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Decreased fetal movements: Perinatal and long-term neurological outcomes

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ABSTRACT

Background: While maternal perception of decreased fetal movements during advanced stages of pregnancy may be an indicator for adverse perinatal outcome, the long-term neurological outcome of offspring of affected pregnancies remains largely unknown.
Objective: To examine whether maternal complaint of decreased fetal movements is associated with adverse perinatal outcomes, and to assess the implications of decreased fetal movements on long-term neurological morbidity of the offspring.
Study design: A single center cohort analysis including deliveries between the years 1991–2014 was conducted. The association between decreased fetal movements and adverse perinatal outcome was evaluated using a general estimation equation (GEE) multivariable analyses. Incidence of hospitalizations (up to age 18 years) due to various neurological conditions was compared between offspring of affected pregnancies, and those who were not, using a Kaplan-Meyer survival curve. A Cox proportional hazards model was used to control for confounders.
Results: 439 (0.18%) of 242,342 deliveries included in this study were accompanied by maternal complaint of decreased fetal movements. Perinatal outcome was comparable between the groups, with no cases of perinatal mortality observed among the exposed group. Total neurological-related hospitalization rate of the offspring, as well as hospitalizations due to movement disorders, were higher among the exposed group (Kaplan-Meyer log-rank test $P < 0.05$). This association between decreased fetal movements and increased long-term neurological hospitalization proved to be independent of potential confounders with an adjusted hazard ratio of 1.54 (95% CI 1.0–2.37).
Conclusion: Maternal complaint of decreased fetal movements does not predict adverse perinatal outcome but is associated with an elevated risk for long-term neurological morbidity of the offspring.

Introduction

Fetal activity begins early in gestation and becomes more pronounced throughout pregnancy. [1,2] By term, the number of fetal movements may exceed 30 per hour [3]. Spontaneous activity reflects the maturity of the regulatory systems involved in movement coordination, as well as their adequate oxygenation. When subjected to mild hypoxemia, the fetus may decrease activity in favor of blood flow redistribution. Severe hypoxemia accompanied by diminished activity may be a harbinger of impending fetal death [4–7].

Women begin to notice fetal movement at around 16 weeks of gestation with favorable accuracy. [1,8] Adequate perception of activity is an indicator of fetal wellbeing whereas abnormal degree of movement raises concern for fetal compromise [3]. Thus, while there is no consensus for the optimal definition of decreased fetal movements (DFM) [9], women are encouraged to report decrease of them [10,11].

Studies that have addressed the clinical significance of DFM have had inconsistent findings. Apart from increased risk of stillbirth, [12,13] DFM has been associated with growth restriction, preterm birth, abnormal Doppler studies, elevated rates of cesarean delivery, poor Apgar scores and neonatal seizures [14–17]. Consistent with these is abnormal placental morphology discovered among women with DFM [18].

Contrarily, others have argued that obstetric outcomes are not different from those without complaint of DFM. [19] And indeed, the majority of women presenting with DFM will have normal pregnancy outcomes [3].

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Given these conflicting pieces of evidence and lack of follow-up studies, we have sought to further assess the relationship between DFM and perinatal outcomes, as well as to examine the neurodevelopmental sequala of the offspring.

Materials and methods

This single-center cohort analysis included singleton pregnancies of women who delivered between the years 1991–2014 at Soroka University Medical Center (SUMC). SUMC is the second largest public hospital in Israel and is the only hospital in the Negev (which extends over Israel's southern region) that serves its entire population of over 1 million residents, [20] which is comprised of various ethnicities and socioeconomical backgrounds [21]. The institutional review board (Soroka University Medical Center IRB Committee) approved this study in accordance with the provisions of the Declaration of Helsinki.

