Review article

The factors affecting the obstetricians-gynecologists workforce planning: A systematic review

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ABSTRACT

Objectives: The purpose of this study was to investigate the models and tools used for the obstetrician-gynecologists (OB-GYNs) workforce planning and to determine the factors affecting their supply and demand.

Methods: This systematic review was conducted by searching the relevant papers published in reputable electronic databases such as PubMed, Scopus and gray literature from 1980 to 2019. PRISMA model was employed to select the papers. The data were extracted by an author-made form and analyzed using framework content analysis method.

Results: Considering the inclusion and exclusion criteria, a total of 45 papers were selected. A variety of factors and models were employed in the reviewed papers for the OB-GYNs workforce planning. The extracted data were classified under three categories: models, supply factors, and demand factors.

Conclusion: The reviewed papers had made more accurate estimates through various variables, scenarios and different mathematical and simulation models. Therefore, the human resources for health (HRH) planners are recommended to consider all effective factors in order to improve the quality of future workforce estimations.

1. Introduction

Human resources planning (HRP) is not a new area of research in medical sciences. In response to the needs of society and the health system, most countries constantly make various decisions to reduce or increase the number of workforces in these fields.¹ Among the medical specialties, obstetrics and gynecology are under the spotlight of workforce planning due to their higher contribution than other specialties and their substantial effects on the promotion of maternal and child health.^{2,3} In addition, the fertility and population growth, the changing population pyramid, and the increasing need of elderly women for the OB-GYNs services necessitate reviewing OB-GYNs training policies to cover these expanded services.⁴ Besides the demands, OB-GYNs workforce planning should also take into account the factors that determine the number of active OB-GYNs and their supply. Physicians' job satisfaction and their efforts to maintain a work-life balance greatly affect their working hours, early retirement patterns or their tendency to work

flexibly and part-time.^{5,6}

As in the other medical specialties, there is no complete and reliable basis for policymakers for the OB-GYNs workforce planning.^{1,7,8} Therefore, it is necessary to conduct a systematic review and synthesis of the literature to ensure OB-GYNs services access. Although several review studies have been carried out about physicians,^{9–11} the specific characteristics of each specialty and differences between the factors influencing the definition of the needs and demand in each specialty justify the significance of a narrower review on OB-GYNs. The present study hence aims to investigate factors affecting the supply and demand of OB-GYNs through a systematic literature review.

2. Methods

To identify the variables for estimating the number of OB-GYNs, a systematic review study was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Statement.¹²

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2.1. Search strategy

The scope of the literature review was defined based on the PICO format (Population, Intervention, Comparator, Outcomes). In this study, the population included the OB-GYNs, the intervention was defined as the type of workforce planning model and the factors mentioned important or used for determining the supply and demand of OB-GYNs, and the outcomes were defined as the OB-GYNs requirement. It was not possible to outline the comparator for this review study. All papers related to the subject were searched on English databases, including Clinical Key, CRD, Embase, PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar Search Engine, and Farsi databases, including IranMedex, Iran-Doc, and Magiran. For gray literature, theses, the websites of health ministries, international organizations such as World Health Organization and World Bank, OECD and OB-GYNs societies, associations, committees, and documents published by them were reviewed. Finally, a cited reference was done to complete the searches.

The search strategy was designed based on Medical Subjects Headings (MeSH) that uses search terms for the review of human resources for health (HRH) in previous systematic literature reviews and articles. The search terms used in this study included “physician”, “specialist physician”, “specialist”, “medical specialist”, “medical workforce”, “medical manpower”, “obstetrics”, “gynecology”, “obstetricians”, “gynecologists”, “OB-GYNs workforce planning”, “need”, “demand”, “requirement”, “supply”, “estimation”, “forecasting”, “modeling”, “predictions”, and “calculating”. The search period was from 1980 to 2019 (Fig. 1).

2.2. Inclusion and exclusion criteria

This review covered all published or unpublished descriptive, qualitative, and quantitative studies as original articles, reviews or theses on theoretical or practical estimation models for OB-GYNs or the factors associated with their supply and demand. Because of the capabilities and constraints of resources, only English and Farsi papers were selected for further analysis.

The selected studies could discuss or estimate OB-GYNs requirement individually or alongside that of other specialties or other related medical fields, such as maternity care. However, having specific figures and analyses on OB-GYNs was the main inclusion criterion.

