Accurate early identification of postpartum depression using demographic, clinical and digital phenotyping

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Introduction

- **Postpartum depression** (PPD) is diagnosed in up to **13 % of women** after childbirth [1-2]
- Development of PPD depends on **many factors**, but its **definite cause** is **unknown.** Several known risk factors are associated with PPD, such as history of depression, postpartum blues or premenstrual syndrome [1, 4-9]
- In contrast to other psychiatric disorders, PPD is **more easily treatable with most effective prevention/ intervention** shortly after delivery in at-risk mothers [3, 5, 10-11]
- Most attempts for the **prediction** have either been **late** in the postpartum period (e.g. after 8-32 weeks) [15] **or** only reached a **low sensitivity** [16]
- There are **no accurate predictors** for PPD to such an extent that at-risk mothers can be identified and can benefit from early interventions

→ Here, we **evaluate** the **potential predictive power** of baseline **demographic, clinical and digital phenotyping** for early identification of PPD

Methods

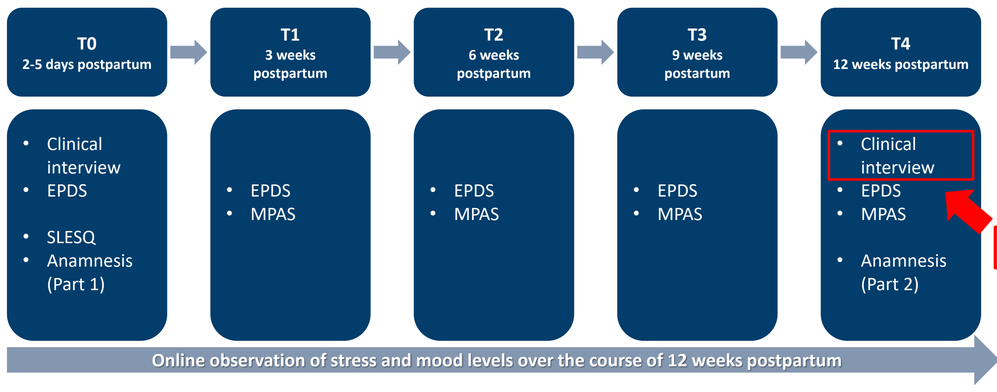

Figure 1. Study design.

EPDS: Edinburgh Postnatal Depression Scale
MPAS: Maternal Postnatal Attachment Scale
SLESQ: Stressful Life Events Screening Questionnaire

- **308 mothers** (mean age = 31.7 ± 4.76) were recruited after giving birth at the University Hospital Aachen
- **Defined into three groups at week 12** (according to DSM-5 [12])
  - Healthy controls (HC)
  - Women with PPD
  - Women with adjustment disorder (AD)
- Measurements at **five different time points (T0 - T4)** separated by three-week intervals
- **Digital phenotyping: mood and stress levels** (i.e. scale from one to ten) were filled in online on a daily basis
- **Statistical analysis:**
  - Anamnestic data incl. SLESQ: Pearson X^2 test and logistic regression
  - Mood and stress levels, MPAS and EPDS scores: mixed ANOVA
- **Machine learning analysis:**
  - Logistic regression classifier with 1000 permutations of three-fold cross-validation for each group comparison
  - Calculation of balanced accuracy, sensitivity, specificity and area under the curve (AUC)

Results

Table 1. Anamnestic data.

Anamnestic variable	HC	PPD	AD	Statistical test
Personal psychiatric history (no/yes)	221/27	16/12	19/14	$X^2(2, N= 309) = 34.7$ $p < .001$ *1,2
Familial psychiatric history (no/yes)	195/53	16/12	18/15	$X^2(2, N = 309) = 13.4$ $p = .001$ *1,2
Birth-related psychological and physical traumas	215/30	19/9	20/13	$X^2(2, N= 306) = 20.2$ $p < .001$ *1,2
Premenstrual syndrome (no PMS/mild PMS/PMS)	111/85/29	4/12/12	7/16/10	$X^2(4, N= 286) = 27.9$ $p < .001$ *1,2
Baby blues (no/yes)	152/93	8/20	7/26	$X^2(2, N= 306) = 28.0$ $p < .001$ *1,2
Stressful life events (no/yes)	145/103	11/17	12/20	$X^2(2, N= 308) = 7.92$ $p = .019$
Breastfeeding T4 (no/yes)	63/183	14/14	8/25	$X^2(2, N= 307) = 7.69$ $p = .021$ *1
Non-significant anamnestic data	Age, marital status, total amount of children, education, week of gestation, birth complications, gender and weight of the baby, child relocated to another ward			
No statistical analysis possible	Family status, professional education, income, breastfeeding T0, psychiatric diagnosis in previous pregnancy, quality of support at home			

* Bonferroni-corrected significant difference ($p < .05$) between [1] HC and PPD, [2] between HC and AD and/or [3] between PPD and AD

