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FULL-LENGTH ORIGINAL RESEARCH

Prevalence and trajectories of depressive symptoms in mothers of children with newly diagnosed epilepsy

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Summary

Purpose: To examine the prevalence, trajectories, and predictors of depressive symptoms (DS) in mothers of children with new-onset epilepsy.

Methods: A sample of 339 mothers was analyzed from the health-related quality of life in children with epilepsy study assessed four times during the first 24 months after diagnosis. Mothers' DS were measured using the Center for Epidemiological Studies Depression Scale. Trajectories of DS were investigated using group-based trajectory modeling, and maternal, child, and family factors were compared across groups using analysis of variance (ANOVA) and chi square tests. Multinomial logistic regression identified predictors of DS trajectories.

Key Findings: A total of 258 mothers completed the study. Prevalence of depression ranged from 30–38% across four times within the first 24 months after their child's diagnosis. Four trajectories of DS were observed: *low stable* (59%), *borderline* (25%), *moderate increasing* (9%), and *high decreasing* (7%). Using the *low stable* group as the reference group, the *borderline* group was younger, had worse family functioning, and fewer family resources; the *moderate increasing* group was younger, had children with cognitive problems, worse family functioning, and more family demands; and the *high decreasing* group had less education and children with lower quality of life.

Significance: Risk for clinical depression is common among mothers of children with new-onset epilepsy. These mothers are not homogenous, but consist of groups with different trajectories and predictors of DS. Child's cognitive problems was the strongest predictor identified; epilepsy severity did not predict DS trajectory. Health care professionals should consider routinely assessing maternal depression during clinic visits for pediatric epilepsy.

KEY WORDS: Depression, Family factors, Health-related quality of life, Latent class growth curve modeling, Longitudinal study.

Caring for a child with a chronic illness can be a significant source of stress for parents. Similar to other childhood chronic illnesses/disorders, the impact of epilepsy is not limited to the child having seizures, but affects all members of the family to a certain degree (Hoare, 1984; Hoare & Kerley, 1991; Thompson & Upton, 1992). Compared to families of healthy children, families of a child with epilepsy have been found to experience significantly more stress, anxiety, and restrictions in family life (Hoare & Kerley, 1991); higher levels of dissatisfaction with their social situation; lower levels of marital satisfaction and support (Thompson & Upton, 1992); and lower quality parent-child relationships and poor family adaptation (Rodenburg et al., 2005). Because mothers are most often primarily responsible for children's care (Gillespie & Primavera, 2000), they might be particularly at risk for psychological distress in response to their child's epilepsy, most notably depression (Shore et al., 1998; Lee et al., 2002).

In the last decade, six studies investigated depressive symptoms in mothers of children with epilepsy (Dunn et al., 1999; Shore et al., 2002; Baki et al., 2004; Rodenburg et al., 2006; Chiou & Hsieh, 2008; Wood et al., 2008). A recent systematic review of studies examining depressive symptoms in mothers of children with epilepsy showed that prevalence estimates vary widely, with between 12% and 49% of mothers scoring at or above the cutoffs for clinical depression based on self-report screening measures (Ferro & Speechley, 2009). Previous studies were affected by limitations in study design including a lack of prospective cohort studies, inclusion of nonrepresentative samples, and

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sampling procedures prone to selection bias. No study has examined maternal depressive symptoms prospectively and none has focused on mothers of children with newly diagnosed epilepsy.

Given the paucity of research in this area, the objectives of this paper were to: (1) estimate the prevalence of depressive symptoms among mothers of children with new-onset epilepsy at diagnosis and 6, 12, and 24 months after diagnosis; (2) identify trajectories of maternal depressive symptoms; and (3) examine predictors of depressive symptom trajectories.

Methods

Sample and data source

Data for this study came from the Health-related Quality of Life of Children with Epilepsy Study (HERQULES), a prospective cohort study designed to examine the determinants of health-related quality of life in children with epilepsy during the first 24 months post diagnosis. Pediatric neurologists across Canada seeing children with new-onset epilepsy approached parents of eligible patients about the study. Inclusion criteria were the following: new case of epilepsy (≥2 unprovoked seizures) in a child 4–12 years of age, in whom a diagnosis had not been confirmed previously, seen for the first time by a participating pediatric neurologist; and parent/caregiver, with sufficient English-language skills, who had been primarily responsible for the child's care for at least the past 6 months and continued to be for the duration of the study. Exclusion criteria were the following: diagnosis of epilepsy that had been previously confirmed by another physician; and diagnosis of other progressive or degenerative neurologic disorder (e.g., mental retardation) or other major comorbid nonneurologic disorders that would have an impact on quality of life (e.g., asthma requiring daily medication, renal failure). Parents who agreed to provide their address for the purpose of this research were mailed a letter describing the study and outlining what their participation would entail. Specifically, participants were asked to complete four mailed questionnaires designed for self-administration (time 1: after diagnosis [baseline], time 2: at 6 months, time 3: at 12 months, and time 4: at 24 months), as well as provide informed consent for their child's neurologist to complete a brief form providing relevant clinical information. Of the 456 eligible families approached to participate in HERQULES, 447 (98.0%) verbally consented. Of these, 374 (83.7%) completed the baseline survey. For this paper, only surveys completed by a child's mother (i.e., biological, adoptive, or foster mother) were used in the analysis [n = 339 (91.0%)]. Approval for HERQULES was obtained from all relevant research ethics boards across the country, and parents provided written consent.

