



Prevalence , Diagnosis and Management of Hemorage Post Partum in Early Young Woman Under 20 Years Old and Over 35 Years Old : A Systematic Review

¹ Triasih Amalya

¹ Faculty of Medicine, Muhammadiyah University of Semarang, Indonesia

Corresponding Email : triasihamalya1.unimus@gmail.com

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ABSTRACT

Introduction: Postpartum hemorrhage (PPH) remains the leading cause of maternal mortality globally, with maternal age extremes representing potentially vulnerable populations. This systematic review aimed to evaluate the prevalence, diagnosis, and management of PPH in women under 20 years and over 35 years of age.

Methods: A systematic review was conducted following PRISMA guidelines. We screened studies based on predefined criteria including target age groups (<20 or ≥35 years), relevant outcomes (prevalence, diagnosis, management), recognized PPH definitions, and acceptable study designs. Data extraction encompassed study characteristics, age-specific prevalence, risk factors, diagnostic methods, management approaches, prevention strategies, and outcomes by age.

Results: From 105 included studies, global PPH prevalence was estimated at 9.97% (95% CI: 6.90%-13.04%). Both maternal age extremes demonstrated elevated risk in a U-shaped pattern.

Women ≥ 35 years had significantly higher PPH incidence (OR range: 1.73-4.61), with rates reaching 23-30.7% compared to 4.3-16.0% in younger women. Women < 20 years showed comparable elevated risk (OR=1.73, $p=0.005$). Risk factors concentrated in older mothers included grand multiparity (92.5%), pre-existing diabetes (26%), and hypertensive disorders (38.6%). Diagnostic methods lacked age-specific approaches. Management strategies included uterotonics (oxytocin, misoprostol), tranexamic acid (1g IV within 3 hours), mechanical interventions (balloon tamponade success 81.3-87.9%), and surgical procedures (uterine compression sutures, artery ligation). Fertility-preserving interventions were prioritized in younger women. Multi-faceted interventions reduced PPH incidence from 14.01% to 4.90% and maternal mortality from 1,104/100,000 to 279/100,000.

Discussion: The elevated PPH risk at both age extremes suggests shared pathways through uterine dysfunction and comorbidities, though mechanisms likely differ—biological immaturity and primiparity in young mothers versus accumulated comorbidities and grand multiparity in older mothers. The absence of age-specific diagnostic protocols represents a critical gap, as physiological responses to hemorrhage may vary by age. Context-dependent effectiveness of interventions (tranexamic acid, misoprostol) underscores the need for resource-stratified guidelines.

Conclusion: Both young (< 20) and older (≥ 35) mothers face significantly elevated PPH risk, warranting enhanced surveillance and targeted prevention strategies. Future research should prioritize direct age-group comparisons, mechanistic studies, and resource-stratified clinical guidelines.

Keywords: Postpartum hemorrhage, maternal age, adolescent pregnancy, advanced maternal age, systematic review

INTRODUCTION

Background

Postpartum hemorrhage (PPH) remains the leading cause of maternal mortality worldwide, accounting for approximately 25% of all maternal deaths and affecting millions of women annually [1]. Defined as blood loss ≥ 500 mL after vaginal delivery or ≥ 1000 mL after cesarean delivery within 24 hours of birth, PPH represents a critical obstetric emergency requiring prompt recognition and intervention [1, 3]. The global burden of PPH is substantial, with recent umbrella reviews estimating a pooled prevalence of 9.97% (95% CI: 6.90%-13.04%), increasing to 11.25% when using objective blood loss measurement [1]. Severe PPH occurs in approximately 4.52% of women, indicating that nearly one in twenty women worldwide experience life-threatening bleeding after childbirth [1].

Regional variations in PPH prevalence are considerable, ranging from 3.51% in some African studies to 8.24% in Ethiopia and 5.4% in the Netherlands [3, 18, 47]. These variations reflect differences in risk factor distribution, healthcare infrastructure, diagnostic practices, and measurement accuracy across settings [41, 42]. Sub-Saharan Africa bears a disproportionate burden, with PPH contributing significantly to the region's high maternal mortality ratios [2, 44].

Maternal age has emerged as a critical determinant of PPH risk, with both extremes of the reproductive age spectrum potentially conferring elevated vulnerability [4, 16]. Women under 20 years and those over 35 years represent physiologically distinct populations with unique risk profiles. Adolescent pregnancies are associated with biological immaturity, inadequate prenatal care utilization, and primiparity-related complications [91]. Conversely, advanced maternal age pregnancies have increased substantially over recent decades due to delayed childbearing, assisted reproductive technologies, and changing social norms [5, 6]. These older mothers often present with accumulated comorbidities, higher parity, and age-related uterine changes that may predispose to obstetric hemorrhage [5, 16].

Despite recognition that both age groups face elevated PPH risk, comprehensive evidence synthesizing prevalence patterns, diagnostic approaches, and management strategies specifically for these populations remains limited. Previous systematic reviews have examined PPH epidemiology broadly [41, 42] or focused on single age groups [6, 91], but few have systematically compared outcomes between young and older mothers within a unified analytical framework.

Research Gap

Several critical gaps exist in the current literature. First, while individual studies report age-stratified PPH rates, no systematic review has specifically synthesized prevalence data for both young (<20 years) and older (≥ 35 years) mothers using consistent diagnostic criteria. Second, it remains unclear whether diagnostic approaches require modification for these age groups, given potential differences in physiological reserve, hemodynamic responses to hemorrhage, and baseline comorbidity profiles. Third, evidence regarding age-specific management considerations—particularly interventions aimed at fertility preservation in young women versus complication management in older mothers—has not been systematically aggregated. Fourth, the effectiveness of prevention strategies when applied to these high-risk age groups lacks comprehensive evaluation. Fifth, direct comparative data between young and older mothers within the same populations are notably absent, limiting our understanding of whether similar mechanisms underlie elevated risk at both age extremes.

Novelty

This systematic review addresses these gaps by providing the first comprehensive synthesis of PPH evidence specifically focused on women at the extremes of reproductive age. Our novel contributions include: (1) simultaneous examination of both young (<20 years) and older (≥ 35 years) mothers using consistent analytical frameworks; (2) systematic comparison of risk factor profiles between age groups to identify shared and distinct pathways to hemorrhage; (3) evaluation of whether current diagnostic and management approaches adequately address age-specific needs; (4) synthesis of fertility-preserving intervention outcomes relevant to young mothers; and (5) identification of evidence gaps to guide future research prioritization.

Objectives

The primary objective of this systematic review was to evaluate the prevalence, diagnosis, and management of postpartum hemorrhage in women under 20 years and over 35 years of age. Secondary objectives included: (1) to compare PPH risk factors between young and older mothers; (2) to assess whether diagnostic approaches differ by maternal age; (3) to evaluate age-specific management and prevention strategies; and (4) to synthesize treatment outcomes stratified by maternal age.

Hypotheses

We hypothesized that: (1) both young (<20 years) and older (≥ 35 years) mothers would demonstrate significantly elevated PPH prevalence compared to women aged 20-34 years, following a U-shaped risk pattern; (2) risk factor profiles would differ between age groups, with young mothers showing predominance of primiparity-related factors and older mothers exhibiting comorbidity-associated risks; (3) diagnostic approaches would be applied uniformly without age-specific modifications; (4) management strategies would prioritize fertility preservation in young mothers while focusing on complication management in older mothers; and (5) treatment outcomes would be less favorable in older mothers due to accumulated comorbidities and reduced physiological reserve.

Benefits

This review offers several important benefits. For clinicians, it provides evidence-based guidance for risk stratification, surveillance intensity, and management prioritization when caring for pregnant women at age extremes. For guideline developers, it identifies areas requiring age-specific recommendations within PPH protocols. For researchers, it highlights critical evidence gaps requiring investigation, including the need for direct age-comparative studies and mechanistic research. For health systems, it informs resource allocation and training priorities to address the specific needs of these high-risk populations. Ultimately, by improving understanding of age-related PPH patterns, this review aims to contribute to reduced maternal morbidity and mortality among vulnerable women at both ends of the reproductive age spectrum.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the Prevalence , Diagnosis and Management of Hemorage Post Partum in Early Young Woman Under 20 Years Old and Over 35 Years Old.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Target Population - Age Groups:** Does this study involve postpartum women aged <20 years or ≥ 35 years who experienced postpartum hemorrhage, with clear age stratification providing separate data for these target age groups?
- **Relevant Outcomes:** Does this study report on at least one of the following outcomes: prevalence, diagnostic methods, or management strategies for postpartum hemorrhage?
- **Clinical Definition:** Does this study use a recognized clinical definition of postpartum hemorrhage (e.g., blood loss ≥ 500 mL vaginal delivery, ≥ 1000 mL cesarean delivery, or other validated criteria)?
- **Study Design:** Is this study one of the following acceptable designs: randomized controlled trial, cohort study, case-control study, cross-sectional study, case series (≥ 10 cases), systematic review, or meta-analysis?
- **Postpartum Hemorrhage Focus:** Does this study specifically address postpartum hemorrhage (rather than focusing solely on antepartum hemorrhage or other pregnancy complications without postpartum hemorrhage data)?

