European Journal of Clinical Pharmacy
Print ISSN: 2385-409X **Online ISSN**: Applied Website:
https://farmclin.com/

GLOBAL COLLABORATION AND RESEARCH HOTSPOTS IN GESTATIONAL DIABETES MELLITUS (2018–2026)

Supriya Bhaskar Kuber1, Dr. P. Sembianmadevi2, Dr. N. Selvi3

1Research Scholar, Department of Library and Information Science, Mother Teresa Women's University, Kodaikanal.TN

2Librarian Head, Mother Teresa Women's University, Kodaikanal. TN, India.

3Library Assistant, Mother Teresa Women's University, Kodaikanal.TN, India

ABSTRACT

Background:
Gestational diabetes mellitus (GDM) is one of the most prevalent medical complications during the pregnancy with a pooled global standardised prevalence of about 14.0% by the criteria of the International Association of Diabetes in Pregnancy Study Groups (IADPSG). Since the publication of the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study in 2008 and the IADPSG diagnostic consensus, GDM research has grown by leaps and bounds, but the number and distribution of researchers, the geographic and regional locations of their research, the other groups with whom they collaborate, and the themes of their studies have not yet been completely described.

Objective:
To present the bibliometric picture of the GDM field from 2018 to 2026, summarizing publication trends, the most prolific contributors (authors, institutions, countries, journals), international cooperation, the intellectual and conceptual structure of the published literature, and the emerging research hotspots, based on the previously published bibliometric analyses of this field and the primary literature they encompass.

Methods:
Bibliometric studies of GDM published in Scopus and/or Web of Science from 2018 to 2026 were synthesized narratively, with the help of selected literature search to identify seminal clinical, epidemiological and methodological studies. Findings were arranged according to standard bibliometric indicators (publication numbers, citation numbers, h-index, co-authorship, co-citation, bibliographic coupling, keyword co-occurrence, thematic mapping) as used in the source studies from the bibliometrix and the VOSviewer toolchains.

Results:
The number of GDM studies has steadily increased over the years in the reviewed bibliometric studies, while primary-care research studies on GDM had an annual increase of 4.29% (276 articles published from 150 sources by 1,375 authors from 1991 to 2024) and peaked at 26 articles in 2020 and 2023. The larger study over the past 24 years, found 27,660 articles on the GDM in the Web of Science, and the U.S. and China were the biggest contributors. The United States and United Kingdom are commonplace in the highest-ranking countries, while universities such as the University of Eastern Finland, Ohio State University and Harvard University are all highly successful. Diabetes Care has been the most productive core journal every time. The literature reviewed can be summarised through four thematic clusters: (i) screening/diagnostic criteria, (ii) gut microbiome/metabolic pathogenesis, (iii) long-term maternal and offspring outcomes and (iv) the most rapid growth in literature is in the field of AI/machine-learning based risk prediction.

Conclusions:
GDM research has grown into an expansive, multinational, and increasingly multifaceted discipline, with the integration of computational risk prediction, and microbiome-based pathophysiology studies, alongside continued solid foundations in screening, diagnosis, and long-term outcome research. In order to follow this changing landscape, it is recommended to continue bibliometric monitoring, preferably by using live, reproducible extractions from Scopus/Web of Science, and by tools like bibliometrix and VOSviewer.

KEYWORDS: gestational diabetes mellitus; bibliometrics; scientometrics; Scopus; co-authorship; research trends; thematic mapping.

How to Cite: Supriya Bhaskar Kuber, Dr. P. Sembianmadevi, Dr. N. Selvi, (2025) GLOBAL COLLABORATION AND RESEARCH HOTSPOTS IN GESTATIONAL DIABETES MELLITUS (2018–2026), European Journal of Clinical Pharmacy, Vol.7, No.1, pp. 10312-10324.

INTRODUCTION

Background

If glucose intolerance is detected for the first time in pregnancy, it is known as gestational diabetes mellitus (GDM) and is any hyperglycaemic condition that arises during pregnancy or is a risk for metabolic disease after birth [1]. The 10th edition of the

International Diabetes Federation (IDF) Diabetes Atlas estimates that in 2021 an estimated 21.1 million live births were to women with some form of hyperglycaemia in pregnancy, which accounted for 16.7% of all live births in the world, with 80.3% of cases being diabetes mellitus in pregnancy (DMP) [2]. A dedicated IDF/IADPSG modelling exercise estimated the pooled global standardised prevalence of GDM as 14.0% (95% CI 13.97–14.04%) and this was found to vary significantly by region ranging from <10% in North America & Caribbean to >20% in parts of the Middle East & North Africa and South Asia [3].

GDM has significant health and public health consequences. The landmark international Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study of over 25,000 mother–infant pairs in nine countries has shown a continuous graded association between maternal hyperglycaemia (even if it is mild and well below any threshold for overt diabetes) and a wide variety of adverse outcomes, such as macrosomia, caesarean delivery, neonatal hypoglycaemia and hyperbilirubinaemia [4,5]. The results have been helpful to support the consensus guidelines for the diagnosis of GDM published by the 2010 International Association of Diabetes and Pregnancy Study Groups (IADPSG) which are considered to be the most widely accepted (but not universally used) GDM diagnostic criteria globally [6]. The systematic review and meta-analysis from 2022 also confirmed the link between GDM and a wide variety of adverse maternal and offspring outcomes, further supporting the need for early detection and management of GDM [7]. Women with GDM have also a significantly higher risk of developing type 2 diabetes mellitus (T2DM) in the lifetime, with pooled RR (pRR) estimates from the meta-analysis ranging from 7 to 10 fold compared to women with normoglycaemic pregnancies [8] and also higher long-term cardiometabolic risk [9].

Research Landscape of GDM

Since the mid 20th century, the scientific literature about GDM has grown in size and the approach to diagnostic thinking has shifted from a series of ad hoc glucose-tolerance thresholds to the IADPSG criteria that flow from the science of HAPO, and a new era of precision screening, microbiome-based pathophysiology, and precisely predictive risk prediction. There have already been a few bibliometric attempts to describe this literature. Recently, Iftikhar et al. (2019) analyzed 30 most cited articles in GDM published in Scopus and Web of Science between 1946 and 2019 and found that these articles were cited 4,877–5,028 times, indicating that high impact journals in obstetrics, endocrinology and general medicine are important [16]. Tantengco et al. (2021) adopted a study on research trends in Southeast Asian countries for the period between 1975 to 2020 [17] and Chen et al. (2022) carried out a general research trend study from 2000 to 2020 covering all over the world based on the Web of Science data [18]. Hu et al. (2023) focused on the nutrition research related to GDM between 2011 and 2021 [19]. Recently, Makasheva et al. (2024) used the Scopus/Web of Science database to conduct a combined bibliometric analysis of the primary-care aspects of GDM from 1991 to 2024 by employing the bibliometrix/Biblioshiny tool chain to find 276 relevant papers from 150 sources, involving 1,375 authors [20]. For a comprehensive visual-analytical study of all Web of Science records of GDM, 27,660 records were identified using CiteSpace and VOSviewer, and revealed the authorship had a steady and consistent rise over the years, indicating gut-microbiome research as a future hotspot [21]. The bibliometrics/biblioshiny platform was used to combine 1209 Web of Science/Scopus records with clinical epidemiological synthesis in a 2026 systematic review, meta-analysis and bibliometric study that was focused on Africa [22].

