A systematic review of economic evaluations of neonatal and maternal healthcare in immigrant and ethnic minority women

Revisione sistematica delle valutazioni economiche sull'assistenza neonatale e materna alle donne immigrate e provenienti da minoranze etniche

Rosario Asciutto,[1] Anteo Di Napoli,[1] Simona Vecchi,[2] Jacopo Sicuro,[1] Concetta Mirisola,[1] Alessio Petrelli[1]

[1] National Institute for Health, Migration and Poverty (INMP), Rome (Italy)
[2] Department of Epidemiology, Lazio Regional Health Service, Rome (Italy)

Corresponding author: Alessio Petrelli; alessio.petrelli@inmp.it

WHAT IS ALREADY KNOWN

- **Immigrant and ethnic minority women have worse health care during pregnancy and worse neonatal outcomes.**

WHAT THIS PAPER ADDS

- **Including immigrant and ethnic minority mothers in national maternal and child healthcare as well as in targeted interventions or screening campaigns is a cost-effective policy for health systems**

ABSTRACT

BACKGROUND: less access to appropriate care during pregnancy for immigrant/ethnic minority women can lead to worse health outcomes and higher costs for health services.
OBJECTIVES: to conduct a systematic review of studies on the economic evaluation of maternal and child healthcare among immigrants and racial/ethnic minority groups in advanced economy countries.
METHODS: the main biomedical/economic bibliographic databases and institutional sources were searched. The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines
RESULTS: encouraging breastfeeding and reducing inappropriate hospital use/length of hospital stay proved potentially able to reduce costs. Most studies showed a cost reduction if immigrant and ethnic minority women were included both in national and targeted programmes, such as nutritional programmes or case management. Screening campaigns targeting immigrants and ethnic minority groups were more cost-effective than broader, universal or non-screening strategies. Screenings were cost-effective when extended to newborns/relatives of pregnant women (Chagas disease) and were cost-effective for unvaccinated women in low-vaccination rates regions (rubella), immigrant women reporting no/uncertain vaccination history (varicella), and first-generation immigrants (HCV).
DISCUSSION: promoting inclusion in pregnancy healthcare programmes or in targeted screening campaigns could be effective in cost saving for health services.

Keywords: economic evaluation, immigrants, maternal healthcare, neonatal healthcare, systematic review, equity

RIASSUNTO

INTRODUZIONE: il minore accesso ad assistenza appropriata durante la gravidanza per le donne immigrate o appartenenti a minoranze etniche può portare a esiti peggiori e costi maggiori a carico del sistema sanitario.
OBIETTIVI: effettuare una revisione sistematica degli studi sulla valutazione economica dell'assistenza materna e infantile alle persone immigrate e appartenenti a minoranze etniche che risiedono in Paesi a sviluppo avanzato.
METODI: è stata effettuata una ricerca utilizzando i principali database bibliografici biomedici ed economici. La revisione sistematica è stata condotta in conformità con le linee guida PRISMA.
RISULTATI: incoraggiare l'allattamento al seno e ridurre i tempi di ricovero si sono dimostrate pratiche capaci di ridurre i costi. La maggior parte degli studi hanno mostrato un risparmio economico se le donne immigrate/appartenenti a minoranze etniche erano arruolate sia in programmi nazionali sia in programmi mirati, come programmi nutrizionali o di *case management*. Le campagne di screening rivolte a gruppi di immigrati e minoranze etniche sono risultate più vantaggiose in termini di costo-efficacia rispetto a strategie più diffuse, universali, o rispetto al non effettuare screening. Gli screening si sono rivelati vantaggiosi in termini di costo-efficacia quando sono stati estesi ai neonati e ai parenti delle donne incinte (malattia di Chagas), alle donne non vaccinate nelle regioni che mostrano bassi tassi di adesione ai piani vaccinali (rosolia), alle donne con una storia vaccinale assente o incerta (varicella) e a immigrate di prima generazione (epatite C).
DISCUSSIONE: promuovere l'inclusione del percorso nascita in programmi di assistenza sanitaria o in campagne di screening mirate può portare a vantaggi economici per i servizi sanitari.

Parole chiave: valutazione economica, immigrati, assistenza materna, assistenza neonatale, revisione sistematica, equità

INTRODUCTION

Although the World Health Organisation (WHO) envisions a world where "every pregnant woman and newborn receives quality care throughout the pregnancy, childbirth, and the postnatal period",[1] immigrant and ethnic minority women in Europe and North America still face poorer pregnancy outcomes, with a higher incidence of induced abortions, caesarean sections, instrumental deliveries, complications, postpartum mental health problems, stillbirth, low birth weight, and maternal mortality as compared to non-immigrants and majority of the population.[2-8]

Maternal health, as defined by the WHO, refers to the health of women during pregnancy, childbirth, and the postpartum period.[1] Specifically, antenatal care aims to reduce perinatal and maternal morbidity and mortality through prevention, mainly based on health education and health promotion, evaluation of women and girls at higher risk of developing complications during labour and delivery, and management of pregnancy-related diseases and complications.[1]

Actually, immigrants and ethnic minority groups represent different groups of populations: international migrant is a person who changes his/her country of usual residence, irrespective of the reason for migration or legal status, while ethnicity refers to the social group a person belongs to, as a result of a mix of cultural and other factors traditionally associated with race including language, diet, religion, ancestry, and physical features. However, the concepts of 'migrant group' and 'ethnic minority group' can partly overlap in countries where the migration process is recent, as in Italy, while in countries with greater migratory tradition, as USA, UK, Netherlands or France, 'migrant group' and 'ethnic minority group' cannot be considered as the same group.[10,11]

Despite the differences, racial/ethnic minorities groups and immigrants often share similar difficulties and barriers to the access of health services. Regarding immigrants, adverse health outcomes are often preventable and explained in terms of substantial barriers to accessing healthcare, such as the right to maternal healthcare, a lack of awareness of rights and the provision of healthcare in host countries, linguistic and cultural issues, and financial limitations.[12,13] Despite the existence of a number of international frameworks that enshrine the right to healthcare for immigrant women,[14] several countries tend to guarantee access only to emergency care,[15] leading to an increase in the cost for healthcare systems.[16] Also in Italy, although the access is always guaranteed (not only in case of emergency), there is evidence of adverse maternal healthcare outcomes among immigrants during pregnancy[17,18] and at birth.[18-20] As regards racial and ethnic minority groups, the structural barriers identified were the lack of health insurance and the high cost of drugs for non-universal health system; the individual barriers are linguistic and cultural for universalistic health system,[21] but also supply factors, as the ability of health staff to cope with different background or other organisational factors.[22]

Thus, ensuring equitable access to healthcare services for immigrants and racial/ethnic minority group represents a major challenge for clinicians, managers and policy makers. In particular, supporting antenatal health, reducing risk behaviours, and providing appropriate healthcare for both mother and infant can reduce adverse maternal and birth outcomes,[23-26] and also lead to a saving in expenditure for healthcare systems.[16,27]

For these reasons, in many countries, debate on the cost-effectiveness of improving equity in antenatal and reproductive healthcare, on promoting primary healthcare access to immigrant or ethnic minority women,[28] and on the possible financial benefits of including undocumented migrants in public funding for antenatal care is underway.[29-31] In fact, cost-effectiveness analysis provides a method for prioritizing the allocation of resources to health care by identifying interventions that have the potential to yield the greatest improvement in health for the least resources.

