

# Impact of perinatal asphyxia on parental mental health and bonding with the infant: a questionnaire survey of Swiss parents

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## ABSTRACT

**Objective** To compare current mental health symptoms and infant bonding in parents whose infants survived perinatal asphyxia in the last 2 years with control parents and to investigate which sociodemographic, obstetric and neonatal variables correlated with parental mental health and infant bonding in the asphyxia group.

**Design** Cross-sectional questionnaire survey of parents whose children were registered in the Swiss national Asphyxia and Cooling register and of control parents (Post-traumatic Diagnostic Scale, Hospital Anxiety and Depression Scale, Mother-to-Infant Bonding Scale).

**Results** The response rate for the asphyxia group was 46.5%. Compared with controls, mothers and fathers in the asphyxia group had a higher frequency of post-traumatic stress disorder (PTSD) symptoms ( $p < 0.001$ ). More mothers ( $n = 28$ , 56%) had a symptom diagnosis of either full or partial PTSD than controls ( $n = 54$ , 39%) ( $p = 0.032$ ). Similarly, more fathers ( $n = 31$ , 51%) had a symptom diagnosis of either partial or full PTSD than controls ( $n = 19$ , 33%) ( $p = 0.034$ ). Mothers reported poorer bonding with the infant ( $p = 0.043$ ) than controls. Having a trauma in the past was linked to more psychological distress in mothers ( $r = 0.31$  (95% CI 0.04 to 0.54)) and fathers ( $r = 0.35$  (95% CI 0.05 to 0.59)). For mothers, previous pregnancy was linked to poorer bonding ( $r = 0.41$  (95% CI 0.13 to 0.63)). In fathers, therapeutic hypothermia of the infant was related to less frequent PTSD symptoms ( $r = -0.37$  (95% CI -0.61 to -0.06)) and past psychological difficulties ( $r = 0.37$  (95% CI 0.07 to 0.60)) to more psychological distress. A lower Apgar score was linked to poorer bonding ( $r = -0.38$  (95% CI -0.64 to -0.05)).

**Conclusions** Parents of infants hospitalised for perinatal asphyxia are more at risk of developing PTSD than control parents.

## INTRODUCTION

Perinatal asphyxia is a life-threatening event affecting 2/1000 infants, which qualifies as a psychologically traumatic stressor for parents.<sup>1</sup> When associated with hypoxic ischaemic encephalopathy (HIE), it may lead

## What is already known on this topic?

- ▶ Perinatal asphyxia is a life-threatening event, potentially psychologically traumatic for parents.
- ▶ Parental mental health problems may impact on bonding with and development of the child.
- ▶ Research examining post-traumatic stress disorder, psychological distress and bonding with their infant in parents of infants born with perinatal asphyxia is lacking.

## What this study hopes to add?

- ▶ More frequent post-traumatic stress symptoms in both parents and poorer bonding with the infant in mothers after perinatal asphyxia were found compared to control parents.
- ▶ Parents of infants hospitalised for perinatal asphyxia are more at risk of developing post-traumatic stress disorder than control parents.

to disabling brain injuries or death.<sup>2-4</sup> Current treatment of HIE requires immediate transfer to a specialised neonatal unit and therapeutic hypothermia in order to reduce the risk of brain lesions and neurodevelopmental disabilities.<sup>5</sup>

Parents of infants admitted to a neonatal intensive care unit report more stress,<sup>6</sup> more adjustment difficulties and need for support during the first year after delivery<sup>7,8</sup> compared with parents of healthy infants. They may experience post-traumatic stress disorder (PTSD),<sup>9-11</sup> anxiety and depression following the birth.<sup>12</sup>

Although two qualitative studies described the experiences of becoming a parent after perinatal asphyxia<sup>13,14</sup> and another showed that fathers may be traumatised,<sup>15</sup> PTSD symptoms or psychological distress have

not been measured in parents of these children. PTSD consists of four symptom clusters (re-experiencing, avoidance, hyperarousal and negative cognitions and mood) and is diagnosable from 1-month post-trauma.<sup>1</sup> Assessing postnatal PTSD and psychological distress is important for the well-being of parents and PTSD may significantly interfere with infant bonding, leading to severe and long-term consequences for the development of the baby.<sup>16–18</sup>

The current study aimed to compare current symptoms of PTSD, psychological distress and infant bonding in parents who had an infant with perinatal asphyxia in the last 2 years with control parents. It was predicted that parents of the asphyxia group would report more PTSD and psychological distress symptoms and poorer infant bonding than controls. Another objective was to investigate which sociodemographic, psychological, obstetric and neonatal variables were correlated with mental health symptoms and infant bonding in both groups.

