RESEARCH



Maternal refugee status is associated with less favourable motor performance and behaviour in term infants referred to a neonatal ward: a cross-sectional study



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Abstract

Background Anxiety and depression are highly prevalent among Syrian refugees. Anxiety and depression during pregnancy may impair infant neurodevelopment. This study evaluated whether potential maternal anxiety and depression in Syrian refugee and native Turkish mothers were associated with less favourable neonatal neurodevelopment.

Study design Cross-sectional study.

Methods Turkish (n = 64) and Syrian (n = 17) term-born infants (37–41 weeks' gestation) referred to a level II-III neonatal intensive care unit in Izmir were assessed shortly after birth (median 5 days) together with their mothers. The Test of Infant Motor Performance (TIMP) was the primary outcome measure. In addition, we evaluated crying behaviour during the TIMP-assessment and performed General Movements Assessment (GMA). Mothers completed Beck Anxiety and Beck Depression Inventories in their native languages. Univariate and multivariate statistics were applied.

Result Perinatal social characteristics of both groups were similar. TIMP scores of Syrian infants were significantly lower than those of Turkish infants (45.53 (SD 7.10) vs. 51.59 (SD 8.59), respectively (p = 0.009)). Sixteen Turkish infants (25%) and ten Syrian infants (59%) had TIMP z-scores below – 1 SD (unadjusted OR = 1.27 (95%CI 1.06–1.54); adjusted OR = 1.30 (95%CI 1.05–1.61)). At TIMP-assessment's end, more Syrian infants cried (29%) compared to Turkish infants (8%; unadjusted OR 4.92 (95%CI 1.23–19.67). This association lost significance after adjustment (OR = 4.87; 95%CI 0.77–31.01). GMA ratings of both groups were similar (definitely abnormal Turkish infants (n = 5; 8%); Syrian infants (n = 1; 7%); unadjusted OR = 0.91 (95%CI 0.30–2.78); adjusted OR = 1.66 (95%CI 0.42–6.61)). Anxiety and depression scores of both mothers' groups were low (median anxiety scores of Syrian mothers 0, Turkish mothers 1; median depression scores of Syrian mothers 0, Turkish mothers 2.5). The low maternal anxiety and depression scores were not associated with the infants'TIMP scores.

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Conclusions Maternal refugee status was associated with less favourable neonatal motor performance, with about half of the Syrian refugee newborns having a TIMP score indicating the need for close monitoring of development and a potential need for early intervention. Motor performance was not associated with maternal reports of anxiety and depression. Nonetheless, the study suggests that the neurodevelopment of babies born to refugee mothers should be carefully monitored to enable early intervention whenever required.

Keywords Beck anxiety inventory (BAI), Beck depression inventory (BDI), Crying behaviour, Displacement, Forced displacement, General movement assessment (GMA), Maternal stress, Refugee, Migration, Test of infants motor performance (TIMP)

Background

Intrauterine life is an essential period for human neurodevelopment characterized by a wealth of developmental processes [1]. Therefore, it is unsurprising that this period is also associated with vulnerability. It is well known that a variety of factors, including prenatal infections [2], trauma [3], obstetric and maternal disorders [4, 5], and environmental pollution [6], may have an adverse effect on brain development with lifelong consequences.

Many studies reported that also maternal mental health problems may have an unfavourable effect on child development. Mental problems occur relatively frequently during pregnancy. Systematic reviews reported that 18.2–24.6% of pregnant women had anxiety [7], and 11.4–13.1% were affected by depression [8], the latter number increasing to 31% in low and middle-income countries [9]. Maternal anxiety, depression and perceived stress have been associated with a negative effect on the infant's cognitive, language, motor and socio-emotional development [10, 11]. The neurobiological plausibility of a direct causal effect of maternal anxiety and depression on child development has been supported by animal studies [12, 13].

A specific group of women at high risk of mental health issues are refugee women. Refugee, immigrant, and asylum-seeking women have been reported to suffer three to five times more often from mental health problems, including postpartum depression, than native women [14]. In addition, women with a refugee background have a higher risk of adverse pregnancy outcomes, including a higher risk of stillbirth and perinatal and neonatal mortality [15]. The increased risk of adverse pregnancy outcomes in women with a refugee background has been attributed to a multitude of interacting factors, including increased levels of stress, communication problems due to cultural differences and foreign language, infections, and preterm birth [16–18].