The objective of this study was to conduct a systematic review of economic evaluations of maternal and child healthcare among immigrants and ethnic minority groups in advanced economy countries.

METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[32]

INFORMATION SOURCES AND SEARCH STRATEGY

PubMed, EMBASE, the Cochrane Library, Scopus, Health Evidence and EconLit databases were searched for relevant studies published from 1st January 2000 to 31st December 2019. No restriction was imposed. The developed search strategy used keywords related to neonatal and maternal healthcare services, immigrants and minority/ethnic group, and economic evaluation studies. A combination of MeSH terms and keywords was chosen for each database (see details of the search strategy for PubMed in table S1 on-line supplementary material). In addition, the websites of agencies and organisations involved in maternal health, including the Organisation for Migration (IOM), the Migrant Integration Policy Index (MIPEX), the Organisation for Economic Co-operation and Development (OECD), the World Health Organisation, the United Nations High Commissioner for Refugees (UNHCR), and the European Union Agency for Fundamental Rights (FRA) were searched and references of systematic reviews were checked.

STUDY SELECTION

The primary studies were included if they:

- focused on pregnant immigrant and ethnic minority women living in more developed countries (regardless of definition based on country of origin, length of stay, le-

gal status, citizenship, residency, reason for migration, first language, and parental country of birth);

- reported any partial (cost analysis) or full economic evaluation (cost-effectiveness, cost-utility, cost-benefit, and cost-minimization) on direct or potential antenatal or maternal healthcare and considered both costs and health outcomes (only for full economic evaluation studies). Direct (e.g., hospital admission, length of stay, medication costs) and indirect costs (loss of productivity due to health problem) were considered. Antenatal and maternal healthcare at delivery, perinatal, or postnatal period, included preventive strategies (e.g., screening) or any interventions to support pregnancy health, reduce risk behaviours, and/or provide appropriate healthcare for both mother and infant was evaluated.
- were published in English.
- referred to advanced economy countries according to the classification of the International Monetary Fund.[33]

Review, editorials, letters, and comments were excluded.

DATA EXTRACTION

Two authors independently screened titles and abstracts of the articles retrieved for relevance and eligibility. Full texts of the articles considered of interest were retrieved, and the same authors independently evaluated them for inclusion. Any disagreement was resolved through consensus.

Data related to the characteristics of the studies (study setting, study design, study period, source of data, target population), any delivered intervention, type of economic evaluation, costing perspective (e.g., healthcare system, societal, third-party payer, patients), source of data, outcome, type of costs, results (e.g., reported costs, standardized costs, type of costs, subgroup analysis, and statistical significance) and conclusions were extracted by the two authors using a data collection form.

QUALITY ASSESSMENT

Two other authors independently assessed the quality of studies using the Drummond checklist, a validated quality assessment tool specifically designed to critically assess economic evaluations.[34,35] Each item can be satisfied (Yes), not satisfied (No), not clearly reported (N/C) or not applicable (N/A). A study was classified as:

- high quality if at least 75% of Drummond's criteria were satisfied;
- medium quality if between 51% and 74% were satisfied;
- low quality if 50% or fewer of the criteria were satisfied.[36]

Results were compared and any disagreements between authors was settled by consensus among all the authors.

DATA SYNTHESIS

Results were presented in a narrative way due to the heterogeneity of the studies in terms of study design, interventions, and population under study. National estimates of the costs from different years and in different currencies from each study were not elaborate or convert. The economic data were described and evidence was summarized in the text and in tables.

RESULTS

STUDY SELECTION

In the initial literature search, 1,401 studies were identified, including one study from an institutional organisation (the European Agency for Fundamental Rights). After removing duplicates, 889 citations were screened on the basis of title and abstract, of which 861 were considered not relevant for the topic, while 28 articles were found to be of interest and their full-text papers were examined in detail; 10 were then excluded for different reasons after full-text evaluation. Overall, 18 studies met the inclusion criteria and were considered eligible for the present review (figure 1).

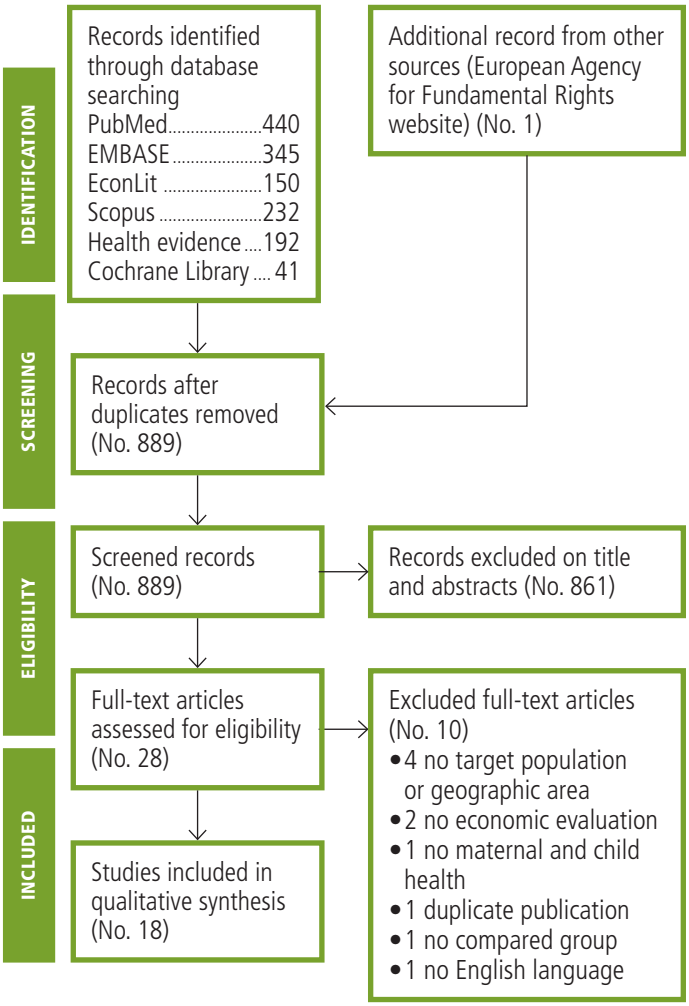

Figure 1. PRISMA 2009 flow diagram: study selection process.
Figura 1. Diagramma di flusso PRISMA 2009: processo di selezione degli studi.