## METHODS

### Study design and sample

This cross-sectional Swiss national cohort study (questionnaire survey of Swiss parents) included infants surviving perinatal asphyxia (asphyxia group) born in 2012 and 2013 (i.e., up to 2 years after birth), registered in the national Asphyxia and Cooling register of the Swiss Neonatal Network and Follow-up Group. Infants are anonymously entered in the register if they have a gestational age of more than 35 weeks and fulfil criteria for therapeutic hypothermia (low Apgar score, need for ventilatory support or abnormal blood gases during the first hour of life, clinical signs of encephalopathy during the first 6 hours of life).<sup>19</sup> The questionnaires were sent out to the participating hospitals in May 2014, who then sent them on to the asphyxia group parents. Parents were sent an invitation letter, a participant information sheet and the questionnaires in French, German or English, with a prestamped envelope, by their local referring hospitals.

The control group was recruited during the same time period. Parents of the control group were recruited via flyers in public places, on Swiss internet forums for parents and on a website of the University of Lausanne. They were eligible if they had given birth in 2012 or 2013 to a full-term infant that they judged to be healthy (i.e., up to 2 years after birth). When accessing the online questionnaire, participants first read the information sheet; informed consent was implied when they completed the anonymous questionnaire in French, German or English.

This study was approved by the cantonal ethical review board (Vaud) and by the Swiss Federal Commission for Privacy Protection in Medical Research.

## MEASURES

Parental PTSD was measured using the 17-item Post-traumatic Diagnostic Scale (PDS).<sup>20–22</sup> It provides both a

diagnosis according to DSM-IV criteria and a measure of PTSD symptom severity, as well as symptom cluster severity (re-experiencing, avoidance and hyperarousal)<sup>23–24</sup> and has been widely used in postnatal populations.<sup>25</sup> Participants rated how often they experienced each of the symptoms in the past month, using a 4-point frequency scale ranging from 0 (*not at all or only one time*) to 3 (*5 times per week or almost always*). A *partial* PTSD symptoms diagnosis was defined as meeting the criteria for two of the three PTSD symptom clusters.<sup>25</sup> The PDS has good psychometric properties.<sup>20–21</sup> Cronbach's alpha of the total PDS frequency score ( $\alpha=0.90$ ) and of the three subscales (re-experiencing:  $\alpha=0.85$ ; avoidance:  $\alpha=0.75$ ; hyperarousal:  $\alpha=0.80$ ) was good to excellent.

General psychological distress of parents in the past week was assessed with the Hospital Anxiety and Depression Scale (HADS),<sup>26–28</sup> a 14-item questionnaire. Each item is scored from 0 to 3, with higher scores indicating greater psychological distress.<sup>29</sup> The HADS has good psychometric properties,<sup>27</sup> with a Cronbach's alpha of  $\alpha=0.81$  in the current study.

The Mother-to-Infant Bonding Scale (MIBS)<sup>30</sup> consists of eight adjectives that describe feelings towards their baby (loving, resentful, neutral or felt nothing, joyful, dislike, protective, disappointed and aggressive) and measures infant bonding. Each adjective is followed by a 4-point scale ranging from 0 (*very much*) to 3 (*not at all*). When the adjective reflects a negative emotional response, the scoring is reversed. Possible scores range between 0 and 24, with high scores indicating problematic bonding.<sup>31–32</sup> Cronbach's alpha was fair,  $\alpha=0.77$ .

Parents also completed a demographic questionnaire (age, marital status, migrant status, educational background for mothers, occupation for fathers, previous pregnancy for mothers) with two items assessing whether they had experienced past or current psychological difficulties (In the past, have you already experienced emotional or psychological difficulties? (yes/no). If yes, can you please briefly describe this? Do you currently experience emotional or psychological difficulties? (yes/no). If yes, can you please briefly describe this?) and whether they had experienced a past traumatic event (Have you already experienced a traumatic or particularly stressful situation? (yes/no). If yes, can you please briefly describe this?). Parental socioeconomic status was determined using the Largo score, a 6-point scale, with recorded mother's education ( $1=university$  and  $6=special$  or *no schooling*) and father's occupation ( $1=leading$  position and  $6=unskilled$  labour).<sup>33</sup> Parents also reported demographic details related to their infant (gender, gestational age, birth weight, current age of infant). Neonatal variables were obtained from the national asphyxia register: Apgar score (at 1, 5 and 10 min), umbilical cord pH, number of days when full sucking was achieved, whether infant was resuscitated >10 min, Sarnat stage,<sup>34</sup> whether therapeutic hypothermia had occurred, whether the neurological examination at discharge had been normal and whether any seizure had occurred.