Measures

Maternal depressive symptoms

Level of depressive symptoms in mothers was measured with the Center for Epidemiological Studies Depression Scale (CES-D), a 20-item questionnaire designed to assess depressive symptoms in the general adult population over the past week (Radloff, 1977). The scale includes 20 items that survey mood, somatic complaints, interactions with others, and motor functioning. A four-point Likert scale (0–3) is used to rate the frequency of symptoms experienced, ranging from ''rarely or none of the time (<1 day)'' to ''most or all of the time (5–7 days).'' The total score spans from 0–60, with a higher score indicating greater level of depressive symptoms. Individuals with a total score of ≥16 are typically identified as being at risk for clinical depression. Among community samples, internal consistency estimates for the CES-D ranged from 0.8–0.9 (Radloff, 1977) and in this sample, estimates ranged from 0.75–0.80.

Child health-related quality of life

Child health-related quality of life was reported by mothers using the quality of life in childhood epilepsy (QOLCE) (Sabaz et al., 2003). The QOLCE is a multifaceted, parent-report instrument for evaluating health-related quality of life of children with epilepsy aged 4–18 years. The QOLCE contains 76 items with 16 subscales spanning 7 domains of life function including physical activities, social activities, cognition, well-being, behavior, general health, and general quality of life (Sabaz et al., 2003). Items are rated on a five-point Likert scale, which is used to calculate the 16 subscale scores ranging from 0 (low functioning) to 100 (high functioning). The subscale scores are averaged to produce an overall health-related quality of life score. This measure has demonstrated good construct validity, internal consistency reliability, and sensitivity to epilepsy severity (Sabaz et al., 2000). The internal consistency reliabilities were excellent for all measurement occasions in this sample (0.92–0.94).

Epilepsy characteristics

Physicians completed a questionnaire documenting the clinical factors of each patient's epilepsy, including severity of epilepsy, seizure type and frequency, type of epilepsy syndrome, age at onset and diagnosis, medication information, and adverse effects. Neurologists were also asked to rate the presence of comorbidities using single-item measures, specifically, any behavior (0 = none to 3 = severe), cognitive (0 = none to 4 = severe), or motor problems (0 = none to 3 = severe). Severity of epilepsy was classified using the Global Assessment of Severity of Epilepsy (GASE), a single-item measure developed for HERQULES (Speechley et al., 2008). With the GASE, neurologists rate the overall severity of each child's epilepsy using a seven-point scale ranging from 1 = extremely severe to 7 = not at

all severe. The GASE was quick and easy to complete, demonstrated adequate validity, and high intrarater and interrater reliability (Speechley et al., 2008).

Family environment

Three aspects of the family environment (functioning, resources, and demands) were measured based on parent report. The Family Adaptability, Partnership, Growth, Affection, and Resolve (Family APGAR) was used to assess satisfaction with family relationships (Smilkstein, 1978). The Family APGAR is a five-item instrument where responses are based on a five-point Likert scale, ranging from 0–4 for each item, with higher scores indicating higher satisfaction with family functioning. The Family APGAR has been found to be valid and reliable in both the clinical and research settings with adults and children (Smilkstein, 1978; Smilkstein et al., 1982; Austin & Huberty, 1989). The internal consistency reliabilities ranged from 0.86–0.89 in this sample.

The Family Inventory of Resources for Management (FIRM) was utilized to assess resources available to aid families' adaptation to stressful events (McCubbin et al., 1996a). For this study, only two subscales (family mastery and health, extended family social support) were used, which have been found to be associated with adaptation to childhood epilepsy, (Austin et al., 1992). Scoring procedures for the FIRM involve summing all response values, which range from 0 (not at all) to 3 (very well), to provide a total FIRM score. The FIRM has demonstrated adequate reliability and validity properties (McCubbin et al., 1996a). Internal consistency reliabilities in this sample ranged from 0.91–0.93 for the Family Mastery and Health subscale and 0.44–0.54 for the Extended Family Social Support subscale.

Family demands were quantified using the Family Inventory of Life Events and Changes (FILE), which assesses the accumulation of simultaneous normal and nonnormal life events and changes in life events experienced by a family during the previous year (McCubbin et al., 1996b). There are 71 items in the FILE with the score computed by giving each ''yes'' response a score of one. Summing responses provides a score for each subscale and the total FILE score. The reliability and validity of the FILE is well-established (McCubbin et al., 1996b). As measured by Cronbach's α, the overall reliability of the FILE ranged from 0.98–0.99 in this sample.

Sociodemographic information was also collected including date of birth (mother and child), child gender, number of children in household, parents' marital and employment status, highest level of completed education, and total annual household income.

