	3	Surgery for Obesity and Related Diseases	6,650	3.71	Q1
4	Medicine	155	1.82	Q3	4	New England Journal of Medicine	6,257	176.08	Q1
5	PLoS One	137	3.75	Q2	5	Surgical Endoscopy and Other Interventional Techniques	4,530	3.45	Q2
6	Surgical Endoscopy and Other Interventional Techniques	125	3.45	Q2	6	JAMA-Journal of the American Medical Association	4,264	157.33	Q1
7	Anz Journal of Surgery	82	2.02	Q3	7	Lancet	4,226	202.73	Q1
8	World Journal of Surgery	76	3.28	Q2	8	Journal of Clinical Endocrinology & Metabolism	4,085	6.13	Q1
9	World Journal of Gastroenterology	70	5.37	Q2	9	Diabetes Care	3,801	17.15	Q1
10	Scientific Reports	67	5.00	Q2	10	International Journal of Obesity	3,055	5.55	Q2

IF[a]: The impact factor (IF) of a journal was issued from the JCR in 2021. Frequently[b]: Data were obtained from reference lists.

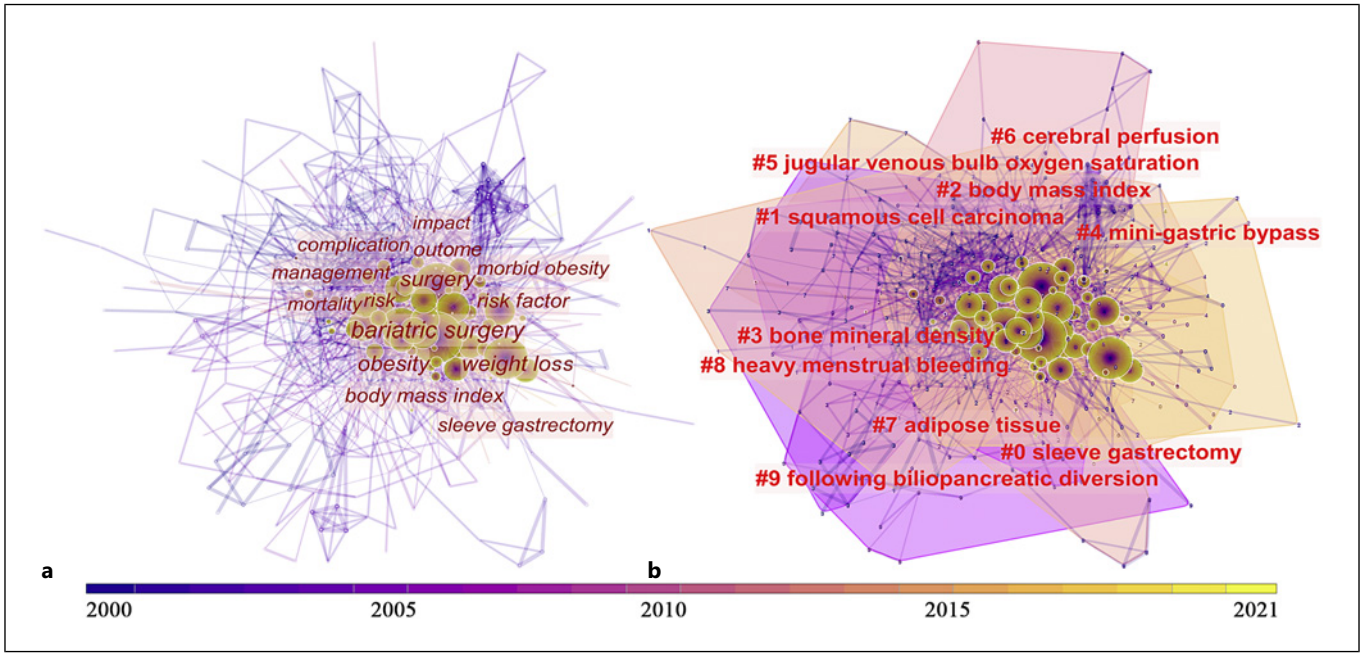

Fig. 3. Co-occurrence network and cluster analysis of keywords. **a** Keyword co-occurrence network. **b** Cluster analysis of keywords. The modularity Q = 0.5295 and the weighted mean silhouette (S) = 0.7919.