## STATISTICAL ANALYSES

Data were analysed using IBM SPSS V.22. Descriptive statistics were calculated for each scale. Mothers and fathers of the asphyxia and control group were compared separately regarding sociodemographic characteristics using  $\chi^2$  tests, independent samples *t*-tests and Mann-Whitney U-tests. Responders and non-responders within the asphyxia group were compared regarding obstetric and neonatal variables using  $\chi^2$  tests and independent samples *t*-tests. To compare the asphyxia and control groups regarding the central tendencies of the non-normally distributed mental health and bonding outcomes (PDS total score and symptom clusters, HADS, MIBS), rank based Mann-Whitney U-tests were performed. The effect size for the Mann-Whitney statistic was estimated as  $r = z/\sqrt{N}$ .<sup>35</sup> The limits of the 95% CI of the effect size estimate *r* obtained for the Mann-Whitney statistic were calculated with Exploratory Software for Confidence Intervals (ESCI).<sup>35</sup> Established guidelines for the interpretation of *r* suggest that a large effect is 0.50, a medium-sized effect is 0.30 and a small effect is 0.10.<sup>35</sup>

The  $\chi^2$  tests were performed to compare PTSD cluster symptoms between groups. The effect sizes of frequencies analysed with a  $\chi^2$  test were expressed as the differences of the two independent proportions and the corresponding 95% CI was calculated using ESCI.<sup>35</sup> To compare groups regarding PTSD diagnosis (none, partial, full), a Kendall rank correlation analysis was carried out. Bivariate correlation analyses (Pearson's and point-biserial correlations) between sociodemographic, obstetric and neonatal variables and mental health or infant bonding were carried out. Prior to assessing the correlation, the non-normally distributed variables (PDS, HADS, MIBS, Largo, gestational age and Apgar score 1 min) were rank-based inverse normal transformed within each gender using Blom's formula.<sup>36</sup> Given that the non-independence of mothers' and fathers' scores may lead to biased estimates,<sup>37</sup> mothers and fathers were analysed separately. Within each gender, correlations with 95% CI were calculated. The 95% CI for correlations and effect size estimates *r* were calculated using the ESCI.<sup>38</sup>

## RESULTS

### Sample characteristics

For the asphyxia group, parents of 114 registered infants were contacted and 95 parents (52 mothers and 43 fathers) of 53 infants (46.5%) responded. The control group was composed of 134 mothers and 58 fathers. Missing data per variable ranged from 0 to 7 (mothers) and 0 to 13 (fathers). Missing data were not replaced. The comparison of responders and non-responders according to infant neonatal variables listed in tables 1 and 2 resulted in no significant differences (see online supplementary table S1).

Regarding demographic variables, three significant differences between asphyxia and control mothers were found (see table 1): asphyxia group mothers had a higher

Largo score,  $p=0.011$  and reported a lower frequency of previous pregnancies ( $p<0.001$ ) compared with controls. Furthermore, the current age of the infant was higher for the asphyxia group (18 vs 14 months) ( $p<0.001$ ). For fathers, corresponding significant differences were found for Largo score, ( $p=0.002$ ) and current age of the infant (18 vs 14 months,  $p<0.001$ ).

### Mental health symptoms and infant bonding: group comparisons

Mothers in the asphyxia group reported a higher frequency of total PTSD symptoms than controls,  $p_{1\text{-tailed}}<0.001$  (see table 3). This difference was due to a higher frequency of re-experiencing symptoms in asphyxia group mothers compared with controls,  $p_{1\text{-tailed}}<0.001$ . Consistent with the latter finding, mothers in the asphyxia group were also more likely to have at least one re-experiencing symptom than controls,  $\chi^2(1)=25.21$ ;  $p<0.001$  (difference in proportions: 41.7%, 90% CI 29.3% to 51.0%). Fourteen mothers (28%) in the asphyxia group met the criteria for partial PTSD compared with 30 (22%) in the control group. An additional 14 mothers (28%) met the criteria for full PTSD diagnosis compared with 22 (16%) in the control group. When comparing both groups, asphyxia mothers were more likely to receive a partial or full PTSD symptom diagnosis (Kendall's  $\tau=0.16$ ,  $p=0.032$ ). Asphyxia group mothers also reported poorer bonding with the infant compared with controls,  $U=2508.5$ ,  $z=1.72$ ,  $p_{1\text{-tailed}}=0.043$  (see table 3). No significant group difference for the HADS total score was found.