From the onset of the civil war in Syria in 2011, people started to leave their homes, families, and friends in order to begin a new life in another country. Reports showed that Syrian refugees had an increased risk of mental health issues like depression, anxiety, and posttraumatic stress disorder (PTSD). This was especially true for women [19, 20], and an increased risk of PTSD was also found in Syrian refugee children [21]. Many Syrian refugees went to Turkey. Also, the Syrian refugees in Turkey had an increased prevalence of symptoms indicating PTSD, anxiety and depression [22]. In addition, outcomes of pregnancies of Syrian refugees in Turkey were less favourable, including higher rates of stillbirth, preterm birth, and low birth weight [23]. However, little is known about the neuromotor development of the off-spring of Syrian mothers with refugee status, especially in the neonatal period.

Knowledge on the neurodevelopmental condition of children of mothers with a refugee status early in postnatal life is important, as insight into the potentially increased risk of neurodevelopmental impairment induces increased awareness of the need for early detection of atypical development. The latter is a prerequisite for early intervention to optimise neuromotor, cognitive, and behavioural development, prevent further neurodevelopmental complications, and improve caregiver wellbeing [24].

We know that physiological and psychological stress during pregnancy is associated with a less optimal neurological condition in infancy [25, 26] and with altered settings of the monoaminergic systems [27]. Therefore, we hypothesized that infants from Syrian refugee mothers have a less optimal neurodevelopmental condition than infants from native Turkish mothers. To test this hypothesis, we assessed neurodevelopmental conditions in newborn infants. We opted for neonates for pragmatic reasons, as the neonatal ward allowed access to both groups of infants. As primary outcome measure, we used the Test of Infant Motor Performance (TIMP), a responsive measure of motor status in early life [28]. Our secondary outcome was crying behaviour, i.e., the frequency that the TIMP-assessment needed to be interrupted for consolation. Exposure to prenatal stress may affect the infant's cortisol and monoaminergic transmitter system, which in turn may increase the infant's proneness to crying [27, 29]. In addition, we assessed the quality of General Movements (GM) to evaluate the infants' risk of cerebral palsy [30].

The specific questions addressed in this study were: (1) Do infants of Syrian refugee women in Turkey have a less favourable motor and crying condition shortly after birth than infants of native Turkish women? (2) Do Syrian refugee women in Turkey exhibit more signs of anxiety and depression in the peripartum period than native Turkish women? (3) Are signs of maternal anxiety and depression in newborn infants of Syrian refugee women and native Turkish women associated with a less favourable neurodevelopmental condition? Maternal anxiety and depression were assessed by means of standardized questionnaires.

Methods

Participants

The infants were recruited at the level II-III neonatal care wards of the Izmir Demokrasi University, Buca Sevfi Demirsoy Education and Research Hospital in Izmir, Turkey, between January and August 2021. Major reasons for referral to these wards in general are preterm birth and neonatal respiratory problems. For our study, inclusion criteria were (1) term gestational age (≥ 37 weeks) and (2) having either a native Turkish mother or a Syrian refugee mother. Infants with genetic disorders or evident neurological disorders, such as neuromuscular disorders or brachial plexus palsy, were excluded from the study. Infants were also excluded when the routine nasopharyngeal swab screening for SARS-COV-2 (the study was conducted during the SARS-COV-2 pandemic) of the pregnant woman during admission to the hospital for delivery tested positive or when the pregnant woman had a respiratory problem at this point in time, even though the SARS-COV-2 screening had been negative. Note that during the COVID pandemic, parents had limited access to the neonatal ward. 184 infants were eligible for the study (57 Syrian and 127 Turkish) of whom 17 Syrian and 64 Turkish infants participated in the study (see the flow diagram in Fig. 1). A relatively high proportion of parents were not willing to participate. This occurred more often for Syrian infants (n = 40; 70%) than for Turkish infants (n = 63; 50%; Fisher Exact Test p = 0.010). Due to strict privacy regulations, we were not allowed to retrieve background information of the mother-infant dyads who did not participate in the study.

