Original Report

# Perinatal Outcomes and Long-term Health in Offspring of Teenage Mothers

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A B S T R A C T

*Study Objective:* To evaluate whether extremely young maternal age (≤17 years) is associated with an increased risk of adverse perinatal outcome and an increased risk for long-term pediatric morbidity in offspring.
*Design, Setting, Participants, Interventions, and Main Outcome Measures:* A retrospective population-based cohort study, in which all singleton deliveries of women, between the years 1991 and 2014 were compared. Parturients were classified into 3 groups according to age at delivery: 17 years or younger, 18-20 years, and 21-35 years (the comparison group). The incidence of long-term hospitalizations of offspring because of cardiovascular, endocrine, hematological, and respiratory morbidity were evaluated in the 3 maternal age groups. Kaplan–Meier survival curves were used to compare the cumulative morbidity incidence. Multiple regression models were used to estimate the association between young maternal age and adverse pregnancy outcomes, and long-term offspring morbidities (using survival analysis) while controlling for multiple potential confounders.
*Results:* Of 213,177 deliveries that met the inclusion criteria, 90.1% (n = 192,185) occurred in mothers aged 21-35 years, 8.7% (n = 18,645) in mothers 18-20 years old, and 2347 were in mothers aged 17 years or younger (1.1%). Using multivariable logistic regression models, low birth weight and preterm delivery were significantly associated with young maternal age. The incidence of long-term morbidities of the offspring did not differ between the groups, in either the Kaplan–Meier analysis or the multivariable survival analysis.
*Key Words:* Maternal age, Perinatal outcomes, Long-term morbidity, Offspring

## Introduction

Teenage pregnancy, defined as pregnancy in girls aged 10-19 years, represents a significant social, economic, and medical burden worldwide.[1] This public health issue concerns, for the most part, developing countries, with an estimated annual pregnancy rate of 21 million girls aged 15-19 years and 2 million girls aged younger than 15 years in developing regions.[2–4] Approximately 700,000 adolescents become pregnant in the United States every year.[5] In Israel, in the year 2009, 1.6% of births were in women younger than the age of 20 years. More than 14% of legal abortions in Israel in 2007 were performed in women younger than the age of 19 years, and 0.4% were in girls aged younger than 14 years.[6] That being said, the global adolescent birth rate has declined in the past 2 decades.[3] However, despite this overall progress, and because the global population of adolescents continues to grow, projections indicate that the number of adolescent pregnancies will increase globally by 2030, with the greatest proportional increases in Africa.[4]

Data are conflicting with regard to perinatal outcomes in the context of young maternal age. Previous studies have reported an increased incidence of adverse maternal and perinatal outcomes, including low birthweight,[1,7–9] preterm delivery (PTD),[7,8] perinatal death,[1] small for gestational age infants,[6] and even maternal death.[8,10] However, it is a matter of controversy as to whether the adverse pregnancy outcomes among adolescent mothers are caused by maternal biological immaturity, poor socioenvironmental factors, or the level of the prenatal care.[10,11]

Although the course of teenage pregnancy and immediate perinatal outcomes were previously described, little is known regarding the long-term effect of young maternal age on offspring future health. In the present study we aimed to assess whether young maternal age increases the risk for short-term adverse pregnancy outcome, as well as for long-term morbidity in the offspring. Long-term offspring health was assessed by according to number of hospitalizations up to the age of 18 years because of cardiovascular, respiratory, endocrine, or hematological morbidity.

## Materials and Methods

We conducted a retrospective population-based cohort study of all singleton pregnancies in women who delivered between the years 1991 and 2014. The study was conducted at the Soroka University Medical Center (SUMC), the largest tertiary medical center in the Negev (the southern part of Israel). The Negev occupies 60% of the land of Israel, and

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Shiran Zer and Tamar Wainstock contributed equally to this work.
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SUMC serves the entire population of the region (14% of Israel's population, approximately 1,190,000). Thus, this study is on the basis of nonselective population data. The institutional review board (in accordance with the Declaration of Helsinki) approved the study. A comparison was performed between the different maternal age groups to determine whether there was an association between young maternal ages, adverse perinatal outcomes, and long-term morbidity of the offspring. Parturients were classified into 3 groups according to maternal age at delivery: aged 17 years or younger, 18-20 years, and 21-35 years (the comparison group). Maternal age older than 35 years, pregnancies after any fertility treatments, multiple gestations, and fetuses with congenital malformations were all excluded from the study.

