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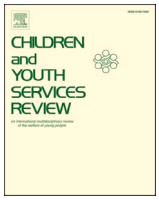

Utilization and costs of health care and early support services in Germany and the influence of mental health burden during the postnatal period

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ABSTRACT

Limited evidence is available about health care utilization and its determinants in the vulnerable postnatal period for mothers and their children. Thus, the aim of our analyses was to assess determinants of health care and early support services utilization regarding mothers and their children and associated costs in the postnatal period in Germany. Moreover, we aimed to investigate the impact of noticeable mental health and psychosocial burdens on health care and early support services utilization and costs. Using a two-step assessment process of parents from a randomly selected sample of 30,000 recently born children in the multicenter observational population-based cohort study of the SKKIPPI project, we firstly identified mothers who were potentially at risk of mental health and psychosocial burden. These mothers were then invited to participate in an in-depth assessment, including a detailed self-developed questionnaire focusing on early support and health care services utilization. A follow-up after 6 months was conducted. Potential determinants of early support services utilization were analyzed using logistic regression. General linear models with gamma distribution and log link functions were applied to analyze potential determinants of health care costs and to estimate mean adjusted costs. Mothers with a noticeable mental health or psychosocial burden and their children caused mean early support services costs of €1073 and caused total costs of €10,849 in the postnatal period from a payer's perspective compared to €349 (early support services) and €9136 (total costs) for mothers without a noticeable mental health or psychosocial burden and their children. The main determinants of total costs were facing a chronic disease (child), preterm delivery, bad experiences with doctors and midwives, and single parenthood. The majority of participants (69 %) utilized some kind of early support services. The most important determinants of early support service utilization in the postnatal period with respect to the children were facing a chronic disease, being the first child, and being born as a twin. Our findings highlight the importance of sufficient appreciation and treatment of mental health problems in the postnatal period from both a societal and payer's perspective. Future research should investigate whether these and more specific interventions could be a cost-effective way to support mothers with mental health or psychosocial burden and their children.

Abbreviations: EPDS, Edinburgh Postnatal Depression Scale; ESS, Early support services; M.I.N.I., Mini-International Neuropsychiatric Interview; NMPB, Noticeable mental health or psychosocial burden; PBA, Parental Burnout Assessment; RCT, Randomized controlled trial; step 2, screening step 2.

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1. Introduction

The postnatal period is regularly accompanied by major life changes. It can potentially affect all family members and areas of living such as housing, social relationships, and future careers. Coping with these changes can be very challenging for those affected. This makes it a vulnerable time for both parents and their children, with potentially negative short to long-term effects on their mental well-being e.g. in the form of psychosocial stress and postnatal depression (Diem-Wille, 2014; Fricke et al., 2020; Insan, Weke, Forrest, & Rankin, 2022; Stein et al., 2014; Verbeke, Bogaerts, Nuyts, Crombag, & Luyten, 2022).

The main research focus on this worldwide health problem has been on maternal postnatal depression and anxiety disorders. A recent systematic review and *meta*-analysis estimated the pooled prevalence of postnatal depression, based solely on the Edinburgh Postnatal Depression Scale (EPDS) (Cox, Holden, & Sagovsky, 1987), to be between 9 % (EPDS score $\geq$ 14) and 27.8 % (EPDS $\geq$ 9) (Lyubenova et al., 2021). The inclusion of additional instruments increased the variation in prevalence which ranged between 4 % and 64 % according to a further review (Arifin, Cheyne, & Maxwell, 2018). The prevalence of postnatal anxiety disorders varies across self-reported anxiety symptoms (15 %) and clinically diagnosed anxiety disorders (10 %) (Dennis, Falah-Hassani, & Shiri, 2017). The displayed variety in results expands to the newer concept of parental burnout (Mikolajczak & Roskam, 2018). Its prevalence ranges between $<$ 1 % and $>$ 8 % across countries in the pre-SARS-CoV-2 era (Isabelle Roskam et al., 2021). A recent study from Spain, which started its data collection shortly after the SARS-CoV-219 related confinements in 2020, found a markedly higher prevalence level of over 26 % (Suárez, Núñez, Cerezo, Rosário, & Rodríguez, 2022). Likewise, current analyses from Germany showed that parental stress increased during the pandemic. Moreover, the authors found higher prevalence levels of depressive symptoms (12.3 %) and anxiety (9.7 %) than the German normative data (Calvano et al., 2022; Löwe et al., 2010). The described maternal and parental mental health problems can have negative implications on their children (Stein et al., 2014). Ranging from regulatory or development problems in early childhood to a greater risk of developing poor mental health outcomes over the course of their lives (Brennan et al., 2000; Martini et al., 2017; Reck, Nonnenmacher, & Zietlow, 2016; Reck et al., 2018; Sidor, Fischer, & Cierpka, 2017).

In addition to clinical treatments such as psychotherapeutic and psychiatric services, so-called early support services (ESS) can be more easily accessible interventions for burdened families. In Germany, early support includes a broad range of services and interventions for families and especially burdened families aiming to improve development opportunities of children and families (Buschhorn, 2012; Nationales Zentrum Frühe Hilfen, 2016). Ranging from support through family midwives, over supervised parents' meetings and welcoming visits by professionals and volunteers to provide useful information about available services to various other services and interventions. With the focus on Germany, Fricke et al., 2020 gives a description of available programs. However, barriers like stigma associated with mental health disorders, lead to insufficient utilization of psychotherapeutic and psychosocial interventions (Ford, Roomi, Hugh, & van Marwijk, 2019; Hadfield & Wittkowski, 2017). Around 90 % of the German population is insured with one of the almost 100, competing, not-for-profit statutory health insurance companies following a solidarity principle. Everyone earning over a fixed income level can choose to opt out of the statutory system and get insured with one of 43 substitutive private health insurance companies. The vast majority of health care expenditures are covered under both insurance systems. The public health sector is organized under broad federal, state and municipalities responsibilities with a heterogeneous level of services. The costs are mainly borne by the general public through taxation. Activities range from prevention, surveillance and containment of communicable diseases, health reporting as well as the provision of ESS. Blümel et al., 2020 are giving a detailed description of the German health care system and its various different players (Blümel, Spranger, Achstetter, Maresso, & Busse, 2020).

Only scarce information about the health care and ESS utilization as well as its underlying costs for mothers facing mental health burdens and their children is available. The limited evidence suggest that a higher educational level is associated with greater knowledge and utilization of ESS interventions in Germany. The only exception is the utilization of family midwives, with higher utilization by less-educated families (Eickhorst et al., 2016; Salzmann, Fullerton, & Sann, 2021).

The aim of our analyses was to investigate the determinants of health care and early support services utilization by mothers and their newborn children and associated costs in the postnatal period in Germany. Moreover, we aimed to investigate the impact of noticeable mental health and psychosocial burdens on health care and early support services utilization and costs in the postnatal period. A priori, no hypotheses were posed due to the explorative character of our secondary analyses.

2. Material and methods

Our analyses are embedded in the collaborative SKKIPPI project, which consists of two randomized controlled trials (RCTs) and an observational population-based cohort study (Fricke et al., 2020). Both RCTs evaluate the efficacy and cost-effectiveness of a parent-infant-psychotherapy program compared to usual care in mothers and children with regulatory disorders in clinical and outpatient settings (Mattheß et al., 2020; Sprengeler et al., 2021).

The present work is based on self-reported health and social care utilization data collected within the observational study. Ethical approval for this study was obtained from the ethics committee of the Charité - Universitätsmedizin Berlin (reference number: EA2/201/18).

2.1. Participants

An extensive two-step assessment process of parents (natural or adoptive, at least 18 years old) from a randomly selected sample of almost 30,000 contact addresses of children born within the last 12 months at the time of sampling, from three urban region registry offices in Germany (25,200 from Berlin, 4250 from Leipzig, and 550 from Flensburg) was conducted between March 2019 and September 2020.

Inclusion criteria comprised that mothers were at least 18 years of age and the child not older than 2 and a half years of age at the screening step 1. Furthermore, mothers must have been able to complete the questionnaires and interview in English, Turkish, or Arabic language.

2.2. Instruments

2.2.1. Baseline

Self-developed online questionnaire (in German, English, Turkish, or Arabic language) to retrieve basic socio-demographic data of the participants and to identify parents who were potentially at risk of facing a mental health or psychosocial burden (Appendix A1). Being potentially at risk was defined as a score of at least 10 points in this questionnaire (Fricke et al., 2020).

2.2.2. Screening step 2 and follow-up after 6 months

Detailed self-developed questionnaire on health and social care utilization of the participating mother and her index child was applied (Appendix A2). The questionnaire consists of 18 questions on the utilization of health care services and 8 questions on the social care service utilization. The assessment of utilization ranged from binary yes/no answers to specific number of utilizations or length of stays.

Adapted version of the Mini-International Neuropsychiatric Interview (M.I.N.I.) (Sheehan et al., 1998), a short structured and validated interview to assess the occurrence of mental health disorders, e.g. postnatal depression or anxiety.

Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987), a

10-item self-report screening instrument to reliably identify woman at risk of postnatal depression. Each question contains 4 possible answers with underlying point values from zero to four. A total score of 13 or higher over all questions indicates major depressive symptoms

Parental Burnout Assessment questionnaire (PBA) (I. Roskam, Brianda, & Mikolajczak, 2018), a 22-item self-report questionnaire consisting of three sections, emotional exhaustion, emotional distancing, and loss of parental accomplishments. All items are rated on 7-point Likert scales from zero (never) to six (every day). A total score above 76 indicates the presence of parental burnout symptoms.