The infants' social, prenatal, perinatal and neonatal history was recorded on standardized forms based on the infants' clinical records. Written informed consent was obtained from all the mothers of the participating infants. For Syrian families, an official translator native to the Arabic language was available to explain the details of the study.

The study was approved by the ethics committee of the Izmir Demokrasi University (2020/21 - 1).

Procedure

The first author (SÜ) assessed the infants with the TIMP and GMA when they were at least 3 days of age (median 5 days; interquartile range 4–6 days) and 30–60 min after feeding. The assessment started with GMA, next the TIMP was performed. Care was taken that the infant was not crying, as a non-crying behavioural state is a prerequisite for a neurodevelopmental assessment [31]. When the infant started to cry, the assessment was interrupted and the infant's nurse calmed the infant. Thus, during the actual assessments the infants were in an adequate behavioural state. The entire assessment session was video recorded. The scoring of TIMP and GMA was based on the video recording. TIMP scoring was performed by SÜ, GMA by SÜ, and MHA. When the latter two disagreed, findings were discussed until a consensus was reached. On the basis of the video, the infant's behavioural response to the TIMP-assessment in terms of crying behaviour was also monitored. We considered this a pragmatic way to assess the infant's crying behaviour in a standardized way, knowing that coping with a motor assessment may be challenging for infants and thus elicit crying in infants who have a vulnerability to cry. To this end, it was recorded whether or not the infant was crying at the start of the TIMP assessment, midway and at the end of the assessment. The midway point was based on the real assessment time. In addition, we calculated the number of times that the TIMP-assessment had to be interrupted to console the infant because of crying.

SÜ and MHA, who scored the infants' behaviour, were blind to the infants' ethnicity and medical history. All conversations with the parents were performed by two of the neonatologists of the research team (MKA and SS), i.e., the latter provided the information about the study, arranged the written consent, collected the parental data, and gave the mothers the inventories. The latter consisted of the Turkish or Arabic version of the Beck Anxiety Inventory (BAI) and the Beck Depression Inventory (BDI) [32, 33]. The inventories were completed on the day that the infants were assessed.

Assessments

Motor performance

The TIMP was our primary outcome measure. It is a performance-based assessment that measures motor and postural control in infants from 34 weeks postmenstrual age (PMA) to five months corrected age (CA) [28]. The TIMP contains 13 items scored by observing the infant's spontaneous movements and 29 elicited items where infant handling is required for motor and postural response. The observed items are scored dichotomously, with the observed items being credited with a point and the non-observed items having no points. The elicited items are scored on a scale of 0 to 4, 5 or 6 points, with a



Fig. 1 Flow-diagram of the study

higher score denoting a better performance. It takes 20 to 40 min to perform the TIMP [34]. TIMP's reliability and construct and concurrent validity are good [35]. In addition, TIMP is able to predict short-term motor outcomes and is a sensitive instrument to monitor neuromotor development [36]. The TIMP has no norm data, but data on a large study population are available. The latter may be used to calculate age-specific z-scores [37]. A z-score

below -1 SD indicates that the infant's development requires close monitoring and may serve as an indication for early intervention.

General movements assessment

For GMA, the infant's spontaneous movements in the supine position were recorded for 3 min. The quality of the GM was assessed according to Hadders-Algra, implying that the infant's movement repertoire was assessed in particular in terms of movement complexity and movement variation [30]. Four categories are distinguished: normal-optimal movements (abundant complexity and variation), normal-suboptimal movements (sufficient complexity and variation), mildly abnormal movements (insufficient variation and complexity; reflecting typical but non-optimal brain function) and definitely abnormal movements (very limited complexity and variation; reflecting brain dysfunction) [30]. GMA is a reliable instrument [35]. Prenatal, perinatal and neonatal risk factors are clearly associated with lower GM quality in the neonatal period and around 3 months CA. In addition, GMA- especially when performed around 3 months CA, but also at younger ages - is an excellent tool to predict neurodisability. It especially predicts cerebral palsy and intellectual disability, but it also has been associated with cognitive and language outcomes [38, 39].