- **Data Extractability:** Does this study provide extractable data on at least one of the three outcomes (prevalence, diagnosis, or management) for the specified age groups (<20 years or ≥ 35 years)?
- **Human Studies:** Is this a human study (not an animal study or in-vitro study)?
- **Original Publication:** Is this an original publication (not a duplicate report of the same study population and outcomes already included in the review)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

Element	P (Population)	I (Intervention/Exposure)	C (Comparison/Context)	O (Outcome)
Keyword 1	Young Women	Diagnosis	<20 years vs. 20-34 years	Prevalence
Keyword 2	Under 20 Years	Management	≥ 35 years vs. 20-34 years	Postpartum Hemorrhage
Keyword 3	Older Women	Prevention	<20 years vs. ≥ 35 years	Maternal Outcomes
Keyword 4	Over 35 Years	Treatment	Age Stratification	Risk Factors

The Boolean MeSH keywords inputted on databases for this research are: (*"Young Women" OR "Under 20 Years" OR "Older Women" OR "Over 35 Years"*) AND (*"Diagnosis" OR "Management" OR "Prevention" OR "Treatment"*) AND (*"<20 years vs. 20-34 years" OR " ≥ 35 years vs. 20-34 years" OR "<20 years vs. ≥ 35 years" OR "Age Stratification"*) AND (*"Prevalence" OR "Postpartum Hemorrhage" OR "Maternal Outcomes" OR "Risk Factors"*)

Data extraction

- **Study Design:**

Extract study design and basic characteristics including:

- Type of study (systematic review, RCT, cohort, case-control, cross-sectional, etc.)
- Study period/years covered
- Geographic location/setting
- Total sample size
- Data sources (if systematic review or meta-analysis)

- **Age Groups:**

Extract details about maternal age groups studied, specifically focusing on:

- Whether the study included women under 20 years old (specify exact age ranges)
- Whether the study included women over 35 years old (specify exact age ranges)
- Sample sizes for each relevant age group
- How age groups were defined/categorized
- Any exclusions based on age

- **PPH Prevalence:**

Extract postpartum hemorrhage prevalence data by maternal age group:

- Overall PPH prevalence rates
- Prevalence rates specifically for women <20 years old
- Prevalence rates specifically for women >35 years old
- Definition of PPH used (blood loss thresholds, timing)
- Type of delivery (vaginal vs cesarean) if specified
- Confidence intervals or statistical measures when available

- **Diagnostic Methods:**

Extract information about how PPH was diagnosed, particularly noting any age-specific approaches:

- Diagnostic criteria used (blood loss measurement methods, clinical signs)
- Timing of diagnosis (immediate vs delayed recognition)
- Tools or techniques for blood loss assessment
- Whether diagnostic approaches differed by maternal age
- Challenges in diagnosis mentioned for young or older mothers

- **Risk Factors:**

Extract risk factors for PPH specifically related to maternal age or identified in young (<20) and older (>35) mothers:

- Age-specific risk factors mentioned
- Relative risks, odds ratios, or effect sizes for age-related factors
- Additional risk factors that may be more common in young or older mothers
- Protective factors by age group
- Any mention of primiparity, multiparity, or grand multiparity in relation to age

- **Management Approaches:**

Extract management and treatment strategies for PPH, noting any age-specific considerations:

- First-line treatments used (uterotonics, surgical interventions, etc.)
- Specific medications and dosages
- Surgical procedures (uterine massage, tamponade, surgical interventions)
- Whether treatment protocols differed by maternal age

- Emergency management approaches
- Any mention of treatment modifications for young or older mothers

- **Prevention Strategies:**

Extract prevention approaches for PPH with attention to age-specific recommendations:

- Active management of third stage of labor
- Prophylactic medications used
- Risk assessment tools or protocols
- Whether prevention strategies were tailored by maternal age
- Antenatal or intrapartum interventions
- Staff training or protocol recommendations

- **Outcomes by Age:**

Extract treatment outcomes and complications specifically comparing young (<20) and older (>35) mothers:

- Treatment success rates by age group
- Maternal morbidity and mortality rates
- Need for advanced interventions (surgery, ICU care, blood transfusion)
- Length of hospital stay
- Long-term complications
- Any statistical comparisons between age groups

- **Key Findings:**

Extract the main conclusions and clinical implications regarding PPH in young and older mothers:

- Authors' conclusions about age-related differences in prevalence, diagnosis, or management
- Clinical recommendations specific to maternal age groups
- Identified knowledge gaps or research needs
- Practice implications for caring for young or older mothers
- Any mention of health system or resource considerations

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	<i>("Young Women" OR "Under 20 Years" OR "Older Women" OR "Over 35 Years") AND ("Diagnosis" OR "Management" OR "Prevention" OR "Treatment") AND ("<20 years vs. 20-34 years" OR "≥35 years vs. 20-34 years" OR "<20 years vs. ≥35 years" OR "Age Stratification") AND ("Prevalence" OR "Postpartum Hemorrhage" OR "Maternal Outcomes" OR "Risk Factors")</i>	65
Semantic Scholar	<i>("Young Women" OR "Under 20 Years" OR "Older Women" OR "Over 35 Years") AND ("Diagnosis" OR "Management" OR "Prevention" OR "Treatment") AND ("<20 years vs. 20-34 years" OR "≥35 years vs. 20-34 years" OR "<20 years vs. ≥35 years" OR "Age Stratification") AND ("Prevalence" OR "Postpartum Hemorrhage" OR "Maternal Outcomes" OR "Risk Factors")</i>	259
Springer	<i>("Young Women" OR "Under 20 Years" OR "Older Women" OR "Over 35 Years") AND ("Diagnosis" OR "Management" OR "Prevention" OR "Treatment") AND ("<20 years vs. 20-34 years" OR "≥35 years vs. 20-34 years" OR "<20 years vs. ≥35 years" OR "Age Stratification") AND ("Prevalence" OR "Postpartum Hemorrhage" OR "Maternal Outcomes" OR "Risk Factors")</i>	150
Google Scholar	<i>("Young Women" OR "Under 20 Years" OR "Older Women" OR "Over 35 Years") AND ("Diagnosis" OR "Management" OR "Prevention" OR "Treatment") AND ("<20 years vs. 20-34 years" OR "≥35 years vs. 20-34 years" OR "<20 years vs. ≥35 years" OR "Age Stratification") AND ("Prevalence" OR "Postpartum Hemorrhage" OR "Maternal Outcomes" OR "Risk Factors")</i>	17,700
Wiley Online Library	<i>("Young Women" OR "Under 20 Years" OR "Older Women" OR "Over 35 Years") AND ("Diagnosis" OR "Management" OR "Prevention" OR "Treatment") AND ("<20 years vs. 20-34 years" OR "≥35 years vs. 20-34 years" OR "<20 years vs. ≥35 years" OR "Age Stratification") AND ("Prevalence" OR "Postpartum Hemorrhage" OR "Maternal Outcomes" OR "Risk Factors")</i>	131

