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## Annals of Medicine and Surgery

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Systematic Review / Meta-analysis

# Anterior cruciate ligament studies in south-east asia over the past 10 years: A systematic review

Sholahuddin Rhatomy<sup>a,b,\*</sup>, Riky Setyawan<sup>c</sup><sup>a</sup> Department of Orthopaedics and Traumatology, Dr. Soeradji Tirtonegoro General Hospital, Klaten, Indonesia<sup>b</sup> Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia<sup>c</sup> Soeradji Tirtonegoro Sport Center and Research Unit, Dr. Soeradji Tirtonegoro General Hospital, Klaten, Indonesia

## ARTICLE INFO

## Keywords:

Anterior cruciate ligament  
ACL  
South-east Asia  
Bibliometric  
Publication

## ABSTRACT

**Purpose:** There was numerous articles that discussed about anterior cruciate ligament (ACL). There was no study that wrapped up all about ACL in South-east asia country. This study aims to apply bibliometric tools to orthopaedics publications on ACL in South-east asia country.

**Methods:** We searched English full text with keyword “ACL” OR “Anterior Cruciate Ligament” AND “injury” OR “tear” OR “rupture” that published from January 1st 2010 to December 31st 2019 on PubMed, EMBASE, and Cochrane Library. We included article with at least has one author affiliation in the South-east asia country.

**Results:** A total of 12,570 articles were analyzed, and 64 articles were included. Study type analysis revealed that clinical research (n = 28; 43.7%) was the most frequent study type. The journal of knee surgery, sports traumatology, arthroscopy (KSSTA) and Orthopaedic Journal of Sports Medicine had the highest number of publications in general (n = 6; 9.4%). Sholahuddin Rhatomy (n = 4) was the top author with highest number in the first author order and Lingaraj Krishna (n = 12) was the top author with highest number of published article. Most of studies (n = 32; 50.0%) were published in high index journal with impact factor >1.0.

**Conclusion:** ACL articles in South-east asia had high quality publication that proved by high impact journal publisher. There has been a steady increase in the article number since 2010 in South-east asia. This article quantifies the increased interest and could act as a baseline for future studies to compare.

## 1. Introduction

There have been numerous researches about anterior cruciate ligament (ACL). ACL is discussed among knee surgeon because it is the most common injured of knee ligament [1]. Researchers attempted to provide the evidence based in diagnosis, treatment, prevention, prognosis, and rehabilitation technique in ACL injured patient [2].

The publications trends about this ligament is increased by year around the world. There is no data that provides all about ACL publications especially in South-east asia country. Organizing information in an effective way mandates the use of the best evidence for decision making in ACL care holistically. This study aims to apply bibliometric tools to orthopaedic publications on ACL in South-east asia country between 2010 and 2019.

## 2. Methods

We search in Pubmed, EMBASE, and Cochrane Library using keyword “ACL” OR “Anterior Cruciate Ligament” AND “injury” OR “tear” OR “rupture”. We added english fulltext and 10 years publications in filter searching engine. The search result in a total of 12,570 articles from 2009 until 2019. We included the articles that discussed about anterior cruciate ligament and at least one author with the affiliation country in South-east asia. All original articles including molecular study, laboratory study, animal study, cadaveric study, imaging study, clinical study, systematic review, review articles, and other study that published between January 1st 2010 until December 31st 2019 were included. We excluded the book sections, conference presentations, guidelines, commentaries, or personal review. The PRISMA guidelines for conducting the review were followed [3] (Fig. 1).

All abstract were screened independently by two reviewers to

\* Corresponding author. Sport and Adult Reconstructive Division, Orthopaedics and Traumatology Department, Dr. Soeradji Tirtonegoro General Hospital, Klaten, Indonesia.

E-mail addresses: [doktergustomrhatomy@yahoo.com](mailto:doktergustomrhatomy@yahoo.com), [sholahuddin.rhatomy@mail.ugm.ac.id](mailto:sholahuddin.rhatomy@mail.ugm.ac.id) (S. Rhatomy).