The following covariates were evaluated: ethnicity, lack of prenatal care (defined in accordance with the World Health Organization as fewer than 3 prenatal visits in any prenatal care facility), pregestational and gestational diabetes mellitus, hypertensive disorders of pregnancy, PTDs, mode of delivery, offspring sex, low birth weight (LBW; < 2500 g), Apgar scores at the first and fifth minute, as well as perinatal mortality (including antepartum death, intrapartum death, and postpartum death).

The long-term outcomes were defined as offspring hospitalizations up to the age of 18 years because of cardiovascular, respiratory, endocrine, and hematological morbidity. Follow-up terminated if any of the following occurred: the first hospitalization at SUMC for each of the investigated categories of morbidity, when any hospitalization resulted in death, when the child reached 18 years of age, or at the end of the study period (January 2014).

Data were collected from 2 databases that were cross-linked and merged: the computerized perinatal database of the Obstetrics and Gynecology Department, and the computerized hospitalization database of the SUMC. The perinatal database consists of information recorded immediately after delivery by an obstetrician. Medical secretaries routinely review this information before entering it into the database to ensure its maximal completeness and accuracy. Coding is performed after assessing prenatal medical care records as well as routine hospital documents. The computerized hospitalization database of the SUMC includes demographic information and International Classification of Diseases, ninth revision codes for all medical diagnoses made during any hospitalization at SUMC.

### *Statistical Analyses*

Statistical analysis was performed using SPSS software version 23 (IBM Corp). Quantitative variables were compared using Student *t* test in the case of normal distribution and Mann–Whitney test in the case of non-normal distribution. Categorical variables are shown in counts and percentages and the differences were assessed using the $\chi^2$ test.

Generalized estimation equation models were used to study the association between maternal age group and risk for pregnancy complications, while adjusting for siblings in the cohort.

Kaplan–Meier survival curves were used to compare cumulative incidence of all major system pediatric hospitalizations. Survival analyses for clustered data were used to estimate the adjusted hazard ratios (HRs) and 95% confidence intervals (CIs) for long-term risk per each major system pediatric hospitalization, while adjusting for maternal clusters, maternal age, gestational age, and birth weight. A *P* value of < .05 was considered statistically significant.

## Results

During the study period 213,177 deliveries met the inclusion criteria. Of them, 90.1% (n = 192,185) occurred in mothers aged 21-35 years. The rest were 18-20 years old

**Table 1**
Demographic Characteristics, Pregnancy Course, and Outcome in the Different Maternal Age Groups

| Characteristic | Maternal Age, years | | | *P* |
|---|---|---|---|---|
| | Younger than 17 (n = 2347; 1.1%) | 18-20 (n = 18,645; 8.7%) | 21-35 (n = 192,185; 90.2%) | |
| Ethnicity | | | | <.001 |
| Bedouin | 1913 (81.5) | 14,541 (78) | 98,025 (51) | |
| Jewish | 434 (18.5) | 4104 (22.0) | 94,160 (49) | |
| Lack of prenatal care | 386 (16.4) | 2204 (11.8) | 16,666 (8.7) | <.001 |
| Gestational age at delivery (mean ± SD), weeks | 38.82 ± 2.172 | 39.0 ± 2.131 | 39.14 ± 1.944 | <.001 |
| Hypertension* | 164 (7.0) | 851 (4.6) | 8520 (4.4) | <.001 |
| Diabetes mellitus† | 21 (0.9) | 180 (1) | 7940 (4.1) | <.001 |
| Preterm delivery (<37 weeks' gestation) | 259 (11) | 1576 (8.5) | 12,386 (6.4) | <.001 |
| Low birth weight (<2500 g) | 306 (13) | 1867 (10) | 12,128 (6.3) | <.001 |
| SGA‡ | 196 (8.4) | 1428 (7.7) | 8553 (4.5) | <.001 |
| Cesarean delivery | 158 (6.7) | 1327 (7.1) | 24,467 (12.7) | <.001 |
| Pathological presentation | 113 (4.8) | 791 (4.2) | 8965 (4.7) | .029 |
| Fetal gender | | | | .010 |
| Female | 1109 (47.3) | 9004 (48.3) | 94,607 (49.2) | |
| Male | 1238 (52.7) | 9641 (51.7) | 97,578 (5.8) | |
| Low Apgar score (<7) at 1 minute | 135 (5.8) | 1012 (5.4) | 9846 (5.1) | .084 |
| Low Apgar score (<7) at 5 minutes | 42 (1.8) | 393 (2.1) | 4218 (2.2) | .313 |
| Perinatal mortality (total)§ | 13 (0.6) | 129 (0.7) | 951 (0.5) | .001 |