After discharge from the hospital, the infants with a TIMP score below average or a definitely abnormal GM quality were referred to the neurodevelopmental follow-up outpatient clinic of the hospital.

Assessments of anxiety and depression

The Beck Anxiety Inventory (BAI) is a self-report inventory which assesses with 21 multiple choice items the subject's anxiety in the last week, including the day of assessment. The inventory, which is valid for persons of at least 17 years, takes 5-10 min to complete. It focuses on somatic symptoms such as numbness, tingling, sweating (other than heat-induced), and fear of the worst happening. The items are scored on a 4-point Likert scale ranging from 0 (not at all) to 3 (severely). A total score is calculated by adding the item scores; it ranges from 0 to 63 points, with higher scores indicating more severe anxiety. A score of 0–7 points indicates minimal anxiety; 8-15 points to mild anxiety; 16-25 to moderate anxiety; and 26-63 to severe anxiety; scores of 16 points or higher are considered to be clinically relevant [40]. The BAI has good construct validity, indicated by a good convergence with other measures of anxiety, including the Hamilton Anxiety Rating Scale (r = 0.51), the State-Trait Anxiety Inventory (r = 0.47 - 0.58), and the anxiety scale of the Symptom Checklist-90 (r=0.81) [32, 41]. The BAI has been translated into several languages and also validated for these languages. Since our population consists of Turkish and Syrian mothers, the BAI in Turkish [42] and Arabic [43] languages was used.

The Beck Depression Inventory also is a self-scored inventory. It consists of 21 items that measure depression in adults. The items are scored with a 4-point Likert scale ranging from 0 (not at all) to 3 (severely). The sum of the responses may range from 0 to 63 points, with higher scores indicating more severe depression. A score

of 0–9 points indicates minimal depression, 10–18 points to mild depression, 19–29 to moderate depression, and 30-63 to severe depression [44], with the latter two categories denoting clinically relevant depression [45]. In addition, it has been shown that the BDI can differentiate between anxiety and depression [46]. The validated Turkish [47] and Arabic [48] versions of the BDI were used in this study.

Statistical analysis

A priori power calculation with *OpenEpi* version 3, based on the primary outcome measure TIMP and taking into account an expected sample ratio between Turkish and Syrian dyads of 3.5, indicated that we needed 64 Turkish and 17 Syrian infants to achieve a power of 80% (at 95% confidence levels) and an ability to detect a clinically relevant difference of 9 points (knowing that the SD is 14 points) [34].

To estimate differences between the groups in background and outcome characteristics, we used a t-test for normally distributed variables and the Mann-Whitney-U test, Chi-square test and Fisher Exact Test for non-normally distributed factors. For the correlation between (a) maternal anxiety and depression scores and (b) duration of maternal stay in Turkey in years and the TIMP-raw scores, we used Spearman's correlations. Additionally, we used multiple logistic regression analyses to study the effect of nationality on the occurrence of a TIMP z-score below - 1 SD, abnormal GM quality (mildly and definitely abnormal GM) and crying at the end of the TIMP-assessment in order to adjust for confounders. Based on the literature, the following covariates were selected: maternal education, monthly income, gestational age, caesarean section, pH umbilical vein, Apgar score after 5 min, need of oxygen therapy, mechanical ventilation, and sepsis. Differences and Odds Ratios (OR) are expressed with 95% confidence intervals (CI); in addition, p < 0.05 is considered statistically significant.

Results

Eighty-one term-born infants and their mothers were included in the study; 64 of the recruited infant-mother dyads were native Turkish, and 17 dyads were refugee Syrian. The most common indication for admission to NICU was respiratory distress (78%). None of the infants had been diagnosed with a serious brain lesion, such as periventricular leukomalacia, grade III or IV intraventricular haemorrhage or cerebral infarction. Other indications and additional background characteristics of both groups are reported in Table 1. The groups were similar in prenatal, perinatal, neonatal, and social characteristics, except for the number of years they lived in Turkey. The Turkish families have always lived in Turkey, whereas the Syrian parents have lived in Turkey for 5.44

Table 1 Background characteristics of both groups: perinatal and social factors and neonatal GM-quality