<https://doi.org/10.1016/j.amsu.2020.10.014>

Received 21 August 2020; Received in revised form 1 October 2020; Accepted 8 October 2020

Available online 21 October 2020

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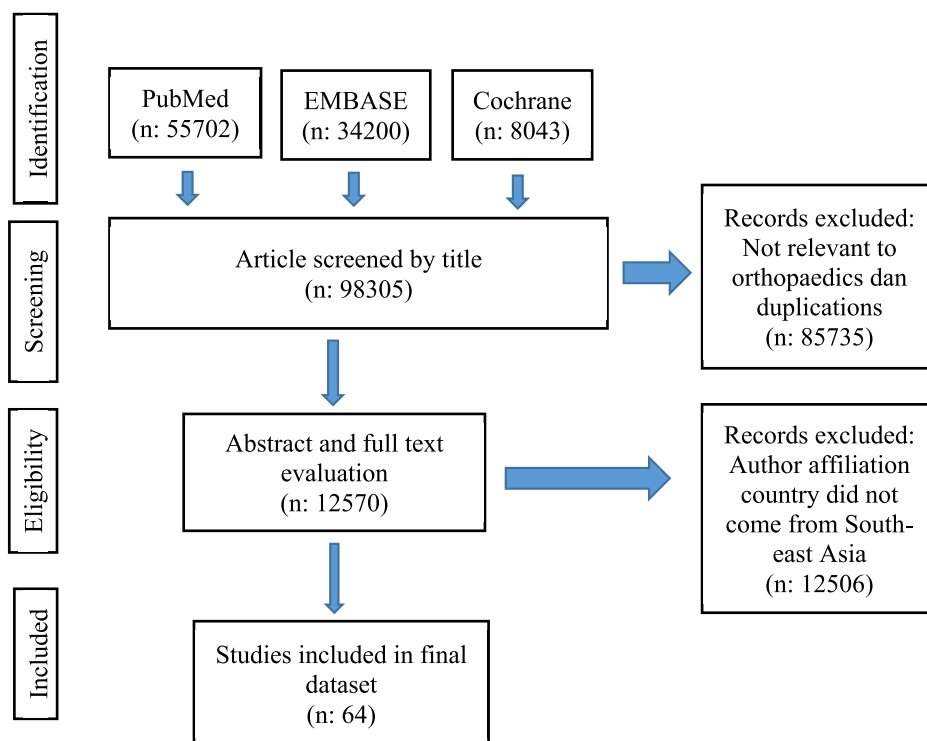
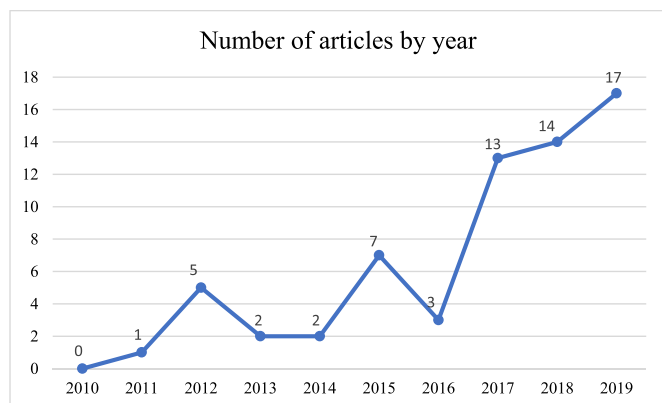


Fig. 1. PRISMA flow chart of the article selection process.



Graph 1. Number of articles by year.