2.3. Study selection

References and abstracts of searched papers were inserted into a reference management software application named Endnote V.X7. After removing the duplications, two independent researchers reviewed the papers in terms of title and abstract. The papers that met the inclusion criteria were selected for the full-text analysis phase. For the gray literature, the papers were screened during the manual search and the related items were inserted into the reference management system and merged with papers selected through electronic searches. Final papers were selected based on the full-text reviews. If there was a disagreement between the researchers, it was addressed by using reconciliation proofs between the two researchers and conciliation with the third co-author used.

2.4. Quality appraisal

The Critical Appraisal Skills Programme (CASP) was employed to critically appraise the quality of the papers. This tool consists of 10 items in three subscales of internal validity, results, and relevance to practice. All included studies were critically appraised by this tool.¹³

2.5. Data extraction

For data extraction, a special form was designed in Excel that included the subheadings such as author, year, goal, country, target group, level of estimation (national or regional), analysis time frame, estimation focus (supply, demand or integrated (both-side)), approach/model, and operational or mathematical method. In addition, this form involved the factors related to demand/need and supply of OB-GYNs, type of approach and model, assumptions, and scenarios.

2.6. Data analysis

The data were analyzed based on the deductive approach and the content analysis framework. Masnick and McDonnell model was used as basic conceptual framework for analysis. This framework included three basic components-the population to be served, the clinical workforce to serve it, and the workload of the related clinical workforce. The model links clinical workforce skill mix planning to health and health care dynamics.¹⁴ The papers were labeled and coded using the existing categories and codes of the conceptual framework. Moreover, new codes were added to the basic framework. After generating

#1 Needs Assessment [MeSH Terms]	#16 health workforce [Mesh Terms]
#2 "Health Services Needs and Demand" [MeSH Terms]	#17 Manpower [Title/Abstract]
#3 "Health Planning" [MeSH Terms]	#18 Gynecologist [Title/Abstract]
#4 Demand [Title/Abstract]	#19 Obstetricians [Title/Abstract]
#5 Needs [Title/Abstract]	#20 "Medical specialist" [Title/Abstract]
#6 Forecast* [Title/Abstract]	#21 Surgeons [Title/Abstract]
# Estimation [Title/Abstract]	#22 "Medical workforce" [Title/Abstract]
#8 Requirement [Title/Abstract]	#23 Specialists [Title/Abstract]
#9 Model [Title/Abstract]	#24 ob-gyn [Title/Abstract]
#10 Predict* [Title/Abstract]	#25 ob/gyn [Title/Abstract]
#11 Supply [Title/Abstract]	#26 Obstetrics [Title/Abstract]
#12 "Workforce planning" [Title/Abstract]	#27 Gynecology [Title/Abstract]
#13 Factors [Title/Abstract]	#28 #15 OR #16 OR #17 OR #18 OR #19 OR #20
#14 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7	OR #21 OR #22 OR #23 OR #24 OR #25 OR #26
OR #8 OR #9 OR #10 OR #11 OR #12 OR #13	OR #27
#15 workforce [Mesh Terms]	#29 #14 AND #28 Publication date from 1980 to 2019

Fig. 1. Search strategy in PubMed.

Fig. 2. Flow of screening and selecting studies (PRISMA Flowchart).

the codes, the data were charted into the matrix. The matrix involved a summary of data with codes and categories from each paper in the spreadsheet form.

3. Results

In this study, a total of 6026 papers were collected based on manual searches and databases. After screening the papers and applying the inclusion and exclusion criteria, 45 papers were selected for systematic review (Fig. 2). General descriptions of the included papers are presented in Table 1.

Of all selected papers, 22 were from the US,^{17,24,25,27,28,31–33,36,38,39,43–46,49,51,54–56,58,59} 5 from Canada,^{30,40,52,53,57} 4 from Australia,^{18,19,26,34} 3 from UK,^{22,23,48} and 10 from Ireland, Japan, Mexico, Oman, Italy, and Iran.^{15,16,20,21,29,35,37,41,42,47,50} A quantitative model had been used in 40 papers to estimate the OB-GYNs requirement, and 5 papers had qualitatively or descriptively investigated the factors affecting the supply and demand of the workforce in this field. The results showed that 28 and 12 papers were related to national and regional studies, respectively. Papers on HRP had focused on demand, supply or both in their estimations and discussions. According to the results, 31, 10, and 4 of the selected papers had focused on both supply and demand, just supply, and only demand, respectively. In terms of the approach used to the planning and estimation of OB-GYNs, four of the approaches employed in the selected papers are worth mentioning. Most of the papers focused on the supply side used the Stoke and Flow model, and the trend analysis method was observed in only two papers.^{33,35} At demand side, 5 papers employed need-based,^{20,23,30,42,52} 19 papers used utilization-based or service-target^{15, 16, 19, 24–27, 32, 34, 40–41, 44, 46, 50–51, 55–58}, and 6 papers employed adjusted need-based (needs adjusted by utilization or other factors affecting demand)^{18,22,33,39,48,53} models. One