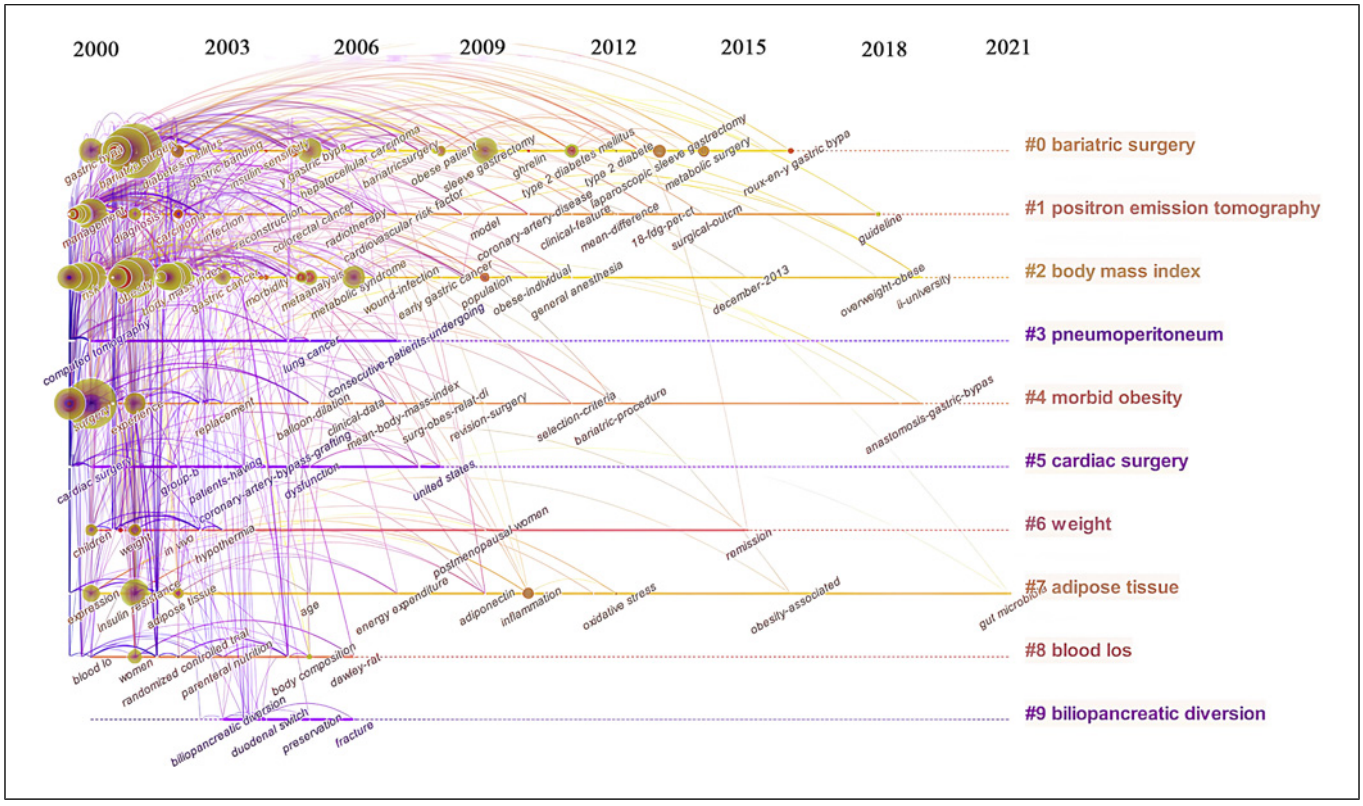

Fig. 4. Timeline view after keywords clustering. The nodes' size indicates the frequency of keywords occurrence. The color of links is indicative of the transition of research focus over time, with the most recently established links in yellow.

largest cluster was cluster #0 (bariatric surgery), representing a topic of interest to most scholars. The longest clusters were cluster #2 (body mass index), and cluster #4 (morbid obesity), suggesting the topics that researchers had always mentioned. The newest cluster was cluster #9 (biliopancreatic diversion). However, cluster #9 was also the shortest cluster, indicating that this topical attention was not well sustained in IFSO-APC.