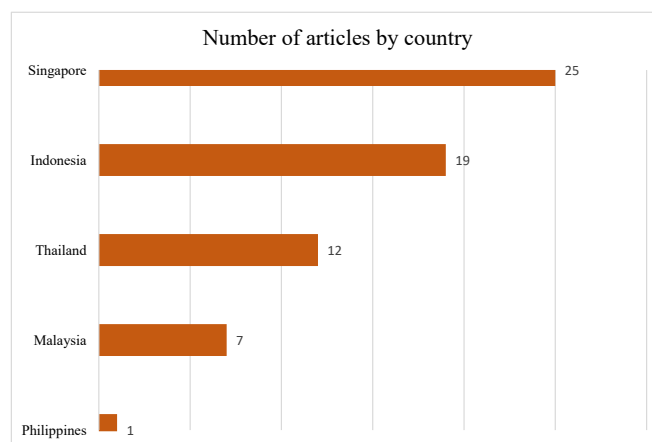
determine whether it met eligibility criteria. The full articles of eligible studies were reviewed and included into the study for further data extraction and analysis. We analyzed the number of published articles by year, top journals with the highest number of publications, top author with highest number of published article in the first order author, top author with highest number of published article, top country with the highest number of published articles, the most cited articles and type of study. The published journals were divided by impact factor (IF) into low (IF below 1) and high (IF of 1 and above) impact journal. Information of a country was collected. Data was analyzed using Microsoft Excel and SPSS version 25.0 and visualized with tables and graphs.

### 3. Results

A total of 64 articles on ACL studies were performed in South-east asia region between 2010 until 2019. The average number of publications is 6 articles per year. The highest published articles was in 2019 with 17 articles and the lowest published article was in 2010 with

Table 1  
Top journal with the highest number of articles.

No	Journal name	Number of articles
1	Knee surgery, sports traumatology, arthroscopy	6
1	Orthopaedic journal of sports medicine	6
3	Arthroscopy: the journal of arthroscopic & related surgery	3
3	The knee	3
3	The journal of knee surgery	3
3	Malaysian orthopaedic journal	3
3	Journal of the Medical Association of Thailand = Chotmaihet thangphaet	3
3	International journal of surgery open	3



Graph 2. Number of articles by country.

0 article. The trend of ACL publications have positive increment values but unsteady (Graph 1).

The journal of knee surgery, sports traumatology, arthroscopy

**Table 2**  
Top 10 most cited articles.

No.	Article title	Number of citation
1	Double-bundle versus single-bundle reconstruction for anterior cruciate ligament rupture in adults [4].	153
2	The importance of patient sex in the outcomes of anterior cruciate ligament reconstructions: A systematic review and meta-analysis [5].	65
3	Accuracy of MRI in the diagnosis of meniscal tears in patients with chronic ACL tears.	44
4	Association between matrix metalloproteinase-3 polymorphism and anterior cruciate ligament ruptures [6].	43
5	Biomechanical analysis of knee laxity with isolated anteromedial or posterolateral bundle-deficient anterior cruciate ligament [7].	29
6	Increased compliance with supervised rehabilitation improves functional outcome and return to sport after anterior cruciate ligament reconstruction in recreational athletes [8].	22
7	Medium-term (5-year) comparison of the functional outcomes of combined anterior cruciate ligament and posterolateral corner reconstruction compared with isolated anterior cruciate ligament reconstruction [9].	20
8	One-leg hop kinematics 20 years following anterior cruciate ligament rupture: Data revisited using functional data analysis [10].	19
9	The effect of leg dominance and landing height on ACL loading among female athletes [11].	17
10	Diagnosis of ligamentous and meniscal pathologies in patients with anterior cruciate ligament injury: comparison of magnetic resonance imaging and arthroscopic findings [12].	16

**Table 3**  
Top author with highest number of published article in the first order author.

No	Orthopaedic Center	Investigator	Number of Publications
1	Department of Orthopaedics and Traumatology, Dr. Soeradji Tirtonegoro General Hospital, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia	Sholahuddin Rhatomy	4
2	Yong Loo Lin School of Medicine, National University of Singapore (NUS), Singapore	Si Heng Sharon Tan	3
3	Division of Sports Medicine and Surgery, Department of Orthopaedic Surgery, National University Hospital, National University Health System, Singapore	Lingaraj Khrisna	2
3	Orthopaedic and Traumatology Department, Hasanuddin University School of Medicine, Indonesia	Muhammad Sakti	2