of the criteria for evaluating the quality of estimates was calculating the requirement in the baseline year and then estimating requirement for the given years.¹² In this respect, 11 papers had measured the baseline need and 3 papers had used proxies such as waiting times, vacant positions, specialists to population for unmet need or demand, and determined sufficiency of OB-GYNs.^{19,34,40} In addition, 24 papers had used different scenarios to reach best estimations.^{16, 19–21, 24, 27, 31, 38, 41, 44, 46, 48, 50, 55–57}

3.1. The factors affecting need/demand of OB-GYNs

Based on the results of the analysis of the factors affecting the demand side in the OB-GYNs workforce planning, 35 factors in 6 categories were extracted. These 6 categories included the demographic status and predicted population growth, women's health status variables, socioeconomic factors affecting health, socioeconomic factors affecting service utilization, parameters of utilization rate, and the service system capacity and service delivery models affecting the workforce requirement. Table 2 clearly identifies the factors highlighted in each of the papers focused on the demand side.

As shown in Table 2, demographic variables including the number, age, and geographical location of women, geographical distribution (urban or rural) of female population, and population growth rate were used in almost all studies to calculate the number of specialists needed.

Variables of women's health status included factors such as birth rate, primiparity rate, mean gestational age, fertility and infertility rate, unwanted pregnancies rate (taking into account the long-term effects of non-invasive contraceptive methods), rate of the medical and surgical complications related to pregnancy, high risk pregnancies, incidence and prevalence of breast and reproductive cancers in women, prevalence of other gynecological diseases (amenorrhea and

Table 1
The characteristics of included studies.

Author, year	Goal	Country	Target group	Level of estimation	Analysis time frame	Estimation focus	Approach (at demand/supply side)	Operational or mathematical method
Alaedini, 2015 ¹⁵	Estimation of the number of 12 clinical trials required for country 2026	Iran	12 specialties including OB/GYNs	national	2017–2025	integrated	utilization-based	N/A
Alshistawy 2009 ¹⁶	To analyze the situation of medical specialists in the Sultanate of Oman, in terms of its past and current size and future needs.	Oman	All specialties including OB-GYNs	national	2007–2032	integrated	service target	N/A
Anderson et al., 2008 ¹⁷	To assess the future physician workforce with a sample of obstetrician-gynecologists.	United States	OB-GYNs	national	N/A	Supply	stock and flow	N/A
Australian Medical Workforce Advisory Committee, 1998 ¹⁸	Determining the factors affecting the current and future requirements for obstetrics and gynecology services. estimating workforce numbers and assessing its adequacy	Australia	Specialist and sub-specialist OB-GYNs	national	1997–2202	integrated	adjusted need –based/stock and flow	N/A
Australian Medical Workforce Advisory Committee, 2004 ¹⁹	To updates and replaces the initial AMWAC review of the obstetrics and gynecology workforce completed in 1998. to identify an optimal supply and distribution of them in Australia to 2013	Australia	OB-GYNs	national	2004–2013	demand	utilization-based, population ratio/stock and flow	the standard AMWAC model
Bayat et al., 2017 ²⁰	To estimate health workforce requirement for 2025 in Iran	Iran	all specialties including ob-gyns	national	2017–2025	integrated	need-based/stock and flow	N/A
Behan et al., 2009 ²¹	To develop a quantitative model can be used as a tool for the assessment of different policy scenarios relevant in the context of the Government's healthcare workforce planning and to simulate the model and assess, in quantitative terms, the balance between the current and expected future demand and supply	Ireland	Many healthcare occupations OB/GYNs	national	2008–2020	Supply	stock and flow	input-output model
Center for workforce intelligence, 2015 ²²	Assessing the key drivers of demand and supply for OB/GYNs and estimating the future number of needed to maintain current levels of OB/GYNs services	United Kingdom	OB/GYNs	national	2015–2028	integrated	adjusted Need-based/stock and flow	the GMI's stock take approach consists of horizon scanning, Delphi panel, a system dynamics workforce model used Vensim DSS
Chilvers, 2014 ²³	The development of a framework for MNH clinical teams requirement and supply with a subnational perspective ready for use by policy and planning teams.	United Kingdom	Human Resources for Health for Maternal and Newborn Care including OB/GYNs	national/regional	2014–2035	integrated	Need-based/stock and flow	N/A
Dall et al., 2013 ²⁴	To estimate the demand for women health care by 2020 using today's national utilization standards.	United States	OB/GYNs	national and regional	2010–2020	demand	utilization based	N/A
Dall et al., 2018 ²⁵	the report offer stakeholders insights into changes expected in physician workforce supply and demand by 2030	United States	40 specialties including ob-gyns	national	2016–2030	integrated	Utilization based/stock and flow	a micro simulation model and supply and demand scenarios
Department of Health, 2018 ²⁶	updating the supply and demand projections previously completed by the former Health Workforce Australia (HWA)	Australia	ob-gyns	national	2016–2030	integrated	utilization-based/stock and flow	A series of exponential smoothing models. by the SAS statistical package
Department of State Health Services, 2018 ²⁷	to identify the degree of shortage of primary care physicians and psychiatrists in Texas	United States	primary care physicians including OB/GYNs	regional (Texas)	2017–2030	integrated	Utilization based/stock and flow	HRSA: the Health Workforce Supply Model (HWSM) and the Healthcare Demand micro simulation Model (HDMM)
Education Council on graduate medical education, 2000 ²⁸	To assess the methodological strengths and weakness of existing specialty workforce studies.	United States	33 specialties and subspecialty including OB-GYNs	national	N/A	integrated	adjusted need-based/stock and flow	Cooper's Trend Model