STUDY CHARACTERISTICS

Key characteristics of included studies are provided in table 1. Twelve studies had an observational design,[29-31,37-43] while 6 were simulation studies.[15,44-48] Nine studies involved immigrant populations and 9 were conducted on ethnic minority groups; in particular, 7 studies described differences in birth outcomes between different racial/ethnic groups: white, black, Hispanic. With regard to the sources, 6 studies used claims data and 12 studies were based on simulation data.

Healthcare delivered types varied widely and were categorised as "screening programmes" (No. 6), "maternal and child healthcare interventions" (No. 5), and descriptive studies (No. 7).

TYPE OF ECONOMIC EVALUATION

All studies included some estimates of direct and indirect costs. Findings were heterogeneous in terms of type of economic evaluation. Cost-analysis was the main approach (7 studies); 4 studies conducted a cost-utility analysis, 4 a cost-benefit analysis, and 4 a cost-effectiveness analysis. In one study, a combination of more than one type of economic evaluation was performed.[44] Most studies took healthcare costing perspective (13/18); some considered a hospital costing perspective (4/18), third-party payer (2/18), and societal perspective (2/18). Three studies considered more than one perspective[30,47] (table 1). Regarding the costs, direct medical costs were evaluated in all the selected articles. Two studies also conducted an analysis of direct non-medical costs, while indirect costs (loss of productivity) were assessed in only one study (tables 2, 3, and 4).

QUALITY ASSESSMENT OF INCLUDED STUDIES

Thirteen were of high quality. Scores for all studies ranged from 43% to 100% (see table S2 Supplementary Material 2). The objective of the study was clearly declared in all the articles, but in most of the studies the economic importance of the research question was not explicitly stated; moreover, in some articles, the statistical methods and the reasons to adopt them were not well described.[15,37,48]

SYNTHESIS OF RESULTS

In order to make the description of the results clearer, the studies were classified into three broad categories according to the type of delivered healthcare: economic evaluation of screening programmes (table 2), economic evaluation of maternal and child healthcare interventions (table 3), and economic evaluation of descriptive studies (table 4). More details regarding the characteristics of the target population and the results of each study are available in in the Supplementary Material 3.

ECONOMIC EVALUATION OF SCREENING PROGRAMMES

In the United Kingdom, Connor et al. asked if antenatal screening programmes for syphilis were
still necessary as the prevalence of syphilis is now very low. On the basis of a cost-effectiveness analysis comparing different strategies to screen pregnant women, it has been shown that targeting screening programme to pregnant women in non-white ethnic groups or in wommen born outside the United Kingdom would save relatively little money, recommending that the current universal antenatal screening for syphilis should continue.[37]

Two studies on Latin American residents in Spain conducted an economic evaluation of screening strategies for Chagas disease. In the first, strategies based on two models were evaluated, one for the newborn and one for the mother. For both, the study shows a higher cost-effectiveness ratio in terms of Quality Adjusted Life Years (QALYs) for the screening compared to the non-screening, proving that screening of all Latin American women giving birth in Spain and of their infants is the best strategy.[45] Similar results were found by another study that considered different screening options for Chagas. No screening was found to be the most expensive and least effective strategy, from both the societal and the Spanish National Health System perspectives, while the most cost-effective strategy from both perspectives proved to be extending antenatal screening of the Latin American pregnant women and their newborns to the relatives of the positive women.[47]

Kowada et al. assessed the cost-effectiveness for five screening options for tuberculosis (TB). The study showed that tuberculin skin test (TST) followed by QuantiFERON-TB Gold In-Tube (QFT) for TB screening of HIV-positive immigrant pregnant women yielded the greatest benefits at the lowest cost.[46]

Immigrant mothers from certain tropical countries have a higher risk of varicella-Zoster virus (VZV) infection, with possible serious complications for themselves and their children. A study investigating two screening strategies to reduce the risk of VZV and the relative cost saving, and comparing them to the current practice (i.e., treating cases as they arise) showed that verbal screening followed by serological screening for VZV immunity may be cost-saving to the NHS for both UK and Bangladeshi women, while the universal screening strategy could be cost-effective if targeted to younger mothers born in countries with a lower childhood VZV infection rate.[44]

Since the first-generation non-Western migrants comprise a large proportion of the undiagnosed HCV-infected population in the Netherlands, Urbanus et al. estimated the cost-effectiveness of implementing Hepatitis C virus (HCV) screening comparing all pregnant women, first-generation non-Western pregnant women, and no screening. The results showed that screening first-generation non-Western women was moderately cost-effective.[43]

ECONOMIC EVALUATION OF MATERNAL AND CHILD HEALTHCARE INTERVENTIONS

Moretti et al. conducted a cost-effectiveness analysis to determine the incremental costs of genotyping CYP2D6 ultrarapid metabolizer phenotype, to avert neonatal adverse events when women taking codeine while breastfeeding, in Canada. The study shows that the cost to avert an infant adverse event may represent good value for money in specific subgroups of population, such as mother from ethnic minority groups, with high prevalence of ultra-rapid metabolizers.[49]

Another study reported the results of a community-based antenatal care programme aimed to reduce local racial disparities in birth outcomes in Nebraska (USA) through the provision of pro-active health care to pregnant women. The study showed an improvement in birth outcomes over the 2 years, with a 31% cost saving in the average hospital expenditure, especially for non-Hispanic Blacks, as compared with non-participants.[40]

Gregory et al. investigated the role of an existing programme – the Special Supplemental Nutrition Programme for Women, Infants, and Children (WIC) – whose aim was to prevent poor birth, infant, and child outcomes. The authors showed how participation in the programme was associated with better birth outcomes (lower LBW, very LBW, neonatal mortality), especially for Blacks. Taking into account the hospitalisation costs, food vouchers, and administrative costs of the programme, WIC participation resulted in significantly lower total cost than did non-WIC participation: the difference was higher for Blacks than for non-Blacks.[38]