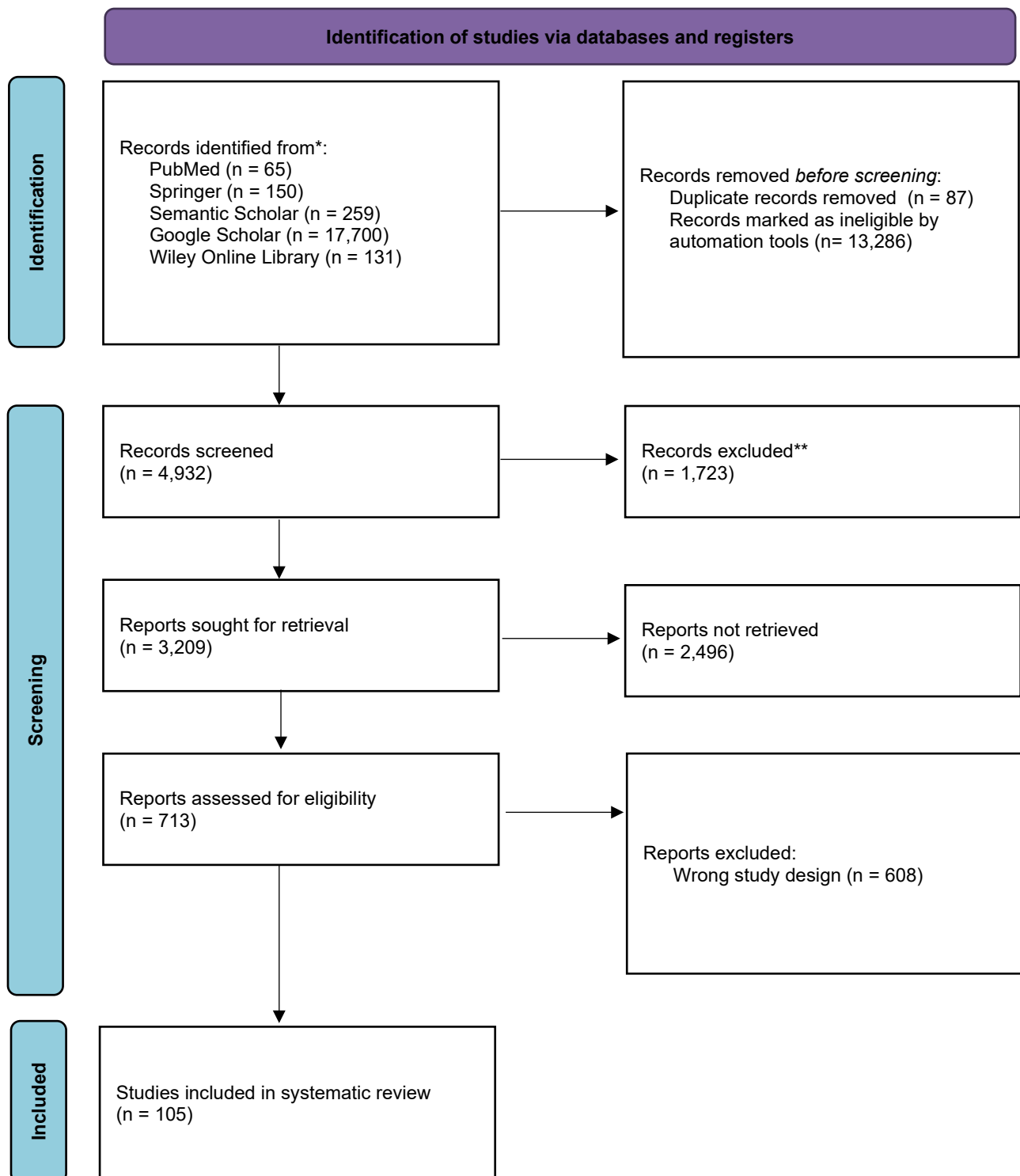


Figure 1. Article search flowchart

RESULTS

Characteristics of Included Studies

Study	Geographic Location	Sample Size
M. Glenzer et al., 2024 [2]	Maputo Central Hospital, Mozambique	14,996 women
Chun-xu Wang et al., 2023 [16]	Not mentioned	Not mentioned
H. Cheema et al., 2023 [7]	Not mentioned	Not mentioned
D. Demissie et al., 2025 [1]	Global	Over 21 million women
Jemberu Nigussie et al., 2021 [3]	Ethiopia	93,898
Ayşegül Durmaz et al., 2017 [17]	Not mentioned	1,286,752 women for maternal age analysis
Prince L. Bestman et al., 2019 [18]	Africa (various countries)	Data from 12 included studies
Saadia Siddique et al., 2025 [5]	Hatta hospital	424 singleton pregnancies
F. J. Ruiz Labarta et al., 2021 [13]	Tertiary referral centre in Madrid, Spain	123 women for cohort study; 551 patients for systematic review
I. Gallos et al., 2025 [19]	Global	312,151 women
배종면 et al., 2010 [20]	Korea	More than 18,000 cases

Study	Geographic Location	Sample Size
Ashley E. Shea et al., 2025 [11]	Multicenter (6 participating centers)	2,404 nulliparous women
Olga Kravchenko et al., 2024 [21]	Multiple health centers across the United States	Not mentioned
Mahabat S. Saeed et al., 2016 [6]	Sulaimania Maternity Teaching Hospital	300 women
A. M. Ziganshin et al., 2024 [22]	Global (domestic and foreign literature)	Not applicable
I. Gallos et al., 2023 [8]	Kenya, Nigeria, South Africa, and Tanzania	210,132 patients
Mb Bellad et al., 2012 [23]	Not mentioned	Not mentioned
R. Ghosh et al., 2019 [24]	Bihar, India; primary care facilities	55,938 deliveries from 320 facilities
H. Shakur et al., 2010 [25]	International	15,000
The Effect of Tranexamic Acid [26]	34 hospitals in Nigeria, Tanzania, Pakistan, and Zambia	Not mentioned
Farah Kausar et al., 2012 [27]	Two referral facilities in Egypt and four in Nigeria	578
F. Okonofua et al., 2014 [28]	Low-income country	Not mentioned
K. Ker et al., 2025 [29]	Not mentioned	Not mentioned

Study	Geographic Location	Sample Size
Shanza Qamar et al., 2025 [30]	Department of Obstetrics and Gynecology, CMH Rawalakot	206
H. Anger et al., 2020 [31]	Secondary Level Hospitals in Uganda, Egypt, and Senegal	Initially 373 (balloon tamponade) and 82 (embolization); Propensity-matched cohort: 50 from each group
J. Earwood et al., 2019 [12]	International	Over 20,000 women
E. V. Vliet et al., 2017 [32]	Not mentioned	Not mentioned
Jessica Anderson et al., 2025 [33]	Metropolitan Melbourne women's hospital	9,659 (168 cases, 9,491 controls)
E. Bjelland et al., 2011 [34]	Hospital setting	79,650 women
A. Ю. Королев et al., 2020 [35]	Not mentioned	24
M. Alalfy et al., 2018 [36]	Two institutions in Egypt (Kasralainy and Aljazeera hospital)	300 women
Trupangi J. Chaudhari et al., 2024 [37]	GK general hospital, Bhuj, Gujarat	100
Monideepa Baruah et al., 2008 [38]	Not mentioned	58 patients

Study	Geographic Location	Sample Size
Hala Yahya AlShamalie et al., 2022 [39]	Tishreen University Hospital, Lattakia, Syria	180
R. A. El-Dakhakhni et al., 2020 [40]	Not mentioned	Not mentioned
S. Feduniw et al., 2020 [41]	Not mentioned	52 studies included
G. Carroli et al., 2008 [42]	Global	3,815,034 women for PPH; 505,379 women for SPPH
D. Chelmow et al., 2011 [43]	Not mentioned	40 systematic reviews, RCTs, or observational studies
Enos Moyo et al., 2024 [44]	Sub-Saharan Africa	106,640 participants
Charlotte Neary et al., 2020 [45]	Hospitals in Italy, China, France, USA, UK, South Korea, Netherlands, Spain, Zimbabwe, Denmark, and Egypt	110 to 56,967 participants
C. Rossi et al., 2010 [46]	Developed countries (excluded underdeveloped countries)	981 cases
L. Ruiter et al., 2019 [47]	The Netherlands	359,737 women
O. Badejoko et al., 2012 [48]	Not mentioned	Not mentioned

Study	Geographic Location	Sample Size
A. Gurevich-Shapiro et al., 2024 [49]	Not mentioned	51 (48 women from literature + 3 from the institution)
Tatiana Stachetti et al., 2019 [4]	Various regions	9,271,519 parturient women
F. Ferrari et al., 2022 [50]	Not mentioned	33,302 women
Nick Scott et al., 2025 [51]	Kenya, Nigeria, South Africa, and Tanzania	312,151 women
Charles G Fahrenholtz et al., 2019 [52]	Both developed and developing nations	Not mentioned
Vanessa Hébert et al., 2026 [53]	Not mentioned	7,091 participants
N. Sloan et al., 2010 [10]	Low-, middle-, and high-income settings in Africa, the Middle East, Asia, Europe, and Latin America	Nearly 250 observational and experimental studies
H. Moghaddam et al., 2021 [54]	Iran	Not mentioned
P. Chaudhuri et al., 2012 [55]	Not mentioned	Not mentioned
I. Gallos et al., 2024 [9]	Kenya, Nigeria, South Africa, Tanzania	210,132 patients
M. Rashid et al., 2009 [56]	Not mentioned	686 women

Study	Geographic Location	Sample Size
F. Sahhaf et al., 2014 [57]	Not mentioned	200 women
Snigdha Rai et al., 2024 [15]	Paropakar Maternity and Women's Hospital, Nepal	65 doctors
K. Ker et al., 2018 [58]	Hospitals in Africa and Asia	10,000 women
M. Gulersen et al., 2023 [59]	Within a university health system	114
A. Korolev et al., 2020 [60]	Russia	24 women
O. Unal et al., 2011 [14]	Not explicitly mentioned	58 women
Xiao Liu et al., 2024 [61]	Two tertiary hospitals	124 patients
Wafa Najeeb et al., 2022 [62]	Department of Obstetrics & Gynaecology, Sheikh Zayed Hospital, Lahore	306
Ammar Joudeh et al., 2021 [63]	22 District Hospitals in Bihar, India	12,307 admissions
The effect of tranexamic acid [64]	34 hospitals across Nigeria, Pakistan, Tanzania, and Zambia	15,068
P. Bouet et al., 2016 [65]	Not specified	289
K. Gungorduk et al., 2012 [66]	Not mentioned	454 (228 experimental, 226 placebo)
A. Kim et al., 2019 [67]	Not mentioned	155

