Review Article

Comment [M1]:

Cesarean Birth Among Women Birthing in Asia: A Literature Synthesis Using the Robson 10-Group Classification System

ABSTRACT

There are increasing concerns about the advancing rates of Cesarean Birth (CB) worldwide as well as in Asia. However, less is known about the antecedent events and/or indicators contributing to rising CB rates. The Robson 10-Group Classification System (TGCS) facilitates comparisons of CB rates among subgroups of women with similar characteristics. While studies using the Robson TGCS have been conducted in Asia, findings from these studies have not been synthesized. This review article aimed to synthesize and critique the literature examining CB among women birthing in Asia using the Robson TGCS from January, 2011 to June, 2021. Of 395 publications, 24 studies met the inclusion criteria, were analyzed, and synthesized in this literature review. The findings show that the primary contributor to rising CB numbers/rates in Asian countries was Group 5 (multiparous women with a history of CB) followed by Group 2 (nulliparous women with induced labor or CB before labor began). Groups 6, 7, and 9 (women with fetal malpresentations) were the lowest contributors to overall CB rates. There was minimal variation in the distribution of Robson Groups across regions and HDI levels in Asia. The lack of consistency in reporting maternal age challenged understanding regarding the association between maternal age and Robson Group CB distribution patterns. Use of the Robson TGCS provides meaningful insight into antecedent events and indicators of CB numbers/rates. Future research should document maternal age, as prior literature suggests that older maternal age at delivery is associated with higher CB risk. These insights can provide opportunities for increased understanding of rising CB rates in Asia and, ultimately, the development of targeted and tailored interventions.

Keyword: Cesarean Birth, Robson 10-Group Classification, Asia, Literature Review

1. INTRODUCTION

Cesarean Birth (CB) is increasing worldwide; yet, CB rates in excess of 10-15% are not associated with improved maternal/child outcomes [1–3]. Many countries now have CB rates higher than 20% and/or rising rates. For example, in the United Arab Emirates (UAE), CB accounted for ~33% of births in 2016 [4], while studies in Thailand and China revealed even

Comment [M2]: Instead of maternal /child ,it would be better to write maternal and neonatal outcomes.

higher CB rates of ~49% in 2017 [5] and 48% between 2010-11 [6], respectively. One concern related to these trends is the possibility of increased numbers of medically unnecessary CB. When CB is medically unnecessary, it does not improve maternal and/or neonatal outcomes [7] but does incur risks for the mother and child [8],[9]. While earlier studies explored CB rates in Asia, findings were difficult to interpret or compare between settings because no standardized tool or classification system was used. A 2011 systematic review identified 27 different CB classification systems being used worldwide and determined that the Robson 10-Group Classification System (TGCS) was the most informative approach to documenting CB rates across the globe [10]. In 2015, the WHO proposed the use of the Robson TGCS as a global standard for assessing, monitoring, and comparing CB within/across healthcare facilities and countries worldwide [11]. The purpose of this study was to synthesize and critique 2011.

Comment [M3]: Intead incur risks

Comment [M4]: Add hospital research setting

Comment [M5]: Sentence sees incomplete,kindly reframe it to look complete and sensible