A study of the European Union Agency for Fundamental Rights (FRA) showed that if all undocumented pregnant women had access to antenatal care, a savings over two years of up to 48% in Germany and Greece and up to 69% in Sweden could be expected (i.e., about 56 euros, 52 euros, and 177 euros per woman, respectively) compared to the provision of emergency-only care.[15]

Rodriguez et al. examined the hospital and state costs of offering a postpartum intrauterine device (IUD) to underinsured recent immigrants to the USA: without an IUD programme, the States spend 2.1 million dollars for repeat pregnancy over the subsequent 4 years, while introducing an IUD programme would reduce these costs to just over 1 million dollars. The State government would save 2.94 dollars for every dollar spent on a State-financed IUD programme, avoiding unintended pregnancies.[30]

ECONOMIC EVALUATION OF DESCRIPTIVE STUDIES

A study conducted in the US investigated racial and ethnic disparities in birth outcomes and labour and delivery-related charges among women with intellectual and developmental disabilities (IDD). The study found that the average labour and delivery-related charges for non-Hispanic Black (18,889 dollars) and Hispanic Women with IDD (22,481 dollars) was higher (27% and 51%, respectively) compared with non-Hispanic White women with IDD (14,886 dollars).[50]

Another study conducted in the US showed that suboptimal breastfeeding is associated with greater burden of disease among non-Hispanic Blacks and Hispanic population determining an increase of the total hospitalisation maternal and child costs per woman ($1,780) compared to non-Hispanic Whites ($1,380).[48]

A longitudinal population-based study investigated the use and cost of hospital services for children with Down syndrome (DS) in Massachusetts based on racial/ethnic origin. An estimated 90% of the total cost of all hospitalisations from birth to three years of age in this cohort was attributable to DS and its complications. Significantly greater hospital use and cost among children of racial/ethnic minority mothers compared to non-Hispanic White mothers, greater respiratory disease burden among children with Hispanic mothers, and greater cardiac disease were observed.[42]

In a Spanish study, Comas et al. did not observe statistically significant differences in the delivery type or in neonatal severity according to the mother's country of origin, and no substantial difference in childbirth-related costs based on the woman's country of origin.[41]

Two studies were conducted in the context of Medicaid. In the first,[39] no differences between White and African-American mothers in the Medicaid group were observed in the rates of LBW and preterm infants. The authors hypothesize that accessing Medicaid services may have contributed to decreasing race-related disparities.

In the second one,[31] a cross-sectional was conducted in 14 Southern States on 10,174,722 Medicaid inpatient hospital records, in order to evaluate racial/ethnic disparities in birth outcomes and the excess of costs related to these inequalities: African Americans were more like to have caesarean section, preeclampsia, placental abruption, preterm birth, small birth size for gestational age, and foetal death/stillbirth, and were associated to a longer stay in the hospital than that of other racial and ethnic groups, thus incurring in higher Medicaid costs. Eliminating racial disparities in adverse pregnancy outcomes (not counting infant costs) could generate relevant Medicaid cost savings ($114 to 214 million dollars per year).

A study conducted by Lu et al. in the United States on a cohort of 970 undocumented immigrants showed that the exclusion from antenatal care was significantly associated with a higher risk (nearly 4 times) of delivering LBW infants (RR 3.8; 95%CI 2.03-7.05) and even higher (>7 times) of premature infants (RR 7.4; 95%CI 4.35-12.59) for women who had not had access to antenatal care than for women who had it. The authors concluded that, although the elimination of publicly funded antenatal care for undocumented women could save the state $58 million in direct antenatal care costs, it could result in a cost for postnatal care up to of 194 million dollars.[29]

STUDY (REFERENCE)	LOCATION AND PERIOD OF STUDY (IF APPLICABLE)	1. STUDY DESIGN, 2. TYPE OF COST ANALYSIS, 3. COSTING PERSPECTIVE	TARGET POPULATION	INTERVENTION
SCREENING PROGRAMMES				
Connor et al., 2000[37]	United Kingdom	**1.** Cohort study **2.** Cost-effectiveness analysis **3.** Healthcare	Pregnant women from the Thames regions, pregnant women in non-White ethnic groups, and pregnant women born outside the United Kingdom	Screening for syphilis
Imaz-Iglesia et al., 2015[47]	Spain	**1.** Simulation study based on decision tree model **2.** Cost utility **3.** Healthcare and societal	Pregnant Latin American women resident in Spain and newborns	Chagas disease screening. Four scenarios: **1.** no screening; **2.** screening of the pregnant Latin American women and their newborns; **3.** screening also of the relatives of positive pregnant women; **4.** screening also of the relatives of negative pregnant women
Kowada, 2014[46]	Japan	**1.** Simulation study **2.** Cost utility **3.** Healthcare	Hypothetical cohort of HIV-positive pregnant immigrant women from high-burden countries	TB screening
Pinot de Moira et al., 2006[44]	United Kingdom	**1.** Simulation study based on Imaginary cohort. Decision tree model. **2.** Cost-effectiveness and cost-utility **3.** Healthcare	Model cohort of UK native and Bangladesh native pregnant women	Varicella screening. The strategies evaluated were: **1.** an initial verbal screen followed by a serological screen for those with a negative or uncertain history; **2.** universal serological screening; **3.** the current strategy, which is to treat cases as they arise. Post-partum vaccination was given to those who resulted negative for varicella Zoster virus antibodies
Sicuri et al., 2011[45]	Spain	**1.** Simulation study based on decision tree model **2.** Cost-utility **3.** (3) Healthcare	Pregnant Latin American women and their newborns	Chagas disease screening
Urbanus et al., 2013[43]	The Netherlands 2003	**1.** Markov model **2.** Cost-effectiveness **3.** Healthcare	Pregnant women (all pregnant women or in first-generation non-Western pregnant women)	HCV screening
MATERNAL AND CHILD HEALTHCARE INTERVENTIONS				
Cramer et al., 2007[40]	Nebraska, USA 2002-2003	**1.** Comparative descriptive **2.** Cost-benefit **3.** Hospital	Three groups of mothers: **1.** Omaha Healthy Start programme mothers; **2.** Non-Omaha Healthy Start participants; **3.** Douglas County mothers, stratified for non-Hispanic White, non-Hispanic Black, and Hispanic.	Community-based programmes for prenatal care (Omaha Healthy Start)
European Union Agency for Fundamental Rights, 2015[15]	Multicentre: • Germany • Greece • Sweden	**1.** Simulation study based on decision tree model **2.** Cost-benefit **3.** Healthcare	Undocumented immigrant women	Simulated access to prenatal care for all undocumented migrant women
Gregory et al., 2003[38]	New Jersey (USA) May 1992-December 1992	**1.** Cross-sectional **2.** Cost analysis **3.** (3) Healthcare	Three groups of Black and non-Black mothers and their newborns: **1.** women included in Special Supplemental Nutrition Programme (WIC) who cashed at least one food voucher during pregnancy); **2.** other WIC enrollees (registered with WIC but who had not cashed any food vouchers); **3.** non-WIC clients (who received Medicaid but who were not enrolled in WIC).	Special Supplemental Nutrition Programme for Women, Infants, and Children programme
Moretti et al., 2018[49]	Canada 2014	**1.** Decision analysis **2.** Cost-effectiveness **3.** Healthcare system and societal	Not specified	Pharmacogenetic testing for identifying mothers with a CYP2D6 ultrarapid metabolizer phenotype
Rodriguez et al., 2010[30]	USA 2002	**1.** Retrospective cohort **2.** Cost-benefit **3.** Hospital/Healthcare	Recent immigrant women who delivered in a hospital in Oregon in 2002	Postpartum intrauterine device