Perception of patient-centered care

A modified version of the patient perception of patient-centeredness (PPPC) questionnaire, based on the patient-centered model of care, was used to assess mothers' perceptions of the extent to which the health care services their child received were patient-centered (Stewart et al., 2004). Seven of the original 14 items were modified slightly to make them appropriate for parent-report by replacing ''your'' with ''your child's'' and ''you'' with ''your child.'' The PPPC is scored so that low scores correspond to positive perceptions. Interitem reliability has been found to be adequate for the PPPC, and evidence for construct validity was examined with a significant correlation with the measure of patient-centered communication (Stewart et al., 2000). In this sample, the internal consistency ranged from 0.77–0.86.

Statistical analysis

Univariable analyses used to describe maternal depressive symptoms at each time-point included descriptive statistics and frequency distributions. Bivariable analyses (*t*-test and chi square test) were used to compare mothers who completed the 24-month follow-up with those who did not complete the study. Trajectories of maternal depressive symptoms were investigated using group-based trajectory modeling (Nagin, 1999, 2005). Maternal, child, and family characteristics were compared across trajectory groups using analysis of variance for continuous variables and chi square tests for categorical variables. Multinomial logistic regression was conducted to identify predictors of depressive symptom trajectory using baseline data. Additional details of the statistical analyses are described in the Appendix.

Results

Sample characteristics

Of the 339 mothers in the study, 258 completed all four measurement occasions and 81 were lost during follow-up. Mothers who did not complete the study were more likely to be younger ($p = 0.0002$), unmarried ($p = 0.0040$), less educated ($p = 0.0122$), have lower household income ($p = 0.0191$), and more likely to have a child rated by his/her neurologist as having cognitive problems ($p = 0.0146$) at baseline compared to mothers who remained in the study (Table 1). In addition, those who were lost to follow-up had more depressive symptoms ($p = 0.0152$), fewer family resources ($p = 0.0206$), and more family demands ($p = 0.0211$) at baseline compared to those mothers who completed the study.

Mothers had a mean age of 37.7 (standard deviation 5.8) years at baseline. Approximately half of the children were male (52.2%). Children had a mean age of seizure onset of 6.9 (2.5) years and a mean age of 7.4 (2.4) years at baseline. Children had a mean score of 70.4 (13.4) on the QOLCE and the majority of children (58.7%) had ''a little severe'' or ''somewhat severe'' epilepsy severity score based on the GASE. Mean scores on family environment measures were as follows: Family APGAR, 14.0 (3.8); FIRM 50.1 (11.1);

Table 1. Sample baseline characteristics of mothers of children with new-onset epilepsy[a]

	Study sample	Completed follow-up	Lost to follow-up	t/χ^2	p-Value
N	339	258	81		
Maternal characteristics					
Age, years	37.7 (5.8)	38.4 (5.5)	35.6 (6.2)	3.73	0.0002
Marital status, %					
Not married	19.8	16.3	30.9	8.27	0.0040
Married[b]	80.2	83.7	69.1		
Employment status, %					
Not employed	9.5	7.8	15.2	5.26	0.1539
Employed	66.1	68.5	58.2		
Homemaker	22.9	22.6	24.1		
Student	1.5	1.2	2.5		
Education, %					
Primary school	11.5	8.5	21.0	10.91	0.0122
High school	20.9	20.2	23.5		
Technical training	13.6	14.3	11.1		
College/University	54.0	57.0	44.4		
Number of children	2.3 (0.9)	2.3 (0.9)	2.5 (1.0)	−1.67	0.0953
Depressive symptoms, CES-D	14.6 (10.6)	13.8 (10.4)	17.0 (10.4)	−2.44	0.0152
Child characteristics					
Age, years	7.4 (2.4)	7.5 (2.4)	7.4 (2.4)	0.23	0.8166
Sex, %					
Male	52.2	51.6	54.3	0.19	0.6632
Female	47.8	48.4	45.7		
Seizure type, %					
Generalized	38.6	37.3	42.9	0.77	0.3808
Partial	61.4	62.7	57.1		
Quality of life, QOLCE	70.4 (13.4)	71.1 (13.5)	68.2 (12.9)	1.64	0.1030
Epilepsy Severity, GASE	5.4 (1.2)	5.4 (1.1)	5.3 (1.3)	0.87	0.3845
Comorbidities, %					
Behavior problems	14.1	13.3	16.5	2.46	0.4835
Cognitive problems	13.6	10.2	24.3	12.41	0.0146
Motor problems	6.3	5.9	7.8	0.95	0.6234
Family characteristics					
Functioning, APGAR	14.0 (3.8)	14.1 (3.9)	13.4 (3.4)	1.54	0.1241
Resources, FIRM	50.1 (11.1)	50.9 (11.3)	47.6 (10.3)	2.33	0.0206
Demands, FILE	9.6 (6.5)	9.1 (6.2)	11.2 (7.4)	−2.34	0.0211
Perception of patient-centered care, PPPC	1.6 (0.5)	1.6 (0.5)	1.6 (0.5)	−0.17	0.8613
Annual household income, %					
<$20,000	7.7	5.7	14.3	13.50	0.0191
$20,000–39,999	13.5	12.1	18.2		
$40,000–59,999	21.2	22.6	16.9		
$60,000–79,999	18.2	16.5	23.4		
≥$80,000	37.2	40.7	26.0		
Unknown	2.2	2.4	1.3		

[a]Reported as mean (standard deviation), unless otherwise stated.
[b]Includes those in married and common-law relationships.

and FILE 9.6 (6.5). Additional baseline characteristics of the study sample are shown in Table 1.