Characteristics	Turkish Infants (n = 64)	Syrian Infants (n=17)
Socio-demographic characteristics		
Male infant sex, n (%)	39 (61)	11 (65)
Maternal age in years, mean (SD)	27.83 (6.68)	26.94 (7.28)
Paternal age in years, mean (SD)	32.08 (7.17)	30.47 (5.63)
Maternal education:		
in years, mean (SD)	7.56 (3.66)	6.18 (5.47)
low education ^a , n (%)	60 (94)	15 (88)
Paternal education:		
in years, mean (SD)	8.19 (3.56)	6.29 (4.87)
low education ^a , n (%)	57 (89)	16 (94)
Mother: number of years living in Turkey, mean (SD)	27.67 (7.02)	5.44 (2.16) *
Father: number of years living in Turkey, mean (SD)	31.83 (7.72)	5.44 (2.16) *
Monthly income of the family (も), mean (SD)	3086 (1314)	2947 (669)
Persons in household, median (IQR)	4 (4–5)	5 (4-5.5)
Prenatal characteristics		
Maternal Hypertension, n (%)	1 (2)	0
Preeclampsia, n (%)	0	0
Gestational Diabetes Mellitus, n (%)	1 (2)	0
Maternal Thyroid Disease, n (%)	4 (6)	2 (12)
Maternal smoking, n (%)	7 (11)	0
Maternal alcohol use, n (%)	1 (2)	0
Perinatal characteristics		
Gestational age in weeks at birth, median (IQR)	39.0 (38–39)	39,0 (39.0–39,4)
Birthweight in grams; mean (SD)	3302 (551)	3323 (430)
First venous umbilical blood pH, mean (SD)	7.25 (0.13)	7.30 (0.09)
APGAR score 1 min, mean (SD)	7.34 (1.34)	7.29 (1.53)
APGAR score 5 min, mean (SD)	8.63 (0.81)	8.71 (0.78)
Major indication for admission to neonatal ward		
Caesarean section delivery, n (%)	41 (64)	7 (41)
Respiratory distress, n (%)	54 (84)	12 (71)
Treatment of Respiratory distress		
- Mechanical Ventilation for Respiratory Distress		
- NIMV, n (%)	42 (66)	10 (59)
- IMV and NIMV, n (%)	9 (14)	1 (6)
- Oxygen Therapy for Respiratory Distress, n (%)	41 (64)	7 (41)
- Duration of Oxygen Therapy for Respiratory Distress in days, median (IQR)	2 (1-3)	1 (1-1)
Jaundice requiring phototherapy, n (%)	6 (9)	2 (12)
Meconium-stained amniotic fluid, n (%)	2 (3)	0 (0)
Sepsis, n (%)	4 (6)	2 (12)
Asphyxia ^b , n (%)	3 (5)	1 (6)
Characteristics at assessment		
Corrected age at TIMP assessment	39 weeks	39 weeks
(Median (IQR))	(39–40 weeks)	(39–40 weeks)
Postnatal age in days, median (IQR)	5 (4–7)	4 (4–5)
Body weight in grams, mean (SD)	3236 (546)	3276 (438)
GMA: GM quality		
Normal Optimal, n (%)	6 (9)	2 (12)
Normal Suboptimal, n (%)	34 (53)	9 (53)

Table 1 (continued)

Characteristics	Turkish Infants	
	(<i>n</i> = 64)	(n=17)
Mildly Abnormal, n (%)	19 (30)	5 (29)
Definitely Abnormal, n (%)	5 (8)	1 (7)

Calculation of differences with T-Test, Mann-Whitney U Test, Chi-Square Test, Fischer's Exact Test or Linear-by-Linear Association where appropriate; * *p* < 0.001 ^a Low educational level: high school graduation and below

^b Asphyxia was defined as a pH-value < 7.0; the 4 infants fulfilled the criteria of neonatal encephalopathy and were treated with hypothermia according to the Treatment Guidelines of 2018 of the Turkish Society of Neonatology

Respiratory support for newborns with respiratory distress was according to the guidelines of the Turkish Neonatology Society. Non-invasive mechanical ventilation (NIVM) methods were preferred initially for respiratory support; infants fulfilling the criteria for intubation were treated with invasive mechanical ventilation (IMV). The goal for oxygen support was to maintain the infant's oxygen saturation between 90–95%, and the administered oxygen was titrated accordingly