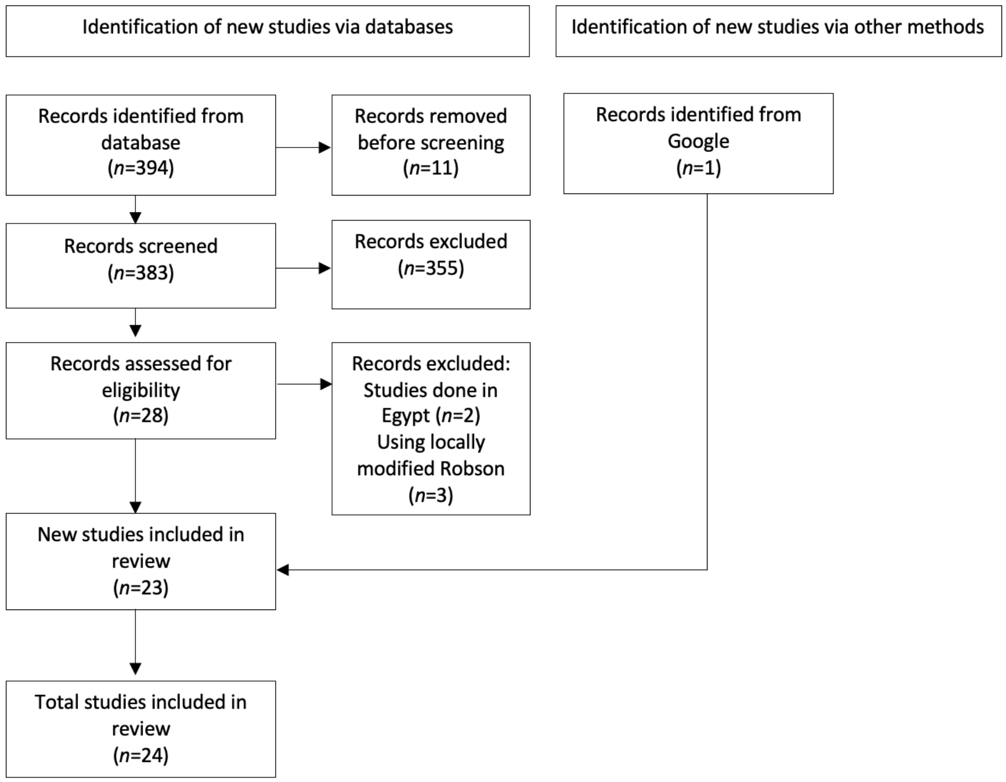
2. MATERIAL AND METHODS

This literature review and synthesis included studies meeting the inclusion criteria published between January, 2011 and June, 2021. This timeframe was selected to correspond with the peer reviewed published introduction of the Robson TGCS in 2011 [10]. Literature searches were conducted in MEDLINE, CINAHL, PubMed, Scopus, and Google Scholar. The Medical Subject Headings (MeSH) terms for CB terms included, "ca/esarean section", "ca/esarean birth", "c-section", "abdominal delivery", "operative birth", "surgical birth", or "surgical delivery". The Robson classification terms included, "Robson classification", "Robson system", "Ten (10)-groups classification", or TGCS. The MeSH terms for Asia included, "asia*, as well as listing each of the countries (e.g., Borneo, Brunei, Cambodia*, Indochin*, Russia*, or Siberia*).

The inclusion criteria were: (a) CB numbers/cases and/or rate was reported, (b) the Robson TGCS was used, (c) the study was conducted in Asia, (d) written in English, and (e) published in a peer-reviewed journal. Exclusion criteria were: (a) studies using an alternate CB classification system or a locally modified Robson TGCS, (b) studies focusing on a single Robson Group, and (c) studies focusing solely on one sub-population (e.g., women undergoing assisted reproductive technology).

The initial search yielded 394 articles, with one additional article identified by searching Google using Robson TGCS, Cesarean birth, and Asia/n. Once duplicates were excluded and a final screening using inclusion/exclusion criteria was conducted, the final number of publications included in this review was 24 (Figure 1).

Figure 1. PRISMA 2020 Flow Diagram



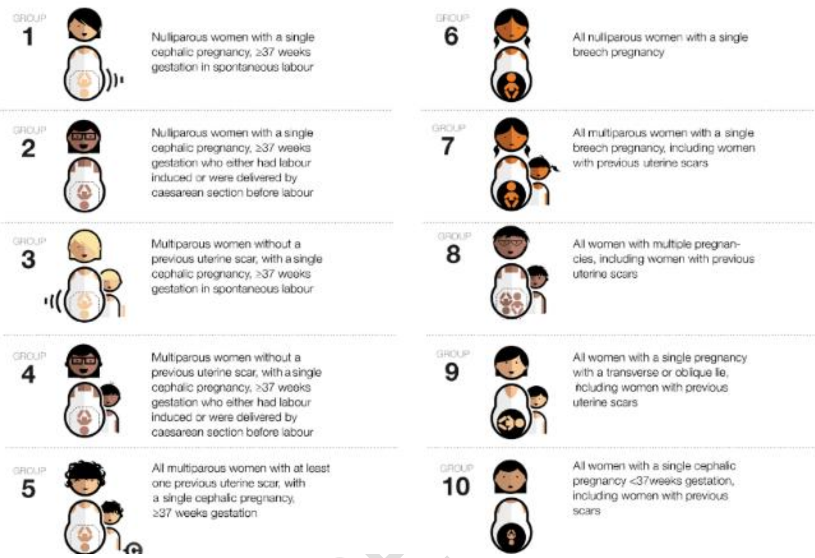
Data extraction included author, year of publication, country, UN geoscheme/region, country Human Development Index (HDI), and Robson TGCS. To better characterize the studies included in this literature review and synthesis, we also extracted information about the number of study participants, participants' age, study timespan (in years), and number of sites/hospitals involved. Among demographic characteristics, maternal age is an important focus for research regarding CB because advanced maternal age has been widely associated with CB in multiple populations [12–14]. As well, teens are at higher risk for CB [15]. Sample size, years during which the study was accomplished, and the number of sites/hospitals involved in each study were included in this review because these data may provide insight into the robustness and external validity of the included studies.

The Robson TGCS, the UN geoscheme/regions, and the UN HDI are briefly introduced in the following paragraphs.

2.1 The Robson 10-Group Classification System (TGCS*)*

The Robson 10-Group Classification System (TGCS) was used to compare CB rates in each of the studies included in this literature synthesis. The Robson TGCS divides women into ten mutually exclusive categories or groups (Figure 2), based on a number of perinatal characteristics, including parity, obstetric history, onset and course of labor and delivery, gestational age, and fetal position [16]. Using Robson TGCS enables comparison of antecedent events and/or indicators of CB rather than focusing only on overall CB numbers/rates. The Robson TGCS is increasingly being used since the WHO recommended it in 2015 [11].