(continued on next page)

Table 1 (continued)

Author, year	Goal	Country	Target group	Level of estimation	Analysis time frame	Estimation focus	Approach (at demand/supply side)	Operational or mathematical method
Eguchi, 2009 ²⁹	To examine the supply of obstetricians and the policies and measures adopted by various countries to secure obstetricians.	Japan	Obstetricians	national	N/A	Supply	supply-based	N/A
Elliott Rose et al., 2015 ³⁰	To identify the primary maternity care needs of women and newborns in Nova Scotia	Canada	Health human resources in women and newborns health including OB/GYNs	regional	2013–2014	demand	Need-based	univariate and multiple regression analyses
Fraher et al., 2013 ³¹	To develop a projection model to forecast the head count and fulltime equivalent supply of surgeons by age, sex, and specialty	United States	Surgery specialties including OB/GYNs	national	2009–2028	Supply	stock and flow	a dynamic stock and flow model
Fraher et al., 2016 ³²	Findings about the supply, demand and adequacy of the physician workforce in North Carolina and the greater Charlotte region	United States	34 specialties including OB/GYNs	regional	2017–2035	integrated	utilization-based/stock and flow	N/A
Gunawan et al., 2017 ³³	To identify the current and projected need for obstetrics and gynecology care in northern Nevada.	United States	OB/GYNs	regional	2017–2022	integrated	adjusted need-based/trend analysis	N/A
Health Workforce Australia, 2012 ³⁴	Projecting doctors at the medical specialty level for future	Australia	All specialties including OB/GYNs	national	2009–2025	integrated	utilization based/stock and flow	N/A
Ide et al., 2009 ³⁵	Analyzing the dynamics of OB/GYNs using longitudinal data.	Japan	OB/GYNs	national	1974, 1984, 1994 and 2004	Supply	Trend analysis	N/A
IHS global INC, 2015 ³⁶	Estimating the current and projected future supply and demand by medical specialty	United States	All specialties including OB/GYNs	regional	2013–2025	integrated	adjusted Need-based/stock and flow	two computer simulation models—the Healthcare Demand Micro simulation Model and the Health Workforce Supply Model-system dynamics approach
Ishikawa et al., 2013 ³⁷	To propose a physician supply forecasting methodology by applying system dynamics modeling to estimate future absolute and relative numbers of physicians.	Japan	All clinical physicians and OB/GYNs specialists	national	2008–2030	Supply	stock and flow	A discrete actuarial supply model
Jacoby et al., 1998 ³⁸	To examine the current supply and distribution of obstetrician-gynecologists and project future supply under various scenarios	United States	OB-GYN	national	1998–2022	Supply	stock and flow	
National Center for Health Workforce Analysis, 2016 ³⁹	presents national and regional projections of the U.S. supply of and demand for women's health service providers	United States	OB/GYNs, certified nurse midwives, nurse practitioners and physician assistants	national	2013–2025	integrated	adjusted need-based/stock and flow	HRSA: the Health Workforce Supply Model (HWSM) and the Healthcare Demand micro simulation Model (HDDMM)
New Brunswick Department of Health and Wellness, 2003 ⁴⁰	comprehensive analysis of the supply of and demand for physicians in New Brunswick and recommendations for ongoing physician resource planning and management	Canada	Physicians by 37 different practice groups including OB-GYNs	regional	2003–2013	integrated	utilization-based/stock and flow	N/A
Nigenda et al., 2015 ⁴¹	To project the supply of specialist physicians in Mexico to produce projections for a public system	Mexico	General/family physicians OB/GYNs Pediatricians Internists	in the three main public health institutions		integrated	utilization-based	N/A
Noori Helmat et al., 2018 ⁴²	To provided a description of the distribution of specialists in Iran in 2016 and its estimates in 2026.	Iran	all specialties including ob-gyns	national	2016–2026	integrated	need-based/stock and flow)	N/A
Pearse et al., 1982 ⁴³	Describing the contribution of obstetrician-gynecologists to that of other specialists in providing medical care to the total female population.	United States	OB-GYNs/General internal medicine/general practice/family practice/general surgery	national	–	demand	utilization-based	N/A
Pearse et al., 2000 ⁴⁴	To project the future supply of practicing subspecialists in obstetrics and gynecology	United States	Subspecialists in obstetrics and gynecology	national	1999–2020	Supply	trend analysis	The discrete actuarial model