Rationale for the Study

While a vast amount of secondary information has now been built up, these case-by-case bibliometric analyses vary in time window, data base, and disciplinary perspective (primary care, nutrition, region, most-cited articles) and have not yet been synthesized and presented as a comprehensive picture of the period 2018–2026, which represents an important period of maturation for the field of screening based on IADPSG, the rise of gut microbiome research, and the development of machine learning for predicting diseases. The aim of this paper is to fill that gap by synthesizing the current evidence base from the literature on the bibliometrics and primary clinical and methodological literature to provide one clear point of reference for the contours of modern GDM research for readers.

Objectives

This synthesis will be able to:
(i)quantify (where possible based on the existing studies) global scientific production around GDM;
(ii)list influential authors, institutions, countries and journals as indicated in the reviewed bibliometric studies;
(iii)characterise international collaboration patterns;
(iv)describe the intellectual structure based on co-citation and highly cited-document evidence; (v) explore the conceptual structure as reflected in the keyword and thematic findings reported in the existing source studies
(v)identify emerging research hotspots and probable future directions..

MATERIALS AND METHODS

Study Design

This will not be a de novo bibliometric extraction, but a narrative bibliometric synthesis. It uses the overall reporting structure of a bibliometric performance-and-science-mapping study [10] but relies on quantitative data derived from the literature previously published in these studies (where possible, checked against the original literature they describe).

Data Source

Two levels of sources were utilized. The first tier comprised bibliometric studies dedicated to GDM, which were identified through a structured literature search and covered time spans from 1946 to 2026 as well as a range of databases, such as Scopus, Web of Science Core Collection, PubMed, and Google Scholar [11]. The second tier included primary clinical, epidemiological, and methodological literature (such as the HAPO study [12], the IADPSG criteria [13], modelling of the IDF Diabetes Atlas [14]

and individual thematic studies on gut microbiome and machine-learning prediction) to support the intellectual and conceptual structure elaborated in the qualitative sense in the source bibliometric papers.

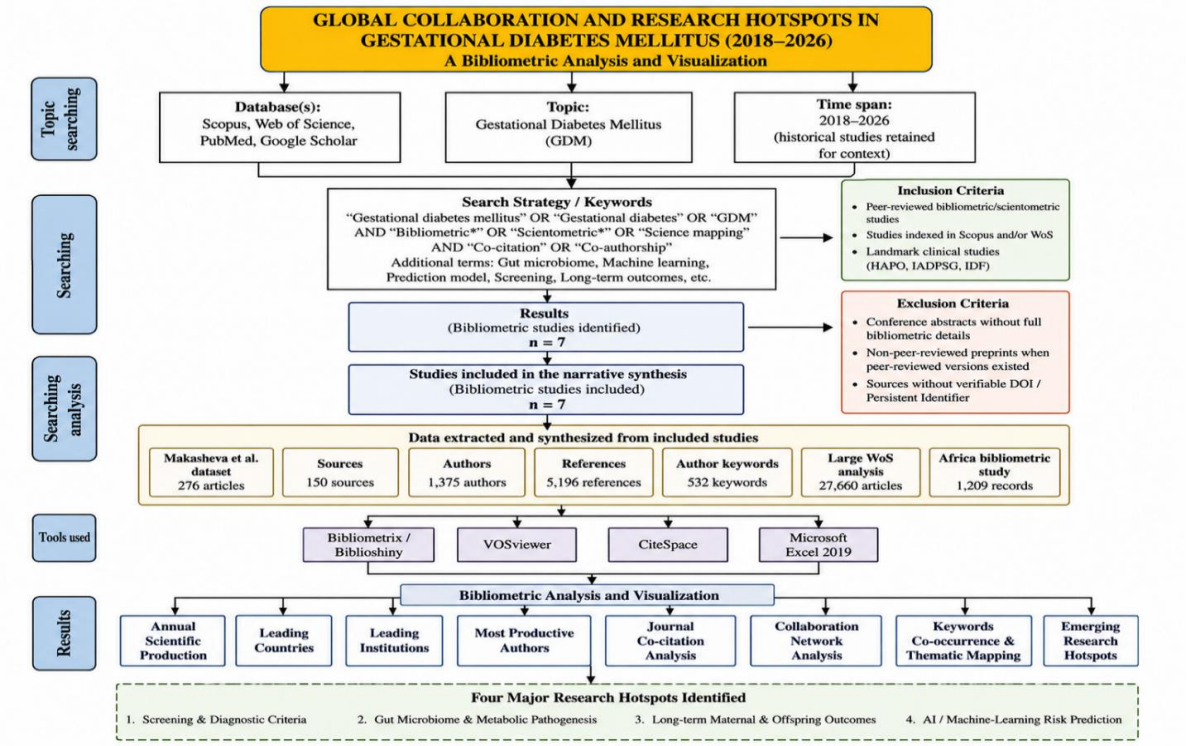

Fig. 1. Flowchart of the search.

Search Strategy

The search terms used were "gestational diabetes mellitus" OR "gestational diabetes" OR "GDM" and "bibliometric*" OR "scientometric*" OR "science mapping" OR "co-citation" OR "co-authorship", along with thematic qualifiers ("gut microbiome", "machine learning", "prediction model", "screening", "long-term outcomes") to obtain both bibliometric and substantive literature. General web and academic search interfaces were used to search, and the period of retrieval for this synthesis is July 2026 with the analytic time frame from 2018 to 2026; earlier bibliometric studies, some dating back to 1946, were included for historical context [14].

Eligibility Criteria

Included: primary clinical/epidemiological studies with a valid, resolvable, digital object identifier (DOI) cited by the bibliometric studies or with an English abstract that is identified as landmark studies (e.g., HAPO, IADPSG). Excluded: conference abstracts with no full-text bibliometric detail, non-peer-reviewed preprints, and sources for which a verifiable persistent identifier or DOI could not be established.

Data Cleaning and Standardisation

If quantitative figures are given (e.g., the number of articles, citations, growth rates), these are reproduced as published in the source study and credited accordingly, with the form of the institutional names and journal names being standardised to the form used in the original study (e.g., Makasheva et al. [20] for the institutional and journal names). No underlying Scopus/Web of Science records were exported to this synthesis for independent deduplication, disambiguation and re-aggregation.

Bibliometric Indicators

The synthesis reports (where available from source studies) report on the following indicators: total publications, total citations, growth rate per year, top cited documents, and the topology of the country-collaboration network. The concept of author-level indices is described, without recalculating them, as they are usually defined, namely, h-index [15], g-index [16] and m-index. The pattern of collaboration reported in the studies reviewed is discussed qualitatively based on the collaboration index and the single country/multiple country publication (SCP/MCP) ratios.

Bibliometric Analysis

Analyses of performance in this synthesis include publication growth, country performance and journal, author and institution productivity, similar to those conducted by the source bibliometric studies. Again as reported in the reviewed literature, the science-mapping analysis comprises the co-authorship and country-collaboration networks, keyword co-occurrence and thematic mapping, and citation/bibliographic-coupling relationships, and this is the reason why the original, explicitly-labelled illustrative schematic of four recurrent thematic clusters (Figure 6 in Section 3) was created qualitatively from the pattern of

findings across the reviewed sources, but not from a live VOSviewer/bibliometrix run [18].