Figure 2. Robson 10-Group Classification



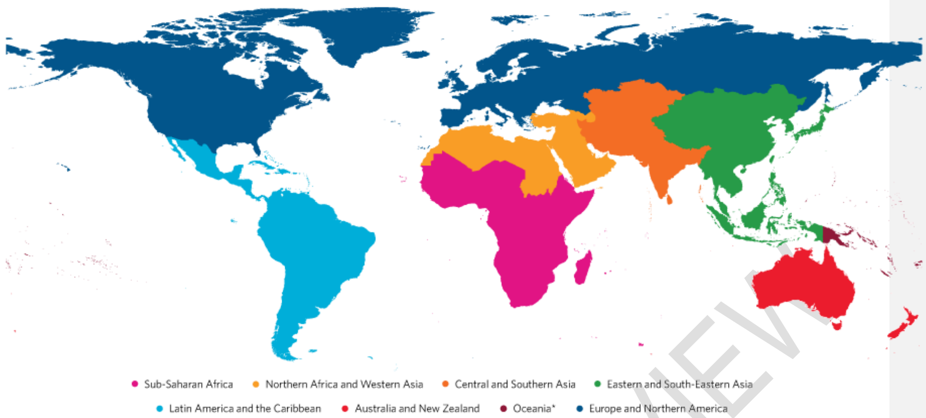
Picture from World Health Organization [17] https://www.who.int/reproductivehealth/publications/maternal_perinatal_health/robson-classification/en/

2.2 United Nations Geoscheme/ Regions of Asia

The United Nations subdivides Asia into five geoschemes or regions: Western, Central, Southern, South-East, and Eastern Asia (Figure 3). Each region includes multiple countries. For example, Western Asia includes Iraq, Saudi Arabia, Turkey, and the UAE. These Western Asian countries, which are also referred to as the Middle East, are different for many reasons from former Soviet countries (e.g., Azerbaijan, etc.), which are included in the Central Asia region, or countries categorized as part of Southern Asia, such as India, Nepal, and Pakistan.

Differences between Asian countries and regions include variations in healthcare practices and health policies, both of which may impact women's/families' options and decision making [18-19]. Further, overall rates of CB vary widely by country and region: for example, the CB rate in China is very high (46.2%) and Chinese CB rates are increasing [6]. In contrast, within the same region (Eastern Asia), the CB rate in Japan is comparatively low (19.8%) and Japanese CB rates are decreasing [6]. Rates also vary within/across individual countries, as access to resources vary especially in rural areas. Based on this information, we extracted information about the country and region in which each study was conducted. This information enabled comparison of the Robson TGCS by region in Asia.

Figure 3. United Nations (UN) Regional Groups

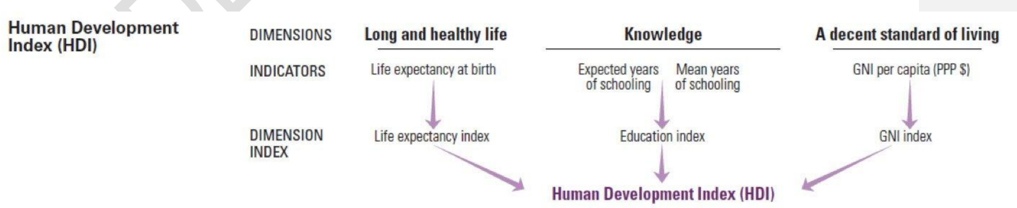


Picture from United Nation [20] https://unstats.un.org/sdgs/report/2019/regional-groups/

2.3 Human Development Index (HDI)

Countries are often classified by economic levels alone. The UN Human Development Index (HDI) is an overall assessment includes three dimensions of human development: 1) a long and healthy life, 2) access to knowledge, and 3) a decent standard of living [21]. The four HDI levels are very high, high, medium, and low. According to the UN, the entire range of HDI levels is represented in Asia [21]. Further, CB rates have been increasing across low to very high level HDI countries, although research suggests that CB rates and associated factors vary by HDI ratings [22]. For low level HDI countries, rising of CB rates are often associated with an increase in access to perinatal care, while in very high level HDI countries rising CB rates are associated with maternal choice [23]. Identifying the country's HDI allows for comparisons of similar HDI countries within Asia, as well as across the globe. It also has the potential to provide additional insight into current CB rates, trends, and Robson group distribution.

Figure 4. The key dimensions of human development



Picture from United Nations Development Programme [21] http://hdr.undp.org/en/content/human-development-index-hdi

3. RESULTS

The primary focus of this literature review and synthesis was to identify which Robson groups were most prevalent among women birthing in Asia. For each study, the three largest Robson groups were recorded, along with the country(ies), region(s), and HDI level(s) (Table 1).

Table 1. Main Contributors to Overall CB

Authors (year)	**Country (Region)**	**HDI Level**	**Contributors by Robson Group**									
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Abdallah et al. (2021) [24]	Lebanon (West Asia)	High		✓			✓					✓
Abdulrahman et al. (2019) [4]	UAE (West Asia)	Very high					✓			✓	✓	
Alsulami et al. (2020) [25]	Saudi Arabia (West Asia)	Very high		✓	✓		✓					
Anekpornwattana et al. (2020) [5]	Thailand (South-East Asia)	High	✓	✓			✓					
Bhati, Jha, & Agarwal (2016) [26]	India (South Asia)	Medium		✓	✓		✓					
Cagan et al. (2021) [27]	Turkey (West Asia)	Very high	✓	✓			✓					
Chung, Kong, & To (2017) [28]	Hongkong (East Asia)	Very high	✓	✓			✓					
Kankoon et al. (2018) [29]	Thailand (South-East Asia)	High	✓	✓			✓					
Karalasingam et al. (2020) [30]	Malaysia (South-East Asia)	Very high	✓		✓		✓					
Malla et al. (2018) [31]	Nepal (South Asia)	Medium	✓		✓		✓					
Markandu (2020) [32]	Sri Lanka (South Asia)	High		✓		✓	✓					
Naik, Rani, & Ratnani (2021) [33]	India (South Asia)	Medium	✓	✓			✓					
Parveen et al. (2021) [34]	Pakistan (South Asia)	Medium	✓				✓					✓