Questionnaire on crying, feeding, and sleeping disorders (CFSQ) (Groß, Reck, Thiel-Bonney, & Cierpka, 2013), a detailed 49-item self-report questionnaire on infants crying, feeding and sleeping behavior. A mean score of ≥ 1.85 over all items (rated on a Likert scale from 1 to 4) indicates the presence of regulatory problems.

2.3. Procedure

After written or online informed consent was given regarding study participation, participants were asked to fill out the self-developed online questionnaire. Fathers were also allowed to participate in this first screening step of the survey, but only mothers at risk of a mental health or psychosocial burden were asked to participate in the screening step 2 (step 2) (Fig. 1).

Step 2 was an in-depth assessment via phone to verify the mental and psychosocial status of the participants by trained study staff, comprising of the M.I.N.I., the EPDS, the PBA, and the CFSQ. Furthermore, a detailed self-developed questionnaire on health and social care utilization of the participating mother and her index child was applied, which was the main data source for our analyses (Appendix A2).

An additional follow-up assessment six months after step 2 was conducted by phone with mothers for whom a noticeable mental health or psychosocial burden (NMPB) was confirmed in step 2. A NMPB was defined as the presence of a) at least one current mental health disorder (according to the M.I.N.I. interview), or b) parental burnout symptoms (defined as a PBA score of ≥ 76), or c) major depressive symptoms (defined as an EPDS score ≥ 13 points). While questionnaires were available in German and English, Turkish, or Arabic language, phone interviews were conducted in German and English. The health and social care utilization questionnaire, analogous to the step 2, was also used at follow-up.

2.4. Utilization and cost data

Data on the amount of health and social care service utilization was collected using the self-developed questionnaire. Costs were calculated for the postnatal period a) between birth and step 2, excluding the costs associated with the birth of the index children and b) between step 2 and follow-up. German national unit cost assumptions and stakeholder information were applied to value the reported utilization data based on 2021 prices (Bock et al., 2015). Different stakeholders, ranging from workers in the field to local authorities and a nationwide operating statutory health insurance company, were involved in estimating the underlying unit costs from a payer's perspective. The intensive stakeholder involvement was necessary to account for the heterogeneity of the ESS sector in Germany and the variety of different often only locally operating providers without a standardized fee scale. Early support services comprise of expert consultation both at home or at walk-in centers, accommodation at mother–child facility, fulltime childcare, crying counseling, or care assistance.

Utilization costs of visitations and consultations were categorized into costs a) only associated with the mother's health and wellbeing (including costs for general practitioners, gynecologists, emergency rooms, hospitals, rehabilitations, physiotherapy and addiction counselling), b) only associated with the index child's health and wellbeing (pediatricians, early detection screenings according to § 26 Book 5 of the German social code (SGB V), emergency rooms, hospitals, ergotherapy, logotherapy, osteopathy and physiotherapy), c) costs associated with both mother's and index child's health and wellbeing (midwife care, mother–child-treatment courses and ESS). Furthermore, total costs and

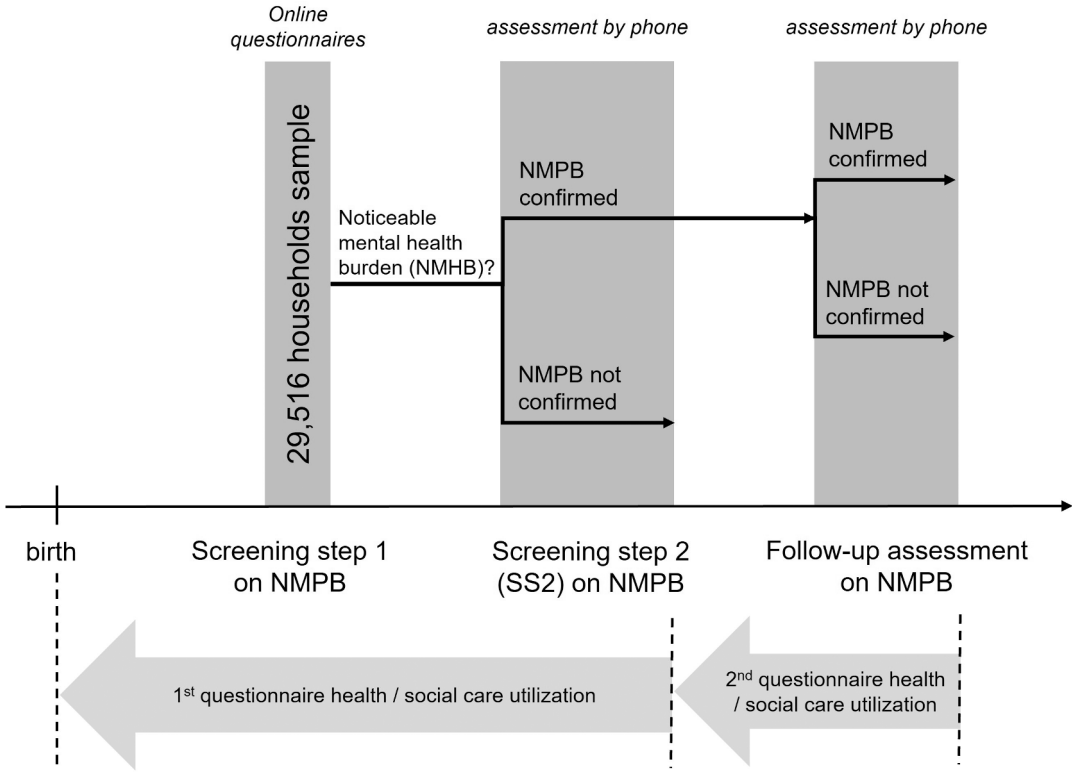

Fig. 1. Description of two-step screening process and follow-up.

ESS costs were estimated. Costs were calculated for every participant with self-reported utilization of health care services or ESS. Missing cost values were not replaced. Standard midwife care was valued under the assumption that every mother received the 16 sessions that are recommended in Germany and reimbursed by statutory health insurance companies. For the valuation of early detection screening costs, screening reimbursement costs from German statutory health insurance companies were applied. Thereby, the maximum possible time intervals for the different early detection screenings were taken into account.

2.5. Statistical analyses

Baseline characteristics from screening step 1 are reported as proportions or means and standard deviation (SD). Utilization data and costs results are described as proportions of utilizers as well as means and SD. Utilization results are further analyzed as median and interquartile range (IQR). Results are presented in total and by NMPB status.

Potential determinants of ESS utilization were analyzed using logistic regression yielding odds ratios (ORs) with 95 % confidence intervals (95 % CIs). Potential determinants of ESS utilization until step 2 in our model related to the mother are facing a NMPB (yes/no); age in years (continuous); living in Berlin (yes/no); being born in Germany (yes/no); high educational level according to the international standard classification of education (ISCED) (UNESCO, 2012) (yes/no); single parenthood (yes/no); bad experiences with doctors/midwives over the course of pregnancy and delivery (yes/no); and receiving state benefit payments (yes/no). Potential determinants related rather to the index children are age in months from birth to step 2 (continuous); being a twin (yes/no); preterm delivered (yes/no); first child (yes/no); facing a chronic disease (yes/no); and regulatory problems according to the CFSQ (yes/no). Since the recruitment started before and ended in the middle of the SARS-CoV-2 pandemic, completing step 2 prior to or after the beginning of the first lockdown in Germany was also added to the model to secondary investigate whether the SARS-CoV-2 pandemic had an impact on ESS utilization in our population. The beginning of the lockdown was dated to the beginning of school closing in Berlin on the 16th of March 2020.

Considering skewness of health care cost data, the assumption of normally distributed cost data was violated. Hence, more suitable general linear models with gamma distribution and log link function (Gregori et al., 2011; Mihaylova, Briggs, O'Hagan, & Thompson, 2011) were applied to analyze determinants of total health care costs and to estimate mean adjusted costs with 95 % CIs for the period up to step 2. Determinants of total health care costs until step 2 are reported as exponentiated estimates of the gamma distributed general linear model and 95 % CIs. The same potential determinants as described above for the utilization of ESS entered the model. Taking our findings on the determinants of total costs into account, the different cost categories (see 2.2) were adjusted a) for the different observation periods reflected in the index children's age at the time of step 2, b) the presence of a chronic disease of the index child, c) single parenting of the mother, d) preterm delivery and e) bad experiences with doctors or midwifes during the course of pregnancy and delivery.

Since follow-up data is only available for a limited portion of participants with confirmed NMPB at step 2, analyses of follow-up data are limited to descriptive analyses of utilization and cost differences (since step 2) with respect to still facing a NMPB or not.

All statistical analyses were performed using R version 4.2.1 (R Core Team, 2022) and SPSS version 27 (IBM Inc.).

2.6. Sensitivity analyses

Taking the heterogeneity and lack of a standardized fee scale particularly in the ESS sector into account, sensitivity analyses were carried out to validate the cost results. A one-way deterministic sensitivity analysis was performed by varying the underlying unit costs consecutively within predefined minimum–maximum ranges (±20 % of the base case cost assumption). This makes it possible to estimate the influence of each individual input on the overall result separately. These results were then plotted in a tornado diagram. In an additional probabilistic sensitivity analysis, a Monte Carlo simulation process was implemented which involves running the calculation 1000 times using randomly sampled values of all cost model inputs simultaneously. Underlying unit costs were allowed to vary within the minimum–maximum ranges of the deterministic sensitivity analysis. The results were then presented in a histogram showing the variance of the results.