CONTINUA ▶

▶ **SEGUE**

DESCRIPTIVE STUDIES				
Akobirshoev et al., 2019[50]	USA 2004-2011	**1.** Cross sectional **2.** Cost analysis **3.** Healthcare	Representative sample of White, Black, and Hispanic women resident in the USA with intellectual and developmental disabilities with delivery-related hospitalisations	No intervention
Bartick et al., 2017[48]	USA	**1.** Simulated cohort (Monte Carlo simulation) **2.** Cost analysis **3.** Healthcare	Three groups of women and their infants: **1.** non-Hispanic Blacks; **2.** Hispanics; **3.** non-Hispanic Whites	No intervention
Comas et al., 2011[41]	Spain October 2006-September 2007	**1.** Cross-sectional **2.** Cost analysis **3.** Hospital	Spanish and foreign-born mothers	No intervention
Derrington et al., 2013[42]	Massachusetts (USA) January 1999-December 2004	**1.** Cohort **2.** Cost analysis **3.** Healthcare	Children with Down Syndrome born alive to mother residents in Massachusetts, stratified by their mother's ethnicity (non-Hispanic Black, non-Hispanic White, Hispanic)	No intervention
Guillory et al., 2003[39]	South Carolina (USA) 1994-1995	**1.** Observational **2.** Cost analysis **3.** Insurance (Third-party payer)	Births between Medicaid recipient residents in a County of South Carolina. Two groups for mother's origin: African American and White.	No intervention
Lu et al., 2000[29]	USA January 1996-December 1997	**1.** Retrospective cohort **2.** Cost-benefit **3.** Healthcare	Undocumented immigrant women who delivered in a University Hospital in California	No intervention
Zhang et al., 2013[31]	14 Southern States of USA (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Missouri, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia) 2006-2007	**1.** Cross-sectional **2.** Cost analysis **3.** Insurance (Third-party payer)	Singleton deliveries. African American; 28.6%; White 39.7%; Hispanic 26.6%	No intervention

Table 1. Characteristics of the studies included in review (No. 18).
Tabella 1. Caratteristiche degli studi inclusi nella revisione (n. 18).

STUDY	OUTCOMES	COSTS	RESULTS
Connor et al., 2000[37]	Case of syphilis detected	Direct medical	• Targeted screening programme to pregnant women in non-white ethnic groups, or those born outside the United Kingdom would save relatively little money, recommending that the current universal antenatal screening for syphilis should continue • Universal screening found 121 pregnant women (in three years) who required treatment, preventing 40 cases of congenital syphilis. • Screening pregnant women in Thames Region found 85 pregnant women (in three years) who required treatment, preventing 27 cases of congenital syphilis. • Screening pregnant women in non-white ethnic groups found 85 pregnant women (in three years), preventing 27 cases of congenital syphilis. • Screening pregnant women born outside the UK found 93 pregnant women (in three years) who required treatment, preventing 29 cases of congenital syphilis
Imaz-Iglesia et al., 2015[47]	Quality Adjusted Life Years	• Direct medical • Direct non-medical; • Indirect (loss of productivity)	No screening was found to be the most expensive and least effective strategy, from both the societal and the Spanish National Health System perspectives, while the most cost-effective strategy from both perspectives proved to be extending antenatal screening of the Latin American pregnant women and their newborns to the relatives of the positive women
Kowada, 2014[46]	Quality Adjusted Life Years	Direct medical	TST followed by QuantiFERON - TB Gold In-Tube yielded the greatest benefits at the lowest cost for TB screening of HIV-positive pregnant women in immigrants and occasional screenings
Pinot de Moira et al., 2006[44]	Case of varicella averted, Quality Adjusted Life Years	Direct medical	Verbal screening followed by serological screening for virus zoster varicella immunity may be cost-saving to the NHS for both UK- and Bangladeshi women, while the universal screening strategy could be cost-effective if targeted to younger mothers born in countries with a lower childhood varicella Zoster virus infection rate
Sicuri et al., 2011[45]	Quality Adjusted Life Years	Direct medical	Higher cost-effectiveness ratio in terms of Quality Adjusted Life Years for the screening compared to the non-screening, proving that screening of all Latin American women giving birth in Spain and of their infants is the best strategy
Urbanus et al., 2013[43]	Life-Years Gained	Direct medical	Screening first-generation non-Western women was moderately cost-effective

Table 2. Economic evaluation of screening programmes.
Tabella 2. Valutazione economica dei programmi di screening.