Authors (year)	Country (Region)	HDI Level	Contributors by Robson Group									
			1	2	3	4	5	6	7	8	9	10
Pukale, Joshi, & Arathi (2016) [35]	India (South)	Medium	✓	✓			✓					
Rookesh, Zarshenas, & Akbarzadeh (2020) [36]	Iran (South Asia)	High		✓			✓					✓
Senanayake et al. (2019) [37]	Sri Lanka (South Asia)	High	✓	✓			✓					
Sukmanee et al. (2020) [38]	Thailand (South-East Asia)	High	✓	✓			✓					
Sungkar et al. (2019) [39]	Indonesia (South-East Asia)	High	✓		✓							✓
Tamang et al. (2020) [40]	Bhutan (South Asia)	Medium	✓			✓	✓					
Tan, Tan, & Kanagalingan (2015) [41]	Singapore (South-East Asia)	Very high		✓			✓					✓
Vogel et al. (2015) [6]	9/21 countries were in Asia (East, South-East, and South Asia)	Low, Medium, High, Very high	✓	✓			✓					
Wen, Chen, & Luo (2020) [42]	China (East Asia)	High		✓			✓					✓
Yadav & Maitra (2016) [43]	India (South Asia)	Medium	✓		✓		✓					
Zimmo et al. (2018) [44]	Palestine (West Asia)	High					✓			✓		✓

Note: ■ *first largest CB contributor,* ■ *second largest CB contributor, and* ■ *third largest CB contributor*

Synthesis of this literature suggests that: 1) Group 5 was the largest overall contributor to CB numbers/rates among women birthing in Asia, with little variation across countries/regions and HDI levels; 2) Groups 6, 7, and 9 were the lowest overall contributors to Asian CB numbers/rates; 3) Most studies were from South, South-East, and East Asia, respectively; and 4) Most studies were conducted in high to very high HDI level countries in Asia. Further details related to each of these findings are presented in the following paragraphs.

3.1 Group 5 was the largest overall contributor to CB numbers/rates in Asia, with little variation across countries/regions and HDI levels

All but one study (*n*=23; 96%) reported that Robson Group 5 [multiparous women with history of CB and a single cephalic pregnancy at 37 or greater weeks gestation] was the main contributor to their overall CB numbers/rate. The majority of these studies (*n*=16; 70%) indicated that Group 5 was the top contributor, while the remaining (*n*=7; 30%) showed that Group 5 was the second largest contributor. After Group 5, the largest contributors were: 1) Group 2 [nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation who either had labor induced or were delivered by CB before labor]; 2) Group 1 [nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation in spontaneous labor]; and 3) Group 10 [all women with a single cephalic pregnancy at less than or equal to 37 weeks gestation], respectively. The majority of studies followed this distribution, with one exception. One study conducted in Indonesia, identified Group 10 [premature birth] as the top contributor to Indonesian CB rates, followed by Groups 1 and 2 respectively.

There was minimal variation in the distribution of Robson groups across regions and HDI levels. Group 5 was a primary contributor to the overall CB numbers/rates in all regions. The dominance of Group 5 as the primary CB driver in Asia was also noted across HDI levels, again with only one study in a high HDI level country not identifying Group 5 in the top three groups.

3.2 Groups 6, 7, and 9 were the lowest contributors to CB numbers/rates in Asia

Robson Groups 6, 7, and 9 [women with non-cephalic presentation of fetus e.g. breech, transverse, oblique] were the lowest overall contributors to reported CB numbers/rates in Asia. No studies placed Group 6 and 7 in their top three contributors, and only one study (the UAE) ranked Group 9 as the third most common Robson indicator for CB.

3.3 Most studies were from South, South-East, and East Asia, respectively

Ten studies (43%) were conducted in South Asia; followed by six (26%) studied in conducted in South-East Asia, five (22%) conducted in West Asia, and two (9%) conducted in East Asia. One additional study included 21 countries, including 12 outside Asia; the 9 Asian countries in this study were also from South, South-East, and East Asia. Multiple countries were represented within/across each region. The highest number of studies in South Asia were conducted in India (*n*=4), followed by Sri Lanka (2), and Pakistan (1), Nepal (1), Bhutan (1), and Iran (1). Of the six studies in South-East Asia, three (50%) were conducted in Thailand, with one additional study in each of the following countries: Indonesia, Malaysia, and Singapore. Each of the five West Asian studies were conducted in a different country, as were the two studies completed in East Asia. No study was conducted solely in Central Asia, making it the region least represented in this review.

3.4 Most studies were conducted in high to very high HDI level countries in Asia

Over half of the studies (~67%) were conducted in high (*n*=10) or very high (*n*=6) HDI level countries. Only seven studies were conducted in medium HDI level countries. One additional study examined a large number of countries (*n*=21) of which nine were Asian countries. These nine countries represented a cross section of HDI levels. This large study was the only one to include low HDI level Asian countries. There was no study that exclusively examined CB rates of low HDI level Asian countries. While the largest number of studies in this review were conducted in South Asia, none of the South Asia countries in which the research was conducted had a very high HDI level designation and only three (30%) were considered high HDI level. In contrast to the other regions of Asia, the majority of countries in South Asia (*n*=7; 70%) are considered medium HDI level.