3. Results

3.1. Participants

From the randomly selected sample of 29,516 households, 5,873 participants (4,933 mothers) from 5,089 households completed the screening step 1. Overall, 1,185 mothers were defined as being at least potentially at risk of psychosocial stress or mental health disorders at the screening step 1. From this sample, 792 mothers and their children could be included in our analyses from birth of the index children to step 2. The mean age of the mothers was 34.4 years (SD ± 4.8 months) at the time of step 2 and the mean index children's age was 17.5 months (±3.4 months). The majority of participants lived in Berlin (82.6 %) and had a high educational level (83.6 %) (Table 1).

A NMPB was found in 368 mothers (46.5 %) at step 2. NMPB was mainly related to have at least one mental health disorder according to the M.I.N.I. (84.5 % of the participants with a NMPB), followed by parental burnout symptoms (39.5 %) and major depressive symptoms (17.2 %). For the remaining 424 mothers, the self-stated burden at screening step 1 could not be confirmed in step 2. Socio-demographic characteristics of participants with and without a NMPB were mostly comparable (Table 1). However, a higher proportion of mothers in the NMPB group had a low educational level according to the ISCED, were single parents, recipients of state benefit payments and had previous bad experience with doctors or midwives during labor or pregnancy.

From the 368 mothers with a confirmed NMPB at step 2, follow-up data was available for only 256 mothers resp. their index children. The mean time between step 2 and follow-up was 6.8 months (208 days ± 39 days). A NMPB at the follow-up was confirmed again in 178 mothers (70.1 %). The distribution of related mental health conditions was comparable to step 2. The majority faced at least one mental health disorder according to the M.I.N.I. (85.4 % of the participants with a NMPB at follow-up), followed by parental burnout symptoms (40.1 %) and major depressive symptoms (19.2 %).

3.2. Health care and early support services utilization

Over 99 % of the index children were seen by a pediatrician and received early detection screenings, which are mandatory in the first months after birth in Germany (Table 2). Moreover, almost all mothers consulted a gynecologist (97.6 %). In general, the proportions of utilizers were comparable over the different services although proportions of utilizers, the mean and median number of visitation or days of stay were often slightly higher in the NMPB group. Notably higher means in the NMPB group were observed for mothers' and index children's hospital stays and mean number of index children's logotherapy visits. The proportion of ESS utilizers was higher in the NMPB group (70.3 %) compared to the group with no NMPB (66.0 %). The difference stems mainly from higher proportions of utilizers of expert consultation at walk-in centers and crying counseling.

For participants with NMPB the proportion of persons utilizing health care and early support services changed from step 2 to follow-up. The largest change in utilization was observed in gynecologist visits of the mothers (from 97.6 % at step 2 to 59.2 % at follow-up), emergency room visits (38.4 % to 19.5 %) and hospital stays (21.1 % to 6.6 %) of the

Table 1
Characteristics of study population by noticeable mental health or psychosocial burden.

	Overall (N = 792)	Noticeable Mental Health or Psychosocial Burden (N = 368) n (%) or mean ± SD	No Noticeable Mental Health or Psychosocial Burden (N = 424) n (%) or mean ± SD
Location			
Berlin	654 (82.9)	299 (81.3)	355 (83.7)
Leipzig	108 (13.6)	51 (13.9)	57 (13.4)
Flensburg	12 (1.5)	9 (2.5)	3 (0.7)
Other region	18 (2.3)	9 (2.5)	9 (2.2)
Age (Mother) in years	34.4 ± 4.8	33.9 ± 5.0	34.8 ± 4.6
Age (Index child) in months	17.5 ± 3.4	17.6 ± 3.5	17.5 ± 3.3
Mother's country of birth (Germany)	662 (83.6)	306 (83.2)	356 (84.0)
Educational level (based on ISCED*)			
Low	5 (0.5)	3 (0.5)	2 (0.5)
Middle	115 (14.5)	76 (20.7)	39 (9.2)
High	662 (83.6)	283 (76.9)	379 (89.4)
Unknown	10 (1.3)	7 (1.9)	3 (0.7)
Single Parent	92 (11.6)	49 (13.3)	43 (10.2)
Number of children < 18 years in the household (including index child)			
1	436 (55.1)	207 (56.3)	229 (54.0)
2	270 (34.1)	123 (33.4)	147 (34.7)
3 or more	86 (10.9)	38 (10.3)	48 (11.3)
Twins	31 (3.9)	8 (2.2)	23 (5.4)
Preterm delivery	80 (10.1)	26 (7.1)	54 (12.7)
First child	445 (56.2)	206 (56.0)	239 (56.4)
Place of birth			
Birthing center	41 (5.2)	19 (5.2)	22 (5.2)
Home birth	14 (1.8)	6 (1.6)	8 (1.9)
Hospital	737 (93.1)	343 (93.2)	394 (92.9)
Index child born with help of fertility treatment (N = 783)	66 (8.4)	25 (6.9)	41 (9.8)
Index child diagnosed with serious illness or disability after birth	55 (6.9)	28 (7.6)	27 (6.4)
Other child diagnosed with a serious illness or disability	32 (4.1)	17 (4.6)	15 (3.6)
Bad experience with doctors/midwives (N = 783)	262 (33.5)	144 (39.6)	118 (28.2)
Recipient of state payment (N = 791)	154 (19.5)	80 (21.7)	74 (17.5)
Screening step 2 prior to first SARS-CoV-2 Lockdown	248 (31.3)	125 (34.0)	123 (29.0)
Mental health disorder according to M.I.N.I. **	311 (39.3)	311 (84.5)	–
Postnatal Depression ***(N = 684)	56 (8.2)	56 (17.2)	–
Parental burnout (N = 787)	144 (18.3)	144 (39.5)	–
Regulatory problems (index child) (N = 682)	303 (43.8)	158 (47.9)	145 (40.1)

Notes: *ISCED = International standard classification of education; **M.I.N.I. = Mini-International Neuropsychiatric Interview; *** Edinburgh Postnatal Depression Scale with score ≥ 13; †Parental burnout assessment with score ≥ 76; †† Questionnaire on crying, feeding and sleeping disorders with score ≥ 1.85.

index children as well as ESS utilization (69.0 % to 25.4 %). In line with the different proportions of utilizers, the mean and median number of visits or days of utilization were lower for most of the services. The utilization trends until step 2, with higher proportions of utilizers and mean number of visitations in the group of participants still facing a NMPB, were confirmed at follow-up (Table 3).

The chance of ESS utilization increased on the mothers' side with a NMPB at step 2, living in Berlin (OR 7.36, 95 %CI 4.65–11.86), being born in Germany (OR 1.83, 95 %CI 1.13–2.95), and being a single parent (OR 2.2, 95CI 1.14–4.46, Table 4). With regard to the index children, the chance of ESS utilization increases with being a twin, a preterm delivery, being the first child and facing a chronic disease. Completing step 2 prior to the first lockdown in Germany was associated with a lower chance of ESS utilization.

3.3. Health care and early support services utilization costs

Categorized unadjusted mean costs (overall and stratified by facing a NMPB) from a payer's perspective until step 2 are displayed in Fig. 2a. Mean costs in the NMPB group were higher over all categories compared to the group without a NMPB. Mean overall total costs were €4612 ± 10,944. The largest cost component of mean total costs were costs of hospital stays both for mothers (€652 ± 4175) and index children (€1181 ± 5658). Further important cost components were pediatrician (€499 ± 239) and common midwife services costs (€547 ± 194). The largest cost component of the mean ESS costs were the utilization and accommodation costs at mother child facilities (€302 ± 6194).

Fig. 2b shows the unadjusted mean costs from step 2 to follow-up with respect to the change in facing a NMPB. The changes in utilization of health care and early support services were reflected in decreasing mean costs in the shorter period between step 2 and follow-up. Moreover, the higher mean costs in the NMPB group until step 2 were confirmed for aged children in the period during step 2 until follow-up. The largest components of mean total costs in this period were the mean cost for hospital stays of the index children (€260 ± 1612) and mothers (€126 ± 637), pediatrician costs (€129 ± 136), and costs of emergency room visits for the index children (€126 ± 328) as well as mothers (€126 ± 1346).

The main determinants of total costs at step 2 were facing a chronic disease (index child), preterm delivery, bad experiences with doctors and midwives during pregnancy and delivery, and single parenthood (Table 5). In line with our findings regarding the determinants of ESS utilization, mean total costs decreased ceteris paribus proportionally if step 2 took place prior to the first lockdown in Germany.

Hence, categorized costs until step 2 were adjusted for these variables as well as the age of the index children in months. Adjusted mean

Table 2
Postnatal health care and early support services utilization until screening step 2 of the mothers.