(KSSTA) and Orthopaedic journal of sports medicine were the highest number of articles ( $n = 6$ ; 9.4%) (Table 1). The country with the highest number of published article was Singapore ( $n = 25$ ; 52.1%), followed by Indonesia ( $n = 19$ ; 29.7%), and Thailand ( $n = 12$ ; 18.7%) (Graph 2). Article by Tiamklang et al. [4] had the highest number of citation with 153 times (Table 2). Sholahuddin Rhatomy from Department of Orthopaedics and Traumatology, Dr. Soeradji Tirtonegoro General Hospital, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia was the author with the highest number of published article in which he was the first order author (Table 3). Author with the first order author came from Indonesia ( $n = 2$ ) and Singapore ( $n = 2$ ). Lingaraj Krishna was the author with the highest number article with 12 articles (Table 4). Clinical research ( $n = 28$ ; 43.7%) was the most common used as type of study in the past 10 years (Table 5), followed by biomechanics study ( $n = 8$ ; 12.5%), and case report ( $n = 7$ ; 10.9%). Cohort study was the highest type of clinical research study that constituted 46.4% of

**Table 4**  
Top author with highest number of published article.

No	Orthopaedic Center	Investigator	Number of Publications
1	Division of Sports Medicine and Surgery, Department of Orthopaedic Surgery, National University Hospital, National University Health System, Singapore	Lingaraj Krishna	12
2	Department of Orthopaedics and Traumatology, Dr. Seotomo General Hospital, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia	Dwikora Novembri Utomo	7
3	Yong Loo Lin School of Medicine, National University of Singapore (NUS), Singapore	Chloe Xiaoyun Chan	5
3	Department of Orthopaedics and Traumatology, Dr. Soeradji Tirtonegoro General Hospital, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia	Sholahuddin Rhatomy	5
5	Department of Orthopaedic Surgery, National University Hospital Sports Center, National University Health System, NUHS Tower Block, Singapore	Keng Lin Wong	4
5	Nicolaas Institute of Constructive Orthopaedics Research and Education Foundation for Arthroplasty & Sports Medicine, Medistra Hospital, Jakarta, Indonesia	Nicolaas C. Budhiparama	4
5	Department of Orthopaedic Surgery, National University Hospital Sports Center, National University Health System, NUHS Tower Block, Singapore	Shi Jie Toh	4
8	Department of Orthopaedic Surgery, Singapore General Hospital, Singapore	Bryan Koh Thean Howe	3
8	Medical Rehabilitation Department, Dr. Soetomo General Hospital, Surabaya, Indonesia	Damayanti Tinduh	3
8	Department of Orthopaedics and Traumatology, Dr. Saiful Anwar General Hospital, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia	Edi Mustamsir	3
8	Department of Orthopaedic Surgery, Singapore General Hospital, Singapore	Hamid Rahmatullah Bin Abd Razak	3
8	Soeradji Tirtonegoro Sport Center and Research Unit, Dr. Soeradji Tirtonegoro General Hospital, Klaten, Indonesia	Riky Setyawan	3
8	Yong Loo Lin School of Medicine, National University of Singapore (NUS), Singapore	Si Heng Sharon Tan	3

clinical research (Table 6), followed by cross sectional study 28.6%. In this systematic review, Asean author submitted their study in high index journal with impact factor more than 1.0 ( $n = 32$ , 50.0%) and there were some articles that submitted in unindexed journal publisher ( $n = 7$ ; 10.9%). Most of articles were published in Q1 journal ( $n = 40$ ; 46.9%), followed by Q3 ( $n = 11$ ; 17.2%), Q2 ( $n = 7$ ; 10.9%), and Q4 ( $n = 6$ ; 12.5%).

#### 4. Discussions

The most important findings from this systematic review were that most of Asean author published their research in high impact factor journal. It proved that Asean authors have good quality of research

**Table 5**

Type of study by year.