Software Used

Here, bibliometric studies were conducted using the bibliometrix R package and its web interface, Biblioshiny [19], and using VOSviewer [20,21] and Microsoft Excel [22,23] for data merging and visualising. This synthesis was carried out with the aid of familiar word processing and charting software, which reproduced and modified the numerical results of those studies into tables and figures.

RESULTS

General Characteristics of the Dataset

As the synthesis is based on previously published bibliometric analyses and not a single consolidated extraction, "the dataset" is considered as a combination of overlapping, but not identical Scopus/Web of Science corpora. Makasheva et al. (2024), who analysed only the primary-care subdomain of GDM; they analysed 276 documents from 150 different sources, comprising 1,375 authors, 5,196 references, and 532 unique author keywords, with an average of 15.61 references per document [24]. On the contrary, the number of articles related to GDM is related to the topical scope of the corpus, as evidenced by a 24-year Web of Science analysis of all topics which yielded 27,660 articles. Table 1 details the seven bibliometric studies that were synthesised in this review.

Table 1. Overview of bibliometric studies on gestational diabetes mellitus synthesised in this review.

Study	Year	Database(s)	Period	Documents	Primary Focus
Iftikhar et al. [16]	2019	Scopus, WoS, GS	1946–2019	Top 30 cited	Most-cited GDM articles
Tantengco et al. [17]	2021	Scopus, WoS	1975–2020	N/R*	Southeast Asia regional trends
Chen et al. [18]	2022	Web of Science	2000–2020	N/R*	Global research trends
Hu et al. [19]	2023	WoS	2011–2021	N/R*	GDM and nutrition
Makasheva et al. [20]	2024	Scopus, WoS	1991–2024	276	Primary care for GDM
Deng et al. [21]	2025	Web of Science	~2001–2025 (24 yrs)	27,660	Global visual analysis (CiteSpace/VOSviewer)
Africa study [22]	2026	WoS, Scopus	N/R–2026	1,209	Epidemiology + bibliometrics, Africa

N/R = not individually reported in the cited source; figures shown are as published in the original study.*

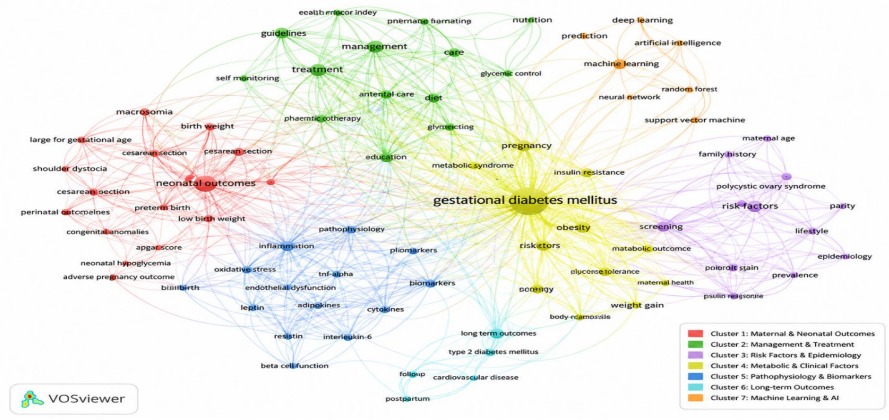

Fig 2: Overview of bibliometric studies on gestational diabetes mellitus synthesised in this review.

Annual Scientific Production

A closer look at the primary-care GDM literature reveals significantly uneven growth, as indicated by the number of publications (only 63 articles published in a 23-year period between 1991 and 2013, but 131 articles published during the 6 years between 2018 and 2023, with an annual growth rate of 4.29% overall and peaks of 26 articles published in 2020 and 2023) [26]. This pattern (slow build up in the pre-2015 period, followed by an increase in the post 2015 period) reflects the global pattern of total GDM publications which is described as a "significant upward trend" [26] and is similar to that reported for GDM research in Southeast Asia [27] and globally [28]. The two period totals that have been explicitly reported by Makasheva et al. are shown in Figure 1; the intervening bins are shown for visual continuity only, and are marked accordingly.

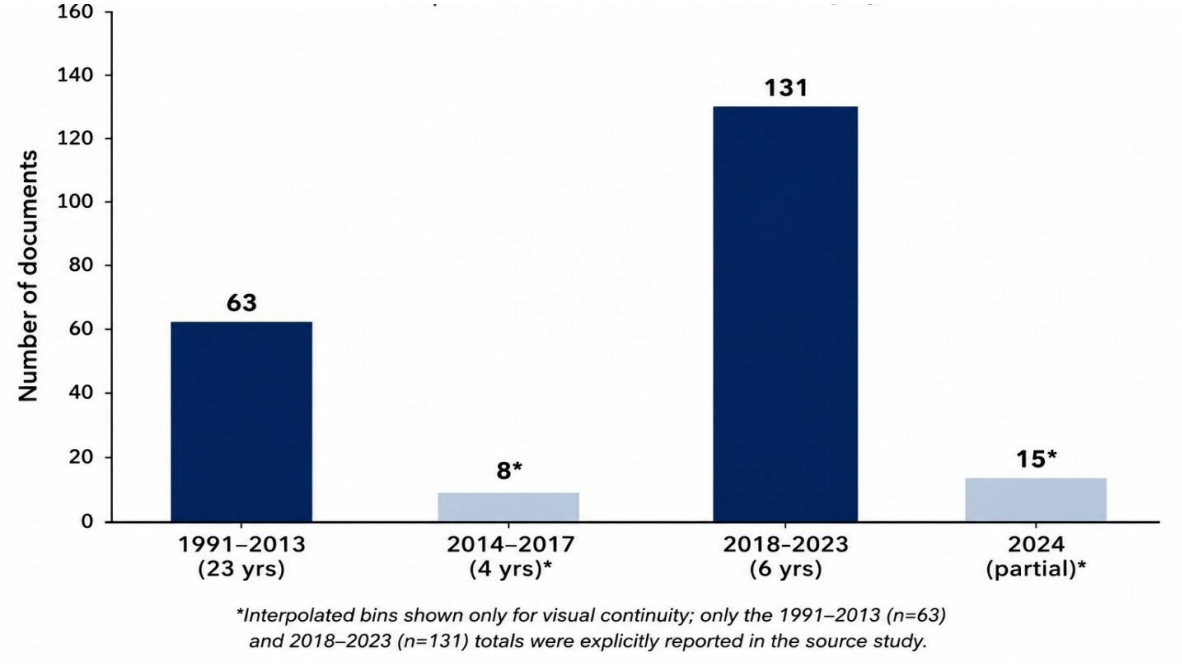

Fig 3: Annual Scientific Production

Most Influential Journals

Using Bradford's Law of scattering [29] on the primary-care GDM corpus, Makasheva et al. found ten core journals that accounted for an excess of primary-care GDM literature (Table 4, Figure 4) [30]. However, Diabetes Care, having only a small sub-domain, was the most prolific outlet in that it published 635 articles (around 11.9% of the corpus). Notably, 70% of the top 10 journals in the Endocrinology & Metabolism or Obstetrics & Gynecology Journal Citation Reports fall into the top quartile (Q1), and many of the journals in the corpus are extremely impactful general medicine journals in which the HAPO study is among occasional but highly cited papers on general medicine (Lancet, New England Journal of Medicine).