STUDY	OUTCOMES	COSTS	RESULTS
Cramer et al., 2007[40]	Low Birth Weight, Infant Mortality Rate, Cost, Adequacy of prenatal care, and initiation of prenatal care in the first trimester	Direct medical	Omaha Healthy Start programme birth outcomes improved during the 2nd year of life resulted in a 31% cost saving in the average hospital expenditure compared with the non-participant groups
European Union Agency for Fundamental Rights, 2015[15]	Low Birth Weight categories	Direct medical	A savings over two years of up to 48% in Germany and Greece and up to 69% in Sweden could be expected compared to the provision of emergency-only care if all undocumented pregnant women had access to antenatal care
Gregory and de Jesus, 2003[38]	Low Birth Weight, very Low Birth Weight, neonatal mortality and infant mortality	Direct medical and costs of the programme	Taking into account the hospitalisation costs, food vouchers, and administrative costs of the programme, Special Supplemental Nutrition Programme for Women, Infants, and Children (WIC) participation resulted in significantly lower total cost than did non-WIC participation: the difference was higher for Blacks than for non-Blacks
Moretti et al., 2018[49]	Central Nervous System depressive adverse events in the infant	Direct medical and indirect (loss of productivity)	The Incremental Cost-Effectiveness Ratio was lower when evaluating those from ethnic populations
Rodriguez et al., 2010[30]	Unintended pregnancies averted	Direct medical	Without an intrauterine device programme, the States spend $2.1 million for repeat pregnancy over the subsequent 4 years, while introducing an intrauterine device programme would reduce these costs to just over $1 million dollars

Table 3. Economic evaluation of maternal and child healthcare interventions.
Tabella 3. Valutazione economica degli interventi per la salute materno-infantile.

STUDY	OUTCOMES	COSTS	RESULTS
Akobirshoev et al., 2019[50]	• Birth outcomes, including in caesarean delivery, preterm birth, small-for-gestational-age neonates, and stillbirth among women with intellectual and developmental disabilities (IDD); • Racial and ethnic disparities in labour and delivery-related charges	Direct medical	• Significant disparities in stillbirth • among non-Hispanic Black and Hispanic women with IDD compared with their non-Hispanic White peers; • There were no racial and ethnic disparities in caesarean delivery, preterm birth and small-for-gestational-age neonates among women with IDD; • The average labour and delivery-related charges for non-Hispanic Black and Hispanic Women with IDD exceeded those for non-Hispanic White women with IDD by 27% and 51%, respectively
Bartick et al., 2017[48]	Excess case disease and cost attributable to suboptimal breastfeeding for: • Child diseases: acute otitis media, gastrointestinal infection, lower respiratory tract infection, necrotizing enterocolitis, sudden infant death syndrome, child deaths total; • Maternal diseases: breast cancer, Type-2 Diabetes Mellitus, hypertension, maternal deaths total	Direct medical	• Suboptimal breastfeeding is associated with a greater burden of disease and associated cost among non-Hispanic Black and Hispanic populations, compared with the non-Hispanic White population for both maternal and paediatric outcomes; • Suboptimal breastfeeding contributes to race disparities, particularly for sudden infant death syndrome and deaths from lower respiratory tract infection, which are more common among non-Hispanic Black infants
Comas et al., 2011[41]	Costs of prenatal care, delivery (vaginal and caesarean), and postnatal care (3 months) up to 3 months after delivery	Direct medical	• No statistically significant differences in the delivery type or in neonatal severity according to the mother's country of origin, no substantial difference in childbirth-related costs based on the woman's country of origin; • Age, origin, and prenatal care were not statistically significant or economically relevant. No differences were found in overall cost or health service utilization between Spanish-born and foreign-born mothers; • Spanish-born mothers had a worse severity profile and a higher average number of emergencies, hospital contacts, and tests per woman during pregnancy; • The cost per woman related to emergencies and tests was significantly higher for Spanish-born women, although the cost for hospital contacts was higher for foreign-born women; • Immigration and antenatal care are not associated with a substantial difference in the overall cost of childbirth
Derrington et al., 2013[42]	• Congenital heart defects, low birth weight, other major (non-cardiac) birth defects, preterm birth • Hospital use (1 post-birth hospitalisation and median days hospitalised birth and post-birth) and reasons for hospitalisation	Direct medical	An estimated 90% of the total cost of all hospitalisations from birth to three years of age in this cohort was attributable to DS and its complications. Significantly greater hospital use and cost among children of racial/ethnic minority mothers compared to non-Hispanic White mothers, greater respiratory disease burden among children with Hispanic mothers and greater cardiac disease were observed
Guillory et al., 200339	Low birth weight, preterm birth	Direct medical	No differences in the rates of preterm infants were noted between White and African American mothers in the Medicaid group.
Lu et al., 2000[29]	Low birth weight, premature birth	Direct medical (non-Medical only for long-term care)	Women without prenatal care were nearly 4 times as likely to deliver low birth weight infants and >7 times as likely to deliver premature infants as were undocumented women who had prenatal care. For every dollar cut from prenatal care, increases of $3.33 in the cost of postnatal care and $4.63 in incremental long-term cost were expected
Zhang et al., 2013[31]	Caesarean section, preeclampsia, placental abruption, preterm birth, small birth size for gestational age and foetal death/stillbirth	Direct medical	Eliminating racial disparities in adverse pregnancy outcomes (not counting infant costs), could generate relevant Medicaid cost savings

Table 4. Economic evaluation of descriptive studies.
Tabella 4. Valutazione economica degli studi descrittivi.

DISCUSSION

A systematic review of economic evaluations of maternal and child healthcare among immigrants and ethnic minority groups in developed countries was conducted; its goal was to summarize evidence about the cost burden of healthcare delivered to immigrant and ethnic minority groups of women living in these countries, in terms of opportunity to invest economic resources to these subgroups of population, and in a perspective of equity in health.

The present review suggests that including immigrant and ethnic minority mothers in national maternal and child healthcare as well as in targeted interventions or screening campaigns is a cost-effective policy for health systems.

Overall, most of the studies highlighted how birth outcomes among immigrants and disadvantaged ethnic groups were worse and were associated with higher costs for healthcare providers.[15,31,40,42,48] These differences were caused by a lack of antenatal care,[15,29,40] but also by nutritional deficiencies[38] and suboptimal breastfeeding.[48] In line with these results, different systematic reviews highlighted that maternal healthcare for migrants is associated with worse birth outcomes,[3] underused and inadequate, although these women are entitled to it in many European countries.[4,51] The results of this review show that including these groups in programmes aimed at providing adequate antenatal care and health information can achieve better outcomes for newborns and their mothers, thereby reducing hospitalisation costs.[15,31,37-39,48] Ensuring access to antenatal care is also important for undocumented immigrants as "the costs of excluding undocumented migrants from healthcare services greatly surpass those of including them, since their health condition will usually worsen, thus leading to increased expenses to the state as emergency care is generally more expensive than preventative care".[52] In fact, excluding undocumented migrants may result in worse health outcomes, especially a greater risk of delivering LBW infants and premature infants, as well as in higher costs, both in the short- and long-term due to the cost related to LBW complications.[29] In this regard, the European Union Agency for Fundamental Rights carried out a simulation study to test whether the provision of antenatal care for undocumented migrants is cost-effective when compared to the provision of emergency-only care. According to the study, providing access to regular preventive healthcare for undocumented migrants would be economically sound and would allow governments to save money.[15]