SGA, small for gestational age.
Data are presented as n (%) or mean ± SD; significance was measured using $\chi^2$ and Mann–Whitney tests.
* Including chronic hypertension, gestational hypertension, and preeclampsia.
† Including pregestational and gestational diabetes.
‡ Defined as less than the fifth percentile for gestational age.
§ Including intrauterine fetal death, intrapartum death, postpartum death.

**Table 2**
Three Multivariable Regression Model for Adverse Perinatal Outcomes in Teenage Pregnancy

| | Maternal Age Groups | Adjusted HR | 95% CI | *P* |
|---|---|---|---|---|
| Perinatal mortality* | 21-35 (Reference) | 1 | | |
| | Maternal age younger than 17 years | 1.39 | 0.81-2.37 | .22 |
| | Maternal age of 18-20 years | 0.97 | 0.79-1.1 | .81 |
| Preterm delivery (<37 weeks)† | 21-35 (Reference) | 1 | | |
| | Maternal age younger than 17 years | 1.71 | 1.5-1.95 | <.0001 |
| | Maternal age of 18-20 years | 1.3 | 1.26-1.41 | <.0001 |
| Low birth weight (<2500 g)‡ | 21-35 (Reference) | 1 | | |
| | Maternal age younger than 17 years | 1.81 | 1.56-2.1 | <.0001 |
| | Maternal age of 18-20 years | 1.54 | 1.45-1.64 | <.0001 |

CI, confidence interval; HR, hazard ratio.
* Adjusted for hypertensive disorders, ethnicity, and gestational age.
† Adjusted for hypertensive disorders, diabetes, poor prenatal care and ethnicity.
‡ Adjusted for hypertensive disorders, poor prenatal care, ethnicity, and gestational age.

(n = 18,645; 8.7%), and 2347 were aged 17 years or younger (1.1%). Table 1 shows a comparison of maternal demographic and obstetric characteristics of pregnancies in the different maternal age groups. A significant linear association was found between maternal age and perinatal mortality, LBW, PTD, and hypertensive disorders of pregnancy.

In the generalized estimation equation models, which controlled for hypertensive disorders, ethnicity, poor