The study had two main objectives. One was to assess the perinatal outcomes of pregnancies accompanied by maternal complaint of 'decreased fetal movements' (DFM) during the late second and third trimester of pregnancy. The second was to examine whether offspring of these pregnancies had higher prevalence of neurological morbidity years thereafter. Included in the exposed group were women who presented to SUMC during the late second or third trimester of pregnancy complaining of subjective feeling of DFM, whether for a single transient period of time, or as a chronic complaint, and for which they have been thoroughly evaluated according to standardized protocols (e.g., physical examination, nonstress test, ultrasound assessment of fetal biometry, amniotic fluid volume and growth, and as-indicated Doppler velocimetry). Findings at initial evaluation, as well as gestational age and the presence of risk factors for stillbirth guided further management of these pregnancies (e.g., labor induction for term pregnancies, expectant management for low-risk preterm pregnancies). We excluded multiple gestation pregnancies, pregnancies without prenatal care, and pregnancies of fetuses with major congenital malformations. Data extracted from the database included maternal demographic characteristics, obstetrical data, short-term pregnancy complications, and immediate neonatal outcome. In addition, we assessed the first hospitalization of the offspring up to the age of 18 years due to any neurological diseases (pre-defined according to the International Classification of Diseases; Appendix 1), irrespective of any previous non-neurological related hospitalizations. Follow-up time was calculated from birth to an event, or until censored. Censoring occurred in case of death (during hospitalization, other than neurological-related), at age 18 (which was calculated for each child based on date of birth) or at the end of data availability (January 2014).

Data were collected from two complementary databases that were linked and merged at the individual level (i.e. the identification number of each participant): the computerized perinatal database of the Obstetrics and Gynecology Department, and the computerized hospitalization database of the SUMC ("SUMC Demog-ICD9"). The perinatal database consists of information recorded immediately after delivery by the obstetrician. This information is thoroughly revised by a medical secretary prior to entering the database, thus maximizing its scientific reliability. Coding is completed after assessing medical prenatal care records as well as routine hospital documents. The SUMC Demog-ICD9 database contains demographic characteristics and ICD-9 codes for all diagnoses made during any medical encounter within SUMC.

Statistical analyses

Exposed group was defined by maternal complaint of DFM during advanced stages of pregnancies. Categorical variables were described using frequencies and numerical distributions, and continuous variables that are normally distributed were described using mean and standard deviation. Differences between the comparison groups were assessed using t-test, Mann-Whitney test, or chi-squared test in accordance with variable type and its distribution. For the first study objective, we employed the General estimation equation (GEE) multivariable analysis to compare the risk for the composite outcome of low Apgar scores and perinatal mortality, with adjustment for maternal and gestational age. For the second objective, we compared incidence of hospitalizations between offspring of DFM-accompanied pregnancies, and those who were not. Kaplan-Meier survival curves were built, and the differences were analyzed using the Log rank test. Finally, Cox

Table 1
Demographical, obstetrical and perinatal characteristics of pregnancies with and without decreased fetal movements.

Characteristic	Decreased fetal movements (n = 439)	No decreased fetal movements (n = 243,243)	*P*-value[a]
Maternal age at index birth (years ± SD)	28.6 ± 5.8	28.2 ± 5.8	0.082
Primiparity (%)	38.7	23.6	<0.001
Maternal diabetes mellitus (%)	6.6	5.0	0.120
Hypertensive disorders of pregnancy (%)[b]	5.5	5.0	0.672
IVF pregnancy (%)[c]	4.8	1.1	<0.001
Polyhydramnios (%)	2.3	3.3	0.28
Oligohydramnios (%)	14.6	2.3	<0.001
Mean gestational age (weeks ± SD)	38.8 ± 2.51	39.1 ± 1.98	0.013
Preterm delivery (<37 weeks, %)	8.4	6.9	0.194
IUGR (%)[d]	4.8	1.8	<0.001
Induction of labor (%)	74.0	26.0	<0.001
Cesarean delivery (%)	34.9	13.5	<0.001
Apgar score < 7 at 1 min (%)	7.1	5.3	0.106
Apgar score < 7 at 5 min (%)	0.2	2.3	0.004
Umbilical arterial blood pH	7.34 ± 0.05	7.37 ± 1.06	0.93
Birthweight (grams ± SD)	3156 ± 525	3206 ± 511	0.042
SGA (%)[e]	4.3	4.6	0.761
Perinatal mortality (%)	-[f]	0.6	0.186

