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Complete List of Authors:	Adler, Limor; Maccabi Healthcare Services, ; Tel Aviv University Sackler Faculty of Medicine, Family Medicine Azuri, Joseph; Maccabi Healthcare Services, Family Medicine; Tel Aviv University Sackler Faculty of Medicine, Family Medicine
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Maternal Perinatal Depression and Health Services Utilisation in the First Two Years of Life: a cohort study

Limor Adler[1,2], MD, Joseph Azuri[1,2], MD MHA

Affiliations: [1]Maccabi Healthcare Services, Israel; and [2]Tel Aviv University, Tel Aviv, Israel

Corresponding Author: Limor Adler, Department of family medicine, Maccabi Healthcare Service, 27 Hamered Street, Tel Aviv, Israel, adler_l@mac.org.il.

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ABSTRACT

Objectives Perinatal depression is a common phenomenon, influencing infants' development. Studies have shown an association between perinatal depression and healthcare resource utilisation, but results were not consistent.

This study aimed to assess whether perinatal depression in mothers is associated with their infants' healthcare utilisation during the first two years of life.

Design A cohort study based on computerized medical records.

Setting Primary care. The second largest health maintenance organization in Israel.

Participants 593 children of women with depression (the exposed group) and 2,310 children of women without depression.

Primary and secondary outcome measures Primary outcome variables included general practitioner/paediatrician (GP/Paed) visits (regular and telehealth), emergency room (ER) visits, hospital admission rates and child-development clinic visits. Secondary outcomes included antibiotic use and anaemia status. The exposure variable, perinatal depression, was based on Edinburgh Postnatal Depression Scale (EPDS). A score of ≥10 was classified as depression.

Results Multivariable analysis of the number of regular visits and telehealth to the GP/Paed showed an adjusted incidence rate ratio (aIRR) of 1.08, 95% CI 1.03,1.13 and aIRR 0.95, 95% CI 0.82,1.10, respectively. Children of mothers with perinatal depression had more hospital admissions (aIRR 1.21, 95% CI 1.01,1.46) and more visits to child development clinics (aIRR 1.33, 95% CI 1.04,1.70). There was a non significant increase in ER visits (IRR 1.26, 95% CI 0.66,2.42), antibiotics prescriptions (IRR 0.95, 95% CI 0.86,1.05) and anaemia status (IRR 0.93, 95% CI 0.72,1.20)

Conclusion This study shows higher health services utilisation among children of mothers with perinatal depression, including regular GP/Paed visits, hospital admission rates, and child-development clinics.

Strengths and limitations of this study

- The dataset was based on a nationwide cohort, using electronic files of all patients in Maccabi Healthcare Services (MHS), the second largest health maintenance organization (HMO) in Isarel.
- The length of follow up (2 years) allowed us to explore long outcomes on children of mothers with perinatal depression.
- For the exposure variable, perinatal depression, we have used a validated tool, commonly used in studies of this field, the Edinburgh Postnatal Depression Scale (EPDS).
- Not all women filled the EPDS in MHS. However, women who did and did not fill the EPDS were similar in most aspects, reducing the impact of selection bias.
- The EPDS is a screening tool and not a diagnostic tool, leading to a non-differential misclassification bias.

INTRODUCTION

Perinatal depression is a common phenomenon affecting mothers with a reported global pooled prevalence of 17.7% and significant heterogeneity, ranging from 3% in Singapore and 38% in Chile.(1) In a recenet survey conducted by the CDC, about 13% of women in the United States, reported depressive symptoms after birth.(2) During the perinatal period, women's mental health may impact their functioning, parenting capability, and the health and well-being of their children(3). There are many possible influences on the infant's development, including bonding and attachment,(4,5) cognitive,(6–9) emotional,(10) and language development,(11) including Intelligence Quotient level.(12)

Parental mental health was shown to affect the healthcare resource utilisation of the child. There is an association between parental depression and a higher rate of specialty consultant visits, emergency department visits, hospital admissions, and general practitioner/paediatrician (GP/Paed) visits.(13,14) Timing of depression is associated with higher utilisation of primary health care services, with the strongest association with recent depression.(15)

Several studies examined the association between perinatal depression and healthcare resource utilisation. Most studies showed an association between perinatal depression and higher rates of non-routine visits to the GP/Paed,(14–20) more emergency room (ER) visits,(21) higher hospital admission rates,(19,21) specialist consultations, and pharmacy claims.(21) However, while several studies found perinatal depression associated with decreased well-child visits,(18) others did not.(20,22) An association was found between antidepressant use during pregnancy and higher rates of infant GP/Paed visits, specialist visits, and hospital admissions.(23) Screening for postpartum depression in paediatric emergency departments showed high rates of maternal depression.(24,25) However, other studies did not find any association between perinatal depression and health care

utilisation.(26) A recent study showed higher total healthcare costs in children of mothers with perinatal depression during the first two years of life compared to children of mothers without perinatal depression.(21)

This study aimed to assess whether perinatal depression in mothers is associated with their infants' healthcare utilisation in the first two years of life. Variables included GP/Paed visits (regular and telehealth), ER visits, hospital admissions, child-development clinic visits and antibiotic use. Haemoglobin at the age of 12 months was also assessed to evaluate anaemia (checking haemoglobin levels at this age is recommended for all children by Israeli health policy).