Additional abbreviations: GM, General Movements; GMA, General Movements Assessment; IQR, interquartile range; SD, standard deviation; 🖏 Turkish Lira

Table 2 TIMP scores in Turkish and Syrian infants

	Turkish infants (n=64)	Syrian infants (n=17)	<i>p</i> -value	Mean differ- ence (95% Cl)
Gestational age at birth (Median (IQR))	39 weeks (38–39 weeks)	39 weeks (39–39 weeks)	0.112 ^{MWU}	-
Corrected age at TIMP assessment (Median (IQR))	39 weeks (39–40 weeks)	39 weeks (39–40 weeks)	0.481 ^{MWU}	-
TIMP-Z Score (Mean (SD))	-0.67 (0.58)	-1.11 (0.46)	0.005 ^{T,*}	0.44 (0.13– 0.74)
Number of infants whose TIMP-assessment needed to be interrupted due to crying and consolation, n (%)	21 (33%)	10 (59%)	0.05 ^{X2*}	
Frequency of interruptions for consolation during the TIMP-assessment (Median (IQR))	0 (0–1)	1 (0–3)	0.018 MWU*	

MWU, Mann-Whitney U-Test; T, T-Test; χ 2, Chi-Square Test; CI = Confidence Interval; IQR, interquartile range; SD = standard deviation; * p < 0.05

years (SD 2.16; Table 1), with a minimum of one year. This also implies that all Syrian infants had been conceived in Turkey. The GMA ratings of both groups were also similar: mildly abnormal GM occurred in 19 Turkish infants (30%) and 5 (29%) Syrian infants, whereas definitely abnormal GM was present in 5 Turkish infants (8%) and 1 Syrian infant (7%) (Table 1). The multivariate analysis confirmed that the presence of abnormal GM (mildly and definitely abnormal) did not differ between the two nationality groups (unadjusted OR 0.91 (95%CI 0.30–2.78); adjusted OR 1.66 (95%CI 0.42–6.61)).

The Syrian infants had significantly lower TIMP z-scores than the Turkish infants: (-1.11 (SD 0.46) vs. -0.67 (SD 0.58); p = 0.005; Table 2; Fig. 2). In addition, application of the age standards of Campbell and colleagues [37], showed that 16 Turkish infants (25%) and 10 Syrian infants (59%) had a TIMP z-score below -1 SD (p = 0.018). The duration of the mothers' stay in Turkey was not associated with the infants' motor performance (Spearman test, $\rho = 0.091$, p = 0.729). The multivariate analysis confirmed the association between Syrian nationality and TIMP scores < -1 SD (unadjusted OR 4.29 (95%CI 1.40-13.13; adjusted OR 5.02 (95%CI 1.53-16.41)).

At the beginning of the assessment, infants virtually never cried (Fig. 3). As the assessment progressed, some infants lost control of their behavioural state, started to cry, and needed consolation. At the end of the assessment, more Syrian infants than Turkish infants cried (29% vs. 8%; Fisher Exact Test p = 0.030; Fig. 3). This difference disappeared in the multivariate analysis (unadjusted OR 4.92 (95%CI 1.23–19.67); adjusted OR 4.87 (95%CI 0.77–31.01). Syrian infants also tended to need more often consolation for crying during the TIMPassessment (Table 2, MWU-test, p = 0.05). The frequency with which the TIMP-assessment was interrupted for consolation due to crying was higher in the Syrian infants than in the Turkish infants (Table 2, MWU test p = 0.018).

The maternal anxiety and depression scores of the Turkish and Syrian mothers are reported in Table 3. Mothers in both groups had low anxiety scores (all \leq 7, i.e., minimal anxiety) and low depression scores (all \leq 9, i.e., minimal depression) [32, 33]. Nonetheless, Syrian mothers had even significantly lower anxiety scores than Turkish mothers: 0 (IQR 0-1.5) versus 1 (IQR 0–5; p = 0.024). In addition, the depression scores of the Syrian mothers were also significantly lower than those of the Turkish ones: 0 (IQR 0-4.5) versus 2 (IQR 0–7; p = 0.046).