Study	Geographic Location	Sample Size
E. Atukunda et al., 2014 [68]	Mbarara Regional Referral Hospital, southwestern Uganda	1,140
Mengjun Dai et al., 2020 [69]	Not mentioned	100 participants
A. Ducloy-Bouthors et al., 2016 [70]	Multicentre	412
S. Goudar et al., 2008 [71]	Rural India	n = 808 (for the placebo arm)
Signe Egenberg et al., 2017 [72]	Kilimanjaro Christian Medical Centre (KCMC) in Tanzania	n = 3,308
J. Blum et al., 2011 [73]	Not mentioned	31,055 women screened; 809 treated for postpartum hemorrhage
Fauzia Anbreen et al., 2010 [74]	DHQ Teaching Hospital D.I.Khan, Pakistan	80 women
Jiahui Chen et al., 2023 [75]	China	Aspirin group: 464; Control group: 434
S. Barinov et al., 2020 [76]	Not mentioned	41
Elisa Ulfiana et al., 2025 [77]	Not mentioned	13 studies
Jessica L Gerard et al., 2022 [78]	Single institution	19,927 deliveries
Stefania Fieni et al., 2025 [79]	Tertiary referral unit	3,850

Study	Geographic Location	Sample Size
Pim B B Schol et al., 2021 [80]	Four hospitals in the Netherlands	252 women
M. Metgud et al., 2024 [81]	Multispecialty hospital in Belagavi, India	210 term patients
Judith Lieber et al., 2026 [82]	34 hospitals in Nigeria, Pakistan, Tanzania, and Zambia	15,068 women
Jing Bai et al., 2013 [83]	Jinan Maternity and Child Care Hospital, Jinan, China	117 females
H. J. Lee et al., 2019 [84]	Not mentioned	381 patients (48 cesarean hysterectomy, 333 UAE)
A. Diop et al., 2020 [85]	Four hospitals in Senegal and Vietnam	258 women
A. Fatah et al., 2018 [86]	El Galaa Maternity Teaching Hospital	64 women
S.A. Esseissah et al., 2022 [87]	Benha University Hospital's Obstetrics & Gynecology department	120
H. Madar et al., 2023 [88]	Multicentre	3,891 women
R. O. Balogun et al., 2024 [89]	Not mentioned	Not mentioned
N. Artymuk et al., 2014 [90]	Kemerovo Perinatal Center	1,095 women

Study	Geographic Location	Sample Size
A. Abdallah et al., 2020 [91]	Women's Health Hospital at Assiut University, Egypt	829 women
P. Rozenberg et al., 2024 [92]	Not mentioned	Not mentioned
Leira Camejo León et al., 2017 [93]	Dr. Luis Diaz Soto Central Military Hospital	57 patients
Gabriel Dogbanya et al., 2023 [94]	Ahmadu Bello University Teaching Hospital, Zaria	334
Xuemei Peng et al., 2019 [95]	Hospital	180
Ahmed M. Bedeir et al., 2022 [96]	Operative rooms of Bab Al-Sharia Maternity Hospital, Obstetrics and Gynecology Department, Al-Azhar University	200 pregnant women
Cong Ye et al., 2018 [97]	China-Japan Union Hospital of Jilin University	120 full-term pregnant women
Uterine Compression Suture Ver [98]	Srisangwornasukhothai Hospital, Thailand	70 patients
M. Küçükbaş et al., 2025 [99]	Tertiary hospital in Istanbul, Turkey	103 PPH patients
Sylvester Nweze Onuegbunam et al., 2023 [100]	ESUT Teaching Hospital, Enugu, Nigeria	200 participants

Study	Geographic Location	Sample Size
Els Judith M. Orvos et al., 2018 [101]	Not mentioned	140 studies from the Cochrane Collaboration
Deepika Verma et al., 2016 [102]	Not mentioned	150
S. Shrivastava et al., 2017 [103]	New Medical College of Chhattisgarh, India	200 women
Ji-kun Zhu et al., 2013 [104]	Not mentioned	300
A. Patil et al., 2015 [105]	Not mentioned	Not mentioned

Prevalence of Postpartum Hemorrhage

The global pooled prevalence of postpartum hemorrhage (PPH) was estimated at 9.97% (95% CI: 6.90%–13.04%) [1]. When using objective blood loss measurement (≥ 500 mL per 100 women giving birth), the prevalence increased to 11.25% (95% CI: 8.78%–13.72%) [1]. Severe postpartum hemorrhage occurred in approximately 4.52% of women (95% CI: 2.47%–6.57%) [1], indicating that nearly 1 in 20 women worldwide experience life-threatening bleeding after childbirth.

Regional variations in PPH prevalence were substantial. In Ethiopia, the pooled magnitude was 8.24% (95% CI 7.07, 9.40) [3], while in sub-Saharan Africa overall, it was 8.6% [44]. In Africa specifically, the prevalence rate was found to be 3.51% [18], though this varied considerably across different studies and regions. The exact frequency in different populations ranged from 1.2% to 12.5% [41], with some studies reporting rates as high as 14.01% before intervention [2].

Studies from developed regions reported different rates. In Korea, the incidence of PPH was approximately 4% [20], while in the Netherlands, it was 5.4% [47]. A large international study across Kenya, Nigeria, South Africa, and Tanzania found PPH prevalence of 1.6% in an intervention group and 4.3% in a usual-care group [8].

Age-Specific Prevalence

Regarding maternal age, older women (≥ 35 years) showed significantly higher incidence of PPH compared to younger women. A meta-analysis found that older subjects (≥ 35 years) had a significantly higher incidence of PPH (MD = 1.15, 95% CI: 1.03-1.27, $p = 0.01$) [16]. In a study from Hatta hospital, PPH occurred in 23% of women over 35 years compared to 4.3% in younger women ($p < 0.0001$) [5].

Women aged 40 and above showed even higher rates, with 30.7% experiencing PPH compared to 16.0% in women aged 20-29 [6]. The relationship between maternal age and PPH appears to follow a U-shaped curve, with both very young (< 19 years) and older mothers (> 35 years) at increased risk [4].

Risk Factors for Postpartum Hemorrhage

Maternal Age as a Risk Factor

Advanced maternal age emerged as a significant risk factor for PPH across multiple studies. Women aged 35 years and older had nearly three times the risk of PPH compared to younger mothers (AOR = 2.88; 95% CI: 1.80-3.96) [1]. In Ethiopia, older mothers (≥ 35 years old) had 4.6 times higher risk of developing PPH than mothers younger than 35 years old (OR = 4.61, 95% CI 2.81, 7.56) [3]. Another meta-analysis confirmed this elevated risk, with women over 35 years being four times more likely to experience PPH (OR = 4.37, 95% CI = 3.03–6.29) [44].

For women at the lower age extreme, maternal age < 20 was also identified as a risk factor, with an odds ratio of 1.73 ($p = 0.005$) [2]. Similarly, maternal age > 35 showed the same odds ratio of 1.73 ($p = 0.001$) [2], suggesting both age extremes confer similar elevated risk.

Other Risk Factors Associated with Age

Several risk factors appeared more prevalent in specific age groups. In older mothers (> 35 years), associated complications included:

- Higher parity (92.5% vs 73.6%, $p < 0.05$) [5]

- Assisted conception (8% vs 2.8%, $p<0.05$) [5]
- Pre-existing diabetes (26% vs 2.8%, $p<0.001$) [5]
- Gestational diabetes (38.6% vs 22.2%, $p<0.001$) [5]
- Essential hypertension (10.3% vs 0%, $p<0.001$) [5]
- Preeclampsia (7.5% vs 3.3%, $p<0.05$) [5]
- Placental abruption (6.1% vs 0.5%, $p<0.05$) [5]

Additional risk factors across age groups included:

- Eclampsia (AOR=3.49, $p<0.001$) [2]
- Grand multiparity (parity >4) (AOR=2.50, $p<0.001$) [2]
- Pre-term delivery (AOR=2.00, $p<0.001$) [2]
- Pre-eclampsia (AOR=1.66, $p<0.001$) [2]
- Absence of antenatal care visits (OR = 13.84, 95% CI 5.57, 34.346) [3]
- Prolonged labor [3]
- History of previous PPH (OR = 4.355, 95% CI 2.347, 8.079) [3]

Primiparity showed a complex relationship with age. While primiparous women generally had higher PPH incidence (MD = 1.27, 95% CI: 1.02-1.56, $p = 0.03$) [16], the risk pattern varied by age, with young nulliparae and elderly grand multiparae at particularly high risk [4].