[a] Calculated using X [2] test for trends.
[b] Including chronic hypertension, gestational hypertension and preeclampsia.
[c] In-vitro fertilization.
[d] Intrauterine growth restriction defined as estimated fetal weight less than 10th percentile for gestational age.
[e] Small for gestational age defined as less than 5th percentile for gestational age.
[f] No cases of perinatal mortality were observed among pregnancies with decreased fetal movements.

proportional hazards model was applied to control for clinically relevant and significant confounders. To note, database considerations have limited our ability to account for some benign factors that can affect maternal perception of fetal activity such as placental location. All analyses were two-sided, and p values of less than 0.05 were considered statistically significant.

Results

During the data collection period of over two decades, 243,682 deliveries met the inclusion criteria. Of those, 439 (0.18%) were accompanied by maternal complaint of DFM. The demographic and perinatal characteristics of the two groups are presented in Table 1. DFM-associated pregnancies were more likely to be of nulliparous women, patients following IVF pregnancy, of shorter duration, complicated by intrauterine growth restriction and present with oligohydramnios ($p < 0.05$ in all). These pregnancies were also associated with higher rates of labor induction and cesarean section. Further evaluation of the subgroup of women who underwent abdominal delivery revealed higher prevalence of fetal distress among DFM-associated pregnancies (29.4% vs. 18.0; $p < 0.001$), whereas rates of other factors that are commonly associated with cesarean delivery (e.g. non-progressive labor, cord prolapse) were similar between groups (data not shown in table).

Perinatal outcome was comparable between the groups (other than lower Apgar scores at 5 min among infants *without* DFM). No cases of perinatal mortality were observed among the exposed group. GEE model controlling for maternal and gestational age revealed no association between DFM and the adverse perinatal outcome assessed, including low Apgar scores (adjusted OR = 1.28; 95% CI 0.88–1.86; p = 0.192; data not shown in a table).

Information regarding 242,342 deliveries out of the original study population was available for the long-term analyses. Concerning the long-term outcomes, neurological-related hospitalization rate was higher among infants of DFM pregnancies (4.8% vs. 3.1%; OR = 1.57, 95% CI 1.01–2.43; p = 0.044; Table 2). Specifically, hospitalization rate due to movement disorders (such as dystonia, tremor, cerebellar ataxia and various seizure disorders) was higher among the exposed group (3.2% vs. 1.8%; OR = 1.76, 95% CI 1.02–3.0; p = 0.036), with earlier age of diagnosis (first encountered after an average of 2.2 ± 1.2 follow-up years vs. 3.4 ± 3.8 years in non-DFM pregnancies; p = 0.001 ;data not shown in a table) but similar obstetrical characteristics such as pregnancy length and birth weight. The risk for autism spectrum disorder, cerebral palsy and other neurological conditions was comparable between the groups.

Likewise, higher cumulative incidence of total neurological-related hospitalizations and hospitalizations due to movements disorders specifically were observed using a Kaplan-Meyer survival curves (log rank p-value = 0.019 and 0.043 respectively; Fig. 1). The association between DFM and increased long-term neurological morbidity remained significant in the COX proportional hazards model controlling for gestational age and oligohydramnios (adjusted HR = 1.54; 95% CI 1.0–2.37, p = 0.048; Table 3).