Prevalence of depressive symptoms

Mothers' mean CES-D score was 14.6 (10.6) at baseline; 11.7 (9.5) at 6 months; 12.2 (9.7) at 12 months; and 12.0 (10.0) at 24 months. At baseline, 37.9% of mothers scored as being at risk for clinical depression. This proportion changed to 29.9% at 6 months, 31.5% at 12 months, and 29.5% at 24 months.

Trajectories of change in depressive symptoms

Based on model fit indices, a four- or five-group model was most appropriate. The BIC scores for the four- and five-group models were −15320.25 and −15227.58, respectively. The four-group model was adopted for the analysis not only in the interest of parsimony (i.e., most statistically efficient model), but also because the posterior probabilities of group membership were superior for the four-group model (0.84–0.96, mean 0.89) compared to the five-group model (0.82–0.91, mean 0.86).

Table 2. Parameter estimates for the four-group trajectory model of depressive symptoms in mothers of children with epilepsy during the first 24 months after diagnosis

Group	% Sample	Parameter	Estimate	Standard error	*t*	p-Value
1	59.3	Intercept	14.1	1.8	8.03	<0.0001
		Linear	−8.5	2.5	−3.38	0.0007
		Quadratic	2.8	1.0	2.76	0.0058
		Cubic	−0.3	0.1	−2.38	0.0173
2	25.1	Intercept	34.7	3.3	10.43	<0.0001
		Linear	−25.1	4.6	−5.48	<0.0001
		Quadratic	10.2	1.8	5.54	<0.0001
		Cubic	−1.2	0.2	−5.59	<0.0001
3	8.6	Intercept	32.1	1.8	17.43	<0.0001
		Linear	−9.9	1.5	−6.81	<0.0001
		Quadratic	2.0	0.2	8.36	<0.0001
4	7.1	Intercept	41.2	1.2	33.81	<0.0001
		Linear	−4.5	0.4	−12.61	<0.0001

Group 1 represents mothers with *low stable* depressive symptoms, Group 2 *borderline* symptoms, Group 3 *moderate increasing* symptoms, and Group 4 *high decreasing* symptoms.

Estimates for the four-group model parameters are shown in Table 2. Inspection of parameter estimates for the model revealed significant variation in the intercept across groups ($F = 25.05$, $p < 0.0001$). In other words, each group had a significantly different CES-D score at baseline. Groups one and two were observed to have two points of inflection (i.e., the point where the trajectory changes from increasing to decreasing or vice versa). Although it was more pronounced in group two, both groups were best modeled with the inclusion of a cubic term to represent time in order to capture these *S*-shaped trajectories. Group three had only one inflection point and was best modeled with the inclusion of a quadratic time term to capture the concave nature of the trajectory. Group four required the inclusion of a simple linear time term only, since the trajectory continued in one direction (i.e., decreasing). Fig. 1 depicts the four distinct trajectories of maternal depressive symptoms identified in the analysis. As indicated in Fig. 1, the predicted and observed trajectories appear to correspond well with each other, suggesting that the data fit the model well.

The first trajectory identified was one of consistently low levels of depressive symptoms (*low stable*). Almost two-thirds of the sample (n = 201, 59.3%) fell into this trajectory, with a mean CES-D score of 8.3 at baseline, which decreased to 7.2 at 24 months. The second trajectory included 25.1% (n = 85) of the sample and is described as having *borderline* symptoms. These mothers had variations in depressive symptoms during the 24-month follow-up that straddle the cut-off score (CES-D ≥ 16), indicating risk for clinical depression. The third trajectory (n = 29, 8.6%) described a group of mothers who had a *moderate increasing* symptom trajectory that was relatively stable during the first 12 months of follow-up, and then increased from 12–24 months. The fourth trajectory identified included mothers with a *high decreasing* trajectory (n = 24, 7.1%). The mean CES-D score at baseline in this group was 37.7, which decreased to 18.1 at 24 months. CES-D scores for each group during the 24-month follow-up are shown in Table 3.

Predictors of depressive symptoms trajectories

Maternal, child, and family characteristics were compared across trajectory groups and results are summarized in Table 4. Statistically significant overall effects were observed for maternal age ($p = 0.0001$); marital status ($p = 0.0008$); educational attainment ($p < 0.0001$); child health-related quality of life ($p < 0.0001$); and family functioning, resources, and demands ($p < 0.0001$). Mothers in the *low stable* group were more likely to have higher education, children with better health-related quality of life, and families with better functioning, more resources, and fewer demands compared to the other trajectory groups. In pairwise contrasts, mothers in the *low stable* and *borderline* group were significantly more likely to be married compared to both the *moderate increasing* and *high decreasing* group. Mothers in the *borderline* group were significantly more likely to have fewer family demands compared to both the *moderate increasing* and *high decreasing* groups. In addition, the *borderline* group had significantly higher educational attainment, better child health-related quality of life, and more family resources compared to the *high decreasing* group. Mothers in the *moderate increasing* group were significantly younger compared to the *low stable* group.