Diagnostic Methods for Postpartum Hemorrhage

Standard Diagnostic Criteria

PPH was most commonly defined as blood loss of ≥ 500 mL after vaginal delivery or ≥ 1000 mL after cesarean delivery within 24 hours of birth [1, 3, 7]. Some studies used additional criteria including blood loss accompanied by signs and symptoms of hypovolemia [7], need for transfusion [2], or any blood loss sufficient to compromise hemodynamic stability [25].

A more comprehensive definition included blood loss causing hypovolemia, a 10% decrease in hematocrit, or requiring blood transfusion [3]. The WHO-led meta-analysis assessed prognostic accuracy of clinical markers including measured blood loss, pulse rate, systolic blood pressure, diastolic blood pressure, and shock index for predicting maternal mortality or severe morbidity [19].

Blood Loss Measurement Methods

Blood loss assessment utilized various techniques. The calibrated blood-collection drape emerged as an important diagnostic tool for objective, accurate, and early diagnosis of PPH [8, 9]. In some settings, blood loss was measured using calibrated drapes at 30 minutes and 2 hours post-delivery [81].

Other measurement methods included:

- Collection bags for vaginal deliveries [13]
- Surgical aspirators for caesarean sections [13]
- Bedpans and jars for volume measurement [10]
- Blood collection sheets or delivery drapes [10]
- Gravimetric method (weighing soaked pads/mats, with 1g = 1 ml) [100]

Visual estimation was commonly used but noted to be less accurate [72]. Some facilities used a standardized visual estimation method combined with measuring suction bottle volume and blood-soaked sponges [96].

Clinical Markers and Timing

Early detection was emphasized, with the E-MOTIVE trial demonstrating improved outcomes with a calibrated drape enabling immediate recognition compared to uncalibrated drapes [9]. The timing of diagnosis was typically immediate, within the first 24 hours after delivery [3, 52].

Clinical signs used for diagnosis included:

- Persistent trickling of more than expected blood loss [24]

- Blood clot the size of a fist [24]
- Changing pads every 5-15 minutes [24]
- Low systolic blood pressure, tachycardia, and reduced urine output [58]

For women with moderate or severe anemia, the median time interval from treatment start to PPH diagnosis was 18.5 minutes (IQR 5-58), with 35% of PPH cases diagnosed before trial treatment was fully administered [64].

Age-Specific Diagnostic Considerations

No studies reported age-specific diagnostic approaches or challenges in diagnosis for young or older mothers. The diagnostic criteria and methods appeared to be applied uniformly across age groups [62].

Management and Treatment Strategies

First-Line Treatments

Prophylactic Medications

Oxytocin remained the standard prophylactic medication globally. The WHO recommends oxytocin as part of active management of the third stage of labor [10]. Dosing regimens varied, with studies examining high-dose (80 international units) versus low-dose (10-30 international units) protocols [11].

Different oxytocin administration routes were evaluated:

- Intramuscular: 10 IU [56, 62]
- Intravenous: 5 IU or 10 IU slow injection [79, 88]
- Continuous infusion: 10 IU over 4 hours [80]

Misoprostol emerged as an important alternative, particularly in resource-limited settings:

- Sublingual: 400 µg to 800 µg [55, 68, 73]

- Rectal: 400 µg to 800 µg [39, 62, 74]
- Intrauterine: 400 mg to 600 mg [36, 96]

Other prophylactic uterotonics included:

- Carbetocin: 50-100 µg intravenously [87, 89]
- Ergot compounds (ergometrine/methylergometrine): 0.2 mg intravenously or intramuscularly [87, 102]
- Syntometrine: 1 ml intramuscularly [56]
- Prostaglandin F2α: 125 µg intramuscularly [102]

Active Management of Third Stage of Labor

Active management protocols typically included:

- Prophylactic oxytocin administration within 2 minutes of birth [66]
- Early clamping of the umbilical cord [66]
- Controlled cord traction [66]
- Uterine massage [8, 43]

Treatment of Established PPH

Pharmacological Interventions

For treatment of established PPH, tranexamic acid (TXA) gained prominence. The WOMAN trial demonstrated that TXA administered within 3 hours of birth reduced deaths due to bleeding (RR 0.81; 95% CI, 0.65–1.00; P=0.045) [12]. Common TXA dosing was 1 gram intravenously, with a possible second dose if bleeding continued [25, 26, 64].

Additional uterotonics for treatment included:

- Oxytocin: 40 IU in 1L IV solution over 15 minutes [73]
- Misoprostol: 800 mg sublingually or rectally [73, 85]

- Carboprost: 0.25 mg myometrial injection, repeated every 15 minutes up to 2 mg [83]
- Sulprostone (prostaglandins) for severe cases [70]

Mechanical and Surgical Interventions

Intrauterine balloon tamponade represented a key conservative surgical intervention. Studies compared:

- Bakri balloon tamponade: Success rate of 81.3% [13]
- Condom-catheter uterine balloon tamponade [31]
- Vacuum-induced hemorrhage control device: Lower massive transfusion rate (2.8% vs. 20.5%, $p < 0.01$) compared to balloon tamponade [59]
- Zhukovsky obstetric double balloon: 1.7-fold reduction in blood loss compared to conventional hysterectomy [76]

Uterine compression sutures included:

- B-Lynch suture technique: Success rate of 87.9% [98]
- COMOC-MG suture: Success rates of 100% for normal deliveries and 95.3% for cesarean deliveries [37]

Pulling down the cervix and packing it in the vaginal fornix (PC-PVF) showed efficacy for PPH in the lower uterine segment, with significantly lower blood loss in the early PC-PVF group ($657.27 \text{ ml} \pm 131.61 \text{ ml}$) compared to routine treatment plus late PC-PVF ($1040.78 \text{ ml} \pm 242.70 \text{ ml}$, $p < 0.01$) [61].

For refractory cases:

- Uterine artery embolization (UAE): Safer and more effective than cesarean hysterectomy for managing uncontrolled PPH, with shorter mean operative time (83 min vs. 179 min) [84]
- Bilateral hypogastric artery ligation: Success rate of 87.9%, preserves fertility [14]

- Emergency hysterectomy: Reserved as life-saving procedure when conservative measures fail [46, 92]

Prophylactic interventions for high-risk patients included:

- Internal iliac artery balloon occlusion combined with Pituitrin intra-arterial infusion: Significantly reduced estimated blood loss, packed red blood cells, and hysterectomy rate [69]

Hemostatic Agents

Advanced hemostatic management included:

- Fibrinogen concentrate: 3g for hypofibrinogenemia [70]
- Early fibrinogen replacement based on shock index and lactate levels (without laboratory confirmation): Associated with improved hemostatic control and reduced ICU admissions [99]
- Recombinant coagulation factor VIIa: 60 µg/kg body weight for refractory bleeding [35, 60]
- Prothrombin complex concentrate: 600-1,200 IU administered before fresh-frozen plasma [35]

Non-Pneumatic Anti-Shock Garment (NASG)

The NASG showed promise in low-resource settings. Women in the NASG-intervention phase had 50% lower blood loss, reduced hysterectomy rates (4% vs. 8.9%), and mortality decreased from 8.5% to 2.3% (RR = 0.27, 95% CI: 0.12–0.60) [27].

Age-Specific Treatment Modifications

No studies reported treatment protocols that differed by maternal age [11, 36, 39]. However, one study noted that bilateral hypogastric artery ligation was recommended as a first choice for PPH in young women to preserve fertility [14]. Additionally, younger patients (<35) and nulliparous women were more likely to choose the B-Lynch procedure, presumably to preserve future fertility [98].

Prevention Strategies

Active Management of Third Stage of Labor

Active management of the third stage of labor emerged as the cornerstone of PPH prevention. This approach includes:

- Administration of prophylactic uterotonics (oxytocin or misoprostol) [18, 43]
- Controlled cord traction [43]
- Uterine massage [10, 43]

The effectiveness of active management was demonstrated across multiple settings, though the specific components varied by resource availability.