Fig. 3 Crying during the TIMP assessment

Prevalence of crying at the beginning of the TIMP assessment, midway and the end. Fisher Exact Test: *p < 0.05

Table 3Maternal anxiety and depression scores in Turkish andSyrian mothers

	Turkish mothers (n=64)	Syrian mothers (n=17)	<i>p-</i> val- ue*
Beck Anxiety Outcome Median (IQR)	1 (0–5)	0 (0-1.5)	0.024
Beck Depression Outcome Median (IQR)	2.5 (0–7)	0 (0-4.5)	0.046

*Mann-Whitney U-Test; IQR = interquartile range

Maternal anxiety and depression scores were not associated with the TIMP raw scores: anxiety scores $\rho = 0.165$ (p = 0.141), depression scores $\rho = 0.150$ (p = 0.181).

Discussion

Our study indicated that the neuromotor development of infants born from mothers with a refugee status (Syrian infants) was significantly less favourable than that of infants born from non-refugee mothers (Turkish infants). Syrian infants also tended to cry more often during and at the end of the TIMP-assessment, but this effect disappeared after correction for confounders. The GM quality did not differ between the groups. The differences in newborn neuromotor development could not be explained by differences in maternal reports of anxiety and depression.

It is well documented that mental disorder symptoms are highly prevalent among Syrian refugees, especially in women living in Sweden, Norway, and Turkey [19, 20, 22]. Many factors play a role in the aetiology of these mental problems, including potential refugee-related traumatic events before and during the flight, including having experienced torture and gender-based violence; post-migration stress; and post-displacement living difficulties, such as sadness of having lost family members [49, 50]. The knowledge of mental problems was the starting point of our study. Yet, the results of our questionnaires indicated that the anxiety and depression scores of the mothers with refugee status (Syrian mothers) were lower than those of the non-refugee mothers (Turkish mothers). It is possible that especially positively minded mothers participated in the study, an effect that might have been stronger for the Syrian mothers than for the Turkish ones. Another recent study also reported that anxiety and depression scores of Syrian pregnant women in Turkey were low [51]. In addition, women are often euphoric in the first few days after childbirth, a happiness that is more often expressed when pregnancy has been stressful [52, 53]. This may explain why anxiety and depression scores of the mothers in both groups were low. Another reason for the low anxiety and depression scores of the Syrian mothers may be the finding that Syrian refugees who receive hospital care in Turkey generally feel grateful to health professionals [54], a feeling that also may have interfered with the expression of signs of anxiety and depression on the questionnaires.

It could be argued that the coping strategies of the Syrian refugee mothers differed from those of the Turkish control mothers. To the best of our knowledge, no studies that compared the coping strategies between Syrian and Turkish women are available. What we know is the following. The literature on Syrian refugee women indicates that they use a mix of coping strategies, including active strategies, such as praying and attending religious meetings, and emotional strategies. The former is associated with post-traumatic growth, whereas the latter interferes with such growth [55–57]. For Turkish women who have experienced a traumatic event, such as a terror attack [58] or a loss of pregnancy [59], similar strategies have been described. It is conceivable that the Syrian refugee mothers, due to potential post-traumatic growth, scored lower on the anxiety and depression scores than the Turkish mothers.

Despite our finding of low levels of anxiety and depression among the Syrian refugee mothers, our study indicated that the neurodevelopmental condition of the Syrian infants was less favourable than that of the Turkish infants. Another explanation for this difference from the hypothesized maternal anxiety and depression could be social determinants, such as a potentially reduced access to healthcare, fewer prenatal check-ups, and language barriers [18].

A tendency to more frequently cry contributed to the less optimal neurodevelopmental condition of the Syrian infants. It is unlikely that the limited access of the parents to the neonatal ward offers an explanation, as the rule of restriction applied to both groups of neonates. It is more likely that the somewhat higher propensity to crying in Syrian infants could be an indicator of less self-regulation. We suggest that future studies on the developmental outcome of refugee offspring evaluate the infant's capacity for self-regulation with maternal reports after the first three months regarding feeding, crying, and sleeping behaviour and/or by means of standardized assessments, e.g. the Neonatal Behavioral Assessment Scale (NBAS) [60] or the Neonatal Intensive Care Unit Network Neurobehavioral Scale [61], or in older infants the Standardized Infant NeuroDevelopmental Assessment (SINDA) [62].