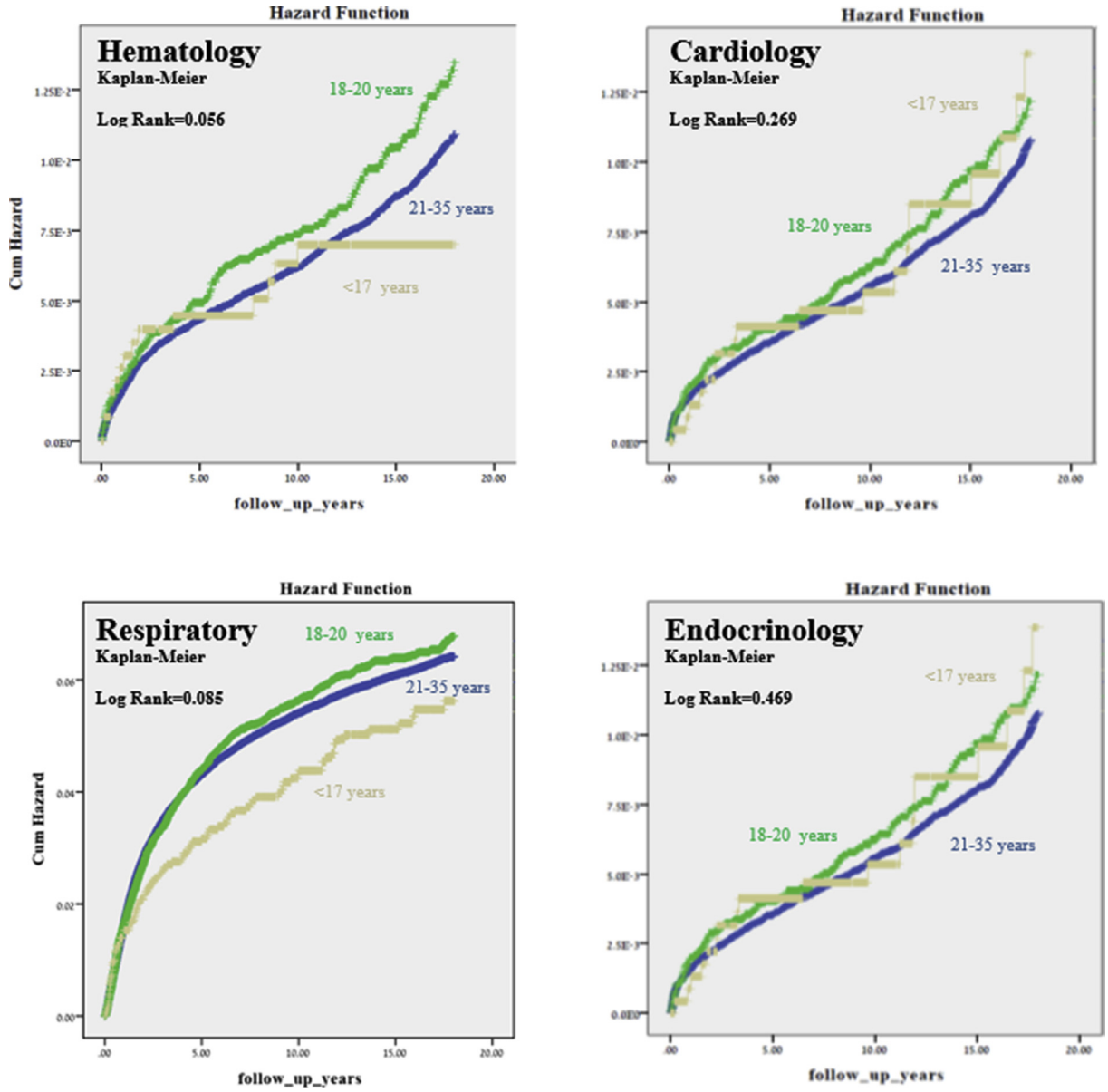


**Fig. 1.** Kaplan–Meier survival curves; comparison of long-term pediatric morbidity among maternal age groups.

**Table 3**
Cox Multivariable Analysis for Maternal Age and Long-Term Different Morbidity in the Offspring

| | Maternal Age Group | Adjusted HR | 95% CI | *P* |
|---|---|---|---|---|
| Hematology | 21-35 | 1 | | |
| | Maternal age of 18-20 years | 1.20 | 1.01-1.42 | .31 |
| | Maternal age <17 years | 0.79 | 0.46-1.34 | .39 |
| Cardiology | 21-35 | 1 | | |
| | Maternal age <17 years | 1.15 | 0.73-1.81 | .53 |
| | Maternal age of 18-20 years | 1.14 | 0.95-1.36 | .14 |
| Respiratory | 21-35 | 1 | | |
| | Maternal age <17 years | 0.81 | 0.67-0.99 | .04 |
| | Maternal age of 18-20 years | 1.03 | 0.96-1.1 | .31 |
| Endocrinology | 21-35 | 1 | | |
| | Maternal age <17 years | 1.33 | 0.82-2.15 | .24 |
| | Maternal age of 18-20 years | 0.99 | 0.80-1.24 | .98 |