Predictors of depression symptom trajectory were examined with multinomial logistic regression. Odds ratios (OR) using the *low stable* group as the reference category are summarized in Table 5. Briefly, the *borderline* group was younger (OR = 0.53, p = 0.0284), had worse family functioning (OR = 0.65, p = 0.0101), and fewer family resources (OR = 0.50, p = 0.0003). The *moderate increasing* group was also younger (OR = 0.31, p = 0.0141), had children with cognitive problems (OR = 9.29, p = 0.0043), worse family functioning (OR = 0.50, p = 0.0202), and more family demands (OR = 4.00, p = 0.0013). The *high decreasing* group had less education (OR = 0.38, p = 0.0005) and lower QOLCE scores (OR = 0.42, p = 0.0148) compared to the *low stable* group.

Discussion

This study used group-based trajectory modeling, a robust statistical method, to identify trajectories of distinct subgroups within a population over time. Whereas traditional growth curve modeling is generally most useful for investigating research questions in which all individuals are hypothesized to change in a homogeneous trajectory over time (Raudenbush, 2001), some phenomena, such as

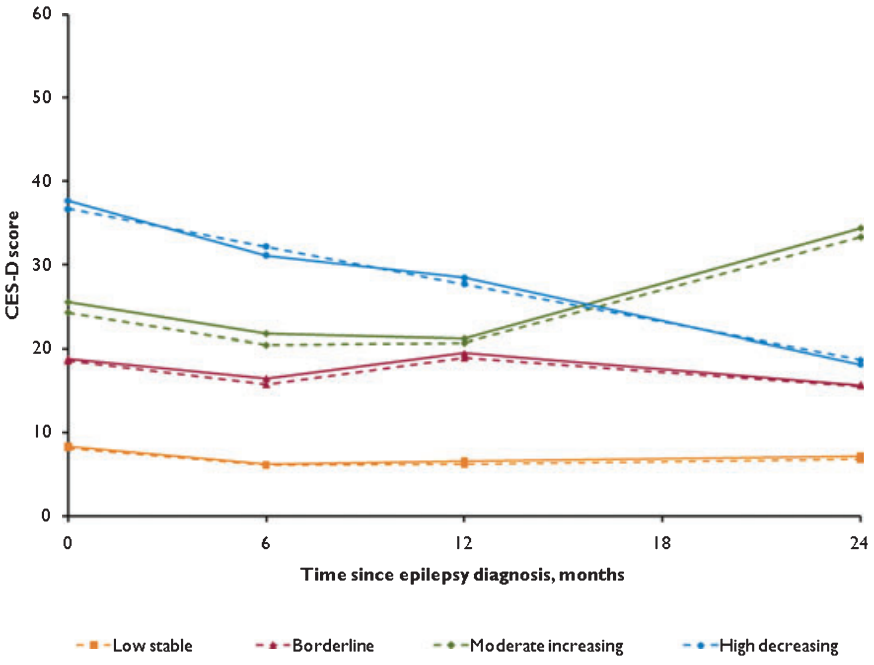

Figure 1.
Trajectories of maternal depressive symptoms during the first 24 months after having a child diagnosed with epilepsy. Solid lines depict observed trajectories (mean CES-D score) and dashed lines predicted trajectories.
Epilepsia © ILAE

Table 3. Maternal depressive symptoms over time, stratified by trajectory[a]

	Trajectory group					
Measurement occasion	Low stable	Borderline	Moderate increasing	High decreasing	*F*	p-Value
1 (baseline)	8.4 (5.5)	18.9 (6.6)	25.6 (7.8)	37.7 (7.1)	227.1	<0.0001[b]
2 (6 months)	6.2 (4.7)	16.5 (7.1)	21.8 (8.8)	31.1 (5.9)	162.5	<0.0001[b]
3 (12 months)	6.6 (4.7)	19.5 (7.7)	21.2 (8.7)	28.4 (10.7)	123.7	<0.0001[b]
4 (24 months)	7.2 (5.8)	15.7 (7.2)	34.4 (6.6)	18.1 (7.6)	132.1	<0.0001[c]

[a]Reported as mean (standard deviation).
[b]No significant difference between *borderline* and *moderate increasing* groups.
[c]No significant difference between *borderline* and *high decreasing* groups.

depressive symptomatology, may exhibit a multinomial pattern whereby interindividual variation may exist in both the magnitude and direction of change (Raudenbush, 2001; Nagin, 2005; Campbell et al., 2007). In such circumstances traditional growth curve modeling can mask significant differences and lead to erroneous inferences about changes in population over time. Therefore, group-based trajectory modeling that considers potential multinomial heterogeneity in change over time was implemented.