Research Frontier

Keywords with the strongest citation bursts, which indicate the intensive presentation of a specific keyword in a specific time region, are often associated with major research milestones that are critical to the development of the field [19]. Publications with sudden bursts of interest have higher burst intensities used to identify the hot topics and research frontier [10, 20]. Red and bold horizontal bars indicate hot spots with the strongest citation bursts in Figure 5. The first detected keyword was "cholecystectomy," which appeared in 2000 and ended in 2011. During the two decades of rapid development of the IFSO-APC bariatric surgery field, the strongest citation bursts keywords in the first 10 years were "cholecystectomy,""bypa" (bypass), "vertical banded gastroplasty," "operation," "roux en y," "morbid obesity,", "prevention," "food intake," "trial," "body weight," "positron emission tomography." These keywords bursts focused on food intake and surgical management of morbid obesity, and several surgical modalities were proposed, such as vertical banded gastroplasty and Roux-en-Y gastric bypass surgery. "Mellitus," "glucose," "medical therapy," "type 2 diabetes mellitus," "carcinoma," "insulin sensitivity," "population," "gastric bypass surgery," "postoperative complication," "meta analysis," "physical activity," "roux-en-y gastric bypa," "laparoscopic sleeve gastrectomy," and "morbidity" had the high burst strength in the next 10 years. The last decade that has had a major impact on the field was the prevalence and the associated complications of morbid obesity, such as mellitus, insulin sensitivity, and carcinoma. During this period, the management of morbid obesity changed to physical exercise and surgery modalities based on