The group of studies focusing on secondary prevention of the most common infectious diseases among pregnant women stressed the importance of focusing on the immigrant population through targeted screening campaigns, which must take into account the prevalence of the screened disease in the country of origin,[47] limit the risk of infection in newborns and are cost-effective.[43-45,47]

The main limitation of the present review is the fact that only few studies are available on these topics; these studies are moreover characterized by different distribution over time and wide heterogeneity in terms of population, healthcare delivered or interventions, study methods, and cost evaluation, making them difficult to compare. Population studies included in the present review, for example, examine very heterogeneous populations: regular migrants, undocumented migrants, ethnic minority groups, that share the experience of cultural or informal barriers in access to appropriate care, but that are often difficult to compare.

Despite these limitations, the present work is the first systematic review on the topic. Moreover, although only a few studies were included, the Drummond 35-item checklist was used to assess them, thus allowing to include in the present work only high-quality articles.

CONCLUSIONS

Improving the maternal health and related outcomes of immigrant or ethnic minority women is a fundamental step towards health equity, but also a complex task that involves promoting effective integration policies[3] and improving the access to primary care.[28] Despite the limitations of the present review, however, the present work shows that improving maternal and child healthcare among immigrants results in cost saving for the healthcare systems. More evidence is needed especially for outcomes that are rarely investigated: maternal morbidity (pre-eclampsia, gestational diabetes, anaemia, uterine rupture, severe postpartum haemorrhage) and adverse newborns' outcomes (LBW, preterm delivery, congenital malformations, and perinatal, neonatal, postnatal, and infant mortality), involving countries with a more recent migratory tradition, including Italy.

Conflict of interest: none declared.

Acknowledgements: the authors would like to thank Jacqueline M. Costa for the English translation and editing.

REFERENCES

1. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva, WHO, 2016. Available from: https://apps.who.int/iris/bitstream/handle/10665/250796/9789241549912-eng.pdf?sequence=1
2. World Health Organization. Refugee and migrant health. Addressing vulnerabilities of women and girls in refugee and migrant populations. Available from: http://www.who.int/migrants/about/areas-of-work/en/index3.html
3. Bollini P, Pampallona S, Wanner P, Kupelnick B. Pregnancy outcome of migrant women and integration policy: a systematic review of the international literature. Soc Sci Med. 2009;68(3):452-61.
4. Almeida LM, Caldas J, Ayres-de-Campos D, Salcedo-Barrientos D, Dias S. Maternal healthcare in migrants: a systematic review. Matern Child Health J 2013;17(8):1346-54.
5. Pedersen GS, Grontved A, Mortensen LH, Nybo Andersen AM, Rich-Edwards J. Maternal mortality among migrants in Western Europe: a meta-analysis. Matern Child Health J 2014;18(7):1628-38.
6. Nilaweera I, Doran F, Fisher J. Prevalence, nature and determinants of postpartum mental health problems among women who have migrated from South Asian to high-income countries: a systematic review of the evidence. J Affect Disord 2014;166:213-26.