	Overall N = 792	Noticeable Mental Health or Psychosocial Burden, N = 368					No noticeable Mental Health or Psychosocial Burden, N = 424				
	n† (%)	n† (%)	all participants		participants with at least one visit or day of stay		n† (%)	all participants		participants with at least one visit or day of stay	
			Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)		Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Mother											
General Practitioner [visits], N = 782	631 (80.7)	289 (79.6)	3.4 (4.4)	2 (3)	4.3 (4.6)	3 (3)	342 (81.6)	2.8 (3.5)	2 (3)	3.5 (3.6)	3 (3)
Gynecologist [visits], N = 783	764 (97.6)	355 (97.5)	2.9 (2.5)	2 (1)	3.0 (2.4)	2 (1)	409 (97.6)	2.7 (2.3)	2 (2)	2.8 (2.3)	2 (1)
Emergency room [visits], N = 783	162 (20.7)	85 (23.4)	0.5 (1.6)	0 (0)	2.1 (2.7)	1 (1)	77 (18.4)	0.4 (2.6)	0 (0)	2.3 (5.7)	1 (1)
Hospital stays [days], N = 782	83 (10.6)	41 (11.3)	1.2 (7.5)	0 (0)	10.6 (20.0)	3(6)	42 (10.1)	0.8 (5.2)	0 (0)	8.0 (14.6)	4 (4)
Rehabilitation care [days], N = 783	8 (1.0)	5 (1.4)	0.4 (4.0)	0 (0)	32.2 (12.7)	28 (21)	3 (0.7)	0.2 (2.8)	0 (0)	32.7 (8.1)	28 (7)
Addiction counseling [visits], N = 778	2 (0.3)	1 (0.3)	0.1 (2.7)	0 (0)	52 (0)	52 (0)	1 (0.2)	0 (0.1)	0 (0)	2 (0)	2 (0)
Physiotherapy [visits], M = 783	265 (33.8)	111 (30.5)	2.8 (6.1)	0 (3)	9.2 (7.9)	6 (7)	154 (36.8)	3.7 (9.0)	0 (6)	10.2 (12.6)	6 (8)
Index child											
Pediatrician [visits], N = 780	779 (99.9)	362 (100.0)	11.8 (6.6)	10 (7)	11.8 (6.6)	10 (7)	417 (99.8)	11.1 (5.6)	10 (7)	11.1 (5.6)	10 (7)
Early Detection Screenings [visits], N = 783	781 (99.7)	363 (99.7)	4.3 (0.5)	4 (1)	4.3 (0.5)	4 (1)	418 (99.8)	3.4 (1.5)	4 (0)	4.3 (0.4)	4 (1)
Emergency room [visits], N = 783	301 (38.4)	145 (39.8)	1.0 (2.7)	0 (1)	2.5 (3.8)	2 (2)	156 (37.2)	0.8 (1.8)	0 (1)	2.0 (2.6)	1 (1)
Hospital stays [days], N = 783	165 (21.1)	78 (21.4)	2.5 (12.0)	0 (0)	11.6 (23.8)	5 (7)	87 (20.8)	1.2 (3.6)	0 (0)	5.7 (6.0)	4 (4)
Ergotherapy [visits], N = 783	27 (3.5)	18 (5.0)	16.1 (23.5)	9 (9)	16.1 (23.5)	9 (9)	9 (2.2)	15.9 (16.1)	10 (21)	15.9 (16.1)	10 (21)
Logotherapy [visits], N = 783	13 (1.7)	5 (1.4)	21 (20.3)	14 (20)	21.0 (20.3)	14 (20)	8 (1.9)	5.9 (9.3)	2 (4)	5.9 (9.3)	2 (4)
Osteopathy [visits], N = 783	366 (46.7)	171 (47.0)	3.4 (3.0)	3 (2)	3.4 (3.0)	3 (2)	195 (46.5)	3.1 (3.0)	2 (3)	3.1 (3.0)	2 (3)
Physiotherapy [visits], N = 783	143 (18.3)	71 (19.5)	17.4 (25.0)	10 (14)	17.4 (25.0)	10 (14)	72 (17.2)	20.3 (29.9)	10 (13.3)	20.3 (29.9)	10 (13.3)
Mother & Index child											
Standard Midwife care [6 weeks utilization]*, N = 783	696 (88.9)	313 (86.0)	–	–	–	–	383 (91.4)	–	–	–	–
Additional Midwife care [visits], N = 783	105 (13.4)	49 (13.5)	1.2 (3.9)	0 (0)	9.0 (7.0)	6 (8)	56 (13.4)	1.1 (4.2)	0 (0)	8.9 (8.3)	6 (5)
Mother-Child-Treatment course [days], N = 783	14 (1.8)	6 (1.7)	0.4 (3.1)	0 (0)	23.3 (5.7)	21 (0)	8 (1.9)	0.4 (2.9)	0 (0)	21.0 (0)	21 (0)
Early support services	529 (69.0)	255 (70.3)					274 (66.0)				
Expert consultation (at walk-in center) [visits], N = 779	281 (36.1)	152 (41.9)	2.5 (8.1)	0 (2)	6.0 (11.8)	2 (4)	129 (31.0)	1.3 (3.3)	0 (1)	4.2 (4.8)	3 (4)
Expert consultation (at home) [visits], N = 779	381 (48.9)	181 (49.9)	0.7 (1.6)	0 (1)	1.5 (2.0)	1 (0)	200 (48.1)	0.5 (0.6)	0 (1)	1.1 (0.4)	1 (0)
Accommodation at mother–child facility [weeks], N = 778	2 (0.3)	2 (0.6)	0.3 (4.7)	0 (0)	60.7 (24.5)	60.7 (17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Crying counseling [visits], N = 778	47 (6.0)	28 (7.7)	0.9 (6.4)	0 (0)	11.1 (20.9)	4 (7)	19 (4.6)	0.3 (1.5)	0 (0)	6.3 (3.8)	7 (7)
Care assistant (family sponsor support) [weeks], N = 778	56 (7.2)	27 (7.4)	1.8 (8.6)	0 (0)	24.6 (21.2)	13 (27.3)	29 (7.0)	1.6 (8.1)	0 (0)	22.5 (21.9)	16 (30.7)

Notes: †Any visit or utilization; *binary question if standard midwife care was utilized.

costs were higher in the NMPB group over all categories (Table 6). Mean additional total costs were €1713 for the NMPB group and largest cost components were costs associated with the index children.

3.4. Sensitivity analyses

The cost results proved to be robust in our sensitivity analyses. The deterministic sensitivity analysis revealed that a ± 20 % change in the valuation of the ESS components had only marginal implications on the mean total costs. It was further observed that changes in the valuation of hospital stays had the largest impact on the mean total costs from a payer's perspective (Fig. 3). The results of the Monte Carlo simulation show only marginal variations in mean total costs, €4612 (base case) to €4635 (Monte Carlo simulation) (Fig. 4).

4. Discussion

In this study we investigated differences in health care and early support services utilization and costs of mothers who faced a NMPB compared to mothers without a NMPB and their respective index children. We further examined the determinants of health care and early support services utilization and associated costs of mothers and their index children in the postnatal period in Germany.

The following results stand out from our analyses. First, mothers with

Table 3
Postnatal health care and early support services utilization from screening step 2 to follow-up.

	Overall, N = 256	Noticeable Mental Health or Psychosocial Burden, n = 178			No Noticeable Mental Health or Psychosocial Burden, n = 78		
	n† (%)	n† (%)	Mean (SD)	Median (IQR)	n† (%)	Mean (SD)	Median (IQR)
Mother							
General Practitioner [visits], N = 230	168 (65.9)	125 (70.2)	3.2 (3.1)	2 (3)	43 (55.8)	2.1 (1.4)	2 (1.5)
Gynecologist [visits], N = 231	149 (58.2)	103 (57.9)	2.5 (2.9)	1 (1)	46 (59.0)	1.9 (2.2)	1 (0.8)
Emergency room [visits], N = 231	23 (9.0)	17 (9.6)	4.1 (11.9)	1 (0)	6 (7.7)	1.0 (0)	1 (0)
Hospital stays [days], N = 231	11 (4.3)	9 (5.1)	4.6 (1.8)	4 (2)	2 (2.6)	4.0 (1.4)	4 (1)
Rehabilitation care [days], N = 231	1 (0.4)	1 (0.6)	12.0 (0)	12 (0)	–	–	–
Addiction counseling [visits], N = 231	1 (0.4)	1 (0.6)	2.0 (0)	2 (0)	–	–	–
Physiotherapy [visits], N = 231	53 (20.7)	10 (12.8)	6.0 (5.2)	6 (3)	43 (24.2)	9.2 (6.0)	6 (5.8)
Index child							
Pediatrician [visits], N = 230	237 (93.3)	162 (92.1)	3.5 (3.1)	3 (2)	75 (96.2)	3.5 (4.2)	3 (3)
Early Detection Screenings [visits], N = 231	255 (99.6)	177 (99.4)	2.6 (0.5)	3 (1)	78 (100)	2.7 (0.5)	3 (1)
Emergency room [visits], N = 231	50 (19.5)	36 (20.2)	1.5 (1.2)	1 (0)	14 (18.0)	1.6 (0.7)	1 (1)
Hospital stays [days], N = 231	17 (6.6)	13 (7.3)	6.2 (8.9)	4 (4)	4 (5.1)	5.0 (2.2)	4.5 (2)
Ergotherapy [visits], N = 231	2 (0.8)	1 (0.6)	10.0 (0)	10 (0)	1 (1.3)	7.0 (0)	7 (0)
Logotherapy [visits], N = 231	5 (2.0)	2 (1.1)	5.5 (5.0)	5.5 (3.5)	3 (3.9)	15.0 (13.0)	8 (11.5)
Osteopathy [visits], N = 231	14 (5.5)	11 (6.2)	1.6 (0.81)	1 (1)	3 (3.9)	2.3 (1.2)	3 (1)
Physiotherapy [visits], N = 231	7 (2.7)	3 (1.7)	15.3 (17.6)	10 (17)	4 (5.1)	7.5 (2.9)	7.5 (2.5)
Mother & Index child							
Standard Midwife care [6 weeks utilization]*,N = 231	–	–	–	–	–	–	–
Additional Midwife care [visits], N = 231	3 (1.2)	2 (1.1)	3.5 (3.5)	3.5 (2.5)	1 (1.3)	4 (0)	4 (0)
Mother-Child-Treatment course [days], N = 231	4 (1.6)	2 (1.1)	22.5 (17.7)	22.5 (12.5)	2 (2.6)	21.0 (0)	21 (0)
Early support services	65 (25.4)	56 (31.5)			9 (11.5)		
Expert consultation (at walk-in center) [visits], N = 231	55 (21.5)	49 (27.5)	3.2 (4.1)	2 (2)	6 (7.7)	3.3 (2.7)	2.5 (3.3)
Expert consultation (at home) [visits], N = 231	7 (2.7)	4 (2.3)	2.3 (2.5)	1 (1.3)	3 (3.9)	1.3 (0.6)	1 (0.5)
Accommodation at mother–child facility [weeks], N = 231	–	–	–	–	–	–	–
Crying counseling [visits], N = 231	4 (1.6)	3 (1.7)	5.2 (4.3)	5 (4)	1 (1.3)	unknown††	unknown
Care assistant (family sponsor support) [weeks], N = 231	4 (1.6)	3 (1.7)	23.0 (16.6)	30.3 (15.3)	1 (1.3)	8.7 (0)	8.7 (0)

Notes: Mean (SD) & Median (IQR) displayed for those participants with at least one visit or day of stay; †Any visits or utilization; *binary question if standard midwife care was utilized, ††utilizer did not state number of utilizations.