METHODS

Study design

This cohort study is based on computerized electronic medical records data of Maccabi Healthcare Services (MHS), the second-largest health maintenance organization (HMO) in Israel, covering 2.8 million people nationwide. In a previous study, we identified women with perinatal depression (antenatal and postpartum) based on the Edinburgh Postnatal Depression Scale (EPDS) delivered to 27,520 women.(27) Data for women were collected for 2015-2016. In the current study, infants' data were collected until the age of two years (2017-2018). All children born to women with perinatal depression were defined as the exposed group. Children of mothers with negative EPDS were considered as the unexposed group. They were chosen with a 4:1 ratio by stratified random sampling (based on age of mother and socioeconomic status [SES]). The local ethics committee (IRB) of MHS approved the study, ID 0022-19-MHS.

Variables

The exposure variable, perinatal depression, was based on the EPDS as recorded for each women in her electronic file. The EPDS is a validated, widely used scale, that was designed specifically to assess perinatal depression.(28,29) The EPDS comprises 10 questions that access information about the respondent's mood and depressive symptoms during the 7 days preceding its administration. The response to each question is scored 0 – 3; thus, the highest possible score is 30. In this study, a score of ≥10 was classified as depression. Women filled the EPDS during pregnancy and until 9 weeks postpartum. If filled twice (antenatal and postpartum), the lower score was taken to ensure a conservative estimate. Women who did not fill the EPDS were excluded from this study. Women who did and did not fill the EPDS were similar in age and similar proportions lived in the periphery of the country.

Outcome variables for healthcare services utilisation in the first 2 years of life were number of visits to the GP/Paed (both regular and telehealth), visits to the ER (direct or with refereal), hospital admissions, child-development clinic visits (a referral from the GP/Paed is mandatory) and antibiotic use. Anaemia status was measured at 12 months old, as it is recommended in Israel to check anaemia status for every child at this age. Anaemia was defined as a haemoglobin level of 10.5 mg/dL or below. We also collected maternal data: age, periphery residence index, SES, population group (Arab, Orthodox Jew, other), and smoking status.

SES is a scale measuring socio-economic status from 1 (lowest) to 10 (highest). It is defined by the Israel bureau of statistics by address. It was grouped to three levels: lower (1-4) and higher (8-10), while the middle group (5-7) was used as a reference group. Periphery residence index is also bases on patients' addresses. Sociodemographic variables exist for all women in the database, since they are inserted automatically, and are not filled by demand from the patient. Data was collected anonymously from the electronic database of MHS.

Sample size

According to MHS data, children visit their GP/Paed once every 1-2 months during the first two years of life (including regular visits and telehealth). The sample size was calculated to be 192 children in the exposed group and 767 in the unexposed group, assuming a difference of one visit (from 24 to 25 visits), with a significance level of 5%, 80% power, and 1:4 ratio between the two groups.

Statistical analysis

Descriptive statistics were calculated using mean and standard deviation for continuous variables and percentages for categorical variables. Univariable and multivariable negative binomial models were constructed (with sample based estimation of the overdispersion parameter) to test the effect of perinatal depression and other potential predictors of healthcare resource utilisation. Akaike's Information Criterion (AIC) was used for model selection between models that were significant according to the omnibus Likelihood Ratio test.

Patient and public involvement

No patients involved.

RESULTS

Descriptive statistics

Data were collected from the electronic records of MHS for 593 children of women with depression (the exposed group) and 2,310 children for the unexposed group (negative EPDS, no perinatal depression) matched by maternal age and SES. The total study population consisted of 2,903 children. Both groups were similar in sex distribution, mothers' country of birth, and religious group (Arab or orthodox Jewish) (Table 1). Mothers with perinatal

depression were more likely to smoke during pregnancy (relative risk 1.51, 95% CI 1.19,1.94).

Univariable analysis

In a univariable analysis, children of women with perinatal depression had more regular visits to their GP/Paed (incidence rate ratio (IRR) 1.07, 95% CI 1.02,1.13) but fewer telehealth visits (IRR 0.96, 95% CI 0.83,1.12). They had more ER visits (IRR 1.26, 95% CI 0.66,2.42), hospital admissions (IRR 1.19, 95% CI 1.00,1.43) and visits to child development clinics (IRR 1.31, 95% CI 1.03,1.68), but recieve less antibiotics prescriptions (IRR 0.95, 95% CI 0.86,1.05) and have less anaemia (IRR 0.93, 95% CI 0.72,1.20) (Table 2).

Multivariable analysis

Multivariable analysis showed that children of mothers with perinatal depression have more regular visits to the GP/Paed (adjusted IRR [aIRR] 1.08, 95% CI 1.03,1.13). Arab or orthodox Jewish children were less likely to go to their GP/Paed (aIRR 0.86, 95% CI 0.79,0.94 and aIRR 0.76, 95% CI 0.69,0.84 respectively). Males and children of mothers who were born in Israel were more likely to go to their GP/Paed (aIRR 1.08, 95% CI 1.04,1.12 and aIRR 1.06, 95% CI 1.00,1.12 respectively) (Table 3). In contrast, no difference was demonstrated for telehealth visits for children born to mothers with perinatal depression (aIRR 0.95, 95% CI 0.82,1.10). Children of mothers who live in the periphery or are Arab or orthodox Jewish were less likely to use this method of communication with their GP/Paed (aIRR 0.75, 95% CI 0.60,0.93; aIRR 0.21, 95% CI 0.16,0.29; aIRR 0.18, 95% CI 0.12,0.25 respectively) (Table 4).