The difference for total PTSD symptoms between asphyxia and control group was also found in fathers,  $p_{1\text{-tailed}}=0.038$  (see table 3). Fathers in the asphyxia group reported a higher frequency of re-experiencing symptoms compared with controls,  $p_{1\text{-tailed}}<0.001$  and were significantly more likely to report at least one re-experiencing symptom compared with controls,  $\chi^2(1)=13.16$ ,  $p<0.001$  (difference in proportions: 37.2%, 90% CI 20.5% to 51.1%). Criteria for partial PTSD were met by  $n=10$  (24%) in the asphyxia group and  $n=13$  (22%) in the control group. Criteria for a full PTSD symptom diagnosis were met by  $n=11$  (27%) fathers of the asphyxia group and  $n=6$  (10%) of the control group. When comparing both groups, asphyxia fathers were more likely to receive a partial or full PTSD symptom diagnosis (Kendall's  $\tau=0.20$ ,  $p=0.034$ ). No significant group differences for the HADS total score or for the MIBS total score were found. In mothers of the asphyxia group, having a trauma in the past was linked to more psychological distress ( $r=0.31$  (95% CI 0.04 to 0.54)) and having a previous pregnancy was linked to poorer bonding ( $r=0.41$  (95% CI 0.13 to 0.63)) (see online supplementary table S2). In fathers of the asphyxia group, therapeutic hypothermia of the infant was related to less frequent PTSD symptoms ( $r=-0.37$  (95%-CI  $-0.61$  to  $-0.06$ )). Past psychological difficulties ( $r=0.37$  (95% CI 0.07 to 0.60)) and past trauma ( $r=0.35$  (95% CI 0.05 to 0.59)) were positively correlated with general psychological distress, and a lower Apgar score

**Table 1** Sample characteristics for mothers and fathers of the asphyxia and control groups

| Characteristics                             | Mothers         |                 |                  | Fathers |                 |                |                  |         |
|---|-----------------|-----------------|------------------|---------|-----------------|----------------|------------------|---------|
|   | Asphyxia (n=52) | Control (n=134) | t, U or $\chi^2$ | p Value | Asphyxia (n=43) | Control (n=58) | t, U or $\chi^2$ | p Value |
| <b>Parents</b>                              |                 |                 |                  |         |                 |                |                  |         |
| Age (years)                                 | 32.02±4.74      | 32.44±4.27      | -0.57            | 0.567   | 35.12±6.29      | 34.64±4.53     | 0.42             | 0.679   |
| Largo score                                 | 2 (1-5)         | 1 (1-5)         | 2668.0           | 0.011   | 3 (1-6)         | 2 (1-4)        | 657.5            | 0.002   |
| Marital status (with partner)               | 48 (92%)        | 126 (94%)       | 0.18             | 0.668   | 42 (98%)        | 56 (97%)       | 0.11             | 0.742   |
| Migrant status (yes)                        | 16 (31%)        | 33 (25%)        | 0.73             | 0.393   | 14 (33%)        | 19 (33%)       | 0.00             | 0.983   |
| Previous pregnancy (yes)                    | 21 (42%)        | 100 (76%)       | 18.55            | <0.001  | -               | -              | -                | -       |
| History of psychological difficulties (yes) | 19 (37%)        | 46 (34%)        | 0.08             | 0.777   | 9 (21%)         | 7 (12%)        | 1.59             | 0.208   |
| Past trauma (yes)                           | 27 (52%)        | 50 (37%)        | 3.30             | 0.069   | 15 (36%)        | 21 (36%)       | 0.00             | 0.960   |
| <b>Infants</b>                              |                 |                 |                  |         |                 |                |                  |         |
| Gestational age (weeks)                     | 40 (35-42)      | 40 (35-42)      | 3378.0           | 0.929   | 40 (35-42)      | 40 (37-46)     | 964.5            | 0.979   |
| Birth weight (g)                            | 3381.25±408.11  | 3396.53±506.19  | -0.19            | 0.846   | 3426.05±421.38  | 3307.55±504.76 | 1.20             | 0.232   |
| Age at survey (months)                      | 18.16±7.46      | 14.13±7.04      | 3.44             | <0.001  | 18.76±7.15      | 13.60±6.28     | 3.66             | <0.001  |
| Gender (female)                             | 21 (40%)        | 75 (56%)        | 3.64             | 0.056   | 18 (42%)        | 20 (41%)       | 0.01             | 0.919   |

Values are expressed as mean±standard deviation, median (range) or n (%). Due to missing data, effective sample sizes ranged from n=182 to 186 (mothers) and from n=88 to 101 (fathers).