Table 4
Associations of potential determinants for postnatal early support services utilization until screening step 2: Odds ratios and 95% Confidence intervals from logistic regression.

	Odds ratio	95 % Confidence intervals
Noticeable mental health burden (vs none)	1.44	0.99 – 2.10
Age in years (Mother)	1.01	0.97 – 1.05
Location (Berlin) vs Leipzig/Flensburg	7.36	4.65 – 11.86
Mother born in Germany (vs no)	1.83	1.13 – 2.95
High educational level (ISCED III*) (vs low/middle)	1.06	0.62–1.76
Single parent (vs both parents)	2.20	1.14–4.46
Bad experiences with doctors/midwives (vs none)	1.17	0.79–1.76
Recipient of state benefit payments (vs no)	1.10	0.67–1.82
Age in months (Index Child)	1.06	0.99–1.13
Twin birth (vs singleton)	2.50	0.88–8.54
Preterm delivery (vs no)	1.81	0.90–3.80
First child (vs no)	2.97	2.03–4.37
Chronic disease (Index Child) (vs none)	3.67	1.62–9.35
Regulatory problems** (vs none)	1.23	0.85–1.78
Screening step 2 prior to Lockdown (vs after)	0.69	0.43–1.10

Notes: * ISCED = International standard classification of education; ** Questionnaire on crying, feeding and sleeping disorders with score $\geq$ 1.85.

a NMPB and their index children caused higher mean ESS and total costs in the postnatal period from a payer's perspective compared to mothers without a NMPB and their index children. Second, main determinants of mean total costs at step 2 were facing a chronic disease (index children), preterm delivery, bad experiences with doctors and midwives, and single parenthood. Third, the majority of participants utilized some kind of ESS, with a higher proportion of utilizers in mothers facing NMPB and their index children. Fourth, the most important determinants of ESS utilization in the postnatal period were living in Berlin, and with respect to the index children: a chronic disease, being the first child and born as a twin. Fifth, our results regarding the utilization and costs of health care and early support services were confirmed for index children advanced in age and mothers who previously faced a NMPB compared to mothers who continuously suffered from a NMPB over the course of our study. Sixth, starting study participation during the SARS-CoV-2 pandemic was associated with a higher chance of ESS utilization and total costs. Seventh, the vast majority of index children have been seen by pediatricians and received mandatory early detection screenings in the postnatal period.

Our cost results support the importance of prevention and sufficient treatment of postnatal mental health problems from a payer's perspective in Germany. Our adjusted cost estimates showed noticeable cost differences between the groups with higher mean costs in the NMPB group over all categories except for costs solely associated with the mothers. All mothers who entered our analyses felt at least some kind of psychosocial stress or another mental health burden at the initial online assessment. These cost differences persisted until follow-up for those who no longer faced a NMPB at this time point compared to those still facing a NMPB. It can be assumed that the cost differences would have been higher if we compared mothers with a NMPB to mothers with no mental health burden at all. Thus, the estimated cost differences between the groups are rather conservative. This conclusion is in line with the international literature which shows uniformly high costs for mothers with postnatal mental health disorders (Bauer, Knapp, & Parsonage, 2016) and higher costs compared to mothers without postnatal mental health disorders (Brown, Adams, George, & Moore, 2021; Dagher, McGovern, Dowd, & Gjerdingen, 2012; Masters et al., 2020; Moran et al., 2020). Unfortunately, to the best of our knowledge no such data is available for Germany.

Evidence of determinants of health care costs in the postnatal period are scarcely available and again no data for Germany is available. Our findings are in line with recent studies focusing on health care utilization and costs of perinatal depression (Pollack et al., 2022) and the impact of

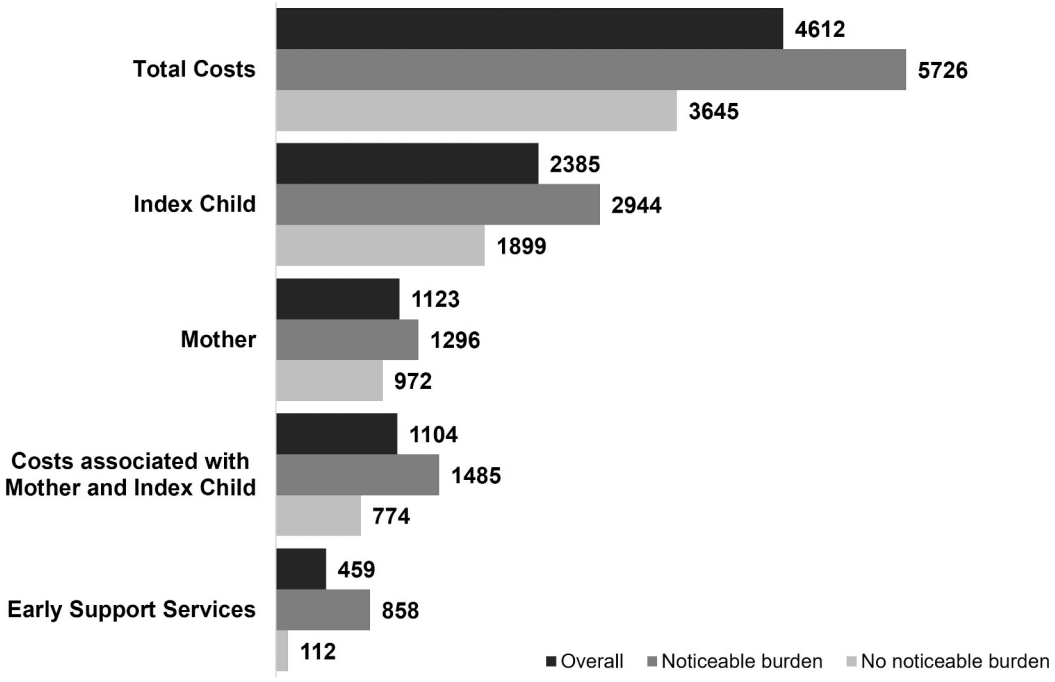

Fig. 2a. Mean costs (€) during postnatal period until screening step 2, n = 792.

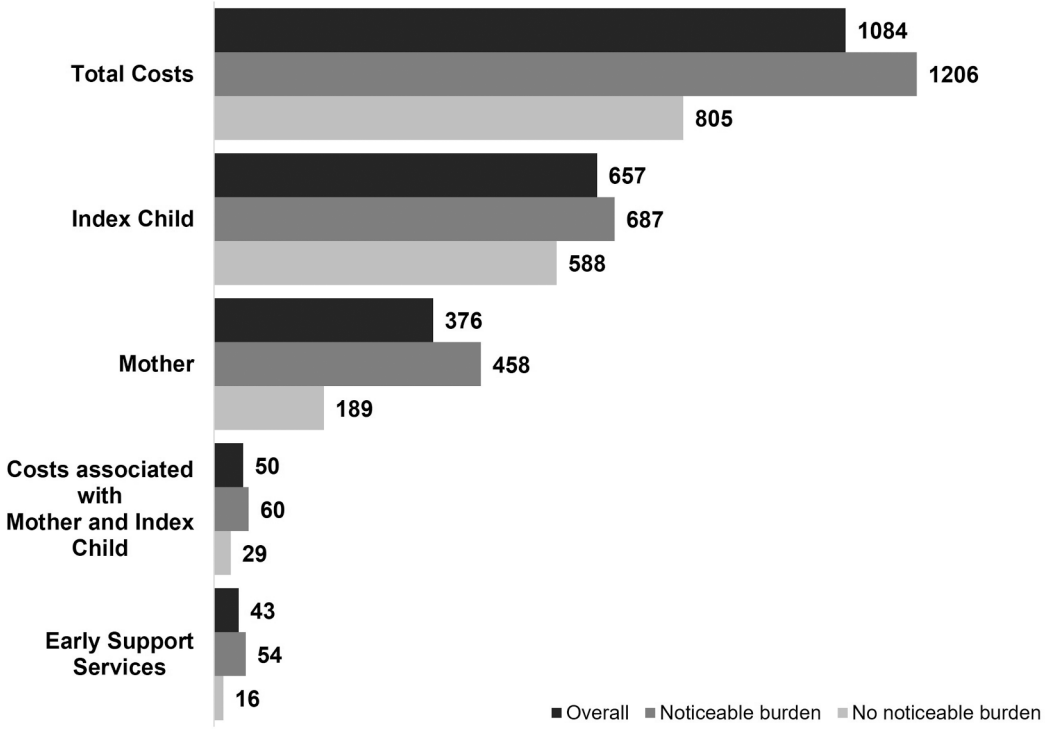

Fig. 2b. Mean costs (€) between screening step 2 and follow-up assessment, n = 256.

a history of poor mental health on health care costs in the perinatal period (Chojenta, William, Martin, Byles, & Loxton, 2019). However, our results regarding the influence of facing a NMPB is weaker and thereby in line with our assumptions made above. The influence of bad experiences with doctors and midwifes highlights the importance of sufficient appreciation of necessities and concerns of expecting mothers and indicates the relevance of psychological support after traumatic experiences during pregnancy.