Three factors were found significant in hospital admissions; Children of mothers with perinatal depression were more likely to be admitted to the hospital (aIRR 1.21, 95% CI 1.01,1.46). Lower rates of admissions were recorded for females (aIRR 0.82, 95% CI 0.70,0.96) and children of older mothers (aIRR 0.98, 95% CI 0.97,0.99).

For child development clinic visits, two significant factors were found; children of mothers with perinatal depression and males had more of these visits, aIRR 1.33, 95% CI 1.04,1.70 and aIRR 1.30, 95% CI 1.05,1.62 respectively.

For the number of prescriptions for antibiotics, perinatal depression was not found significant in the multivariate analysis. Males and Jewish orthodox background were less likely to get prescriptions (aIRR 0.83, 95% CI 0.77,0.89, and aIRR 0.71, 95% CI 0.59,0.85, respectively). Children of mothers born in Israel were more likely to get prescriptions (aIRR 1.12, 95% CI 1.01,1.26). Children from lower SES groups were more likely to get prescriptions, and children from higher SES groups were less likely to get prescriptions (aIRR 1.18, 95% CI 1.06,1.31 and aIRR 0.83, 95% CI 0.75,0.91, respectively).

DISCUSSION

Main findings

This study suggests that perinatal depression affects children's health care utilisation from birth to 2 years old. These children more frequently visit their GP/Paed's and child development clinics and have higher hospital admission rates. There was also a non significant increase in ER visits. However, there was no significant difference in the rates of telehealth visits or the number of antibiotic prescriptions issued.

Strengths

The strengths of the study include the dataset which is based on a nationwide cohort, using electronic files of all patients in MHS, the second largest HMO in Isarel. All HMOs in Israel have fully computerized healthcare systems, and therefore sociodemogrphic data were available for all participants in the study. The length of follow up allowed us to explore long outcomes on children of mothers with perinatal depression. For the exposure variable, perinatal depression, we have used a validated tool, commonly used in studies of this field.

Weaknesses

The sample was based on the filled EPDS questionnaires in the electronic database of MHS. Not all women filled the EPDS. However, women who did and did not fill the EPDS were similar in most aspects(27), reducing the impact of selection bias. Secondly, the EPDS is a screening tool and not a diagnostic tool, leading to a non-differential misclassification bias. Thirdly as this study is based on electronic data mining, information bias may exist, due to missing data such as private visits, outside the HMO. However, this is not likely, as in Israel, GP/Paed visits are fully reimbursed.

Interpretation

Kenneth et al. suggested the excessive use of healthcare services may be a sign of help-seeking behavior of the mother or a sign of anxiety to the well-being of her child.(17) It has been suggested that some women might find it easier to seek help for their child rather than for themselves.(16) On the other hand, mothers with perinatal depression may feel unconfident about their children's health issues, thus bringing them more quickly to see their GP/Paed.(15) Non-specific baby-related complaints may reflect maternal distress (crying, irritability, feeding, or weight problems).(19) Another explanation could suggest that mothers of infants with more health problems may be more prone to depression.(16) However, in this study, we identified children who were born following maternal, perinatal depression. While children of mothers with perinatal depression significantly visit their GP/Paed more often, telehealth visits are less used by these mothers. This may also reflect the more soothing effect of a regular visit vs. the distant and technical telehealth visit.

Higher rates of visits to child-development clinics may result from several factors. Children of mothers with perinatal depression show higher rates of developmental problems, including cognitive, emotional, and language development.(30) Furthermore, it may be related to the more worried mother as a reflection of her depression.

Minorities in Israel, such as Arabs and Orthodox Jewish populations, were shown to visit the GP/Paed less frequently, in both regular visits and telehealth. Orthodox Jewish children also received fewer antibiotic prescriptions during the first two years of life. As there are no restrictions to consumption for these population groups, these findings may be explained in several aspects. As these populations tend to have larger families, with more children than the average Israeli family,(31,32) they may be more experienced with raising children and deal with health problems. These populations also have a high level of community support that may help when minor health problems arise.

CONCLUSION

This study shows higher health services utilisation among children of mothers with perinatal depression, including GP/Paed visits, hospital admissions, and child-development clinics. This emphasizes the need to increase awareness of perinatal depression in mothers, thus reducing the burden of their children's health service utilisation. Further studies are needed to examine if increased awareness and early diagnosis of mothers' perinatal depression reduce the use of their children's health services.

Contribution Statement

LA conceptualized and designed the study protocol, made the acquisition, analysis and interpretation of data, drafted the manuscript, approved the final version to be published and agreed to be accountable for all aspects of the work.

JA designed the study protocol, made interpretation of data, revised the work critically for important intellectual content, approved the final version to be published and agreed to be accountable for all aspects of the work.

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Patient consent for publication: Not required.

Data Sharing Statement: Data are available upon reasonable request.