Prophylactic Medications

Oxytocin

Oxytocin remained the gold standard for PPH prevention globally [10]. Studies evaluated various dosing regimens:

- High-dose (80 international units) versus low-dose (10-30 international units): High-dose associated with lower odds of composite outcome (OR 0.53, 95% CI 0.34-0.82) and PPH (OR 0.44, 95% CI 0.27-0.72) [11]
- Intravenous administration (5 IU or 10 IU) more effective than intramuscular administration (10 IU) in reducing PPH incidence after vaginal deliveries (21.3% vs 11.0%, $p < 0.001$ for 10 IU IM vs 5 IU IV) [79]

Misoprostol

Misoprostol served as an important alternative in settings where oxytocin was unavailable:

- Combined with oxytocin: Intrauterine misoprostol (400 mg) added to oxytocin decreased PPH incidence (1.33% vs 6.67%) [36]

- Rectal misoprostol (800 mcg) plus oxytocin: Associated with significantly reduced mean blood loss (418 ± 150 ml vs. 649 ± 214 ml, $p < 0.0001$) [39]

Tranexamic Acid

Prophylactic TXA administration showed promise:

- For women with moderate or severe anemia: 1g TXA administered within 15 minutes of cord clamping aimed to prevent PPH, though results showed no significant reduction in clinically diagnosed PPH (7.0% in TXA group vs 6.6% in placebo group) [64]
- For general prevention: Adding intravenous TXA to standard active management reduced PPH > 500 mL (1.8% vs 6.8%, $p = 0.01$) [66]

Other Agents

Additional prophylactic agents included:

- Carbetocin (50-100 μ g intravenously) [89]
- Ergot compounds and prostaglandin E2 [43]
- Herbal medicines as potential alternatives [54]

Antenatal Interventions

Key antenatal prevention strategies included:

- Addressing prenatal anemia, which facilitates PPH [2]
- Improving antenatal care (ANC) attendance [44]
- Risk assessment and identification of high-risk women [3]
- For high-risk patients with placenta accreta spectrum: Prophylactic internal iliac artery balloon occlusion combined with Pituitrin infusion [69]

Low-dose aspirin (100 mg/day from 12 to 20 gestational weeks until 34 weeks) for pre-eclampsia prevention showed no significant increase in PPH incidence (6.5% aspirin group vs 5.3% control group, $p = 0.459$) [75].

Implementation Strategies

Training and Education

Staff training emerged as crucial for PPH prevention and management:

- Multi-professional, scenario-based training on the birthing simulator MamaNatalie®, followed by realistic PPH scenarios and debriefing [72]
- Simulation-based training as part of implementation strategies [9]
- Nurse-mentoring programs with simulation training [24]
- PPH education and simulations improved outcomes [2]

Skills development training for healthcare workers was associated with:

- Significant reduction in blood transfusion rates (41% vs 17.2%, $p=0.0001$) [15]
- Reduction in ICU admission (7% vs 1.7%, $p=0.0001$) [15]
- Reduction in peripartum hysterectomy (1.3% vs 0.04%, $p=0.03$) [15]
- Most importantly, maternal mortality due to PPH dropped from 75% to 0% [15]

Early Detection Systems

Implementation of early detection protocols included:

- Calibrated blood-collection drapes for objective blood loss measurement [8, 9]
- WHO first-response treatment bundle (uterine massage, oxytocic drugs, tranexamic acid, intravenous fluids) [9]
- Use of shock index and lactate levels for early fibrinogen replacement [99]

Age-Specific Prevention Recommendations

Most studies did not report prevention strategies specifically tailored by maternal age [11, 36, 39]. However, general recommendations included:

- Close monitoring of high-risk women, which may include those under 20 and over 35 years old [44]
- Increased awareness for caregivers regarding young nulliparae and elderly grand multiparae [4]
- Encouraging ANC visits, particularly important for older mothers at increased risk [3]

Treatment Outcomes

Overall Intervention Effects

Several large-scale interventions demonstrated substantial improvements in maternal outcomes:

The E-MOTIVE trial in Kenya, Nigeria, South Africa, and Tanzania showed that early detection using calibrated drapes combined with bundled treatment led to significant reduction in severe PPH, laparotomy for bleeding, or death (1.6% intervention vs 4.3% usual-care, risk ratio 0.40; 95% CI, 0.32 to 0.50; $P < 0.001$) [8].

In Mozambique, a multi-faceted intervention including cryoprecipitate production capacity, early massive transfusion protocol, standardized PPH care, and education demonstrated remarkable improvements:

- Maternal mortality reduced from 1,104/100,000 to 279/100,000 ($P < 0.001$) [2]
- PPH incidence decreased from 14.01% to 4.90% ($P < 0.001$) [2]

In Tanzania, multi-professional scenario-based training was associated with a 47% reduction in whole blood transfusion rates [72].

In Nepal, skills development training resulted in:

- Reduced blood transfusion rate (41% to 17.2%, $p = 0.0001$) [15]
- Reduced ICU admission (7% to 1.7%, $p = 0.0001$) [15]
- Reduced peripartum hysterectomy (1.3% to 0.04%, $p = 0.03$) [15]
- Maternal mortality from PPH dropped from 75% to 0% [15]

Specific Treatment Comparisons

Uterotonic Comparisons

Misoprostol versus oxytocin studies showed mixed results:

- In Uganda, misoprostol showed higher PPH rates than oxytocin (28.6% vs 17.4%, RR 1.64, 95% CI 1.32 to 2.05) [68]
- For treating established PPH, misoprostol and oxytocin showed similar effectiveness in controlling bleeding (60.2% placebo vs 56.9% TXA, $p=0.59$) [73]

Carbetocin compared to oxytocin:

- Lower blood loss in carboprost group (438 ml) versus oxytocin (610 ml) and oxytocin plus carboprost (520 ml) groups ($P<0.05$) [83]

Tranexamic Acid

For treatment of PPH, TXA within 3 hours reduced deaths from bleeding (155 [1.5%] TXA vs 191 [1.9%] placebo, RR 0.81; 95% CI, 0.65–1.00; $P=0.045$) [12]. The number needed to treat was 200 when given within the first three hours [12].

For prevention in women with anemia, prophylactic TXA showed no significant reduction in PPH (7.0% TXA vs 6.6% placebo) [64].

Surgical Interventions

Intrauterine vacuum-induced hemorrhage device versus balloon tamponade:

- Lower massive transfusion rate (2.8% vs 20.5%, $p<0.01$) [59]
- Lower estimated blood loss (1,500 mL vs 1,875 mL, $p=0.02$) [59]

Uterine artery embolization versus cesarean hysterectomy:

- Similar rates of hysterectomy (12% each) [31]
- Shorter operative time for UAE (83 min vs 179 min) [84]

- Lower mean hospital stay (7.37 days vs 12.88 days) [84]

Outcomes by Maternal Age

Limited data directly compared outcomes between young (<20) and older (>35) mothers. Available evidence included:

In women aged 40 and above compared to 20-29 years:

- Higher PPH rate (30.7% vs 16.0%) [6]
- Higher cesarean delivery rate (61.3%) [6]
- Higher NICU admission (50.7% vs 16.0%) [6]
- Higher neonatal mortality (1.3% vs 0.0%) [6]

One study noted younger maternal age as associated with secondary PPH ($p=0.004$) [33], though most complications occurred in older mothers.

In women under 20 years, one study reported:

- PPH prevalence of 0.47% [91]
- Higher rates of PROM and preterm labor compared to control group ($p<0.05$) [91]

Statistical comparisons between age groups for treatment outcomes were limited. The study on older mothers (≥ 35) showed significantly higher rates of:

- Gestational diabetes (26.0% vs 11.3%) [6]
- Pre-eclampsia (45.3% vs 16.0%) [6]
- Placenta abruption (8.7% vs 1.3%) [6]

Synthesis

The body of evidence on postpartum hemorrhage in young women under 20 and older women over 35 years reveals several key patterns, though direct comparative data between these age groups remains limited.

Age-Related Risk Patterns

Both maternal age extremes (<20 years and >35 years) demonstrate elevated PPH risk, with a U-shaped relationship between age and hemorrhage incidence [4]. Older mothers face particularly pronounced risk, with odds ratios ranging from 1.73 [2] to 4.61 [3] for women ≥ 35 years. This increased risk in older mothers appears driven by several interconnected factors including higher rates of grand multiparity [2], hypertensive disorders [5], placental complications [5], and diabetes [5]. The biological mechanisms likely include age-related changes in uterine contractility and vascular integrity, as well as accumulated comorbidities.

For younger mothers under 20, evidence is more limited but suggests elevated risk (OR 1.73) [2], potentially related to biological immaturity, inadequate prenatal care, and primiparity. However, the literature provides minimal direct comparison between these two age extremes.

Diagnostic Approaches Across Settings

While diagnostic criteria remain standardized across age groups (≥ 500 mL for vaginal delivery, ≥ 1000 mL for cesarean) [1, 7], important variations exist in measurement accuracy and timing. High-resource settings increasingly employ calibrated drapes for objective measurement [8, 9], while low-resource settings rely more heavily on visual estimation [72], which is notably less accurate. This measurement gap may contribute to regional variations in reported PPH prevalence, with some variation reflecting true incidence differences and some reflecting diagnostic ascertainment differences.

No studies identified age-specific diagnostic challenges or modified diagnostic approaches for young or older mothers. This represents a potential knowledge gap, as physiological responses to hemorrhage may differ by age, potentially affecting the timing and sensitivity of clinical markers.

Treatment Effectiveness and Context

Treatment outcomes demonstrate substantial heterogeneity, which can be explained through several contextual lenses:

Setting-Specific Effectiveness: Interventions show differential effectiveness based on baseline care quality and resource availability. In Mozambique, where baseline maternal mortality was extremely high (1,104/100,000), a multi-faceted intervention reduced PPH from 14.01% to 4.90% [2], suggesting that settings with initially poor outcomes have greater potential for improvement. Conversely, in well-resourced settings with existing protocols, incremental improvements are smaller but still meaningful, as seen with the E-MOTIVE trial's reduction from 4.3% to 1.6% [8].