In contrast to the scarce available literature for Germany, the educational level had no influence on the utilization of ESS in our population (Eickhorst et al., 2016). The dominance of living in Berlin as a determinant of ESS utilization is most likely attributable to the fact that Berlin was the only study site which promotes so called initial home visits by trained social workers of the local public children, youth and health service via postal mail. Hence, the more striking determinants of ESS utilization besides facing a NMPB are the presence of a chronic

Table 5
Associations of potential determinants of postnatal total costs until the screening step 2: Exponentiated estimates and 95% Confidence intervals from general linear models with gamma distribution and log link function.

	estimates	95 % Confidence intervals
Noticeable burden (Screening Step 2)	1.15	0.93–1.43
Age in years (Mother)	0.99	0.97–1.01
Location (Berlin) (vs Leipzig/Flensburg)	0.98	0.73–1.28
Mother born in Germany (vs no)	1.14	0.85–1.49
High Educational level (ISCED III*) (vs low/ middle)	0.90	0.67–1.21
Single parent (vs no)	1.28	0.92–1.81
Bad experiences with doctors/midwives (vs none)	1.33	1.07–1.67
Recipient of state payments (vs none)	1.16	0.88–1.56
Age in months (Index Children)	1.05	1.01–1.09
Twin birth (vs singleton)	0.96	0.56–1.77
Preterm delivery (vs no)	1.61	1.11–2.40
First child (vs no)	0.94	0.75–1.17
Chronic disease (Index Child) (vs none)	3.99	2.69–6.14
Regulatory problems** (vs none)	1.01	0.82–1.24
Screening step 2 prior to Lockdown (vs after)	0.90	0.69–1.18

Notes: * ISCED = International standard classification of education; ** Questionnaire on crying, feeding and sleeping disorders with score $\geq$ 1.85.

Table 6
Health care costs from birth of the index children until screening step 2: Mean and 95% Confidence intervals from general linear models with gamma distribution and log link function adjusted for age of the index child, presence of chronic disease (index child), single parenthood, preterm delivery & bad experiences during pregnancy.

	Noticeable Mental Health or Psychosocial Burden	No Noticeable Mental Health or Psychosocial Burden	Difference
	Adj. Mean* (€) (95 % CI)	Adj. Mean* (€) (95 % CI)	Δ €
Mother	1784 (966–3295)	1777 (939–3364)	7
Index Child	6896 (5236–9082)	5660 (4239–7556)	1236
Costs associated with mother & index child	2094 (1286–3411)	1505 (885–2560)	589
Early Support	1073 (391–2947)	349 (113–1079)	724
Total	10,849 (8329–14,131)	9,136 (6942–12,023)	1713

condition of the children as well as single parenthood, twin birth and preterm delivery. All of these circumstances have in common that they are particularly challenging for the affected families. In line with the German literature, higher utilization by mothers born in Germany might be explained by better knowledge of the available support services (Hurrelmann, Klinger, & Schaeffer, 2020). Consequently, special attention should be given to possible access barriers for mothers with a migration background. Hence, these determinants highlight the importance of ESS especially for those families facing severe life challenges. In line with this conclusion, we could show that the assessment prior to the first lockdown was associated with a smaller chance of ESS utilization. This result is reflected in the growing evidence of the negative impact of the pandemic for mothers (Calvano et al., 2022; Davenport, Meyer, Meah, Strynadka, & Khurana, 2020).

Even though our study solemnly focuses on the specific German health care system, our results highlight the importance of sufficient appreciation and treatment of mental health problems. Our results on ESS utilization further indicate the importance of the established ESS system in Germany. Against the background of existing entrance barriers and weaker social protection systems in the international context, our results should promote building an awareness for enforcing early support services to eliminate unmet needs of mothers in the postnatal period.

4.1. Strengths and limitations

Our analyses are embedded in the first approach in Germany to assess the psychosocial stress and mental health disorders in parents and their children in early childhood using a large population based random sample from local registry offices and established/validated questionnaires to evaluate the mental health burden of participating mothers. Furthermore, we have made the first attempt to systematically evaluate the utilization and underlying costs of health care and early support services in the vulnerable postnatal period in Germany with a self-developed questionnaire. Numerous stakeholders were involved in valuing the underlying costs of ESS utilization. We accounted for the rapidly changing challenges in the postnatal period by adjusting the costs of health care and early support services utilization to the different observational periods represented by the age of the index children. We further adjusted costs to detected confounders. The mental health burden of the participants was assessed with standardized and validated questionnaires.

The main limitations of our analyses are a result of the observational study design. Even though parents of almost 30,000 randomly selected children were asked to participate in the SKKIPPI study, selection bias might have affected the generalizability of our results (Tripepi, Jager, Dekker, & Zoccali, 2010). Our study population was rather well educated and slightly older compared to the general population. Although Berlin, Leipzig, and Flensburg reflect cities with distinct levels of urbanization, only few participants lived in rural areas with potentially different access to ESS and general health care services over the course of the study. Since our analyses were based on self-reported data, some uncertainty to the responses arises. Even though the interviewers were specifically trained, social desirability bias might have affected the responses of participating mothers (Chung & Monroe, 2003). Mothers might have been ashamed of certain utilizations like addiction counseling or have felt obligated to state false utilizations of their index child, e.g., early detection screening. The overall effect of the challenges mentioned above stays unclear.

Another limitation arises from the age-related inclusion criteria. According to our study protocol, the recruitment of parents was restricted to participants with at least 18 years. Adolescents were not included, although it is reasonable to assume that teenage pregnancy again emerges with particular challenges that have a likely impact on mental health, particularly for mothers.

In order to minimize the effort for the participants (e.g. to reduce the number of dropouts) the self-developed questionnaire on health and social care utilization was made as short as possible. The questionnaire provides a good opportunity to analyze and value general health care and early support services utilization. It is detailed enough to ascertain the extent of services utilized, but unable to distinguish between different reasons of utilization. Hence, it is unclear which medical conditions influenced the utilizations and costs apart from the NMPB in the mothers.

The absence of fathers in our sample was a priori justified by the assumption that mothers are the main reference persons of the children after birth and would thereby be more likely to participate in the study (Fricke et al., 2020). Focusing on mothers makes the cohort more balanced but leaves a blind spot to our analyses on the fathers' side. Also, fathers face unique challenges in the postnatal period (Giallo et al., 2013). Hence, our utilization and cost results might be underestimated. However, with respect to ESS utilization mothers are likely to answer for the entire family and thereby reduce the effect of neglecting fathers in our study.

Furthermore, we did not monetarily value care assistance by family sponsors. According to the involved stakeholders, family sponsors are

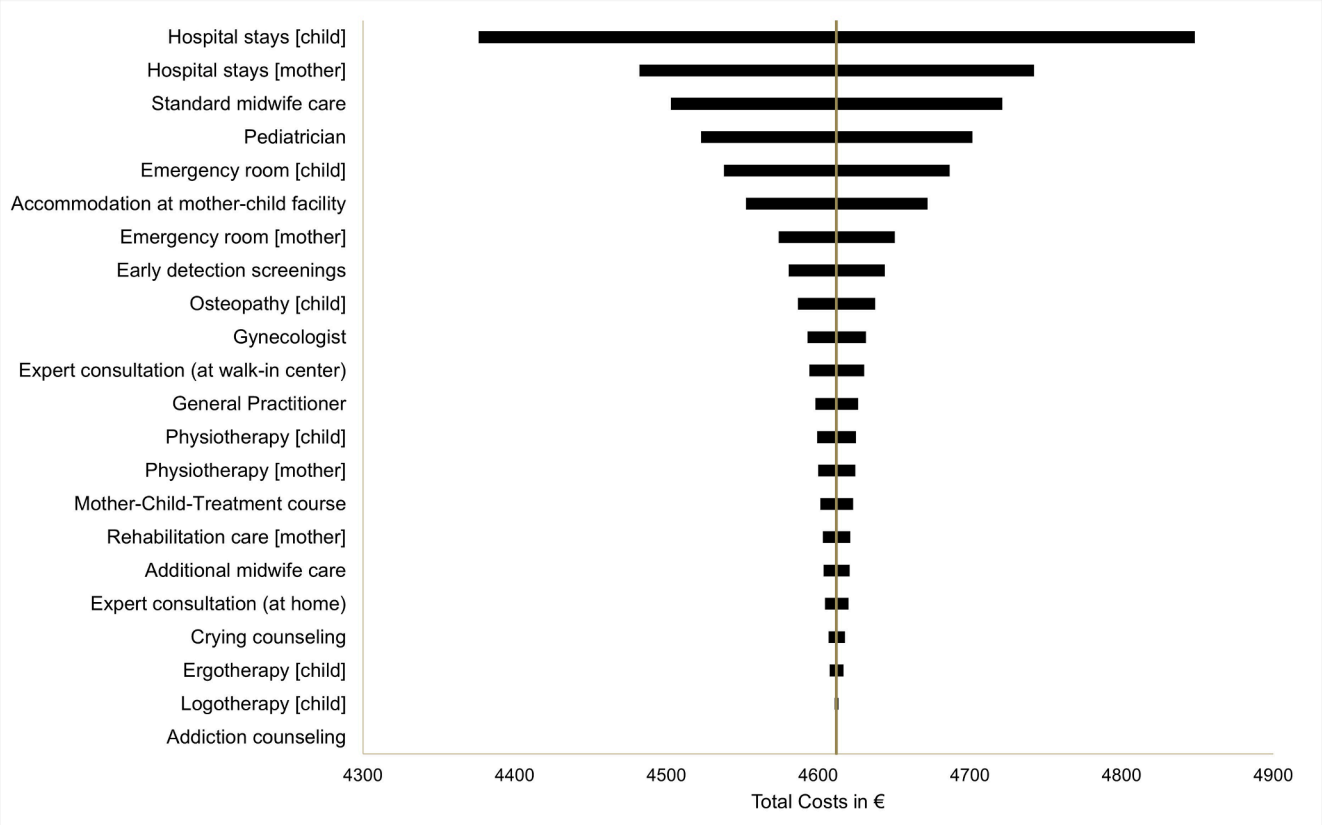

Fig. 3. Tornado diagram of impact of consecutive ± 20 % variation in unit costs on total costs.