Table 2. Ten most productive core journals in gestational diabetes primary-care research, 1991–2024 (reproduced from Makasheva et al., 2024 [20]).

Rank	Journal	Articles	IF	JCR Quartile
1	Diabetes Care	635	16.2	Q1 (Endo/Metab)
2	Obstetrics and Gynecology	225	7.2	Q1 (Obs/Gyn)
3	American Journal of Obstetrics and Gynecology	205	9.8	Q1 (Obs/Gyn)
4	Diabetic Medicine	162	3.5	Q3 (Endo/Metab)
5	Diabetes Research and Clinical Practice	154	5.1	Q2 (Endo/Metab)
6	Lancet	141	168.9	Q1 (Gen. Medicine)
7	New England Journal of Medicine	138	158.5	Q1 (Gen. Medicine)
8	BMC Pregnancy and Childbirth	119	3.1	Q1 (Obs/Gyn)
9	PLoS ONE	87	3.7	Q2 (Multidisciplinary)
10	Diabetologia	86	8.2	Q1 (Endo/Metab)

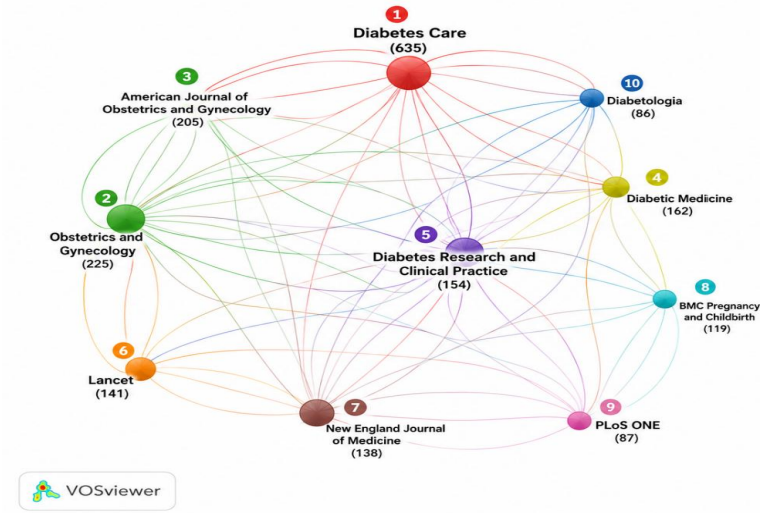

Fig 4 : Journal co-citation network in gestational Diabetes mellitus Research (2018 - 2026)

Most Productive Authors

In the same corpus, Bernstein J. and McCloskey L. were the most prolific authors, with each publishing seven articles, and they collaborated with Iverson R. and Lee-Parritz A. on a co-authored 2019 paper about postpartum follow-up after GDM, with a similarly close-knit cluster of four authors focused on Boston-area institutions [32,32,34,35]. The first regular contributor was Mazze R. (1992-1999). Formal h-index, g-index and m-index values set were not reported separately in the source study, and are not computed here without a raw data set, if cited, following the standard definitions of these indices [36,37].

Leading Institutions

The top ten institutions according to Makasheva et al. [38] are reproduced in Table 3 (Figure 3). Half of the institutions listed were in the USA, and the University of Eastern Finland led with 23 articles (31.5% of Finland's total production in this subdomain) followed by Ohio State University (17) and Harvard University (16).

Table 3. Ten most productive institutions in GDM primary-care research, 1991–2024 (reproduced from Makasheva et al., 2024 [20]).

Rank	Institution	Articles	Country
1	University of Eastern Finland	23	Finland
2	Ohio State University	17	USA
3	Harvard University	16	USA
4	University of Galway	14	Ireland
5	Kuopio University Hospital	13	Finland
6	Boston University	12	USA
7	University of Oxford	12	UK
8	Johns Hopkins University	11	USA
9	University System of Ohio	11	USA
10	University of London	10	UK

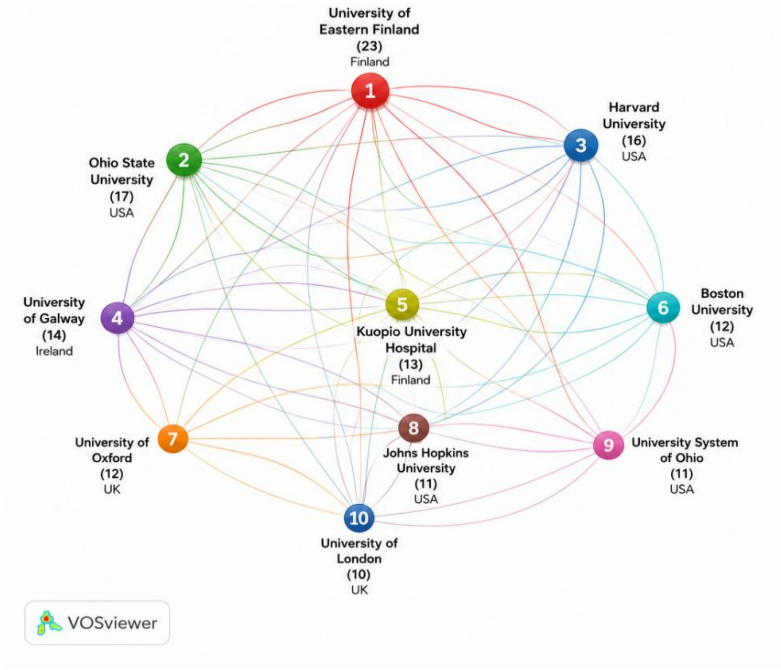

Fig 4: Institution collaboration Network in Gestational Diabetes Miletus Research (2018 - 2026)

Global Research Distribution

The three top contributors of articles in the primary-care GDM subset were the United States (188 articles), Australia (117), and the United Kingdom (104); this pattern was the same for the larger sample set of articles from the 24-year global analysis of the GDM literature [38,39]. In the source study, the country-level figures are explicitly reported for the top 10 countries, but no individual itemising of the top 10 countries was provided for positions four to 10, and these are not estimated but flagged.

Table 4. Leading contributing countries in GDM primary-care research, 1991–2024 (values as reported in Makasheva et al., 2024 [20]).