7. Nybo Andersen AM, Gundlund A, Villadsen SF. Stillbirth and congenital anomalies in migrants in Europe. Best Pract Res Clin Obstet Gynaecol 2016;32:50-59.
8. Juarez SP, Hjern A. The weight of inequalities: Duration of residence and offspring's birthweight among migrant mothers in Sweden. Soc Sci Med 2017;175:81-90.
9. Wittkowski A, Patel S, Fox JR. The Experience of Postnatal Depression in Immigrant Mothers Living in Western Countries: A Meta-Synthesis. Clin Psychol Psychother 2017;24(2):411-27.
10. Bhopal R. Glossary of terms relating to ethnicity and race: for reflection and debate. J Epidemiol Community Health 2004;58(6):441-45.
11. Dalla Zuanna T, Spadea T, Milana M, et al. Avoidable hospitalization among migrants and ethnic minority groups: a systematic review. Eur J Public Health 2017;27(5):861-68.
12. Ahmed S, Shommu NS, Rumana N, Barron GR, Wicklum S, Turin TC. Barriers to Access of Primary Healthcare by Immigrant Populations in Canada: A Literature Review. J Immigr Minor Health 2016;18(6):1522-40.
13. de Jong L, Pavlova M, Winters M, Rechel B. A systematic literature review on the use and outcomes of maternal and child healthcare services by undocumented migrants in Europe. Eur J Public Health 2017;27(6):990-97.
14. Migration and the Right to Health. A Review of International Law. International Migration Law No. 19. International Organization for Migration 2009. Available from: https://publications.iom.int/system/files/pdf/iml_19.pdf
15. European Union Agency for Fundamental Rights. Cost of exclusion from healthcare. The case of migrants in an irregular situation. Vienna, FRA, 2015. Available from: http://fra.europa.eu/en/publication/2015/cost-exclusion-healthcare-case-migrants-irregular-situation
16. Keygnaert I, Ivanova O, Guieu A, Van Parys AS, Leye E, Roelens K. What is the Evidence on the Reduction of Inequalities in Accessibility and Quality of Maternal Health Care Delivery for Migrants? A Review of the Existing Evidence in the WHO European Region. WHO Health Evidence Network Synthesis Reports. Copenhagen, WHO, 2016.
17. Lauria L, Bonciani M, Spinelli A, Grandolfo ME. Inequalities in maternal care in Italy: the role of socioeconomic and migrant status. Ann Ist Super Sanita 2013;49(2):209-18.
18. Cantarutti A, Franchi M, Monzio Compagnoni M, Merlino L, Corrao G. Mother's education and the risk of several neonatal outcomes: an evidence from an Italian population-based study. BMC Pregnancy Childbirth. 2017;17(1):221.
19. Zanconato G, Iacovella C, Parazzini F, Bergamini V, Franchi M. Pregnancy outcome of migrant women delivering in a public institution in northern Italy. Gynecol Obstet Invest 2011;72(3):157-62.
20. Cacciani L, Asole S, Polo A, et al. Perinatal outcomes among immigrant mothers over two periods in a region of central Italy. BMC Public Health 2011;11:294.
21. Gil-Gonzalez D, Carrasco-Portino M, Vives-Cases C, Agudelo-Suarez AA, Castejon Bolea R, Ronda-Perez E. Is health a right for all? An umbrella review of the barriers to health care access faced by migrants. Ethn Health 2015;20(5):523-41.
22. Szczepura A. Access to health care for ethnic minority populations. Postgrad Med J 2005;81(953):141-47.
23. Conway KS, Kutinova A. Maternal health: does prenatal care make a difference? Health Econ 2006;15(5):461-88.
24. Iams JD, Romero R, Culhane JF, Goldenberg RL. Primary, secondary, and tertiary interventions to reduce the morbidity and mortality of preterm birth. Lancet 2008;371(9607):164-75.
25. Rosenthal MB, Li Z, Robertson AD, Milstein A. Impact of financial incentives for prenatal care on birth outcomes and spending. Health Serv Res 2009;44(5 Pt 1):1465-79.
26. WHO recommendations on interventions to improve preterm birth outcomes. WHO 2015. Available from: http://apps.who.int/iris/bitstream/handle/10665/183037/9789241508988_eng.pdf;jsessionid=480854442E9C461A18871BAC7B64F932?sequence=1
27. Henderson JW. The cost effectiveness of prenatal care. Health Care Financ Rev 1994;15(4):21-32.
28. Norredam M, Nielsen SS, Krasnik A. Migrants' utilization of somatic healthcare services in Europe – a systematic review. Eur J Public Health 2010;20(5):555-63.
29. Lu MC, Lin YG, Prietto NM, Garite TJ. Elimination of public funding of prenatal care for undocumented immigrants in California: a cost/benefit analysis. Am J Obstet Gynecol 2000;182(1 Pt 1):233-39.
30. Rodriguez MI, Caughey AB, Edelman A, Darney PD, Foster DG. Cost-benefit analysis of state- and hospital-funded postpartum intrauterine contraception at a university hospital for recent immigrants to the United States. Contraception 2010;81(4):304-08.
31. Zhang S, Cardarelli K, Shim R, Ye J, Booker KL, Rust G. Racial disparities in economic and clinical outcomes of pregnancy among Medicaid recipients. Matern Child Health J 2013;17(8):1518-25.
32. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6(7):e1000097.
33. International Monetary Fund. World Economic Outlook Database. October 2017 Edition 2017. Available from: https://www.imf.org/external/pubs/ft/weo/2017/02/weodata/index.aspx
34. Drummond MF, Jefferson TO. Guidelines for authors and peer reviewers of economic submissions to the BMJ. The BMJ Economic Evaluation Working Party. BMJ 1996;313(7052):275-83.
35. Walker DG, Wilson RF, Sharma R, et al. Best Practices for Conducting Economic Evaluations in Health Care: A Systematic Review of Quality Assessment Tools. Rockville (MD), AHRQ Methods for Effective Health Care; 2012.
36. Cutler RL, Fernandez-Llimos F, Frommer M, Benrimoj C, Garcia-Cardenas V. Economic impact of medication non-adherence by disease groups: a systematic review. BMJ Open 2018;8(1):e016982.
37. Connor N, Roberts J, Nicoll A. Strategic options for antenatal screening for syphilis in the United Kingdom: a cost effectiveness analysis. J Med Screen 2000;7(1):7-13.
38. Gregory PM, de Jesus ML. Racial differences in birth outcomes and costs in relation to prenatal WIC participation. N J Med 2003;100(3):29-36.
39. Guillory VJ, Samuels ME, Probst JC, Sharp G. Prenatal care and infant birth outcomes among Medicaid recipients. J Health Care Poor Underserved 2003;14(2):272-89.
40. Cramer ME, Chen LW, Roberts S, Clute D. Evaluating the social and economic impact of community-based prenatal care. Public Health Nurs 2007;24(4):329-36.
41. Comas M, Catala L, Sala M, et al. Descriptive analysis of childbirth healthcare costs in an area with high levels of immigration in Spain. BMC Health Serv Res 2011;11:77.
42. Derrington TM, Kotelchuck M, Plummer K, et al. Racial/ethnic differences in hospital use and cost among a statewide population of children with Down syndrome. Res Dev Disabil 2013;34(10):3276-87.
43. Urbanus AT, van Keep M, Matser AA, et al. Is adding HCV screening to the antenatal national screening program in Amsterdam, the Netherlands, cost-effective? PLoS One 2013;8(8):e70319.
44. Pinot de Moira A, Edmunds WJ, Breuer J. The cost-effectiveness of antenatal varicella screening with post-partum vaccination of susceptibles. Vaccine 2006;24(9):1298-307.
45. Sicuri E, Munoz J, Pinazo MJ, et al. Economic evaluation of Chagas disease screening of pregnant Latin American women and of their infants in a non endemic area. Acta Trop 2011;118(2):110-17.
46. Kowada A. Cost effectiveness of interferon-gamma release assay for TB screening of HIV positive pregnant women in low TB incidence countries. J Infect 2014;68(1):32-42.
47. Imaz-Iglesia I, Miguel LG, Ayala-Morillas LE, et al. Economic evaluation of Chagas disease screening in Spain. Acta Trop 2015;148:77-88.
48. Bartick MC, Jegier BJ, Green BD, Schwarz EB, Reinhold AG, Stuebe AM. Disparities in Breastfeeding: Impact on Maternal and Child Health Outcomes and Costs. J Pediatr 2017;181:49-55 e6.
49. Moretti ME, Lato DF, Berger H, Koren G, Ito S, Ungar WJ. A cost-effectiveness analysis of maternal CYP2D6 genetic testing to guide treatment for postpartum pain and avert infant adverse events. Pharmacogenomics J 2018;18(3):391-97.
50. Akobirshoev I, Mitra M, Parish SL, Moore Simas TA, Dembo R, Ncube CN. Racial and ethnic disparities in birth outcomes and labour and delivery-related charges among women with intellectual and developmental disabilities. J Intellect Disabil Res 2019;63(4):313-26.
51. Winters M, Rechel B, de Jong L, Pavlova M. A systematic review on the use of healthcare services by undocumented migrants in Europe. BMC Health Serv Res 2018;18(1):30.
52. Platform for International Cooperation on Undocumented Migrants. Undocumented migrants and the Europe 2020 strategy: making social inclusion a reality for all migrants in Europe. PICUM 2015. Available from: http://picum.org/wp-content/uploads/2017/11/UndocumentedMigrantsandEurope2020Strategy_EN.pdf