Pharmacological Nuances: Uterotonic comparisons reveal important contextual dependencies. Misoprostol's performance varies by indication: for PPH prevention in women already receiving prophylactic oxytocin, additional misoprostol increased PPH rates in Uganda [68], but for treatment of established PPH, misoprostol showed comparable effectiveness to oxytocin [73]. This apparent contradiction likely reflects different underlying mechanisms—prophylactic misoprostol may cause excessive uterine activity leading to retained products, while therapeutic misoprostol aids in controlling established atony. Additionally, setting matters: misoprostol's utility is highest where cold chain maintenance for oxytocin is unreliable.

Tranexamic acid demonstrates a similar context-dependency. For treatment of established PPH, TXA within 3 hours significantly reduces mortality (NNT=200) [12], but prophylactic TXA in women with anemia failed to reduce PPH incidence [64]. This difference may reflect timing—prophylactic administration occurs before hemorrhage onset when fibrinolysis has not yet been pathologically activated, while treatment administration targets active hyperfibrinolysis. The median time from treatment start to PPH diagnosis in the prophylactic trial was only 18.5 minutes [64], with 35% of PPH cases diagnosed before treatment was fully administered, suggesting many women were already hemorrhaging at the time of "prophylactic" administration.

Mechanical Interventions: Balloon tamponade and related devices show consistently high success rates (81-87%) [13, 14], with newer vacuum devices demonstrating superiority over traditional balloons in reducing massive transfusion [59]. Success rates for these interventions appear less influenced by maternal age than by underlying cause (placenta accreta vs. atony) and

timing of intervention, with maternal age serving primarily as a marker for increased likelihood of other risk factors [13].

Prevention Strategy Variations

Prevention strategies demonstrate similar effectiveness across age groups, but implementation challenges differ by setting. Active management of the third stage of labor reduces PPH universally, but the specific components vary by resource availability. High-income settings can implement complex protocols including prophylactic TXA [66] and calibrated measurement [9], while low-resource settings focus on ensuring basic oxytocin availability and training [24, 72].

Training interventions show remarkable effectiveness, with Nepalese skill-building reducing PPH-related mortality to zero [15] and Tanzanian simulation-based training cutting transfusion rates by 47% [72]. These results suggest that provider competence may be as important as specific interventions, particularly in managing the cascade from recognition to action.

Critical Evidence Gaps

Several important gaps limit age-specific recommendations:

1. **Direct Comparative Data:** Almost no studies directly compare PPH outcomes, management effectiveness, or prevention strategies between young (<20) and older (>35) mothers within the same population, despite both groups carrying elevated risk.
2. **Mechanistic Understanding:** Whether the elevated risk in young versus older mothers stems from similar or different pathophysiological mechanisms remains unclear. This knowledge would inform whether age-specific prevention or treatment modifications are warranted.
3. **Resource-Stratified Recommendations:** While some interventions (like calibrated drapes or TXA) show effectiveness in trial settings, real-world implementation challenges in low-resource environments serving predominantly young or older high-risk mothers remain understudied.

4. **Long-Term Outcomes:** Focus on immediate PPH-related mortality and morbidity leaves unknown the long-term reproductive and health consequences for survivors across age groups.
5. **Intervention Timing Precision:** The critical time windows for prevention versus treatment interventions, and whether these differ by maternal age or other risk factors, need clarification to optimize protocols.

Practical Implications

For clinical practice, the evidence supports:

1. Universal implementation of active management of third stage of labor, with high-dose oxytocin (10 IU IV) preferred over lower doses or IM administration where feasible [11, 79].
2. Enhanced surveillance for both young (<20) and older (>35) mothers, recognizing their elevated baseline risk, with particular attention to additional risk factors (anemia, grand multiparity, hypertensive disorders) that compound age-related risk.
3. Early implementation of TXA (within 3 hours) for treatment of established PPH across all age groups [12].
4. Context-appropriate prevention strategies: comprehensive multi-faceted interventions (including training, protocols, and hemostatic products) in low-resource settings showing highest impact [2, 15], while high-resource settings benefit from refined protocols and enhanced detection systems [8].
5. Balloon tamponade or compression sutures as first-line conservative surgical management before proceeding to hysterectomy, with particular consideration in younger mothers for fertility preservation [14, 98].

DISCUSSION

This systematic review synthesizes evidence from 105 studies examining postpartum hemorrhage in women at the extremes of reproductive age, revealing several important patterns, contextual dependencies, and evidence gaps that inform clinical practice and future research priorities.

Age-Related Risk Patterns and Mechanisms

Our findings confirm a U-shaped relationship between maternal age and PPH risk, with both young (<20 years) and older (≥ 35 years) mothers demonstrating significantly elevated incidence compared to women aged 20-34 years [4]. However, the magnitude of risk differs substantially between groups. Older mothers face particularly pronounced risk, with odds ratios ranging from 1.73 to 4.61 across studies [2, 3, 44], and absolute PPH rates reaching 23-30.7% in women over 35 years compared to 4.3-16.0% in younger counterparts [5, 6]. This elevated risk appears driven by multiple interconnected factors including higher rates of grand multiparity (92.5% vs 73.6%), pre-existing diabetes (26% vs 2.8%), gestational diabetes (38.6% vs 22.2%), essential hypertension (10.3% vs 0%), preeclampsia (7.5% vs 3.3%), and placental abruption (6.1% vs 0.5%) [5].

For young mothers under 20 years, the evidence base is more limited but suggests comparable relative risk elevation (OR=1.73) [2], though absolute rates appear lower (0.47% in one study) [91]. The mechanisms underlying elevated risk in adolescents likely differ fundamentally from those in older mothers. Young nulliparae may experience PPH due to uterine immaturity, prolonged labor from inadequate uterine coordination, and higher rates of obstetric interventions [4]. Additionally, adolescents often have delayed prenatal care initiation, higher rates of anemia, and limited social support, all of which may compound hemorrhage risk [2, 44].

These divergent risk profiles have important implications. The elevated risk in older mothers appears largely attributable to accumulated comorbidities that are potentially modifiable through preconception counseling and enhanced antenatal surveillance. In contrast, adolescent risk factors may be more amenable to community-based interventions addressing prenatal care access, nutritional support, and comprehensive sexual education. This suggests that age-specific prevention

strategies should target different causal pathways rather than applying uniform approaches across high-risk groups.

Diagnostic Approaches: A Critical Evidence Gap

Perhaps the most striking finding is the complete absence of age-specific diagnostic considerations in the reviewed literature. All studies applied uniform diagnostic criteria (≥ 500 mL vaginal delivery, ≥ 1000 mL cesarean delivery) and measurement methods across age groups [1, 3, 7]. This represents a critical gap, as physiological responses to hemorrhage may differ substantially by age. Older mothers with cardiovascular comorbidities may exhibit blunted compensatory responses to hypovolemia, potentially delaying clinical recognition until hemorrhage is advanced [19]. Conversely, young mothers with robust cardiovascular reserve might maintain normal vital signs despite significant blood loss, creating a false sense of security [88].

The shock index (heart rate/systolic blood pressure) has shown promise for PPH prediction [88], but its performance across age groups remains unevaluated. Given age-related differences in baseline cardiovascular physiology, it is plausible that optimal shock index thresholds for triggering intervention differ between adolescents and older mothers. Similarly, the prognostic accuracy of other clinical markers—including pulse rate, blood pressure, and lactate levels—may require age-specific calibration [19, 99].

The reliance on visual estimation in many low-resource settings [72] disproportionately affects young and older mothers in these environments. Visual estimation consistently underestimates blood loss, particularly at higher volumes, potentially delaying recognition and treatment in precisely those populations already at elevated risk. The E-MOTIVE trial's demonstration that calibrated drapes enable earlier detection and reduce severe PPH [8, 9] suggests that improving measurement accuracy could disproportionately benefit high-risk age groups, though this hypothesis requires direct testing.

Context-Dependent Treatment Effectiveness

Our synthesis reveals that treatment effectiveness varies substantially by context, with important implications for age-specific care. Tranexamic acid (TXA) exemplifies this context-dependency. For treatment of established PPH, TXA administered within 3 hours significantly

reduces mortality (RR 0.81; 95% CI, 0.65-1.00; NNT=200) [12]. However, prophylactic TXA in women with anemia failed to reduce PPH incidence [64]. This apparent contradiction likely reflects timing: treatment administration targets active hyperfibrinolysis, while prophylactic administration occurs before pathological fibrinolytic activation. Notably, the median time from treatment start to PPH diagnosis in the prophylactic trial was only 18.5 minutes, with 35% of PPH cases diagnosed before treatment was fully administered [64], suggesting many women were already hemorrhaging at the time of "prophylactic" administration. For older mothers with higher baseline PPH risk, this narrow therapeutic window may be particularly consequential.