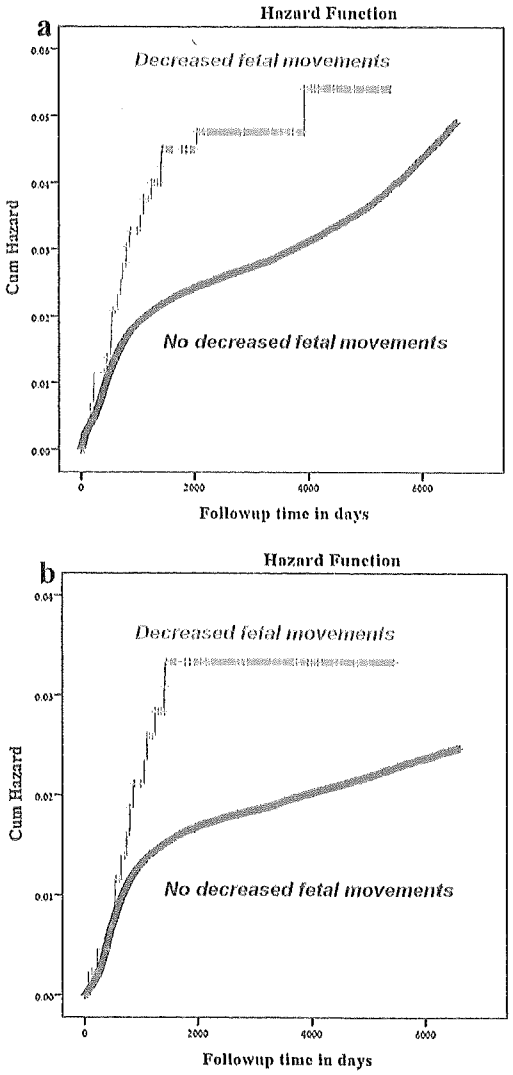

Fig. 1. (a) Cumulative incidence of total neurological hospitalizations in offspring according to reported fetal movements status (Log Rank p-value = 0.019). (b) Cumulative incidence of hospitalizations due to movement disorders in offspring according to reported fetal movements status (Log Rank p-value = 0.043).

Table 2
Neurological hospitalization of the offspring by fetal movement status.

Neurological condition	Decreased fetal movements (n = 439)	No decreased fetal movements (n = 241,903)	*P*-value
Autism spectrum disorders	0%	0%	>0.999
Eating disorders	0.2%	0.2%	0.546
Sleep disorders	0%	0%	>0.999
Movement disorders	3.2%	1.8%	0.036
Cerebral palsy	0%	0.1%	>0.999
Psychiatric morbidity	1.1%	0.5%	0.068
ADHD[a]	0.2%	0.1%	0.228
Developmental disorders	0%	0.1%	>0.999
Demyelinating & degenerative diseases	0%	0.1%	>0.999
Myopathy	0%	0.1%	>0.999
Other neurological morbidity[b]	0.2%	0.4%	>0.999
Total hospitalizations	4.8%	3.1%	0.044

[a] Attention deficit hyperactivity disorder.
[b] See Appendix 1.

Table 3
Cox hazards regression model for the prediction of neurological hospitalization of the offspring.

Characteristic	HR	95% CI	P-value
Decreased fetal movements	1.54	1.0–2.37	0.048
Gestational age (weeks)	0.93	0.92–0.94	< 0.001
Oligohydramnios	1.2	1.04–1.38	0.012

Discussion

The goal of our study was to examine the short and long-term implications of DFM reported during pregnancy. We have found that DFM was not associated with adverse perinatal outcomes but was linked to higher rates of neurological morbidity in the form of movements disorders, independent of gestational age of delivery.