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Table 1. Demographic and clinical characteristics of children and mothers according to maternal, perinatal depression, defined by the Edinburgh Postpartum Depression Scale.

Characteristics	with perinatal depression n=593	without perinatal depression n=2,310
	N (%)	N (%)
Children		
sex		
Male	293 (49.4)	1,237 (53.5)
female	300 (50.6)	1,073 (46.5)
Mothers		
Age		
Mean ± SD[1]	33.4±0.24	32.8±0.12
Born in Israel		
yes	505 (85.2)	1,994 (86.3)
no	88 (14.8)	316 (13.7)
Smoking status		
yes	73 (12.3)	173 (7.5)
no	520 (87.7)	2,137 (92.5)
Children and mothers		
Living in a peripheral region		
yes	38 (6.4)	206 (8.9)
no	555 (93.6)	2,104 (91.1)
Population group		
Arab	49 (8.3)	169 (7.3)
Orthodox Jewish	30 (5.1)	126 (5.5)
Others	514 (86.7)	2,015 (87.2)
Socioeconomic status		
1-4	124 (20.9)	501 (21.7)
5-7	325 (54.8)	1,227 (53.1)
8-10	144 (24.3)	583 (25.2)

[1] Standard deviation

Table 2. Primary outcomes – children's healthcare service utilisation during the first two years of life, univariable analysis

Characteristics	with perinatal depression n=593	without perinatal depression n=2,310	Incidence Rate Ratio (95% confidence interval)
Number of Regular visits to general practitioner/paediatrician mean ± SD[1]	28.74 ± 0.60	26.8 ± 0.31	1.07 (1.02,1.13)
Number of telehealth visits to the GP/Paed mean ± SD	3.78 ± 0.26	3.91 ± 0.12	0.96 (0.83,1.12)
Emergency room visits (ever)	12 (2%)	37 (1.6%)	1.26 (0.66,2.42)
Hospital admissions (ever)	154 (26%)	502 (21.7%)	1.19 (1.00,1.43)
Visits to child development clinics (ever)	85 (14.3%)	252 (10.9%)	1.31 (1.03,1.68)
Number of prescriptions for antibiotics mean ± SD	2.49 ± 0.11	2.61 ± 0.06	0.95 (0.86,1.05)

[1] Standard deviation

Table 3. Regular visits to the General Practitioner/Paediatrician, Multivariable Analysis

Variable	Adjusted incidence rate ratio (95% confidence interval)
perinatal depression	
with	1.08 (1.03,1.13)
without	reference
Sex	
male	1.08 (1.04,1.12)
female	reference
Birth country	
Israel	1.06 (1.00,1.12)
Other	reference
Arab Background	
yes	0.86 (0.79,0.94)
no	reference
Orthodox Jewish Background	0.76 (0.69,0.84)
yes	reference
no	
Age	0.99 (0.99,1.00)
Socioeconomic status	
1-4 (low)	1.02 (0.96,1.08)
5-7	reference
8-10 (high)	0.90 (0.86,0.95)

Table 4. Telehealth Visits to the General Practitioner/Paediatrician, Multivariate Analysis

Variable	Adjusted incidence rate ratio (95% confidence interval)
perinatal depression	
with	0.95 (0.82-1.10)
without	reference
Living in a peripheral region	
yes	0.75 (0.60-0.93)
no	reference
Arab Background	
yes	0.21 (0.16-0.29)
no	reference
Orthodox Jewish Background	0.18 (0.12-0.25)
yes	reference
no	
Age	1.01 (1.00-1.02)
Socioeconomic status	
1-4 (low)	0.56 (0.46-0.68)
5-7	reference
8-10 (high)	0.99 (0.86-1.14)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	7-8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-10
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Maternal Perinatal Depression and Health Services Utilisation in the First Two Years of Life: a cohort study

Limor Adler[1,2], MD, Joseph Azuri[1,2], MD MHA

Affiliations: [1]Maccabi Healthcare Services, Israel; and [2]Tel Aviv University, Tel Aviv, Israel

Corresponding Author: Limor Adler, Department of family medicine, Maccabi Healthcare Service, 27 Hamered Street, Tel Aviv, Israel, adler_l@mac.org.il.

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ABSTRACT

Objectives Maternal perinatal depression is a common phenomenon, influencing infants' development. Studies have shown an inconsistent association between perinatal depression and healthcare resource utilisation.

This study aimed to assess whether perinatal depression in mothers is associated with their infants' healthcare utilisation, during the first two years of life.

Design A cohort study based on computerized medical records.

Setting Nationwide primary care clinics in the second largest health maintenance organization in Israel.

Participants 593 children of women with depression (the exposed group) and 2,310 children of women without depression.

Primary and secondary outcome measures Primary outcome variables included general practitioner/paediatrician (GP/Paed) visits (regular and telehealth), emergency room (ER) visits, hospital admission rates and child-development clinic visits. Secondary outcomes included antibiotic use and anaemia status. The exposure variable, perinatal depression, was based on Edinburgh Postnatal Depression Scale (EPDS). A score of ≥10 was classified as depression.