CI, confidence interval; HR, hazard ratio.

prenatal care, and gestational age, LBW was significantly associated with young maternal age in the teenage years and more so in the youngest group. PTD was also significantly associated with young maternal age after controlling for hypertensive disorders, diabetes, poor prenatal care, and ethnicity. These extremely young mothers were more likely to experience PTD (adjusted HR, 1.71; 95% CI, 1.5-1.95; $P < .001$; Table 2) and to deliver a LBW newborn (adjusted HR, 1.81; 95% CI, 1.56-2.1; $P < .001$; Table 2).

Figure 1 shows Kaplan–Meier curves for the 3 maternal age groups showing the cumulative incidence of long-term outcomes of offspring. Children born to younger mothers did not have a significantly different cumulative incidence of any of the long-term pediatric morbidities evaluated compared with older mothers in the comparison group.

Table 3 shows a summary of the rates of offspring long-term pediatric hospitalizations according to maternal age group. Long-term hospitalizations related to cardiovascular, respiratory, endocrine, and hematological systems exhibited rates comparable among the different maternal age groups. In the Cox model, adjusted for gestational age, diabetes, and hypertensive disorders, no independent association was noted between young maternal age and long-term morbidities of the offspring (Table 3).

## Discussion

Adolescent pregnancies are a global problem, and remain a major challenge in developed and developing countries.[3] It has been shown before, and confirmed by our study, that early childbearing can increase the risk of adverse pregnancy outcomes.[1,7,9] We suspected that beyond immediate pregnancy complications, young maternal age might also harbor future health threats to the offspring, similar to the effect found in other maternal conditions that affect offspring long-term morbidity.[12] However, in this large population-based cohort study, we have shown that pregnancies of very young parturients do not appear to pose an additional risk for future cardiovascular, respiratory, endocrine, and hematological morbidities in the offspring during childhood. To the best of our knowledge, our study is the first to investigate the long-term health effects in offspring of adolescent mothers.

Young maternal age was previously noted as a risk factor for adverse short-term perinatal outcomes, including low birth weight (<2500 g), PTD (<37 weeks' gestation), eclampsia, fetal death, anemia, congenital deformities, small for gestational age fetuses, and chorioamnionitis.[1,7,9–11] Several studies have disputed the independent effect of maternal age on pregnancy outcomes by showing that the association of adverse perinatal outcomes in teenagers had been confounded mainly by lack of or inadequate prenatal care and by other sociocultural characteristics often associated with teenage pregnancy.[10,13–15] Raatikainen et al concluded that increased risks of adverse pregnancy outcomes in teenagers reported in earlier studies can probably be overcome by improving antenatal care in this group. This study was carried out in Finland, where maternity care is provided free of charge in and is used by virtually the entire pregnant population.[16]

As expected, and in agreement with previously published data,[1,4,8–11] we found that young maternal age, including those aged 17 years and younger and those 18-20 years old, was significantly associated with higher rates of short-term adverse perinatal outcomes including PTD, low birth weight, and hypertensive disorders in pregnancy compared with older parturients. Two general features of biological immaturity are thought to be implicated in increased risk of adverse birth outcomes. The first one is the effect of a girl becoming pregnant before she has ceased growing. It was reported that women who are still growing appeared not to mobilize fat reserves late in pregnancy to enhance fetal growth, apparently reserving them instead for their own continued development. The second is the low gynecological age (defined as conception within 2 years after menarche) and immaturity of the uterine or cervical blood supply, which might predispose young mothers to subclinical infections, an increase in prostaglandin production, and a consequent increase in the incidence of PTD.[1]