(continued on next page)

Table 1 (continued)

Author, year	Goal	Country	Target group	Level of estimation	Analysis time frame	Estimation focus	Approach (at demand/supply side)	Operational or mathematical method
Rayburn et al., 2016 ⁴⁵	to describe what changes will impact the future OB-GYN workforce; discuss what changes in practice will be most likely experienced by OB-GYNs; identify various means of addressing the increasing demand for women's health care; describe aims of a framework to guide women's health care.	United States	OB/GYNs	national		integrated	need-based/stock and flow	N/A
Rayburn, 2017 ⁴⁶	To provides detailed and descriptive statistics about changes affecting ob-gyns in active practice and those in training	United States	OB/GYNs	national	2010–2050	integrated	utilization-based/stock and flow	mathematical formula
Ronsmans et al., 2002 ⁴⁷	To review indicators of service use and need for obstetric care, and briefly discuss data collection issues.	World Health Organization	Obstetric care workforce	national		demand	service target	N/A
Royal College of Obstetricians and Gynecologists, 2009 ⁴⁸	To determine situation in terms OB-GYNs and workforce need over the next 10 year	United Kingdom	OB-GYNs and its sub specialties	national	2007–2020	integrated	adjusted need-based and service target population ratio/stock and flow	N/A
Satiani et al., 2011 ⁴⁹	To estimate the OB/GYN Surgical workforce needed in the U.S by 2030 to meet the needs of our population.	United States	OB/GYNs	national	2005–2030	supply	service target population ratio/stock and flow	N/A
Senese et al., 2015 ⁵⁰	To provide regional decision-makers with a requirement model to forecast the future demand of specialists at the regional level.	Italy	all specialties including OB/GYNs	regional	2011–2030	integrated	utilization-based/stock and flow	A System dynamics (SD) model
Shelton, 2001 ⁵¹	To examine the need for physicians and estimate the costs and revenues associated with establishing a primary care physician practice	United States	Primary Care Physicians: Including OB-GYNs and pediatrician physicians	regional	2000	demand	utilization-based	N/A
Singh et al., 2010 ⁵²	the development of a Population Needs-Based Physician Simulation Model for Ontario	Canada	Certified physician specialties in Ontario including OB/GYNs	national	2008–2030	integrated	need-based/stock and flow	HRSA's Health Workforce integrated micro simulation Model (HWSM)
Social Sector Metrics Inc. and Health Intelligence Inc, 2012 ⁵³	provides a recommended model and implementation framework for physician resource planning for the province	Canada	20 specialties including OB/GYNs	regional	2012–2021	integrated	adjusted Need-based/stock and flow	An Adjusted Population Needs-Based Model (APNM)
Stonehocker et al., 2017 ⁵⁴	To answer the question, "Is there a shortage of obstetrician-gynecologists?"	United States	OB/GYNs	national		integrated	need-based/stock and flow	N/A
The Center for Health Workforce Studies University at Albany, 2006 ⁵⁵	Forecasting the supply and demand of physicians throughout the state by specialty through 2020	United States	18 specialties and specialty groups including OB-GYNs	regional	2005–2020	integrated	utilization-based/stock and flow	Physician Demand Model (PDM) by HRSA
Health Resources and Services Administration, 2008 ⁵⁶	To determine affecting factors on physician supply and demand and their projection	United States	35 specialties including OB-GYNs	national	2000–2020	integrated	utilization-based/stock and flow	the Physician Supply Model: PSM and the Physician requirements Model PRM
Verhulst et al., 2007 ⁵⁷	To demonstrate the feasibility of a population-based measure of physician services utilization by type of service as a tool for physician workforce planning.	Canada	Some specialties including OB-GYNs	regional	2002–2003	demand	utilization-based	N/A
Wallace et al., 2010 ⁵⁸	To estimate the ratio of gynecologic cancer cases to practicing gynecologic oncologists in the United States over the next 40 years	United States	Gynecologic oncologists	national	2009–2050	integrated	utilization-based	N/A
Williams et al., 2009 ⁵⁹	To estimate the workforce needed by 2030 in 7 surgical specialties to serve a population and to quantify the cost associated with training additional surgeons	United States	7 surgical specialties including OB/GYNs	national	2011–2030	Supply	stock and flow	N/A