**Table 2** Clinical characteristics of the asphyxia children

| Characteristics                          | M±SD or n (%) |
|--|---------------|
| Apgar 1 min                              | 2.11±2.05     |
| Apgar 5 min                              | 3.74±2.27     |
| Apgar 10 min                             | 5.06±2.37     |
| When was full sucking achieved (in days) | 6.88±5.11     |
| Resuscitated>10 min (yes)                | 27 (51%)      |
| Therapeutic hypothermia (yes)            | 41 (77%)      |
| Neurological examination normal (yes)    | 31 (59%)      |
| Seizures (yes)                           | 4 (8%)        |
| Sarnat stage 1                           | 14 (33%)      |
| Sarnat stage 2                           | 25 (58%)      |
| Sarnat stage 3                           | 4 (9%)        |

Due to missing data, effective sample size ranges n=43 to 53.

was linked to poorer bonding ( $r=-0.38$  (95% CI=-0.64 to -0.05)) (see online supplementary table S3).

## DISCUSSION

This cross-sectional questionnaire-based Swiss national cohort study comparing parents of infants surviving perinatal asphyxia with those of healthy infants found more frequent PTSD (and particularly re-experiencing) symptoms and more frequent partial or full PTSD symptom diagnosis in asphyxia parents compared with control parents. Furthermore, poorer bonding with the infant in mothers of infants born with asphyxia compared with controls was found. Results need to be considered with caution, as mothers in the asphyxia group had a lower socioeconomic status, a lower frequency of previous pregnancies and slightly older infants compared with controls. Compared with control fathers, fathers in the asphyxia group had a lower socioeconomic status and older infants.

These results show for the first time that parents of infants with perinatal asphyxia experience elevated symptoms of PTSD, such as has been reported for other populations of high-risk parents, for example, those of premature or critically ill infants.<sup>9-11</sup> Our finding that mothers of the asphyxia group reported poorer bonding with their infant is in line with other studies of traumatised mothers.<sup>18</sup> The lack of differences between the asphyxia and control parents in relation to general psychological distress (HADS total score) points to a generally healthy psychological adjustment of parents that might partly be due to a good experience of care regarding their infant and effective staff support.

When investigating potential risk factors for mental health problems in asphyxia group parents, we found that having experienced a past trauma was moderately associated with more general psychological distress in both mothers and fathers. This is in line with research identifying a previous traumatic experience as a risk factor

for developing PTSD following childbirth<sup>39</sup> and depression in the general adult population.<sup>40</sup> Our finding that having previously been pregnant was moderately associated with more bonding problems in mothers is novel. It may be that already being a mother makes it harder to invest oneself in a relationship with another child, particularly one that is severely ill. Alternatively, infants who had asphyxia at birth may be less effective in interactions with mothers and mothers may thus find it harder to bond with them. However, more research is needed to explore this. Given the small number of mothers in the asphyxia group, none of the weak correlations of the other neonatal variables were statistically significant but the small to medium-sized effects might be detected with a more powerful design.

For fathers in the asphyxia group, therapeutic hypothermia of the infant was moderately related to less frequent PTSD symptoms. This is a novel finding and might be linked to a certain level of reassurance that fathers feel when witnessing a highly technological treatment, thus reducing their perceived threat to their infant's life. Similar to mothers, past psychological difficulties and past trauma were positively and moderately correlated with current general psychological distress, which is in line with previous research in the general adult population.<sup>40</sup> Finally, a lower Apgar score (10 min) was moderately associated with more bonding problems. This novel result may be explained by the fact that a lower Apgar score would have indicated a more severe life threat for the infant and fathers might have unintentionally found it harder to develop a bond with their infant for fear of losing it. However, this remains to be explored in future studies.