Information about the number of study participants, participants age, study timespan (in years), and number of sites/hospitals involved (Table 2).

Table 2 Data Collection of Each Study

<table>
<tr><th rowspan="2">Author(s) (year)</th><th colspan="4">Medical Record</th></tr>
<tr><th>Participants
Overall #

(CB #)</th><th>Length Date(s)</th><th># Hospitals</th><th>Maternal Age
(Overall sample; unless specified otherwise)</th></tr>
<tr><td>Abdallah et al. (2021) [24]</td><td>1,779
(1,011)</td><td>3 years
(2018-20)</td><td>1</td><td>Not reported</td></tr>
<tr><td>Abdulrahman et al. (2019) [4]</td><td>5,461
(1,824)</td><td>9 months
(2016)</td><td>2</td><td><table><tr><th>Age</th><th>No. (%)</th></tr><tr><td><20
20-29
30-34
≥35</td><td>76 (1%)
2,361 (44%)
1,673 (31%)
1,300 (24%)</td></tr></table></td></tr>
<tr><td>Alsulami et al. (2020) [25]</td><td>3,168
(870)</td><td>1 year
(2018)</td><td>1</td><td>Not reported</td></tr>
<tr><td>Anekpornwattana et al. (2020) [5]</td><td>4,998
(2,442)</td><td>8 months
(2017)</td><td>1</td><td><table><tr><th>Type of birth</th><th>Mean age ±SD</th></tr><tr><td>Overall</td><td>29.9 ± 6.3 years</td></tr><tr><td>CB</td><td>31.6 ± 5.9 years</td></tr><tr><td>Vaginal birth</td><td>28.4 ± 6.2 years</td></tr></table></td></tr>
</table>

<table>
<tr><th rowspan="2">Author(s) (year)</th><th colspan="4">Medical Record</th></tr>
<tr><th>Participants
Overall #

(CB #)</th><th>Length
Date(s)</th><th>#
Hospitals</th><th>Maternal Age
(Overall sample; unless specified otherwise)</th></tr>
<tr><td>Bhati, Jha, & Agarwal (2016) [26]</td><td>5,285
(1,514)</td><td>3 months
(2012)</td><td>1</td><td>Women with CB

Age — No.(%)
15-20 — 336 (22%)
21-25 — 752 (50%)
26-30 — 337 (22 %)
31-35 — 71 (5%)
35-40 — 18 (1%)</td></tr>
<tr><td>Cagan et al. (2021) [27]</td><td>10,458
(4,236)

Total number across 5 datasets</td><td>5 years
(1 year-study conducted every 10 years)
(1976-2016; 5 datasets)</td><td>1</td><td>Not reported</td></tr>
<tr><td>Chung, Kong, & To (2017) [28]</td><td>86,262
(17,140)</td><td>20 years
(1995-2014)</td><td>1</td><td>Not reported</td></tr>
<tr><td>Kankoon et al. (2018) [29]</td><td>18,043
(5,666)</td><td>1 year
(2014)</td><td>24</td><td>Not reported</td></tr>
<tr><td>Karalasingam et al. (2020) [30]</td><td>608,747
(141,257)</td><td>5 years
(2011-15)</td><td>12</td><td>Not reported</td></tr>
<tr><td>Malla et al. (2018) [31]</td><td>4,892
(1,104)</td><td>5 years
(2012-17)</td><td>1</td><td>Overall sample Mean age: 26.9 years old.

Women with CB

Age — No. (%)
16-25 — 411 (37%)
26-35 — 658 (60%)
36-45 — 34 (3%)
46-55 — 1</td></tr>
</table>

<table>
<tr><th rowspan="2">Author(s) (year)</th><th colspan="4">Medical Record</th></tr>
<tr><th>Participants
Overall #

(CB #)</th><th>Length
Date(s)</th><th>#
Hospitals</th><th>Maternal Age
(Overall sample; unless specified otherwise)</th></tr>
<tr><td>Markandu (2020) [32]</td><td>2,968 (720)</td><td>6 months
(2019)</td><td>1</td><td>Women with CB
<table><tr><th>Age</th><th>No. (%)</th></tr><tr><td><16
17-35
>35</td><td>76 (11%)
500 (69%)
144 (20%)</td></tr></table></td></tr>
<tr><td>Naik, Rani, & Ratnani (2021) [33]</td><td>1,586 (972)</td><td>1 year
(2019-20)</td><td>1</td><td>Not reported</td></tr>
<tr><td>Parveen et al. (2021) [34]</td><td>---