Table 2
Affecting factors on the need/demand of OB-GYNs based on the analysis of included studies.

Factors	Studies discussed the factor
population Demographic status	Population of women by age group Geographical distribution of women
women's health status variables	Population growth, aging Birth rate First time pregnancy rate Average gestational age Fertility rate Infertility rate The rate of unwanted pregnancies The rate of medical and surgical complications of pregnancy High-risk pregnancies Incidence and prevalence of breast and reproductive cancers in women Prevalence of other gynecological diseases Mortality Rates of Pregnancy and Gynecological Diseases Prevalence of risk factors in pregnancy and diseases related to women (such as lifestyle, smoking, obesity, etc.) Women's literacy level Household income level
socioeconomic factors affecting health	Prevalence of risk factors in pregnancy and diseases related to women (such as lifestyle, smoking, obesity, etc.) Women's literacy level Household income level
socioeconomic factors affecting utilization of services	The amount and type of women's insurance coverage (affecting economic access) Changing the level of women's expectations and expectations of women's health services
utilization rate parameters	Geographical accessibility to outpatient and inpatient centers Average waiting time for outpatient and inpatient services Outpatient visits to gynecologists Per capita hospitalized services related to gynecology The number of pregnancies by method and place of delivery Place of delivery with service Number of surgeries visit times
Service system capacity	Structural capacity and availability of facilities and equipment to provide services to gynecologists The Growth and Advancement of Technologies Related to Women's Health Services GDP and overall growth of the economy
service delivery models	Guidelines and guidelines and standards of care (affecting services needed such as screening and periodic testing of non-pregnant women) prevention and public health measures Payment reform/system reforms/regulations and policies efficiency of services

dysmenorrhea, endometriosis, fibroids, reproductive tract infections, and urinary incontinence), rate of pregnancy-related mortality, and gynecological diseases.

Socioeconomic factors such as the prevalence of risk factors for pregnancy-related and gynecological diseases (such as lifestyle, smoking, obesity, etc.), women's literacy level, and household income were mentioned in the reviewed papers. In addition, some of the reviewed papers measured socioeconomic factors affecting the utilization of women's health services, such as the extent and type of women's insurance coverage, changing women's expectations of health services, and geographic access to health centers.

The most important factors estimated in utilization-based papers were the number and rate of outpatient and inpatient visits. Some studies also measured the extent of utilization with greater depth and accuracy by examining factors such as average waiting time for outpatient and inpatient services, average time per visit, rate of different delivery methods, and the number of gynecological surgeries.