Results Multivariable analysis of the number of regular visits and telehealth to the GP/Paed showed an adjusted incidence rate ratio (aIRR) of 1.08, 95% CI 1.03,1.13 and aIRR 0.95, 95% CI 0.82,1.10, respectively. Children of mothers with perinatal depression had more hospital admissions (aIRR 1.21, 95% CI 1.01,1.46) and more visits to child development clinics (aIRR 1.33, 95% CI 1.04,1.70). There was a non significant increase in ER visits (IRR 1.26, 95% CI 0.66,2.42), antibiotics prescriptions (IRR 0.95, 95% CI 0.86,1.05) and anaemia status (IRR 0.93, 95% CI 0.72,1.20)

Conclusion This study shows higher health services utilisation among children of mothers with perinatal depression, including regular GP/Paed visits, hospital admission rates, and child-development clinics.

Strengths and limitations of this study

- The dataset was based on a nationwide cohort, using electronic files of all patients in Maccabi Healthcare Services (MHS), the second largest health maintenance organization (HMO) in Isarel.
- The length of follow up (2 years) allowed us to explore long outcomes on children of mothers with perinatal depression.
- For the exposure variable, perinatal depression, we have used a validated tool, commonly used in studies of this field, the Edinburgh Postnatal Depression Scale (EPDS).
- Not all women filled the EPDS in MHS, however, women who did and did not fill the EPDS were similar in most aspects, reducing the impact of selection bias.
- The EPDS is a screening tool and not a diagnostic tool, leading to a non-differential misclassification bias.

INTRODUCTION

Perinatal depression is a common phenomenon affecting mothers with a reported global pooled prevalence of 17.7% and significant heterogeneity, ranging from 3% in Singapore and 38% in Chile.(1) In a recenet survey conducted by the CDC, about 13% of women in the United States, reported depressive symptoms after birth.(2) During the perinatal period, women's mental health may impact their functioning, parenting capability, and the health and well-being of their children(3). There are many possible influences on the infant's development, including bonding and attachment,(4,5) cognitive,(6–9) emotional,(10) and language development,(11) including Intelligence Quotient level.(12)

Parental mental health was shown to affect the healthcare resource utilisation of the child. There is an association between parental depression and a higher rate of specialty consultant visits, emergency department visits, hospital admissions, and general practitioner/paediatrician (GP/Paed) visits.(13,14) Timing of depression is associated with higher utilisation of primary health care services, with the strongest association with recent depression.(15)

Several studies examined the association between perinatal depression and healthcare resource utilisation. Most studies showed an association between perinatal depression and higher rates of non-routine visits (sick / emergency visits) to the GP/Paed,(14–20) emergency room (ER) visits,(21) hospital admission rates,(19,21) specialist consultations, and pharmacy claims.(21) Controversy exists regarding the association between well-child visits and perinatal depression; while several studies found perinatal depression associated with decreased well-child visits,(18) others did not.(20,22) Anderson et. al did not find any association between perinatal depression and health care utilisation.(23) This might be explained by the substial difference between the depressed and not depressed mothers, and

because health care utilisation was based on self-report, which might have been subjected to measurement error.

An association was found between antidepressant use during pregnancy and higher rates of infant GP/Paed visits, specialist visits, and hospital admissions.(24) Screening for postpartum depression in paediatric emergency departments showed high rates of maternal depression.(25,26) (23)A recent study showed higher total healthcare costs in children of mothers with perinatal depression during the first two years of life compared to children of mothers without perinatal depression.(21)

This study aimed to assess whether perinatal depression in mothers is associated with their infants' healthcare utilisation in the first two years of life. Variables included GP/Paed visits (regular and telehealth), ER visits, hospital admissions, child-development clinic visits and antibiotic use. Haemoglobin at the age of 12 months was also assessed to evaluate anaemia (checking haemoglobin levels at this age is recommended for all children by Israeli health policy).

METHODS

Study design and setting

This cohort study is based on computerized electronic medical records data of Maccabi Healthcare Services (MHS), the second-largest health maintenance organization (HMO) in Israel, covering 2.8 million people nationwide. In a previous study, we identified all women who filled the Edinburgh Postnatal Depression Scale (EPDS) during 2015-2016 (n=27,520), estimated 70% of all women who went to mother and child clinics in MHS. Nursing staff were responsible for delivering the EPDS to women. A score of 10 or above was classified as perinatal depression. (27) In the current study, we have followed the infants of mothers with or without depression according the to EPDS until they reached the age of 2 years old.

All children born to women with perinatal depression (EPDS≥10) were defined as the exposed group. Children of mothers with an EPDS score of 9 or below were considered as the unexposed group. The sample of children were chosen with a 4:1 ratio by stratified random sampling (for each child in the exposed group, 4 children with the same age of mother and socioeconomic status [SES] were chosen randomly).

Variables

The exposure variable, perinatal depression, was based on the EPDS as recorded for each women in her electronic file. The EPDS is a validated, widely used scale, that was designed specifically to assess perinatal depression.(28,29) The EPDS comprises 10 questions that access information about the respondent's mood and depressive symptoms during the 7 days preceding its administration. The response to each question is scored 0 – 3; thus, the highest possible score is 30. In this study, a score of _10 or above was classified as depression. Women filled the EPDS during pregnancy and until 9 weeks postpartum. If filled twice (antenatal and postpartum), the lower score was taken to ensure a conservative estimate. Among the women who filled the questionnaire, we know the timing for 77.9%; 29.9% filled the questionnaire during pregnancy and 48% filled the questionnaire after delivery. For those who filled the questionnaire after delivery, the median number of days after delivery was 35. Women who did not fill the EPDS were excluded from this study. Women who did and did not fill the EPDS were similar in age and similar proportions lived in the periphery of the country.