These are all well established risk factors for long-term morbidity of offspring.[12,17–22] Preterm delivery was highly associated with young maternal age, in both young maternal age groups, and especially in the youngest mothers (aged ≤17 years). Prematurity is a well established risk factor for long-term morbidity of the offspring.[19–21] Raju et al reviewed 126 publications that focused on adults born prematurely and their long-term health issues stratified into system-specific outcomes. One consistent observation was that these adults had significantly higher systolic and diastolic blood pressure values and a tendency

to have abnormal vascular architecture.[19] Our findings also show the substantial increased risk for hypertensive disorders in this adolescent age group (mothers who were ≤17 years old). It is known that children exposed in utero to preeclampsia have a higher risk of hypertension, cardiovascular disease,[12] and long-term neuropsychiatric morbidity.[22]

We suspected that known short-term outcomes such as PTD, low birth weight, and hypertensive disorders would mediate the association between young maternal age and long-term morbidity of the offspring. However, although young maternal age was found to be associated with multiple pregnancy complications and adverse short-term outcomes, the risk for long-term morbidity in the offspring was not elevated. This could be explained by insufficient cohort or the fact that some of the morbidities will evolve later in life, and not by the age of 18 years. Prenatal care in Israel is routinely not performed in the setting of a tertiary hospital, but rather in spread primary ambulatory clinics of the Israeli health insurance and Ministry of health. Although the most common barriers to prenatal care attendance in modern western communities are lack of insurance and low income, in Israel prenatal care has been provided by the Ministry of Health through a network of local maternal and child health clinics for a very small fee. These clinics cover antenatal care and infant care and immunizations. The recommendations of the Israeli Ministry of Health for routine prenatal care include several physician visits, and additional visits to the public health nurse.[15]

Our study's main strength stems from its population-based nature, and the fact that our hospital is the only tertiary hospital serving the entire population of southern Israel (the Negev). The hospital provides maternity services as well as pediatric services, thus, as long as the mother and child live in this area, they would seek treatment in the same facility in which the child was born. The population-based nature of the cohort, without a selection bias, enhances the robustness of our findings. Our data set combines maternal, neonatal, and long-term pediatric data, thereby enabling the unique opportunity to examine the long-term outcomes of offspring of teenage mothers while controlling for many parameters surrounding the pregnancy and delivery.

Our study has several limitations. The first limitation relates to the possibility of immigration of families outside of the Negev area after birth, leading to future medical management outside the SUMC area of coverage. We assume that this limitation is insubstantial, because there is no reason to assume that negative immigration was more prevalent in the young maternal age groups compared with the comparison group. We acknowledge the fact that we were able to follow only hospitalized offspring. It is thus possible that our results represent severe morbidities, which required assessment and treatment in a hospital setting. Diseases diagnosed and treated in a community setting alone without requiring hospitalization were not covered in this study, but it is common practice that physicians add any chronic condition that had previously been diagnosed in the community to the medical chart. Although better estimates of these morbidities could be found in community clinics specializing in each condition, the regional hospitalization database is still the most appropriate database for achieving a comprehensive follow-up of a variety of conditions in a large nonselective study group.

In our study, we included (in all analyses) only the first hospitalization for each child in each category. This might have led to the underestimation of some medical disorders. Nevertheless, the alternative of including all hospitalizations could have led to bias, because a single child with multiple hospitalizations could have influenced the entire cohort. Another important point is the fact that we were able to follow these children only up to the age of 18 years. It is possible that different morbidities would have surfaced only at an older age, an important point that remains to be investigated in future studies.

In conclusion, teenage pregnancy is an independent risk factor for LBW and PTD, as well as for hypertensive disorders of pregnancy, especially when the parturient is younger than 17 years of age. Our findings emphasize the importance of appropriate educational programs in teenagers. However, in our cohort, young maternal age did not appear to have a significant effect on long-term health of the offspring. Further studies are needed to examine the long-term implications of teenage pregnancies.

## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jpag.2019.08.003.