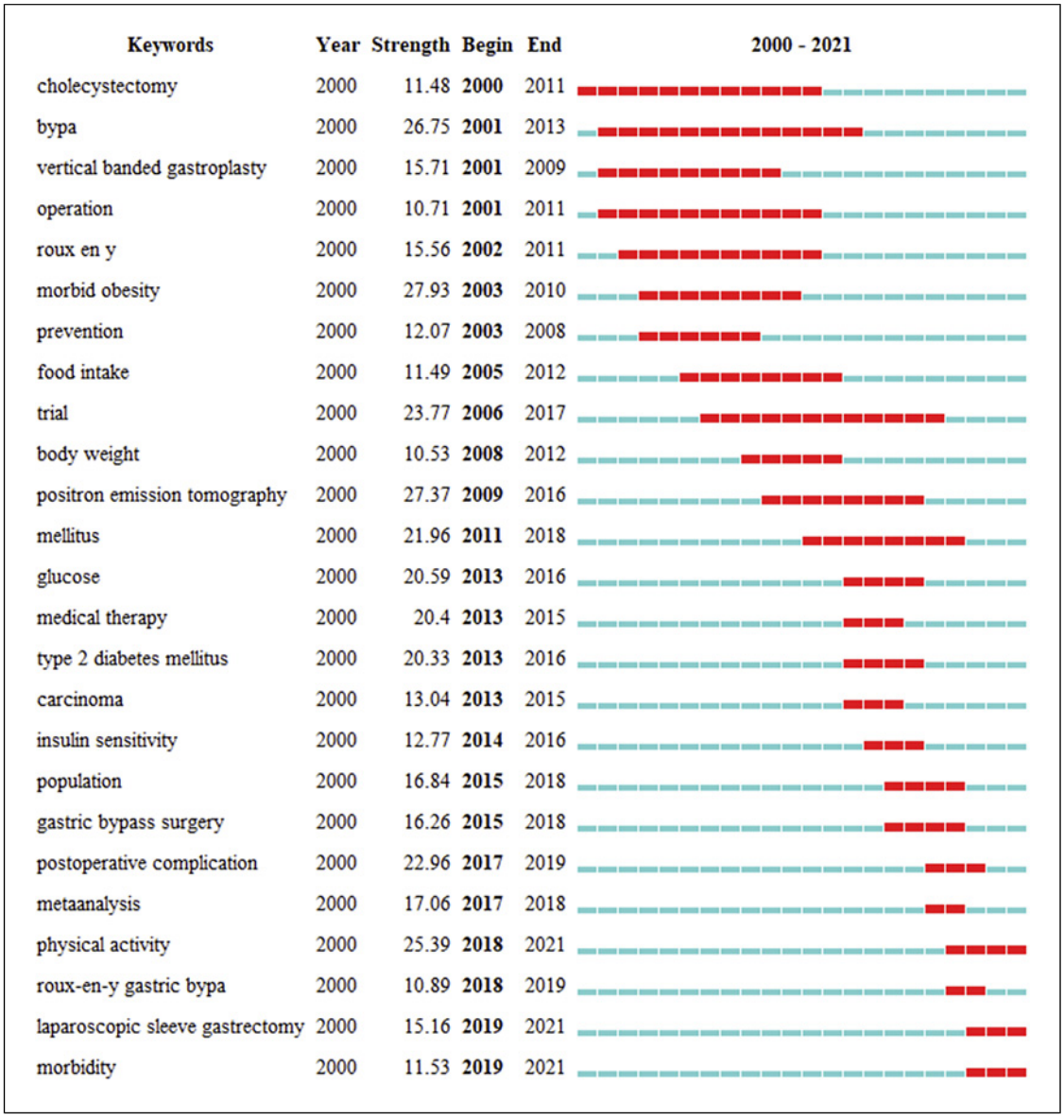

Fig. 5. Top 25 keywords with the strongest citation bursts. Red and bold horizontal bars indicate hot spots with the strongest citation bursts. The green bars mean keywords that appear infrequently.

laparoscopic sleeve gastrectomy and Roux-en-Y gastric bypass. "Morbid obesity" was the strongest citation bursts.

Analysis of Related Indicators

The total number of publications by countries/regions in IFSO-APC depends on many factors. In this study, we obtained indicators of five main aspects from various official institutions worldwide. The first aspect was the prevalence of people living with overweight or obesity. The second aspect was the diet plans or related policies. The third aspect was insufficient physical activity prevalence or related policies. The fourth aspect was the basic information of medical care, education and R&D. The fifth aspect was the economic and demographic profile. All data were extracted from the latest data provided by the official institutional website, and were subjected to univariate and multivariate regression analysis with the total number of publications published in each country/region in the IFSO-APC (Table 3). Hong Kong and Taiwan were not included in the analysis because most of the data were missing. Univariate analysis found that the total number of publications in each

Table 3. Univariate and multivariate regression analysis between various indicators and the number of publications in each country/region