Outcome variables for healthcare services utilisation in the first 2 years of life were number of visits to the GP/Paed (both regular and telehealth), visits to the ER (direct or with refereal), hospital admissions, child-development clinic visits (a referral from the GP/Paed is mandatory) and antibiotic use. Anaemia status was measured at 12 months old, as it is recommended in Israel to check anaemia status for every child at this age. Anaemia was

defined as a haemoglobin level of 10.5 mg/dL or below. We also collected maternal data: age, periphery residence index, SES, population group (Arab, Orthodox Jew, other), and smoking status.

SES is a scale measuring socio-economic status from 1 (lowest) to 10 (highest). It is defined by the Israel bureau of statistics by address. It was grouped to three levels: lower (1-4) and higher (8-10), while the middle group (5-7) was used as a reference group. Periphery residence index is also bases on patients' addresses. Sociodemographic variables exist for all women in the database, since they are inserted automatically, and are not filled by demand from the patient. Data was collected anonymously from the electronic database of MHS.

Sample size

According to MHS data, children visit their GP/Paed once every 1-2 months during the first two years of life (including regular visits and telehealth). The sample size was calculated to be 192 children in the exposed group and 767 in the unexposed group, assuming a difference of one visit (from 24 to 25 visits), with a significance level of 5%, 80% power, and 1:4 ratio between the two groups. However, in the current study we included all eligible children of women who filled the EPDS questionnaire, therefore the actual sample was much higher.

Statistical analysis

Descriptive statistics were calculated using mean and standard deviation for continuous variables and percentages for categorical variables. Univariable and multivariable negative binomial models were constructed (with sample based estimation of the overdispersion parameter) to test the effect of perinatal depression and other potential predictors of healthcare resource utilisation. Akaike's Information Criterion (AIC) was used for model selection between models that were significant according to the omnibus Likelihood Ratio test.

Ethics statement

The local ethics committee (IRB) of MHS approved the study, ID 0022-19-MHS.

Patient and public involvement

No patients involved.

RESULTS

Descriptive statistics

Data were collected from the electronic records of MHS for 593 children of women with depression (the exposed group) and 2,310 children for the unexposed group (negative EPDS, no perinatal depression) matched by maternal age and SES. The total study population consisted of 2,903 children. Both groups were similar in sex distribution, mothers' country of birth, and religious group (Arab or orthodox Jewish) (Table 1). Mothers with perinatal depression were more likely to smoke during pregnancy (relative risk 1.51, 95% CI 1.19,1.94).

Univariable analysis

In a univariable analysis, children of women with perinatal depression had more regular visits to their GP/Paed (incidence rate ratio (IRR) 1.07, 95% CI 1.02,1.13, p value 0.005) but fewer telehealth visits (IRR 0.96, 95% CI 0.83,1.12, p value 0.653). They had more ER visits (IRR 1.26, 95% CI 0.66,2.42, p value 0.482), hospital admissions (IRR 1.19, 95% CI 1.00,1.43, p value 0.053) and visits to child development clinics (IRR 1.31, 95% CI 1.03,1.68, p value 0.03), but recieve less antibiotics prescriptions (IRR 0.95, 95% CI 0.86,1.05, p value 0.313) and have less anaemia (IRR 0.93, 95% CI 0.72,1.20, p value 0.572) (Table 2).

Multivariable analysis

Multivariable analysis showed that children of mothers with perinatal depression have more regular visits to the GP/Paed (adjusted IRR [aIRR] 1.08, 95% CI 1.03,1.13, p value 0.002) (figure 1). Arab or orthodox Jewish children were less likely to go to their GP/Paed (aIRR

0.86, 95% CI 0.79,0.94, p value 0.001 and aIRR 0.76, 95% CI 0.69,0.84, p value <0.001 respectively). Males and children of mothers who were born in Israel were more likely to go to their GP/Paed (aIRR 1.08, 95% CI 1.04,1.12, p value < 0.001 and aIRR 1.06, 95% CI 1.00,1.12 p value 0.039 respectively). In contrast, no difference was demonstrated for telehealth visits for children born to mothers with perinatal depression (aIRR 0.95, 95% CI 0.82,1.10, p value 0.491) (figure 2). Children of mothers who live in the periphery or are Arab or orthodox Jewish were less likely to use this method of communication with their GP/Paed (aIRR 0.75, 95% CI 0.60,0.93, p value 0.009; aIRR 0.21, 95% CI 0.16,0.29, p value < 0.001; aIRR 0.18, 95% CI 0.12,0.25, p value < 0.001respectively).

Three factors were found significant in hospital admissions; Children of mothers with perinatal depression were more likely to be admitted to the hospital (aIRR 1.21, 95% CI 1.01,1.46, p value 0.034). Lower rates of admissions were recorded for females (aIRR 0.82, 95% CI 0.70,0.96, p value 0.014) and children of older mothers (aIRR 0.98, 95% CI 0.97,0.99, p value 0.026).