Approximately 90% of surveys were completed by a maternal primary caregiver, indicating that it is predominately mothers who assume the primary caregiving responsibility for children with epilepsy. This is consistent with previous child health reports in Canada, where it is the mother who performs the role of primary caregiving to children in most cases (Marshall, 2006). Findings describing the family environment in our sample of families with a child with epilepsy were similar to other samples of children with a chronic illness (McCubbin et al., 1996b), but less favorable compared to families of healthy children (Gardner et al., 2001). For example, in a study of families with healthy children aged 4–15 years, 95% scored above 10 on the Family APGAR, a measure of satisfaction with family functioning (Gardner et al., 2001), compared to only 81–85% in the current sample. The extent to which families have experienced an accumulation of life events in the past year, as measured by the FILE, was similar in the current sample compared to a sample of families with a child with diabetes (9.6 vs. 10.5) (McCubbin et al., 1996b).

Mothers' depressive symptoms, based on the CES-D and assessed at four times over the 24 months following the diagnosis of epilepsy, were significantly higher than those reported in a sample of mothers with a healthy child aged 4–10 years ($p = 0.0017$) (Gump et al., 2009). The proportion of mothers at risk for clinical depression ranged from 30–38% during the four measurement occasions. These results represent two-fold higher prevalence rates compared to mothers of healthy preschool children whose estimates

Table 4. Baseline characteristics of mothers of children with new-onset epilepsy, stratified by trajectory[a]

	Trajectory group						
	Low stable	Borderline	Moderate increasing	High decreasing	F/χ^2	p-Value	Pairwise contrasts
Maternal characteristics							
Age, years	38.7 (5.6)	37.1 (5.5)	34.2 (6.2)	35.7 (5.6)	6.99	0.0001	1 > 3
Married[b], %	85.5	80.0	62.1	58.3	16.76	0.0008	1 > 3, 4 2 > 3, 4
Employed, %	67.3	73.5	44.8	54.2	9.52	0.0231	
College/University, %	63.0	45.9	41.4	20.8	21.25	<0.0001	1 > 2–4 2 > 4
Child characteristics							
Age, years	7.6 (2.3)	7.2 (2.3)	7.0 (2.5)	7.9 (2.8)	1.04	0.3761	
Male, %	53.5	52.9	48.3	45.8	0.72	0.8886	
Partial seizures, %	61.0	56.1	71.4	69.6	2.81	0.4212	
Quality of life, QOLCE	73.6 (12.6)	68.4 (12.2)	65.7 (11.3)	56.4 (15.0)	14.86	<0.0001	1 > 2–4 2 > 4
Epilepsy severity, GASE	5.5 (1.2)	5.3 (1.2)	5.2 (1.2)	5.3 (1.0)	0.69	0.5603	
Comorbidities, %							
Behavior problems	10.1	18.3	20.7	26.1	7.65	0.0539	
Cognitive problems	5.9	19.5	25.0	17.4	9.25	0.0262	
Motor problems	4.5	9.8	10.7	4.4	3.78	0.2859	
Family characteristics							
Functioning, APGAR	15.1 (3.2)	12.6 (3.3)	12.4 (4.1)	10.8 (5.3)	20.05	<0.0001	1 > 2–4
Resources, FIRM	54.6 (8.6)	44.8 (10.7)	43.9 (9.9)	38.8 (13.3)	37.74	<0.0001	1 > 2–4 2 > 4
Demands, FILE	7.9 (5.5)	10.3 (6.8)	14.4 (5.3)	14.9 (8.5)	17.44	<0.0001	1 < 2–4 2 < 3, 4
Perception of Patient-centered care, PPPC	1.5 (0.5)	1.7 (0.6)	1.4 (0.3)	1.7 (0.6)	2.56	0.0550	
Annual household income ≥$80,000, %	40.3	38.3	20.7	26.1	5.75	0.1243	

[a]Reported as mean (standard deviation), unless otherwise stated.
[b]Includes those in married and common-law relationships.

Table 5. Multinomial logistic regression identifying baseline predictors of depressive symptom trajectories[a]

	Trajectory			
	Low stable[b]	Borderline	Moderate increasing	High decreasing
Maternal age	1.00	**0.53 (0.31, 0.94)**	**0.31 (0.12, 0.79)**	0.64 (0.27, 1.52)
Maternal education	1.00	0.88 (0.64, 1.20)	0.91 (0.53, 1.55)	**0.38 (0.22, 0.65)**
Child quality of life	1.00	0.90 (0.65, 1.23)	1.10 (0.63, 1.94)	**0.42 (0.21, 0.84)**
Child cognitive problems	1.00	2.00 (0.70, 5.71)	**9.29 (2.01, 42.88)**	0.56 (0.09, 3.54)
Family functioning	1.00	**0.65 (0.46, 0.90)**	**0.50 (0.28, 0.90)**	0.64 (0.36, 1.16)
Family resources	1.00	**0.50 (0.35, 0.73)**	0.72 (0.37, 1.41)	0.69 (0.34, 1.40)
Family demands	1.00	0.91 (0.65, 1.30)	**4.00 (1.72, 9.31)**	2.00 (0.95, 4.21)

Significant associations are shown in bold.
[a]Reported as odds ratio (95% confidence interval).
[b]Reference group.

ranged from 14–17% during the years leading to school-age (Horwitz et al., 2009).