Variables	Univariate analysis			Multivariate analysis		
	Coefficients	95% CI	*p* value	Coefficients	95% CI	*p* value
BMI ≥25% prevalence	288.999	−3,261.680–3,839.678	0.861		−	
BMI ≥25 population	4.268	1.015–7.522	**0.015**	−40.245	−72.635 to −7.856	**0.021**
BMI ≥30% prevalence	−333.050	−6,015.223–5,349.123	0.900		−	
BMI ≥30 population	21.602	4.116–39.088	**0.020**	81.698	−	0.082
Mean BMI	−11.526	−320.540–297.489	0.936		−	
Diet plans	492.833	−1,531.196–2,516.863	0.603		−	
Sugar-sweetened beverages	−849.500	−1,789.306–90.306	0.072	−0.172	−	0.269
Trans-fatty acid elimination	−286.200	−1,393.009–820.609	0.581		−	
Saturated fatty acids	130.111	−1,050.467–1,310.689	0.813		−	
Physical activity public awareness program	597.300	−866.009–2,060.609	0.384		−	
Reduce physical inactivity	492.833	−1,531.196–2,516.863	0.603		−	
Insufficient physical activity prevalence	−5,409.615	−11,766.753–947.522	0.088	−0.013	−	0.945
Medical doctors (per 10,000)	33.829	−12.156–79.814	0.134		−	
Students of upper secondary education	0.016	−0.010–0.042	0.209		−	
R&D personnel	0.001	0.000–0.001	**0.001**	0.481	−	0.796
GDP on R&D	38,639.700	2,704.674–74,574.726	**0.037**	0.219	−	0.250
Public expenditure on education (% of GDP)	14,216.568	−22,193.073–50,626.208	0.405		−	
Current health expenditure	0.166	−0.105–0.437	0.204		−	
GDP per capita	0.010	−0.014–0.033	0.388		−	
GDP	0.162	0.097–0.227	**0.000**	0.479	0.255–0.702	**0.001**
Population	0.919	−0.028–2.865	0.056	3.969	0.781–7.156	**0.021**

95% CI, 95% confidence interval; BMI, body mass index; BMI ≥25% prevalence: prevalence of overweight among adults, BMI ≥25 (%); BMI ≥25 population: the total population of adults with BMI ≥25 kg/m^2; BMI ≥30% prevalence: prevalence of obesity among adults, BMI ≥30 (%); BMI ≥30 population: the total population of adults with BMI ≥30 kg/m^2; Diet plans: existence of operational policy/strategy/action plans to reduce unhealthy diet; Sugar-sweetened beverages: existence of tax on sugar-sweetened beverages; Trans-fatty acid elimination: existence of national policies on trans-fatty acid elimination; Saturated fatty acids: existence of national policies on saturated fatty acids; Physical activity public awareness program: implementation of physical activity public awareness program; Reduce physical inactivity: existence of operational policy/strategy/action plan to reduce physical inactivity; Insufficient physical activity prevalence: prevalence of insufficient physical activity among adults aged 18+ years (%); Students of upper secondary education: students enrolled in upper secondary education (thousands); R&D personnel: research and development personnel (total numbers in full-time equivalent); GDP: gross domestic product; GDP on R&D: gross domestic expenditure on R&D: as a percentage of GDP (%); Current health expenditure: current health expenditure per capita in US$. *p* values less than 0.1 in univariate linear regression analysis are underlined (8 variables). *p* values less than 0.05 are bolded.

country/region in the IFSO-APC was correlated with the total population of adults with body mass index (BMI) ≥25 kg/m^2 (BMI ≥25 population, $p = 0.015$), population with BMI ≥30 kg/m^2 (BMI ≥30 population, $p = 0.020$), R&D personnel ($p = 0.001$), gross domestic product (GDP) on R&D ($p = 0.037$), and GDP ($p \leq 0.001$). Multivariate regression analysis found that the number of publications was associated with BMI ≥25 population ($p = 0.021$), GDP ($p = 0.001$) and total population ($p = 0.021$). Populous countries/regions gaining economic development need to pay attention to the incidence of obesity.

Discussion

Quantitative Analysis Research Overview of Bariatric Surgery in the Asia-Pacific

The global prevalence of obesity has nearly tripled since the 1970s [22, 23]. Obesity not only leads to a reduction in life expectancy [24, 25], it may also impose a huge health burden on society [26]. With more than half of the world's population, the Asia-Pacific region has experienced the most significant socioeconomic and demographic changes in the last two decades [27].