For child development clinic visits, two significant factors were found; children of mothers with perinatal depression and males had more of these visits, aIRR 1.33, 95% CI 1.04,1.70, p value 0.024 and aIRR 1.30, 95% CI 1.05,1.62, p value 0.016 respectively.

For the number of prescriptions for antibiotics, perinatal depression was not found significant in the multivariate analysis. Males and Jewish orthodox background were less likely to get prescriptions (aIRR 0.83, 95% CI 0.77,0.89, p value < 0.001, and aIRR 0.71, 95% CI 0.59,0.85, p value < 0.001, respectively). Children of mothers born in Israel were more likely to get prescriptions (aIRR 1.12, 95% CI 1.01,1.26, p value 0.05). Children from lower SES groups were more likely to get prescriptions, and children from higher SES groups were less likely to get prescriptions (aIRR 1.18, 95% CI 1.06,1.31, p value 0.004 and aIRR 0.83, 95% CI 0.75,0.91, p value < 0.001 respectively).

DISCUSSION

Main findings

This study suggests that perinatal depression affects children's health care utilisation from birth to 2 years old. These children more frequently visit their GP/Paed's and child development clinics and have higher hospital admission rates. There was also a non significant increase in ER visits. However, there was no significant difference in the rates of telehealth visits or the number of antibiotic prescriptions issued.

Strengths

The strengths of the study include the dataset which is based on a nationwide cohort, using electronic files of all patients in MHS, the second largest HMO in Isarel. All HMOs in Israel have fully computerized healthcare systems, and therefore sociodemogrphic data were available for all participants in the study. The length of follow up allowed us to explore long outcomes on children of mothers with perinatal depression. For the exposure variable, perinatal depression, we have used a validated tool, commonly used in studies of this field.

Weaknesses

The sample was based on the filled EPDS questionnaires in the electronic database of MHS. Not all women filled the EPDS. However, women who did and did not fill the EPDS were similar in most aspects(27) such as age (33.2±5.63 vs. 32.4±6.17, respectively) or women who live in the periphery (8% vs. 7.5%, respectively). This similarity reduces the impact of selection bias. Secondly, the EPDS is a screening tool and not a diagnostic tool, leading to a non-differential misclassification bias. Thirdly as this study is based on electronic data mining, information bias may exist, due to missing data such as private visits, outside the HMO. However, this is not likely, as in Israel, GP/Paed visits are fully reimbursed.

Interpretation

In this study, we report an increase of 8% in the number of regular visits to the GP/Paed by children of mothers with perinatal depression. Many studies have differentiated between sick/emergency visits and well-child visits. While the first is increased for children of mothers with perinatal depression in most studies the second is more controversial. In this study, we could not differentiate between the two visit types. In addition to frontal visits, we also examined telehealth visits. To our knowledge, this is the first study that examined this type of visits in the context of health services utilisation. We report no significant difference for telehealth visits of children born to mothers with or without perinatal depression.

We did not have data about parity and the place of the child in relation to his or hers siblings. This might be an important variable that could confound the findings.

Kenneth et al. suggested the excessive use of healthcare services may be a sign of help-seeking behavior of the mother or a sign of anxiety to the well-being of her child.(17) It has been suggested that some women might find it easier to seek help for their child rather than for themselves.(16) On the other hand, mothers with perinatal depression may feel unconfident about their children's health issues, thus bringing them more quickly to see their GP/Paed.(15) Non-specific baby-related complaints may reflect maternal distress (crying, irritability, feeding, or weight problems).(19) Another explanation could suggest that mothers of infants with more health problems may be more prone to depression.(16) However, in this study, we identified children who were born following maternal, perinatal depression. While children of mothers with perinatal depression significantly visit their GP/Paed more often, telehealth visits are less used by these mothers. This may also reflect the more soothing effect of a regular visit vs. the distant and technical telehealth visit.

Higher rates of visits to child-development clinics may result from several factors. Children of mothers with perinatal depression show higher rates of developmental problems, including

cognitive, emotional, and language development.(30) Furthermore, it may be related to the more worried mother as a reflection of her depression.

Minorities in Israel, such as Arabs and Orthodox Jewish populations, were shown to visit the GP/Paed less frequently, in both regular visits and telehealth. Orthodox Jewish children also received fewer antibiotic prescriptions during the first two years of life. As there are no restrictions to consumption for these population groups, these findings may be explained in several aspects. We hypothesize that as these populations tend to have larger families, with more children than the average Israeli family,(31,32) they may be more experienced with raising children and deal with health problems. These populations also have a high level of community support that may help when minor health problems arise. However these assumptions should be investigated in future studies.

CONCLUSION

This study shows higher health services utilisation among children of mothers with perinatal depression, including GP/Paed visits, hospital admissions, and child-development clinics. This emphasizes the need to increase awareness of perinatal depression in mothers, thus reducing the burden of their children's health service utilisation. Further studies are needed to examine if increased awareness and early diagnosis of mothers' perinatal depression reduce the use of their children's health services.

Contribution Statement

LA conceptualized and designed the study protocol, made the acquisition, analysis and interpretation of data, drafted the manuscript, approved the final version to be published and agreed to be accountable for all aspects of the work.