The rate of growth and development of technologies related to women's health services, economic growth, and the guidelines defining the models of service delivery and care standards such as required screening and periodic testing for pregnant or non-pregnant women were among the main factors employed in some of the reviewed papers as the model parameters, assumptions or scenarios for estimations.

In addition to all the factors mentioned above, there were a number of factors that determine the standards and capacity of the health system to provide services and thus affect the demand for services of OB-GYNs. These factors included the structural and equipment capacity of health facilities and their geographical availability to deliver OB-GYNs services.

3.2. The factors affecting the supply of OB-GYNs

The 34 factors associated with the supply of OB-GYNs were classified under 9 categories. Table 3 shows the frequency of factors in each paper separately. In most papers that focused on the supply side, the number of active OB-GYNs determined using different data sources and registries. One of the important reasons for the shortage of professionals was their uneven distribution across different regions of a country as well as gender. The proportion of women participating in obstetrics and gynecology has increased. Moreover, given that women work less than men, these rates should be taken into account in estimating the number of available OB-GYNs.^{17,21,23,29,31,37,42,44,56} In the calculation of the net flow, the inflow was decreased by outflow. The factors used in the reviewed papers also included the retirement age of OB-GYNs, mortality, exit from the field, immigration rate, the number of OB-GYN residents, and annual graduation rate. The growth of OB-GYN graduates' participating in specialized fields was the main trend affecting the number of available OB-GYNs.^{17,21,22,30,39,40,47,50}

One of the important factors in evaluating the supply of OB-GYNs was the participation and contribution of other physicians in providing specialized services in this field.⁶⁰ According to the results, maternity services provided by OB-GYNs interference and overlap by primary care physicians, general practitioners, internal medicine and urology specialists. In addition, gynecological services, are also provided by general surgeons. Furthermore, considering the roles of midwives and nurses, many pregnancy services are provided by these individuals. Of course, these factors are difficult to measure and most studies have addressed them as hypotheses and scenarios.^{19,22,23,29,30,36,45,47,48,53,54}

Working hours of OB-GYNs or their time allocation between clinical,

Table 3
Affecting factors on the supply of OB-GYNs based on the analysis of included studies.

Factors	Studies discussed the factor
available ob-Gyns	Number of Ob-Gyns in practice Geographical distribution of Ob-Gyns Demographic status of ob-Gyns (age and sex distribution) 15,16,18–40,42,46,48–59
Out flow of the workforce	Aging and retirement age of Ob-Gyns Mortality rate of Ob-Gyns Departure rates for gynecologists 18,20,25,26,28–30,33,35,40,42,45,46,53,54 18–23,25–31,34–36,38–40,45,46,48,50,53–56,59 15,17–40,45,46,48–50,52–56,58,59 20,21,23,25–28,30,31,34,37–40,48,55,56,59 15,20,21,23,25–31,34,35,37,39,40,48,50,52,53,55,56 19–23,26,30,32,34,36,39,48,52,53,55
workforce inflow	Migration rate Specialist Returns 20–23,45 immigration rate 19–23,26,30,32,34,36,39,48,52,53,55
residency inflow	The number of Ob-Gyns specialty resident The number of Ob-Gyns specialty graduates Annually registration in Ob-Gyns specialty Duration of Ob-Gyns education cost of training Ob-Gyns 18,20,23,25–28,30,31,34,40,44,48–50,52,55,56 19–21,23,25,27,28,30–32,34–36,38,40,45,46,48–50,52,54,56,58,59 19–23,26–31,34,36,37,40,46,52,53,55 18–21,30,31,34,40,44,46,48–50,59, 18,46,49,54,59
residency outflow	possibility of expansion of ob-gyn residency Student dropout rate in the field of Ob-Gyns specialty graduates The number of fellowships in Ob-Gyns 16,18,19,22,26,34,44–46,48,49,52 20–23,26,28,30–32,46,53 20,31,32,44,48,54
Ob-gyn services plasticity(60)/task shifting	The rate of participation of gynecological graduates specialized fields Role of other specialist in Ob-Gyn services contribution of assistants such as midwives In the provision in Ob-Gyn services 20,21,29,37–40,44–46,48,53,54 22,28,32,34,43,45,46,51 18,22,23,26,28,29,32,33,38,43,45,46,52–54,56
Ob-gyns Full Time Equivalency	The extent of the role of Ob-Gyns Resident and Fellow Work Hour Restrictions Productivity of Ob-Gyns Average Ob-Gyns ' hours of work The amount of time dedicated to clinical and non-clinical activities The amount of Ob-Gyns working in the private and public sector at the same time 28,30,38,46,54 46,55 22,28,30,38,46,52,53,55,56 15,18–21,23,25–30,32,34,36,38,46,48,52–54,56 22,26,28,46,53,55 29
Ob-gyns motivations for service delivery	Job Satisfaction Changing practice patterns, including flexible or part-time schedules, work–life integration medical malpractice premiums 18,45,46 18,22,26–29,38,45,46,52–54 17
Structure and System factors Affecting Supply	Type of payment system to physician Modifying care delivery models in Ob-Gyns services Rate of remote services and telemedicine in Ob-Gyns services Staffing patterns 46,52 26,28,30,38,46,53 46 30,46