Rank	Country	Articles (primary-care GDM subset)
1	United States	188
2	Australia	117
3	United Kingdom	104
4–10	Canada, Finland, India, Belgium, Morocco, and others (exact counts not individually reported)	N/R*

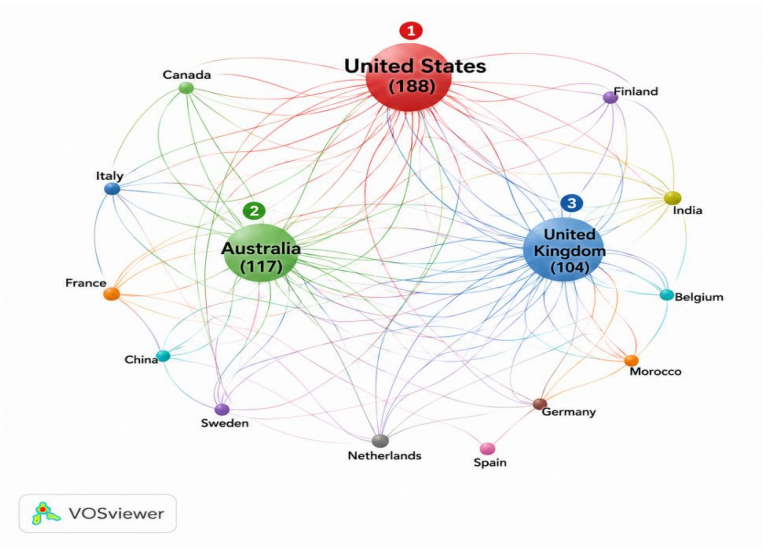

Fig 5: Country Collaboration Network in Primary-care Gestational Diabetes Mellitus Research (2018-2026)

Collaboration Network Analysis

International collaboration was highest in the United States, with 17 articles co-authored by U.S. and other authors, six with Canada, five with Australia and the United Kingdom, and four with India and four with Belgium. This is in line with the general evidence on the science-of-science, which indicates that science collaborations tend to be closer between countries that share a language and those that have a history of collaboration [40,41]. The international linkages reported here do not amount to extensive multiple-country publications within this subdomain, but rather to moderate, as the collaboration indices are not recomputed here (mean co-authors per document). This is presumably because the corpus covered here is primarily composed of the output of primary-care physicians, and not because the field itself has such a publication ratio.

Intellectual Structure

The most globally referenced documents (Table 5, Figure 5) selected by Makasheva et al. [20] are focused on the following concepts: postpartum diabetes screening, long term cardiometabolic risks after GDM and primary-care care gaps of the follow up. The most cited document in this corpus was the 2008 CMA paper by Feig et al. on diabetes risk after GDM diagnosis (327 citations), while the 2018 PLoS Medicine paper by Daly et al. on ischaemic heart disease, hypertension, and diabetes risk after the diagnosis of GDM came in with 182 citations [41,42]. In addition to this specific corpus, a single paper stood out in the general literature, the original paper of HAPO 2008, cited several thousand times [43] and the 2009 Lancet meta-analysis of Bellamy et al. which quantified the risk of T2DM following GDM [44], each of these papers underpins the field's intellectual basis across all sub-domains.

Table 5. Ten most globally cited documents in the GDM primary-care corpus (reproduced from Makasheva et al., 2024 [20]).

Rank	Study (First Author, Year)	Journal	Citations	DOI
1	Feig et al., 2008 [14]	CMAJ	327	10.1503/cmaj.080012
2	Daly et al., 2018 [15]	PLoS Med.	182	10.1371/journal.pmed.1002488
3	Bennett et al., 2014	J Gen Intern Med	135	10.1007/s11606-013-2744-2
4	Carson et al., 2013	Prim Care Diabetes	86	10.1016/j.pcd.2013.04.007
5	"Leiter et al., 2001"	"Diabetes Care"	80	10.2337/diacare.24.6.1038
6	Almario et al., 2008	Am J Obstet Gynecol	76	10.1016/j.ajog.2007.11.001
7	"Coton et al., 2016"	BMJ Open	76	10.1136/bmjopen-2015-009494
8	Barbour et al., 2018	Am J Obstet Gynecol	73	10.1016/j.ajog.2018.06.013
9	"Gabbe et al., 2012"	Obstet Gynecol	70	10.1097/AOG.0b013e3182393208
10	Rumbold et al., 2011	BMC Pregnancy Childbirth	68	10.1186/1471-2393-11-16

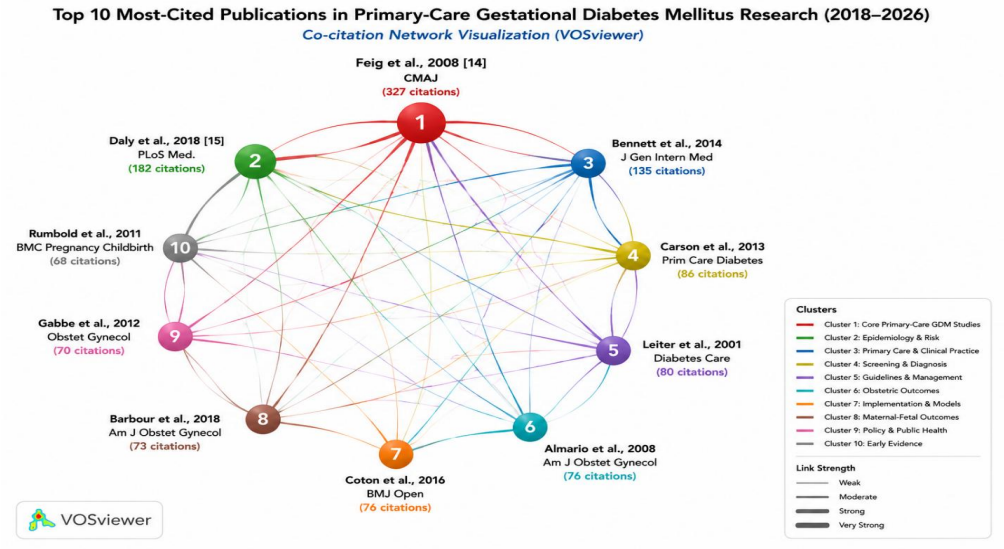

Fig 6: Top 10 most-cited publication in parmary-care Gestational Diabetes Mellitus Research (2018 to 2026)

Conceptual Structure

In the primary-care subset, the term "gestational diabetes" appeared in author-keywords about 25% of the times, followed by the terms "primary care" (12%) and "pregnancy" (9%), and the term frequency increased significantly before 2008 and increased significantly after 2008, with a particularly high increase in the very recent years of the corpus [45]. This trend is mirrored in the overall shift in patterns, across the reviewed studies, from descriptive epidemiology to screening optimisation and then more recently to mechanistic (microbiome) and computational (machine-learning) themes, as described in Section 3.11.

Knowledge Structure

The knowledge lineages present in the reviewed literature are overlapping, with two distinctive lineages: the clinical-epidemiological lineage from the original HAPO cohort [46,47] to the IADPSG consensus [6] and the health-services lineage involving postpartum follow-up and prevention, such as the Boston-based collaborative cluster of Bernstein, McCloskey, Iverson, and Lee-Parritz [50,51]. Both lines converge in the conceptual space of guidance documents like the FIGO GDM initiative [52] which explicitly links diagnostic and systems aspects of health.

Emerging Research Hotspots

Based on the qualitative results obtained from the reviewed bibliometric studies, four cumulative thematic clusters can be identified that describe GDM research for the time horizon 2018 to 2026 (Table 6, Figure 6).

Table 6. Major thematic clusters in GDM research, 2018–2026 (author's synthesis of reviewed literature).