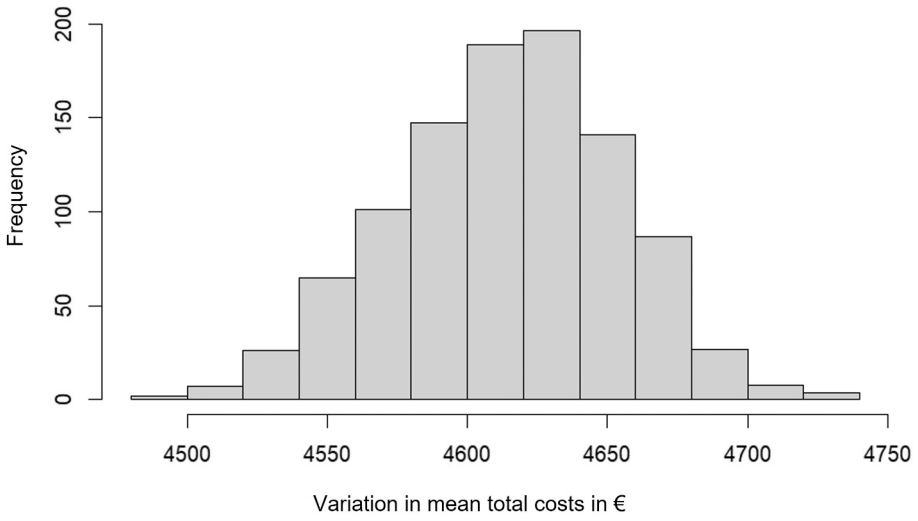

Fig. 4. Graphical overview of variations in mean total costs based on Monte Carlo simulation [1000 times repeated randomly and simultaneous resampling of all unit costs within ± 20 % range, with replacement].

predominantly working on a voluntary basis making a valuation from a payer's perspective obsolete. Utilization of care assistance is evenly allocated over both groups. Hence a valuation would not have changed directions of cost results, but the costs might be further underestimated. No specific information on psychiatric treatment of the mothers or index children was available. This adds to the potential underestimation of utilization costs.

Even though we focused on the postnatal period, some mothers might have falsely stated the initial hospital visit associated with the birth of the index children as a postnatal hospital visit and thereby lead to an overestimation of costs. Since hospital costs were the dominant component of our total costs this could have reduced the underestimation of total costs.

In line with previous studies, the follow-up period and therefore the time horizon of our analysis was rather short given the transgenerational origin and potential long-lasting impacts of mental disorders (Bauer et al., 2016; Verbeke et al., 2022). However, our results add to the vulnerable postnatal period, but no conclusions can be drawn regarding long-term health care and early childhood intervention utilization and associated costs of mothers facing mental health burdens and their

children.

No data on financial resources, insurance type (statutory or private), support from mothers' family or social networks or experienced stigmatization were collected in our study. All could have potentially altered the utilization of health care and social services and therefore influenced our results. Yet, ESS as part of the public health services in Germany are generally free of charge and provided outside of the German health insurance system. Hence, we would not expect large effects on our results since the barriers for access ESS are comparably low. Nonetheless, future research should account for and investigate these potential confounders.

Finally, it was beyond the scope of our observational study design to investigate the cost-effectiveness of ESS or more specific interventions to support mothers with NMPB. However, in the SKKIPPI project there are ongoing RCTs to investigate Parent-Infant-Psychotherapy a) for mothers with postpartum mental disorders and their infants (Mattheß et al., 2020) and b) for infants with regulatory disorders and their mothers (Sprengeler et al., 2021).

5. Conclusion

Our findings indicate an additional burden associated with mental health problems during the postnatal period and highlight the importance of sufficient appreciation and treatment of mental health problems from both a societal and payer's perspective. In Germany, early support services seem to play an important positive role in supporting families in the vulnerable postnatal period. Future research should investigate whether these and more specific interventions could be a cost-effective way to promote well-being for mothers with mental health burdens and their children.

Funding

The SKKIPPI project is supported by the German Health Care Innovation Fund (grant number 01 VSF17027).

Ethics approval

Ethical approval for this study was obtained from the ethics committee of the Charité - Universitätsmedizin Berlin (reference number: EA2/201/18).

Trial registration

The study has been registered in the German Clinical Trial Registry on February 8th 2019 (DRKS-ID: DRKS00016653).

CRediT authorship contribution statement

Benjamin Kass: Methodology, Formal analysis, Data curation, Writing – original draft, Methodology, Visualization. **Stephanie Roll:** Validation, Writing – review & editing. **Marie Bolster:** Validation, Writing – review & editing. **Michaela Heinrich-Rohr:** Writing – review & editing. **Lars Kuchinke:** Investigation, Writing – review & editing, Project administration, Funding acquisition. **Christiane Ludwig-Körner:** Investigation, Writing – review & editing. **Franziska Schlensog-Schuster:** Investigation, Writing – review & editing. **Julia Fricke:** Writing – review & editing. **Anne Berghöfer:** Validation, Writing – review & editing, Project administration. **Thomas Keil:** Writing – review & editing, Project administration. **Thomas Reinhold:** Conceptualization, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.childyouth.2023.107373.

References

Arifin, S. R. M., Cheyne, H., & Maxwell, M. (2018). Review of the prevalence of postnatal depression across cultures. *AIMS Public Health, 5*(3), 260–295. https://doi.org/10.3934/publichealth.2018.3.260

Bauer, A., Knapp, M., & Parsonage, M. (2016). Lifetime costs of perinatal anxiety and depression. *Journal of Affective Disorders, 192*, 83–90. https://doi.org/10.1016/j.jad.2015.12.005

Blümel, M., Spranger, A., Achstetter, K., Maresso, A., & Busse, R. (2020). Germany: health system review. *Health Systems in Transition, 22*(6), 1–272.

Bock, J. O., Brettschneider, C., Seidl, H., Bowles, D., Holle, R., Greiner, W., & König, H. H. (2015). Ermittlung standardisierter Bewertungssätze aus gesellschaftlicher Perspektive für die gesundheitsökonomische Evaluation. [Calculation of Standardised Unit Costs from a Societal Perspective for Health Economic Evaluation]. *Gesundheitswesen, 77*(01), 53–61.

Brennan, P. A., Hammen, C., Andersen, M. J., Bor, W., Najman, J. M., & Williams, G. M. (2000). Chronicity, severity, and timing of maternal depressive symptoms: Relationships with child outcomes at age 5. *Developmental Psychology, 36*(6), 759–766. https://doi.org/10.1037/0012-1649.36.6.759

Brown, C. C., Adams, C. E., George, K. E., & Moore, J. E. (2021). Mental health conditions increase severe maternal morbidity By 50 percent and cost $102 million yearly in the United States. *Health Aff (Millwood), 40*(10), 1575–1584. https://doi.org/10.1377/hlthaff.2021.00759

Buschhorn, C. (2012). *Frühe Hilfen: Versorgungskompetenz und Kompetenzüberzeugung von Eltern*. Springer-Verlag.

Calvano, C., Engelke, L., Di Bella, J., Kindermann, J., Renneberg, B., & Winter, S. M. (2022). Families in the COVID-19 pandemic: Parental stress, parent mental health and the occurrence of adverse childhood experiences-results of a representative survey in Germany. *European Child & Adolescent Psychiatry, 31*(7), 1–13. https://doi.org/10.1007/s00787-021-01739-0

Chojenta, C., William, J., Martin, M. A., Byles, J., & Loxton, D. (2019). The impact of a history of poor mental health on health care costs in the perinatal period. *Archives of Women's Mental Health, 22*(4), 467–473. https://doi.org/10.1007/s00737-018-0912-4

Chung, J., & Monroe, G. S. (2003). Exploring Social Desirability Bias. *Journal of Business Ethics, 44*(4), 291–302. https://doi.org/10.1023/A:1023648703356

Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *The British Journal of Psychiatry, 150*, 782–786.

Dagher, R. K., McGovern, P. M., Dowd, B. E., & Gjerdingen, D. K. (2012). Postpartum Depression and Health Services Expenditures Among Employed Women. *Journal of Occupational and Environmental Medicine, 54*(2), 210–215.

Davenport, M. H., Meyer, S., Meah, V. L., Strynadka, M. C., & Khurana, R. (2020). Moms Are Not OK: COVID-19 and Maternal Mental Health. *Front Glob Womens Health, 1*, 1. https://doi.org/10.3389/fgwh.2020.00001

Dennis, C. L., Falah-Hassani, K., & Shiri, R. (2017). Prevalence of antenatal and postnatal anxiety: Systematic review and meta-analysis. *The British Journal of Psychiatry, 210*(5), 315–323. https://doi.org/10.1192/bjp.bp.116.187179

Diem-Wille, G. (2014). *Young children and their parents: Perspectives from psychoanalytic infant observation*. London: Karnac.