	Laboratory/ Molecular Study	Animal Study	Biomechanics Study	Clinical Imaging Study	Surgical Technique	Case Report	Clinical Research	Meta-Analysis & Systematic Review	Review Article	Total
2010	0	0	0	0	0	0	0	0	0	0
2011	1	0	0	0	0	0	0	0	0	1
2012	0	0	1	0	0	2	1	1	0	5
2013	0	0	0	0	0	0	1	0	1	2
2014	0	0	1	0	1	0	0	0	0	2
2015	0	0	1	2	0	0	4	0	0	7
2016	0	0	0	1	0	0	1	1	0	3
2017	2	0	2	1	1	2	4	0	1	13
2018	1	1	1	0	1	2	8	0	0	14
2019	2	0	2	0	1	1	9	1	1	17
Total	6	1	8	4	4	7	28	3	3	64

**Table 6**

Clinical research study.

Year	Case Series	Cross Sectional	Case Control	Cohort	Randomized Controlled Clinical Trial
2010	0	0	0	0	0
2011	0	0	0	0	0
2012	1	0	0	0	0
2013	0	0	1	0	0
2014	0	0	0	0	0
2015	0	0	1	3	0
2016	0	1	0	0	0
2017	0	2	0	2	0
2018	0	2	1	3	2
2019	0	3	0	5	1
Total	1	8	3	13	3

protocol. It can be motivated by raising the international ranking of the university or education center. Asean authors wanted to document and made their work accessible for other surgeons around the world. Most of articles were published in Q1 journal (46.9%) according to grading by [www.scimagojr.com](http://www.scimagojr.com) also proved that the quality of Asean author research was excellent.

The number of journal increment in ACL field is associated with the development of new method in ACL reconstruction, although not every single article discussed about that. There is still many things to explore in ACL itself, such as in histological feature, biomechanics, and the animal study, moreover cadaveric study. The research is not only about surgical technique with the many choices of autograft but also about imaging study.

Article with the highest citation number was clinical research with the title Double-bundle versus single-bundle reconstruction for anterior cruciate ligament rupture in adults with 153 citation. It indicates that the novelty of the study was new, thus the other researcher cited the article. Clinical research was dominating in this systematic review. It may be caused by the background of the most Asean authors is orthopaedic surgeon. Singapore was the country with the highest number of published article. It indicates that the development of technology, awareness to update the new and more effective method of diagnosis, treatment, and rehabilitation program of the researcher were good. The countries with small number of published article did not mean they had not research protocol. It signifies that whether they had published the article in unindexed journal publisher, or they had data to write a manuscript but they did not have time to write because of the high load of patients to be operated. Other countries were hoped can follow the country to produce more article that can enliven the research database.

This study indicates the need to collaboration research in the region. In order to bridge the ACL research gap among South-east asia country, international collaborations with guidance from more established research centers should be encouraged.

Limitations of his systematic review only focuses on studies

performed in the South-east asia region. Many researchers in South-east asia countries may have contributed data in an oversea-based research project, or participated in research when they resided overseas. This exclusion is to depict a clearer picture on local research output and quality.

## 5. Conclusions

There have been a large number of the ACL publications among Asean author over the past 10 years with the high impact journal publisher. Data mining based on PubMed result provided the useful information about the hot issue on ACL and led other author to follow with the mimicking the research. The increment in number of publications in recent years indicates continually increase interest in the topic of ACL.

## Ethical approval

This is review article, no need ethical approval.

## Sources of funding

The authors declare that this study had no funding resource.

## Author contribution

Sholahuddin Rhatomy and Riky setyawan conceived the study. Sholahuddin Rhatomy and Riky setyawan collected data. Sholahuddin Rhatomy and Riky setyawan analyzed data. Sholahuddin Rhatomy and Riky setyawan prepared and drafted the manuscript. Sholahuddin Rhatomy and Riky setyawan edited manuscript. Sholahuddin Rhatomy and Riky setyawan reviewed the manuscript.

## Registration of research studies

We have registered our study with unique identifying number: reviewregistry967.

URL: [https://www.researchregistry.com/browse-the-registry#registryofsystematicreviewsmeta-analyses/5f3b1f96411b080015b5af42//](https://www.researchregistry.com/browse-the-registry#registryofsystematicreviewsmeta-analyses/registryofsystematicreviewsmeta-analysesdetails/5f3b1f96411b080015b5af42//)

## Guarantor

Sholahuddin Rhatomy, MD.