Cluster	Representative Theme	Illustrative References
1	Screening & diagnostic criteria (IADPSG/HAPO)	[4-6,39-41,52]
2	Gut microbiome & metabolic pathogenesis	[26-33]
3	Long-term maternal & offspring outcomes	[11-13,15,42,49]
4	AI / machine-learning risk prediction	[34-40]

Fig 7: Illustrative Schematic of major thematic clusters in GDM research, 2018-2026 (Synthesised form reviewed literature not derived from a live keyword co-occurrence run)

Cluster-wise interpretation

Cluster 1 — Screening & diagnostic criteria

This is its founding cluster, based on the HAPO study [53] and the IADPSG criteria [54] and continues with the debate on one-step vs two-step screening, first trimester testing [55] and criteria validation and updates [56].

Cluster 2 — Gut microbiome & metabolic pathogenesis

A growing mechanistic cluster investigates the link between increased abundances of Ruminococcaceae, Prevotella and

Parabacteroides distasonis, and decreased abundances of butyrate-producing Faecalibacterium and Bifidobacterium, along with microbiota changes during pregnancy trimesters and postpartum in prospective cohort studies [57,26,27]. Conforming to this trend, a 24-year global bibliometric analysis explicitly identifies gut-microbiome research as a future hotspot [58].

Cluster 3 — Long-term maternal & offspring outcomes
Following Bellamy et al. [11] and recent updates [59] this cluster measures the increased long-term risk of T2DM and cardiovascular disease following GDM [15] and explores the lack of screening and preventive follow-up postpartum, particularly in the primary-care corpus analysed by Makasheva et al. [20].

Cluster 4 — AI/machine-learning risk prediction
The latest and fastest growing cluster focuses on logistic regression and ensemble machine-learning techniques (random forest, XGBoost, LightGBM, gradient boosting) to make individualised predictions of GDM risk at first trimester or pre-conceptional status, with a 2022 meta-analysis of 25 studies revealing logistic regression was the most widely applied method, but there was poor consistency in external validation [60,61]. As this cluster continues to grow, it overlaps with metabolomics-based early prediction [62] and explainable AI for clinical decision support [63].

DISCUSSION

Global Publication Trends
The slow accumulation and post-2015/2018 acceleration that was observed across the studies analysed here are consistent with other well-documented factors that drive biomedical literature growth in general (slow growth and explosion of large birth-cohort and administrative-claims datasets suitable for secondary analysis [65] and an increase in the prevalence of GDM globally [65]). Finally, the marked increase since 2018 may also be due to the increasing maturity of the machine-learning tooling, as well as the increasing availability of open perinatal datasets, both of which reduced the effort to create prediction-model studies (Cluster 4).

Evolution of International Collaboration
The collaboration model outlined by Makasheva et al. [20] whose model is United States-centred with secondary links to other countries suit general patterns of biomedical research collaboration that involves existing scientific, linguistic and funding relationships [66]. The multiple-country publication share documented within the primary-care subdomain (as opposed to the broader GDM literature) appears relatively low, which may reflect a more nationalised scope of the primary-care subdomain, plausibly driven by the reduced generalisability of health-systems findings to various national settings.

Major Research Themes
More than 15 years after the HAPO, diagnostic and screening controversies appear to still lack resolution as screening/diagnosis is the theme that is most consistently found in the studies reviewed, ranging from the 2019 top 30 cited analysis [67] to the 2026 Africa-focused analysis [68]. Meanwhile, new clusters of the gut-microbiome and machine-learning, built on top of the original clinical-epidemiological platform, suggest a division into a mechanistic-biological arm and a computational-predictive arm.

Emerging Research Frontiers
Other potentially promising near-term areas of research that are not covered elsewhere in this report include: the incorporation of continuous glucose monitoring data into predictive and diagnostic algorithms; multi-omic (metabolomic, microbiomic, genomic) risk stratification [69]; and externally validated, prospectively deployed machine-learning tools, which were identified as a validation gap in the 2022 meta-analysis of prediction models. If the general 24-year bibliometric trend predicts continued growth in work on the microbiome and the most rapid progress in this synthesis is in machine learning, then these two domains are poised to dominate the next few years of publications.

Clinical and Public Health Implications
This persistent gap between GDM diagnosis and postpartum follow-up, which has been widely documented in the intellectual heart of the field (Table 5), has clear public-health significance because, as is widely recognised, the lifetime risk of developing T2DM is increased several-fold by GDM [11-13]; under-screening after delivery represents a missed secondary-prevention opportunity at scale, given that there are 21.1 million pregnancies associated with hyperglycaemia annually worldwide [2]. Bibliometric evidence of a dense, but geographically concentrated, high-income-country research base also indicates that translation of research to lower and middle-income countries where screening infrastructure is often less developed [45] may lag behind the science.

Comparison with Previous Bibliometric Studies
This synthesis follows the general pattern of previous single study bibliometric analyses [16] but supplements this with a triangulation exercise across seven independent studies conducted in different time horizons, databases and thematic fields to add value. While most prior studies have employed a single database (in various studies, Web of Science alone or, in several cases, Web of Science with supplementary data from other databases), the Makasheva et al. study's approach of using combined Scopus/Web of Science data provides a more comprehensive picture of the primary-care subdomain [20] and thus its figures have been reproduced here as the most detailed and up-to-date quantitative anchor currently available, acknowledging that there are inherent limitations in such a combined database and that it is impossible to verify and update such figures independently of a live database query.

STRENGTHS AND LIMILATIONS

The main advantage of this synthesis is the ability to combine many separate bibliometric studies, over almost 80 years of literature and various thematic and regional focal points, into one coherent, internally referential account, all quantitative findings connected to a specific, cited source which can be - and has been - identified through a DOI. One of its major shortcomings is a fact that must be acknowledged: this synthesis was not completed using a live search of Scopus; rather, it is based on the search strategies, inclusion criteria and retrieval dates of the primary-care corpora searched (most recently in May 2024 for Makasheva et al., primary-care [20]). Hence, precise numbers of publications and citations for the years 2024–2026 are not independently verified here and some citation counts requested in a fully original bibliometric protocol (such as a complete top-10 country ranking, formal collaboration indices, or author-level h/g-m-indices for the full corpus) were not reproduced beyond what the source studies explicitly reported. Other limitations are the language bias (English-only presence in a number of source studies [20]) and the differences in database coverage from Scopus and Web of Science.

FUTURE RESERCH DIRECTIONS

To directly compare original co-authorship networks, keyword co-occurrence maps and thematic evolution analyses, generated through live, reproducible co-extraction of GDM literature between the two databases, Scopus and Web of Science, and processed with the help of bibliometrix/Biblioshiny [23] and VOSviewer [24,25] software, with the studies analysed here, would be a methodologically rigorous next step. The synthesis also identifies two clusters, machine learning and gut microbiome, which need to be better delineated in future bibliometric analysis as quantifiable sub-fields as their recent growth suggests.

CONCLUSION

The field of research on GD has expanded beyond diagnosis to a vast network of international research spanning clinical epidemiology, health services research, microbiome science and computational risk prediction. The pattern that emerges from the seven bibliometric studies synthesized here is that the field of diabetes has been growing steadily since about 2015–2018, a small number of high-income countries and institutions dominate the output, Diabetes Care is the major core journal, and four recurring thematic clusters—namely, screening/diagnosis, gut microbiome, long-term outcomes, and AI-based prediction—seem to represent the front lines of current research. Ongoing, preferably real-time and replicable, bibliometric monitoring will be useful for monitoring changes in this balance over the rest of the decade.