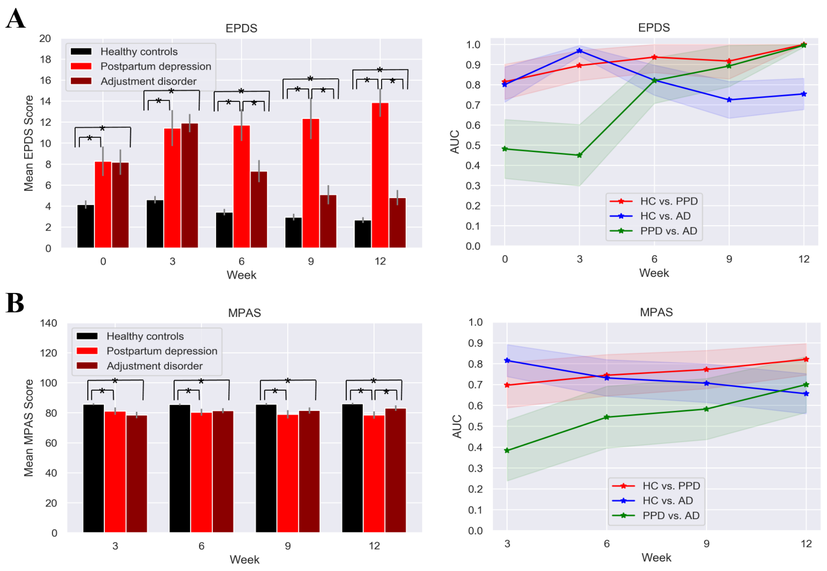

Figure 2. EPDS and MPAS mean scores. EPDS (A) and MPAS (B) mean scores and associated AUCs for each time point and group separately incl. their standard error and 95 % confidence interval. Statistically significant t-tests for group comparisons are marked with *.

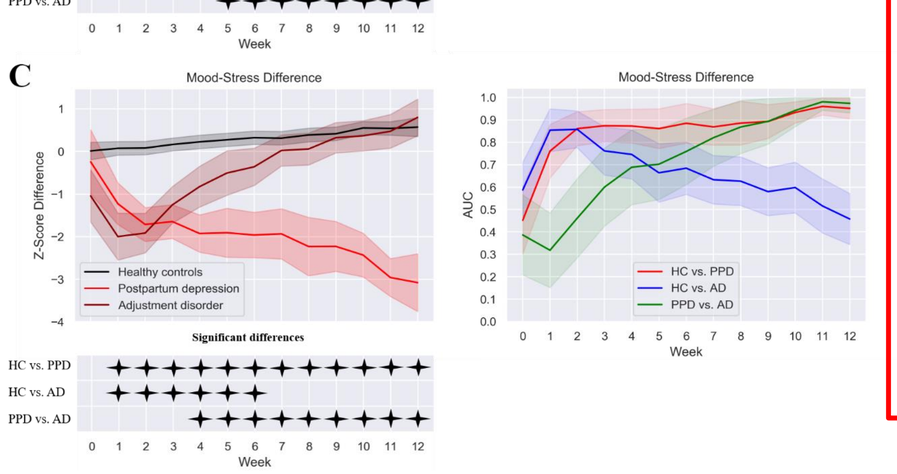

Figure 3. Mood, stress and mood-stress difference scores. Weekly mood (A), stress (B) and mood-stress difference scores (C) incl. 95 % confidence intervals, results of the simple effects analyses and AUCs incl. 95 % confidence interval for each group comparison.