administrative, and research activities^{17,23,25,29,48} were among other important determinants of the supply of physicians addressed in recent models.

4. Discussion

This systematic review aimed to identify the approaches used to estimate the number of OB-GYNs in different countries, as well as the determinants of supply and demand in this field. The results of analyzing the 45 selected papers showed that most studies have covered both supply and demand sides of OB-GYNs estimations and determined the number of specialists needed based on the difference between the supply and demand. About a quarter of papers, however, have examined either the supply or demand sides. Demand-based calculations were performed by four approaches, the most commonly used of which was utilization-based. On the supply side, except for two papers, the stock and flow method had been used in all papers. Various effective factors (more than 60 factors) had been proposed and employed in different studies to estimate OB-GYNs supply and demand. The wide range of these factors can be indicative of the complexity of HRP in medical fields.

This complexity and incongruity in methods and factors make it difficult to determine the accuracy of the estimates made in various studies. However, examining the models and factors used in previous studies suggests that the new models are moving towards greater completeness and are trying to take into account all aspects of supply, demand, and needs, as well as the use of advanced modeling systems such as simulation and system dynamism.^{22,25,39,50} However, access to complete and accurate data sources has always been one of the limitations of HRP models. That is why various models have focused on a

limited number of factors in formulating the estimates and taken into account numerous assumptions, scenarios, and expert opinions to greatly alleviate data problems.^{16,19–21,27,41,61}

The study findings indicated that although there is no standardized and comprehensive method for modeling workforces requirement in this field, there are many similarities between medical specialties and health care providers in terms of approaches and factors. Differences in the attitude of HR planners, the amount of data available, and the type of services and diseases covered in each medical specialty have changed the composition of the factors used.^{28,62–64} For example, due to horizontal and vertical overlap with some medical specialties, as well as midwifery and nursing, greater contribution of women to the field of obstetrics and gynecology, and their greater attention to the work-life balance, determining the available active workforce (supply) in this field requires greater focus and precision. Inattention to these factors leads to unrealistic estimation and creates a surplus or shortage of OB-GYNs.

As the results showed, various methods and models have been designed and implemented to estimate OB-GYNs. The ever-increasing changes in social, political, cultural, economic, and technological conditions have altered the pattern of diseases, social needs and demands for services, as well as the ways and means of providing these services. As mentioned in many studies,^{26,36,52} physician workforce forecasting is not a precise and stringent science. Since the factors affecting supply and demand change constantly, they should be continually monitored to address assumptions, scenarios, and policy changes to affect the real requirements.

Despite the valuable results of the current systematic review, this study had some limitations like other studies. Restricted knowledge on other languages and the choice of merely English or Farsi studies are

likely to exclude some of the knowledge produced in other languages. Additionally, despite the selection of a sophisticated search strategy and searching a large number of databases, there may still exist a knowledge gap in this area due to the high volume of gray literature in the field and unpublished organizational reports, especially in developing and underdeveloped countries.

5. Conclusion

This study was conducted to investigate the factors affecting the determinants of the OB-GYNs supply and demand. The result showed that different models with a set of heterogeneous factors have been used to estimate the OB-GYNs supply and demand. The data showed more commonly-used factors produced more accurate and complete estimates. Given the importance of proper estimation of the number of required obstetricians and gynecologists and other specialties, HRH planners and policymakers should pay more attention to the complexities and different dimensions of this issue.

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Declaration of competing interest

There are no conflicts of interest.

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