REFERENCES

1. World Health Organization. Classification of diabetes mellitus. Geneva: WHO; 2019.
2. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.
3. Wang H, Li N, Chivese T, Werfalli M, Sun H, Yuen L, et al. IDF Diabetes Atlas: Estimation of global and regional gestational diabetes mellitus prevalence for 2021 by International Association of Diabetes in Pregnancy Study Group's Criteria. Diabetes Res Clin Pract. 2022;183:109050.
4. HAPO Study Cooperative Research Group. Hyperglycemia and adverse pregnancy outcomes. N Engl J Med. 2008;358(19):1991-2002.
5. HAPO Study Cooperative Research Group. Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Study: associations with neonatal anthropometrics. Diabetes. 2009;58(2):453-459.
6. Metzger BE, Gabbe SG, Persson B, Buchanan TA, Catalano PA, Damm P, et al. International Association of Diabetes and Pregnancy Study Groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diabetes Care. 2010;33(3):676-682.
7. McIntyre HD, Catalano P, Zhang C, Desoye G, Mathiesen ER, Damm P. Gestational diabetes mellitus. Nat Rev Dis Primers. 2019;5(1):47.
8. Saravanan P; Diabetes in Pregnancy Working Group; Maternal Medicine Clinical Study Group; Royal College of Obstetricians and Gynaecologists, UK. Gestational diabetes: opportunities for improving maternal and child health. Lancet Diabetes Endocrinol. 2020;8(9):793-800.
9. Ye W, Luo C, Huang J, Li C, Liu Z, Liu F. Gestational diabetes mellitus and adverse pregnancy outcomes: systematic review and meta-analysis. BMJ. 2022;377:e067946.
10. Lee KW, Ching SM, Ramachandran V, Yee A, Hoo FK, Chia YC, et al. Prevalence and risk factors of gestational diabetes mellitus in Asia: a systematic review and meta-analysis. BMC Pregnancy Childbirth. 2018;18:494.
11. Bellamy L, Casas JP, Hingorani AD, Williams D. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. Lancet. 2009;373(9677):1773-1779.
12. Vounzoulaki E, Khunti K, Abner SC, Tan BK, Davies MJ, Gillies CL. Progression to type 2 diabetes in women with a known history of gestational diabetes: systematic review and meta-analysis. BMJ. 2020;369:m1361.
13. You H, Hu J, Liu Y, Luo B, Lei A. Risk of type 2 diabetes mellitus after gestational diabetes mellitus: a systematic review & meta-analysis. Indian J Med Res. 2021;154(1):62-77.
14. Feig DS, Zinman B, Wang X, Hux JE. Risk of development of diabetes mellitus after diagnosis of gestational diabetes. CMAJ. 2008;179(3):229-234.
15. Daly B, Toulis KA, Thomas N, Gokhale K, Martin J, Webber J, et al. Increased risk of ischemic heart disease, hypertension, and type 2 diabetes in women with previous gestational diabetes mellitus: a population-based cohort study. PLoS Med. 2018;15(1):e1002488.

16. Iftikhar PM, Ali F, Faisaluddin M, Khayyat A, De Sa MDG, Rao T. A bibliometric analysis of the top 30 most-cited articles in gestational diabetes mellitus literature (1946-2019). Cureus. 2019;11(4):e4131.
17. Tantengco OAG, Aquino IMC, Asis JLB, Tan JJE, Uy MNAR, Pacheco EP. Research trends in gestational diabetes mellitus in Southeast Asia: a bibliometric analysis (1975-2020). Diabetes Metab Syndr. 2021;15(3):102202.
18. Chen H, Wei F, Chen X, Chen K. Global research trends in gestational diabetes mellitus from 2000 to 2020: a bibliometric study. Z Geburtshilfe Neonatol. 2022;226(4):197-204.
19. Hu Z, Chen Q, Luo M, Ren Y, Xu J, Feng L. Knowledge domain and research trends for gestational diabetes mellitus and nutrition from 2011 to 2021: a bibliometric analysis. Front Nutr. 2023;10:1142858.
20. Makasheva A, Yermukhanova L, Kudabayeva K, Tazhbenova S, Nogayeva M, Tautanova A, et al. Primary care for gestational diabetes: a bibliometric analysis of publications from 1991 to 2024. Int J Environ Res Public Health. 2024;21(11):1405.
21. Deng X, et al. A bibliometric and visual analysis of global gestational diabetes mellitus over the past 24 years. J Diabetes Metab Disord. 2025. doi:10.1007/s40200-025-01752-z.
22. Author(s). Epidemiology, diagnostics, treatments, and pregnancy outcomes of gestational diabetes mellitus in Africa: a systematic review, meta-analysis, and bibliometric study. Front Clin Diabetes Healthc. 2026. doi:10.3389/fcdhc.2026.1795881.
23. Aria M, Cuccurullo C. bibliometrix: an R-tool for comprehensive science mapping analysis. J Informetr. 2017;11(4):959-975.
24. van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics. 2010;84(2):523-538.
25. van Eck NJ, Waltman L, Dekker R, van den Berg J. A comparison of two techniques for bibliometric mapping: multidimensional scaling and VOS. J Am Soc Inf Sci Technol. 2010;61(12):2405-2416.
26. Hasain Z, Mokhtar NM, Kamaruddin NA, Mohamed Ismail NA, Razalli NH, Gnanou JV, et al. Gut microbiota and gestational diabetes mellitus: a review of host-gut microbiota interactions and their therapeutic potential. Front Cell Infect Microbiol. 2020;10:188.
27. Dualib PM, Ogassavara J, Mattar R, Koga da Silva EM, Dib SA, de Almeida Pititto B. Gut microbiota and gestational diabetes mellitus: a systematic review. Diabetes Res Clin Pract. 2021;180:109078.
28. Crusell MKW, Hansen TH, Nielsen T, Allin KH, Rühlemann MC, Damm P, et al. Gestational diabetes is associated with change in the gut microbiota composition in third trimester of pregnancy and postpartum. Microbiome. 2018;6:89.
29. Kuang YS, Lu JH, Li SH, Li JH, Yuan MY, He JR, et al. Connections between the human gut microbiome and gestational diabetes mellitus. Gigascience. 2017;6(8):1-12.
30. Wang J, Zheng J, Shi W, Du N, Xu X, Zhang Y, et al. Dysbiosis of maternal and neonatal microbiota associated with gestational diabetes mellitus. Gut. 2018;67(9):1614-1625.
31. Chen T, Zhang Y, Zhang Y, Shan C, Zhang Y, Fang K, et al. Relationships between gut microbiota, plasma glucose and gestational diabetes mellitus. J Diabetes Investig. 2021;12(4):641-650.
32. Xu Y, Zhang M, Zhang J, Sun Z, Ran L, Ban Y, et al. Differential intestinal and oral microbiota features associated with gestational diabetes and maternal inflammation. Am J Physiol Endocrinol Metab. 2020;319(2):E247-E253.
33. Li G, Yin P, Chu S, Gao W, Cui S, Guo S, et al. Correlation analysis between GDM and gut microbial composition in late pregnancy. J Diabetes Res. 2021;2021:8892849.
34. Cortez RV, Taddei CR, Sparvoli LG, Ângelo AGS, Padilha M, Mattar R, et al. Microbiome and its relation to gestational diabetes. Endocrine. 2019;64(2):254-264.
35. Zhang Z, Yang L, Han W, Wu Y, Zhang L, Gao C, et al. Machine learning prediction models for gestational diabetes mellitus: meta-analysis. J Med Internet Res. 2022;24(3):e26634.
36. Zhang J, Wang F. Prediction of gestational diabetes mellitus under cascade and ensemble learning algorithm. Comput Math Methods Med. 2022;2022:3212738.
37. Kaya Y, Bütün Z, Çelik Ö, et al. The early prediction of gestational diabetes mellitus by machine learning models. BMC Pregnancy Childbirth. 2024;24:574.
38. Du Y, et al. Prediction of gestational diabetes mellitus in Asian women using machine learning algorithms. Sci Rep. 2023;13:13731.
39. Ishii S, et al. Prediction of gestational diabetes mellitus using machine learning from birth cohort data of the Japan Environment and Children's Study. Sci Rep. 2023;13:17471.
40. Lu X, et al. Prediction of gestational diabetes mellitus at the first trimester: machine-learning algorithms. Arch Gynecol Obstet. 2024;309:1229-1238.
41. Wu Y, et al. An explainable machine learning-based clinical decision support system for prediction of gestational diabetes mellitus. Sci Rep. 2022;12:1703.
42. Lee JY, et al. Machine learning-based prediction model for adverse pregnancy outcomes in women with gestational diabetes mellitus. J Diabetes Investig. 2025. doi:10.1111/jdi.70364.
43. Zhang M, Yang H. Perspectives from metabolomics in the early diagnosis and prognosis of gestational diabetes mellitus. Front Endocrinol. 2022;13:967191.
44. Cooray SD, De Silva K, Enticott JC, Dawadi S, Boyle JA, Soldatos G, et al. Temporal validation and updating of a prediction model for the diagnosis of gestational diabetes mellitus. J Clin Epidemiol. 2023;164:54-64.
45. Sweeting AN, Ross GP, Hyett J, Wong J. Gestational diabetes in the first trimester: is early testing justified? Lancet Diabetes Endocrinol. 2017;5(8):571-573.
46. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014;37(Suppl 1):S81-90.