(167)</td><td>6 months
(2019-20)</td><td>1</td><td>Mean age: 26.53±5.1 years
<table><tr><th>Age</th><th>No. (%)</th></tr><tr><td><20
20–35
>35</td><td>10 (6%)
152 (91%)
5 (3%)</td></tr></table></td></tr>
<tr><td>Pukale, Joshi, & Arathi (2016) [35]</td><td>2,00 (939)</td><td>1.5 years
(---)</td><td>1</td><td><table><tr><th>Age</th><th>Vaginal Birth
No. (%)</th><th>CB
No.(%)</th></tr><tr><td><20
20-24
25-29
30-34
35-39
40-44</td><td>89 (8%)
691 (65%)
242 (23%)
32 (3%)
7 (1%)
-</td><td>52 (6%)
507 (54%)
303 (32%)
57 (6%)
19 (2%)
1 (<1%)</td></tr></table></td></tr>
<tr><td>Rookesh, Zarshenas, & Akbarzadeh (2020) [36]</td><td>----
(1,787)</td><td>3 months
(2018)</td><td>2</td><td>Mean age 26.4±5.7 years
<table><tr><th>Age</th><th>No. (%)</th></tr><tr><td><20
20-24
25-29
≥30</td><td>173 (10%)
423 (24%)
824 (46%)
367 (20%)</td></tr></table></td></tr>
</table>

<table>
<tr><th rowspan="2">Author(s) (year)</th><th colspan="4">Medical Record</th></tr>
<tr><th>Participants
Overall #

(CB #)</th><th>Length
Date(s)</th><th>#
Hospitals</th><th>Maternal Age
(Overall sample; unless specified otherwise)</th></tr>
<tr><td>Senanayake et al. (2019) [37]</td><td>7,504
(2,251)</td><td>2 years
(2015-17)</td><td>1</td><td>Not reported</td></tr>
<tr><td>Sukmanee et al. (2020) [38]</td><td>10,474
(5,825)</td><td>3 years
(2014-16)</td><td>1</td><td><table>
<tr><td rowspan="2">Age</td><td>No. (%)</td><td>No. (%)</td><td>No. (%)</td></tr>
<tr><td>Year 1
(n=3,484)</td><td>Year 2
(n=3,609)</td><td>Year 3
(n=3,381)</td></tr>
<tr><td><20
20-34
≥35</td><td>157 (5%)
2,545 (73%)
782 (22%)</td><td>139 (4%)
2,612 (72%)
858 (24%)</td><td>116 (3%)
2,428 (72%)
837 (25%)</td></tr>
</table></td></tr>
<tr><td>Sungkar et al. (2019) [39]</td><td>2,606
(1,252)</td><td>1 year
(2013)</td><td>1</td><td><table>
<tr><td>Age</td><td>No. (%)</td></tr>
<tr><td>10-19
20-29
30-39
40-49
≥50</td><td>220 (9%)
1,109 (43%)
1,075 (41%)
157 (6%)
6 (<1%)</td></tr>
</table>**There were 39 missing data</td></tr>
<tr><td>Tamang et al. (2020) [40]</td><td>2,337 (804)</td><td>3 years
(2016-18)</td><td>1</td><td><table>
<tr><td>Age</td><td>No. (%)</td></tr>
<tr><td><20
20-29
30-39
>40</td><td>165 (7%)
1388 (60%)
703 (30%)
81 (3%)</td></tr>
</table></td></tr>
<tr><td>Tan, Tan, & Kanagalingan (2015) [41]</td><td>6,074
(2,011)</td><td>4 years
(2008-14)</td><td>1</td><td>Not reported</td></tr>
</table>

Author(s) (year)	Medical Record			
	Participants Overall # (CB #)	**Length Date(s)**	**# Hospitals**	**Maternal Age** (Overall sample; unless specified otherwise)
Vogel et al. (2015) [6]	Survey 1 227,811 (60,090) (Asia subset) 104,946 (28,631)	2 years (2007-08)	287 (Asia subset) 118	Overall sample includes Asian subset Age | Survey 1 <20 | 27,381 (12%) 20–35 | 182,72 (80%) >35 | 17,263 (8%) Age | Survey 2 <20 | 26,069 (11%) 20–35 | 192,693(81%) >35 | 19,905 (8%)
	Survey 2 239,144 (74,582) (Asia subset) 116,046 (35,105)	˜2 years (2010-11)		
Wen, Chen, & Luo (2020) [42]	54,085 (24,689)	3 years (2015-17)	1	Not reported
Yadav & Maitra (2016) [43]	40,086 (10,093)	10 years (2004-13)	1	Age | No. (%) 18-20 | 6,315 (16%) 21-25 | 21,211 (53%) 26-30 | 9,649 (24%) 31-35 | 2,359 (6%) >35 | 552 (1%)
Zimmo et al. (2018)	18,908	1.5 years (2016-	3	Not reported. Narrative comments: Ages 21-30 was

Author(s) (year)	Medical Record			
	Participants Overall # (CB #)	**Length Date(s)**	**# Hospitals**	**Maternal Age** (Overall sample; unless specified otherwise)
[44]	(4,377)	17)		largest group.

Synthesis of this literature suggests that: 1) maternal age was inconsistently reported, 2) most studies were ≤ 2 years in length and involved one hospital/site, and 3) study sample sizes ranged from 167 - 608,747, with the majority (*n*=13; 54%) of the studies having sample sizes of 1,500-7,500.