Inevitably, these changes, accompanied by urbanization and lifestyle changes, lead to changes in dietary habits and a reduction in daily physical activity. As a result, these changes have contributed to a higher prevalence of people living with overweight and obesity in the region [2], which will ultimately negatively impact global health. Bariatric surgery has become the most effective and feasible sustainable weight loss strategy [28], and the development of laparoscopic techniques and the maturity of bariatric surgery have led to a rapid increase in bariatric surgery in the Asia-Pacific region [29, 30]. Similarly, researchers have shown great interest in bariatric surgery in the Asia-Pacific region. Our results showed that after more than two decades of development, the total number of publications in the Asia-Pacific region represented by IFSO-APC was 9,547. Among them, China had the most publications (n = 2,782) because of the increasing prevalence of obesity in recent years [31] and the gradual development of bariatric surgery in China [29, 32].

Since the introduction of assisted visualization in bibliometrics, many useful scientific knowledge mapping tools have also emerged. In this study, we applied CiteSpace to conduct keywords co-occurrence network analysis and cluster analysis and used it to study the temporal evolution trend of keywords further. Additionally, we used Bibliometrix to extract literature data to visualize social cooperation networks of publications. In bariatric surgery, several studies have performed bibliometric analyses [11, 33–36]. Nonetheless, bibliometrics, as time-sensitive studies, must keep pace with the times, and only Toro-Huamanchumo et al. [37] reported on bariatric surgery studies in Latin America in 2020 for regional studies. Therefore, to better grasp the research status of bariatric surgery in the Asia-Pacific, we conducted a bibliometric analysis from 2000 to 2021 with IFSO-APC as its main representative.

The Evolution of Bariatric Surgery

Bariatric surgery originated in the 1950s [38, 39], and after decades of development, has proven to be the most effective intervention for weight loss and improvement of obesity-related complications [8, 40]. From the 1950s to the present, many bariatric surgical procedures have been introduced [41]. Some have proved beneficial, while others were abandoned due to weight loss failures, unacceptable complications, or the development of more effective regimens. Vertical band gastroplasty (VBG) was first proposed by Mason [42] in the early 1980s. From the end of the 20th century to the beginning of the 21st century, adjustable gastric banding (AGB) was widely used and became one of the mainstream bariatric surgeries instead of VBG.

Subsequently, biliopancreatic diversion (BPD) and its modification, biliopancreatic diversion with duodenal switch (BPD-DS), were developed by Scopinaro [43] in 1979 and by Hess [44] in 1998, respectively. However, BPD or BPD-DS surgery is difficult and time-consuming, and not all bariatric surgeons can perform it [45, 46], which lead to the low development rate and few scientific research papers of BPD or BPD-DS in IFSO-APC. The earliest gastric bypass surgery began in the 1960s. Several improvements followed, and Griffen [47] first reported the standardized Roux en-Y gastric bypass (RYGB) in 1977, which has become one of the classic and commonly used methods of bariatric surgery. Sleeve gastrectomy (SG) was originally conceived as the first step in a two-stage procedure and popularized by Dr. Gagner and Rogula [48–50]. Due to its relatively simple operation and low complication rate, it has developed rapidly in the past two decades and has become the most mainstream bariatric surgery in the world [29, 51, 52].

Generally, timeline view and the strongest citation bursts of keywords visualize the evolution of bariatric surgery in IFSO-APC. VBG showed strong citation bursts from 2001 to 2009. This might be because VBG involved revision surgery [53, 54], and revision studies might report keywords related to other major surgery. BPD or BPD-DS only briefly appeared in the timeline view of keywords clustering from publications. Owing to the difficulty of its operation and the trouble of effectively eliminating postoperative complications [45], its research intensity in IFSO-APC had not been continued. RYGB and SG, as the two most popular bariatric surgeries globally, have always attracted the attention of researchers. Among them, RYGB appeared in several periods as a strong keyword, indicating its importance in bariatric surgery the unfailing attention of researchers to it. In addition, obesity increases the incidence of gallbladder disease [55], with a proportion of patients undergoing bariatric surgery accompanied by cholecystectomy. Weight loss after bariatric surgery increases the risk of biliary stones, so prophylactic cholecystectomy has also been proposed to be performed in conjunction with bariatric surgery [56].