Regarding the obstetrical characteristics, it is unsurprising that DFM was associated with lower parity order and IVF-pregnancies, as these less experienced mothers may become easily concerned about their fetal well-being. [22–24] Reduced amniotic fluid volume that can directly influence maternal perception of movements or infrequently suggest uteroplacental dysfunction, was also more typical for DFM-pregnancies, as reported previously. [25] In line with previous studies [15–17], DFM-pregnancies were characterized by several other high-risk features, including fetal growth restriction and earlier delivery, although not to the point of preterm birth. Inadequate placental function that impairs fetal growth and oxygenation can at times be evident to the parturient with decreased sensation of movements. While there are few studies that have compared the various approaches of obstetrical management, these pregnancies of suspected fetal compromise are subsequently more likely to be actively managed by labor induction or delivered by cesarean section [26]. This may reflect an attempt to prevent fetal death given no harmful consequences of labor induction at term [27]. While the possibility of imminent stillbirth should always remain the main concern when evaluating DFM [13], our study fortunately did not report any neonatal deaths or stillbirths among parturient with DFM, nor did the GEE revealed increased risk of adverse perinatal outcomes. These results are consistent with the finding of Scala and colleagues [28] that observed similar rates of stillbirth among women with recurrent episodes of DFM as compared to women with one episode of DFM, and may be attributed to modern methods of antepartum evaluation that help identify pathologic causes of DFM and guide risk-lowering pregnancy management [3,10]. It should be noted however that a standardized management protocol for DFM evaluated recently [26], have not proven beneficial in terms of reduction in the incidence of stillbirth or perinatal morbidity. Even though this abovementioned study was the largest of its kind, lack of effect of intervention on the risk of stillbirth may be attributed to the low predictive value of this prevalent complaint, as most women with DFM will have normal outcome to their pregnancy [3].

As for the long-term outcomes, we observed elevated rates of neurological morbidity due to movement disorders among offspring of DFM-pregnancies that were first presenting to the hospital at an earlier age.Besides the heterogenous group of genetic disorders that can affect various sites along the motor system pathway (e.g. spinal muscular atrophy, congenital myasthenic syndromes, congenital muscular dystrophies) and can manifest at first during pregnancy as DFM, [29,30] it is also plausible that DFM implies significant insult that gives rise to a neurological impairment years thereafter. One study that has evaluated the pregnancy predictors of childhood disability found that DFM reported by the mother conferred an increased risk of neurodevelopmental disability in infancy, mainly in the form of developmental delays [31]. Results of our study only partially parallel, as our exposed group of offspring have not been excessively affected by neurological conditions other than movement disorders. In any case, fetal growth restriction (that is itself associated with neurodevelopmental abnormalities [32]) and neuromuscular diseases are both major fetal pathologies that should be considered when evaluating women with DFM [3]. It thus appears that normal evaluation does not guarantee uneventful neurological development.

Our observational retrospective study has several limitations, including inability to establish causality, limited validation of clinical records and changes undertaken in hospitalization policy throughout the years. Another limitation relates to diagnosis of DFM, as it is based on subjective maternal perception, can be recurrent, persistent or of short duration (which may correlate with the severity of the underlying pathology), and may be influenced by benign conditions for which we could not account. [33] Moreover, because our follow-up data was comprised of neurological conditions that necessitated hospitalization, milder forms of morbidity that are dealt with in ambulatory settings were overlooked. Lastly, in our effort to examine the significance of DFM in a context of a seemingly normal pregnancy, we have excluded pregnancies with major fetal anomalies that are inherently associated with changes in movement patterns [30], thus biasing the results toward the null. The strengths of the study are a large cohort size, long follow-up duration and favorable generalizability owing to heterogenous group women and their offspring that are served by the only hospital of the area [23].

In conclusion, in our cohort of pregnancies DFM was not associated with adverse neonatal outcomes but was linked to higher rates of offspring hospitalization due to neurological morbidity, and due to movements disorders specifically. The clinical significance of this observation and appropriate investigational strategies are yet to be defined.

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Author contributions

Zamstein, Wainstock: Establishing scientific background, data analysis and interpretation, initial draft of manuscript, manuscript revision. Sheiner: Study concept and design, interpretation of results, critical revision of manuscript. All authors read and approved the final manuscript as submitted.

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Declaration of Competing Interest

The authors report no conflict of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ejogrb.2019.07.034.

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