JA designed the study protocol, made interpretation of data, revised the work critically for important intellectual content, approved the final version to be published and agreed to be accountable for all aspects of the work.

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Table 1. Demographic and clinical characteristics of children and mothers according to maternal, perinatal depression, defined by the Edinburgh Postpartum Depression Scale.

Characteristics	with perinatal depression n=593	without perinatal depression n=2,310
	N (%)	N (%)
Children		
sex		
Male	293 (49.4)	1,237 (53.5)
female	300 (50.6)	1,073 (46.5)
Mothers		
Age		
Mean ± SD[1]	33.4±0.24	32.8±0.12
Born in Israel		
yes	505 (85.2)	1,994 (86.3)
no	88 (14.8)	316 (13.7)
Smoking status		
yes	73 (12.3)	173 (7.5)
no	520 (87.7)	2,137 (92.5)
Children and mothers		
Living in a peripheral region		
yes	38 (6.4)	206 (8.9)
no	555 (93.6)	2,104 (91.1)
Population group		
Arab	49 (8.3)	169 (7.3)
Orthodox Jewish	30 (5.1)	126 (5.5)
Others	514 (86.7)	2,015 (87.2)
Socioeconomic status		
1-4	124 (20.9)	501 (21.7)
5-7	325 (54.8)	1,227 (53.1)
8-10	144 (24.3)	583 (25.2)

[1] Standard deviation

Table 2. Primary outcomes – children's healthcare service utilisation during the first two years of life, univariable analysis

Characteristics	with perinatal depression n=593	without perinatal depression n=2,310	Incidence Rate Ratio (95% confidence interval)	P value
Number of Regular visits to general practitioner/paediatrician mean ± SD[1]	28.74 ± 0.60	26.8 ± 0.31	1.07 (1.02,1.13)	0.005
Number of telehealth visits to the GP/Paed mean ± SD	3.78 ± 0.26	3.91 ± 0.12	0.96 (0.83,1.12)	0.653
Emergency room visits (ever)	12 (2%)	37 (1.6%)	1.26 (0.66,2.42)	0.482
Hospital admissions (ever)	154 (26%)	502 (21.7%)	1.19 (1.00,1.43)	0.053
Visits to child development clinics (ever)	85 (14.3%)	252 (10.9%)	1.31 (1.03,1.68)	0.03
Number of prescriptions for antibiotics mean ± SD	2.49 ± 0.11	2.61 ± 0.06	0.95 (0.86,1.05)	0.313

[1] Standard deviation

Figure 1. Regular visits to the General Practitioner/Paediatrician, Multivariable Analysis

Figure 2. Telehealth Visits to the General Practitioner/Paediatrician, Multivariate Analysis

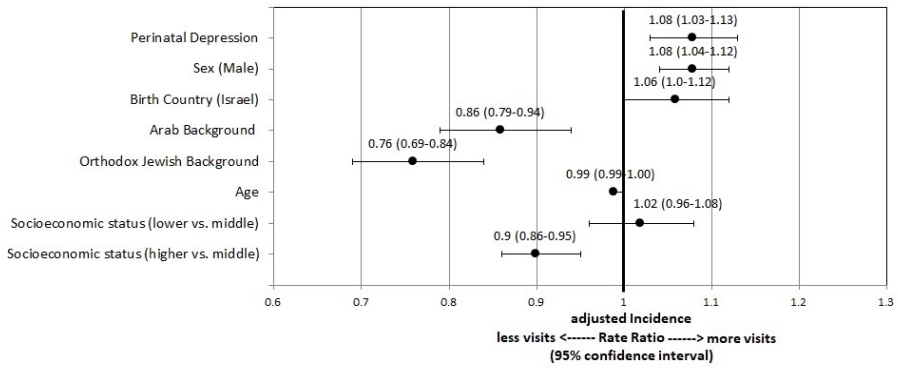

Figure 1. Regular visits to the General Practitioner/Paediatrician, Multivariable Analysis

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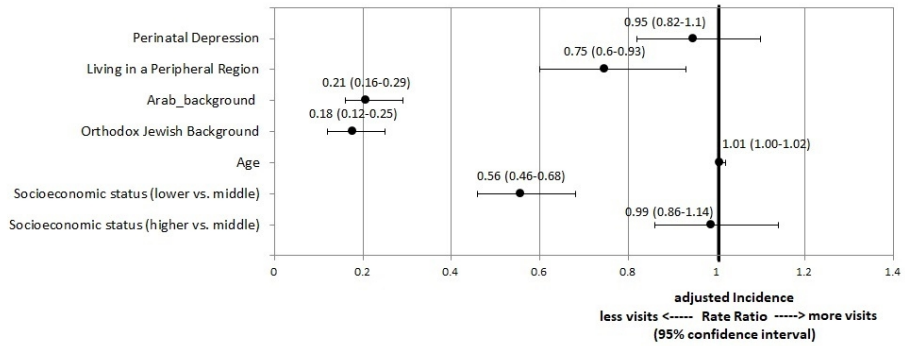

Figure 2. Telehealth Visits to the General Practitioner/Paediatrician, Multivariate Analysis

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	7-8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-10
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.