Misoprostol's performance similarly varies by indication and setting. For PPH prevention in women already receiving prophylactic oxytocin, additional misoprostol paradoxically increased PPH rates in Uganda (28.6% vs 17.4%) [68], yet for treatment of established PPH, misoprostol showed comparable effectiveness to oxytocin [73]. This difference likely reflects distinct mechanisms: prophylactic misoprostol may cause excessive uterine activity leading to retained products, while therapeutic misoprostol aids in controlling established atony. Setting also matters critically: misoprostol's utility is highest where cold chain maintenance for oxytocin is unreliable—a circumstance more common in low-resource settings serving disadvantaged populations, including many adolescent mothers [18].

Oxytocin dosing studies reveal additional nuances. High-dose protocols (80 international units) appear more effective than low-dose (10-30 international units) for prevention (OR 0.44 for PPH) [11], and intravenous administration (5-10 IU) outperforms intramuscular injection (21.3% vs 11.0% PPH incidence) [79]. These findings have particular relevance for older mothers, whose higher baseline risk may warrant maximal prophylactic efficacy. However, no studies examined whether optimal oxytocin dosing differs by maternal age, representing another evidence gap.

Surgical and Mechanical Interventions: Fertility Considerations

The choice between surgical interventions reveals implicit age-based considerations, though explicit protocols remain absent. Bilateral hypogastric artery ligation has been recommended as first-line for PPH in young women specifically to preserve fertility [14]. Similarly, younger patients and nulliparous women were more likely to choose B-Lynch compression sutures over

hysterectomy [98]. These patterns reflect appropriate clinical judgment prioritizing fertility preservation when possible, but the absence of standardized age-based algorithms leaves decision-making to individual clinician discretion.

Comparative effectiveness data support these conservative approaches when feasible. Uterine compression sutures demonstrate high success rates (B-Lynch 87.9%, COMOC-MG 95.3-100%) [37, 98]. Intrauterine balloon tamponade succeeds in 81.3-87.9% of cases [13, 14], with newer vacuum-induced devices showing superiority over traditional balloons for reducing massive transfusion (2.8% vs 20.5%) [59]. Uterine artery embolization offers shorter operative time (83 vs 179 minutes) and hospital stay (7.37 vs 12.88 days) compared to hysterectomy [84]. For young mothers, these fertility-preserving options should be prioritized when clinically appropriate, though availability varies considerably by setting.

The Zhukovsky obstetric double balloon represents an innovative approach that reduced blood loss 1.7-fold compared to conventional hysterectomy [76], suggesting potential for hemorrhage control while avoiding definitive fertility loss. Similarly, early fibrinogen replacement based on shock index and lactate levels improved hemostatic control and reduced ICU admissions [99], though age-specific outcomes remain unreported.

Prevention Strategies: Universal Approaches with Differential Impact

Active management of the third stage of labor remains the cornerstone of PPH prevention universally [10, 43]. However, implementation varies dramatically by setting. High-income settings can implement complex protocols including prophylactic TXA [66], calibrated measurement [9], and multidisciplinary response teams [67]. Low-resource settings focus on ensuring basic oxytocin availability and provider training [24, 72]—interventions that may disproportionately benefit young mothers in these environments.

Training interventions show remarkable effectiveness regardless of setting. In Nepal, skills development training reduced blood transfusion (41% to 17.2%), ICU admission (7% to 1.7%), peripartum hysterectomy (1.3% to 0.04%), and eliminated PPH-related mortality [15]. In Tanzania, multi-professional simulation training reduced transfusion rates by 47% [72]. These results suggest that provider competence may be as important as specific interventions, particularly in managing

the cascade from recognition to action. For young and older mothers alike, ensuring providers can rapidly recognize and respond to hemorrhage may be the most effective intervention.

Antenatal interventions addressing PPH risk factors have indirect age-specific implications. Improving anemia prevalence—more common in adolescents due to nutritional inadequacy and short interpregnancy intervals—may reduce PPH severity when hemorrhage occurs [2, 64]. Enhanced antenatal care attendance, particularly important for older mothers with comorbidities, enables earlier identification of risk factors [3, 44]. Low-dose aspirin for pre-eclampsia prevention does not increase PPH risk [75], reassuring for older mothers with hypertensive indications.

Outcome Disparities and Unexplained Variations

Treatment outcomes differ substantially between age groups, though direct comparative data remain limited. Women aged 40 years and above compared to those 20-29 years show higher PPH rates (30.7% vs 16.0%), cesarean delivery (61.3%), NICU admission (50.7% vs 16.0%), and neonatal mortality (1.3% vs 0.0%) [6]. These disparities likely reflect both direct effects of age and accumulated comorbidities. Notably, young maternal age was associated with secondary PPH ($p=0.004$) [33], suggesting different temporal patterns of hemorrhage risk.

The substantial variations in intervention effectiveness across settings merit careful interpretation. In Mozambique, where baseline maternal mortality was extremely high (1,104/100,000), a multi-faceted intervention reduced PPH from 14.01% to 4.90% [2], demonstrating that settings with initially poor outcomes have greatest potential for improvement. Conversely, in well-resourced settings with existing protocols, incremental improvements are smaller but still meaningful, as seen with the E-MOTIVE trial's reduction from 4.3% to 1.6% [8]. This pattern suggests that resource allocation should prioritize settings with highest baseline burden—often those serving disadvantaged populations including adolescent mothers—to maximize population-level impact.

Implications for Clinical Practice

Despite these limitations, several practical recommendations emerge. First, universal implementation of active management of the third stage of labor with high-dose oxytocin (10 IU IV) where feasible [11, 79]. Second, enhanced surveillance for both young (<20) and older (≥ 35)

mothers, recognizing their elevated baseline risk, with particular attention to additional risk factors that compound age-related risk. Third, early TXA administration (within 3 hours) for treatment of established PPH across all age groups [12]. Fourth, calibrated blood-collection drapes for objective measurement to overcome visual estimation inaccuracies [8, 9]. Fifth, fertility-preserving surgical interventions (compression sutures, artery ligation, balloon tamponade) as first-line conservative management before proceeding to hysterectomy in young mothers [14, 98]. Sixth, context-appropriate prevention strategies: comprehensive multi-faceted interventions in low-resource settings showing highest impact [2, 15], and refined protocols with enhanced detection in high-resource settings [8].

Research Priorities

This review identifies critical research priorities. First, direct comparative studies examining PPH outcomes, management effectiveness, and prevention strategies between young and older mothers within the same populations are urgently needed. Second, mechanistic studies elucidating whether elevated risk in young versus older mothers stems from similar or different pathophysiological pathways would inform whether age-specific prevention or treatment modifications are warranted. Third, diagnostic accuracy studies evaluating whether clinical markers (shock index, vital signs, lactate) require age-specific thresholds. Fourth, resource-stratified implementation research examining how to optimize evidence-based interventions in settings serving predominantly young or older high-risk mothers. Fifth, long-term outcome studies examining reproductive and health consequences for PPH survivors across age groups. Sixth, intervention timing precision studies to optimize protocols for prevention versus treatment.

CONCLUSION

This systematic review demonstrates that both young women under 20 years and older women over 35 years face significantly elevated risk of postpartum hemorrhage compared to women aged 20-34 years, confirming a U-shaped relationship between maternal age and PPH incidence. The risk elevation is particularly pronounced in older mothers, with odds ratios ranging

from 1.73 to 4.61 and absolute rates reaching 23-30.7%, driven by accumulated comorbidities including hypertensive disorders, diabetes, and placental complications. Young mothers under 20 years show comparable relative risk elevation (OR=1.73) but through different mechanisms including biological immaturity, primiparity, and inadequate prenatal care.

Critically, despite both age groups representing high-risk populations, current diagnostic approaches are applied uniformly without age-specific modifications. This represents a substantial evidence gap, as physiological responses to hemorrhage likely differ by age, potentially affecting the timing and sensitivity of clinical markers. Similarly, while management strategies are generally applied uniformly, implicit age-based considerations influence surgical decision-making, with fertility-preserving interventions prioritized in young women.

Treatment effectiveness demonstrates substantial context-dependency. Tranexamic acid reduces mortality when administered within 3 hours for established PPH but shows no benefit for prophylaxis in anemic women. Misoprostol's utility varies by indication and setting, with greatest value where oxytocin cold chain is unreliable. Multi-faceted interventions in low-resource settings show dramatic improvements, reducing PPH incidence from 14.01% to 4.90% and maternal mortality from 1,104/100,000 to 279/100,000.

For clinical practice, we recommend enhanced surveillance for both age extremes, universal active management of third stage with high-dose oxytocin, early TXA for established PPH, calibrated blood loss measurement, and fertility-preserving surgical interventions when feasible. Future research must prioritize direct age-comparative studies, mechanistic investigations, age-specific diagnostic threshold evaluation, and resource-stratified implementation research to optimize outcomes for these vulnerable populations.

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