3.5 Maternal age was inconsistently reported.

Information about maternal age was reported in just over half (*n*=14; 58%) of the studies; however, the details provided were inconsistent. While some studies reported age range distributions, the reported age ranges were inconsistent, with studies separating age groups into three to six groups. For example, Markandu et al (2020) reported age ranges using three categories [<16 years old; 17-35 years old; >35 years old], while Pukale et al (2016) reported age ranges using six categories [<20 years old; 20-24 years old; 25-29 years old; 30-34 years old; 35-39 years old; 40-44 years old]. These kinds of variations in reporting challenged age-based comparison between studies. Higher risk age groups were never the primary study focus and/or never made up more than 25% of the sample size in each study. The dominant age group in the literature included in this review was 20-35 years of age. When mean age was shared for the overall sample as a whole, it fell between 26-29 years of age, although one study reported mean scores for vaginal births (28.4 years of age) and CB (31.6 years of age) separately [5]. Importantly, no studies reported maternal age distribution within Robson Groups.

3.6 Most studies were ≤ 2 years in length and involved one hospital/site

Over half of the studies (*n*=13; 54%) were ≤ 2 years in length; however, there was a broad range of timeframes (3 months – 20 years). The median study duration was 1.75 years and the mean study duration was 3.2. And there was a bimodal distribution with one and three years being most prevalent. The majority of studies (*n*=18; 75%) collected data from one hospital/site; however, the remaining six studies varied widely, using 2-24 hospitals/sites.

3.7 The majority of the studies had robust sample sizes

Just over half (*n*=13; 54%) of the studies reported overall sample sizes between 1,500-7,500, followed by four (17%) studies with sample sizes between 10,000-20,000[27], [29], [38], [44]; two (8%) studies with sample sizes between 40,000-50,000 [42], [43]; two (8%) studies with sample sizes between 85,000-120,000 [6], [28]; one (4%) study with a sample size over 600,000 [30]. Two studies did not report the sample sizes [34], [36]. When examining only the sample size in CB subsets, half (*n*=13; 54%) were between 1,000-5,800; five (21%) between 700-999; and four (17%) between 17,000-35,000. There was one outlier with a sample size under 200 (4%) and one outlier with a sample size over 100,000 (4%).

4. DISCUSSION

Results of this literature review and synthesis suggest that while there are minor differences in CB contributors by region and/or country HDI level, multiparous women with history of CB (Robson Group 5) is the largest overall contributor to reported CB numbers/rates across Asia. Most studies were conducted in South, South-East, and East Asia and included countries with high to very high HDI levels. Maternal age was inconsistently reported, if at all, and there were no reports of maternal age by Robson Groups, even for those high-risk groups at the extremes of reproductive age (< 20 years and > 35 years age) [45]. Finally, while most studies boast robust sample size, most were local studies, limited to one hospital/ site and covered relatively short time periods, which limits generalizability.

4.1 Robson Classification Variations

The primary contribution from this synthesis of the literature was documenting the sizeable contribution of Robson Group 5 to CB rates in Asian countries since 2011. This finding is consistent with studies conducted in non-Asian countries [46], [47], as well as Robson's primary study (2001) which demonstrated that while Groups 1 and 3 continue to be the largest in size in most obstetric populations, Group 5 is the largest contributor to the overall CB rate [16]. The findings also highlight the value of using the Robson TGCS and the importance of closely examining CB indicators and maternal characteristics, such as age [14], that might shape patterns of CB use among Asian women.

In the one study in which Group 5 was not one of the top three contributors [39], we noted that the study was conducted at a tertiary care hospital, where high risk women and/or women with identified complications are typically referred. This may have importantly impacted the reason that Group 10 (preterm pregnancy) was their largest contributor to CB numbers/rates [39].

Comment [M6]: You may provide a better justification as in case that facility was referring high risk women,they might certainly be referring preterm gestations also in need of better nursery and NICU facilities

While women whose labors were categorized as Group 5 were the most common contributor to CB rates, Group 2, nulliparous pregnant women experiencing either labor induction or prelabor CB was the second largest contributor to CB among women birthing in Asia. This finding is similar to prior studies that found a positive association between labor induction and CB [48]. Further, nulliparous women with induced labor have a greater chance of delivery by CB compared to multiparous women with labor induction [49]. However, one study including women who were at least 39 week gestation suggests that induction is not associated with CB and may actually lower rate of CB [50].

The third largest contributor to CB rates was Group 1: nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks of gestation in spontaneous labor. There is no literature to support a biophysical rationale for this trend. However, there are some regional practices that may contribute to this finding. For example, in Thailand and China many women choose CB because they can pick the date of birth and thus select auspicious birth dates [51–53]. This is likely related to the belief that if children are born on an auspicious date, they will bring prosperity and peace in their family [54]. In Iran, a common belief is that if a woman has a CB it reflects their elevated class and status, as it is more expensive than natural childbirth and not everyone can afford it [55]. It will be important for future CB research among Asian women to explore these and other cultural factors that may shape mode of delivery outcomes.

Comment [M7]: Suggestion may be given for increase in access of labour analgesia even in government hospitals to motivate nulliparous women to withstand labourpain and opt for vaginal delivery. The fear of perineal trauma and disfiguration of genitalia may be one of the reasons for nulliparas to opt for CB

Groups 6, 7, and 9 were the lowest Robson TGCS contributors to CB across the studies. These Robson groups are commonly smaller CB contributors than the other groups as the incidence of malpresentation (e.g. transverse, oblique) of fetus is low [56] and the incidence of breech presentation decreases as gestational age increases [57].