Eickhorst, A., Schreier, A., Brand, C., Lang, K., Liel, C., Renner, I., … Sann, A. (2016). Knowledge and use of different support programs in the context of early prevention in relation to family-related psychosocial burden. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz, 59*(10), 1271–1280. https://doi.org/10.1007/s00103-016-2422-8

Ford, E., Roomi, H., Hugh, H., & van Marwijk, H. (2019). Understanding barriers to women seeking and receiving help for perinatal mental health problems in UK general practice: Development of a questionnaire. *Primary Health Care Research & Development, 20*, e156.

Fricke, J., Bolster, M., Ludwig-Körner, C., Kuchinke, L., Schlensog-Schuster, F., Vienhues, P., … Keil, T. (2020). Occurrence and determinants of parental psychosocial stress and mental health disorders in parents and their children in early childhood: Rationale, objectives, and design of the population-based SKKIPPI cohort study. *Social Psychiatry and Psychiatric Epidemiology*. https://doi.org/10.1007/s00127-020-02004-6

Giallo, R., D'Esposito, F., Cooklin, A., Mensah, F., Lucas, N., Wade, C., & Nicholson, J. M. (2013). Psychosocial risk factors associated with fathers' mental health in the postnatal period: Results from a population-based study. *Social psychiatry and psychiatric epidemiology, 48*, 563–573.

Gregori, D., Petrinco, M., Bo, S., Desideri, A., Merletti, F., & Pagano, E. (2011). Regression models for analyzing costs and their determinants in health care: An

introductory review. *International Journal for Quality in Health Care, 23*(3), 331–341. https://doi.org/10.1093/intqhc/mzr010
Groß, S., Reck, C., Thiel-Bonney, C., & Cierpka, M. (2013). Empirische Grundlagen des Fragebogens zum Schreien, Füttern und Schlafen (SFS). *Prax. Kinderpsychol. Kinderpsychiat., 62*, 327–347.
Hadfield, H., & Wittkowski, A. (2017). Women's Experiences of Seeking and Receiving Psychological and Psychosocial Interventions for Postpartum Depression: A Systematic Review and Thematic Synthesis of the Qualitative Literature. *Journal of Midwifery & Women's Health, 62*(6), 723–736. https://doi.org/10.1111/jmwh.12669
Hurrelmann, K., Klinger, J., & Schaeffer, D. (2020). Gesundheitskompetenz der Bevölkerung in Deutschland: Vergleich der Erhebungen 2014 und 2020. In *Interdisziplinäres Zentrum für Gesundheitskompetenzforschung (IZGK)*. Bielefeld: Universität Bielefeld. https://doi.org/10.4119/unibi/2950303.
Insan, N., Weke, A., Forrest, S., & Rankin, J. (2022). Social determinants of antenatal depression and anxiety among women in South Asia: A systematic review & meta-analysis. *PLoS One1, 17*(2), e0263760.
Löwe, B., Wahl, I., Rose, M., Spitzer, C., Glaesmer, H., Wingenfeld, K., … Brahler, E. (2010). A 4-item measure of depression and anxiety: Validation and standardization of the Patient Health Questionnaire-4 (PHQ-4) in the general population. *Journal of Affective Disorders, 122*(1–2), 86–95. https://doi.org/10.1016/j.jad.2009.06.019
Lyubenova, A., Neupane, D., Levis, B., Wu, Y., Sun, Y., He, C., … Thombs, B. D. (2021). Depression prevalence based on the Edinburgh Postnatal Depression Scale compared to Structured Clinical Interview for DSM DIsorders classification: Systematic review and individual participant data meta-analysis. *International Journal of Methods in Psychiatric Research, 30*(1), e1860.
Martini, J., Petzoldt, J., Knappe, S., Garthus-Niegel, S., Asselmann, E., & Wittchen, H. U. (2017). Infant, maternal, and familial predictors and correlates of regulatory problems in early infancy: The differential role of infant temperament and maternal anxiety and depression. *Early Human Development, 115*, 23–31. https://doi.org/10.1016/j.earlhumdev.2017.08.005
Masters, G. A., Li, N., Lapane, K. L., Liu, S. H., Person, S. D., & Byatt, N. (2020). Utilization of Health Care Among Perinatal Women in the United States: The Role of Depression. *Journal of Women's Health (2002), 29*(7), 944–951. https://doi.org/10.1089/jwh.2019.7903
Mattheß, J., Eckert, M., Richter, K., Koch, G., Reinhold, T., Vienhues, P., … Kuchinke, L. (2020). Efficacy of Parent-Infant-Psychotherapy with mothers with postpartum mental disorder: Study protocol of the randomized controlled trial as part of the SKKIPPI project. *Trials, 21*(1), 490. https://doi.org/10.1186/s13063-020-04443-7
Mihaylova, B., Briggs, A., O'Hagan, A., & Thompson, S. G. (2011). Review of statistical methods for analysing healthcare resources and costs. *Health Economics, 20*(8), 897–916. https://doi.org/10.1002/hec.1653
Mikolajczak, M., & Roskam, I. (2018). A Theoretical and Clinical Framework for Parental Burnout: The Balance Between Risks and Resources (BR(2)). *Frontiers in Psychology, 9*, 886. https://doi.org/10.3389/fpsyg.2018.00886
Moran, P. S., Wuytack, F., Turner, M., Normand, C., Brown, S., Begley, C., & Daly, D. (2020). Economic burden of maternal morbidity - A systematic review of cost-of-illness studies. *PLoS One1, 15*(1). https://doi.org/10.1371/journal.pone.0227377
Nationales Zentrum Frühe Hilfen. (2016). Leitbild Frühe Hilfen - Beitrag des NZFH-Beirats. Retrieved from Köln.
Pollack, L. M., Chen, J., Cox, S., Luo, F., Robbins, C. L., Tevendale, H. D., . . . Ko, J. Y. (2022). Healthcare Utilization and Costs Associated With Perinatal Depression Among Medicaid Enrollees. *Am J Prev Med, 62*(6), e333-e341. doi:10.1016/j.amepre.2021.12.008.
R Core Team. (2022). R: A language and environment for statistical computing. Retrieved from https://www.R-project.org/.
Reck, C., Nonnenmacher, N., & Zietlow, A. L. (2016). Intergenerational Transmission of Internalizing Behavior: The Role of Maternal Psychopathology, Child Responsiveness and Maternal Attachment Style Insecurity. *Psychopathology, 49*(4), 277–284. https://doi.org/10.1159/000446846
Reck, C., Van Den Bergh, B., Tietz, A., Müller, M., Ropeter, A., Zipser, B., & Pauen, S. (2018). Maternal avoidance, anxiety cognitions and interactive behaviour predicts infant development at 12 months in the context of anxiety disorders in the postpartum period. *Infant Behavior and Development, 50*, 116–131.
Roskam, I., Aguiar, J., Akgun, E., Arikan, G., Artavia, M., Avalosse, H., … Mikolajczak, M. (2021). Parental burnout around the globe: A 42-country study. *Affective Science, 2*(1), 58–79. https://doi.org/10.1007/s42761-020-00028-4
Roskam, I., Brianda, M. E., & Mikolajczak, M. (2018). A Step Forward in the conceptualization and measurement of parental burnout: The parental burnout assessment (PBA). *Frontiers in Psychology, 9*, 758. https://doi.org/10.3389/fpsyg.2018.00758
Salzmann, D., Fullerton, B., & Sann, A. (2021). Kenntnis und Inanspruchnahme von Präventionsangeboten in der frühen Kindheit in Abhängigkeit vom Bildungsstand der Eltern. Faktenblatt 3 zur Prävalenz- und Versorgungsforschung der Bundesinitiative Frühe Hilfen. In. Köln.
Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., . . . Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry, 59 Suppl 20*, 22-33;quiz 34-57.
Sidor, A., Fischer, C., & Cierpka, M. (2017). The link between infant regulatory problems, temperament traits, maternal depressive symptoms and children's psychopathological symptoms at age three: A longitudinal study in a German at-risk sample. *Child and Adolescent Psychiatry and Mental Health, 11*(1), 10. https://doi.org/10.1186/s13034-017-0148-5
Sprengeler, M. K., Mattheß, J., Eckert, M., Richter, K., Koch, G., Reinhold, T., … Schlensog-Schuster, F. (2021). Efficacy of parent-infant psychotherapy compared to care as usual in children with regulatory disorders in clinical and outpatient settings: Study protocol of a randomised controlled trial as part of the SKKIPPI project. *BMC Psychiatry, 21*(1), 118. https://doi.org/10.1186/s12888-021-03112-6
Stein, A., Pearson, R. M., Goodman, S. H., Rapa, E., Rahman, A., McCallum, M., … Pariante, C. M. (2014). Effects of perinatal mental disorders on the fetus and child. *Lancet, 384*(9956), 1800–1819. https://doi.org/10.1016/S0140-6736(14)61277-0
Suárez, N., Núñez, J. C., Cerezo, R., Rosário, P., & Rodríguez, C. (2022). Psychometric Properties of Parental Burnout Assessment and Prevalence of Parental Burnout: A Person-Centered Approach. *International Journal of Clinical and Health Psychology, 22*(1), Article 100280. https://doi.org/10.1016/j.ijchp.2021.100280
Tripepi, G., Jager, K. J., Dekker, F. W., & Zoccali, C. (2010). Selection bias and information bias in clinical research. *Nephron Clinical Practice, 115*(2), c94-c99.
UNESCO. (2012). International standard classification of education: ISCED 2011. *Comparative Social Research, 30*.
Verbeke, E., Bogaerts, A., Nuyts, T., Crombag, N., & Luyten, J. (2022). Cost-effectiveness of mental health interventions during and after pregnancy: A systematic review. *Birth*. https://doi.org/10.1111/birt.12623