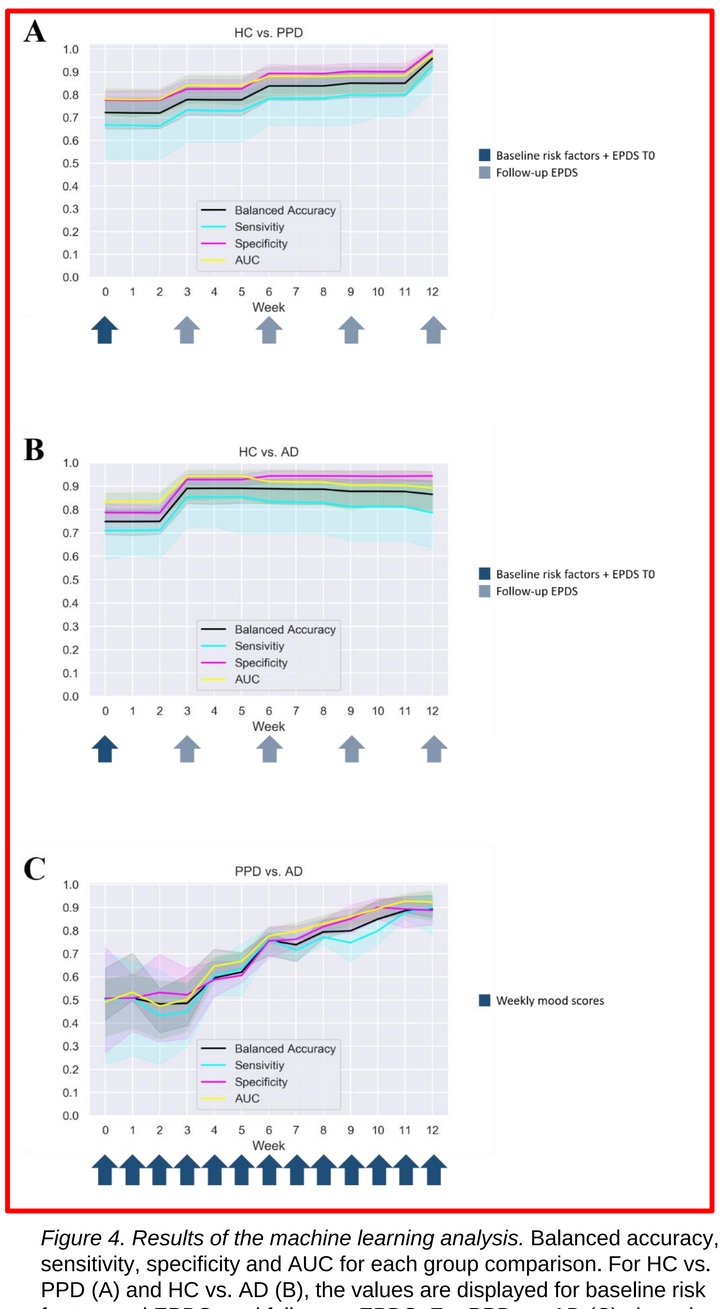

Figure 4. Results of the machine learning analysis. Balanced accuracy, sensitivity, specificity and AUC for each group comparison. For HC vs. PPD (A) and HC vs. AD (B), the values are displayed for baseline risk factors and EPDS, and follow-up EPDS. For PPD vs. AD (C), the values are displayed for mood scores without anamnestic data.

Discussion

- **Demographic and clinical risk factors** alone **did not differentiate** between women with **PPD and** women with **AD**
- Significant **risk factors for PPD** were largely **in accordance with** the **literature** [1, 4-9]
  - Breastfeeding (T4) as consequence and not as protective factor [13-14]
- **EPDS** and **MPAS** scores, **mood** and **stress** levels **displayed** a **distinctive pattern** for PPD and AD as compared to HC
  - EPDS was more sensitive than MPAS
  - Mood levels allowed for an accurate early differentiation of PPD and AD from HC
- The single factor **mood** allowed for an **accurate discrimination** of both **PPD and AD from HC** at **week 1** with an **AUC of 0.78** (PPD vs. HC) **and 0.86** (AD vs. HC)
- Most **accurate early differentiation** was achieved by using baseline demographic and clinical risk factors and EPDS **at week 3** with a **balanced accuracy of 0.78 for PPD vs. HC and** a balanced accuracy of **0.89 for AD vs. HC**
- **Accurate differentiation of PPD vs. AD** was only possible at **week 6** with mood scores being most accurate resulting in a balanced accuracy of 0.76
- Combinations of mood evaluation, EPDS and baseline demographic and clinical risk factors allowed for an **accurate identification of women at risk for PPD**

References: [**1**] O'Hara & Swain 1996, International Review of Psychiatry, 8:1, 37-54; [**2**] Goodman et al. 2008, Handbook of Clinical Psychology, 2, 937-965; [**3**] O'Hara 2009, Journal of Clinical Psychology, 65(12), 1258-1269; [**4**] Beck 2001, Nursing Research, 50(5), 275-285; [**5**] O'Hara & McCabe 2013, Annual Review of Clinical Psychology, 9, 379-407; [**6**] Robertson et al. 2004, General Hospital Psychiatry, 26(4), 289-295; [**7**] Buttner et al. 2013, Archives of Women's Mental Health, 16(3), 219-225; [**8**] Lee et al. 2015, Obstetrics & Gynecology Science, 58(5), 353-358; [**9**] Sylvén et al. 2013, Acta Obstetricia et Gynecologica Scandinavica, 92(2), 178-184; [**10**] Miller 2002, JAMA, 287(6), 762-765; [**11**] Stewart & Vigod 2016, New England Journal of Medicine, 375(22), 2177-2186; [**12**] American Psychological Association 2013, Diagnostic and statistical manual of psychiatric disorders (5th ed.); [**13**] Henderson et al. 2003, Birth, 30(3), 175-180; [**14**] Taveras et al. 2003, Pediatrics, 112(1), 108-115; [**15**] Camdeviren et al. 2007, Expert Systems with Applications, 32(4), 987-994; [**16**] Tortajada et al. 2009, Methods of Information in Medicine, 48(03), 291-298; [**17**] Jiménez-Serrano et al. 2015, Telemedicine and e-Health, 21(7), 567-574