Strengths of the study are the inclusion of a national cohort, the comparison with a control group and the use of standardised questionnaires. The effect sizes of the significant correlations were all moderate and are thus of potential clinical relevance. The relatively low response rate (47%) is comparable with other studies of high-risk populations<sup>8</sup> and regarded as fair, particularly given the tendency of traumatised parents to avoid reminders of the childbirth or hospital stay. Limitations of the study include the cross-sectional, retrospective design of the study, thus not allowing for causal conclusions, the risk of a reporting bias and potential problems with multiple testing. The small sample size related to the low prevalence of perinatal asphyxia limited the statistical power, despite it being a national cohort study. The MIBS has so far not been validated for the use with fathers, for whom a bonding questionnaire remains to be developed. Caution needs to be taken in interpreting the results, given that both groups differed on sociodemographic characteristics. Further limitations are the recruitment of the anonymous control group via flyers in public places, not allowing us to check for health problems of their infants and relying on the self-report of the parents. Finally, the temporal nature of the associations, and the potential impact of events between birth and the parental

**Table 3** Range and median questionnaire scores, Mann-Whitney-U-test coefficients and effect size estimates *r* for mothers and fathers in the asphyxia group and control group

|                       | Asphyxia |       |      |       | Control |      |       |       | U      | z       | r (95% CI)             |
|-----------------------|----------|-------|------|-------|---------|------|-------|-------|--------|---------|------------------------|
|                       | M        | SD    | Md   | Range | M       | SD   | Md    | Range |        |         |                        |
| <b>Mothers</b>        |          |       |      |       |         |      |       |       |        |         |                        |
| PDS total score       | 8.80     | 7.19  | 6.00 | 0-37  | 5.95    | 6.55 | 4.00  | 0-30  | 2291.0 | 3.14*** | 0.23 (0.11 to 0.34)    |
| PDS re-experiencing   | 3.29     | 2.81  | 3.00 | 0-12  | 1.29    | 2.09 | 0.00  | 0-12  | 1600.0 | 5.58*** | 0.40 (0.29, to 0.50)   |
| PDS avoidance/numbing | 2.52     | 2.86  | 1.50 | 0-12  | 2.07    | 2.78 | 1.00  | 0-16  | 2954.0 | 1.27    | 0.09 (-0.03 to 0.21)   |
| PDS hyperarousal      | 2.88     | 2.95  | 2.00 | 0-13  | 2.59    | 2.84 | 2.00  | 0-14  | 3101.5 | 0.79    | 0.06 (-0.06 to 0.18)   |
| HADS total score      | 9.38     | 5.88  | 9.00 | 0-25  | 10.83   | 5.55 | 10.00 | 0-33  | 2871.5 | -1.86   | -0.14 (-0.25 to -0.02) |
| MIBS total score      | 3.38     | 3.65  | 2.00 | 0-13  | 2.38    | 3.38 | 1.00  | 0-20  | 2508.5 | 1.72*   | 0.13 (0.01 to 0.25)    |
| <b>Fathers</b>        |          |       |      |       |         |      |       |       |        |         |                        |
| PDS total score       | 8.82     | 10.61 | 7.00 | 0-45  | 4.62    | 5.10 | 3.00  | 0-20  | 892.0  | 1.77*   | 0.18 (0.01 to 0.34)    |
| PDS re-experiencing   | 2.93     | 3.56  | 2.00 | 0-15  | 0.66    | 1.19 | 0.00  | 0-5   | 612.0  | 4.29*** | 0.41 (0.26 to 0.54)    |
| PDS avoidance/numbing | 2.71     | 3.76  | 1.00 | 0-18  | 1.81    | 2.59 | 1.00  | 0-12  | 1002.0 | 1.39    | 0.14 (-0.02 to 0.30)   |
| PDS hyperarousal      | 3.27     | 3.91  | 2.00 | 0-14  | 2.16    | 2.18 | 2.00  | 0-8   | 1085.0 | 0.76    | 0.06 (-0.11 to 0.22)   |
| HADS total score      | 8.57     | 5.74  | 7.00 | 0-27  | 9.10    | 5.38 | 9.00  | 2-32  | 1158.0 | -0.61   | -0.06 (-0.22 to 0.11)  |
| MIBS total score      | 2.09     | 2.79  | 1.00 | 0-11  | 2.55    | 3.05 | 1.00  | 0-14  | 843.0  | -0.80   | -0.08 (-0.26 to 0.09)  |

$r = z / \sqrt{N}$ ; 95% CI=lower and upper level of the 95% CI. The total sample sizes ranged from n=179 to 186 (mothers) and from n=89 to 101 (fathers).