## References


1. Chen XK, Wen SW, Fleming N, et al: Teenage pregnancy and adverse birth outcomes: a large population based retrospective cohort study. Int J Epidemiol 2007; 36:368
2. World Health Assembly, 65: Early marriages, adolescent and young pregnancies-report by the Secretariat. World Health Organization. Available: https://apps.who.int/iris/handle/10665/78901. Accessed 2012.
3. Department of Child and Adolescent Health and Development, Department of Reproductive Health and Research, World Health Organization: Contraception: issues in adolescent health and development. Available: http://apps.who.int/iris/bitstream/10665/42901/1/9241591447_eng.pdf. Accessed 2004.
4. Loaiza E, Liang M, UNFPA: Adolescent pregnancy: a review of the evidence. UNFPA 2013;1–58
5. Committee on Adolescence: Addendum–adolescent pregnancy: current trends and issues. Pediatrics 2014; 133:954
6. Fisher M, Ben Shlomo I, Solt I, et al: Pregnancy prevention and termination of pregnancy in adolescence: facts, ethics, law and politics. Isr Med Assoc J 2015; 17:665
7. Sikron F, Wilf-Miron R, Israeli A: Adolescent pregnancy in Israel: a methodology for rate estimation and analysis of characteristics and trends. Harefuah 2003; 142:131. [in Hebrew].
8. Gortzak-Uzan L, Hallak M, Press F, et al: Teenage pregnancy: risk factors for adverse perinatal outcome. J Matern Fetal Med 2001; 10:393
9. Conde-Agudelo A, Belizán JM, Lammers C: Maternal-perinatal morbidity and mortality associated with adolescent pregnancy in Latin America: cross-sectional study. Am J Obstet Gynecol 2005; 192:342
10. Liran D, Vardi IS, Sergienko R, et al: Adverse perinatal outcome in teenage pregnancies: is it all due to lack of prenatal care and ethnicity? J Matern Fetal Neonatal Med 2013; 26:469
11. Fraser AM, Brockert JE, Ward RH: Association of young maternal age with adverse reproductive outcomes. N Engl J Med 1995; 332:1113
12. Nahum Sacks K, Friger M, Shoham-Vardi I, et al: Prenatal exposure to preeclampsia as an independent risk factor for long-term cardiovascular morbidity of the offspring. Pregnancy Hypertens 2018; 13:181
13. Ganchimeg T, Ota E, Morisaki N, et al, WHO Multicountry Survey on Maternal Newborn Health Research Network: Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. BJOG 2014; 121(suppl):40
14. Loto OM, Ezechi OC, Kalu BKE, et al: Poor obstetric performance of teenagers: is it age- or quality of care-related? J Obstet Gynaecol 2004; 24:395

15. Abu-Ghanem S, Sheiner E, Sherf M, et al: Lack of prenatal care in a traditional community: trends and perinatal outcomes. Arch Gynecol Obstet 2012; 285: 1237
16. Raatikainen K, Heiskanen N, Verkasalo PK, et al: Good outcome of teenage pregnancies in high-quality maternity care. Eur J Public Health 2006; 16:157
17. Padeh E, Wainstock T, Sheiner E, et al: Gestational age and the long-term impact on children's infectious urinary morbidity. Arch Gynecol Obstet 2018; 299:385
18. Walfisch A, Wainstock T, Beharier O, et al: Early term deliveries and the risk of pediatric obstructive sleep apnea in the offspring. Paediatr Perinat Epidemiol 2017; 31:149
19. Raju TNK, Buist AS, Blaisdell CJ, et al: Adults born preterm: a review of general health and system-specific outcomes. Acta Paediatr 2017; 106:1409
20. Davis EF, Lazdam M, Lewandowski AJ, et al: Cardiovascular risk factors in children and young adults born to preeclamptic pregnancies: a systematic review. Pediatrics 2012; 129:e1552
21. Vatten LJ, Romundstad PR, Holmen TL, et al: Intrauterine exposure to preeclampsia and adolescent blood pressure, body size, and age at menarche in female offspring. Obstet Gynecol 2003; 101:529
22. Nahum Sacks K, Friger M, Shoham-Vardi I, et al: Long-term neuropsychiatric morbidity in children exposed prenatally to preeclampsia. Early Hum Dev 2019; 130:96