Four distinct trajectories of depressive symptoms in mothers of children with new-onset epilepsy were identified during the first 24 months after epilepsy diagnosis. The shapes of trajectories in this sample were similar to several of the trajectories identified by Campbell et al. (2007) in their study of depressive symptoms in mothers of children prior to school entry. The sociodemographic differences (e.g., maternal age, education, and income) across groups reported by Campbell et al. (2007) were not observed in the current study, however. The largest group consisted of mothers with *low stable* CES-D scores who generally had more favorable characteristics (i.e., better child health-related quality of life, and a more positive family environment) compared to the other trajectory groups. The second largest group consisted of mothers with *borderline* depressive symptoms that varied over time and straddled the

CES-D cut-score for risk of clinical depression. This trajectory pattern is consistent with current research documenting the periodic recurrence of depression in a large proportion of women (Hughes & Cohen, 2009). The next largest group was composed of mothers with *moderate increasing* depressive symptoms during the 24-month follow-up. The smallest group consisted of mothers with *high decreasing* depressive symptoms. This declining trajectory is consistent with previous research documenting high initial levels of maternal depressive symptoms at child diagnosis that diminish over time (Dahlquist et al., 1996; Manne et al., 1996; Sawyer et al., 2000; Steele et al., 2003; Dolgin et al., 2007) and with research that suggests that resilience among adults experiencing trauma is a common response to an adverse event, in this case having a child diagnosed with epilepsy (Bonanno, 2004). Interestingly, both the *moderate increasing* and *high decreasing* trajectory groups were observed to have significantly elevated depressive symptoms at each measurement occasion compared to the *low stable* group.

The multinomial predictive model demonstrated that baseline maternal age and education; child health-related quality of life; child cognitive problems; and family functioning, resources, and demands play an important role in determining membership in a specific depressive symptoms trajectory. Having a child with cognitive problems was the strongest risk factor in the model, significantly predicting membership in the *moderate increasing* trajectory group. Such results may be useful for health care professionals, since they demonstrate that strong predictors can be obtained using efficient measures that are well-suited for use in clinical settings. It was not surprising that epilepsy severity did not predict a depressive symptom trajectory. This study included children aged 4–12 years with relatively less severe and stable epilepsy and showed little variation among children and over time. Previous research has shown that children with an earlier age of onset tend to have less favorable prognoses (MacDonald, 2001). The absence of correlation between epilepsy severity and the trajectory of mothers' depressive symptoms may be attributable to the fact that the age group studied tends to exclude the most catastrophic epilepsies.

This predictive model may be useful for health care professionals in developing a psychosocial profile of mothers and families post diagnosis to assess what extent that individuals' profiles match the collection of risk factors identified for each depressive symptoms trajectory. The model has the potential to aid in predicting which trajectory might unfold and whether an intervention may be warranted. Recognizing that resources for mental health services are limited, priority for early intervention should be directed at mothers with increasing depressive symptoms in an effort to improve such an unfavorable trajectory. Our findings suggest that there may be a window of opportunity to intervene on mothers' depressive symptoms to potentially interrupt unfavorable trajectories. Treating maternal depression has been shown to have immediate significant benefits. Recently in the health economics literature, Perry demonstrated that treatment of maternal depression resulted in a reduction of health care costs in the six months after having a child diagnosed with asthma (Perry, 2008). This result supports health policy to invest in training pediatric health care professionals to detect depressive symptoms in adults. Such a policy can lead to more efficient use of limited health care funds.

Being mindful of the mental and emotional state of caregivers is an important component of family-centered care, and may present an avenue for intervention that can potentially improve child outcomes (Smith et al., 2002). Family-centered care is a multidisciplinary model of health care delivery that may include, for example, physicians, nurses, psychologists, and social workers. It has been shown to be associated with an increase in parents' satisfaction with health care services and lower parent stress, and with positive child health outcomes (Law et al., 2003). It is understandable how maternal depressive symptoms can become easily overshadowed by a presenting child's epilepsy during the medical encounter. Health care professionals in this situation should be active in considering how the family environment influences the illness process and vice versa. The Bright Futures health promotion initiative encourages pediatric health care professionals to support families as part of providing care to children and recommends open questioning surrounding symptoms of maternal depression (Green & Palfrey, 2002; Jellinek et al., 2002). It is a collaboration of the American Academy of Pediatrics and other institutional projects that provides resources for health care professionals guided by the principle that ''every child deserves to be healthy and that optimal health involves a trusting relationship between the health professional, the child, the family, and the community'' (http://www.brightfutures.org). There is value in more formally considering mothers' mental health during the clinic visit. Referrals to a social worker or local epilepsy support centers are resources that can be offered soon after diagnosis to help ensure the best possible outcomes for families.

This study has several strengths. First, to our knowledge this is the only study to prospectively document the depressive symptoms of mothers of children with epilepsy. In addition, the relatively large sample and strong response and retention rates increase the external validity of findings. Second, this study utilized the CES-D, a well-validated and reliable instrument, to measure maternal depressive symptoms. Third, this study focused on incident rather than prevalent cases of childhood epilepsy. Results may be useful for health care professionals as part of the initial consultation when diagnosing childhood epilepsy so as to prevent any potential negative impact of maternal depressive symptoms on child health outcomes.