Analysis of the Relevant Factors Affecting the Number of Publications

Considering other factors, weighing the number of publications together may provide a reference on how research is being conducted in different countries/regions of IFSO-APC. In a multivariate analysis, Dabi et al. [11] found that the number of publications in bariatric surgery was associated with GDP, health total expenditure, and

obesity prevalence. Paolino et al. [36] also found more publications of scientific research in higher-income countries than in lower-income countries. Ozsoy and Demir [35] conducted a correlation analysis on some factors and the number of publications, and found that population number, GDP, GDP per capita and hour worked, human development index, Internet users, percentage of individuals using the Internet, English proficiency index, productivity had significant correlations. To the best of our knowledge, this study is the first bibliometric research to incorporate multi-dimensional indicators such as people living with overweight or obesity prevalence, diet plans or related policies, insufficient physical activity prevalence or related policies, medical care, education, R&D, economy and population into a reference for linear regression correlation analysis in Asia-Pacific. Although food intake and physical activity appeared as strongly citation bursts keywords, we found that neither the diet plans and its associated policies nor the physical activity and its associated policies were statistically significant. Diet or activity-related policies may not be directly related to the number of publications, but country/region-level policies may impact the prevalence of people living with overweight or obesity [57–59]. Multivariate regression analysis found that the number of publications in IFSO-APC was associated with a population with BMI ≥25 kg/m^2, GDP and total population. Growing economic development in many low to middle-income countries/regions in the IFSO-APC is a major contributor to the growing prevalence of obesity and cardiovascular disease [60]. Economic and demographic dividends allow researchers to have sufficient assistants, resources, and finances to support their continued scientific contributions.

Strengths and Limitations

Given the rapid increase in IFSO-APC bariatric surgery publications, this study performed a more comprehensive bibliometric analysis of these publications using two tools, CiteSpace and Bibliometrix. In addition, this study obtained indicators of five main aspects from various official institutions worldwide, searching their correlation with the number of publications.

This study has several limitations. First, only the WoS database was used for data extraction, which resulted in publications in some national or regional journals that might not be included. However, we chose WoS because of its wide coverage and the most reliable service for publication. Besides, all journals indexed in the WoS database have impact factors and categories, analyzing the journal more specifically. Second, we only involved the countries/regions in the IFSO-APC in representing the Asia-Pacific region, which might lead to incomplete data. Most of the affiliations that perform bariatric surgery in the Asia-Pacific region have joined IFSO-APC, which actively promotes and improves bariatric surgery in the Asia-Pacific region, making it the most influential international federation of the region [61, 62]. Hence, it is acceptable that IFSO-APC represented publications in bariatric surgery in the Asia-Pacific.

Conclusion

The current study found that publications on bariatric surgery in the Asia-Pacific region have been steadily increasing over the past 20 years, which might be attributed to the growth of BMI ≥25 population, GDP and total population in the region, with China, Japan and Australia contributing the most to the number of publications. This study also explored the major contributing authors/affiliations, and major journals of interest in the field of bariatric surgery. However, in social cooperation networks such as authors, affiliations, and national/regional cooperation networks were mostly limited to intra-regional cooperation. In general, future research in the Asia-Pacific region should involve deeper and broader cross-regional collaboration on "morbid obesity" and surgical options.

Statement of Ethics

An ethics statement was not required for this study type, no human or animal subjects or materials were used.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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Author Contributions

Guanhua Lu and Wah Yang designed and conducted the study, collated and analyzed the data, and Guanhua Lu wrote the manuscript. Ruixiang Hu and Zhiyong Dong were responsible for literature collation and screening. Jianxue Wang was assigned to

assist in the visualization of the bibliometric analysis. Wah Yang and Cunchuan Wang supervised the study, provided guidance, and edited the manuscript. As this work's guarantor, Cunchuan Wang has full access to all data in the study and is responsible for the data's integrity and accuracy.

Data Availability Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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