\* $p < 0.05$ .

\*\*\* $p < 0.001$  (1-tailed).

HADS, Hospital Anxiety and Depression Scale; M, mean; Md, median; MIBS, Mother-to-Infant Bonding Scale; PDS, Post-traumatic Diagnostic Scale; U, MannWhitney test statistic; z, z test (a positive z-score denotes higher scale scores in the asphyxia group).

responses, which we did not ask for in either group, may have potentially influenced the study outcomes. We also did not ask parents in either group about infant health issues or events since birth, which may have potentially influenced the study outcomes. Future studies with a larger cohort, a prospective design and a control group matched on important sociodemographic variables are needed. Furthermore, investigating the effects of PTSD and bonding on infant outcomes would be of interest.

## CONCLUSION

This study showed for the first time more frequent PTSD (and particularly re-experiencing) symptoms and more partial or full PTSD diagnosis in asphyxia group parents and poorer infant bonding in asphyxia group mothers compared with the control group. Furthermore, we found that a history of past trauma puts parents at increased risk of general psychological distress after perinatal asphyxia.

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**Data sharing statement** The datasets analysed during the current study are available from the corresponding author on reasonable request.

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## REFERENCES

- American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. 5th edn. VA, Arlington: American Psychiatric Publishing, 2013.
- Azzopardi D. Clinical management of the baby with hypoxic ischaemic encephalopathy. *Early Hum Dev* 2010;86:345–50.
- Shankaran S, Barnes PD, Hintz SR, *et al*. Brain injury following trial of hypothermia for neonatal hypoxic-ischaemic encephalopathy. *Arch Dis Child Fetal Neonatal Ed* 2012;97:F398–F404.
- Pappas A, Shankaran S, McDonald SA, *et al*. Cognitive outcomes after neonatal encephalopathy. *Pediatrics* 2015;135:e624–e634.
- Edwards AD, Brocklehurst P, Gunn AJ, *et al*. Neurological outcomes at 18 months of age after moderate hypothermia for perinatal hypoxic ischaemic encephalopathy: synthesis and meta-analysis of trial data. *BMJ* 2010;340:c363.
- Lau R, Morse CA. Stress experiences of parents with premature infants in a special care nursery. *Stress and Health* 2003;19:69–78.
- Rautava P, Lehtonen L, Helenius H, *et al*. Effect of newborn hospitalization on family and child behavior: a 12-year follow-up study. *Pediatrics* 2003;111:277–83.
- Horsch A, Tolsa JF, Gilbert L, *et al*. Improving maternal mental health following preterm birth using an expressive writing intervention: a randomized controlled trial. *Child Psychiatry Hum Dev* 2016;47:780–91.
- Feeley N, Zerkowicz P, Cormier C, *et al*. Posttraumatic stress among mothers of very low birthweight infants at 6 months after discharge from the neonatal intensive care unit. *Appl Nurs Res* 2011;24:114–7.
- Karatzias T, Chouliara Z, Maxton F, *et al*. Post-traumatic symptomatology in parents with premature infants: a systematic review of the literature. *J Prenat Perinat Psychol Health* 2007;21:249–61.
- Pierrehumbert B, Nicole A, Muller-Nix C, *et al*. Parental post-traumatic reactions after premature birth: implications for sleeping and eating problems in the infant. *Arch Dis Child Fetal Neonatal Ed* 2003;88:–.
- Lefkowitz DS, Baxt C, Evans JR. Prevalence and correlates of posttraumatic stress and postpartum depression in parents of infants in the Neonatal Intensive Care Unit (NICU). *J Clin Psychol Med Settings* 2010;17:230–7.
- Heringhaus A, Blom MD, Wigert H. Becoming a parent to a child with birth asphyxia-From a traumatic delivery to living with the experience at home. *Int J Qual Stud Health Well-being* 2013;8:20539–13.
- Nassef SK, Blennow M, Jirwe M. Experiences of parents whose newborns undergo hypothermia treatment following perinatal asphyxia. *J Obstet Gynecol Neonatal Nurs* 2013;42:38–47.
- Arockiasamy V, Holsti L, Albersheim S. Fathers' experiences in the neonatal intensive care unit: a search for control. *Pediatrics* 2008;121:e215–e222.
- Cook N, Ayers S, Horsch A. Maternal posttraumatic stress disorder during the perinatal period and child outcomes: A systematic review. *J Affect Disord* 2017;225:18–31.
- Forcada-Guex M, Pierrehumbert B, Borghini A, *et al*. Early dyadic patterns of mother-infant interactions and outcomes of prematurity at 18 months. *Pediatrics* 2006;118:e107–e114.
- Parfitt YM, Ayers S. The effect of post-natal symptoms of post-traumatic stress and depression on the couple's relationship and parent–baby bond. *J Reprod Infant Psychol* 2009;27:127–42.
- Brotschi B, Grass B, Ramos G, *et al*. The impact of a register on the management of neonatal cooling in Switzerland. *Early Hum Dev* 2015;91:277–84.
- Foa EB, Cashman L, Jaycox L, *et al*. The validation of a self-report measure of posttraumatic stress disorder: The Posttraumatic Diagnostic Scale. *Psychol Assess* 1997;9:445–51.
- Hearn M, Ceschi G, Brillon P, *et al*. A French adaptation of the Posttraumatic Diagnostic Scale. *Can J Behav Sci* 2012;44:16–28.
- Stieglitz RD, Frommberger U, Foa EB, *et al*. Evaluation of the German version of the PTSD Symptom Scale (PSS). *Psychopathology* 2001;34:128–33.
- Foa E. *Manual for the Posttraumatic Stress Diagnostic Scale (PDS)*. Minneapolis, MN: National Computer Systems Inc, 1995.
- Foa EB, Meadows EA. Psychosocial treatments for posttraumatic stress disorder: a critical review. *Annu Rev Psychol* 1997;48:449–80.
- Shlomi Polachek I, Dulitzky M, Margolis-Dorfman L, *et al*. A simple model for prediction postpartum PTSD in high-risk pregnancies. *Arch Womens Ment Health* 2016;19:483–90.
- Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand* 1983;67:361–70.
- Bocéréan C, Dupret E. A validation study of the Hospital Anxiety and Depression Scale (HADS) in a large sample of French employees. *BMC Psychiatry* 2014;14:1.
- Herrmann C, Buss U, Snaith R, *et al*. *Depression Scale–Deutsche Version*[Ein Fragebogen von Angst und Depressivität in der somatischen Medizin]. Bern, Schweiz: Hans Huber, 1995.
- Norton S, Cosco T, Doyle F, *et al*. The Hospital Anxiety and Depression Scale: a meta confirmatory factor analysis. *J Psychosom Res* 2013;74:74–81.