The finding of a less favourable outcome of the Syrian infants than of the Turkish infants corresponds to the report of Ayaz and colleagues that the motor and language development of preschool children of Syrian refugees in Turkey was less optimal than that of Turkish children [63]. Considering (1) the fact that our two groups did not differ in parental education, parental age, financial status and prenatal, perinatal and neonatal characteristics, (2) multivariable analyses indicated that

the differences in neuromotor development between the two groups persisted after correction for important confounders, and (3) the ample evidence that prenatal stress is associated with less favourable neurodevelopmental outcome [10], we assume that the differences in neuromotor outcome between infants of Syrian refugee mothers and Turkish mothers are the result of elevated stress during pregnancy and the first days after delivery. Prenatal and early postnatal stress may result in direct changes in neuronal and synaptic development, for instance in the monoaminergic systems, and via epigenetic mechanisms in indirect changes resulting in altered structural and functional brain development [64]. Yet, we should not forget that the questionnaires used in our study were not able to detect these differences in stress.

The strength of our study was the use of standardized neurodevelopmental tests and questionnaires, assessment by examiners masked for refugee status and other background factors, and the good matching of the two study groups and the multivariate analyses being able to correct for potential confounders. To the best of our knowledge, this is the first study that evaluated motor status and crying behaviour in Turkish and Syrian neonates. The study also has some limitations. First, as mentioned above, most likely, the well-validated BAI and BDI were not able to detect increased levels of mental health problems in Syrian refugee women who had just delivered a baby. It would have been better to longitudinally measure the pregnant women's cortisol level in the saliva [65-67]. Second, many families declined participation in the study, perhaps due to the COVID-19 pandemic situation with its many restrictions. Due to strict privacy regulations, we could not assess whether the study sample well represented all infants referred to the neonatal wards. Yet, we know that mother-infant dyads who participate in scientific studies usually form a selection from the entire group of eligible pairs. Typically participating families have a higher level of education than non-participating families [68]. Therefore, we assumed that our study sample was selective, meaning that the results cannot be generalized to all Turkish and Syrian mother-infant dyads referred to the neonatal wards. The fact that the study groups had been recruited in a neonatal ward implies that the findings cannot be generalized to all infants of Syrian mothers with refugee status. Third, the infants' assessments were carried out in the neonatal period, which means that information on longterm development is missing. Fourth, our groups were relatively small and unequally distributed over the two groups, which weakened the statistical power.

Conclusion

In our study, newborn infants of Syrian mothers with a refugee background had a significantly less favourable neonatal motor performance than neonates of non-refugee Turkish mothers. The Syrian infants also tended to cry more often during and at the end of the TIMPassessment than the Turkish infants. Different from what we had expected, the less favourable newborn neuromotor status was not associated with maternal anxiety and depression scores, the indicators that we had used as parameters of maternal stress during pregnancy and delivery. We therefore recommend that new studies use larger groups of mother-infant dyads and longitudinally evaluate maternal stress from early pregnancy onwards by means of standardized questionnaires and biomarkers, such as cortisol levels in saliva, and use standardized tests to assess neonatal self-regulation.

Abbreviations

- BAI Beck Anxiety Inventory
- BDI Beck Depression Inventory
- CA Corrected age
- GM General Movements
- GMA General Movements Assessment
- PMA postmenstrual age
- TIMP Test of Infant Motor Performance

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Author contributions

All authors fulfil the criteria for authorship; S.Ü., M.Y.O., and M.H.A. initiated the study; S.Ü., S.S., M.K.A. collected the data; S.Ü. and M.H.A. analysed the data; S.Ü., M.Y.O., A.S.S. and M.H.A. interpreted the data; S.Ü. and M.H.A. drafted the report. All authors commented on the drafts and have seen and approved the final version.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of the Izmir Demokrasi University (2020/21 - 1). Written informed consent was obtained from all mothers of the participating infants.

Consent for publication

Not applicable

Competing interests

The authors declare no competing interests.

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