## Consent

Written informed consent was obtained from the all of the patients for publication of this case report and accompanying images. A copy of the written consent is available for review by the corresponding author of this journal on request.

**Availability of data and material**

Data will be provided by request.

**Declaration of competing interest**

No potential conflict of interest relevant to this article was reported.

**Appendix A. Supplementary data**

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2020.10.014>.

**References**

- [1] G.J. Davies, E. McCarty, M. Provencher, R.C. Manske, ACL return to sport guidelines and criteria, *Curr. Rev. Musculoskelet. Med.* 10 (3) (2017) 307–314.
- [2] S.B.S. Kambhampati, R. Vaishya, Trends in publications on the anterior cruciate ligament over the past 40 years on pubmed, *Orthop. J. Sport Med.* 7 (7) (2019) 1–8.
- [3] A. Liberati, D.G. Altman, J. Tetzlaff, C. Mulrow, P.C. Gøtzsche, J.P.A. Ioannidis, et al., The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration, *PLoS Med.* 6 (7) (2009).
- [4] T. Tiamklang, S. Sumanont, T. Foocharoen, M. Laopaiboon, Double-bundle versus single-bundle reconstruction for anterior cruciate ligament rupture in adults (review), *Cochrane Database Syst. Rev.* 11 (2012) 1–90.
- [5] S.H.S. Tan, B.P.H. Lau, L.W. Khin, K. Lingaraj, The importance of patient sex in the outcomes of anterior cruciate ligament reconstructions: a systematic review and meta-analysis, *Am. J. Sports Med.* 44 (1) (2016) 242–254.
- [6] S. Malila, P. Yuktanandana, S. Saowaprut, W. Jiamjarasrangsi, S. Honsawek, Association between matrix metalloproteinase-3 polymorphism and anterior cruciate ligament ruptures, *Genet. Mol. Res.* 10 (4) (2011) 4158–4165.
- [7] E. Kondo, A.M. Merican, K. Yasuda, A.A. Amis, Biomechanical analysis of knee laxity with isolated anteromedial or posterolateral bundle-deficient anterior cruciate ligament, *Arthrosc. J. Arthrosc. Relat. Surg.* 30 (3) (2014) 335–343.
- [8] F. Han, A. Banerjee, L. Shen, L. Krishna, Increased compliance with supervised rehabilitation improves functional outcome and return to sport after anterior cruciate ligament reconstruction in recreational athletes, *Orthop. J. Sport Med.* 3 (12) (2015) 1–8.
- [9] M. Cartwright-Terry, J. Yates, C.K. Tan, I.P. Pengas, J.V. Banks, M.J. McNicholas, Medium-term (5-year) comparison of the functional outcomes of combined anterior cruciate ligament and posterolateral corner reconstruction compared with isolated anterior cruciate ligament reconstruction, *Arthrosc. J. Arthrosc. Relat. Surg.* 30 (7) (2014) 811–817.
- [10] K. Hébert-Losier, A. Pini, S. Vantini, J. Strandberg, K. Abramowicz, L. Schelin, et al., One-leg hop kinematics 20 years following anterior cruciate ligament rupture: data revisited using functional data analysis, *Clin. Biomech.* 30 (10) (2015) 1153–1161.
- [11] H. Mokhtarzadeh, K. Ewing, I. Janssen, C.H. Yeow, N. Brown, P.V.S. Lee, The effect of leg dominance and landing height on ACL loading among female athletes, *J. Biomech.* 60 (2017) 181–187.
- [12] H.R. Bin Abd Razak, A.A. Sayampanathan, T.-H.B. Koh, H.-C.A. Tan, Diagnosis of ligamentous and meniscal pathologies in patients with anterior cruciate ligament injury: comparison of magnetic resonance imaging and arthroscopic findings, *Ann. Transl. Med.* 3 (17) (2015) 1–6.