4.2 Regional Variations

While Robson Group 5 was identified as the largest contributor across regions, almost all of the studies in this synthesis were from South, South-East, and West Asia, respectively, with only two studies from East Asia. There are distinct differences between Asian regions and countries. For example, East Asia includes China, Japan, and Korea, as well as others. While there are similarities between these countries, it is important to recognize that each country, even though they are in the same region, has its own beliefs, culture, and policies, each of which might shape CB rates. Each country also has its own healthcare system, practices, and resources, which in turn influence the mode(s) of delivery available. One example is the long-standing, one-child policy in China, which was reversed in 2016, which resulted in a decreased rate of CB [19].

4.3 HDI Level Variations

Findings of this literature indicate that most CB research in Asia has been conducted in high to very high HDI level countries, although there were some studies from medium level HDI countries. The only study to provide any insight into low level HDI countries was part of a very large study that included almost all Asia regions along with other UN geoscheme designations. Our finding that Robson Group 5 was the largest CB contributor in Asia may not hold true for low level HDI countries for many possible reasons (e.g., CB may not be as broadly available in low level HDI countries of Asia). We did find that while Robson Group 5 dominated the first ranked contributor in both high and very high countries, medium level HDI countries more commonly found Group 5 ranking second behind Group 1. This pattern may be even more pronounced among low level HDI countries. Our findings align with the WHO mulitcountry survey indicating that while Group 5 was the largest contributor followed by Group 2 in high and very high level HDI countries, Group 1 was the largest contributor followed by Group 5 in medium level HDI countries[6]. It is important to keep in mind that Group 8 (multiples) was ranked as the second largest in one study [4]. This study was from the UAE, a very high level HDI country, which may more frequently offer costly assisted reproduction technologies (ART) than lower level HDI Asian countries. ART is strongly associated with twinning [58].

Comment [M8]: USE TERM WIDELY OR FREELY AVAILABLE

Comment [M9]: REFRAME THE SENTENCE ,I THINK YOU MEAN GROUP 1 WAS HIGHEST RANKING GROUP FOR MEDIUM HDI COUNTRIES?

4.4 Maternal Age

Maternal age was inconsistently reported, if at all, even for those women in the high-risk extremes of reproductive age group at both ends (< 20 years and > 35 years age) [45]. Pregnancies among teens are at increased risk for complication by anemia, preterm labor, low birth weight, pre-eclampsia, and a high rate of CB [15], [59]. At the another extreme, advanced maternal age (AMA) is also a known risk factor for CB [60]. This finding was also seen in one study in this review where Pukale and colleagues demonstrated that CB rates of pregnant women whose age was greater than 35 years old (vs. < 35 years old) were significantly more likely to deliver by CB [35].

Comment [M10]: PLEASE REFRAME THE SENTENCE,EITHER WRITE CB RATES WERE HIGHER OR WRITE MORE LIKELY TO DELIVER BY CS

4.5 Trial of Labor After Cesarean (TOLAC)

There were very few details or comments within/across the studies about Trial of Labor After Cesarean (TOLAC) or unsuccessful Vaginal Birth After Cesarean (VBAC). One study mentioned that although TOLAC reduces repeated CB, TOLAC is not recommended in their institution [5], [29], [40]. Moreover, there are other reasons why women in Robson Group 5 tended to undergo repeat CB, such as fear of uterine rupture [34], [36], need for TOLAC training [32], [38], [44], or having low rates of successful VBAC [41], [42]. This suggests that maternity care health systems factors in Asia may importantly shape patterns of CB use [61]. A recent meta-analysis identified a number of maternal and neonatal factors that contribute to unsuccessful VBAC rates, including AMA, Body Mass Index, and macrosomia [62]. For these reasons, future CB research among women birthing in Asia especially those of AMA should also collect those maternal and neonatal characteristics to inform best practice. Refining understanding of these phenomenon in Asia will importantly contribute to international literature regarding interventions to reduce unnecessary CB [63].

5. Conclusion

This literature review and synthesis of studies conducted in Asian countries over the past 10 years using the Robson TGCS provides insights and identified gaps in understanding still in need of being addressed. The gaps we note include: 1) the lack of identification of maternal age groups, including women of AMA; 2) the lack of studies exploring rising CB rates and Robson TGCS in low level HDI Asian countries; and 3) the lack of studies from Central Asia. Each of these indicate important directions for future research.

Comment [M11]: noted

One key finding of this review was that women with a previous CB (Robson Group 5) provided the largest contribution to CB rates across Asia, regardless of region, country, or HDI level. While not all studies included in this review and synthesis included information about TOLAC and VBAC norms within their institutions, three studies suggested that TOLAC and VBAC are not common in their hospital setting in especially in Thailand [5], [29], [40]. Association between hospital level systems discouragement for TOLAC and VBAC has been associated with Robson Group 5 dominance as the leading CB indicator in three countries [5], [29], [40]. Studies regarding the influence of maternity health systems factors and CB use will be an important direction for future research.

Comment [M12]: remove IN

Use of the Robson TGCS provides meaningful insight into the broad variation in antecedent events and/or indicators of CB numbers/rates. More granular data collection and reporting with future studies will support deeper insights into the local influences and unique differences within/across Asian countries and regions as well as facilitate comparison between Asian CB patterns vs. worldwide CB patterns. It is also important to document rates of CB by maternal age, as different age groups have different risks of CB. These insights can provide opportunities for increased understanding of CB rates and the development of targeted and tailored interventions. Ultimately, this collective information will support decreasing unnecessary CB use among women birthing in Asia.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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