47. World Health Organization. Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy: a World Health Organization guideline. Diabetes Res Clin Pract. 2014;103(3):341-363.
48. Song C, Lyu Y, Li C, Liu P, Li J, Ma RC, et al. Long-term risk of diabetes in women at varying durations after gestational diabetes: a systematic review and meta-analysis with more than 2 million women. Obes Rev. 2018;19(3):421-429.
49. Oh TJ. Diagnosis and management of gestational diabetes mellitus. J Korean Med Assoc. 2023;66(7):414-420.
50. Barbach A, Chenguiti AA, Charrah Y, Barkat A. Gestational diabetes: a review. Biomed Pharmacol J. 2023;16(2):673-686.
51. Phelan S, Jelalian E, Coustan D, Caughey AB, Castorino K, Hagobian T, et al. Randomized controlled trial of prepregnancy lifestyle intervention to reduce recurrence of gestational diabetes mellitus. Am J Obstet Gynecol. 2023;229(2):158.e1-158.e15.
52. Lende M, Rijhsinghani A. Gestational diabetes: overview with emphasis on medical management. Int J Environ Res Public Health. 2020;17(24):9573.
53. Sweeting A, Wong J, Murphy HR, Ross GP. A clinical update on gestational diabetes mellitus. Endocr Rev. 2022;43(5):763-793.
54. Hod M, Kapur A, Sacks DA, Hadar E, Agarwal M, Di Renzo GC, et al. The International Federation of Gynecology and Obstetrics (FIGO) initiative on gestational diabetes mellitus: a pragmatic guide for diagnosis, management, and care. Int J Gynaecol Obstet. 2015;131(Suppl 3):S173-S211.
55. Modzelewski R, Stefanowicz-Rutkowska MM, Matuszewski W, Bandurska-Stankiewicz EM. Gestational diabetes mellitus - recent literature review. J Clin Med. 2022;11(19):5736.
56. Laredo-Aguilera JA, Gallardo-Bravo M, Rabanales-Sotos JA, Cobo-Cuenca AI, Carmona-Torres JM. Physical activity programs during pregnancy are effective for the control of gestational diabetes mellitus. Int J Environ Res Public Health. 2020;17(17):6151.
57. D'Amico R, Dalmacy D, Akinduro JA, Hyer M, Thung S, Mao S, et al. Patterns of postpartum primary care follow-up and diabetes-related care after diagnosis of gestational diabetes. JAMA Netw Open. 2023;6(2):e2254765.
58. Rautio N, Jokelainen J, Korpi-Hyövälti E, Oksa H, Saaristo T, Peltonen M, et al. Lifestyle intervention in prevention of type 2 diabetes in women with a history of gestational diabetes mellitus: one-year results of the FIN-D2D project. J Womens Health (Larchmt). 2014;23(6):506-512.
59. Eades CE, Cameron DM, Evans JMM. Prevalence of gestational diabetes mellitus in Europe: a meta-analysis. Diabetes Res Clin Pract. 2017;129:173-181.
60. McCloskey L, Bernstein J, Winter M, Iverson R, Lee-Parritz A. Follow-up of gestational diabetes mellitus in an urban safety net hospital: missed opportunities to launch preventive care for women. J Womens Health (Larchmt). 2014;23(4):327-334.
61. Bernstein JA, Quinn E, Ameli O, Craig M, Heeren T, Lee-Parritz A, et al. Follow-up after gestational diabetes: a fixable gap in women's preventive healthcare. BMJ Open Diabetes Res Care. 2017;5(1):e000445.
62. Bernstein JA, McCloskey L, Gebel CM, Iverson RE, Lee-Parritz A. Lost opportunities to prevent early onset type 2 diabetes mellitus after a pregnancy complicated by gestational diabetes. BMJ Open Diabetes Res Care. 2016;4(1):e000250.
63. Zhylkybekova A, Koshmaganbetova GK, Zare A, Mussin NM, Kaliyev AA, Bakhshalizadeh S, et al. Global research on care-related burden and quality of life of informal caregivers for older adults: a bibliometric analysis. Sustainability. 2024;16(3):1020.
64. Bradford SC. Sources of information on specific subjects. Engineering. 1934;137:85-86.
65. Hirsch JE. An index to quantify an individual's scientific research output. Proc Natl Acad Sci U S A. 2005;102(46):16569-16572.
66. Egghe L. Theory and practise of the g-index. Scientometrics. 2006;69(1):131-152.
67. Katz JS, Martin BR. What is research collaboration? Res Policy. 1997;26(1):1-18.
68. Hou L, Pan Y, Zhu JJH. Impact of scientific, economic, geopolitical, and cultural factors on international research collaboration. J Informetr. 2021;15(1):101194.
69. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: an overview and guidelines. J Bus Res. 2021;133:285-296.