30. Taylor A, Atkins R, Kumar R, *et al.* A new Mother-to-Infant Bonding Scale: links with early maternal mood. *Arch Womens Ment Health* 2005;8:45–51.
31. van Bussel JC, Spitz B, Demyttenaere K. Three self-report questionnaires of the early mother-to-infant bond: reliability and validity of the Dutch version of the MPAS, PBQ and MIBS. *Arch Womens Ment Health* 2010;13:373–84.
32. Wittkowski A, Wieck A, Mann S. An evaluation of two bonding questionnaires: a comparison of the Mother-to-Infant Bonding Scale with the Postpartum Bonding Questionnaire in a sample of primiparous mothers. *Arch Womens Ment Health* 2007;10:171–5.
33. Largo RH, Pfister D, Molinari L, *et al.* Significance of prenatal, perinatal and postnatal factors in the development of AGA preterm infants at five to seven years. *Dev Med Child Neurol* 1989;31:440–56.
34. Sarnat HB, Sarnat MS. Neonatal encephalopathy following fetal distress. A clinical and electroencephalographic study. *Arch Neurol* 1976;33:696–705.
35. Fritz CO, Morris PE, Richler JJ. Effect size estimates: current use, calculations, and interpretation. *J Exp Psychol Gen* 2012;141:2–18.
36. Bishara AJ, Hittner JB. Reducing bias and error in the correlation coefficient due to nonnormality. *Educ Psychol Meas* 2015;75:785–804.
37. Kenny DA. The effect of nonindependence on significance testing in dyadic research. *Relationships* 1995;2:67–75.
38. Cumming G *Understanding the new statistics: effect sizes, confidence intervals, and meta-analysis: Routledge* 2013.
39. Andersen LB, Melvaer LB, Videbech P, *et al.* Risk factors for developing post-traumatic stress disorder following childbirth: a systematic review. *Acta Obstet Gynecol Scand* 2012;91:1261–72.
40. Flory JD, Yehuda R. Comorbidity between post-traumatic stress disorder and major depressive disorder: alternative explanations and treatment considerations. *Dialogues Clin Neurosci* 2015;17:141.