This study also has some limitations. First, the sample under study was recruited from pediatric neurology

practices that may not be representative of all families of a child with epilepsy, thereby potentially limiting external validity. Although it may be that some children are diagnosed and treated for new-onset epilepsy by a primary care pediatrician or family practitioner, it was not feasible to recruit a random sample of such physicians in a large national study. In the absence of population-based registries for epilepsy to facilitate such studies, Speechley et al. demonstrated that it may be feasible to recruit a representative population-based sample of children with epilepsy by targeting pediatric neurologists (Speechley et al., 1999). In this study, family physicians practicing in southwestern Ontario, reported they would refer between 80% and 99% of their patients with childhood epilepsy (depending on the type of seizure and syndrome) to a pediatric neurologist.

Second, it is important to consider that mothers with higher levels of depressive symptoms and other risk factors for clinical depression (Lehtinen & Joukamaa, 1994) were less likely to complete the 24-month follow-up compared to mothers who did not exhibit such traits. A similar trend has been observed in other research of mothers with depressive symptoms (de Graaf et al., 2000; Avison, 2010). Bias due to losses during follow-up may underestimate the proportion of mothers at risk. When baseline characteristics of mothers who did not complete the study were compared to characteristics from each trajectory group, results showed that those lost during follow-up most closely resembled the *moderate increasing* group (i.e., younger, less likely to be married, lower socioeconomic status, and less favorable family environment). This means that the group of mothers classified as having what might be characterized as the most concerning pattern of depressive symptoms, that of *moderate increasing*, may actually be larger than estimated.

Third, because this study relied on mothers' perceptions of measures for both exposures and outcomes, there was potential for mothers' reports to be biased, threatening the study validity. This phenomenon, more commonly known as depression distortion (Richters, 1992), was thoroughly investigated in a previous analysis using a series of regression analyses to determine if the association between mothers' and neurologists' reports of child health outcomes varied significantly when stratified by level of maternal depressive symptoms; results suggested no evidence of informant discrepancy in this sample of mothers (Ferro et al., 2010).

Conclusion

Risk for clinical depression is very common among mothers of children with new-onset epilepsy and decreases during the first 24 months of diagnosis. This research has demonstrated that mothers of children with new-onset epilepsy are not a homogeneous group of women with a single trajectory of change in depressive symptoms over time, but instead consist of distinct heterogeneous groups. Having a child with cognitive problems was the strongest risk factor in the model, significantly predicting those mothers who fell into the *moderate increasing* depressive symptoms trajectory group. It is important for health care professionals caring for children with epilepsy to be aware of how diagnosing epilepsy in a child can impact the mothers' mental health status. By adopting a family-centered approach, health care professionals may be able to alter trajectories of depressive symptoms in mothers to in turn promote more positive child outcomes.

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Disclosure

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines. None of the authors has any conflict of interest to disclose.

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Appendix

Details of statistical analysis

Trajectories of self-reported maternal depressive symptoms, as measured by the CES-D, during the first 24 months after having a child diagnosed with epilepsy were investigated with the semiparametric group-based approach (Nagin, 1999, 2005). The essence of this method is to use polynomial functions to identify unobserved patterns of depressive symptoms over time. Through this approach distinctive growth trajectories are identified. The degree to which an individual's trajectory resembles the prototypic trajectory is estimated and individuals are categorized into trajectory groups based on the similarity of the individual trajectory to the prototypic trajectories. A censored normal model was fitted to the data since there were a number of mothers who exhibited no or few depressive symptoms, resulting in a cluster of data at the scale minimum. The number of groups to be included in the model is guided by a priori expectations, overall model fit based on the Bayesian Information Criterion (BIC), and posterior probability scores for each trajectory group. The model with the maximum BIC, optimized probability scores, and least number of groups is selected. The modeling process followed the strategy of Campbell et al. (2007), whereby cubic trajectories were specified for three groups being examined and additional groups were added to the model and the change in BIC scores examined to determine the best model. In order to ensure model parsimony (i.e., most statistically efficient model), nonsignificant higher-order terms (i.e., quadratic and cubic) were removed and the model was respecified until optimal fit was achieved (Helgeson et al., 2004).

Maternal, child, and family characteristics were compared across trajectory groups using analysis of variance for continuous variables and chi square tests for categorical variables. The Bonferroni correction was applied for multiple comparisons. Pairwise group contrasts (post hoc Tukey or chi square test, when appropriate) were examined only if a statistically significant overall difference was observed across trajectory groups.

Multinomial logistic regression was conducted to identify predictors of depressive symptom trajectory using baseline data. A backward, stepwise selection approach using maternal, child, and family characteristics was utilized. Only variables that were statistically significant in the bivariate comparisons were included in the regression analysis. In order to generate a robust model, the condition for variables to enter and remain in the model was set at $\alpha = 0.20$ (Wang et al., 2008). Continuous variables in the model were categorized into quartiles to increase interpretability of the model. Data analysis was conducted with Statistical Analysis Software (SAS, Windows build 9.1.3 Service Pack 4, SAS Institute Inc., Cary, NC, U.S.A.). Group-based trajectory modeling was conducted with PROC TRAJ as described by Jones and Nagin (2007). All hypothesis tests were two-sided.